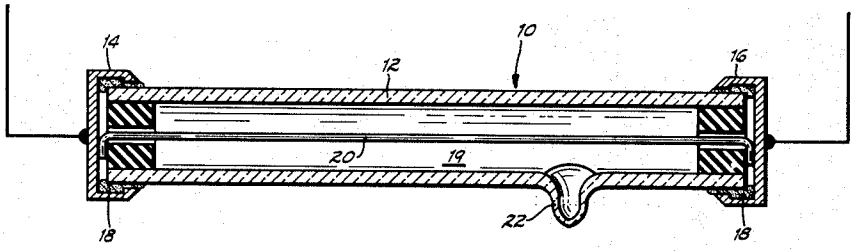
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CIRCUIT INTERRUPTING DEVICES

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CIRCUIT INTERRUPTING DEVICES

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This invention relates to circuit interrupting devices and more particularly to an arc quenching medium for circuit interrupting devices.

In many respects the mechanics of an arc drawn between separated elements of a circuit interrupting device, such as would exist between the parted ends of a fuse link, are similar to those of a discharge device and such separated elements can be considered as instantaneously forming an anode and a cathode. The arc itself can be thought of as comprising three main portions. Near the cathode a small region exists in which there is a voltage drop in the order of a few volts and which establishes an intense electric field at the cathode. In this region, the current is carried by positive ions from the surrounding medium to the surface of the metallic cathode and by electrons emitted from the cathode by thermal emission. The voltage drop in this region is chiefly determined by the space charge of the positive ions. At the anode there is a similar region, usually having a smaller voltage drop, which is caused solely by the space charge of the electrons flowing thereto. Between these regions lies the main arc stream or column, in which the density of ions nearly equals the density of electrons so that it is almost free of space charge. The arc column usually accounts for the major portion of the total voltage drop in the arc and its voltage gradient is substantially constant because of substantially uniform conductivity along its length. The voltage of an arc column varies with arc length, current, and the nature of the atmosphere and of the electrodes.

The positive ions play a large part in maintaining the arc in that their energy helps maintain the temperature of the cathode, and their space charge draws electrons away from the cathode surface. These positive ions are generated by collisions between emitted electrons and molecules in the arc path by thermal ionization due to the heat of the arc stream.

Arc quenching gaseous mediums for circuit interrupting devices such as fuses, circuit breakers, switches and the like are well known. Such gaseous mediums usually comprise fluorine compounds having large molecular cross-sections, high electron affinity and high dielectric strength. These gases accomplish arc extinction mainly by capturing electrons to form negative ions of low mobility and velocity, whereby the number of electrons available to form positive ions through electron-molecule collision is reduced. In order for such gases to extinguish an arc efficiently, it is necessary that the mean free path between gas molecules be small enough to insure a high probability of electron collision. This is accomplished in the use of prior art arc extinguishing mediums, by maintaining them at a pressure of several atmospheres, thereby providing a large number of gas molecules in the arc path and, hence, a smaller mean free path than would exist at atmospheric pressure. As a result, circuit interrupting devices utilizing prior art arc extinguishing mediums require costly hermetic sealing means to prevent the leakage of said gaseous arc extinguishing medium to the atmosphere.

It is an object of the invention to provide circuit interrupting devices with an effective gaseous arc extinguishing medium.

It is another object of the invention to provide a circuit interrupting device with an arc extinguishing medium which quenches arcs effectively at relatively low pressures.

It is another object of the invention to provide an arc extinguishing gas for circuit interrupting devices wherein high pressure sealing means to prevent the leakage of the arc extinguishing medium to the atmosphere is not required.

Other objects and advantages of the invention will become apparent from the following detailed description of the invention taken in view of the accompanying drawing which shows a fuse in which a gaseous arc extinguishing medium according to the invention may be utilized.

The objects of the invention are accomplished by providing a circuit interrupting device with a gaseous arc extinguishing medium containing trifluoromethylsulfurpentafluoride, which is chemically symbolized CSF_8.

The use of CSF_8 as an arc extinguishing medium eliminates the necessity of elevated pressures because it provides a smaller mean free path during arc interruption than is possible with prior art gaseous mediums for two reasons. First, because of its atoms of carbon and sulphur, it has a larger molecular size than that of prior art mediums which thereby shortens the distance between molecules. Secondly, when CSF_8 is subject to an arc, it decomposes into CF_4 and SF_4, which are, in themselves, good arc extinguishers, each having a high electron affinity so that the number of electron capturing fluoride molecules available in the arc path is substantially doubled whereby the probability of electron collision and the resulting electron capture is materially increased. It can be seen, therefore, that although the CSF_8 may normally be disposed in the circuit interrupter at a very low pressure, such as atmospheric pressure for example, this decomposition at the moment of arcing increases the instantaneous pressure in the arc path to substantially two atmospheres. Hence, because the device is normally at a very low pressure, the necessity for providing expensive hermetic seals, as would be the case if the medium were normally at several atmospheres pressure, is eliminated while at the same time the decomposition at the moment of arcing provides a degree of arc extinction heretofore only obtainable at higher pressures. The usefulness of CSF_8 as an arc extinguishing medium is further enhanced by its stability at ordinary temperatures.

The drawing shows an interrupting device in which the arc extinguishing medium according to the instant invention may be utilized. This circuit interrupting device comprises a fuse **10** having a hollow casing **12** of any suitable gas impervious insulating material, such as glass or the like and a pair of conductive end caps **14** and **16**, one being disposed on each end of casing **12** and secured thereto by a suitable cementing compound **18** to define a chamber **19**. A fusible element **20** is disposed co-axially within the casing **12** and is electrically connected to each of the conductive end caps **14** and **16** to complete the electrical circuit through the fuse. A tubulation **22** is provided in casing **12** so that chamber **19** may be charged with a gaseous medium containing CSF_8.

In operation, when the fusible element **20** is traversed by a current having a magnitude which it is designed to interrupt, the link will begin to melt at some point along its length and then separate due to gravity and surface tension. If the circuit voltage is sufficiently high, an arc will be struck at the break. This arc is apparently started by heating and may be aided by field emission of electrons from the negative side of the gap. As the arc lengthens, due to evaporation of material from the ends of the link, some of the molecules of CSF_8 in the arc path decompose to form CF_4 and SF_4 thereby substantially increasing the number of molecules in the arc path available to capture the emitted electrons. This capture of electrons substantially limits the ionization which is necessary to sustain the arc, so that as the voltage passes through zero, the ionization between the parted ends of the fusible element

is not sufficient to cause re-ignition and the arc is thereby extinguished.

Because the gaseous medium is disposed within chamber **19** at a very low pressure, it is not necessary for the cementing compound **18** to sustain several atmospheres of pressure, as in the case of prior art devices. As a result, the necessity of providing an expensive hermetic seal which can withstand several atmospheres of pressure is eliminated. The fact that the cementing compound **19** may not be able to withstand the increased pressure after arcing, which results from the aforementioned decomposition, is not critical, however, because after the fuse has performed its function it is normally removed from the system and discarded.

It can be seen, therefore, that the invention provides a circuit interrupting device having a gaseous arc extinguishing medium which, prior to operation, may be maintained at relatively low pressures, thereby eliminating the necessity for hermetic sealing means.

I claim:

1. In a circuit interrupting device for protecting an electrical system, spaced apart terminals for connection to said system, current carrying means in circuit between said terminals, sealed container means surrounding said current carrying means, an arc extinguishing medium within said container and including trifluoromethylsulfurpentafluoride, said current carrying means being separable whereby an arc is struck within said chamber, said medium effecting extinction of said arc to interrupt the current in said system, at least a portion of said trifluoromethylsulfurpentafluoride being broken down by the action of said arc into carbon tetrafluoride and sulphur tetrafluoride to substantially increase the pressure within said container and thereby enhance said arc extinction.

2. An electric fuse having a pair of spaced apart terminals for connection in an electric system, a fusible element in circuit between said terminals, a sealed container surrounding said fusible element, and an arc extinguishing medium within said container and including trifluoromethylsulfurpentafluoride, said fusible element being constructed and arranged to part upon the flow of a predetermined overload current between said terminals whereby an arc will be struck between the parted ends thereof, said medium effecting extinction of said arc.

References Cited in the file of this patent

UNITED STATES PATENTS

2,539,261	Miller	Jan. 23, 1951
2,697,726	Silvey et al.	Dec. 21, 1954

FOREIGN PATENTS

303,090	Great Britain	Dec. 28, 1928

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,005,074 October 17, 1961

Richard A. Arzapalo

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 2, for "chamber" read -- container --.

Signed and sealed this 3rd day of April 1962

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

Disclaimer

3,005,074.—*Richard A. Arzapalo*, West Orange, N.J. CIRCUIT INTERRUPTING DEVICES. Patent dated Oct. 17, 1961. Disclaimer filed Sept. 19, 1962, by the inventor, and the assignee, *McGraw-Edison Company*.

Hereby enter this disclaimer to claims 1 and 2 of said patent.

[*Official Gazette October 23, 1962.*]