

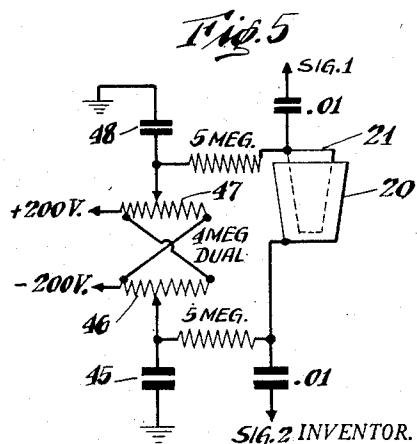
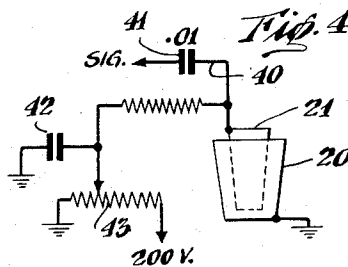
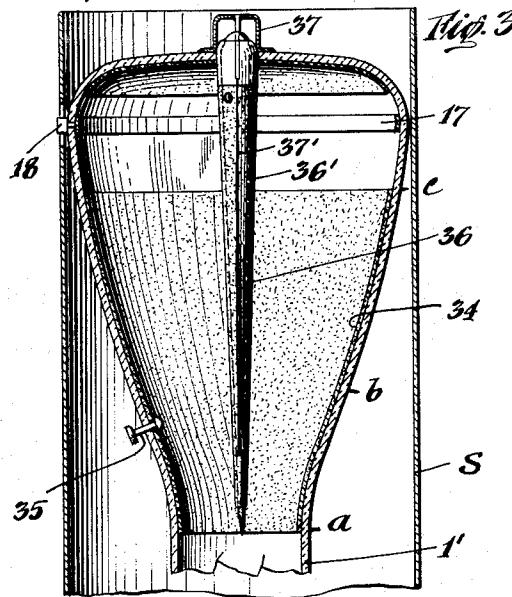
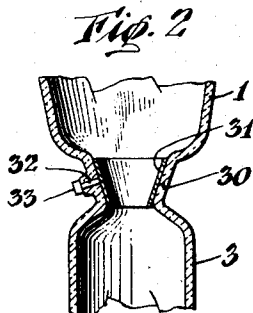
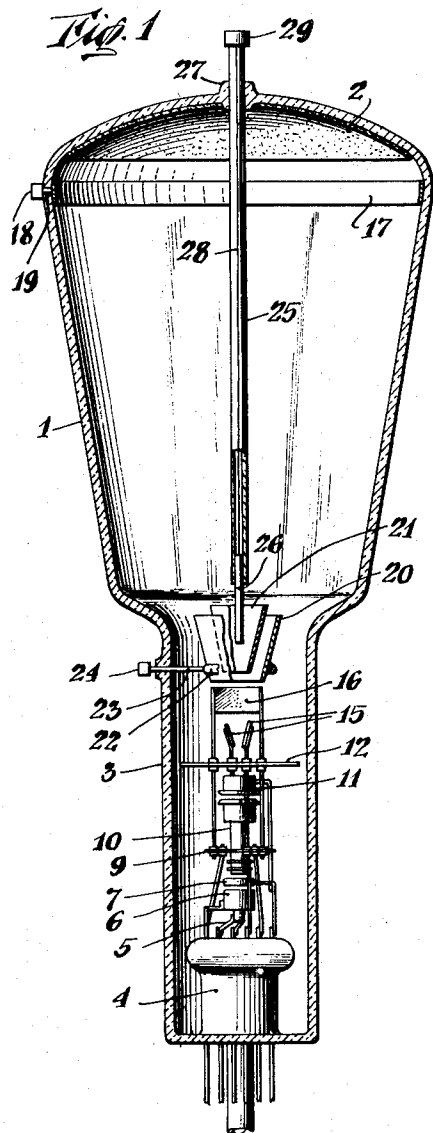
Aug. 31, 1943.

P. S. CHRISTALDI ET AL

2,328,259

POLAR COORDINATE CATHODE-RAY TUBE

Filed Nov. 18, 1941



Peter S. Christaldi and
Stanley J. Koch,
By
Charles W. Montrose, ATTORNEY

UNITED STATES PATENT OFFICE

2,328,259

POLAR COORDINATE CATHODE-RAY
TUBE

Peter S. Christaldi, Wood-Ridge, and Stanley J. Koch, Clifton, N. J., assignors to Allen B. Du Mont Laboratories, Inc., Passaic, N. J., a corporation of Delaware

Application November 18, 1941, Serial No. 419,530

3 Claims. (Cl. 250-158)

This invention relates to polar coordinate cathode-ray tubes in which electron beams are deflected electro-dynamically. This is a continuation-in-part of our application Serial No. 405,188, filed August 2, 1941.

In carrying out this invention, deflection of an electron beam may be caused to take place electro-dynamically along two orthogonal axes by means of pairs of plates energized by applying voltages to either or both pairs, or deflection of the beam may be caused to take place magnetodynamically by means of deflecting coils energized by applying electric currents. At the same time the electron beam is deflected electro-dynamically by a signal along a direction at an angle to the beam.

It is well known that an electron beam can be caused to trace visible circular or elliptical or other shaped paths on a prepared surface such as a fluorescent screen at the end of an exhausted glass tube. A signal to be observed can be applied to such a beam in accordance with this invention so as to cause a variation that can be seen and recorded by an observer.

The invention may be understood from the description in connection with the accompanying drawing, in which:

Fig. 1 is a side view of an illustrative embodiment of the invention;

Figs. 2 and 3 are similar views partly broken away showing modifications; and

Figs. 4 and 5 are diagrams showing circuit connections to the cones.

In the drawing, reference character 1 indicates a glass tube having a fluorescent screen 2 on the inside of the large end thereof. This screen may, for example, be formed by sprayed willemite on the inside of the end of the tube 1.

The gun structure for producing and deflecting the electron beam is located in the neck 3 of the tube. Such a gun structure is shown in the Christaldi Patent 2,225,099. The gun structure may be mounted upon the stem 4, and connections (not shown) made through this stem to the gun structure. This gun structure may comprise the cathode 5, modulating electrode 6, a first accelerating electrode 7, a mica disc 9, a focusing electrode 10, a second accelerating electrode 11, a mica disc 12 for supporting the electrode 11, a set of deflecting plates 15 supported on the disc 12, and a second set of deflecting plates 16 also supported on the disc 12 but located at right angles to the set 15. An intensifier electrode 17 may be placed near the screen 2 on the inside of

the tube, and may be connected to the outside terminal 18 by the wire 19.

An electron tube such as that described above, as well as other electron tubes, may be modified in accordance with the present invention to produce desired results.

In carrying out the invention, an outer cone 20 and an inner cone 21, which are used as electrodes, are located along the axis of the tube 1 and are preferably so mounted that they are concentric with each other. Each one of them is shaped like a truncated cone, and the outer one 20 is large enough to leave an annular space between it and the inner one 21 for the passage of the electron beam from the gun structure described above to the screen 2. The cones 20 and 21 may be made of conducting material, or they may be made of insulating material with their surfaces coated with conducting material.

The outer cone 20 may be held along the axis of the tube 1 in any convenient way. For example, a holding ring 22 may be placed around this tube having a rod 23 rigidly connected thereto, this rod passing through the neck 3 of the tube 1 and being hermetically sealed therein and terminating with a connecting terminal 24. Or the cone 20 may be supported by rods from the disc 12 to assure alignment with the gun structure, and conductor 23 may then be a flexible connection.

The cone 21 may be kept or supported in position, for example, by means of a glass tube 25 that is provided with a short metal rod 26 projecting into the end of this tube 25 and being attached to the cone 21 in any convenient way. The tube 25 passes through the large end of the tube 1 and is sealed in place, as indicated at 27. A connecting wire 28 extends through the tube 25 from the rod 26 to the connector 29.

In the modification shown in Fig. 2 the tube 1 is made so that the upper portion of the neck 3 is reduced in diameter and shaped like the frustum of a cone, as indicated at 30. The inside surface of the portion 30 is lined or coated with conducting material 31 and is connected by a hermetically sealed connection 32 to the terminal 33 outside of the tube, so that the coated surface 31 takes the place of the truncated cone 20 of Fig. 1.

In the modification shown in Fig. 3 the tube 1' has its neck portion gradually enlarged as it merges into the larger portion of the tube. Instead of using a separate cone such as the cone 20, the inside surface of the tube is coated or lined with conductive material 34, such as metal

or carbon, for example, from a point *a* near the end of the gun structure for some distance, for example to the point *c*, into the enlarged portion of the tube. A connecting terminal 35 may extend through the wall of the tube for making connection from an external source of potential to the conducting cone 34, this cone being supported by the inside wall of the tube.

The inner or centrally located conductive surface may be provided by means of a cone 36 of insulating material coated with conductive material 36' extending from the center of the large end of the tube 1' the desired distance towards the other end thereof. This cone 36 is supported by the large end of the tube, and a terminal 37 is connected to the conducting surface 36' by means of an internal wire 37'. Although Fig. 3 indicates the outer cone as being a coating of conducting material on the inside of the glass and extending from the region *a* to the region *c*, it is sometimes desirable to have the length of the cone reduced so that the coating extends only from the region *a* approximately to the region *b*. When a metal shield *S* is placed around the cathode-ray tube, the outer cone 34 will have a large capacitance to this shield, making it more difficult for the amplifiers to apply electrical signals to the cone. Reducing the extent of the cone 34 by having it reach from *a* to *b* rather than from *a* to *c* will decrease this capacitance materially. This reduction in length of the cone reduces the radial deflection sensitivity of the tube to some extent, although the most effective region for radial deflection still is utilized.

Magnetic orthogonal deflection, though limited in frequency response, may be employed with these various cone radial deflection embodiments, and for many applications it yields more symmetrical results than electrostatic orthogonal deflection.

Although a variety of signals may be received and observed by using a tube of this sort, two convenient circuits are shown in Figs. 4 and 5, respectively, for receiving signals on the cones 20 and 21 or the other conductors for radially deflecting the electron beam. In Fig. 4 the outer cone is grounded and the signal is received on the inner conducting surface as cone 21 through a connection 40 having a condenser 41 therein and being connected through a 5 megohm resistance to ground through the condenser 42, and also by a movable contact to the resistance 43, one end of which is grounded and the other end of which is supplied with 200 volts. In the hook-up shown in Fig. 5, one signal is connected through a 0.01 mfd. condenser to the cone 21 and another signal is connected through a 0.01 mfd. condenser to the cone 20 with a 5 megohm branch connected to the ground through a condenser 45 and also to a 4 megohm resistance 46 one end of which is connected to 200 volts negative and both ends of which are cross connected to opposite ends of a 4 megohm resistance 47 one end of which is connected to 200 volts positive. The cone 21 is also connected through a 5 megohm resistance to a movable contact on the resistance 47 and through a condenser 48 to the ground.

The tube may be operated as follows: An electron beam is produced by the gun structure 5-16 and caused to trace a visible circular or

other shaped pattern on the fluorescent screen 2 in the known way. This beam passes through the annular space between the truncated cones 20 and 21 or the other pairs of conductors. The signal to be observed is applied to one or both of these cones or conductors, resulting in electro-dynamically energizing them so that a change in the amount of deflection of the electron beam will be caused to take place when the signal arrives due to the field between the cones through which the beam passes. By coordinating the rate of revolution of the beam on the screen 2 with the arrival of the signal at the cones 20, 21, the incoming signal may be detected or examined, as it varies the beam path on the screen.

The circuits shown in Figs. 4 and 5 provide for either single ended or double ended application of signal voltages through conventional condenser coupling means, and they also show means for direct current positioning of the beam to suitable radial extents.

The earlier conventional cathode-ray tubes with two sets of deflecting elements at right angles to each other provide facilities for producing electrical graphs in Cartesian coordinates, frequently using the unknown signal voltage along the Y-axis and a voltage linear with time along the X-axis. In the present invention a circular pattern produced by the two deflecting plate pairs 15 and 16 serves as a time base along which radial deflections produced by the unknown signals may be plotted in polar coordinates.

Advantages of such polar coordinate indications are the continuity of the time base without the break characteristic of the return time of saw-tooth scanning, and the simplicity of indication in 360° which is particularly useful in indications for rotating machinery and azimuth or surveying problems for example.

A feature of the construction in this tube is the bringing out of the four deflecting plates and the two deflecting cones or conductors to separate leads whereby direct current voltages as well as signal voltages may be applied to each deflecting element for improvement of spot and pattern focus by reduction of astigmatism.

What is claimed is:

1. A polar coordinate cathode-ray tube, having a cylindrical neck portion reduced in diameter and formed into the frustum of a cone at the upper end thereof where it joins the body portion, said tube having means for deflecting an electron beam along orthogonal axes and means for independently deflecting said beam radially of said tube, said last named means comprising a pair of conically shaped conducting elements one of which is supported on said reduced neck portion.

2. The tube according to claim 1, in which the conically shaped conducting element supported on the reduced neck portion is coated thereon.

3. The tube according to claim 1, in which the conically shaped conducting element supported on the reduced neck portion is coated thereon and is connected to the outside by a conductor passing through the wall of said reduced conically shaped neck portion.

PETER S. CHRISTALDI.
STANLEY J. KOCH.