United States Patent [19]

Link

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[54] **VACUUM INTERRUPTER**

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[52] **U.S. Cl.** .... **200/144 B,** 337/405, 337/152, 337/166, 337/410, 337/248

[51] **Int. Cl.** **H01h 33/66**

[58] **Field of Search** .... 200/144 B; 337/405, 410, 337/166, 152, 248

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[57] **ABSTRACT**

A high voltage, high current vacuum fuse having a pair of conductive members supported in a spaced relation within a dielectric housing and shielded by a condensation shield, the conductive members being interconnected either by a fusible link or by a conductive element and a pair of fusible links, the fusible link or links being of a minimum volume and the conductive members being spaced to provide a gap of sufficient length to interrupt current. The conductive members or the element being biased to increase the gap on fusing on the fusible link.

9 Claims, 5 Drawing Figures

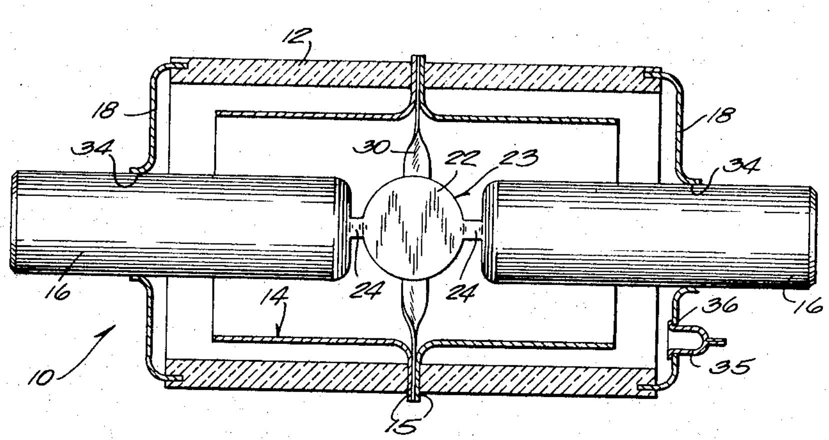
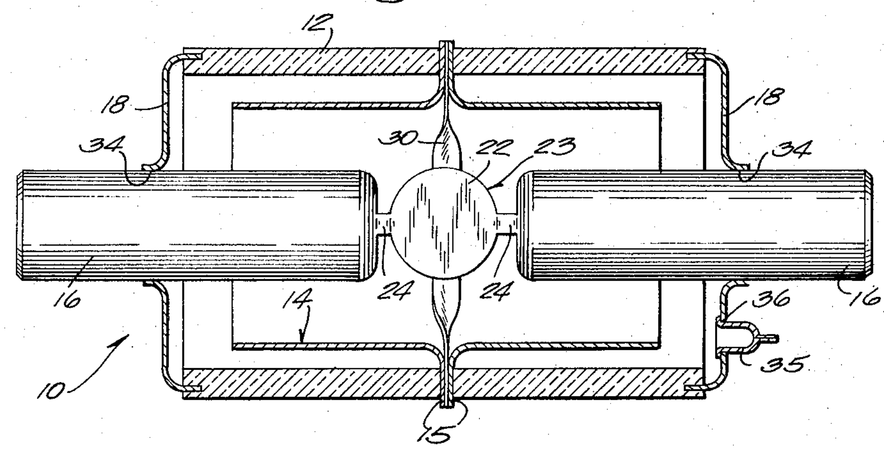


Fig. 1



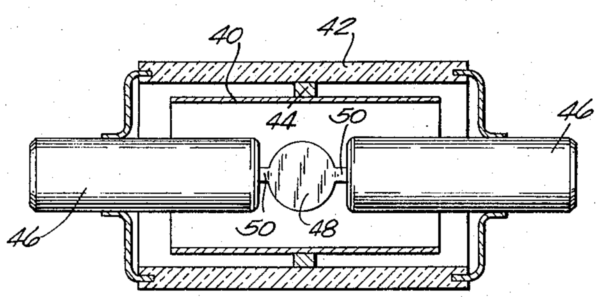


Fig. 3

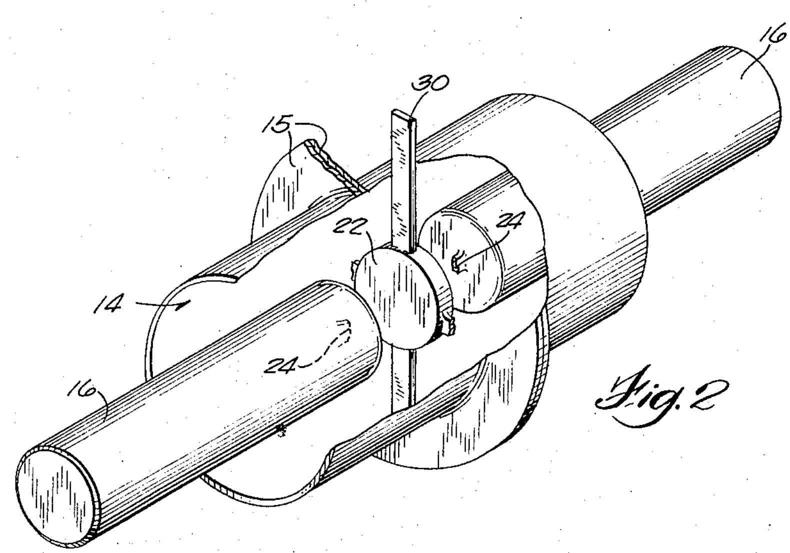


Fig. 2

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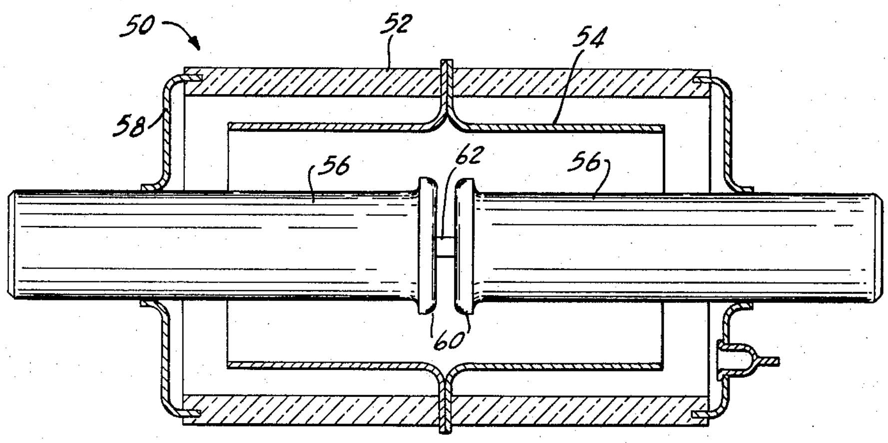

Fig. 4

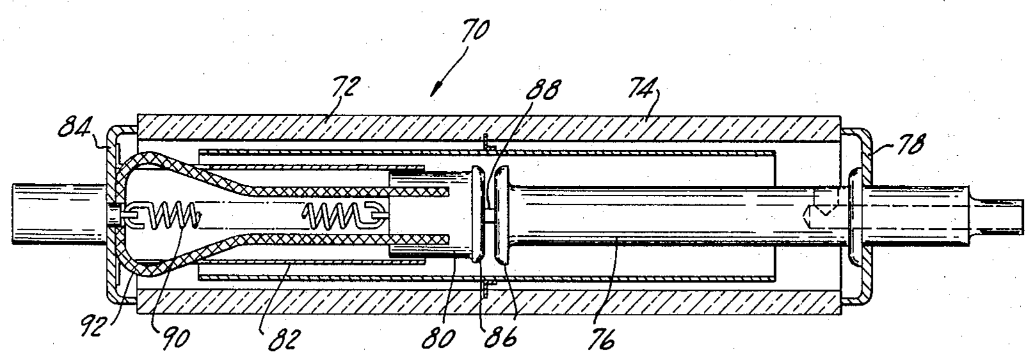

Fig. 5

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VACUUM INTERRUPTER

RELATED APPLICATION

The application is a continuation-in-part of my co-pending application Ser. No. 18,868, entitled Vacuum Fuse, filed on Mar. 12, 1970.

BACKGROUND OF THE INVENTION

Vacuum fuses generally have been provided with a fusible link throughout the full length of the fuse connected to conductive members at each end of the fuse. A condensation shield is often provided around the fusible link to mask the inside surface of the dielectric housing and prevent the vaporized fuse link material from depositing on the inside surface of the housing thereby preventing flash-over between the conductive members. However, it has been found that due to the large mass of the fusible element, the vapor pressure produced on fusing of the element is large enough to produce an arc plasma sufficient to support an arc long enough to cause an explosive condition in the fuse.

SUMMARY OF THE INVENTION

The vacuum fuse of the present invention minimizes the amount of material in the fuse link while still providing a sifficient gap between the conductive members to interrupt current. The reduced amount of fusible material which can be vaporized and the establishment of a gap between the conductive members assures immediate interruption of current. This can also be achieved by supporting an electrically conductive element on a pair of small fusible links in the gap provided between the conductive members. On fusing of the small links, the large movable element will drop out of the gap in the conductive members leaving a gap of sufficient size to prevent arc-over. The movable element can be supported on a torsion spring which is biased to move the movable element to a neutral position relative to the conductive member on fusing of the fusible link.

In another embodiment of the invention, a pair of conductive members having a substantially large mass are supported in a spaced relation within the housing with a single fusible link interconnecting the stationary members. The mass of the conductive members provided a cooling surface immediately adjacent the fusible link for condensing the vaporized fuse material. The immediate condensation of the vaporized fuse material minimizes the possibility of establishing an are plasma between the conductive members which could prolong the time of arc interruption.

THE DRAWINGS

FIG. 1 is a side view in section of the vacuum fuse showing the position of the conductive member in the condensation shield;

FIG. 2 is a perspective view partly broken away to show the position of the disc after fusing of the links;

FIg. 3 is a side view in section of a modified vacuum fuse;

FIG. 4 is a side view in section of another form of the invention having a single fusible link interconnecting stationary conductive members having an enlarged head at the end; and

FIG. 5 is a side view in section of another embodiment of the invention showing a single fusible link connecting a stationary conductive member to a movable conductive member.

DETAILED DESCRIPTION OF THE DISCLOSURE

The vacuum fuse of this invention is shown in FIGS. 1 and 2 as a one shot type fuse **10** as generally used in a high current, high voltage network. The fuse **10** generally includes a hollow, cylindrical housing **12** formed of a dielectric material such as procelain or glass, a cylindrical condensation shield **14** having flanges **15** secured to the housing **12** and conductive members **16** supported within the housing **12** by means of end walls **18**. The edges of the end walls **18** are hermetically sealed to the housing **12** and the conductive members **16**. Circuit interruption is achieved by fusing links **24** connected to the conductive members **16** within the condensation shield **14** to produce a gap **23** of sufficient width to prevent arc-over.

In accordance with one aspect of the invention, means are provided for producing the gap **23** between the conductive members **16** under overload or fault current conditions by fusing only a small portion of fusible material. Such means includes a movable element or disc **22** supported in the gas **23** between the conductive members **16** by a pair of small fusible elements or links **24**. The disc **22** and the links **24** can be formed as integral parts of the conductive members **16** or as separate parts secured to the conductive members **16**. The disc **22** normally lies in a plane generally parallel to the longitudinal axis "a" of the conductive members **16**. When an overload occurs in the line, the two small fusible links **24** will fuse leaving the disc **22** free to drop out of the gap **23** between the conductive members **16**. The gap produced in the conductive members **16** by removing the disc **22** is of sufficient width to prevent arc-over.

The vaporized material of the links **24** is prevented from depositing on the inside surface of the housing **12** by means of the condensation shield **14** which substantially completely condenses all of the vaporized material. More specifically, it should be noted that the links **24** are quite small so that a relatively small amount of material is vaporized when the links **24** are fused. This small amount of material will be completely condensed by the condensation shield **14**. Little, if any, material will deposit on the inside surface of the housing thereby substantially eliminating the possibility of flash-over occurring across the inside surface of the housing **12**.

Means are provided for supporting the disc **22** for movement from the normal or conductive position parallel to the longitudinal axis "a" of the conductive member **16** to a neutral or non-conductive position transverse to the longitudinal axis "a" of the conductive member **16**. Such means is in the form of a torsion spring **30** secured to the condensation shield **14** and to the disc **22**. The spring **30** is normally twisted, as seen in FIg. **1**, to provide a bias for moving the disc **22** to the neutral position on release of the disc **22** from the conductive members **16**. The space or gap between the conductive members and the disc or movable element **22** must be large enough to prevent arc-over when rotated to the neutral position.

Air is evacutaed from the housing by means of a tube **35** sealed in an opening **36** provided in one of the end walls **18.** Air is withdrawn from the housing by any conventional means to produce a vacuum and the tube **35** crimped and tinned to seal the housing. The end walls **18** and condensation shield **14** should be formed of a material having substantially the same coefficient of expansion as the housing **12.** Kovar has been used for both the end walls **18** and the condensation shield.

The vacuum fuse **10** can be formed by machining the two links **24** and the disc **22** as in integral part of the conductive member **16.** The torsion spring **30** can be attached directly to the disc **22** or inserted into a slot provided in the disc **22** which is then pinched to secure the spring **30** in the disc. The ends of the torsion spring **30** are twisted and secured to the flange **15** on one of the condensation shields **14.** The housing **12** is initially formed in two sections, with the outer edges of the end walls **18** embedded in and hermetically sealed to the ends of the housing **12.** The two sections of the housing **12** are hermetically sealed to the flanges **15** with the conductive member **16** projecting outwardly through the apertures **32** provided in the end walls **18.** The flanges **15** on the condensation shield **14** are welded together with the ends of the torsion spring positioned between the flanges **15.** A seal is provided between the end walls **18** and the conductive member **16** by silver soldering the edges of the end walls to the conductive member **16.**

In FIG. 3 an alternate form of the invention is shown in which a unitary shield **40** is supported within a dielectric housing **42** by means of an annular ring **44.** The ring **44** can be formed as an integral part of the housing **42,** as a separate ring or as a number of independent segments all made of a dielectric material. The conductive members **46** are provided with a movable element or conductive disc **48** supported by fusible links **50.** When the links **50** fuse, the movable member **48** will merely drop onto the shield **40** leaving a gap between the conductive members **46.**

Referring to FIG. 4 of the drawings, another embodiment of the invention is shown wherein a fuse **50** having a dielectric housing **52** and a cylindrical metallic shield **54** which acts as a condenser for metallic vapor and prevents the dielectric housing from being coated with metal. The housing **52** is closed at each end by end walls **58** to form a chamber within the housing **52** which is evacuated as described above. Conductive members **56** are supported in a spaced relation in the housing **52** by means of the end walls **58.** The ends of each of the conductive members **56** are located in a spaced relation within the housing. The space or gap is closed to complete the circuit through the conductive members **52** by means of a fusible element or link **62.**

In accordance with the invention, the mass of the fusible element is kept to a minimum for a given volumetric space to interrupt current in a **60** cycle system as soon as the current passes through zero. It should be understood that if the current continues to arc for two or more cycles an explosive condition will exist within the fuse.

In this regard the mass of the fuxible element **62** is determined by the anticipated KV in which the fuse is to be used. For example, in a 15 KV system the fusible link **62** should have a length of approximately one-half inch. It should be noted that the ends **60** are massive in relation to the fusible element **62** and thereby provide a large cooling surface on each side of the fusible element **62.** When a short circuit current occurs, the fusible link **62** will vaporize and will immediately condense on the surface of the ends **60,** and shields **54.** In a high voltage application as contemplated here in, a cross-sectional area relationship between the ends **60** of the conductive members **56** and the fusible element **62** of five to one is required to provide sufficient cooling.

Immediate condensation of the vaporized fuse material prevents the increase of vapor pressure within the housing **52.** It should be understood that on vaporization of a fusible element an increase pressure occurs creating arc plasma sufficient to allow the arc to continue for more than one cycle. In order to achieve higher KV levels, it might be necessary to move one of the electrodes to increase the arc gap. In this regard another embodiment of the invention is shown wherein a fuse **70** having a dielectric housing **72** and a metallic shield **74** in FIG. **5** is provided with a stationary conductive member **76** on one of the end walls **78** and a movable conductive member **80** supported by a tubular member **82** provided on the other end wall **84.** The conductive members **76** and **80** have their inner ends **86** spaced a predetermined distance apart. The circuit through conductive members **76** and **80** is completed by means of a fusible element link **88** as described above.

The movable conductive member **80** is mounted on the tubular member **82,** which is secured to the end wall **84** and is biased by means of a spring **80** toward the end wall **84.** The conductive member **80** is connected into the circuit by means of a flexible electric line **92.** The fuse of this embodiment is operated substantially in the same manner as FIG. **4.** However, on fusing of the link **88** the spring **90** will move the member **80** toward the end wall **84.** A dual function is thereby provided by the movable member **80,** it provides a large cold mass to condense vaporized fuse material and increases the allowable KV recovery voltage of the gap minimizing the possitilities for arc-over. Although a spring has been shown for biasing the conductive member **80,** other types of biasing means can be used including the inherent resiliency of the conductive members. I claim:

1. A one use high voltage vacuum fuse comprising a housing formed of a dielectric material,

to stationary electrically conductive members supported in a spaced relation within said housing and extending outwardly therefrom for connection to an electric circuit,

a conductive bridging element,

a pair of fusible links connecting said bridging element to said stationary members, and

means for supporting said bridging element for movement with respect to said stationary members whereby said bridging element is free to move to a position to form a gap on either side of said bridging element between said two stationary members when said links fuse, said gaps being of sufficient length to interrupt the circuit across the two stationary members.

2. A vacuum fuse according to claim **1** including a condensation shield supported within said housing in a position to mask said housing from said fusible elements.

3. A vacuum fuse according to claim 1 wherein said bridging member and said fusible links are formed as an integral part of said stationary members.

4. A vacuum fuse according to claim 1 wherein said supporting means moves said bridging member to a position transverse to said stationary members.

5. A vacuum fuse according to claim 1 wherein said supporting means comprises a torsion spring.

6. A high voltage vacuum fuse comprising a pair of fixed electrically conductive members adapted to be connected to an electric circuit,

an electrically conductive disc and a pair of electrically conductive fusible links connected between said disc and said fixed member,

a housing formed of a dielectric material hermetically sealed to said fixed members to enclose said disc and said fusible links,

and means for biasing said disc for movement with respect to said fixed members whereby said disc is free to move on fusing of said links to provide a gap on either side of said disc between said fixed members of sufficient length to interrupt current flow.

7. The fuse according to claim 6 wherein said supporting means comprises a torsion spring for biasing said disc to a current interrupting position.

8. The fuse according to claim 7 including a condensation shield supported within said housing in a position to mask said housing from said fusible links.

9. The fuse according to claim 6 wherein said fixed members, conductive disc and fusible links are formed from a single piece of electrically conductive material.

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