

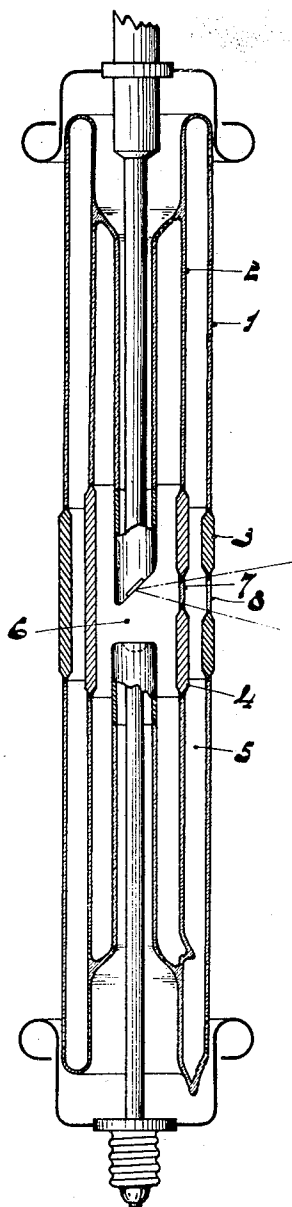
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HIGH VACUUM DISCHARGE VESSEL IN PARTICULAR X-RAY TUBES

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HIGH VACUUM DISCHARGE VESSEL IN
PARTICULAR X-RAY TUBESLeopold Völkel, Hamburg, Germany, assignor to
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7 Claims. (Cl. 250—35)

This invention relates to discharge devices and more particularly to discharge devices which operate at high voltages and with pure electron discharge, and which are provided with an envelope of insulating material comprising a middle portion of conductive material, surrounding the discharge space.

It is known that in such devices, the voltage drop along the envelope is divided by the middle portion of conductive material. The division of voltage between the two insulating portions of the envelope depends on two factors.

The first factor is the symmetrical location of the conductive portion between the two metal parts, for instance, between two electrodes, from which the conductive portion is insulated by the insulating portions of the envelope and between which the voltage drop exists which the conductive portion is subdividing.

The second factor is the presence of free electrons in the discharge space.

The first factor will tend to produce an equal division of the voltage between the two insulating portions; when such a discharge tube is operated on alternating current or on a rectified alternating current without using a special smoothing circuit, thus as long as the voltage has a continuously varying value, such equal division of voltage will be permanently maintained.

However, in certain cases, as for instance, when working with pure direct current of very high voltages, as used in therapeutical installations, the second factor, namely, the presence of free electrons, manifests itself and causes a space charge, which while partly counteracted by the discharge between the positive electrode and the conductive middle portion, nevertheless will prevent equal voltage division.

In the case just mentioned, the electrons will cause the conductive middle portion to take up a negative charge, and unless special means are provided or the positive electrode is closely spaced to the middle portion, the middle portion will assume a potential which is nearer to that of the cathode than that of the anode,—consequently, the voltage is no more equally divided, but the insulating portion between the middle conductive portion and the anode has to take care of a much larger portion of the total voltage, than the insulating portion between the conductive middle portion and the cathode.

It has already been proposed to retain the conductive or metallic central part at ground potential so as to apply between same and each of the two electrodes half of the total voltage. This method, however, can only be used with tubes having a small output or with tubes operating at low voltages. With tubes operating at high voltages, the electrons impinging upon the metallic middle portion, due to the intense electric

field prevailing between this portion and the electrodes, have such a high speed, that the metal wall becomes very hot under their impact. In the case of tubes operating at a small voltage, but having a large output, the current intensity in the common connection to ground—through the arrival of the correspondingly large number of electrons,—becomes so high, that here again the central metallic part becomes very hot. Such heating up of the metallic part leads in both cases to the destruction of the tube.

According to the present invention, it is possible to ground the central metallic part so as to obtain a symmetrical distribution of the voltage between the electrodes by disposing inside the discharge vessel a metal screen, which is insulated from the electrodes and inside which the discharge occurs. The annular space between the outer wall of the tube and the just mentioned screen is brought to a high vacuum whereby this annular space forms a layer of high insulating capacity. Consequently the danger of perforation of the tube is materially reduced. It has already been proposed to construct an X-ray tube made entirely of glass with a protective casing of metal or glass. This arrangement has the drawback inter alia of reducing the insulating capacity of the vacuum between the inner glass wall and the protective casing, in case of disturbances occurring in its relation to the vacuum in the discharge space. For this reason, the annular space between the outer wall and the inner screen, according to the present invention is completely sealed with reference to the inner space and evacuated independently therefrom. Thus the stray electrons from the electrodes can no more fall on the metallic central part of the outer wall and consequently the latter may be directly connected to ground whereby the distribution of potential in the tube is perfectly symmetrical. This provides the further advantage, that it is possible to support the tubes directly through their central metal part even when operating at high potentials.

A further improvement of the above described discharge vessel is accomplished by using metal for the central part of the screen surrounding the discharge space as well as for the central part of the outer wall. This metal part surrounds the electrodes and causes the electrons to fall on the central metal part of the screen. Thereby the load is evenly distributed over the whole length of this inner metallic central part. Consequently no point of the screen may receive a particularly high load and eliminates local overloading, which would otherwise cause an excessive strain on the wall and indefinite operating conditions in the discharge space. The load on the metallic part of the inner screen surrounding directly the discharge space quickly reaches its maximum value

whereby constant conditions are obtained during the discharge and variations in the cathodic ray beam and thus in the size of the cathodic spot is prevented.

5 It is found, however, that not only the electrons falling on the wall bounding the discharge space have such a detrimental action on the discharge and on the constancy of its operating conditions, but also that the metal particles falling on the
10 wall, and due to the atomizing and vaporizing of the electrode material, may also have such an action. If this wall is of glass, the electric conditions vary during the life of the discharge vessel as the metal deposit on the glass wall increases
15 constantly during the life of the tube. This drawback is removed by making the central part of the inner screen originally of metal, whereby the projection of metal particles on the wall surrounding the discharge space, while gradually
20 forming an increasingly thick coating, do not influence the conditions of the discharge.

A further increase of safety as to voltage is obtained in such a discharge vessel by having the inner metal part surrounding the discharge space
25 project on both ends by equal amounts beyond the edges of the opposing central metallic part of the outer wall. The size of these two central metallic parts is chosen such that the areas of the annular metal surfaces lying opposing each
30 other are equal. Owing to the different diameters of the two metal rings the area of the inner ring would be smaller than that of the outer ring for equal widths of said rings, but this is compensated by making the inner ring larger.
35 If this care is taken to give equal areas to the two rings they form a condenser, in which a homogeneous electric field prevails and points of greater field intensities which might cause perforations, are avoided.

40 In the accompanying figure is shown by way of example of a form of execution of the invention, a cylindrical X-ray tube having an outer glass wall 1 provided with a central metal part 3. To the outer wall is welded the hollow cylinder 2
45 the major part of which is also of glass and the central part 4 of which is of metal in the form of execution illustrated. The size of the metal parts 3 and 4 is so selected that the opposing surfaces have equal areas. Between the glass parts
50 1 and 2 lies the annular space 5 closed with reference to the inner discharge space and brought to a high vacuum. For the main outlet of the X-rays, there are provided in the metal parts 3 and 4 outlet windows 7 and 8, for instance of
55 glass.

I claim:

1. A high voltage electric discharge tube comprising a receptacle and at least two electrodes, said receptacle comprising a wall having a metallic portion and two substantially similar insulating portions on each side of said metallic portion, said electrodes being supported by said insulating portions, a partition dividing said receptacle into
60 two sealed concentric chambers, the inside chamber containing the electrode members and the outer chamber forming a highly evacuated annular jacket around the first chamber, said partition comprising a metallic portion surrounding the operating portions of the electrodes and being insulated from said electrodes and from the metallic portion of the outer wall.

2. An electric discharge tube comprising electrode members and a wall supporting same, which

by an integral metallic portion is subdivided into two substantially similar insulating portions, a metal screen disposed within said metallic portion and concentric therewith, said screen surrounding those parts of the electrodes between
80 which the discharge takes place and extending beyond the edges of said metallic portion, and substantially similar insulating members between said screen and each of said electrode members.

3. An electric discharge tube having electrode members and a wall supporting same, said wall comprising a metallic part and two substantially similar insulating portions, a metal screen arranged concentrically within the metallic part, said screen being insulated from the electrodes and said metallic part, and surrounding the electrodes at their portions where the discharge takes place, said screen having substantially the same area as the said metallic part.

4. A high voltage X-ray tube for direct current operation comprising a cylindrical envelope having a metallic ring and two substantially similar insulating portions, one on each side of said ring, electrodes in said envelope, a substantially cylindrical partition disposed within said envelope, interposed between said electrodes and said envelope, and hermetically sealed to said envelope, and comprising a metallic ring opposing said first ring and concentric therewith, said first and second rings surrounding the operating portions of the electrodes, and X-ray transmitting windows provided in each of said metallic rings to permit the X-rays to pass from said tube, the window of the first ring being slightly larger than the window of the second ring.

5. An electric discharge tube, electrodes therefor, an enveloping wall structure which mechanically connects said electrodes, said wall structure comprising a middle portion of conductive material and two substantially insulating portions on each side of said conductive material, each insulating portion supporting one electrode, a second envelope within said first envelope and surrounding said electrodes, said second envelope being welded to the first envelope and forming a sealed chamber therein, the chamber formed between the first and second envelope forming a high vacuum insulating jacket.

6. An electric discharge tube having electrode members between which during the operation of the tube a high potential difference occurs, said members being connected to each other by a wall including substantially similar parts of insulating material, said wall having at its middle portion a waist section of conductive material, a screen interposed between said wall and said electrode members and hermetically sealed to said wall to form a sealed high vacuum chamber between said wall and said screen.

7. An electric discharge tube having electrode members between which during the operation of the tube a high potential difference occurs, said members being connected to each other by a wall including substantially similar parts of insulating material, said wall having at its middle portion a waist section of conductive material, a screen having a metallic waist section opposing the first waist section interposed between said wall and said electrodes and welded to said wall, to form a sealed highly evacuated chamber between said wall and said screen.

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