March 22, 1966 R. E. FRINK 3,242,291

GAS EVOLVING ARC-ELONGATING HIGH-VOLTAGE FUSE

Filed Jan. 18, 1963 2 Sheets-Sheet 1

Fig. 1.

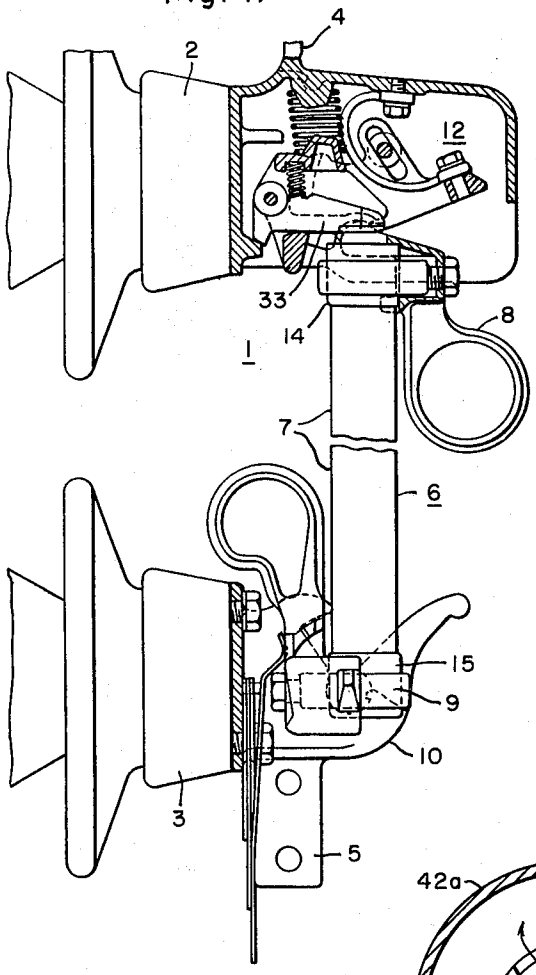


Fig. 5.

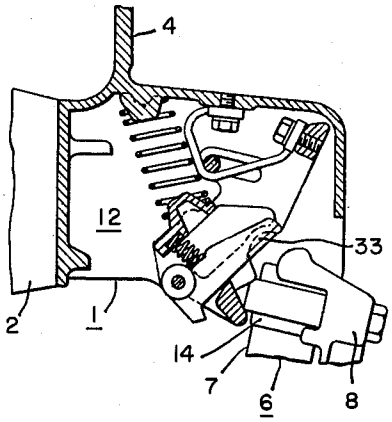
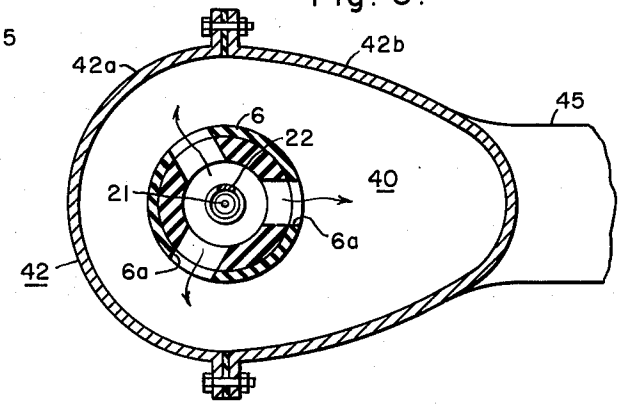


Fig. 3.



WITNESSES

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March 22, 1966 R. E. FRINK 3,242,291

GAS EVOLVING ARC-ELONGATING HIGH-VOLTAGE FUSE

Filed Jan. 18, 1963 2 Sheets-Sheet 2

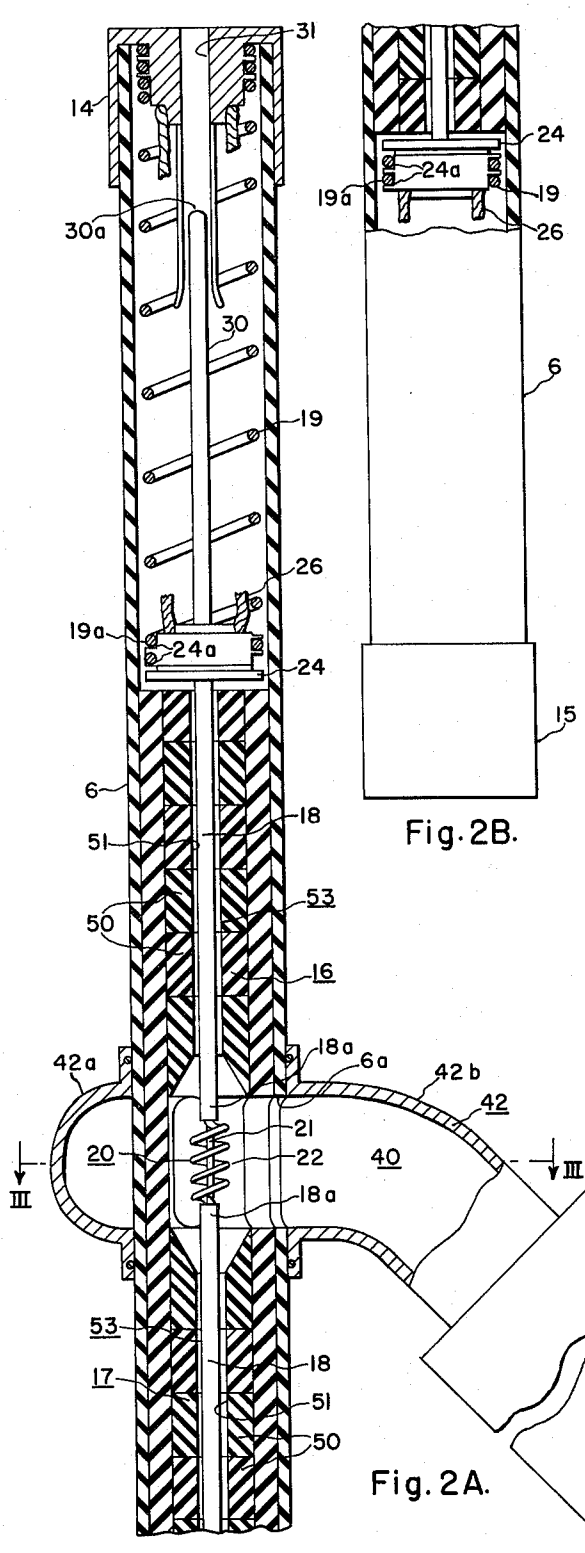

Fig. 2A.

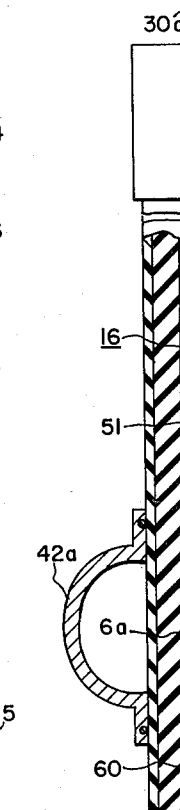

Fig. 2B.

Fig. 4.

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GAS-EVOLVING ARC-ELONGATING HIGH-VOLTAGE FUSE

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Filed Jan. 18, 1963, Ser. No. 252,397

5 Claims. (Cl. 200—120)

This invention relates to fuse constructions, in general, and, more particularly, to fuse constructions suitable for relatively high capacity.

A general object of the present invention is the provision of an improved fuse construction suitable for interrupting circuits having considerable capacity.

Recent rapid expansion of electrical systems has resulted in requirements of higher interrupting capacity for all protective devices, and this requirement includes fuse constructions. For many years, the interrupting capacity of a high voltage commercial fuse of the type DBA–2 manufactured by the assignee of the present invention, has been 1000 mva., and recently, by improved construction, such rating has been increased to 1500 mva. However, as mentioned, the requirements of electrical systems has increased to the point where further interrupting capacity is needed.

In a fuse which interrupts in a small bore, and depends upon gas evolution for de-ionization, the voltage interrupting capacity per unit length depends upon the diameter of the bore. To obtain high voltage ratings, long bores are required. However, for a given current, gas evolution per unit length is constant, and the longer the bore, the more gas must be expelled from the open end. When the velocity of the jet reaches the speed of sound, no more gas can escape, and the pressure rises until the tube possibly bursts. The results is that the longer the bore, the lower the maximum interrupting rating.

As a further approach to this difficult problem a particular manufacturer, constructs his fuses to exhaust from both ends and, as a result, considerably higher interrupting ratings are claimed. However, it is considered that such a construction is inadvisable because the jet, which exhausts from the energized end of the fuse would tend to aggravate breakdown to ground, and because of the necessity of providing a vent at the top of the fuse tube structure prevents adequate protection against icing during inclement weather conditions.

It is, therefore, an object of the present invention to provide an improved fuse construction in which venting is facilitated, and yet provision against icing is readily obtained.

Still a further object of the present invention is the provision of an improved fuse construction in which a pair of arcing rods are utilized having connected therebetween the fusible element, whereby during an opening operation both arcing rods separate in opposite directions, and, accordingly, quickly lengthen the established arc.

It is a further object of the present invention to provide an improved venting arrangement for a fuse construction utilizing two movable arcing rods having connected therebetween the fusible element.

Yet a further object of the present invention is the provision of an improved high-capacity fuse utilizing two movable arcing rods having a fusible element connected therebetween and, additionally, having a trigger rod associated therewith to effect actuation of an associated drop-out mechanism.

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

FIGURE 1 is a side elevational view of a fuse construction embodying the principles of the present invention, with the fuse being shown in its intact condition;

FIGS. 2A and 2B illustrate an enlarged sectional view taken through the fuse tube structure, with the fittings omitted, and illustrating the fusible element in its intact condition;

FIG. 3 is a sectional view taken substantially along the line III—III of FIG. 2;

FIG. 4 is a fragmentary view similar to that of FIG. 2, but illustrating the position of the several parts during a fuse opening operation; and,

FIG. 5 is a fragmentary sectional view taken through the upper terminal of the fuse structure illustrating the actuation of the drop-out mechanism.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral **1** generally designates a fuse structure. As well known by those skilled in the art, generally, the fuse structure **1** comprises a supporting means, in this particular instance including a pair of support insulators **2, 3** having terminal means **4, 5** associated therewith. Electrically interconnecting the terminal means **4, 5** is a fuse-holder assembly, generally designated by the reference numeral **6**, and comprising a fuse-tube structure **7** and associated mounting hardware **8, 9**.

As well known by those skilled in the art, the fuse-tube structure **6** (FIG. 2) may have suitably clamped adjacent the ends thereof hardware fixtures, such as the eyelet ring **8** and the hinge fixture **9**, to permit pivotal mounting upon a stationary hinge contact **10** fixedly secured adjacent the lower terminal means of structure **1**.

Associated with the upper terminal means **4** is a drop-out mechanism, generally designated by the reference numeral **12**, and more fully described in United States Patent 2,403,121, issued July 2, 1946, to Herbert L. Rawlins and John J. Mikos, and assigned to the assignee of the instant application.

Generally, the operation of the fuse structure **1** is such as to effect fusion of the fusible element disposed interiorly of the fuse tube **7**, whereby suitable means, more fully described hereinafter, causes the upward ejection of a trigger rod to effect actuation of the kick-out or drop-out mechanism **12** fully set forth in the aforesaid patent.

With reference to FIGS. 2–4 of the drawings, it will be observed that the fuse-tube structure **6** has a pair of fuse ferrules **14, 15** secured by any suitable means to the opposite ends thereof. As viewed in FIG. 2, a pair of interrupting sections **16, 17** are provided, each of which has associated therewith a movable arcing rod **18** spring-biased by a tension spring **19** toward an open-circuit position.

Electrically and mechanically interconnecting the inner opposed ends **18***a* of the arcing rods **18** is a fusible element, generally designated by the reference numeral **20**, and comprising a strain wire **21** and a fusible link **22**. As shown, the fuse wire **22** is coiled about the strain wire **21** and, in fact, carries the major proportion of the current, the strain wire **21** having a relatively high resistance, as well known by those skilled in the art.

As shown in FIG. 2, the outer ends of the movable arcing rods **18** have fixably secured thereto spring caps **24** having grooves **24***a* within which are secured turns **19***a* of the tension springs **19**. As a result, the two

movable arcing rods **18** are biased outwardly away from each other by the tension springs **19** to a circuit-opening position. Resisting this action is the fusible element **20**, which maintains the rods in their operative condition, as illustrated in FIG. 2.

Electrically interconnecting the fuse caps **24**, or spring seats is a flexible cable assembly, generally designated by the reference numeral **26**, and comprising one or more parallel-disposed flexible connecting cables to carry the current. As a result, the tension spring **19** need not perform this purpose.

It will be observed that the upper movable arcing rod **18** has associated therewith and movable therewith a trigger rod **30**, which projects through an opening **31** in the fuse ferrule **14** during a circuit-opening operation to effect thereby actuation of the kick-out or drop-out mechanism **12**, as set forth in the aforesaid patent. FIG. 5 illustrates the actuation of the drop-out mechanism **12** following impact of the extremity **30***a* of the trigger rod **30** against the release latch **33**. Drop-out operation ensues in accordance with the aforesaid patent, the entire fuse-holder assembly **6** pivoting in a clockwise direction about the trunnions associated with the lower hinge assembly. This provides a visible indication of fuse operation and, additionally, furnishes an isolating air gap to prevent any voltage breakdown across insulating surfaces.

As illustrated in FIGS. 2 and 3, venting means **40** are preferably provided intermediate the ends of the fuse-tube structure **6**. Such venting means preferably includes one or more vents **6***a* registering with a collecting chamber **42** provided by a split casting, as more fully illustrated in FIG. 3 of the drawings. If desired, a suitable condenser **45** may be associated with the exhaust end of the collecting chamber **40** to deionize any exhaust gases. The internal construction of the condenser may, for example, follow the teachings set forth in U.S. patent application, filed April 30, 1958, Serial No. 731,916, by Calvin C. Patterson and assigned to the assignee of the instant application.

To facilitate arc interruption within the fuse-tube structure **6**, there is preferably provided a plurality of stacked gas-evolving blocks **50** having bores **51** provided therethrough. The gas-evolving material may be boric acid, horn fiber, or a synthetic resin. The alignment of the several bores **51** provides an arcing passage, generally designated by the reference numeral **53**, and effecting gas evolution by the contact of the established arc with the inner wall of the fuse-tube bore.

From the foregoing description of the several parts it will be obvious as to the operation of the fuse-tube structure **6**. Briefly, by way of recapitulation, fusion of the fusible element **20** will effect release of the two arcing rods **18**, and separating outward movement thereof as caused by the biasing action exerted by the tension springs **19**. The ejection of the trip rod **30** externally of the fuse-tube structure **6** will actuate the kick-out mechanism **12** to effect drop-out action of the fuse-holder assembly **6**.

The fusible element **20** operates in a manner well known to those skilled in the art, namely first fusion of the coiled fuse link **22** and immediately thereafter or practically simultaneously therewith fusion of the strain wire **21**. Such releasing action quickly occurs, and the established arc **60**, more clearly shown in FIG. 4, effects evolution of the gas along the fuse-tube bores. The gas will generally be directed inwardly and out the collecting chamber **40** into the condenser **45**, if used.

It is readily apparent from the maximum interrupting ratings of a current line of commercial fuses manufactured by the assignee of the present application that to obtain high voltage ratings, long bores are required. However, for a given current, gas evolution per unit length is constant, and the longer the bore, the more gas must be expelled from the open end. When the velocity of the jet reaches the speed of sound, no more gas can escape, and the pressure rises until the tube possibly bursts. The result is that the longer the bore, the lower the maximum interrupting rating. To illustrate this point more clearly, the following tabulation of present ratings for a particular type of fuse construction is presented:

Fuse type	Rated kv.	Rated max. interrupting amps (sym.)
BA 400----	7.2	25,000
BA 400----	14.4	20,000
BA 400----	23.0	16,000
DBA-2----	34.5	12,500
DBA-2----	46.0	12,500
DBA-2----	69.0	10,000
DBA-2----	92.0	6,300
DBA-2----	115.0	5,000
DBA-2----	138.0	4,000

It will be apparent that the particular construction as proposed in the present invention surmounts this venting problem particularly acute in the high-voltage fuses by providing the double movable arcing-rod construction with the centrally-located venting means to accommodate venting from both gas-evolving tube sections. In addition, adequate arc length is quickly achieved and intensive arc deionization is brought into play over a long length of the established arc. The result is prompt and effective arc extinction with consequent circuit interruption.

A number of important improvements result from the construction of the present invention:

(1) Using two arcing rods results in double the rate of contact separation.

(2) The voltage gradient is in the center of the fuse and therefore less likely to cause flashover.

(3) The collecting chamber acts as a corona shield around the element.

(4) By venting the fuse in the center, approximately double the quantity of gas can be exhausted before the rupture point is reached. In effect, instead of a single fuse, there are two fuses in series. Referring to the foregoing table a 92 kv. fuse would handle the same current as a 46 kv. fuse now handles, or a 138 kv. fuse would handle the same current as now handled by a 69 kv. fuse. This amounts to practically doubling the rating.

From the foregoing description of the invention it will be apparent that there is provided an improved fuse structure particularly adapted for high-capacity ratings and effective to very quickly establish and lengthen an arc due to the simultaneous outward separating movement of the two arcing rods **18**. The arc, as a result, is quickly lengthened, and considerable gas evolution ensues. Each of the arcing sections has venting access to the venting means **40**, and, consequently, there does not arise any excessive build-up of pressure within the arcing section **16**.

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. In combination, a high-voltage power fuse including a fuse tube having terminal means adjacent opposite ends thereof, gas-evolving means situated adjacent the central portion of said fuse tube defining a pair of axially aligned gas-evolving arc passages, a pair of spaced movable arcing rods, means biasing each of said arcing rods away from the adjoining movable arcing rod along said arc passages, fusible link means for mechanically and electrically securing the opposed inner ends of the movable arcing rods in opposition to the effect of said biasing means, said fuse tube having venting means therein adjacent the central portion thereof and in close proximity to the fusible link means, and means forming a gas collecting chamber communicating with the venting means.

2. A high-voltage power fuse including an elongated insulating fuse tube, said fuse tube having a centrally-located arcing section and two end spring sections, a pair of spaced generally cylindrical gas-evolving means disposed within the fuse tube and defining a pair of axially aligned arc passages with a fuse link chamber therebetween in said arcing section, a pair of movable spaced arcing rods in the pair of arc passages respectively, a tension spring assembly disposed in each spring section and connected to the outer end of each movable arcing rod, and fuse link means mechanically and electrically connecting the opposed inner ends of the movable arcing rods, the fuse tube having venting means therein in the central portion thereof and adjacent the fuse-link means, whereby fusion of the fuse link means will release the two movable arcing rods and quickly establish and lengthen an arc through the arcing section.

3. The combination of claim 2, wherein one of the tension spring assemblies carries a release rod for actuating a kick-out mechanism by extending exteriorly of the end of the fuse tube.

4. A high-voltage power fuse including, in combination, an elongated fuse tube having an apertured central portion, spaced terminal means disposed adjacent the ends of the fuse tube, gas collecting means surrounding said central portion of the fuse tube, gas-evolving means defining a pair of elongated gas-evolving arc passages joined adjacent said apertured central portion, a pair of biasing spring sections disposed adjacent opposite ends of the fuse tube, a pair of spring-biased-apart spaced movable arcing rods extending coaxially of the arcing passages and terminating adjacent the central apertured portion of the fuse tube, fuse link means electrically and mechanically connecting the opposed inner ends of the movable arcing rods, a pair of spring assemblies connected to the outer ends of the movable arcing rods and additionally carrying current to said spaced terminal means, whereby fusion of the fuse link means will release the two arcing rods and permit retracting movement thereof into the gas-evolving arc passages to bring about extinction of the established arc by a flow of gas toward said gas collecting means.

5. The combination of claim 4, wherein one of the spring assemblies carries a release rod for actuating an associated kick-out mechanism for drop-out operation of the power fuse.

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