Oct. 12, 1937. F. G. HOUTERMANS ET AL 2,095,930

ELECTRIC DISCHARGE TUBE

Filed Dec. 26, 1933

Fig. 1.

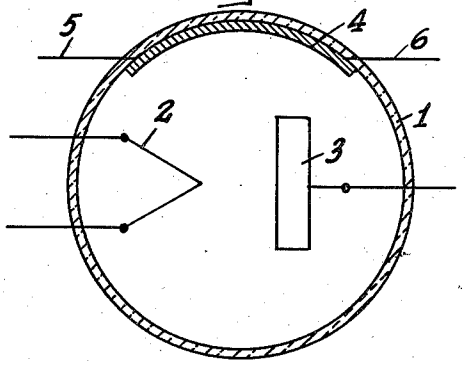
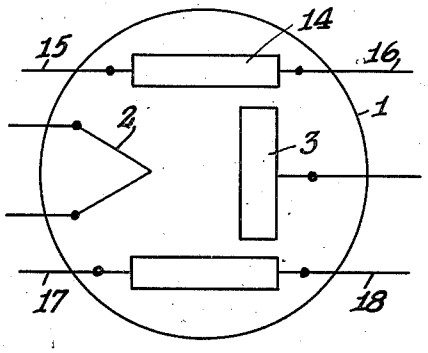


Fig. 3.



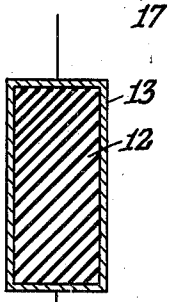


Fig. 4.

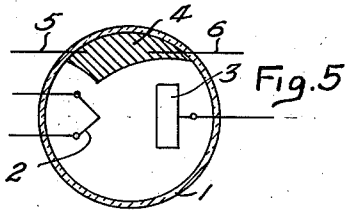
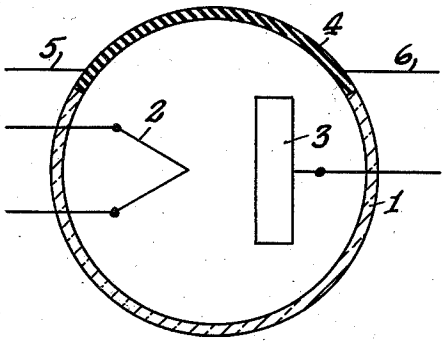


Fig. 5

Fig. 2.



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ELECTRIC DISCHARGE TUBE

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2 Claims. (Cl. 250—27.5)

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Our invention relates to electric discharge tubes, and particularly to electric discharge tubes provided with means to produce an electric field having substantially spherical potential surfaces for controlling the motion and direction of the electron beam.

The well-known electric discharge tubes of any kind, such as Braun tube, cathode ray oscillograph, amplifier tube, electron microscope, etc., usually are provided with metallic electrodes connected with one pole only of a potential source, which electrodes exert an influence of the electron beam. The surfaces of said metallic electrodes present equipotential surfaces, as the electrodes are connected with one pole only of a potential source. Therefore it is necessary to arrange a plurality of such unipolarly connected electrodes in order to produce spherical potential surfaces as required for the operation of said tubes. Apart from the considerable number of electrodes necessary for the production of spherical potential surfaces, such an arrangement has the disadvantage that, if a certain geometrical arrangement of the electrodes is given, subsequently a variation of the field distribution is impossible.

One of the objects of our invention is to provide an electric discharge tube, which prevents the above mentioned disadvantages and permits a variation of the field distribution as it may be desired.

In order to carry out our invention into practice, we provide the electric discharge tube with electrode means connected at least at two points with a special circuit and adapted to be traversed by an electric current. While the electric lines of force always terminate upon the surface of unipolarly connected electrodes at a right angle and independently of the potential of the electrodes, the electric lines of force terminate upon the surface of electrodes traversed by a current at an angle depending on the current intensity for a given resistance of said electrodes. Thus, it is possible to obtain any desired field distribution on the surface of the electrodes and in the surroundings thereof by variation of the current intensity, so that spherical potential surfaces of the electric field may be produced by means of a single electrode or a considerable less number of electrodes than hitherto used, and that the field distribution may be varied within a wide range for a given geometrical arrangement of the electrodes.

Preferably, the electrodes traversed by a current have a high resistance, so that an undesired temperature rise is avoided, although a high potential field is present along their surfaces, and that said electrodes produce the spherical potential surfaces controlling the electron beam without undue emitting of electrons.

Other objects and advantages will be apparent and the principle and apparatus of the invention will be more readily understood by reference to the following description taken in connection with the accompanying drawing, in which:

Fig. 1 shows diagrammatically a sectional view of an electric discharge tube, whereby the field producing electrode is formed upon the envelope of the tube.

Fig. 2 is a sectional view similar to Fig. 1, but illustrates the field producing electrode as constituting a portion of the tube wall.

Fig. 3 shows diagrammatically another embodiment of an electric discharge tube, whereby the field producing electrode is formed by a body arranged within the envelope of the tube.

Fig. 4 is a cross-sectional view of a field producing electrode according to our invention, and

Fig. 5 is a sectional view similar to Fig. 1, whereby, however, the field producing electrode has a resistance varying from point to point.

In carrying the invention into effect, we provide an electrode adapted to have a current passed therethrough, an electric field being generated by the drop in potential along the surface of the electrode.

In this manner it is possible to cause lines of force to end upon a conductor at angles other than normal, and in this way to control in any desired manner the characteristics, and particularly the shape, of the field so generated. The employment of current carrying electrodes renders it possible to pre-determine the boundaries of the field in a well defined shape with more sides than it would be possible to obtain by the use of spaced equipotential electrodes. For example by using a single electrode it becomes possible to produce a homogeneous electric field.

It is a well known fact that lines of force generated by a current carrier will terminate upon the surface of the conductor at an angle determined by the voltage drop along the conductor. Thus for example when directly heated incandescent filamentary cathodes are employed in radio tubes the distortion of the electric field by the voltage drop across the filament is known to cause an effect which can be eliminated more or less by suitable devices.

In practice, the current carrying electrodes in order to draw only a small current for a given

voltage drop will have to have a high resistance and are therefore highly resistant material; or conductive layers on an insulator, will have to be used.

Further, the use of current carrying electrodes arranged as a coating upon the wall of the envelope of the tube eliminates the occurrence of uncontrollable and undesired charges on the wall which would occur if the wall were of insulating material. Hitherto, it has been possible to prevent the occurrence of such changes by the provision of a conducting coating upon the wall of the envelope, but this then becomes a contributory factor to the shape of the electric field within the valve since the coating is equipotential.

If the wall of the envelope is of an insulating material, then it can be used as a direct support for the resistive layer. The desired distribution of the field can be obtained either by variation from point to point of the resistance of the electrode body for example the resistance of the layer or by suitably shaping the resistance support or the support for the coating.

In order that the potential of the electrode may be fixed at two or more points on its surface a suitable number of terminals to these points are provided.

The invention is applicable to numerous cases. For example, it is applicable to all kinds of vacuum or gas filled electron discharge tubes in which it is desired to affect or control the movement of the charge carriers—ions or electrons—by a certain distribution of the electric field. This applies to radio tubes of all kinds, Braun tubes and cathode ray oscillographs more particularly for television, photo tubes and illuminating tubes.

In the case of radio tubes it becomes possible by the use of current carrying electrodes to control without the use of a metallic grid a stream of electrons emanating from a cathode through an electric field without the field being distorted by the size of the grid wires and the grid mesh. In the same way all kinds of auxiliary grids, such as space charge or screening grids, can be replaced by current carrying electrodes. Further, for valves energized in the manner of a Barkhausen-Kurz circuit, a field which can be exactly calculated can be obtained by current carrying electrodes.

Further applications, in Braun tubes, cathode ray oscillographs and electron microscopes, require a field distribution which corresponds to an electron lens for reproducing on a fluorescent screen an electron source, for example a cathode or an object illuminated by electrons or ions, in the case of the microscope on an enlarged scale, and in the case of the oscillograph on a reduced size to produce a point of brilliant illumination.

The production of such a field distribution, where it is essential to have potential surfaces as nearly spherical as possible is easily accomplished by the present invention. In the case of Braun tubes for example the current carrying electrodes are formed either by the incorporation of a special resistant body or by arranging it as a thin metallic or conductive coating on the inside of the tube envelope. In the latter case the field distribution for focussing or concentrating the electron stream is obtained either by suitably shaping the inner wall of the tube or by producing a layer of resistant material locally modified or by the provision of a suitable concentrating electrode also designed according to this invention.

In the same way current carrying electrodes according to this invention may be used for the deflecting plates, for which it is important to have a homogenous field or a field which ensures the constant proportion of the deflection.

In high tension technique it is frequently desirable to have exactly defined fields at given points on an insulator. If however very highly insulating materials are employed this is not possible since as a result of charges accumulating a field results along their length which cannot be determined, and in some cases arcing or sparking may result. The use of conductors of very low conductivity renders possible the definition of fields at given points of the insulator or on the whole surface thereof; in particular intense fields may be kept away from points where sparking is likely to occur.

Thus it is possible to construct a discharge tube in which the potential drop down the tube is evenly distributed, and thus to use very high voltages, by arranging a highly resistant body inside the discharge tube, for example a thin metallic layer on the insulating wall.

Referring now in detail to the accompanying drawing: The valve of Fig. 1 consists of an envelope **1** in which is secured in the usual manner a cathode **2** and anode **3**. The field producing electrode **4** of the present invention is the other electrode in the tube and is preferably arranged as shown, remote from the path of the charged particles passing between cathode **2** and anode **3**. In the embodiment of Fig. 1, electrode **4** comprises a thin metallic coating applied to the inner surface of envelope **1**, and may extend partly or completely around the envelope. Terminals **5** and **6** are provided to the coating to permit the application of a potential to the terminals so that a current may be caused to pass through the electrode. The passage of the current therethrough generates an electric field which may usefully be employed to vary the path of electrons or other charged particles passing in the anode-cathode direction.

Fig. 2 is similar to Fig. 1 (like characters representing the same or corresponding parts). The field producing electrode **4**, however, constitutes a portion of the wall of envelope **1** and is composed of a partly conducting ceramic material.

In Fig. 3 the electrode **4** is replaced by an electrode **14** arranged within the envelope **1**. Terminals **15**, **16**, **17**, **18** are provided to enable current to be supplied to various parts of the electrodes. Owing to the passage of current through the electrode **14**, and to the consequent field produced therein, it is suitable for use as a control electrode for controlling the cathode-anode stream in the manner of a control grid in a thermionic triode.

Fig. 4 illustrates a suitable method of forming the field producing electrode. The electrode consists of an insulating body **12**, preferably of ceramic material, to which is applied a thin conductive coating **13** for example by cathode sputtering.

According to the embodiment shown in Fig. 5, the control electrode **4** has a resistance varying from point to point. The arrangement of the cathode **2** and the anode **3** is similar to the arrangement of these parts in the embodiment shown in Fig. 1.

What we claim and desire to secure by Letters Patent is:—

1. Apparatus comprising an exhausted envelope, an electrode within said envelope for emitting charged particles, a second electrode within said envelope upon which said particles are to impinge, and means for producing an electric field for controlling the motion of said particles comprising a third electrode of highly resistive material constituting a part of said envelope and adapted to be traversed by an electric current.

2. An apparatus comprising an exhausted envelope, electrode means within said envelope for emitting charged particles, second electrode means within said envelope upon which said particles are to impinge, and non-thermionic control electrode means of poorly conductive insulating material constituting a part of said envelope and having terminals for the passage of an electric current therethrough.

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