Aug. 4, 1942. C. R. CRAIG 2,292,058

FUSE

Filed Sept. 17, 1941

Fig. 1.

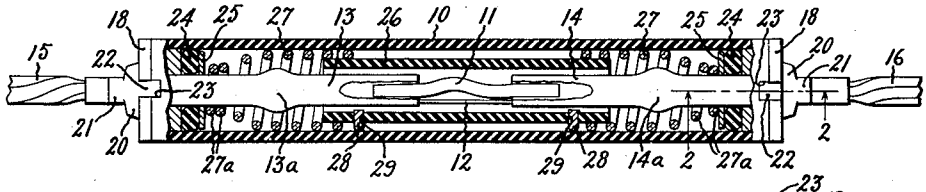



Fig. 2.

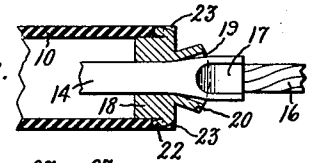



Fig. 3.

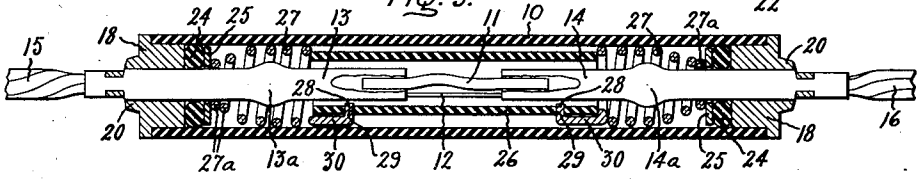



Fig. 4.

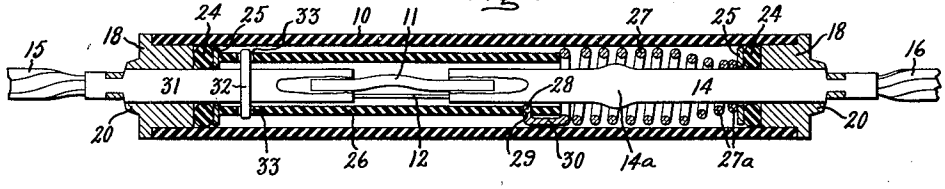



Fig. 5.

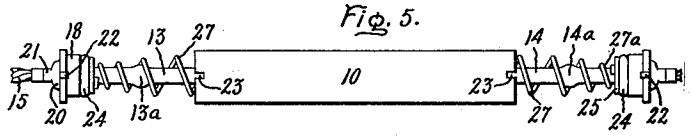



Fig. 6.

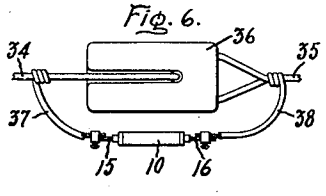
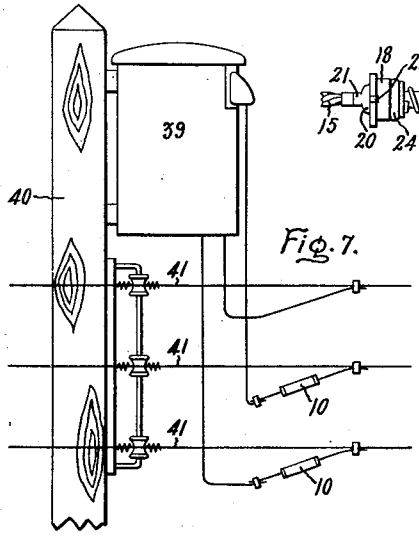



Fig. 7.




Inventor:
Charles R. Craig,
by Harry E. Dunham
His Attorney.

Patented Aug. 4, 1942 2,292,058

# UNITED STATES PATENT OFFICE

2,292,058

## FUSE

Charles R. Craig, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

Application September 17, 1941, Serial No. 411,133

15 Claims. (Cl. 200—117)

My invention relates generally to circuit-interrupting apparatus, such as secondary fuses, and specifically is an improvement on the fuse construction disclosed and claimed in United States Letters Patent 2,172,226, granted September 5, 1939, upon an application of S. R. Smith, and assigned to the same assignee as the present application.

Secondary fuses are used very extensively in connection with the distribution of electrical energy through overhead secondaries. They are usually used to bridge across insulators, such as of the strain type, between transformer sections. Also, they are often used directly to connect distribution transformer secondaries to the secondary lines and to isolate service entrance faults.

An object of my invention is to provide an improved secondary fuse which has satisfactory means for indicating when the fuse has blown, which is completely sealed against moisture in the unblown condition to prevent deterioration thereof, which upon interruption of the circuit prevents mechanical separation of the parts thereof, thereby preventing the dangling of conductors so as to interfere with the operation of other adjacent sound conductors, or cause secondary short circuits to adjacent grounded parts, and which is simple and sturdy in construction so that, among other things, twisting of the fuse link in handling or when swayed in service by the wind cannot occur.

A further object of my invention is to provide a new and improved low-cost fuse construction particularly suited for but not necessarily limited to outdoor installations, such as on overhead secondary distribution lines.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 is a diagrammatic view partly in section of a fuse construction embodying my invention; Fig. 2 is a view taken on line 2—2 of Fig. 1, Figs. 3 and 4 are sectional views somewhat similar to Fig. 1 of modifications of my invention; Fig. 5 is a schematic diagram illustrating the blown condition of a fuse embodying my invention, and Figs. 6 and 7 are diagrammatic showings of applications of my invention.

Referring to Fig. 1 of the drawing, I have illustrated an open-ended tubular casing or cylinder 10 of insulating material preferably weatherproof which is adapted to form part of a housing for a fuse link. Any suitable form of fuse link may be utilized in connection with my invention and, as shown in Fig. 1, the fuse link has a fusible section which is disposed within cylinder or casing 10 and is comprised of a relatively low melting point wire 11 and a strain wire 12 connected to and extending between a pair of terminal sleeves 13 and 14. The terminal sleeves 13 and 14 are spaced from one another at their inner adjacent ends to provide a gap across which the fusible section is connected. The outer ends of the terminal sleeves 13 and 14, which are adapted to project from the opposite ends of the tubular casing 10, are connected to flexible leads 15 and 16, respectively, by crimping or swaging, as indicated at 17, best shown in Fig. 2.

Each of the open ends of tubular casing 10 through which the outer ends of terminal sleeves 13 and 14 protrude is preferably closed by a closure member or stopper 18 formed of a suitable metal and having an opening 19 therein through which terminal sleeves 13 or 14 may extend. Closure members 18 each have a cylindrical body portion which fits into the bore of casing 10 and also an outer peripheral flange which has the same diameter as casing 10 and bears against the end thereof. Each closure member 18 is also provided with an integral collar portion 20 surrounding the opening 19 through which the terminal sleeves 13 or 14 may extend, which collar is adapted to be crimped or swaged as indicated at 21 in Fig. 1 to the terminal sleeves 13 or 14, for a purpose to be described in greater detail hereinafter. The peripheral flange of the closure or stopper member 18 is provided with a plurality of tabs or lugs 22 which, in the assembled fuse as shown in Fig. 1, fit into cooperating notches 23 formed in the ends of tubular casing 10, thereby preventing the fuse link from being twisted in handling or when swayed in service by the wind.

In order to seal the ends of tubular casing 10 against the entrance of moisture, each end is provided with a toroidal packing washer 24 formed of a resilient compressible material and a fiber or other suitable bearing washer 25 annular in shape, both of which are adapted to be slipped over either of the terminal sleeves 13 or 14 so that the packing washer 24 is adjacent closure member 18 and the bearing washer 25 is on the inner side of toroidal washer 24 relative to casing 10 to serve as a bearing member for

the compressive force applied to the packing washer 24 to be described hereinafter.

In order to aid in extinguishing the arc formed upon rupture of the fusible section 11 and strain wire 12 of the fuse link, I provide an inner sleeve or cylinder of insulating material 26 which is preferably formed of a material such as horn fiber or the like which emits gas when subjected to the heat of an electric arc. Inner cylinder or sleeve 26 is positioned centrally within tubular casing 10 of Fig. 1 to enclose the fusible section of the fuse link and is held in this position by a pair of coiled compression springs 27 each fastened to one end thereof. The coils at the adjacent ends of springs 27 preferably have such a diameter as closely to encircle the respective ends of inner sleeve 26. Furthermore, the ends of springs 27 which encircle sleeve 26 are each bent radially inward to form a locking portion 28 for engagement with a cooperating opening 29 in each end of inner sleeve 26. The outer ends of springs 27 are adapted to bear against bearing washers 25 so that when the fuse device is assembled, packing washers 24 will be compressed to seal the ends of tubular casing 10 in a moisturetight manner. The round cross section of the toroidal packing washers 24 facilitates deformation and radial expansion thereof into sealing engagement with the terminal sleeves 13 and 14 and the inner wall of tubular casing 10. As in the above mentioned Letters Patent, the expanisve force of the packing washers 24 against the end closures 18 imposes a tension upon the fuse link and the tensioned fuse link, in turn, maintains the packing washers under compression. Coil spring means 27 serve to maintain substantially constant tension on the fusible section of the fuse link regardless of any setting of the packing washers and of any creeping or straightening out of the strain wire which may occur during or after final assembly of the fuse device.

In order to prevent the terminal sleeves 13 and 14 from being blown out of tubular casing 10 upon interruption of the circuit by rupture of fusible element 11 thereby to prevent dangling of the conductors 15 and 16 which might swing across other live conductors and cause short circuits or the like as well as to prevent hot parts of the apparatus from falling to the ground, each of the terminal sleeves 13 and 14 is provided with an enlarged portion 13*a* and 14*a*, respectively. Also, the end turns 27*a* of coiled compression springs 27, which are remote from one another when positioned within tubular casing 10, are of a reduced diameter relative to the remaining turns of these springs so as to slide over terminal sleeves 13 and 14 readily but constructed to engage the enlargements 13*a* or 14*a*, respectively, upon rupture of the fusible element. Upon such rupture of the fusible section of the fuse link, the terminal sleeves 13 and 14 are forced out of tubular casing 10 by the compressive force of packing washers 24 and springs 27 as well as by the expulsive forces of the gases formed within inner sleeve 26 when subjected to the heat of the arc upon rupture of the fusible section of the fuse link. However, as soon as the terminal sleeves 13 and 14 have moved out of tubular casing 10 to the position indicated in Fig. 5, the end turns 27*a* of reduced diameter engage the enlargements 13*a* and 14*a* of terminal sleeves 13 and 14, respectively. Since the locking portions 28 at the inner ends of springs 27 are hooked in the cooperating openings 29 of inner sleeve 26, electrical separation of terminal sleeves 13 and 14 is permitted but mechanical separation thereof is prevented. Furthermore, the protrusion of one or more of the springs 27 from tubular casing 10 provides an excellent visual indicating means of the blown condition of the fuse requiring replacement.

In the assembly of the fuse device of Figs. 1 and 2, the component elements above described are arranged as illustrated with one of the terminal sleeves crimped to one of the associated flexible cables and with the corresponding closure member 18 also crimped thereto. The desired tension is then applied to the fuse link to maintain the packing members 24 under the desired sealing compression and the other terminal sleeve and closure member 18 are crimped or swaged to hold the structure in the manner indicated in Fig. 1 with the tabs or lugs 22 engaging the notches 23 in the tubular casing 10 to prevent twisting of the fuse link.

In the fuse device disclosed in Fig. 1, it is practically impossible for the spring means 27 to become unhooked from sleeve 26 to permit mechanical separation of terminal sleeves 13 and 14 upon blowing of the fuse because of the fact that, in addition to locking portions 28 being inserted in openings 29 in sleeve 26, the end turns of coil springs 27 closely encircle sleeve 26.

In Fig. 3 I have disclosed a fuse device which is identical in every respect with the fuse of Fig. 1 except for the manner in which the coiled compression springs 27 are attached to inner sleeve 26. The corresponding parts of Fig. 3 are designated by the same reference numerals as in Figs. 1 and 2. Instead of the end turns of coiled compression springs 27 encircling sleeve 26 as in Fig. 1, the ends of these springs are bent to form short straight portions 30 parallel to the spring axis, the ends of which are again bent radially to form the locking portion 28 as in Fig. 1. With this construction, the springs 27 can be more readily fastened to sleeve 26, thereby reducing the assembly cost. The operation of the fuse construction in Fig. 3 is in other respects identical with that of Fig. 1 and will be readily understood by those skilled in the art in view of the detailed description included above.

In Fig. 4, I have disclosed a fuse device in which only a single compression spring is used, and the corresponding parts of Fig. 4 are designated by the same reference numerals as in Figs. 1 and 3. In this case, however, a terminal sleeve 31 is provided in place of the terminal sleeve 13 which is somewhat shorter and which has no enlargement such as 13*a* thereon. Terminal sleeve 31 is pinned to inner sleeve 26 by pin means 32 which engages cooperating openings 33 in inner sleeve 26. In this case, if desired, the single compression spring 27 may be made somewhat longer than the springs 27 of Figs. 1 and 3 although this is not essential. As in Figs. 1 and 3, the packing washers 24 together with compression spring 27 provide the tension means for the fuse link, the openings 33 allowing some longitudinal movement of sleeve 26 with respect to terminal sleeve 31, and the tension of the fuse link holds the resilient packing washers in sealing engagement. The fuse of Fig. 4 is preferably constructed so that the terminal sleeve 14 including the spring 27 is forced out of casing 10 upon blowing of the fusible element much more readily than the end of the fuse device which is pinned to the inner sleeve 26. Furthermore, the point of fastening spring 27 to inner sleeve 26

remains within the casing in the construction of Fig. 4 in the same manner as is disclosed in Fig. 5 so that unhooking of the spring from the sleeve is prevented. The operation of the fuse device of Fig. 4 will be obvious to those skilled in the art and no further discussion thereof will be included herewith.

The constructions hereinbefore described provide extremely low-cost fuse units which may be supplied to operating companies for quick and easy installation on overhead lines in various ways, two of which are illustrated for example in Figs. 6 and 7. In the arrangement shown in Fig. 6, line conductors 34 and 35 are fastened to a strain insulator 36 in a well-known manner so as to leave the ends 37 and 38, respectively, of the conductors free for connection to the flexible leads 15 and 16 of a fuse device such as shown in Figs. 1 to 5 which is diagrammatically illustrated and labeled with the casing designation 10.

In Fig. 7 is another typical installation for which the secondary fuses of the type disclosed above are particularly adaptable. In this case, there is shown a transformer 39 supported by a suitable element, such as a wooden pole 40, also supporting secondary power lines 41 in a well-known manner. The transformer 39 is electrically connected to the power lines 41 and the live legs of the transformer secondary winding are connected through secondary fuses which are diagrammatically illustrated and labeled with the casing designation 10.

As will be evident from the foregoing construction, the fuse devices of the present invention are of such weather-tight construction that they may be installed in any position without danger of entrance of moisture into the casing or housing thereof to cause corrosion or damage of the internal fuse parts. This fuse, furthermore, is constructed so as to permit electrical but not mechanical separation of the associated conductors so as not to cause short circuits with other adjacent sound conductors or grounded parts. In addition, this fuse construction has suitable means for indicating the condition thereof and is simple and sturdy in construction, including, among other things, means for preventing twisting of the fuse link either by handling or when swayed in service by the wind.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a fuse device, a pair of conductors in spaced relation interconnected by fusible means, an enlargement on one of said conductors, a protecting means for said fusible means including an outer cylinder of insulating material, an inner sleeve of insulating material, means including a coiled compression spring having turns of reduced diameter at one end thereof mounted to surround said conductor having said enlargement thereon and operatively connected for imposing tension on said fusible means during the unblown condition of said fuse device, and means including mechanical connections through said inner sleeve and the other end of said coiled spring so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement on said conductor whereby a mechanical but not an electrical connection is maintained to prevent dangling of said conductors upon operation of said fuse device.

2. In a fuse device, a pair of conductors in spaced relation interconnected by fusible means, an enlargement on one of said conductors, a protecting means for said fusible means including an outer cylinder of insulating material, an inner sleeve of insulating material, means including a coiled compression spring having turns of reduced diameter at one end thereof mounted to surround said conductor having said enlargement thereon and operatively connected for imposing tension on said fusible means during the unblown condition of said fuse device, means including mechanical connections through said inner sleeve and the other end of said coiled spring so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement of said conductor to permit electrical but not mechanical separation of said conductors, and means for preventing said fusible means from being twisted.

3. In a fuse device, a pair of conductors in spaced relation interconnected by fusible means, an enlargement on one of said conductors, a protecting means for said fusible means including an outer cylinder of insulating material, an inner sleeve of insulating material, means including a coiled compression spring having turns of reduced diameter at one end thereof mounted to surround closely said conductor having said enlargement thereon and operatively connected for imposing tension on said fusible means during the unblown condition of said fuse device, means including a mechanical connection through said inner sleeve and the other end of said coiled spring so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement of said conductor to permit electrical but not mechanical separation of said conductors, and means for substantially sealing said outer cylinder against the entrance of moisture during the unblown condition of said fuse device.

4. In a fuse device, a pair of conductors spaced apart at their inner adjacent ends to provide a gap, a fusible element bridging said gap and electrically connected at its opposite ends to said conductors, a strain wire connected to and extending between the inner adjacent edges of said conductors, an enlargement on one of said conductors, a protecting means for said fusible means including an outer cylinder of insulating material, an inner sleeve of insulating material, means including a coiled compression spring having turns of reduced diameter at one end thereof mounted to surround closely said conductor having said enlargement thereon and operatively connected for imposing tension on said fusible means during the unblown condition of said fuse device, and means including a mechanical connection through said inner sleeve and the other end of said coiled spring so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement on said conductor whereby a mechanical but not an electrical connection is maintained to prevent dangling of said conductors upon operation of said fuse device.

5. In a fuse device, a pair of conductors in spaced relation interconnected by fusible means, an enlargement on one of said conductors, a protecting means for said fusible means including

an outer cylinder of insulating material, an inner sleeve of insulating material, means including a coiled compression spring having turns of reduced diameter at one end thereof mounted to surround closely said conductor having said enlargement thereon and operatively connected for imposing tension on said fusible means during the unblown condition of said fuse device, and means including a mechanical connection through said inner sleeve and the other end of said coiled spring so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement of said conductor to permit electrical but not mechanical separation of said conductors, said coiled compression spring being maintained in a position where a portion thereof is extended from an end of said outer cylinder when said fusible means has ruptured so as to indicate the blown condition of said fuse device.

6. A fuse device comprising in combination, a weatherproof tubular casing, a pair of terminal sleeves interconnected by a fuse link having a fusible section mounted in said casing with the ends of said terminal sleeves extending outwardly respectively through openings at opposite ends of said casing, means operative normally to tension said fusible section and operative upon rupture of said fusible section to effect relative movement apart of said terminal sleeves and widening of the gap between the ruptured ends of said fusible section, and means including said last-mentioned means and an enlargement on one of said terminal sleeves for permitting electrical separation but preventing mechanical separation of said terminal sleeves to preclude dangling of the conductors associated with said fuse device upon rupture of the fusible section in said casing.

7. A fuse device comprising in combination a weatherproof tubular casing, a fuse link having a fusible section in said casing and connection portions extending outwardly respectively through openings at opposite ends of the casing, means including a coiled compression spring having turns of reduced diameter at one end thereof operative normally to tension said fusible section and operative upon rupture of the fusible section to effect relative movement apart of said connection portions and widening of the gap between the ruptured ends of the fusible section, and means including said turns of reduced diameter for permitting electrical but preventing mechanical separation of said connection portions upon rupture of said fuse link in said casing.

8. A fuse device comprising in combination a weatherproof tubular casing, a fuse link having a fusible section in said casing and connection portions extending outwardly respectively through openings at opposite ends of the casing, means including a coiled compression spring having turns of reduced diameter at one end thereof operative normally to tension said fusible section and operative upon rupture of the fusible section to effect relative movement apart of said connection portions and widening of the gap between the ruptured ends of the fusible section, means including said turns of reduced diameter for permitting electrical but preventing mechanical separation of said connection portions upon rupture of said fuse link in said casing, closure means for the openings in said casing including resilient packing means, and means operative under the influence of the tension of said fuse link to maintain said packing means normally compressed in substantially moistureproof sealing relationship to said openings.

9. A fuse device comprising in combination, a weatherproof tubular casing, a pair of terminal sleeves interconnected by a fuse link having a fusible section mounted in said casing with the ends of said terminal sleeves extending outwardly respectively through openings at opposite ends of said casing, means operative normally to tension said fusible section and operative upon rupture of said fusible section to effect relative movement apart of said terminal sleeves and widening of the gap between the ruptured ends of said fusible section, means including said last-mentioned means and an enlargement on one of said terminal sleeves for preventing mechanical separation of said terminal sleeves to prevent dangling of the conductors associated with said fuse device upon rupture of the fusible section in said casing, closure means for the openings in said casing including resilient packing means, and means operative under the influence of the tension of said fuse link to maintain said packing means normally compressed in substantially moistureproof sealing relationship to said openings.

10. A fuse device for outdoor installation comprising in combination, a weatherproof tubular casing, a pair of terminal sleeves interconnected by a fuse link having a fusible section mounted in said casing with the ends of said terminal sleeves extending outwardly respectively through openings at opposite ends of said casing, means operative normally to tension said fusible section and operative upon rupture of said fusible section to effect relative movement apart of said terminal sleeves and widening of the gap between the ruptured ends of said fusible section, means including said last-mentioned means and an enlargement on one of said terminal sleeves for preventing mechanical separation of said terminal sleeves to prevent dangling of the conductors associated with said fuse device upon rupture of the fusible section in said casing, and means for preventing the fuse link from being twisted in handling or when swaying in service by the wind.

11. A fuse device for outdoor installation comprising in combination a weatherproof tubular casing, a fuse link having a fusible section in said casing and connection portions extending outwardly respectively through openings at opposite ends of the casing, means including a coiled compression spring having turns of reduced diameter at one end thereof operative normally to tension said fusible section and operative upon rupture of the fusible section to effect relative movement apart of said connection portions and widening of the gap between the ruptured ends of the fusible section, means including said turns of reduced diameter for permitting electrical but preventing mechanical separation of said connection portions upon rupture of said fuse link in said casing, and means for preventing the fuse link from being twisted in handling or when swaying in service by the wind.

12. In a fuse device comprising a weatherproof tubular casing, an inner sleeve concentrically arranged within said casing and formed of a material of a gas-emitting nature when subjected to the heat of an electric arc, a pair of terminal sleeves interconnected by a fuse link having a fusible section mounted in said casing with the ends of said terminal sleeves extending outwardly respectively through openings at opposite ends of said casing, means operative normally to tension said fusible section and operative upon rupture of said fusible section to effect relative movement apart of said terminal sleeves and widening

of the gap between the ruptured ends of said fusible section, and means including said last-mentioned means and an enlargement on one of said terminal sleeves for permitting electrical separation but preventing mechanical separation of said terminal sleeves to preclude dangling of the conductors associated with said fuse device upon rupture of the fusible section in said casing.

13. In a fuse device comprising a weatherproof tubular casing, an inner sleeve concentrically arranged within said casing and formed of a material of a gas-emitting nature when subjected to the heat of an electric arc, a fuse link having a fusible section mounted in said sleeve in said casing and connection portions extending outwardly respectively through openings at opposite ends of said casing, means including a coiled compression spring having turns of reduced diameter at one end thereof and mechanically connected to said inner sleeve at the other end thereof operative normally to tension said fusible section and operative upon rupture of the fusible section to effect relative movement apart of said connection portions and widening of the gap between the ruptured ends of the fusible section, means including said turns of reduced diameter for permitting electrical but preventing mechanical separation of said connection portions upon rupture of said fuse link in said casing, and means for preventing the fuse link from being twisted in handling or when swaying in service by the wind.

14. In a fuse device, a pair of conductors in spaced relation interconnected by fusible means, an enlargement on one of said conductors, a protecting means for said fusible means including an outer cylinder of insulating material, and means adapted to interconnect mechanically said pair of conductors comprising an insulating member and a coiled compression spring hooked to said insulating member and having turns of reduced diameter at one end thereof mounted to surround closely said conductor having said enlargement thereon so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement on said conductors to permit electrical but not mechanical separation of said conductors.

15. In a fuse device, a pair of conductors in spaced relationship electrically interconnected by fusible means, an enlargement on one of said conductors, a protecting means for said fusible means including an outer cylinder of insulating material, and means adapted to interconnect mechanically said pair of conductors comprising an insulating member and a coiled compression spring hooked to said insulating member and having turns of reduced diameter at one end thereof mounted to surround closely said conductor having said enlargement thereon so that upon blowing of said fusible means said turns of reduced diameter engage said enlargement on said conductors to permit electrical but not mechanical separation of said conductors, said coils of said compression spring adjacent said insulating member being closely coiled around said insulating member to prevent unhooking of said spring from said member.

CHARLES R. CRAIG.