Dec. 9, 1969 H. W. MIKULECKY 3,483,502

CURRENT LIMITING FUSE

Filed Dec. 21, 1967

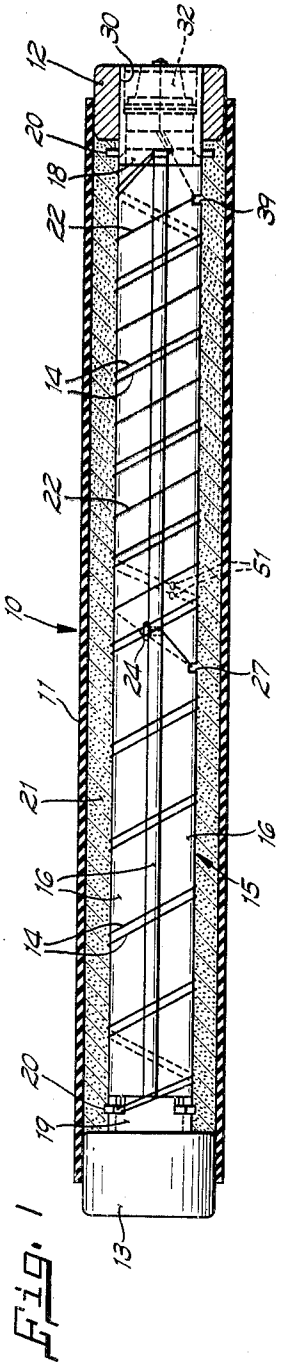


Fig. 1

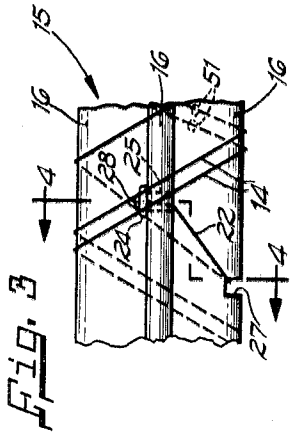


Fig. 3

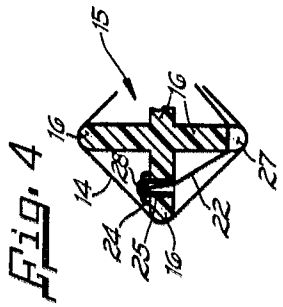


Fig. 4

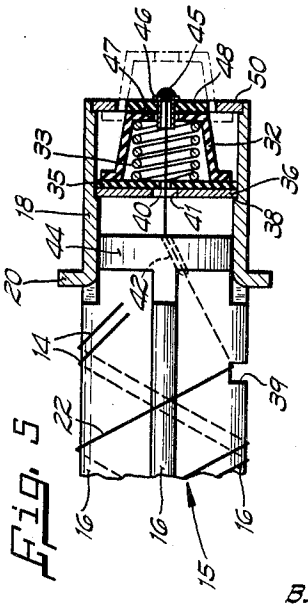


Fig. 5

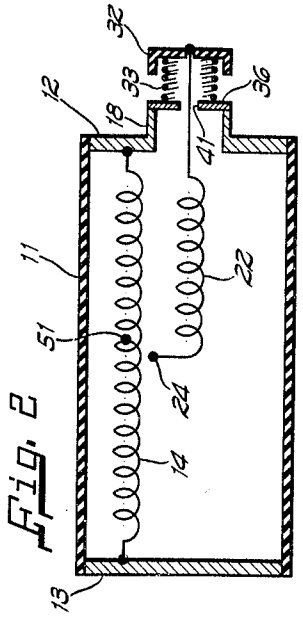


Fig. 2

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CURRENT LIMITING FUSE

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ABSTRACT OF THE DISCLOSURE

A current limiting fuse enclosed in an insulating fuse tube and including a fusible element helically wound on a support core for interconnecting terminals at the opposite ends of the casing and a granular insulating material filling the casing. An indicator wire is helically wound on the support core in a general parallelism with a portion of the fusible element and is isolated therefrom and from the terminals. The indicator wire normally holds a spring-loaded indicator member and parts when subject to an arc at one of the terminals after the fusible element has parted to release the indicator member.

BACKGROUND OF THE INVENTION

This invention relates to current limiting fuses and, more particularly, to a new and improved indicator for such fuses.

One type of current limiting fuse generally includes one or more fusible elements which may be helically wound on a central core so as to provide a sufficient element length within a reasonably sized housing. In order to give a visual indication that the fuse has operated, an indicator may be provided which includes a spring operated plunger held by an indicator wire which parts when the fusible element melts. Such indicator wires are generally connected to one terminal of the fuse and are helically wound on the core for the full length of the fuse tube, except for a small gap intermediate its ends. Indicator wires which runs the full length of the fuse tube tend to provide an internal arc-over path through the full length of the fuse housing in the event of a failure.

In the operation of prior art current limiting fuses, the fusible elements first part in one or more locations, after which the gap in the indicator wire flashes over causing the current to be switched to the indicator wire which then vaporizes. Upon this event, the current is switched back to the segments of the fusible element which then vaporize causing a high voltage surge.

It is an object of the invention to provide an indicator for a current limiting fuse wherein the indicator wire does not provide an arc-over path through the full length of the fuse tube.

Another object of the invention is to provide a current limiting fuse wherein various portions of the fusible element vaporize at different times during the interruption of high current faults to reduce the magnitude of the resultant voltage surge.

These and other objects and advantages of the invention will become apparent from the detailed description thereof taken with the description of the preferred embodiment set forth hereinbelow.

SUMMARY OF THE INVENTION

A current limiting fuse including a fusible element for interconnecting spaced apart terminals and an indicator wire disposed in general parallelism with the fusible element and extending for only a partial distance through the fuse tube and having one end disposed in a gapped relation to one terminal wherein the indicator wire will part

at the gap when the fuse operates to release an indicator member and to momentarily shunt the current from one portion of the fusible element.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a fuse assembly incorporating an indicator according to the instant invention;

FIG. 2 schematically illustrates the fuse assembly shown in FIG. 1;

FIG. 3 is an enlarged fragmentary view of the fuse assembly shown in FIG. 1;

FIG. 4 is a view taken along lines 4—4 of FIG. 3; and

FIG. 5 is an enlarged view showing the indicator member of the fuse assembly shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a current limiting fuse **10** incorporating the instant invention and including a tubular casing **11** formed of a suitable insulating material such as glass, fiber, or glass impregnated with epoxy resin. The opposite ends of tube **11** are closed by metallic conductive terminal members **12** and **13** which may be affixed in a sealing relation in any suitable manner, such as by epoxy cement. Those skilled in the art will appreciate that the terminals **12** and **13** may include means (not shown) for mechanically supporting the fuse **10** and for electrically connecting it into the circuit being protected.

The fuse **10** also includes one or more fusible elements **14** which may take the form of thin wires of conductive material, such as silver or copper, and which melt when subject to a predetermined temperature in a manner well known in the art. The wires **14** are helically wound on an elongate insulating core member **15** which extends axially within the casing **11** and which is generally X-shaped in cross-section and formed by a plurality of radially protruding, peripherally spaced apart, longitudinally extending fins **16**.

Conductive, tubular end members **18** and **19** are affixed to each end of the core member **15**, and each is in turn affixed to the terminal members **12** and **13**, respectively, to join the members in a unitary assembly. Each end member **18** and **19** has a plurality of radially extending tabs **20** adjacent its outer periphery, and forming terminals to which the fusible wires **14** may be suitably joined by solder or the like.

The space within the casing **11** and around the core member **15** and the fusible conductors **14** is filled with a suitable pulverulent refractory arc quenching material such as quartz sand **21**.

A fusible indicator wire **22** is helically wound on the core **15** in spaced relation between the helical turns of, and in general parallelism with, the fusible elements **14**. As seen in FIGS. 1 and 2, the indicator wire **22** is approximately one-half the length of the fusible elements **14** and extends substantially one-half the length of the core **15**. As seen more clearly in FIGS. 3 and 4, one end of the indicator wire **22** may be anchored by means of an eyelet **24** disposed in an aperture **25** formed in one of the fins **16**. In order to maintain the wire **22** in a taut condition, it is passed around a notch **27** cut in an adjacent fins **16** and located beyond the eyelet **24** and extends backwardly to eyelet **24** where it may be affixed in any suitable manner, such as solder **28**.

In the preferred embodiment of the invention seen in FIG. 4, the aperture **25** may be located inwardly of the outer edge of the fin **16** so that the fusible elements **14** pass above the eyelet **24**. As a result, there is no direct electrical connection between the fusible elements **14** and the indicator wire **22** at this point, as schematically illustrated in FIG. 2.

Referring now to FIGS. 1 and 5, the terminal member **12** is shown to have a central bore **30** for receiving the end member **18** which, in turn, encloses a nonconductive indicating plunger **32** that is urged in an axially outward direction by a spring **33** but normally restrained against a nonconductive washer **35** by the indicator wire **22**. The nonconductive washer **35** is supported by a conductive washer **36** which is suitably secured to a shoulder **38** formed on the internal surface of sleeve **18** so that washer **36** is in circuit with the fusible elements **14**.

The indicator wire **22** is anchored on a notch **39** formed in one fin **16** of core **15** and passes through central apertures **40** and **41** in washers **35** and **36**, respectively, and an oblique hole **42** formed in a disc portion **44** formed integrally on the core member **15** and upon which the sleeve **18** is secured. The aperture **40** is substantially smaller than the aperture **41** and serves to centrally locate the wire **22** in spaced relation from the margins of the aperture **40**. The terminal end of wire **22** is secured in any suitable manner, such as by solder **45**, to an eyelet **46** which passes through an aperture **47** in the indicator plunger **32** and is secured in an insulating masking washer **48** which normally covers the outer end of plunger **32**.

As will be more fully explained hereinbelow, when the fuse **10** is subject to a predetermined current, fusible elements **14** will part, and this, in turn, will cause the indicator wire **22** to part so as to release the indicating plunger **32** for movement outwardly of the sleeve **18** under the influence of the spring **33**, and until it engages a stop ring **50** secured to the outer end of sleeve **18**, as shown by phantom lines in FIG. 5.

The indicator plunger **32** may be of some bright color which is normally masked by the washer **48**. However, when the indicator wire **22** parts, the eyelet **46** will be released from the aperture **47** in the plunger **32** so that the masking washer **48** will fall away to uncover the plunger **32**.

As seen in FIGS. 1 and 2, the indicator wire **22** extends for only approximately one-half the length of the fusible element **14** and, in addition, is preferably isolated therefrom by the gap between the eyelet **24** and the fusible elements **14** and from the terminal **11** by the gap that exists between the indicator wire **22** and the periphery of the aperture **41** in the washer **36**. Initially, therefore, no current flows through the indicator wire **22** so that it can in no way affect the time current characteristic of the fuse **10**. This is true even though there may be contact between one end of the wire **22** and the fusible element **14** and to the eyelet **24**.

The fusible elements **14** may be provided with beads **51** which are composed of a low melting temperature alloy, such as tin-lead solder, and which are in intimate contact with the fusible elements **14** and preferably at the mid-point thereof. At the time current operating point of the fuse, elements **14** become hot enough to melt the beads **51** and the amalgamation of the silver and the bead alloy causes a hot spot with a high enough resistance to melt the elements **14** at this point.

In the absence of the indicator wire **22**, initial separation of the fusible elements **14** will cause these elements to separate into a plurality of segments interconnected by arcs and which substantially simultaneously vaporized. The vapor thus formed is disbursed among and condenses on the relatively cool granules of the surrounding arc quenching material **21** and is thereby no longer available for current conduction as the arc energy is dissipated in this heat transfer. This has the effect of inserting a relatively large resistance in the circuit to sharply limit the current through the fuse to some value less than the prospective fault current and gives rise to a voltage surge which is initiated at approximately the instant of vaporization and which is potentially damaging to the system.

The indicator wire **22** operates to limit the surge voltage incident to a current interruption by delaying the vaporization of a portion of the fusible elements **14**. More specifically, as the current interruption is initiated, the indicator wire **22** provides a low resistance shunt path across approximately one-half of the fusible elements **14** and is, accordingly, switched into a parallel circuit relation by arc-overs at the eyelet **24** and the aperture **41** in the conductive washer **36**. This arcing separates the indicator wire at the aperture **41** to provide the indication as described hereinabove and, in addition, momentarily shunts a portion of the elments **14**. During this time, the remainder of the elements **14** vaporized to cause a voltage surge whose peak amplitude is lower than that which would normally occur if the entire elements **14** vaporized simultaneously. When the fault current is switched to the indicator wire **22**, it also vaporizes and the current is switched back to the remaining portion of the fusible elements **14**, and these, in turn, vaporize to produce a second voltage surge which is also of reduced magnitude. In this manner, the indicator wire **22** delays the vaporization of approximately one-half of the fusible elements **14** to provide two successive voltage surges, each of which is of substantially lower magnitude than would normally occur.

Current limiting fuses of this type sometimes fail as the result of an internal flashover along the length of the core **15** and between adjacent turns of the fusible elements **14**. The presence of an indicator wire extending the full length of the fuse **10** enhances the possibility of such failures. However, by limiting the length of the indicator wire to substantially one-half the length of the fusible elements, this possibility of internal flashover is substantially reduced.

While only a single embodiment of the invention has been shown and described, and while the invention has been discussed with respect to a pair of relatively thin fusible wires **14**, those skilled in the art will appreciate that the invention also contemplates the use of a greater or lesser number of fusible elements, or the use of a relatively wider ribbon of fusible material. In addition, while only a single embodiment of the invention has been shown and described and while the invention has been described with respect to a particular type of current limiting fuse, it is not intended to be limited thereby, but only by the scope of the appended claims.

I claim:

1. A current limiting fuse comprising a tubular insulating casing, conductive terminal means mounted on each end of said casing, at least one elongate fusible element extending through said casing and interconnecting said terminals, and indicator means mounted on one of said terminals, indicator wire means restraining the operation of said indicator means and extending for substantially one-half the distance through said casing in general parallelism with said fusible element, one end of said indicator wire being electrically insulated from said one terminal and passing in close proximity thereto, the other end of said indicator wire terminating intermediate the ends of said casing.

2. The current limiting fuse set forth in claim **1** wherein an insulating core member extends generally parallel to the axis of said casing, said fusible element being generally helically wound on said core member and said indicator wire being wound on said core member in generally spaced relation with respect to said fusible element, and an inert granular material of high dielectric strength disposed in said casing and in surrounding relation to said core and fusible element and indicator wire.

3. The current limiting fuse set forth in claim **1** wherein said one end of said indicator wire is secured to said indicator means by an eyeletted insulating washer to restrain the operation thereof, and insulating gap means electrically connecting said one end of said in-

dicator wire and said one terminal by an electrical arc during an overcurrent fault.

4. The current limiting fuse set forth in claim 2 wherein said other end of said indicator wire is anchored by an eyelet on said core member.

5. The current limiting fuse set forth in claim 2 wherein said indicator means includes an indicator member, resilient means urging said indicator member outwardly of said casing, and an insulating masking washer fastened to said indicator wire and normally covering and holding said indicator member against said resilient means, said indicator wire being severed by an electrical arc adjacent said one terminal after said fusible element parts, to release said insulating masking washer so that said indicator member may move outwardly of said casing.

6. The current limiting fuse set forth in claim 3 wherein said insulating gap means comprises a conductive disc member affixed to said terminal means and having an aperture formed therein, said indicator wire passing through said aperture, and nonconductive means attached to said conductive disc member for holding said indicator wire generally centrally of said aperture.

7. The current limiting fuse set forth in claim 3 wherein the other end of said indicator wire is anchored by an eyelet that is electrically insulated from said fusible element and in close proximity thereto.

8. The current limiting fuse set forth in claim 3 wherein said indicator means includes an indicator member, resilient means urging said indicator member outwardly of said casing, and an insulated masking washer fastened to said indicator wire and normally covering and hold said indicator member against said resilient means, said indicator wire being severed by an electrical arc adjacent said one terminal after said fusible element parts to release said masking member so that said indicator member may move outwardly of said casing.

9. The current limiting fuse set forth in claim 2 wherein there is an insulating gap means comprising a conductive disc member affixed to said terminal means and having an aperture formed therein, said indicator wire passing through said aperture, and nonconductive means attached to said conductive disc member for

holding said indicator wire generally centrally of said aperture.

10. A current limiting fuse comprising a tubular insulating casing, conductive terminal means on each end of said casing, and insulating core within said casing, at least one fuse element attached to said insulating core and interconnecting said terminals, indicator means mounted within the terminal on one end of said casing, indicator wire means restraining the operation of said indicator means and extending for substantially one-half the length and in general parallelism with said fuse element, insulating gap means for electrically isolating in close proximity said indicator wire means and said terminal on one end of said casing, and spring biasing means for forcing said indicator means outwardly from said terminal on one end of said casing when an electrical arc strikes from said indicator wire means to said terminal on one end of said casing during an overcurrent fault.

11. A current limiting fuse as defined in claim 10 in which said insulating gap means is formed between said indicator wire means and the inner diameter edge of an apertured metallic disc joined to said terminal on one end of said casing, said indicator wire means extending centrally through said apertured metallic disc and being held centrally through an apertured insulating disc positioned adjacent said apertured metallic disc, the aperture in said metallic disc being larger than the aperture in said insulating disc, thereby constructing a precise insulating gap for arc severing purposes.

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337—159