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3,483,501

ELECTRIC CARTRIDGE FUSE

Filed June 17, 1968

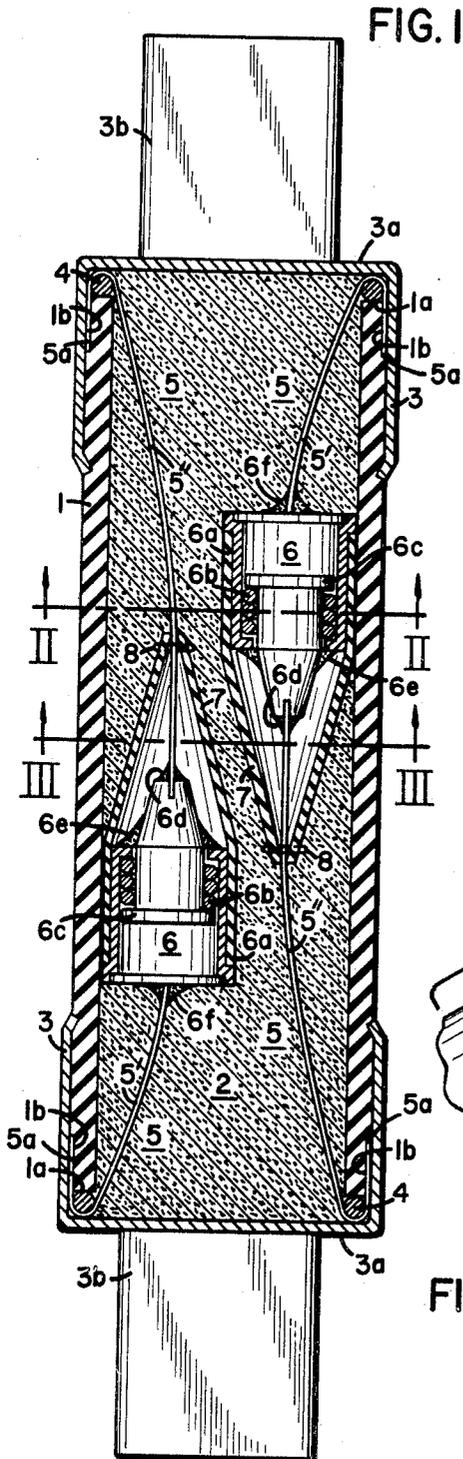


FIG. 1

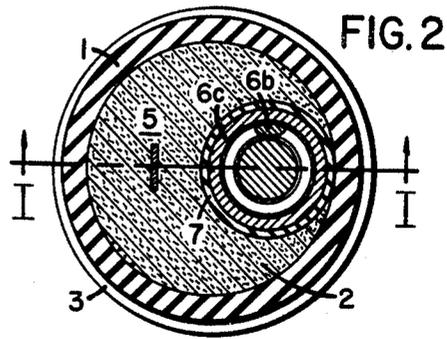


FIG. 2

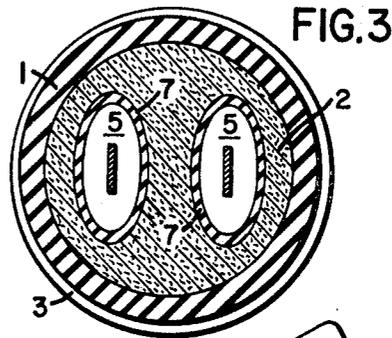


FIG. 3

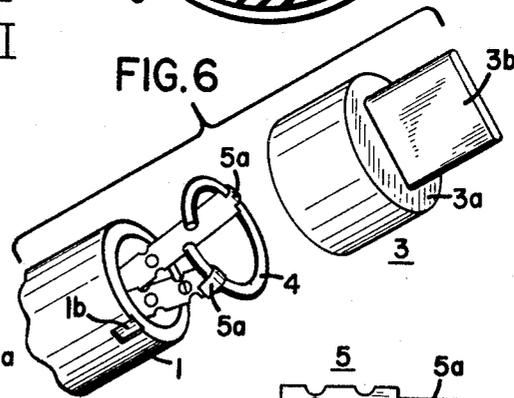


FIG. 4

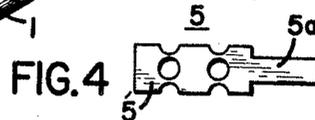


FIG. 5

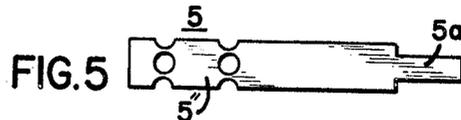


FIG. 6

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ELECTRIC CARTRIDGE FUSE

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6 Claims

ABSTRACT OF THE DISCLOSURE

An electric cartridge fuse has improved mechanical pressure contact means for establishing conductive connections between the terminal caps and a fusible ribbon element, thus avoiding soft solder joints, or similar joints, generally used for the above purpose. The fuse further includes a pair of overload-current-interrupting spring-biased switch means arranged to maximize the ability of the fuse to interrupt relatively small overload currents of inadmissible duration.

BACKGROUND OF INVENTION

In the past there have been many attempts to substitute mechanical pressure contact means for the conventional solder joints widely used for conductively connecting the ends of fusible ribbon elements to the terminal caps of a cartridge fuse. United States Patent 3,378,659 to P. C. Hitchcock, Apr. 16, 1968, for Cartridge Fuses discloses and claims a more recent invention relating to mechanical pressure contacts of the above description. The present invention is a solution to the problem of providing mechanical pressure contacts for the purpose under consideration which are less expensive and/or more reliable than comparable prior art pressure contacts.

The invention further solves the problem of providing compact overload interrupting devices of increased effectiveness and capable of operating with the degree of time lag required for protection of electric motors.

SUMMARY OF INVENTION

Electric fuses embodying this invention include a tubular casing of relatively soft insulating material and a pulverulent arc-quenching filler inside said casing. A pair of terminal caps is mounted on the casing and closes the axially outer ends thereof. Each of a pair of helical wire spring lock washers is interposed between one of the rims of the casing and the end surface of one of said pair of caps. Each of said pair of helical wire spring lock washers is axially compressed into a plane parallel to said end surface of each of said pair of caps. A fusible ribbon element means is arranged inside said casing and embedded in said arc-quenching filler. This fusible element means has a pair of axially outer end tabs each bent around one of said pair of helical wire spring lock washers into engagement with the outer surface of said casing. These end tabs form a pair of recesses in the outer surface of the casing of which each conforms with the shape of one of said pair of end tabs. Each of said pair of recesses forms jointly with one of said pair of end tabs a key means tending to preclude any rotary displacement of one of said pair of tabs relative to said casing.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is mainly a longitudinal section of a fuse embodying this invention taken along I—I of FIG. 2, certain portions thereof being shown in side elevation rather than sectionalized;

FIG. 2 is a section along II—II of FIG. 1;

FIG. 3 is a section along III—III of FIG. 1;

FIG. 4 is an elevation of one end of the fuse link means of FIG. 1;

FIG. 5 is an elevation of the other end of the fuse link means of FIG. 1; and

FIG. 6 is an exploded isometric view of one end of the structure of FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the drawings, numeral 1 has been applied to indicate a tubular casing of relatively soft insulating material. Relative softness of the material of casing 1 is an essential element of this invention. Casing 1 is preferably a tubing of convolutely wound paper. Hard fiber, or vulcanized fiber, is not suitable for reasons which will become more apparent as this description proceeds. Pulverulent arc-quenching filler 2 is arranged inside of casing 1. A pair of terminal caps 3 is mounted on casing 1 and closes the axially outer ends thereof. Each terminal cap 3 has a flat end surface 3a and a blade contact 3b projecting at right angles from end surface 3a. The axially inner ends of caps 3 are crimped into casing 1. If desired drive screws (not shown) may project through the sides of caps 3 into casing 1 to tie caps 3 more firmly to casing 1. Reference numeral 4 has been applied to indicate a pair of helical wire spring lock washers each interposed between one of the rims 1a of casing 1 and the end surface 3a of one of terminal caps 3. The cross-section of wire spring lock washers 4 is circular. This is of considerable importance as will be pointed out below more in detail. The ends of helical wire spring lock washers 4 are normally arranged in spaced relation in different planes which are parallel and at right angles to the central axis of the respective washer 4 (see FIG. 6). In addition thereto, the ends of helical wire spring lock washers are angularly displaced, and thus form a peripherally extending gap having a predetermined width. This has been clearly shown in FIG. 6. As shown in FIG. 1 each helical wire spring lock washer 4 is compressed between rims 1a and end surfaces 3a of caps 3 into planes parallel to end surfaces 3a of caps 3. The axial compression of washers 4 establishes a tendency to expand radially, thus establishing a considerable pressure between the radially outer surface of washers 4 and the radially inner surface of caps 3. The fuse structure shown further includes one or more fusible ribbon elements 5, preferably of silver, or copper. Fusible elements 5 are arranged inside of casing 1 and embedded in arc-quenching filler 2. Fusible ribbon elements 5 have axially outer end tabs 5a of which each is bent around one of washers 4 into engagement with the outer surface of casing 1. Since the cross-section of washers 4 is circular, the bends of tabs 5a have a predetermined radius equal to the radius of washers 4. This tends to preclude undesirable stresses in fusible ribbon elements 5 and tabs 5a. Such stresses occur always if fusible ribbon elements are subjected to sharp bends. Tabs 5a of fuse link means 5 are pressed by lock washers 4 under considerable pressure radially outwardly into film engagement with caps 3. This established good contact pressure between parts 3 and 5a. Each tab 5a is pressed by caps 3 into the outer surface of casing 1 and forms rectangular recesses 1b therein. The formation of such recesses 1b occurs only if casing 1 is made of relatively soft insulating materials, e.g. if casing 1 is a tubing of convolutely wound paper. If casing 1 is a length of tubing of hard fiber, tabs 5a do not penetrate into its surface forming recesses 1b therein and tabs 5a do not establish key means precluding rotary displacement thereof. Each recess 1b conforms with the shape of one of tabs 5a, since recesses 1b are formed by pressing tabs 5a by means of caps 3 radially inwardly into the outer surface of casing 1. As is apparent from the above

recesses 1b and cooperating tabs 5a jointly form key means tending to preclude a rotary displacement of tabs 5a relative to casing 1.

The width of the portion of tabs 5a pressed into the outer surface of casing 1 is less than the width of fusible elements 5 at the points of largest cross-section thereof. This tends to maintain the portion of end tabs 5a inside recesses 1b in the outer surface of casing 1. FIGS. 4 and 5 show the ends of multiperforated fusible elements 5 including end tabs 5a whose width is less than the portions of fusible elements 5 at the points of largest width.

Each fusible ribbon element 5 comprises a pair of axially spaced sections 5' and 5'' of which the former are relatively short, and the latter are relatively long. An overload interrupting device generally indicated by reference character 6 is interposed between sections 5' and 5''. The overload interrupting device 6 is preferably of the type disclosed and claimed in United States Patent 2,321,711 to Elmer H. Taylor, June 18, 1943, for Fusible Electric Protective Device. It includes a spring housing 6a, a helical spring 6b arranged therein, a plunger 6c under the bias of said spring 6b, a first solder joint 6d conductively connecting plunger 6c and fusible element section 5'', a second solder joint 6e conductively connecting plunger 6c and spring housing 6a and a third solder joint 6f conductively connecting spring housing 6a and fusible element section 5'. Solder joints 6d and 6e have a relatively low softening point and solder joint 6f has a relatively high fusing point. Plungers 6c are provided with slots engaged by link sections 5'' and secured therein by solder joints 6d. The structure of FIG. 1 establishes two parallel current paths. As seen in FIG. 1, one of these current paths includes upper cap 3, upper link section 5'', left overload interrupting device 6, lower link section 5' and lower cap 3. The other current path includes upper cap 3, right link section 5', right overload interrupting device 6, right link section 5'' and lower cap 3.

It has been found that it is preferable to provide in a fuse a plurality of parallel connected ribbon fuse link means for interrupting major fault currents of which each includes a spring-biased normally solder-locked overload switching device for interrupting overload currents such as disclosed, for instance, in the above Taylor patent. It is, however, extremely difficult to accommodate in a casing, or fuse tube, of standard size side by side two or more solder-locked overload interrupting devices as, for instance, overload devices of the type disclosed in the above Taylor patent. The structure shown in FIG. 1 overcomes these difficulties.

As shown in FIG. 1 the left overload interrupting device 6 has a relatively large axial spacing from upper cap 3 and a relatively small axial spacing from lower cap 3. On the other hand, the right overload interrupting device 6 has a relatively small axial spacing from the upper cap 3 and a relatively large axial spacing from lower cap 3. The plunger 6c of the left overload interrupting device 6 is connected to upper cap 3 by means of the relatively long ribbon fuse link means, or fuse link section 5'', and the spring housing 6a of the left overload interrupting device 6 is conductively connected to the lower cap 3 by means of the relatively short ribbon fuse link means, or fuse link section 5'. The plunger 6c of the right overload interrupting device 6 is conductively connected to the lower cap 3 by the relatively long ribbon fuse link means, or fuse link section 5'' and the spring housing 6a of the right overload interrupting device 6 is conductively connected to the upper cap 3 by means of the relatively short fuse link means, or fuse link section 5'. Springs 6b bias plungers 6c in opposite directions.

On occurrence of relatively small overloads of inadmissible duration the solder joints 6d between plungers 6c and fuse link means 5' and the solder joints 6e between parts 6a, 6c soften, and plungers move under the action of their biasing springs 6b in opposite directions, thus form-

ing a pair of breaks between plungers 6c and fuse link means 5'' which are spaced axially from each other. Consequently the arc energy resulting from kindling of a pair of parallel arcs is generated at two axially spaced points of the fuse structure. This greatly facilitates the dissipation of the arc energy.

It is preferable to interrupt low current arcs, i.e., arcs resulting from the formation of a break in an overloaded circuit—as distinguished from a short-circuited circuit—in air rather than inside of a pulverulent arc-quenching filler. This is particularly true if quartz sand is used as pulverulent arc-quenching filler in the interest of maximizing the interrupting capacity under short-circuit current conditions, or major fault current conditions. In view of these facts the structure shown in FIG. 1 includes means for precluding access of the pulverulent arc-quenching filler 2 to the breaks formed upon softening of solder joints 6d, 6e and parting of plungers 6c from fuse link means 5''. To achieve this end the spring housing 6a of each overload interrupting device 6 includes a tubular sleeve-shaped member 7 of insulating material. The axially outer ends of sleeve-shaped members 7 are plugged by spring housings 6a, and the axially inner ends of sleeve-shaped members 7 are squashed and permanently closed by an appropriate fastener 8, e.g., a staple.

On occurrence of major fault currents each fuse link means 5', 5'' forms two breaks each at a point of reduced cross-sectional area formed by perforations therein. On occurrence of overloads of inadmissible duration solder joints 6d, 6e, soften, allowing plungers 6c to move in opposite directions under the action of helical springs 6b.

It will be understood that I have illustrated and described a preferred embodiment of the invention, and that various alterations may be made in the details thereof without departing from the invention as defined in the appended claims.

I claim as my invention:

1. An electric cartridge fuse including:

- (a) a tubular casing of relatively soft insulating material;
- (b) a pulverulent arc-quenching filler inside said casing;
- (c) a pair of terminal caps mounted on said casing and closing the axially outer ends thereof;
- (d) a pair of helical wire spring lock washers each interposed between one of the rims of said casing and the end surface of one of said pair of caps, each of said pair of helical wire spring lock washers being axially compressed into a plane parallel to said end surface of each of said pair of caps;
- (e) fusible ribbon element means inside said casing embedded in said arc-quenching filler and having axially outer end tabs bent around said pair of helical wire spring lock washers into engagement with the outer surface of said casing, said end tabs being pressed by said pair of caps into the outer surface of said casing and forming recesses therein, each of said recesses conforming with the shape of said end tabs and each of said recesses forming jointly with one of said end tabs a key means tending to preclude a rotary displacement of one of said end tabs relative to said casing.

2. An electric cartridge fuse as specified in claim 1 wherein said tubular casing of relatively soft insulating material includes a tubing of convolutely wound paper.

3. An electric cartridge fuse as specified in claim 1 wherein the width of the portion of each of said pair of end tabs pressed into said outer surface of said casing is less than the width of the said fusible ribbon element at the points of the largest width thereof.

4. An electric fuse as specified in claim 1 including a pair of fusible element means conductively interconnecting said pair of caps; a pair of overload interrupting devices each inserted into one of said pair of fusible elements; a pair of plungers each in one of said pair of overload interrupting devices and each normally held in posi-

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tion by solder joint means; a pair of springs each biasing one of said pair of plungers and each of said pair of springs being arranged to bias said pair of plungers in opposite directions; one of said pair of interrupting devices having a relatively large axial spacing and the other of said pair of interrupting devices having a relatively small axial spacing from one of said pair of caps, and said one of said pair of interrupting devices having a relatively small axial spacing and said other of said pair of interrupting devices having a relatively large axial spacing from the other of said pair of caps.

5. An electric cartridge fuse including in combination:

- (a) a casing of electric insulating material;
- (b) a pulverulent arc-quenching filler inside said casing;
- (c) a pair of terminal elements closing the ends of said casing;
- (d) a pair of overload interrupting devices each including a plunger normally held in position by solder joint means and movable upon softening of said solder joint means, said plunger of one of said pair of interrupting devices having a relatively large axial spacing from one of said pair of terminal elements and a relatively small axial spacing from the other of said pair of terminal elements, said plunger of the other of said pair of interrupting devices having a relatively small axial spacing from said one of said pair of terminal elements and a relatively large axial spacing from said other of said pair of terminal elements;
- (e) a pair of springs arranged to bias said plunger of each of said pair of overload interrupting devices in opposite directions;
- (f) a relatively long ribbon fuse link means conductively connecting said one of said pair of interrupting devices to said one of said pair of terminal elements and a relatively short ribbon fuse link means con-

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ductively connecting said one of said pair of interrupting devices to said other of said pair of terminal elements; and

- (g) a relatively short ribbon fuse link means conductively connecting said other of said pair of interrupting devices to said one of said terminal elements and a relatively long ribbon fuse link means conductively connecting said other of said pair of interrupting devices to said other of said pair of terminal elements.

6. An electric cartridge fuse as specified in claim 5 wherein each of said pair of overload interrupting devices includes a tubular sleeve-shaped member of electric insulating material for precluding access of said arc-quenching filler to the break formed upon softening of said solder joint means and movement of said plunger of each of said pair of overload interrupting devices; said sleeve-shaped member of each of said pair of overload interrupting devices having an axially outer plugged end circular in cross-section and axially inner squashed end closed by a fastener means.

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337—234, 248