

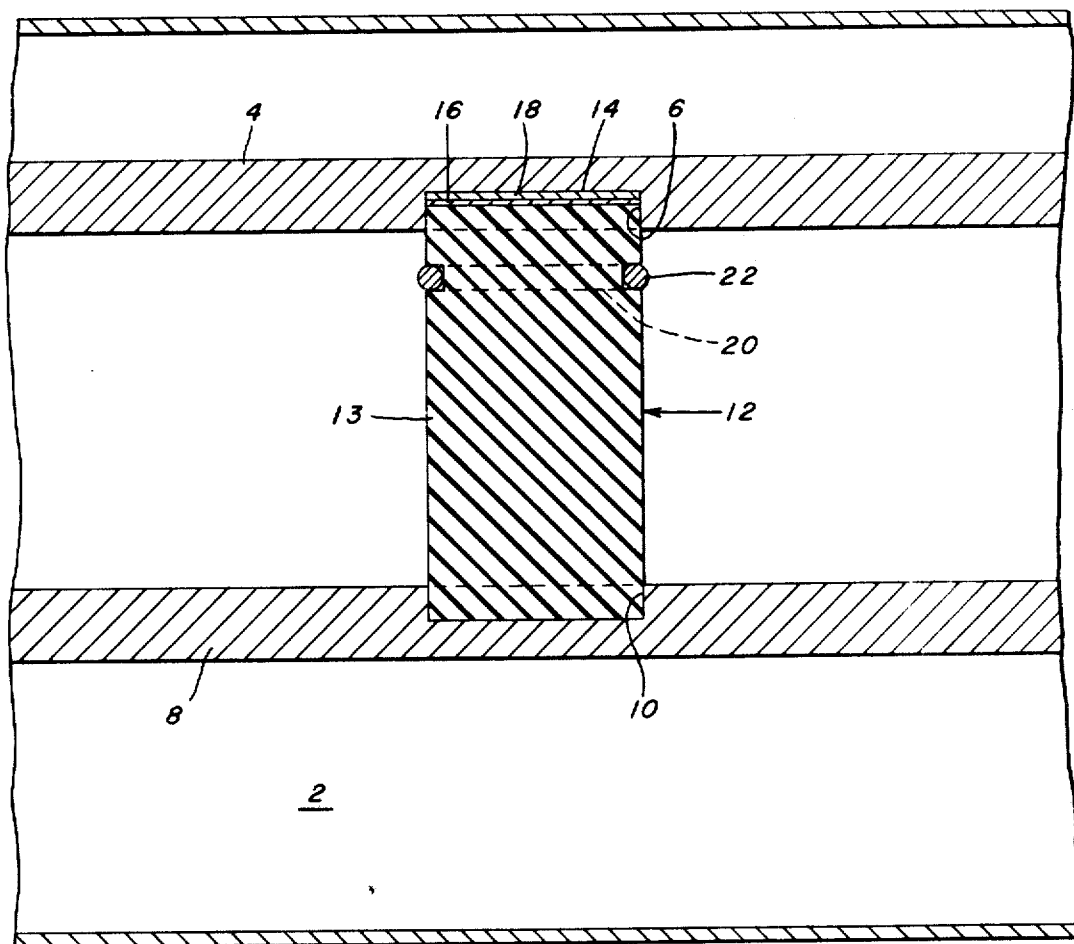
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GLOW DISCHARGE SUPPRESSING INSULATOR

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GLOW DISCHARGE SUPPRESSING INSULATOR
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8 Claims

ABSTRACT OF THE DISCLOSURE

A high voltage insulator for use in a sub-atmospheric chamber between cathode and anode. The cathode end of the insulator has a conductive plate thereon and a metal corona ring is provided on the insulator adjacent its cathode end to suppress arcing.

This invention relates to a high voltage insulator for use in a sub-atmospheric chamber and more particularly to an insulator for use in the vapor deposition of aluminum such as disclosed in Coleman et al. Pat. No. 3,333,136 dated July 25, 1967. In such vacuum deposition apparatus it is necessary to insulate high voltage bus bars or cathodes from electrical ground or anode within a vacuum chamber. If an electrical discharge path exists, either direct or of a gaseous nature, a transient short circuit condition will occur that is often deleterious to the process. Such electrical discharge across an insulator is especially deleterious since the intense heat often developed during said discharge evaporates metal and volatile compounds surrounding the insulator. These evaporated solids may coat the insulator surface, making it conductive and producing a permanent short circuit condition or a condition in which a high voltage may not be maintained without further arcing.

Normally the insulator is held in place mechanically which results in a poor insulator-to-conductor bond. The junction between the insulator and bus bar contains a small void in which the electrical field is typically five times as great as that along the insulator. This localized high field region helps to initiate breakdown since it accelerates secondary emission of electrons resulting from ion bombardment or field emission. If the pressure in the chamber increases suddenly, as may result from a localized out-gassing, the breakdown voltage decreases rapidly, initiating an electrical discharge which is initially a glow discharge unless the presence of localized emitting surfaces heated by ion bombardment converts the discharge to an electric arc discharge.

The above described problem arises when the pressure is such that the conduction is almost exclusively by high temperature electrons. In air this is approximately $\frac{1}{10}$ of an atmosphere and below. In other atmospheres this point will vary.

It is therefore an object of my invention to provide an insulator which inhibits arcing between an electrical conductor and ground in a sub-atmospheric chamber.

Another object is to provide such an insulator which inhibits high voltage breakdown and glow discharge.

A further object is to provide such an insulator in which local electrical field intensities are minimized.

A still further object is to provide an insulator which is free from localized out-gassing.

These and other objects will be more apparent after referring to the following specification and attached drawing, in which:

The single figure is a sectional view of the insulator within a vacuum chamber.

Referring more particularly to the drawing, reference numeral 2 indicates a sub-atmospheric chamber such as

a vacuum aluminum vapor deposition chamber. The chamber 2 contains a bus bar or cathode 4 having an indentation or seat 6 therein. An anode 8, which may be a ground, is spaced from the cathode 4 and also contains an indentation or seat 10 aligned with seat 6. An insulator 12 extends between the cathode and anode with its ends snugly fitted into the seats 6 and 10. While only one insulator is shown, it will be understood that more than one insulator will commonly be used between the cathode and anode.

According to my invention the insulator 12 includes a body 13 which is preferably made of sintered alumina which is a high density dielectric containing little trapped gas and water vapor. Other dielectric or insulating materials may also be used if they contain little trapped gas or water vapor. It is preferred to have the body cylindrical as shown, but it may be otherwise shaped. The cathode end of the insulator is provided with an integral conductive plate 14 which is a good conductor. It is preferred that metal plate 14 be provided by a first layer 16 deposited by plating with colloidal gold and fired to form a conductive gold coating fused with the surface, and a second layer 18 provided by electroplating with copper to a thickness of approximately $\frac{1}{32}$ inch. While it is much preferred to use the metal plate 14, it may be eliminated if the cathode end of the insulator and the seat 6 are very carefully machined and/or press fitted to provide a joint which substantially eliminates voids therebetween, especially about the periphery. A peripheral groove 20 is provided in the body of the insulator for receiving a band 22 of conductive material, such as copper beryllium, which may be in the form of a snap ring. The outer periphery of the band 22 extends above said body. The groove, for example, may be $\frac{3}{32}$ inch wide and $\frac{1}{16}$ inch deep with the snap ring having a $\frac{3}{4}$ inch outside diameter and a thickness of $\frac{3}{32}$ inch. The ring 22 is located adjacent the cathode end of the insulator and, in one particular embodiment in which the insulator is $1\frac{1}{2}$ inches long and $\frac{3}{4}$ inch in diameter, the groove is located $\frac{1}{4}$ inch from the cathode end. The ring must be positioned within the free path length of the electrons leaving the cathode 4 in the vicinity of the insulator. This position is always adjacent the cathode end, that is, it is closer to the cathode end than the anode end. I have found that the conductive ring intrudes into the path of the electrons contained within the cathode 4 and captures some of them so as to build up a charge approaching that of the cathode, thus minimizing any accelerating force acting upon electrons in the cathode.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made.

I claim:

1. An insulator adapted to extend between a cathode and anode in a sub-atmospheric chamber comprising a body of insulating material, and a band of conductive material surrounding and extending above said body adjacent the cathode end within the free path length of electrons leaving the cathode.

2. An insulator according to claim 1 in which said body has a circumferential groove therein adjacent its cathode end and said band is received in said groove with its outer periphery extending above said body.

3. An insulator according to claim 1 including conductive means so secured to the cathode end of said body as to substantially eliminate voids between the body and conductive means about their periphery.

4. An insulator according to claim 3 in which said body has a circumferential groove therein adjacent its cathode end and said band is received in said groove with its outer periphery extending above said body.

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5. An insulator according to claim 4 in which said body is made of sintered alumina.

6. An insulator according to claim 4 in which said conductive means consists of a first layer of fired colloidal gold, and a second layer of copper on the gold layer.

7. An insulator according to claim 6 in which said body is made of sintered alumina.

8. An insulator according to claim 7 in which said band is made of copper beryllium.

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References Cited

UNITED STATES PATENTS

2,461,728 2/1949 Gessford ----- 313—256 X

5 RAYMOND F. HOSSFELD, Primary Examiner

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174—138; 313—292