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ELECTRICAL GASEOUS DISCHARGE DEVICE

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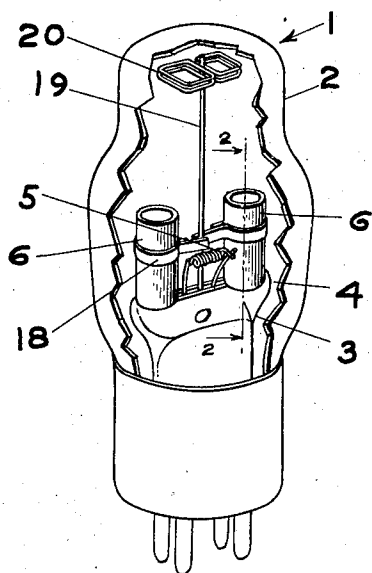


FIG. 1.

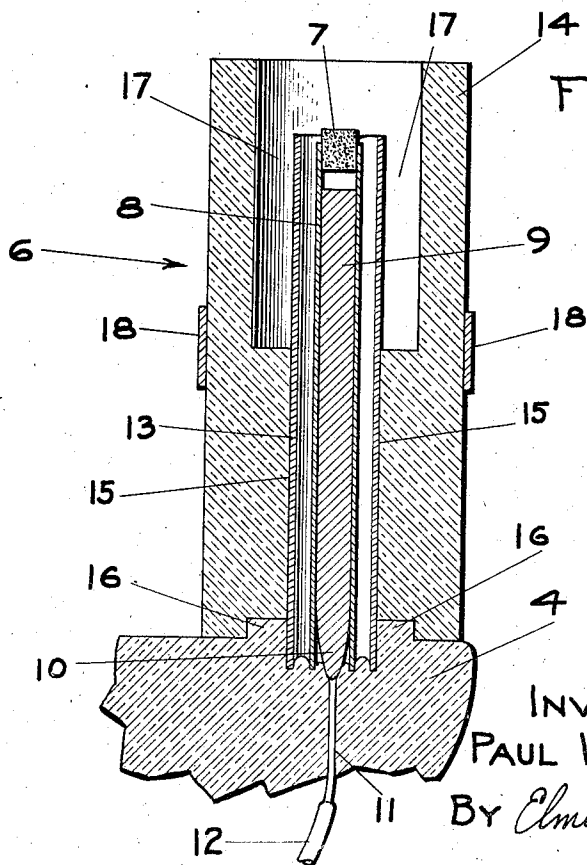


FIG. 2.

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## UNITED STATES PATENT OFFICE

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## ELECTRICAL GASEOUS DISCHARGE DEVICE

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mesne assignments, to Raytheon Manufacturing  
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Delaware

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13 Claims. (Cl. 250—27.5)

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This invention relates to electrical gaseous discharge devices, and more particularly to those containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein.

In devices of the character described, one of the major difficulties encountered has been the occurrence of undesired arcing. This difficulty has imposed a serious limit as to the voltage which may be successfully applied to said devices. I have invented means for shielding electrodes of such devices so as to permit higher voltages to be employed without objectionable arcing.

An object of this invention is the provision of means for shielding the electrodes of devices of the character described so as to prevent undesirable arcing.

Another object of the present invention is the provision of means in said devices for permitting the employment of higher voltages therein.

Other objects and advantages of my invention will become apparent, and the foregoing objects will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing wherein:

Fig. 1 is a front elevational view of a tube embodying my invention; and

Fig. 2 is a fragmentary view taken along the line 2—2 of Fig. 1 and is partly in section.

The tube which I have shown by way of exemplification is a thermionic gaseous rectifier having a self-heating cathode and two anodes.

Tube 1 consists of a glass envelope 2 having a reentrant stem 3 with a press 4 at the upper end thereof, said press carrying a cathode 5 and a plurality of anode structures 6.

Each anode structure 6 consists of a short rod of graphite 7 carried within a nickel sleeve 8, the graphite rod extending partially outside of the sleeve. A nickel rod 9 is also arranged within said nickel sleeve 8 and is spaced a distance from said graphite rod. The lower end 10 of the nickel rod 9 may be tapered and a dumet wire 11 is butt-welded thereto. The dumet wire 11 passes through the press 4 and is welded to a heavy copper lead-in 12, said lead-in serving to conduct heat from said nickel rod. The lower end 10 of the rod 9 is sealed in the press 4. Similarly, the nickel sleeve 8 is sealed therein, the glass from the press being forced upwards into the space between the tapered lower end of the nickel rod and the nickel sleeve 8.

Rod 9 serves as a relatively low-resistance conductor of the anode current. Rod 9 conducts current from the lead-in 12 and dumet wire 11

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to a point on the nickel sleeve 8 which is adjacent the lower end of the space separating the top of rod 9 from the bottom of graphite rod 7. The nickel sleeve 8, which has greater resistance than rod 9, then conducts the current to the graphite rod 7. The graphite rod 7 serves as the active anode element.

The aforescribed anode structure has several advantages. The separation of the active anode element 7 from the rod 9 reduces heat transference between them since this heat transference takes place substantially entirely through the comparatively small cross-sectional area of the material of sleeve 8. Consequently rod 9 and the dumet wire 11 are maintained at a lower temperature, heat being transferred away from them through the heavy lead-in wire 12, and damage because of heat is less likely to occur to the stem press 4 in which these members are sealed. By this arrangement the anode element 7 is also maintained at a substantially higher temperature than it would ordinarily have. It has been found that such higher anode temperature is desirable in certain types of operation.

In order to confine the active area of the anode to the upper end thereof, I surround the anode structure by a conducting shield 13 which may be made of any suitable material such as nickel. The shield 13 is cylindrical in configuration and extends to a point above the top of the nickel sleeve 8 and below the top of the graphite rod 7.

The maximum distance between the exterior of the sleeve 8 and the interior of the shield 13 is sufficiently small so that a discharge cannot occur in the space between these elements. This distance is of the order of, or less than, the mean free path of the electrons in the gas. The lower end of the shield 13 is likewise sealed in the press by having glass from the press forced upwards on both the interior and exterior sides of the bottom thereof.

In arrangements of this general type, difficulties have been encountered in discharges occurring between the lower end of the shield 13 and the lower end of the anode structure, due to leakage paths and the like through the seal. In order to avoid this the lower end of the shield 13 is sealed higher up in the press than the lower end of the nickel rod 9.

In order to prevent the undesired arcing mentioned heretofore, I prefer to arrange an insulating material about the anode and its shield. For this purpose materials having relatively high dielectric strength are required. Furthermore such material should not give off excessive vapor at the

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temperatures attained during operation of the tube. In addition, such material should be able to withstand the temperatures and ionic bombardment occurring within said devices during operation without breakdown, either physical, chemical or electrical. I have found steatite to be a satisfactory material. More particularly that type of steatite known commercially as Al Si Mag 35 made by the American Lava Corporation, a dense steatite consisting chiefly of clinoenstatite crystals ( $\text{MgO}-\text{SiO}_2$ ) has been used and found satisfactory for this purpose.

The insulating member 14 made of steatite is cylindrical in outline and has an opening 15 therein so that it may be arranged over the shield 13 in contact therewith.

An annular ring of glass 16 may be formed at the top of the press 4 and an annular opening corresponding thereto formed at the bottom of the member 14 so that member 14 may be arranged on said ring and positioned thereby.

The member 14 extends a substantial distance above the top of the graphite rod 7. In order to insulate the shield 13 from any material sputtered off the graphite rod 7, which sputtered material may cling to the walls of the member 14, I prefer to provide an insulating space 17 between the upper portion of the shield 13 and the interior wall of the insulating member 14. This space is comparatively narrow and the distance between the exterior of the shield 13 and the interior wall of the insulating member measured transversely across said space is of the order of the mean free path of the electrons in the gas enclosed within the tube or less. This insulating space 17 may be formed by cutting away a portion of the walls of the insulating member 14 at the place designated. The shield 13 is thereby arranged in a restricted chamber which serves to prevent flashing to said shield.

In the tube 1 two such anode structures are provided and arranged at opposite ends of the press 4. A metallic band 18 may be arranged about each of the anode structures 6 to hold them in position, the bands being connected together and to a standard 19 secured in the press 4. At the upper end of said standard 19 loops of wire 20 having getter material therein may be arranged and are adapted to be flashed in the usual manner.

The cathode 5 is a spiral wire supported by suitable standards and connected to lead-in wires in a manner well known in the art and which therefore will not be hereinafter described. The envelope 2 is filled with any suitable ionizable gas such as argon preferably at a pressure of 2.5+.25 millimeters of mercury. The tube may be provided with a suitable base and contact prongs.

In actual tests of a tube of the general type hereinabove described it was found that without the insulating members 14 it was incapable of delivering an output of 250 volts D. C. because of the flashing and arcing within the tube. When, however, insulating members 14 of steatite (Al Si Mag 35) were arranged as hereinabove described, such tube readily delivered an output of 550 volts D. C. without any sign of breakdown or arcing therein.

While I have described the specific details of this embodiment of my invention it will be apparent that these details may be varied without departing from the spirit thereof. For example, other materials besides steatite having the desired characteristics may be employed. The specific shape of the insulating member and the various

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elements of the tube may be altered without departing from this invention. Other variations within the scope of this invention will readily occur to one versed in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a shield arranged about at least one of said electrodes, and a member having the characteristic of emitting vapor at substantially no greater rate than steatite at the operating temperature of said electrical space discharge device arranged about said shield, said member and shield being provided with openings therein to permit the passage of the discharge therethrough.

2. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a conducting shield arranged about at least one of said electrodes, and a steatite insulating member arranged about said shield, said shield and member being provided with openings therein to permit the passage of the discharge therethrough.

3. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a conducting shield arranged about at least one of said electrodes and spaced therefrom a distance of the order of the mean free path of the electrons in said atmosphere or less, and an insulating member arranged about said shield, said shield and member being provided with openings therein to permit the passage of the discharge therethrough.

4. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, said electrodes including an anode, a conducting shield arranged about said anode, and a non-conducting member arranged about said shield, said shield terminating in a plane spaced closely to a plane including the end of said anode, said shield and member being provided with openings therein to permit the passage of the discharge therethrough.

5. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, said electrodes including a plurality of anodes, conducting shields arranged about said anodes, each of said shields terminating in substantially the same plane as the end of the corresponding anode, and an insulating member arranged about each of said shields, said shields and members being provided with openings therein to permit the passage of the discharge therethrough.

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6. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, said electrodes including a cylindrical anode, a hollow cylindrical conducting shield arranged around said anode and spaced therefrom, said anode projecting beyond the end of said shield, and a hollow cylindrical insulating member arranged about said shield, said shield and member being provided with openings therein to permit the passage of the discharge therethrough.

7. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a shield arranged about one of said electrodes, and an insulating member arranged about said shield, said shield and member having openings therein for the passage of the discharge therethrough, said anode having a portion projecting beyond said shield, the portion of said member adjacent said opening projecting beyond said shield to thereby form a restricted chamber to thereby prevent flashing to said shield.

8. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a conducting shield arranged about and terminating adjacent the end of at least one of said electrodes, and an insulating member arranged about said shield, said shield and member being provided with openings therein to permit the passage of the discharge therethrough, said member and said shield being constructed and arranged to provide an insulating space therebetween.

9. In an electrical space discharge device a conducting sleeve, an anode element arranged at least partially within said conducting sleeve in electrical contact therewith, and an electrical conducting member arranged at least partially within the conducting sleeve and spaced from said anode element, said conducting member being in electrical contact with said sleeve at a point on said member nearest said anode element.

10. In an electrical space discharge device a hollow cylindrical conductor, an anode element

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arranged within one end thereof in electrical contact therewith, and an electrical conducting member projecting at least partially within said conductor from the other end thereof, and being spaced from said anode element, said member making electrical contact with said conductor at a point on said member nearest said anode element.

11. In an electrical space discharge device a conducting sleeve, an anode element arranged within said conducting sleeve in electrical contact therewith, and an electrical conducting member having at least a portion thereof arranged within said sleeve, the portion of said conducting member arranged within said sleeve being in electrical contact throughout its length with said sleeve, said conducting member being spaced from said anode element.

12. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a conducting shield arranged about at least one of said electrodes, and an insulating member arranged about said shield, said shield and member being provided with openings therein to permit the passage of the discharge therethrough, said member and said shield being constructed and arranged to provide an insulating space therebetween, the distance between said shield and member across said space being of the order of the mean free path of the electrons in said atmosphere or less.

13. An electrical space discharge device comprising an envelope containing an ionizable atmosphere at a pressure sufficiently high to produce substantial ionization upon the occurrence of a discharge therein, electrodes adapted to support an ionizing discharge through said atmosphere, a conducting shield arranged about at least one of said electrodes and spaced therefrom a distance of the order of the mean free path of the electrons in said atmosphere or less, and an insulating member arranged about said shield, said shield and member being provided with openings therein to permit the passage of the discharge therethrough, the distance between said shield and member across said space being of the order of the mean free path of the electrons in said atmosphere, or less.

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