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(54) Protection device.

(57) Protection device for protecting equipment against induced voltage signal spikes is arranged to become conductive very rapidly. An evacuated chamber is provided with free electrons so as to ensure rapid ionisation of the chamber. The chamber is so shaped as to constitute a transmission line having a predetermined impedance, the wall of the chambers and a central electrode constituting the two conductors of the transmission line with their spacing being least at the region of conduction.

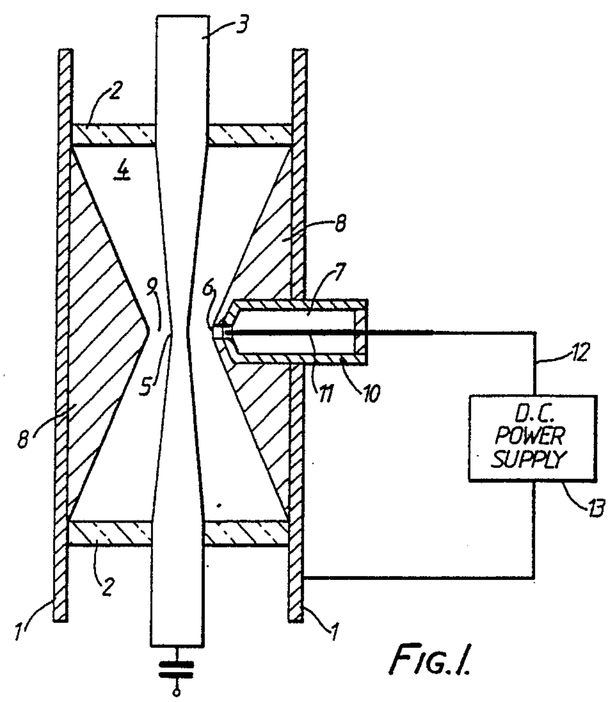

FIG.1.

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PROTECTION DEVICE

This invention relates to a protection device of the kind which is arranged to become conductive when a transient excess voltage appears between two electrodes which form part of it. Typically, such a device is to withstand a large potential difference without breaking down into conduction between the two electrodes, but it can be brought rapidly into conduction when required so that typically a current of several thousand amps can flow between the two electrodes for a short period. A device of this kind can be used to protect relatively delicate electronic equipment or the like from the effect of transient over-voltages which can be induced onto the conductors by external events.

The invention provides a protection device including a sealed chamber having a first conductor projecting into it; a second conductor which constitutes part of the wall of the chamber; the first conductor being tapered so that it has a reducing cross section within the chamber, and the second conductor being shaped so that the two conductors together constitute an electrical transmission line having a substantially constant characteristic impedance and so that the distance between the two conductors is least in the region of smallest cross section of the first conductor.

A rise in potential difference between the two conductors above a threshold value causes electrical breakdown to occur between them. The shaping of the conductors to provide an electrical transmission line of substantially constant characteristic impedence enables the protection device to handle the transmission of high frequency signals without causing reflections which would result from variation in line impedence.

Advantageously, a radioactive source, or a separate chamber region connecting with the first chamber and having a source of free electrons, is provided to release electrons into the chamber in a controlled manner. The source of free electrons is such that electrons are released into that region of the chamber where electrical discharge between the two conductors is to be achieved at a reasonably slow rate so as not to initiate breakdown below the desired threshold value. However, the release of electrons should be sufficiently large to ensure that there is always at least one free electron in the vicinity of the discharge region so as to promptly initiate discharge the moment an over-voltage occurs.

The invention is further described by way of example with reference to the accompanying drawings, in which:

Figure 1 illustrates a transient protection device in accordance with the present invention, and

Figure 2 shows a modification.

Referring to the drawing, a first envelope consists of an outer cylindrical wall 1 formed of an electrically conductive material carrying a circular disc 2 at each end, these discs being formed of an electrically insulating material such as ceramic and being sealed around their outer peripheral edges to the wall 1 to enclose a chamber 4. An inner solid conductor 3 passes through the chamber 4 so formed and is sealed to the two end discs 2 where it passes through them. The central inner conductor 3 is a relatively robust and substantial conductor but it is of tapered section within the chamber 4, tapering smoothly to a mid-point 5 which is adjacent to an opening 6 in a second chamber 7. The inner walls of the outer conductor 1 are provided with a shaped portion 8 which is dimensioned to form a relatively small gap 9 in the region of the opening 6. A typical dimension for gap 9 is 0.5 mm.

The second chamber 7 constitutes a source of free electrons and it consists of a conductive outer wall 10 having an inner central electrode 11 which is connected via a lead 12 to a d.c. power supply 13.

The two chambers 4 and 7 are, of course, interconnected via the opening 6 but both are hermetically sealed from the atmosphere. The chambers are initially evacuated to a fairly high level of vacuum, e.g. 10^{-4} Torr after which the chambers are filled with an inert gas, such as argon or neon or a mixture of these. The gas type and pressure are chosen to determine the breakdown voltage, but the pressure is expected to be in the range 20 Torr to in excess of 760 Torr.

During operation, it is assumed that a relatively modest potential difference exists between the two conductors 1 and 3 which is such so as not to cause electrical breakdown in the region 9. Electrons are generated at the second chamber 7, particularly in the region of the opening 6 where an electron plasma exists. Free electrons from this plasma are randomly distributed in the region of the opening 6 and the gap 9, but it is arranged that the electron density is very low indeed, in principle it being sufficient to ensure that at least one free electron exists within the gap at any one time. The electron plasma is generated by striking a glow discharge between the electrodes 10 and 11 under the action of the power supply 13. The resulting ions as well as the electrons assist in the rapid electrical breakdown. The d.c. current in the glow discharge is typically of the order of a few tens of microamps.

When a high voltage transient appears so as to raise the potential difference between the conductors 1 and 3 above a threshold value, electrical discharge in the region of the gap 9 occurs, and this breakdown is initiated by the presence of free electrons. It is the contribution and effect of these free electrons that ensures a reliable and very prompt breakdown. In the absence of any free electrons, electrical breakdown would occur eventually, provided that the potential difference is large enough, but at a much slower and indeterminate rate.

In order to ensure that the electrical breakdown occurs very rapidly indeed it is necessary that the gap 9 is small, and since the chamber 4 is evacuated the spacing between the two conductors can be made much smaller within the chamber than it is possible to space the two conductors 1 and 3 in a normal atmosphere. Consequently, in order to permit the conductors to carry high frequency signals, the inner conductor 3 is also tapered so as to provide a constant impedance transmission line. By ensuring that the relative diameters of the conductor 3 and the conductor 1, as modified by the extension portion 8, is constant, then the characteristic impedance is preserved. A typical characteristic impedance is 50 Ω , with the maximum diameter of the conductors 1 and 3 being 10 mm and 4.35mm respectively, reducing to 1.84 mm and 0.8mm respectively in the region of the gap 9. The provision of the tapered section greatly enhances the reliability and speed of operation and for certain applications the free electon source may not always be necessary. The two conductors 1 and 3, together with the portion 8, therefore constitute an electrical transmission line having a characteristic impedance which does not alter at different points along the conductors. This enables the protection device to handle the transmission of high frequency signals without causing signal reflections which would result from variations in the line impedance. The benefit of the tapered conductor sections to give a constant characteristic impedance can also be obtained with a conventional radioactive source of electrons and/or ions, such as Tritium or other radioactive isotope.

Instead of the gap 9, one of the insulating discs can be placed at the point where the separation between the two electrodes is least. Such an arrangement is shown in Figure 2, in which two insulating discs 20 and 21 are provided to define the walls of a gas filled chamber 22. Electrical breakdown occurs across the surface 23, and a cathodic electron source can be included (in a manner similar to Figure 1) to initiate electrical breakdown, or a radioactive isotope can be included in the gas which fills the chamber 22.

Claims

1. A protection device including a sealed chamber having a first conductor projecting into it; a second conductor which constitutes part of the wall of the chamber; the first conductor being tapered so that it has a reducing cross section within the chamber; and the second conductor being shaped so that the two conductors together constitute an electrical transmission line having a substantially constant characteristic impedance and so that the distance between the two conductors is least in the region of smallest cross section of the first conductor.

2. A protection as claimed in claim 1, in which the first conductor has a second reducing cross-section within the chamber meeting the first reducing cross-section at the region of smallest cross-section of each.

3. A protection device is claimed in claim 1 or claim 2, in which there is provided a radioactive source to provide free electrons and/or ions in the chamber.

4. A protection device as claimed in any one of claims 1 to 3, in which there is provided a separate chamber region connecting with the first free chamber and having an electrode to provide a source of free electrons, the two chambers being such that in operation free electrons from the second chamber are released into the first chamber.

5. A protection device as claimed in any one of claims 1 to 4, in which an insulating disc is placed at the point where the distance between the two conductors is least.

6. A protection device substantially as herein described with reference to the accompanying drawings.

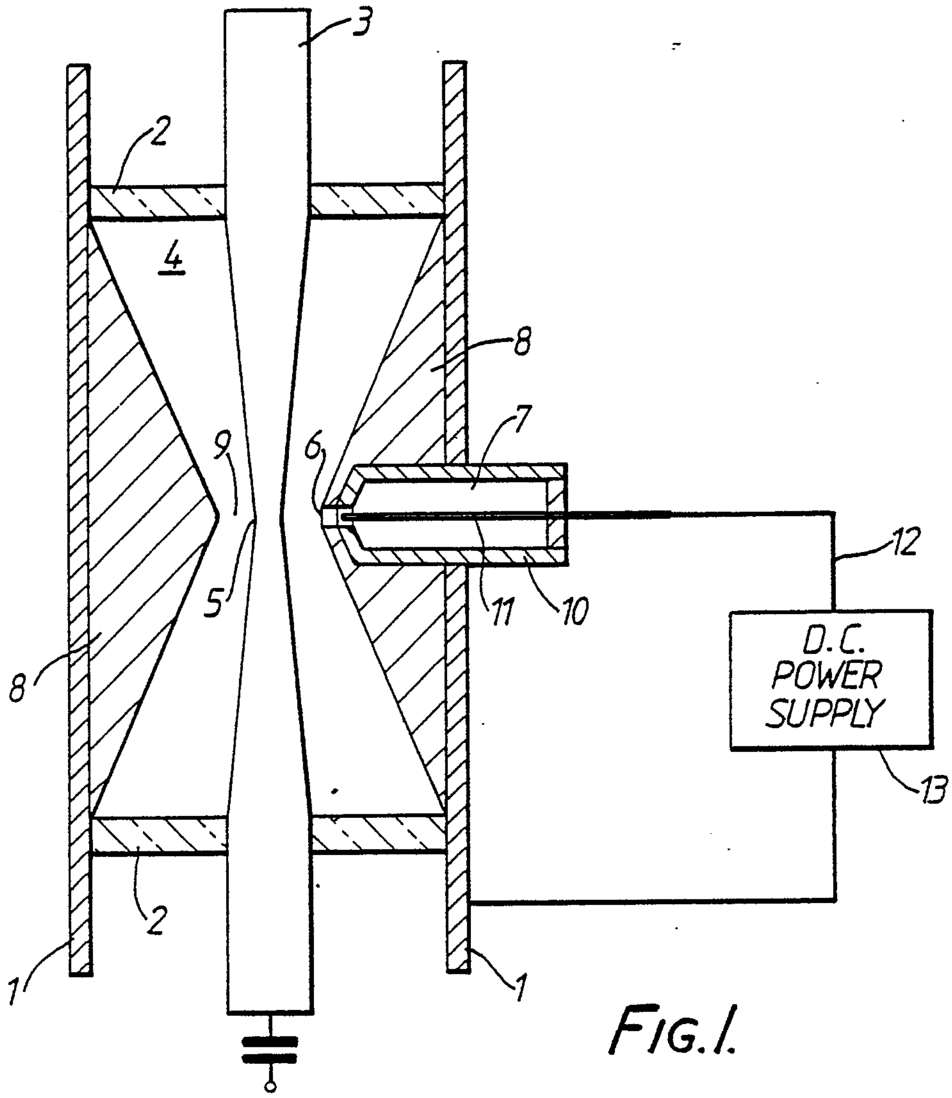

FIG.1.

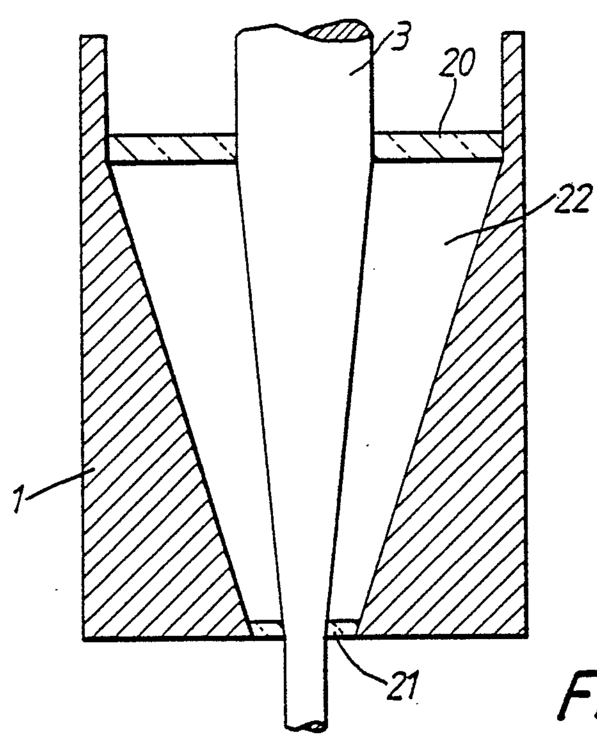

FIG.2.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 30 0542

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	GB-A-2 083 945 (COOK) * Page 1, lines 74-122; figures 1,2 * ---	1,3,5	H 01 T 4/12 H 01 T 4/08
A	GB-A- 28 894 (WESTERN ELECTRIC CIE.) * Page 3, lines 48-51; figure 3 * ---	1,2	
A	GB-A- 895 577 (GENERAL ELECTRIC CIE.) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 T

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10-05-1988	BIJN E.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
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T : theory or principle underlying the invention
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