April 2, 1968 C. LOTY ETAL 3,376,464

BEAM DEFLECTION SYSTEM COMPRISING A FLATTENED HELIX

Filed Nov. 21, 1966

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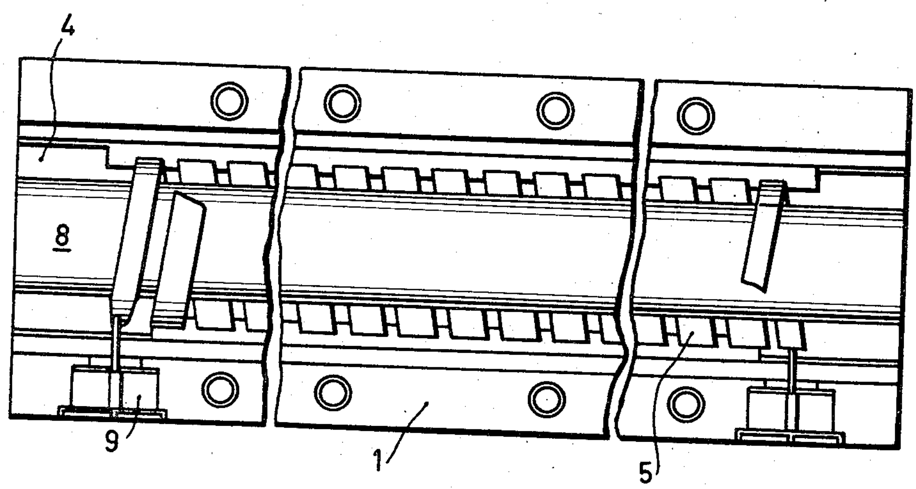

FIG.1

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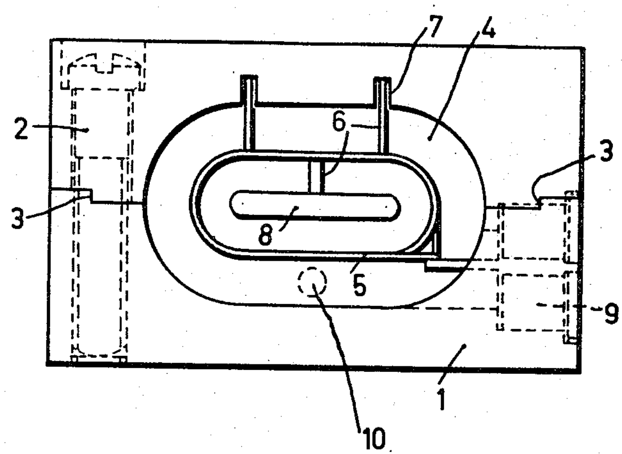

FIG.2

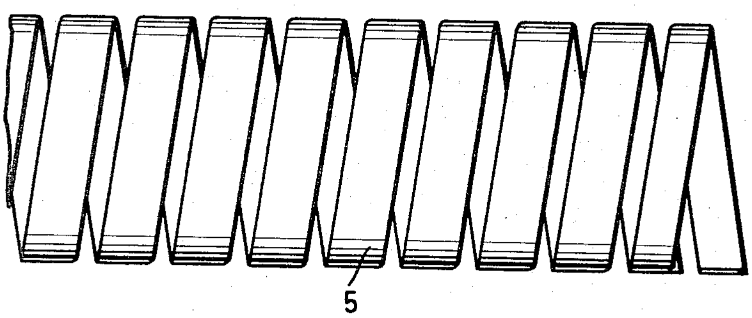

FIG.3

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3,376,464

Patented Apr. 2, 1968

3,376,464

BEAM DEFLECTION SYSTEM COMPRISING A FLATTENED HELIX

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Filed Nov. 21, 1966, Ser. No. 596,011
Claims priority, application France, Nov. 30, 1965, 40,195
5 Claims. (Cl. 315—3)

ABSTRACT OF THE DISCLOSURE

A charged particle beam deflection apparatus particularly for a cathode-ray tube, consisting of a pair of electrodes, one of which is a helical winding of substantially flat, conductive ribbon having a flattened part parallel to the axis of the winding and the other comprising an inner part disposed within and extending along the axis of the helical winding and an outer part practically completely surrounding the helical winding. The walls of these latter parts facing the helical winding are coaxial with the winding and have cross-sections which are similar to that of the helical winding.

The invention relates to a charged particle beam deflection apparatus, consisting of a system of two electrodes, one of which is a helical winding of substantially flat conductive ribbon, having a flattened part parallel to the axis of the winding.

The invention is particularly, though not exclusively, related to a cathode-ray tube, comprising an electron gun for the production of an electron beam and comprising a charged particle beam deflection apparatus of the above kind for the deflection of the electron beam.

As an apparatus for the deflection of a charged particle beam a system has been widely used consisting of two electrodes placed at opposite sides of the path of the beam. A large number of the existing cathode-ray tubes is provided with one or more of such systems for the deflection of the electron beam. However, these systems involve an upper limit for the frequencies of the voltage signals which may yield an adequate deflection of the charged particle beam. When the time of transit of the charged particles through the deflection region becomes comparable with the period of the deflecting signals, there an adequate deflection is not obtained.

In order to make these apparatus appropriate for a broad band-width it has been proposed to construct the system consisting of the two electrodes in the form of a transmission line. An electromagnetic wave propagating along a transmission line and influencing a charged particle beam propagating in its immediate neighborhood can give an adequate deflection of the beam, when the velocities of the wave and of the beam are substantially equal. This situation can easily be obtained. The transmission line may reduce the apparent velocity of the electromagnetic wave to a fraction of its velocity of propagation in the medium, for instance to a tenth of it, and the velocity of the charged particle beam may be fitted by means of a convenient electric field.

It is, of course, very important, that in a deflection apparatus consisting of a system of two electrodes, which form a transmission line, the signals are not deformed during propagation along the transmission line. The principal causes of distortion are the time of transit through the transmission line, the attenuation and the dispersion of the phase velocities. The most important cause of distortion is the dispersion of the phase velocities. In order to reduce this the mode of propagation called T.E.M. is used, wherein the wave has transverse electric and magnetic fields and propagates along the electrodes with a velocity independent of the frequency and equal to the velocity of light. As the charged particle beam has a much smaller velocity, it is necessary to have a line with a long length and to wind it in order to obtain the required retardation.

Until now the most promising constructions of a system, wherein the two electrodes, between which the voltage differences for the deflection of the beam are applied, form a transmission line, seem to be the constructions, wherein one of these electrodes is constructed in the form of a helical winding of substantially flat conductive ribbon, having a flattened part parallel to the axis of the winding. At present, there are a number of known different deflection apparatus constructed in this manner.

In some of these apparatus the second electrode of the deflection system is disposed within the helical winding. There is known, for instance, a type, wherein the second electrode is a stainless steel arbor surrounded by a ceramic spacer around which the helical winding is wound. The stainless steel arbor has a flattened part parallel to its axis, and parallel to the flattened part of the helical winding. The ceramic spacer has an opening between these flattened parts of the electrodes. The charged particle beam passes through this opening, which is rectangular in cross-section.

In others of these apparatus, the helical winding is disposed within the second electrode of the deflection system. There are known, for instance, types, wherein the second electrode is a hollow cylinder, flattened along one side and wherein the helical winding is wound on an insulating former contained within the second deflection electrode the insulating former being of such shape and so positioned, that the helical winding has a flattened region parallel to, immediately opposite from the flattened regions of the second electrode. The flattened regions of the electrodes lie on opposite sides of the charged particle beam path and extend along it.

There are also known some of these apparatus, wherein each of the two electrodes is a helical winding. The two helical windings are herein placed on opposite sides of the path of the charged particle beam in a symmetrical manner. There is, for instance, known a type, wherein each of the two helical windings is disposed about a grounded planar conductive sheet. Each winding is wound close to the grounded plane in a flat oval fashion.

The known apparatus indicated above can give an adequate deflection of the beam for signals of a fairly high frequency. Yet, these apparatus permit the existence of a dispersion of the phase velocities which cannot be neglected.

It is an object of the invention, to provide a charged particle beam deflection apparatus wherein the two deflecting electrodes form a transmission line, which involves a neglectable dispersion of the phase velocities.

It is a further object of this invention to provide a cathode ray tube, comprising an electron beam deflection apparatus, wherein the bandwidth of the frequencies which involve an adequate deflection is broader than in the known cathode-ray tubes.

In accordance with the invention in a charged particle beam deflection apparatus consisting of a system of two electrodes, one of which is a helical winding of substantially flat conductive ribbon, having a flattened part parallel to the axis of the winding, the other electrode has two parts, an inner part disposed within the helical winding and an outer part practically completely surrounding the helical winding. The walls of these parts facing the helical winding are coaxial with the helical winding and have cross-sections of a form similar to the form of the cross-section of the helical winding.

In this charged particle beam apparatus the dispersion of the phase velocities is highly reduced, the second electrode being so constructed and positioned as to substantially prevent the lines of force of the electrical field closing longitudinally. When either the inner part or the outer part of the second electrode does not exist, as is the case in the forementioned known apparatus, the lines of force of the electrical field may easily close longitudinally and so one removes from the mode of propagation T.E.M.

Preferably the helical winding has, all over the winding, a constant distance to the inner part and a constant distance to the outer part of the second electrode in order to have a characteristic impedance which is constant along the circuit.

The distances between the helical winding and the two parts of the second electrode are preferably not longer than the pitch of the winding in order to assure a practically transversal closure of the lines of force of the electrical field. Greater distance would not prevent as satisfactorily as possible the longitudinal closure of lines of force of the electrical field and so the deformation of signals by the dispersion of the phase velocities would not be prevented as satisfactorily as possible.

The electrodes are preferably fixed together by means of a few thin insulating sheets so as to have a minimum of dielectric material between the electrodes. As a matter of fact, the presence of dielectric material increases the dispersion changing locally the velocity of the wave.

The invention concerns particularly a cathode-ray tube, comprising an electron gun for the production of an electron beam and comprising a charged particle beam deflection apparatus, as just described, for the deflection of the electron beam, wherein according to the invention the path of the electron beam extends in the space between the helical winding and the second electrode of said apparatus in the same general direction as the axis of the winding and along the flattened part of the winding. In this cathode ray tube one has the advantages of the described deflection apparatus, so that it involves the possibility of transmitting signals with frequencies of a very broad band-width. The cathode ray tube is so constructed that the beam extends along the flattened parts of the electrodes. These parts permit having a uniform transverse electric field along them, where as the curved parts create a slight distortion of the field.

The invention will now be described with reference to the accompanying drawing, of which:

FIGURE 1 represents a longitudinal section of a charged particle beam deflection apparatus;

FIGURE 2 represents a cross-section of a charged particle beam deflection apparatus; and

FIGURE 3 represents on a large scale the helical winding of a charged particle beam deflection apparatus.

In the figures is shown a helical winding **5** of substantially flat conductive ribbon, which serves as one of the deflecting electrodes of the apparatus. The second electrode of the apparatus has two parts, an inner part **8** and an outer part **1**. These parts are electrically connected, which is not shown in the drawing.

The outer part **1** is a block of metal, which has the

form of a parallelopiped. It consists of two parts assembled by means of the screws **2** and their internal surfaces touching each other have shoulders **3** in order to be sure of a precise assembling. Both parts of this block are hollowed out so as to obtain a tunnel **4** in the form of a cylinder having a cross-section consisting of two semicircles linked by two straight segments, so that the wall of the tunnel presents two flattened regions. The cross-section of the cylinder on which the helical winding **5** is traced resemble the cross-section of the tunnel **4** and the helical winding is so positioned within the tunnel that all the points of the exterior surface of the winding have the same distance to the wall of the tunnel. The inner part **8** of the second electrode is a flat ribbon of metal. Its cross-section resembles the cross-section of the tunnel **4** and it is so positioned within the helical winding **5**, that all the points of the interior surface of the winding have the same distance to it. The helical winding **5** and the inner part **8** of the second electrode are maintained in position within the tunnel **4** by means of three thin sheets of mica **6**. Two of these sheets are disposed between the helical winding **5** and the wall of the tunnel **4**. They are fixed in the notches **7** in the wall of the tunnel **4**. The third one is disposed between the helical winding **5** and the inner part **8** of the second electrode. The two extremities of the helical winding **5** are connected to coaxial plugs **9** by means of which the voltage signals may be applied to the transmission line and the circuit may be closed by its characteristic impedance. The distance between the helical winding **5** and the inner part **8** of the second electrode is 1.2 mm. and the distance between the helical winding **5** and the outer part **1** of the second electrode is 1.8 mm. The pitch of the helical winding is 2.8 mm. This results in a characteristic impedance of 100 ohms and a practically negligible dispersion of the phase velocities. The reference **10** in FIG. 2 refers to a preferred position of the path of the charged particle beam. In this position the path of the charged particle beam extends between the flattened parts of the electrodes and from this position the mica sheets cannot be seen. A practically equally favorable position exists just opposite to this one on the other side of the helical winding between the helical winding and the inner part **8** of the second electrode. In cathode ray tubes according to the invention comprising an embodiment of the deflection apparatus, as just described, the electron gun and the deflection apparatus are so positioned in the cathode ray tube, that the electron beam path has one of these preferred positions in the deflection apparatus. The electrodes of the deflection apparatus in these tubes are preferably gilt to prevent oxidation during the finishing of the tubes.

What is claimed is:

1. A cathode ray tube comprising a source of electrons, means for projecting an electron beam from said source between the electrodes of a beam deflection apparatus, said apparatus consisting of a system of two electrodes, one of which is a helical winding of substantially flat conductive ribbon having a flattened part parallel to the axis of the winding, the other electrode comprising an inner flat part disposed within and extending along the axis of the helical winding and parallel to said flattened part, and an outer part practically completely surrounding the helical winding the walls of which parts facing the helical winding are coaxial with the helical winding and have cross-sections of a form similar to the form of the cross-section of the helical winding.

2. A cathode ray tube, as claimed in claim **1**, characterized in that the helical winding has all over the winding a constant distance to the inner part and a constant distance to the outer part of the second electrode.

3. A cahode ray tube, as claimed in claim **2**, characterized in that the distances between the helical winding and the two parts of the second electrodes are not longer than the pitch of the winding.

4. A cathode ray tube, as claimed in claim 3, characterized in that the electrodes are fixed together by means of a few thin insulating sheets.

5. A cathode ray tube as claimed in claim 1, characterized in that the path of the electron beam extends in the space between the helical winding and the second electrode of said apparatus, in the same general direction as the axis of the winding and along the flattened part of the winding.

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