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Link

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[54] **FLUID FUSE**

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[52] **U.S. Cl.** **337/277,** 337/204

[51] **Int. Cl.** **H01h 85/40**

[58] **Field of Search** ..... 337/204, 281, 277, 337/275, 239, 273; 200/166 BA

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[57] **ABSTRACT**

A fluid fuse having an electric terminal at each end of a tubular dielectric housing, an electrically conductive member electrically connected to each of said terminals, an electrically conductive fusible element interconnecting the members, a barrier positioned adjacent to the element to separate the housing into high and low pressure chambers, and an arc extinguishing fluid, either liquid or gas, confined under pressure within the high pressure chamber. The barrier is located close enough to the element so that the heat of the arc on rupture of the fusible element will form a hole in the barrier releasing the arc extinguishing fluid to extinguish the arc between the members.

8 Claims, 2 Drawing Figures

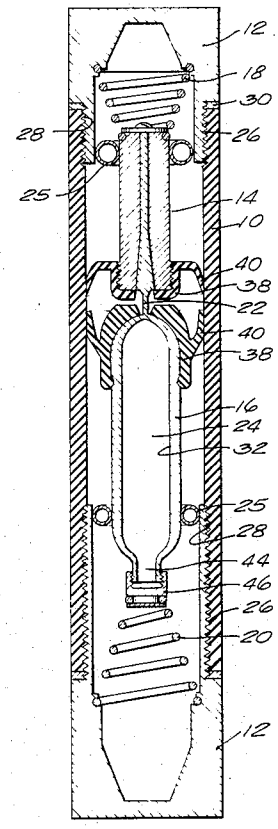


Fig. 1

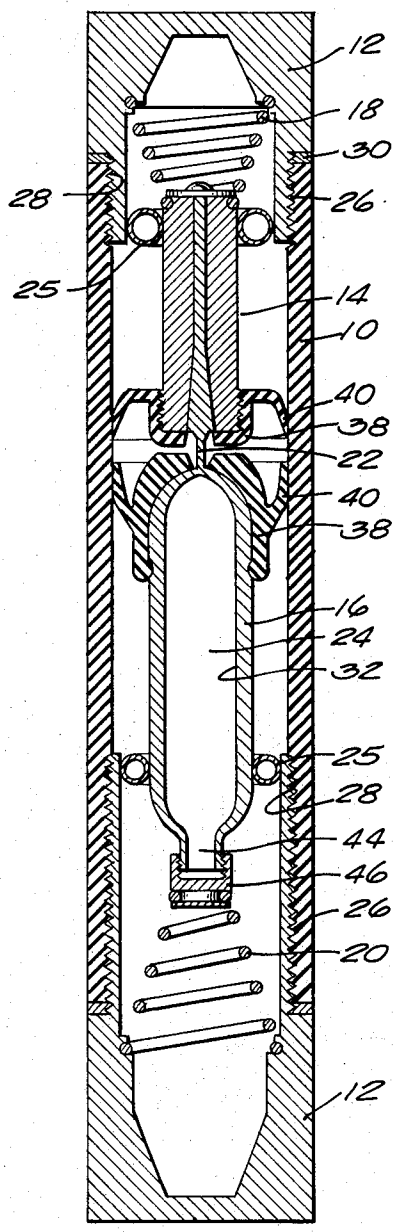
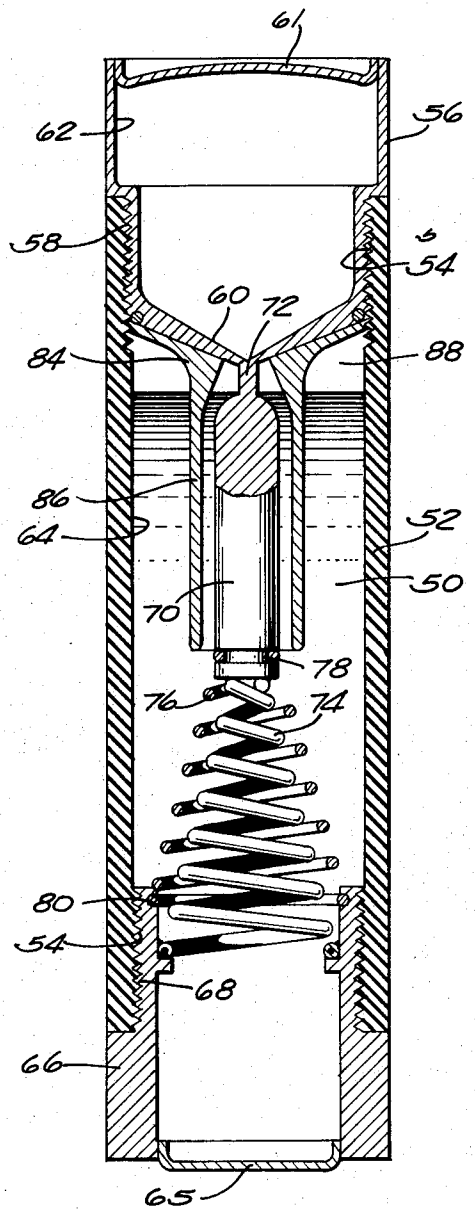


Fig. 2



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FLUID FUSE

BACKGROUND OF THE INVENTION

Fuses of the type contemplated herein are used as circuit interrupters for high voltage cables. These devices generally include a pair of conductive members connected by an elongate fusible element which ruptures in response to an overload condition setting up an arc between the conductive members. Various devices have been used to extinguish the arc on rupture of the fusible element such as gas generating sleeves which are heat activated to produce an arc suppressing atmosphere between the members. The gap between the conductive members is usually large or the conductive members are separated rapidly to aid in extinguishing the arc. Arc extinguishing gases have been used with some success as shown in the Lingal et al. U.S. Pat. No. 2,757,261, issued July 31, 1956, and entitled "Circuit Interrupters" to extinguish the arc, but have not been entirely satisfactory.

SUMMARY OF THE INVENTION

The fluid fuse of this invention provides for rapid extinguishing of the arc created on rupture of a fusible element through the immediate release of an arc extinguishing fluid, either liquid or gas, on rupture of the fuse. The fluid is confined under pressure on one side of a barrier which separates the fuse into high and low pressure chambers. On rupture of the fusible element, the heat of the arc will burn a hole in the barrier releasing the pressurized arc extinguishing fluid into the gap between the conductive members to extinguish the arc. The arc extinguishing fluid confined within the housing can be either in the form of a dielectric liquid or gas. This arrangement provides for a non-explosive type fuse by the immediate release of an arc extinguishing fluid into the area of the arc upon rupture of the fusible element. The pressure of the arc extinguishing fluid can also be used to aid in rapidly increasing the gap between the conductive members thereby increasing the length of the arc path between the conductive members.

Other objects and advantages will be apparent from the following detailed description when read in connection with the accompanying drawing.

THE DRAWING

FIG. 1 is a section view of one form of the invention wherein the arc extinguishing fluid,in the form of a gas,is confined under pressure within a chamber in one of the electrical members;

FIG. 2 is another form of the invention wherein an arc extinguishing fluid,in the form of a liquid,is confined within the housing under pressure.

DESCRIPTION OF THE INVENTION

The fluid fuse **8** disclosed herein essentially includes a housing having a pair of conductive members connected by means of a fusible element to form an electrical circuit through the housing. The housing is separated by means of a barrier into high and low pressure chambers. An arc extinguishing fluid is confined in the high pressure chamber. The barrier is made of a material which will burn or fuse when subjected to the heat of an arc set up between the conductive members on rupture of the fusible element. As soon as a hole forms in the barrier, the arc extinguishing fluid which is under high pressure will flow across the arc to extinguish the arc.

Arc extinguishing fluids of the type contemplated herein may be either gas or liquid. Any of the following fluids can be used to extinguish an arc. Sulfur hexafluoride; fluorinated hydrocarbons such as Freon; oxyfluorides such as mono-oxytetrafluoride or di-oxydifluoride; carbon dioxide and insulating oils. Sulfur hexafluoride is preferred because of its stability, low condensation temperature $-64°$ C at atmospheric pressure, and its high dielectric strength, two to four times that of air.

More specifically, and referring to FIG. **1**, a fluid fuse **8** is shown which includes a tubular dielectric housing **10** having an electric terminal **12** threadedly received and sealed in each end of the housing. Electrically conductive members **14** and **16** are positioned within the housing **10** and are biased by means of springs **18** and **20**, respectively, for movement toward their respective terminals **12**. The conductive members **14** and **16** are interconnected by means of a fusible element **22** which is designed to rupture under fault current conditions to break the circuit through the fuse **8**. The conductive members **14** and **16** will normally be pulled apart by the springs **18** and **20** to draw out the arc set up on rupture of fusible element **22**. In accordance with the invention, means are provided for immediately extinguishing the arc between the conductive members **14** and **16**. Such means is in the form of an arc extinguishing fluid **24** confined under pressure within a wall or barrier which will burn or fuse from the heat of the arc to release the arc extinguishing fluid for flow across the gap between the conductive members.

In this regard, and referring to FIG. **1**, the electric terminals **12** each include a threaded section **26** which is screwed into a threaded section **28** provided at each end of the housing **10**. Seals **30** on the terminals **12** are used to seal the housing **10**. The electric terminals **12** are adapted to be connected into an electric circuit in a conventional manner. The conductive members **14** and **16** are positioned within the housing and are biased toward the adjacent terminal **12** by means of the springs **18** and **20**, respectively. Electric contact between the conductive members **14** and **16** and the terminals **12** is provided by means of electrically conductive garter springs **25** positioned between the terminal **12** and the conductive members **14** and **16**. The garter springs **25** also allow for the movement of the conductive members **14** and **16** into the housing terminal **12** on rupture of the fusible element **22**.

The arc drawn between the conductive members **14** and **16** on rupture of the fusible element **22** is immediately extinguished by the release of the arc extinguishing fluid **24**. This fluid **24** is confined within a chamber **32** formed by means of the barrier or wall of the conductive member **16**. The chamber **32** is filled with the arc extinguishing fluid **24** prior to assembly through an opening **44** provided at one end of the conductive member **16**. The opening **44** is sealed by means of a cap **46**. On rupture of the fusible element **22**, the heat of the arc between the conductive members will burn a hole in the wall of the conductive member **16**, releasing the arc extinguishing fluid **24**, in this case a gas, such as sulfur hexafluoride. The gas will flow through the gap between the conductive members **14** and **16** extinguishing the arc before an explosive condition occurs.

Means are provided for confining the arc extinguishing fluid **24**, released from the chamber **32**, to the space between the ends of the conductive members **14** and **16**. Such means is in the form of a pair of resilient arc chutes **38** secured to the conductive members **14** and **16**. Each arc chute includes an outwardly extending flange **40** which is positioned to sealingly engage the inside walls of the tubular housing **10**. The arc extinguishing fluid **24** on release from the chamber **32** will be confined in the space between the arc chutes **38**. The increase in pressure in the space between the arc chutes **38** will also aid in separating the conductive members **14** and **16**.

Although the chamber **32** is shown only in conductive member **16**, it is also possible to include a chamber in the conductive member **14** and to confine an arc extinguishing fluid in both chambers. On rupture of the fusible element, a hole will be formed in the wall of both chambers and the gas will flow across the arc gap. The arc extinguishing fluid **24** could also be confined within a chamber located next to the fusible element **22** and in parallel relation thereto. On rupture of the fusible element, a hole will be burned in the wall of the chamber, releasing the arc extinguishing fluid so that it flows transversely across the arc gap.

In the embodiment shown in FIG. **2**, a fluid fuse is shown wherein arc extinguishing fluid in the form of a liquid **50** such as insulating oil is used to extinguish the arc. This fuse includes a tubular insulating housing **52** having threaded sections **54** at each end. One end of the housing **52** is closed by means of a cylindrical electric terminal **56** having a threaded section **58** which is screwed into one end of the housing **52**. Terminal **56** is in the form of a hollow tubular member closed by a cap **61** and an end wall **60**, to form a chamber **62** within the terminal **56**. The wall **60** forms a barrier which separates the housing **10** into two chambers, one chamber **62** within the terminal **56** and a second chamber **64** within the housing **52**. The other end of the housing **52** is closed by means of a second tubular electric terminal **66** having a threaded section **68** which is screwed into threaded section **54** at the other end of the housing. The terminal **66** is closed by a cap **65**. Both of the terminals **56** and **66** are adapted to be connected into an electric circuit.

The electric circuit across the terminals **56** and **66** is completed by means of a conductive member **70** in the form of a copper slug which is connected to the wall **60** by means of a fusible element **72** and to the terminal **66** by means of an electrically conductive winding **74** welded to the terminal **66**. The copper slug is biased into the terminal **66** by means of a spring **76** secured to groove **78** provided in the slug and a groove **80** provided in the terminal **66**. The spring **76** is an invertible type spring so that on release or rupture of the fusible element **72**, the copper slug will be pulled into the tubular terminal **66**. The heat of the arc between the terminal **56** and the conductive member **70** will burn a hole in the barrier or wall **60** which will allow the arc extinguishing liquid to flow into chamber **62**.

In this regard, an arc chute **84** having a depending sleeve **86** is secured to the wall **60** and surrounds the copper slug **70** and is spaced therefrom. The arc extinguishing fluid **52** is forced through the space between the slug **70** and sleeve **86** by means of a pressure differential provided between the chambers **62** and **64**. In this respect, the housing **52** is partially filled with the arc extinguishing insulating fluid **52** leaving a space or pocket **88** adjacent the arc chute. The pressure of the gas or air in this space or pocket **88** is higher than the pressure in the chamber **62**. The pressure differential between chambers **62** and **64** is achieved by partially evacuating chamber **62** and by inserting or filling the space **88** with an inert gas or air under pressure. On rupture of the fuse **72**, a hole will be burned in the wall **60** and the higher pressure air or gas in space **88** in the chamber **64** and the low pressure in chamber **62** will cause the fluid **52** in chamber **64** to flow through the hole in the barrier **60**. The immediate transfer of the arc extinguishing liquid through the gap between the terminal **56** and the conductive member **70** will extinguish the arc before an explosive condition can occur. The device shown in FIG. **2** can also be used as a gas fuse by filling chamber **62** with a gas under pressure and partially evacuating chamber **64**. On rupture of the fuse **72**, a hole will be burned in the wall **60** allowing the gas to flow into chamber **64**.

RESUME

The fluid fuse of the present invention provides a non-explosive type fuse by means of the immediate transfer of an arc extinguishing fluid across the gap between the conductive members on rupture of the fuse. The arc extinguishing fluid is released by using the heat of the arc to burn a hole in a barrier between two chambers in the housing. The chambers are under different pressure with the arc extinguishing fluid in the chamber of higher prssure. As soon as a hole forms in the barrier, there will be an immediate flow of arc extinguishing fluid across the gap.

I claim:

1. A fluid fuse for interrupting an electric circuit in a high voltage cable, said fuse comprising:

a housing having an electric terminal at each end adapted to be connected to the electric circuit,

an electrically conductive member connected to each of said terminals and positioned within said housing,

a fusible element connected in series with said conductive members,

a chamber within one of said members and an arc extinguishing fluid confined at high pressure within said chamber, said fluid confining members being so located that on rupture of said fusible element the heat of the arc will form a hole in said member releasing said arc extinguishing fluid for transfer from the high pressure chamber into the housing and means mounted on each of said members and sealingly engaging said housing for confining said fluid to the space between said conductive members.

2. The fuse according to claim **1** wherein a high pressure chamber is provided in the other of said conductive members.

3. The fuse according to claim **1** including means for biasing said conductive members toward said terminals to elongate said arc in the space where said fluid is confined.

4. The fuse according to claim **1** wherein said fluid is sulfur hexafluoride.

5. A non-explosive fluid fuse connected in series with a high voltage cable comprising:

an insulating sleeve,

an electrically conductive terminal sealed at each end of said sleeve,

a first electrically conductive member connected to one of said terminals,

a second electrically conductive member connected to the other of said terminals,

a fusible element electrically connected to said members and means for forming a chamber in one of said conductive members for an arc extinguishing fluid, said chamber forming conductor being formed of a material that will fuse on subjection to the heat of the arc to release said arc extinguishing fluid and means mounted on said members and sealingly engaging said housing for confining the

fluid to the space between the conductive members.

6. The fuse according to claim **5** wherein said confining means includes a resilient seal on both of said members positioned to sealingly engage said housing whereby said fluid is confined to the space between said sealing means on rupture of said element.

7. The fuse according to claim **5** including means for biasing said members toward said terminals on rupture of said element.

8. The fuse according to claim **5** wherein said fluid is sulfur hexafluoride.

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