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FUSE

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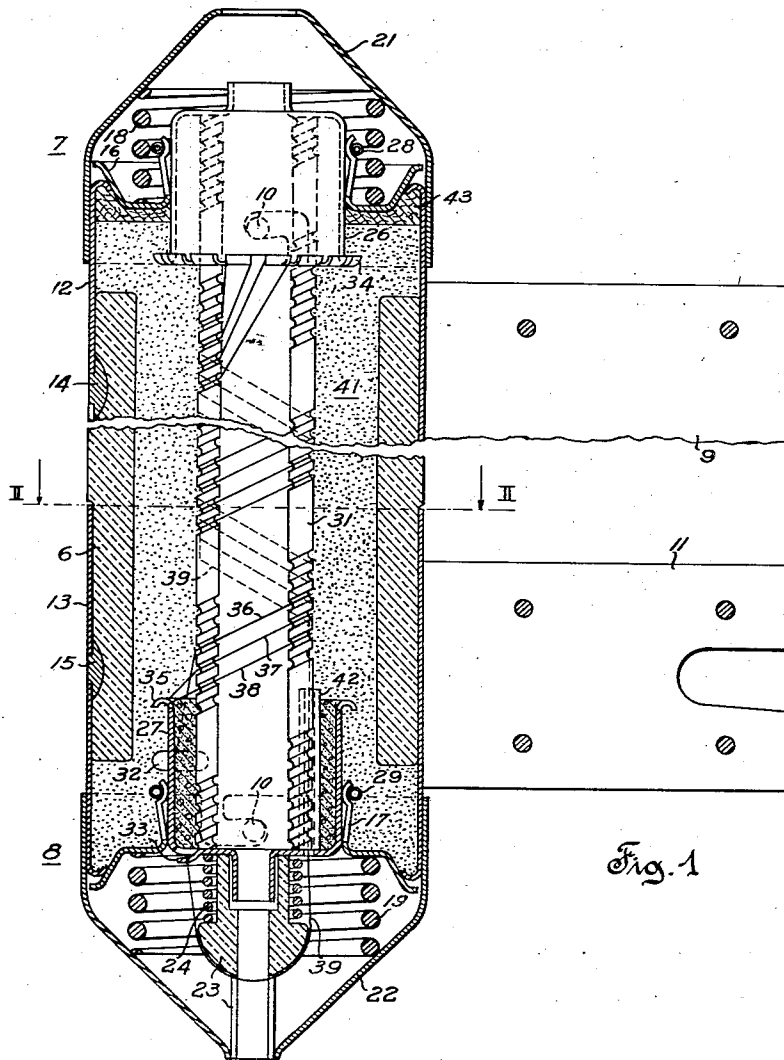


Fig. 1

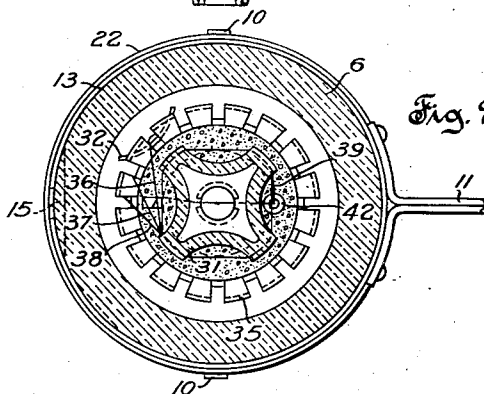


Fig. 2

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FUSE

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8 Claims. (Cl. 200—131)

This invention relates in general to improvements in fuses for protecting high voltage electric circuits, and more particularly to a fuse of the type in which the fuse element is embedded in a pulverulent insulating material.

High voltage fuses are well known in which a fuse element shaped as a wire or a plurality of parallel wires is embedded in a pulverulent insulating material such as fine sand. The fuse wires utilized in high voltage fuses must be of small diameter to avoid occurrence of excessive local pressures upon operation of the fuse, and these wires, being of relatively soft metal, are easily stretched or even broken. It has been proposed to fasten the wires between the fuse terminals without supporting them at any intermediate point. This construction presents the disadvantage that some of the wires may be broken when the fuse is filled with sand, and this defect cannot be conveniently detected as long as some of the wires remain unbroken. The wires may also be helically wound on a cylindrical insulator provided with suitable helical grooves. The wires are then well supported, but a continuous coating of conductive material from the wires may be deposited on the insulator upon operation of the fuse resulting in current leakage between the fuse terminals.

These disadvantages may be avoided by supporting each fuse wire at spaced points intermediate the fuse terminals by helically winding the wires on a star shaped rod insulator for example. When a plurality of parallel wires are necessary, these wires are preferably obtained by looping a single piece of conductor back and forth between the fuse terminals. One of the wires may be used to maintain an indicator out of operation indicating position, and the indicator wire is preferably made longer than the other wires to preclude any premature release of the indicator. A relatively large amount of heat is frequently evolved in large capacity fuses which are therefore preferably provided with a passage for the flow of cooling fluid there-through.

It is therefore one of the objects of the present invention to provide a fuse of the type containing pulverulent insulating material in which each fuse wire is supported at spaced points intermediate the fuse terminals.

Another object of the present invention is to provide a fuse of the type containing pulverulent insulating material in which one of a plurality of parallel fuse wires is utilized to control an operation indicator.

Another object of the present invention is to provide a fuse of the type containing pulverulent insulating material in which a relatively large amount of heat may be dissipated without excessively raising the temperature of the fuse.

Objects and advantages other than those above described will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a longitudinal cross section through the two end portions of a fuse utilizing a single conductor looped between the fuse terminals and helically wound on a hollow insulator of star shaped cross section herein shown in elevation; and

Fig. 2 is a cross section taken on plane II—II through the embodiment illustrated in Fig. 1 from which the filling of pulverulent insulating material is removed.

Referring more particularly to the drawing by characters of reference, reference numeral 6 designates an insulating fuse casing on which are mounted a pair of apertured terminal structures generally designated by 7, 8. Casing 6 preferably consists of a hollow cylinder of porcelain. The two terminals are generally similar to one another in construction and comprise suitable contact members such as knife blade contacts 9, 11, adapted to be inserted in a suitable holder (not shown) for connecting the fuse in an electric circuit in the usual known manner. Blades 9, 11 are assembled on casing 6 through internally flanged metal tubes or ferrules 12, 13, to which the blades are riveted or otherwise fastened. Each ferrule is slipped over one end of casing 6 and is maintained in position thereon by any suitable means. For example, the casing may be provided with recesses 14, 15, into which solder may be run through apertures drilled in the ferrules. The parts are preferably preheated and the ferrules are coated with a suitable flux or even tinned before introducing the solder, which forms lugs integral with the ferrules preventing their displacement relative to casing 6.

The terminals further comprise a pair of washers 16, 17, resiliently maintained in contact with ferrules 12, 13 by means of helical springs 18, 19. The springs are abutted against the internal surfaces of a pair of apertured caps 21, 22, fastened to ferrules 12, 13 by any convenient means such as a bayonet fastening 10. The lower cap 22 also contains a hollow fuse operation indicator or target 23 mounted on casing 6 through the elements of terminal 8 and tending to protrude through the aperture of cap 22 under the joint

action of gravity and of a spring 24. Washers 16, 17 are provided with slotted tubular extensions fitted around a pair of apertured caps 26, 27 and urged in contact therewith by springs 28, 29. Cap 27 is provided with suitable ears 32, 33 for fastening the ends of a conductor serving as fuse wire and caps 26 and 27 are flanged to form rows of hooks 34, 35 between which the conductor may be looped to form a plurality of parallel fuse wires. If it is desired to utilize an odd number of fuse wires, ears similar to 32 on cap 27 may be utilized on cap 26.

Caps 26, 27 are cemented or otherwise fastened to the ends of a rod insulator 31 arranged in casing 6 and maintained between terminals 7 and 8 by the caps, which form part of the terminals. Insulator 31 is a hollow rod of star shaped cross section and the bore thereof is aligned with the apertures of caps 21, 22, of caps 26, 27, and of indicator 23 to define a passage for the flow of cooling fluid through the fuse. In general, sufficient cooling of the fuse will be obtained by allowing atmospheric air to circulate through the passage under natural draft caused by heating of the air during its travel through the passage.

The fuse element is mounted in casing 6 for interconnecting terminals 7 and 8, and consists of a plurality of parallel fuse wires 36, 37, 38 and 39 embedded in a body of pulverulent insulating material 41 such as fine sand contained in casing 6 between the casing and insulator 31. It is generally necessary to utilize a plurality of parallel fuse wires to obtain a fuse element having the desired current carrying capacity because the diameter of the wires should not exceed one-third of a millimeter to limit the amount of metal vapor produced at any point by fusion of a wire and thus to limit the maximum pressure developed in the fuse. The wires are most conveniently obtained from a single piece of fusible conductor looped between the fuse terminals. Wires 36, 37 and 38 are of substantially uniform predetermined length and are embedded in sand over their entire length. Wire 39, which is longer than the other wires, is embedded in sand 41 over a length substantially equal to the length of the remaining wires. Wire 39 however extends out of the sand through an insulating tube 42 into engagement with indicator 23 to maintain the indicator out of operation indicating position. Insulator 31 is provided with a plurality of interleaved discontinuous helical grooves to accommodate an equal number of fuse wires, although the fuse wires actually used may be in any number not exceeding the number of grooves. The wires are wound around insulator 31 in interleaved helical paths partly in the grooves and partly in sand between the successive groove portions. In this manner the length of the fuse can be made considerably less than the length of the fuse wires and the cost of the fuse and of the associated fuse holder may be considerably reduced. The fuse wires are discontinuously supported between terminals 7 and 8 in order that they may be completely surrounded by sand between the spaced points of support of the wires on insulator 31. The wires are accordingly wound sufficiently tightly to obtain spacing of the wire portions intermediate the spaced points of support thereof on insulator 31 from the insulator across the concave portions thereof. The volume of sand confined between the wires and the concave portions of the insulator prevents deposition

of a continuous coating of conductor material from the wire on the insulator surface between the spaced points of support of the wires upon fusing thereof. A coating is indeed deposited in the insulator grooves with which the wires are in contact, but the sand present between the wires and the concave insulator surfaces prevents the deposition on the insulator of a continuous coating extending between terminals 7 and 8, which continuous coating would cause current leakage between the terminals.

The distance between adjacent parallel wires should be sufficient to permit interpositioning of a substantial thickness of sand between wires. The metallic vapors produced by each wire upon fusion thereof may then be oxidized and condensed by separate masses of sand, thereby preventing excessive heat concentration and production of excessive pressures in the fuse casing. The distance between successive turns of the group of wires is preferably made greater than the distance between adjacent wires to positively preclude establishment of a direct arc between the terminals from turn to turn of the fuse wires upon operation of the fuse.

To assemble the fuse, a piece of fusible conductor of suitable length is selected and one end thereof is anchored under ear 32 of cap 27. The conductor is passed between two of hooks 35 and is helically wound around insulator 31 to form wire 36. The conductor is then slipped over one of hooks 34 and helically wound a second time around the insulator 31 to form wire 37. The conductor is thus looped back and forth between the terminals to form as many wires as are required. The last wire 39 is not brought back to ear 32, but is instead threaded through tube 42 and looped around indicator 23. The indicator comprises a lower tubular portion which is slotted so that the wire may rest on the upper globular portion of the indicator. The indicator is pressed upward by hand against the action of spring 24 until the indicator abuts against cap 27. Wire 39 is then pulled tightly around the indicator and the end thereof is anchored under ear 33. Washer 17 is then mounted on cap 27 and the insulator is inserted into casing 6. Spring 19 is abutted against washer 17 and is held in place by means of cap 22 which is fastened on ferrule 13 through bayonet mounting 10. Sand is then poured into casing 6 to fill the space between the casing and insulator 31 to a level slightly above hooks 34. A layer of resilient material 43, such as rock wool, is then disposed above the sand up to approximately the upper edge of ferrule 12. Washer 16 is slipped over cap 26 and brought into contact with the edge of ferrule 12, thus compressing the rock wool and holding sand 41 immovable in casing 6. Spring 18 is laid on washer 16 and is compressed by cap 21 which is fastened on ferrule 12 through its bayonet mounting. The fuse is thus completely assembled and may be put in service by inserting knife blades 9, 11 in a suitable holder connected in an electric circuit.

The fuse wires are so dimensioned and in such number that the temperature of the fuse will not become so high as to damage the fuse or any material in proximity thereto when the fuse is carrying its rated current or a lower current. The fuse temperature is materially reduced by the flow of air through the passage provided through the fuse. Wire 39 being slightly longer than the other wires, has a slightly higher resistance and carries a slightly lower current than 75

each of the remaining wires. If the current through the fuse reaches or exceeds the value at which the fuse should operate, wires 36, 37 and 38 fuse first substantially simultaneously. The fused material is vaporized and the metallic vapor is oxidized by the air contained between the sand grains and diffuses into the sand surrounding the wires. The oxidized metallic vapor settles on the sand grains which are thus coated with a layer of substantially non-conductive metallic oxide. Some molten metal from the wire portions located in the grooves of insulator 31 may form a conductive layer on the surface of the grooves but this layer is interrupted by the concave portions of insulator 31 and therefore cannot carry any leakage current between the terminals of the fuse.

Wire 39, receiving less current than the other wires, will fuse at a somewhat later moment and even if the total current merely reaches the value sufficient to cause wires 36, 37 and 38 to fuse, wire 39 will certainly fuse after the other wires have fused when the entire fuse current is carried by wire 39. The portion of wire 39 embedded in sand, which is thus insulated against heat transmission, fuses while the portion thereof enclosed in cap 22, which may radiate heat through the surrounding air, remains unaffected. The portion of wire 39 looped around indicator 23 is then no longer held taut and releases the indicator. Spring 24 causes the indicator to project through the aperture of cap 22 to indicate operation of the fuse. The sequential fusing of wires 36, 37, 38 and of wire 39 insures that the indicator will not be released except upon flow of current sufficient to fuse all wires. When the fuse has operated, it may be disassembled, the sand and the unfused ends of the wires removed, and the fuse reassembled with a new fusible conductor and a new sand filling in the manner above set forth.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention or from the spirit of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A fuse comprising a pair of terminals, a rod insulator of star shaped cross section arranged between said terminals, and a fuse element interconnecting said terminals and comprising a group of parallel fuse wires wound in spaced interleaved helical paths around said insulator, the distance between successive turns of the group of wires being greater than the distance between adjacent parallel wires.
2. A fuse comprising a pair of terminals, a fuse element consisting of a single piece of fusible conductor looped between said terminals to form a plurality of parallel fuse wires, and an indicator for indicating operation of the fuse, said indicator being maintained out of operation indicating position by a single one of said wires.
3. A fuse comprising a pair of terminals, an indicator for indicating operation of the fuse, and a fuse element consisting of a single piece of fusible conductor looped between said terminals to form a plurality of parallel fuse wires, one of said wires being longer than the remainder of said wires and serving to maintain said indicator out of operation indicating position.
4. A fuse comprising an insulating casing, a

pair of terminals mounted on said casing, an indicator mounted on said casing for indicating operation of the fuse, a body of pulverulent insulating material contained in said casing, and a fuse element consisting of a single piece of fusible conductor looped between said terminals to form a plurality of parallel fuse wires of predetermined length embedded in said material and another wire embedded in said material over a length substantially equal to said predetermined length and extending out of said material into engagement with said indicator to maintain said indicator out of operation indicating position.

5. A fuse comprising an insulating casing, a pair of terminals mounted on said casing, a rod insulator of star shaped cross section arranged in said casing between said terminals, an indicator mounted on said casing for indicating operation of the fuse, a body of pulverulent insulating material contained between said casing and said insulator, and a fuse element consisting of a single piece of fusible conductor looped between said terminals to form a plurality of parallel wires interconnecting said terminals helically wound around said insulator and embedded in said material, one of said wires extending out of said material into engagement with said indicator to maintain said indicator out of operation indicating position.

6. A fuse comprising an insulating casing, a pair of apertured terminals mounted on said casing, a hollow rod insulator of star shaped cross section arranged in said casing, a fuse element interconnecting said terminals and helically wound around said insulator, and a body of pulverulent insulating material in said casing in exclusive contact with said element between the points of contact of said element with said insulator, said insulator and said terminals defining a passage for the flow of cooling fluid through the fuse.

7. A fuse comprising an insulating casing, a pair of apertured terminals mounted on said casing, a hollow rod insulator of star shaped cross section arranged in said casing between said terminals, a hollow indicator arranged to extend through an aperture of one of said terminals to indicate operation of the fuse, a body of pulverulent insulating material contained between said casing and said insulator, and a fuse element comprising a plurality of parallel wires interconnecting said terminals helically wound around said insulator and embedded in said material, one of said wires extending out of said material into engagement with said indicator to maintain said indicator out of operation indicating position, said terminals, insulator and indicator defining a passage for the flow of cooling fluid through the fuse.

8. A fuse comprising an insulating casing, a pair of terminals mounted on said casing, a rod insulator of star shaped cross section arranged in said casing, a body of pulverulent insulating material contained between said casing and said insulator, and a fuse element interconnecting said terminals and comprising a plurality of parallel wires wound in spaced interleaved helical paths around said insulator, the spacing of said wires comprising means for confining to a separate mass of said pulverulent material the metallic vapor formed at each of said wires upon fusion thereof.

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