# United States Patent [19]

**Sanger et al.**

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[54] **SURGE ARRESTER**


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[73] Assignee: **General Signal Corporation,** Rochester, N.Y.



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**Related U.S. Application Data**

[63] Continuation of Ser. No. 53,463, July 9, 1970, abandoned.

[52] **U.S. Cl.** ..... **317/61.5,** 337/28, 315/36, 313/204, 313/217, 317/62, 317/69

[51] **Int. Cl.** ..... **H02h 3/22**

[58] **Field of Search** ..... 337/28, 29, 34; 317/61, 61.5, 62, 69; 315/36; 313/204, 217



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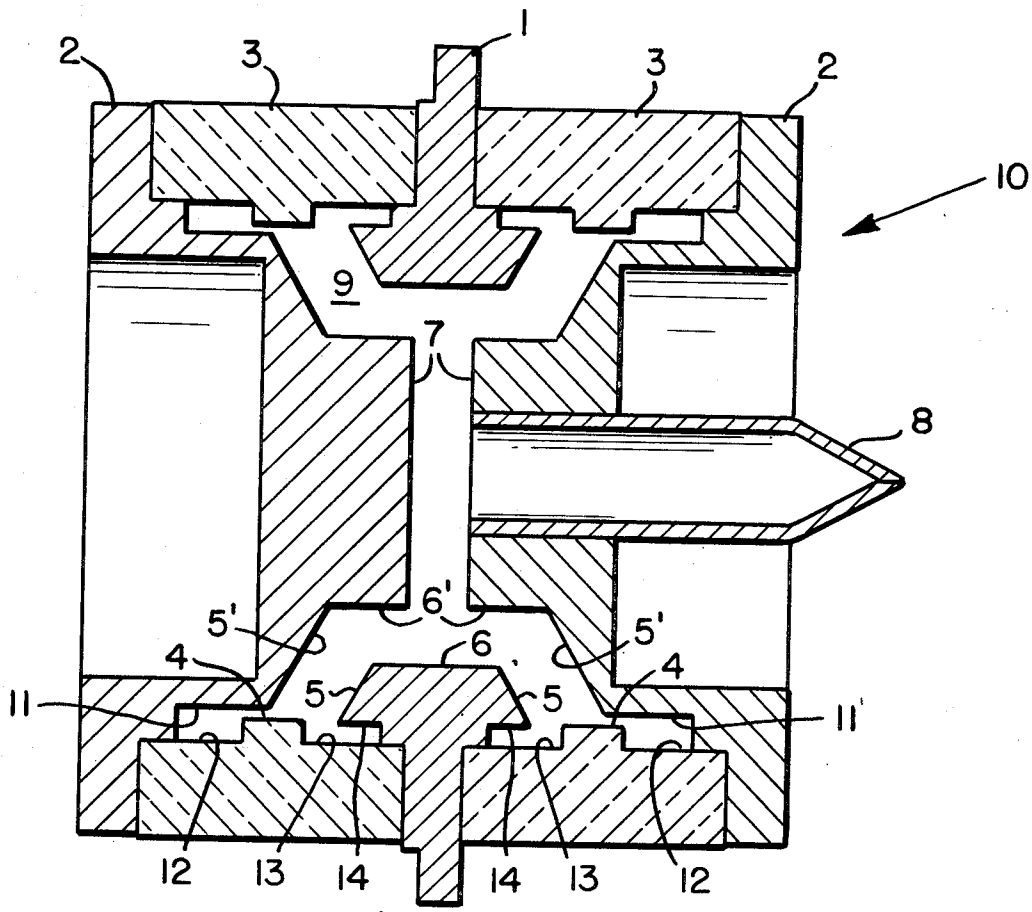
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[57] **ABSTRACT**

A surge protection device has been provided having a central ground electrode disposed midway between spaced terminal electrodes. The improvement includes a ground electrode having a central annular opening and line terminal electrodes axially disposed at opposite sides of the ground electrode, each line terminal electrode being formed with an annular boss extending partly within the opening of the ground electrode. Means including insulative spacers between electrodes forms an air tight cavity for gas in the vicinity of bosses and the annular opening of the electrodes for discharge of the surges through said cavity.


**4 Claims, 3 Drawing Figures**



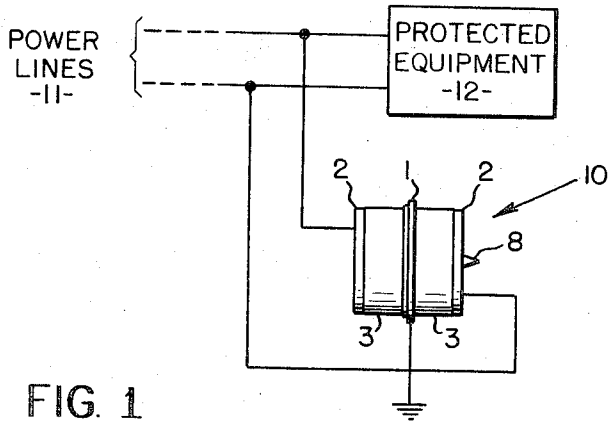



FIG. 1

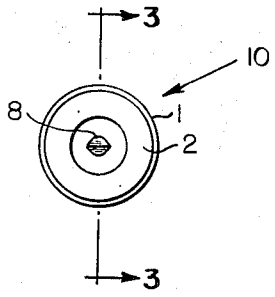



FIG. 2

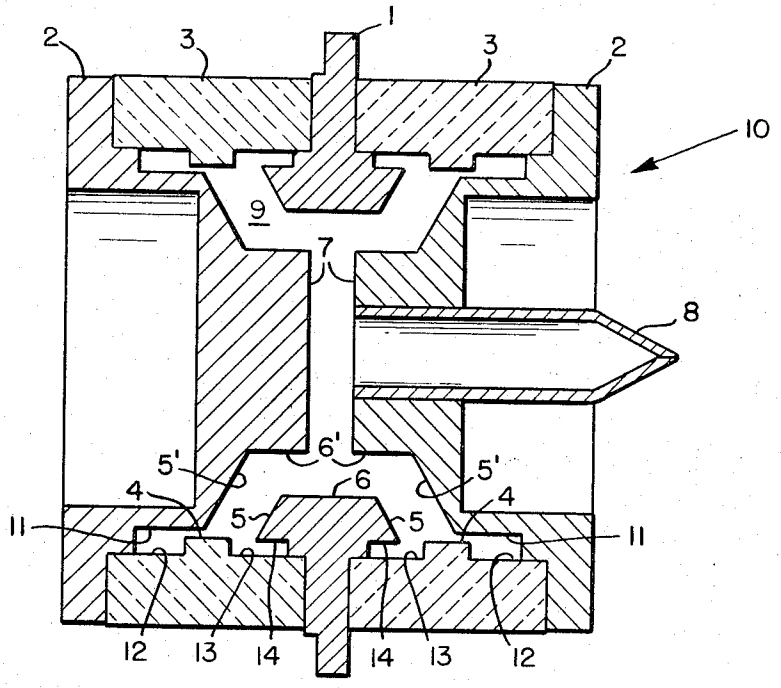



FIG. 3

# SURGE ARRESTER

This is a continuation, of application Ser. No. 53,463 filed July 9, 1970, now abandoned.

## BACKGROUND OF INVENTION

This invention relates to circuit protection devices and in particular to a surge arrester for connection across two conductor communications or power lines for protection of equipment coupled thereto.

Equipment connected across two conductor communications or power lines requires protection against electrical surges whether those lines are an open pair of wires or coaxial cable. These surges can be either metallic circuit surges in which they follow conventional electrical circuits by flowing down one wire and returning on the other or longitudinal circuits which proceed simultaneously in the same direction down both conductors. This discussion holds whether or not one conductor is at ground potential. Such a grounded conductor may swing considerably above or below true ground potential when subjected to high electrical surges.

Gas filled surge arresters, air gaps and various types of semi-conductors such as zener diodes or back-to-back silicon or selenium rectifiers provide protection from these surges. Usually a surge arrester across the line will protect against metallic surges, and arresters from each line to ground will protect against longitudinal surges.

Firing of one of these arresters without the firing of the other or the firing of one of these arresters before the firing of the other will put the surge voltage exactly where it will do the most harm; that is, across the apparatus to be protected. Even though the time between firing of a shunting arrester across the line and the firing of the arresters from line to ground may be in the order of milliseconds or microseconds, damage can be done to the apparatus. The same discussion holds even if no surge protectors are used because the weakest side of the line may break down to ground first, throwing the major portion of the surge across the equipment to be protected.

This problem has been recognized and three element gas filled surge arresters have been used in order to insure firing of all protective branches and to approximate simultaneous firing of these branches. These devices have all had one or several of the following design deficiencies: Bulky outline; long, high thermal and high electrical impedance feed throughs; or non-symmetrical spacings or separate areas of ionization that result in unequal voltage breakdown or unequal breakdown times.

It is therefore an object of the present invention to provide a surge protection device which obviates one or more of the limitations and disadvantages described in prior arrangements.

It is another object of the present invention to provide a gas-filled surge arrester that has equal voltage breakdown and equal breakdown times between any pair of electrodes.

It is another object of the present invention to provide a gas-filled surge arrester that has minimum delay time between the breakdown between any pair of gaps and the breakdown between all other gap combinations.



It is another object of the present invention to provide a compact easily socketed surge arrester for various electrical circuits.

It is another object of the present invention to provide electrode surfaces that have short, solid thermal and electrical paths to their outside terminals.

## SUMMARY OF INVENTION

There has been provided a surge protection device having a central ground electrode disposed midway between spaced terminal electrodes. The improvement comprises a ground electrode having a central annular opening, line terminal electrodes axially disposed at opposite sides of the ground electrode each line terminal electrode being formed with an annular boss extending partially within the opening of the ground electrode and a means including insulative spacers between the electrodes forming an air tight cavity for gas in the vicinity of the bosses and the annular opening of the electrode.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, while the scope will be pointed out in the appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows one view of the surge arrester of the present invention connected across a pair of line wires coupled to equipment to be protected.

FIG. 2 shows a second view of the surge arrester of the present invention.

FIG. 3 shows a cross section of the surge arrester of FIG. 2 taken along line 3—3.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The surge arrester **10** of the present invention shown in FIG. **1** is suitably coupled across a pair of line wires **11** to line terminals **2** and similarly its ground electrode **1** is coupled to ground as shown. The lines **11** are coupled to the equipment to be protected **12** and surges either metallic or longitudinal are diverted from the inputs to the equipment **12** through the surge protection device **10.**

A cross sectional elevation of the surge arrester **10** is shown in FIG. **3.** The arrester **10** includes a central ground electrode **1** disposed midway between the spaced line terminal electrodes **2.** Spacers **3** hold the ground electrode **1** and line terminal electrodes **2** in a spaced relation one to the other and are sealed for forming a gas chamber **9.** An evacuating tube **8** formed integrally with one of the line electrodes **2** is used for drawing the air out of the chamber **9** and inserting a suitable gas medium.

The line terminal electrodes **2** have bosses formed thereto and can be readily described by observing the shape outlined by the surfaces **11, 5', 6', 7, 6', 5'** and **11** on each of the line terminal electrodes **2.** The ground electrode **1** has an extension thereof inserted in the chamber **9** outlined by the surfaces **5, 6** and **5.**

The spaced relation between the surfaces **6** and **6'** are determined in order to provide for a substantially equal breakdown potential between each of the bosses of the line terminal electrodes **2** and the ground electrode **1,** while the distance between the surfaces **7** on each of the line terminal electrodes is similarly dis-

posed in order to provide for a substantially equal breakdown potential across the bosses for protection against metallic surges.

It can be seen from the drawing that the ground electrode **1** has an unusual cross section. Upper and lower surfaces **6** and **14** respectively are coaxial with each other and with surfaces **6'** of bosses **2** and **13** of spacers **3.** The surfaces **5** of electrode **1** are truncated conical sections which are associated with similar coaxial conical sections **5'** of bosses **2.**

The distances between surfaces **5** and **5'** are greater than between surfaces **6** and **6'** thereby keeping the start of any discharge between the line electrodes **2** and the center electrode **1** to the surfaces **6** and **6'** rather than between **5** and **5'.** Any ionization between electrodes **2** and **2** cannot take place at the center of the opposing faces of electrodes **2** because of the void left by the exhaust tube **8.** Such ionization therefore would occur in a ring area **7** near the outer face of these electrodes **2.** The region of ionization and subsequent electrical discharge between the line electrodes **2** or between any line electrode **2** and the ground electrode **1** overlap each other in the area of the surfaces **6–6'** and **7** and therefore any discharge between any two of the three electrodes immediately transfers to the third electrode, and all other electrodes are clamped at or near the potential of the ground electrode **1.**

The spacers **3** are constructed of some insulative material, preferably a ceramic, and have integral therewith an annular protrusion **4** on each one. The annular protrusion **4** is provided in order to shield the surfaces **12** of the insulating member **3** from deposition of sputtered material that would otherwise provide surface leak paths between electrodes. Surfaces **13** are likewise shielded by the overhang **14** of electrode **1.**

The present design also lends itself to constructing a surge arrester of relatively small size but of high thermal and electrical capacity. The external configuration can be made with connecting rings of various diameters to mate with sockets. It can also be supplied with flying leads, so that it can attach directly to input terminals or printed circuit boards, or have notched tabs, to fit directly onto a printed circuit board.

The present device combines compact size with a three element surge arrester having a substantially equal breakdown potential from line to line and from line to ground and as such has essentially simultaneous breakdown upon occurrence of a sufficiently high electrical surge. The breakdown time between one set of electrodes and another is not as previously described milliseconds or even microseconds, but in the order of tenths of a microsecond or less between the firing of any gap and the firing of any other gaps.

There has therefore been provided a surge protection device having a design capable of sustaining high level electrical surges and providing adequate protection from line to line to ground by simultaneous or substantially simultaneous breakdown time from one electrode to another. While there has been provided what at present is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

What is claimed is:

**1.** A surge protective device having a tubular chamber for containing an ionization gas wherein the improvement comprises,

a. a longitudinal tubular housing of insulating material having an annular grounding electrode disposed at an intermediate point therein, and

b. oppositely disposed coaxial line electrodes with one closing one end, and the other closing the other end, of the tubular housing and having coaxial cylindrical inner ends with oppositely disposed faces proportioned to make the spacing between their peripheries be less than the spacing between other parts of said faces and positioned so that their peripheries have substantially the same spacing from the inner periphery of the annular grounding electrode for providing a substantially uniform inter-electrode gap in the common region between the line electrodes and between each line electrode and the inner periphery of the grounding electrode, and wherein the line electrodes have a frustoconical intermediate portion and the grounding electrode has complementary portions cooperationg with the line electrodes to form second relatively wider gaps between the respective line electrodes and the grounding electrode,

c. whereby said common region is the region of greatest probability of initial ionization and in response to the ionization of the gas in the gap between any two electrodes in said common region all electrodes are immediately clamped at or near the potential of the grounding electrode.

**2.** A surge protection device having a tubular chamber for containing an ionization gas wherein the improvement comprises,

a. a longitudinal tubular housing of insulating material having an annular grounding electrode disposed at an intermediate point therein and having sputter shields for preventing the deposit of metal at junctions of the ground electrode and the inner periphery of the insulating material, and

b. oppositely disposed coaxial line electrodes with one closing one end, and the other closing the other end, of the tubular housing and having coaxial cylindrical inner ends with oppositely disposed faces proportioned to make the spacing between their peripheries be less than the spacing between other parts of said faces and positioned so that their peripheries have substantially the same spacing from the inner periphery of the annular grounding electrode for providing a substantially uniform inter-electrode gap is in the common region between the line electrodes and between each line electrode and the inner periphery of the grounding electrode,

c. whereby said common region is the region of greatest probability of initial ionization and in response to the ionization of the gas in the gap between any two electrodes in said common region all electrodes are immediately clamped at or near the potential of the grounding electrode.

**3.** A surge protective device having a tubular chamber for containing an ionization gas wherein the improvement comprises,

a. a longitudinal tubular housing of insulating material having an annular grounding electrode disposed at an intermediate point therein,

b. oppositely disposed coaxial line electrodes with one closing one end, and the other closing the

other end, of the tubular housing and having coaxial cylindrical inner ends with oppositely disposed faces proportioned to make the spacing between their peripheries be less than the spacing between other parts of said faces and positioned so that their peripheries have substantially the same spacing from the inner periphery of the annular grounding electrode for providing a substantially uniform inter-electrode gap in the common region between the line electrodes and between each line electrode and the inner periphery of the grounding electrode, and

c. an evacuation tube extending coaxially through one of the line electrodes for proportioning its face so that the peripheries of the oppositely disposed faces are closer together than the central portions of the oppositely disposed faces.

d. whereby said common region is the region of greatest probability of initial ionization and in response to the ionization of the gas in the gap between any two electrodes in said common region all electrodes are immediately clamped at or near the potential of the grounding electrode.

**4.** A surge protective device according to claim **2** wherein additional sputter shields are provided for preventing the deposit of metal at junctions of the line electrodes and the insulating material.

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