May 24, 1966 H. R. HOLSINGER 3,253,106

INDICATING FUSE CONSTRUCTIONS

Filed May 2, 1962 2 Sheets-Sheet 1

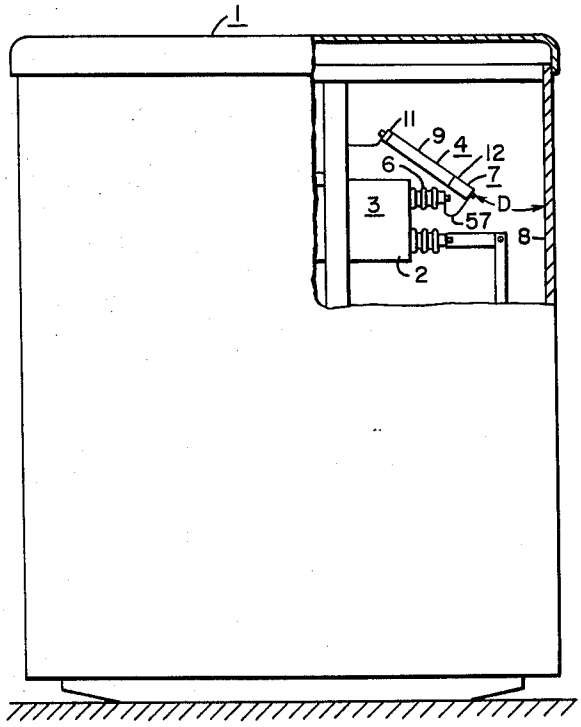

Fig. 1.

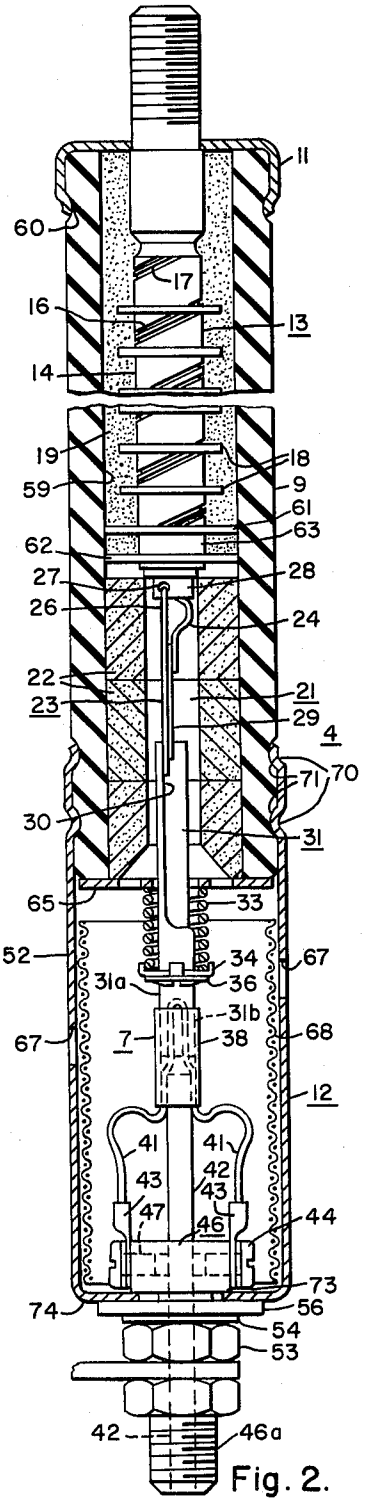

Fig. 2.

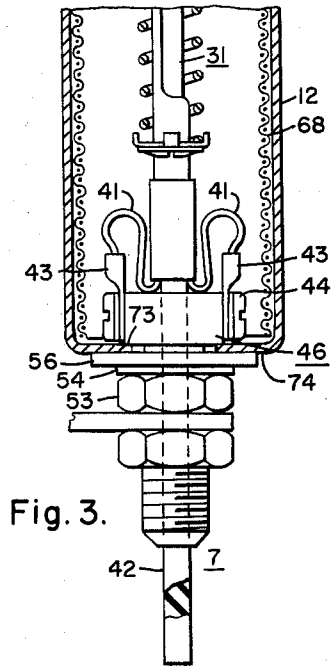

Fig. 3.

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INDICATING FUSE CONSTRUCTIONS

Filed May 2, 1962 2 Sheets-Sheet 2

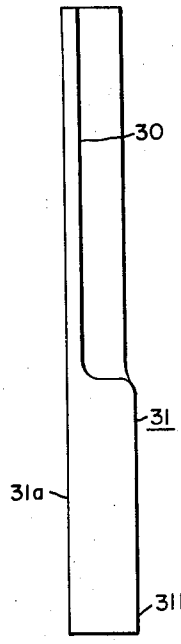

Fig. 5.

Fig. 4.

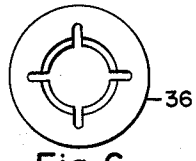

Fig. 6.

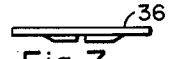

Fig. 7.

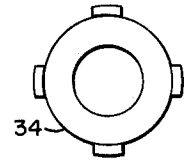

Fig. 13.

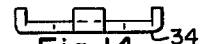

Fig. 14.

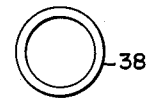

Fig. 16.

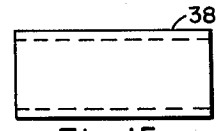

Fig. 15.

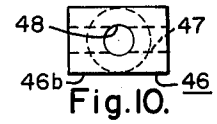

Fig. 10.

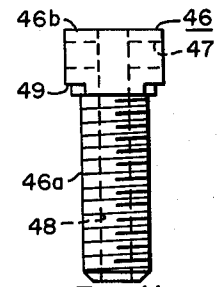

Fig. 11.

Fig. 12.

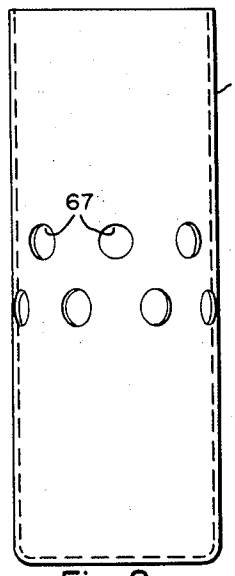

Fig. 8.

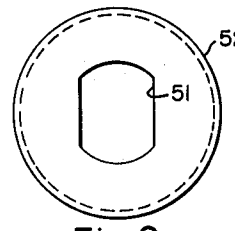

Fig. 9.

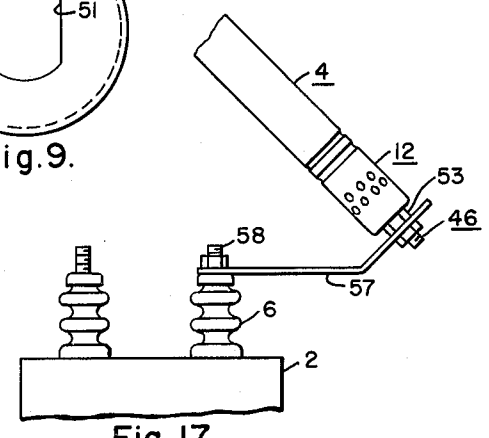

Fig. 17.

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3,253,106

INDICATING FUSE CONSTRUCTIONS

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4 Claims. (Cl. 200—121)

This invention relates generally to indicating fuse constructions and, more particularly, to indicating fuse constructions wherein an indicating assembly is desired for externally indicating operation of the fuse in response to overload or fault conditions.

A general object of the present invention is to provide an improved indicating fuse construction of highly-efficient operation, composed of few parts and yet providing an improved external indication of operation of the fuse under overload or fault conditions.

A more specific object of the present invention is the provision of an indicating-type fuse having relatively few parts, and associating an indicating-rod assembly with one of the terminals of the fuse, so as to give an external readily-visible indication of fuse operation.

A further object of the present invention is the provision of a fuse, particularly adapted for capacitor-unit installations, wherein an insulating fuse-indicator rod is employed, the fuse construction being very suitable for confinement within an enclosed cubicle construction without the hazard of any flashover occurring between the grounded cabinet and the indicator assembly to the live terminals of the fuse during fuse operation.

Still a further object of the present invention is the provision of an improved method for assembling a fuse-indicator device with a fuse for eliminating as far as possible soldered connections, and providing instead crimping operations, or threaded connections, for good contact transfer and adequate securement of the several parts.

Still a further object of the present invention is the provision of an improved indicator assembly for a fuse having a fuse-indicating rod which protrudes axially through a fuse terminal to an external length sufficient for readily-visible external indication.

Yet a further object of the present invention is the provision of an improved fuse construction wherein a biasing spring adapted for fuse-terminal withdrawal is also effective as a biasing means for an indicating-rod assembly.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

FIGURE 1 is an end section view, partially in section, of an enclosed protected capacitor installation indicating internal stacking of capacitor units with individual protective fuse elements closely situated to the cabinet wall;

FIG. 2 is an enlarged axial sectional view taken through the improved indicating fuse construction of the present invention, with the fuse elements shown in their intact condition;

FIG. 3 is a fragmentary sectional view, similar to that of FIG. 2, but indicating the position of the several parts following blowing, or operation of the fuse elements;

FIGS. 4 and 5 illustrate, respectively, end and side elevational views of the deformed connector element of the present invention;

FIGS. 6 and 7 illustrate, respectively, side elevational and end elevational views of the push-on-type speed nut utilized in an assembly operation of the present invention;

FIGS. 8 and 9 illustrate, respectively, side elevational and end elevational views of the perforated condenser

chamber utilized in the fuse construction of the present invention;

FIGS. 10–12 illustrate, respectively, detailed views of the improved terminal-stud construction of the present invention;

FIGS. 13 and 14 illustrate, respectively, side elevational and end elevational views of the metallic crimp washer used in an assembly operation;

FIGS. 15 and 16 illustrate, respectively, side elevational and end elevational views of the metallic connector sleeve utilized in the indicator assembly of the present invention; and,

FIG. 17 is a fragmentary side elevational view indicating installation of the fuse construction of the present invention on the terminal of a capacitor unit.

Although the improved fuse construction of the present invention may be utilized in a wide variety of applications, merely for the purpose of describing the present invention, and not by way of limitation, the fuse construction is illustrated as applied to an individual capacitor unit. As well known by those skilled in the art, the primary purpose of fusing individual capacitor units is to remove a faulted capacitor from service before the capacitor case ruptures and damages adjacent units. The removal of the faulted capacitor unit must take place before the main protective device can operate and interrupt service to the remaining capacitor units, which are unaffected. Another purpose is to protect the unaffected capacitor units from the high transient current associated with the failure of a capacitor unit in the same capacitor bank.

Capacitor equipment usually consists of a number of individual capacitor units connected in parallel to make up the total capacity required for a given installation. In most installations, the complete equipment is protected by a circuit breaker or power fuses. The current rating is determined by the normal current rating of the equipment plus an ample margin to allow for increased current due to operation above rated voltage, manufacturing tolerances, presence of harmonics, and transient currents during switching operations.

Usually, individual capacitor units are liberally designed to withstand the requirements of normal service; nevertheless, a capacitor unit may fail if operated under abnormal conditions. Should this occur, no protection can be expected from the circuit breaker or power fuses, because of the high ratio of total bank current to the small current that can be drawn by a faulty capacitor unit. As a result, individual capacitor unit fuses are recommended for use on all power capacitor installations to provide maximum protection, preserve continuity of service and provide identification of a faulted capacitor unit.

Referring to FIG. 1 of the drawings, it will be observed that a capacitor bank compartment **1** encloses a plurality of stacked capacitor units **2** in a plurality of banks **3**. Individual capacitor fuses **4** are secured to one of the terminals **6** of the capacitor units **2** for protection against fault conditions. It will be observed that the indicating assembly **7** of the capacitor fuse **4** is situated relatively closely to the wall **8** of the compartment **1**. As a result, there is the danger of flashover conditions occurring between the capacitor fuse **4** and the grounded compartment wall **8** if the fuse is not properly constructed.

In previous individual capacitor fuses, operation of the fuse element was indicated by the position of a coiled flipper spring attached to a flexible cable at the lower end of the fuse assembly. Such a flipper indicating spring, at the time of fuse operation, moves several inches, carrying with it a portion of the flexible fuse cable. When the capacitor, to which the fuse is connected, is mounted

inside a cubicle, or compartment (as is usually the case). special care must be exercised to allow sufficient electrical clearance between the lower end of the fuse, the indicator parts, and the sides, or walls of the cubicle compartment **1**. This often requires extra space inside the cubicle, which was undesirable. In addition, previous individual-type capacitor fuses were suitable only for bus mounting, there being no means of attachment of the lower end of the fuse assembly to the terminal bushing of the capacitor unit.

The improved indicating fuse construction of the present invention comprises generally the addition of a condenser chamber, together with an indicator-rod assembly extending through the condensing chamber and also through the terminal stud. Electrical connection is preferably made to the terminal stud, which may also be used to support the fuse itself. As a result, the fuse may be mounted directly onto a capacitor bushing by means of a simple flat mounting strap. Moreover, the fuse may also be mounted upon a capacitor bus for other installations. The utilization of a condensing chamber permits the fuse to be used more closely adjacent other live parts, because the expelled gases, generated during fuse operation, are cooled and deionized by the condenser chamber.

FIG. 2 shows more clearly the improved fuse construction of the present invention. As shown, the fuse **4** is of the current-limiting type for limiting the fault current passing through the fuse **4**. More specifically, the fuse unit **4** is encased by a tubular fuse holder **9** made of insulating material, such as fiber, or synthetic resin and by a terminal cap **11** and condenser chamber **12** associated with opposite ends of the fuse tube **9**.

The current-limiting section **13** includes a supporting or interrupting rod **14** of suitable insulating material, such as fiber, or the like. Preferably, the insulating rod **14** is helically grooved, as at **16**, for the accommodation of a plurality of parallel-disposed current-limiting fuse wires **17**, preferably of silver wire. Reference may be had to United States Patent 2,605,371, issued July 29, 1952, to Harold H. Fahnoe, and assigned to the assignee of the instant application for a detailed description of the function and operation of the current-limiting section **13**. As shown, fiber washers **18** are slipped over the helically-grooved insulating rod **14** to prevent flashover, and to increase the arc voltage during a current-limiting operation. In addition, a suitable filler, such as quartz sand **19**, is disposed interiorly of the fuse tube **9** for condensation of the fused metallic particles caused during fuse operation.

In addition to the provision of a current-limiting section **13**, there is also provided a boric-acid interrupting section **21** comprising a plurality of apertured boric-acid blocks **22**, through which extends a fusible element **23** comprising a fuse wire **24** and a strain wire **26**. The fuse wire **24** and the strain wire **26** are suitably secured by means of a hole **27** bored transversely through a rod end portion **28**, to which the plurality of silver fuse wires **17** are conductively secured, as by solder.

As illustrated in FIG. 2, the lower ends of the strain link **26** and main fuse element **29** are soldered to a crimped portion **30** of a fuse connector **31**, the particular configuration of which is more clearly shown in FIGS. 4 and 5 of the drawings.

As shown in FIG. 2, an indicator compression spring **33**, which is of coiled spring construction, is placed over the fuse connector **31**, and is compressed by a crimp washer **34**, the latter being shown more clearly in FIGS. 13 and 14 of the drawings. A speed nut **36**, more clearly shown in FIGS. 6 and 7 of the drawings, is frictionally pressed on over the tubular portion **31***a* of the fuse connector **31** to temporarily frictionally maintain the indicator spring **33** in compression.

At this point in the assembly operation a connector sleeve **38** is slipped over the connector **31**; and flexible leads **41** and insulating indicator rod **42** are inserted a short distance, such as ⅜ or ½ inch for example, into the open tubular end **31***b* of connector **31**. The rod **42** is centered in the several strands of flexible leads **41**. A first crimping step takes place by means of pressing the connector sleeve **38**, shown in FIGS. 15 and 16, over the tubular portion **31***a* of the fuse connector **31** to deform the same to an oval configuration. Such a oval deformation maintains the crimp washer and the push-on-type speed nut **36** into a fixed permanent position (as contrasted to the previous temporary position of the speed nut **36**), so that the lower end of the indicating spring **33** is fixedly determined into a proper permanent position, as shown in FIG. 2. The upper end of sleeve **38** and end **31***a* of connector **31** are crimped simultaneously the operation also securing the leads **41** fixedly into position.

A second crimping operation is subsequently performed between the lower end of the connector sleeve **38** and the flexible leads **41** and the insulating indicator rod **42**. The second crimping operation thereby ensures a fixed securement of the insulating indicator rod **42** together with the flexible leads **41** into a proper position and importantly provides additional contact between leads **41** and connector sleeve **38**, and hence to connector **31**. The lower ends of the flexible leads **41** have terminal lugs **43** secured thereto, which terminal lugs are fastened by mounting screws **44** to a terminal stud **46**, the particular configuration of which is more clearly shown in FIGS. 10–12 of the drawings.

With reference to FIGS. 10–12 of the drawings, it will be observed that a transversely-extending hole **47** is provided, and tapped, to accommodate the mounting screws **44**. Additionally, an axial bore **48**, through the terminal **46**, is provided for the accommodation of the insulating indicator rod **42**. Finally, the terminal stud **46** has a shoulder portion **49** adapted for insertion through a substantially square hole **51** of the tubular condenser chamber **52**, the configuration of which is more clearly shown in FIGS. 8 and 9 of the drawings. As a result, the terminal stud **46** will not turn within the hole **51** of condenser cap **52** upon rotation of a clamping, or jam nut **53**. Preferably, a lock washer **54** and an oversized metallic washer **56** are additionally employed under the nut **53**.

As shown in FIG. 17, by the addition of a capacitor mounting strap **57**, the fuse **4** may be fixedly secured to the terminal **58** of a capacitor unit **2**.

During the existence of fault conditions associated with the capacitor unit **2**, the fuse **4** will function to provide a current-limiting action, as provided by the current-limiting section **13**. Additionally, the fusible element **23** will blow to release the indicator spring **33**, which additionally functions as a fuse-terminal retraction spring. The indicator rod **42** will be ejected to a readily-visible external position, as indicated in FIG. 3 of the drawings.

By way of recapitulation, the assembly operations are performed by first lowering the current-limiting fuse section **13**, together with the fusible element **23** and attached connector sleeve **30**, through the bore **59** of the fuse tube **9**, so that the terminal cap **11** may be crimped into an annular recess **60** provided thereon. A square centering washer **61** is employed to center the current-limiting interrupter rod **14**. The fuse tube **9** is preferably inverted so that the cap **11** is positioned downwardly, at which time a suitable filler, such as quartz sand **19**, is poured downwardly into the fuse tube **9** past the square positioning washer **61**. The tube **9** may be vibrated to settle and compact the sand. When the fuse tube **9** has been properly filled with the quartz sand **19** to the requisite amount, a closure washer **62** of round configuration is pushed over a tapered portion **63** of the fuse rod **14**. Subsequently, the boric-acid blocks **22** are placed, or stacked into position together with a metallic apertured spring-seat washer **65**, which provides a metallic seat for one end of the indicator spring **33**. The spring **33**, crimp washer **34**, and frictionally-engaging

speed-nut **36** are pushed over connector **31**. The speed-nut **36** temporarily holds the lower end of the spring **33** in position, as viewed in FIG. 2. Then, connector sleeve **38** is slipped loosely over connector **31**. The flexible leads **41**, together with indicator rod **42**, are inserted into the open tubular end **31***b* of the fuse connector **31**; and the aforesaid first crimping operation is performed. Subsequently, the second crimping operation is additionally performed to provide thereby additional secure attachment of the leads **41** with the connector sleeve **38** with good current-carrying qualities. This assures additional contact between leads **41** and sleeve **38** and hence to connector **31**. The terminal lugs **43**, secured to the flexible leads **41**, are secured by the mounting screws **44** into the transversely-tapped bores **47** of the terminal **46**. Finally, a rolled-up copper screen **68** is inserted into the condensing chamber **52** for the condensation of the evolved gases during fuse operation and the condenser closure **52** is slipped over the reduced end **46***a* of the terminal stud **46**, and the crimping operation performed to crimp sleeve portions **70** into annular recesses **71** for secure attachment. As shown in FIGS. 8 and 9, the condenser chamber **52** has venting apertures **67** associated therewith for expulsion of the generated gases. As a final operation, the jam nut **53** is tightened over the lock washer **54** and oversize washer **56** to fixedly force the enlarged portion **46***b* of the terminal stud **46** against the inside surface **73** of the end **74** of condenser chamber **52**.

From the foregoing description of the invention it will be apparent that there is provided an improved indicating fuse construction particularly adapted for the individual protection of capacitor units in capacitor installations, but not exclusively limited to this use. The invention has particular applicability for enclosed constructions, as pointed out hereinbefore, by the use of the insulating indicator rod **42**, the indicating position of which does not reduce the flashover distance "D" (FIG. 1) between the fuse unit **4** and the wall **8** of the cubicle compartment **1**.

The novel indicating fuse construction of the present invention has an additional advantage inasmuch as the expelled gases, generated during fuse operation, are cooled and deionized prior to ejection through the venting holes **67** of condenser chamber **52** to the atmosphere. As pointed out hereinbefore, during the crimping operations, there is avoided the presence of soldered joints; and preferably all connections are attached by crimping and threading operations. Thus, there is a minimum of risk that a soldering operation on the indicator will damage any portion of the fusible element **23**, which cannot normally be seen after the fuse has been completely assembled, since it is completely enclosed.

Although the invention has been described as particularly relating to an individual capacitor-unit indicating fuse device, nevertheless it will be apparent to those skilled in the art that certain features of the invention are applicable, as indicating devices, to other types of fuse constructions for different applications other than the capacitor application herein described merely by way of illustration of one possible use of the invention.

Although there has been illustrated and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim as my invention:

1. The combination in an indicating-type fuse of a tubular fuse holder having at least an axial portion thereof composed of insulating material, a first fuse terminal secured to one end of the fuse holder, a second fuse terminal secured to the other end of the fuse holder, a current-limiting fuse section connected to said first fuse terminal, an axial bore-type interrupting section having gas-evolving wall portions intermediate the current limiting fuse section and the second fuse terminal, a fuse element in the interrupting section, a retracting spring for biasing said fuse element to a separated condition, a fuse connector for the fuse element electrically connecting the fuse element to the second fuse terminal and having a tubular portion, and an indicating rod fixedly secured within said tubular portion, the second fuse terminal having an axial bore therethrough, the indicating rod being positioned within said axial bore of the second fuse terminal and slidable therein to an indicating position in response to force applied thereto from the retracting spring when the fuse element blows.

2. The combination in an indicating-type fuse of a tubular fuse holder having at least an axial portion thereof composed of insulating material, a first fuse terminal secured to one end of the fuse holder, a second fuse terminal secured to the other end of the fuse holder, a current-limiting fuse section connected to said first fuse terminal, an axial bore-type interrupting section having gas-evolving wall portions intermediate the current limiting fuse section and the second-fuse terminal, a fuse element in the interrupting section, a retracting spring for biasing said fuse element to a separated condition, a fuse connector for the fuse element electrically connecting the fuse element to the second fuse terminal and having a tubular portion, means defining a spring seat secured to said fuse connector, said spring having one end thereof abutting against said spring seat, and an indicating rod fixedly secured within said tubular portion, the second fuse terminal having an axial bore therethrough, the indicating rod being positioned within said axial bore of the second fuse terminal and slidable therein to an indicating position in response to force applied thereto from the retracting spring when the fuse element blows.

3. In combination, an indicating fuse including a fuse-cap terminal secured to one end of a tubular insulating fuse holder, a tubular apertured metallic condensing chamber secured to the other end of the fuse holder, means defining a current-limiting section, a tubular gas-evolving axial-bore-type interrupting section having rupturable fuse means therein, a condensing chamber section, a deformed tubular fuse connector, said rupturable fuse means being secured to the deformed end of the fuse connector, an indicating insulating rod, at least one fuse cable secured to the undeformed end of the tubular connector, a terminal stud having an axial bore therethrough secured to said condensing chamber and having said indicating rod extending through the axial bore thereof, and means conductively securing the other end of said fuse cable to the interior end of the terminal stud.

4. In combination, an indicating fuse including a fuse-cap terminal secured to one end of a tubular insulating fuse holder, a tubular apertured metallic condensing chamber secured to the other end of the fuse holder, means defining a current-limiting section, a tubular gas-evolving axial-bore-type interrupting section having fusible fuse means therein, a condensing chamber section, a deformed tubular fuse connector, said fusible fuse means secured to the deformed end of the fuse connector, an indicating insulating rod and at least one fuse cable secured to the undeformed end of the tubular connector, a terminal stud having an axial bore therethrough secured to said condensing chamber and having said indicating rod extending axially through the axial bore thereof, and an indicator spring encircling said deformed tubular fuse connector and biasing the same to an indicating condition of the fuse wherein said indicator rod is ejected along said terminal stud bore.

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