March 15, 1949. G. DIEMER 2,464,562

DISCHARGE TUBE

Filed Nov. 22, 1946

Fig. 1.

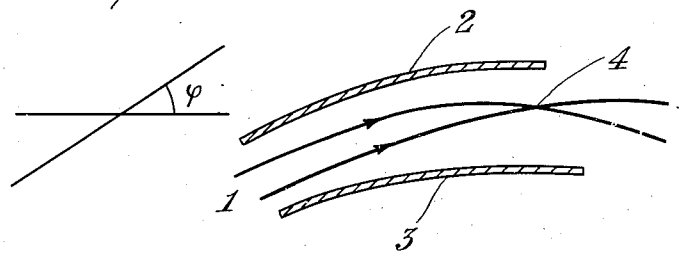


Fig. 2.

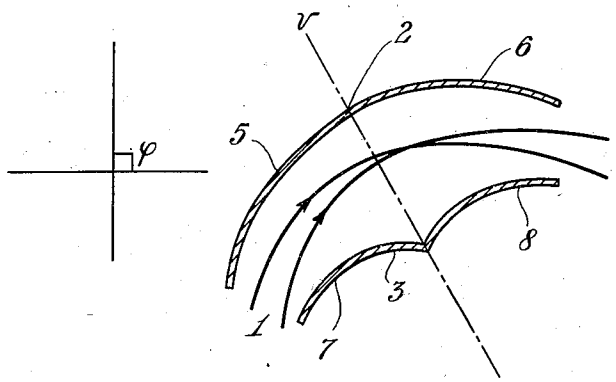
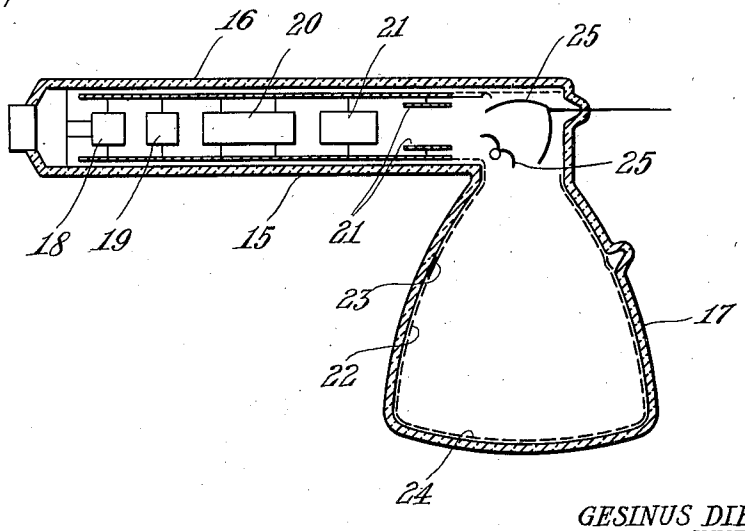


Fig. 3.



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DISCHARGE TUBE

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3 Claims. (Cl. 250—159)

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This invention relates to a discharge tube in which a stream of electrically charged particles is formed into a beam. Such discharge tubes are known for different purposes, in accordance with which the tubes are exhausted or furnished with a gasfilling. Therefore the charged particles in these tubes are of a different nature. In cathode-ray tubes the charged particles are electrons, as in the so-called velocity-modulation tubes. Tubes in which the charged particles are not electrons are, for instance, cyclotrons and mass spectrographs. In all these tubes the path of the beam requires to be influenced for various purposes. Thus, for instance, in cathode-ray tubes it is necessary to draw an oscillogram or a television image, or to produce a current variation in a number of collecting electrodes. In velocity-modulation tubes it may be desirable to cause the electrons to travel along a curved path to obtain a simpler positioning of the electrode system. In cyclotrons and mass spectrographs curvature of the path of the charged particles is vital for the operation of the tube i. e. splitting of the ion beam into its various components.

In the present specification the expression "stream of charged particles which is formed into a beam" is not to be understood to mean that the paths of the particles in the beam are all parallel, but that the angle between the paths is small. At any rate the formation into a beam is such that there is a marked main direction of the stream of particles.

The paths of the charged particles can be influenced electro-magnetically or electrostatically. A special manner of influencing the path of the electron beam in cathode-ray tubes electrostatically is obtained by means termed a "cycling track." This "cycling track" comprises two curved coaxial cylindrical electrodes, provided on both sides of the electron beam, and serves to curve the beam along a curved path through a given angle. Between the electrodes there is set up a potential difference which is chosen in connection with the velocity of the incoming electrons, the electrode distance and the desired curvature of the path and of the electrodes, it being assumed that an electron entering exactly midway between the electrodes of the cycle track has to follow a path extending midway between the two electrodes.

It appears that the "cycle track" construction is possessed of the particular property that a beam entering parallel between the electrodes is focussed. Regardless of the length of the "cycle track" a focus is always found at an angle of

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rotation of 63.5° of the electron beam. Upon a rotation of 127° a parallel beam emerges again in the parallel direction.

The "cycle track" construction has also been described for tubes in which the charged particles are not electrons but, for instance, ions.

The particular properties of the "cycle track" construction resulting in focussing at 63.5° is a drawback since for several purposes focussing of the beam is required at a different angle of rotation. Another drawback is due to the coaxial positioning of the electrodes of the "cycle track," owing to which the distance between the electrodes is always the same. If, for instance, a diverging beam is caused to enter the "cycle track," the beam, after a given angle of rotation, will have such a width that some of the electrons reach the electrodes, which is undesirable. When the initial beam, before reaching the "cycle track," is deflected by an alternating voltage, the same drawbacks are experienced, since upon a strong deflection the beam is likely to be intercepted by the electrodes of the "cycle track." The aforesaid drawbacks can be met by giving the distance between the electrodes a large value. In this case, however, it is necessary, to set up a large potential difference at the plates to ensure the desired path and to satisfy the condition that a particle entering midway between the electrodes, continues to move midway between the plates.

The aforesaid drawbacks of the "cycle track" construction are avoided in a discharge tube according to the invention, which comprises a number of electrodes by which a stream of charged particles is formed into a beam which, over part of the path travelled, is caused to follow a curved path by a number of curving electrodes placed on both sides of the beam and of which at least one is curved, these electrodes being positioned in such a manner that the distance between the electrodes on both sides of the beam increases or decreases in the direction of motion of the beam, and the line connecting the middles of these distance lines being curved in the same sense as the curving electrode exhibiting the strongest curvature.

Since the electrodes diverge it can be provided that a diverging beam or a deflected beam is not intercepted by a curving electrode. Moreover, focussing may take place practically at any desired angle of curvature.

In a particular form of construction of a tube according to the invention the curving electrode system comprises two curved electrodes each of which consists of two interconnected curved

parts, one of which is the image of the other in a plane through the connecting points of the parts of each electrode.

Naturally the system according to the invention may be combined with an ordinary "cycle track" or with a magnetic field of curvature. In the case of deflection of the beam being desired, this may be effected by means of separate electrodes or by dividing a curving electrode and by supplying the deflecting voltage to part thereof. As has been said above this part may be the image of the remaining part of the curving electrode, but without being connected thereto.

In order that the invention may be more clearly understood and readily carried into effect it may now be described more fully with reference to the accompanying drawing, in which two forms of construction of a curving system of a tube according thereto are represented diagrammatically.

Figure 1 is a cross-sectional view of applicant's novel electrode system;

Fig. 2 is a cross-sectional view of another of applicant's novel electrode system; and

Fig. 3 is a cross-sectional view, partially diagrammatic, of an embodiment of applicant's invention comprising a cathode ray tube having a fluorescent screen and including applicant's novel electrodes.

In Figure 1 the electron beam 1 is curved through an angle ϕ by curving electrodes 2 and 3 which are placed on both sides and diverge in the direction of motion of the beam. Between the electrodes 2 and 3 is set up a given potential difference as a result of which the beam is focussed at 4. The angle of curvature ϕ may be arbitrary owing to the divergence of the electrodes.

In Figure 2 an electron beam 1 is curved through an angle ϕ which in the present case amounts to 90°. On both sides of the beam is provided a curved electrode 2 and 3 respectively. These electrodes consist of parts 5, 6 and 7, 8 respectively, one of which is the image of the other in the plane v.

The aforesaid curving systems may be used in various kinds of discharge tubes, for instance radio tubes, secondary-emission tubes, tubes involving deflection control e. g. television tubes, in cyclotrons, mass spectrographs and so on.

In Fig. 3, there is shown somewhat diagrammatically a complete cathode ray tube comprising an envelope 15 having a cylindrical portion 16 and a bulbous portion 17. In the cylindrical portion 16 is an electron gun 18, a first anode 19, a second anode 20, and two pairs of deflection plates 21. In the bulbous portion 17 is a graphite coating 22 along the sides thereof with a lead 23 thereto and a fluorescent screen 24 on the face of said bulbous portion. A pair of electrodes 25, corresponding to those illustrated in Fig. 2, are situated in the junction between the cylindrical portion 16 and the bulbous portion 17 of the envelope 15. Electrons leaving the gun and passing through the first and second anodes are deflected by deflecting plates 21 and their path is curved by the electrodes 25 in their passage therebetween through a 90° angle, and focused upon the screen 24 at a place thereof depending upon the deflecting voltages on deflecting plates 21.

What I claim is:

1. A discharge tube comprising an envelope, and within the envelope, means to generate a beam of electrically charged particles, and means to curve the path of said particles comprising two electrodes having active metallic surfaces facing each other between which said beam is directed, said surfaces being curved in the same sense and being separated by a distance therebetween varying with the distance from the place of entry of said beam particles therebetween to the place of measurement of said separation distance.

2. A discharge tube comprising an envelope, and within the envelope, means to generate a beam of electrically charged particles and means to curve the path of said particles comprising two electrodes each having first and second portions each having an active metallic surface, said first portion surfaces facing each other and said second portion surfaces facing each other, said facing portion surfaces having the beam directed therebetween and being curved in the same sense and being separated by a distance therebetween varying with the distance from the place of entry of said beam particles therebetween to the place of measurement of said separation distance, said first and second portion surfaces having a common plane of symmetry substantially normal to the direction of said beam at its intersection with said plane.

3. A discharge tube comprising an envelope, and within the envelope, means to generate a beam of electrically charged particles and means to curve the path of said particles comprising two electrodes each having electrically separate first and second portions each having an active metallic surface, said first portion surfaces facing each other and said second portion surfaces facing each other, said facing portion surfaces having the beam directed therebetween and being curved in the same sense and being separated by a distance therebetween varying with the distance from the place of entry of said beam particles therebetween to the place of measurement of said separation distance, said first and second portion surfaces having a common plane of symmetry substantially normal to the direction of said beam at its intersection with said plane.

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