Dec. 17, 1957 H. HINDERER 2,817,044

UNSYMMETRICAL ELECTROSTATIC DEFLECTION DEVICE FOR ELECTRON RADIATION TUBES

Filed May 19, 1955 4 Sheets-Sheet 1

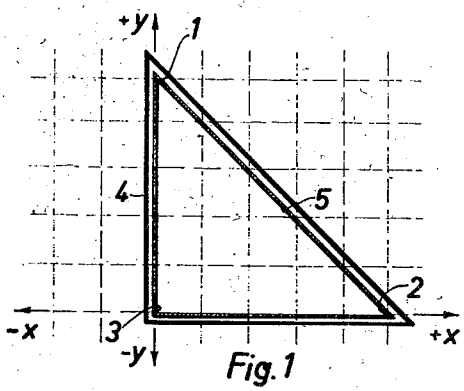


Fig. 1

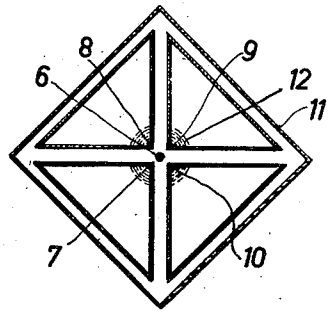


Fig. 2

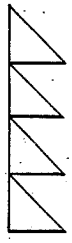


Fig. 3



Fig. 4

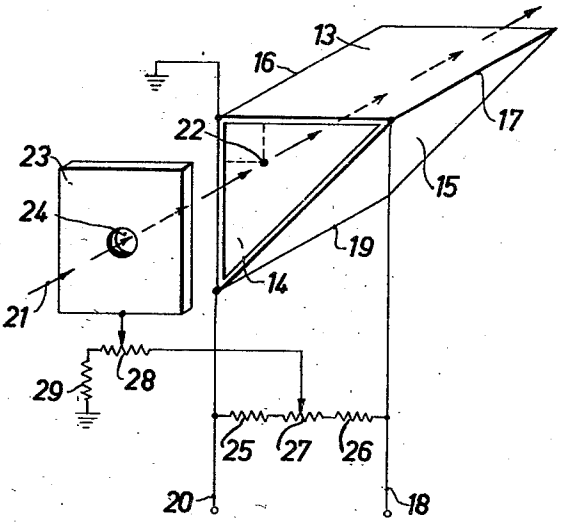


Fig. 5

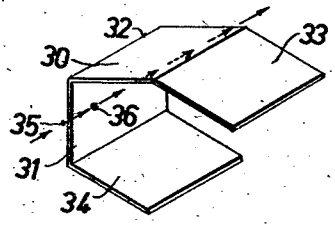


Fig. 6

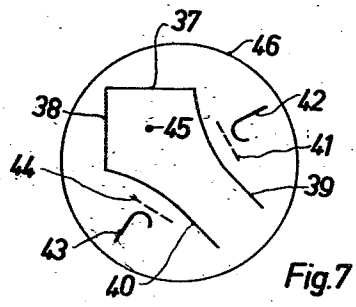


Fig. 7

Inventor:
Hermann Hinderer.
By
Atty.

Dec. 17, 1957 H. HINDERER 2,817,044

UNSYMMETRICAL ELECTROSTATIC DEFLECTION DEVICE FOR ELECTRON RADIATION TUBES

Filed May 19, 1955 4 Sheets-Sheet 2

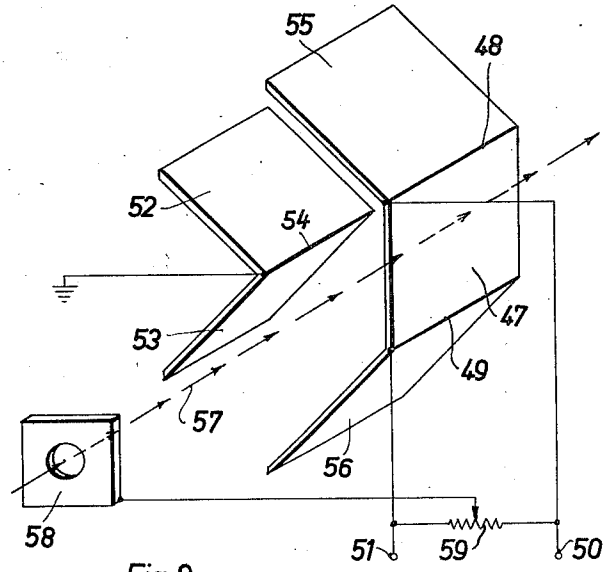


Fig.8

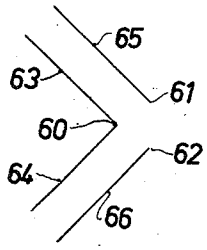


Fig.9

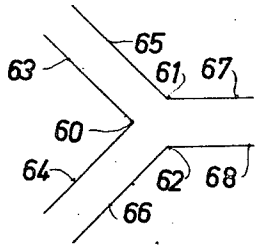


Fig.10

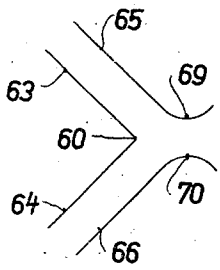


Fig.11

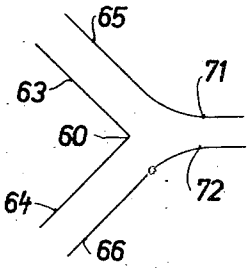


Fig.12

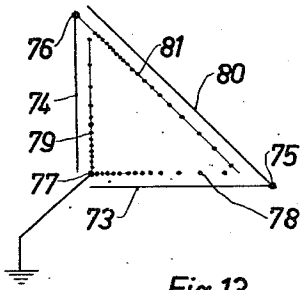


Fig.13

Inventor:
Hermann Hinderer
By. Atty.

Dec. 17, 1957 H. HINDERER 2,817,044

UNSYMMETRICAL ELECTROSTATIC DEFLECTION DEVICE FOR ELECTRON RADIATION TUBES

Filed May 19, 1955 4 Sheets-Sheet 3

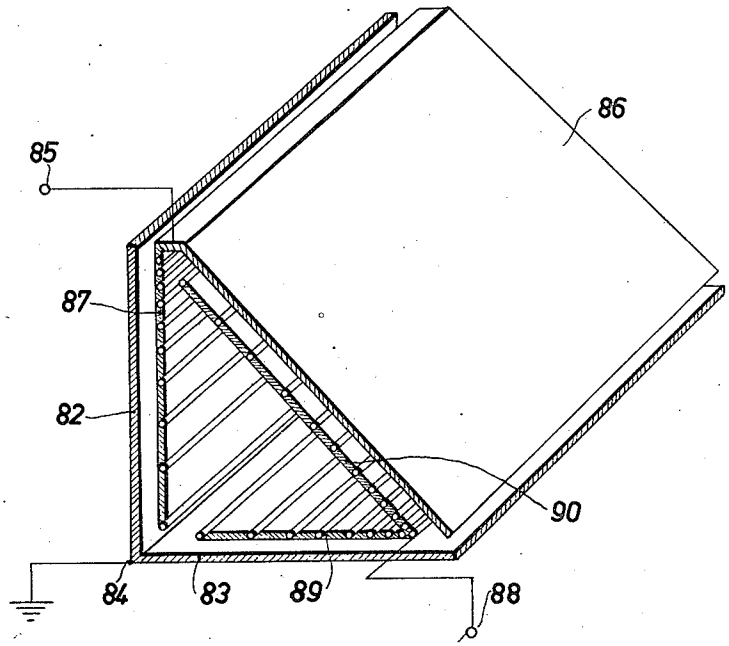


Fig.14

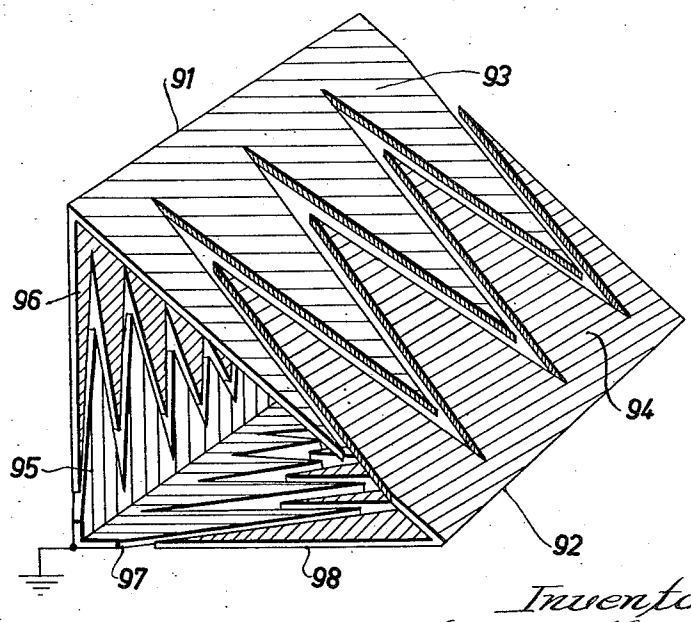


Fig.15

Inventor:
Hermann Hinderer.

By. Atty.

Dec. 17, 1957 H. HINDERER 2,817,044
UNSYMMETRICAL ELECTROSTATIC DEFLECTION DEVICE
FOR ELECTRON RADIATION TUBES
Filed May 19, 1955 4 Sheets-Sheet 4

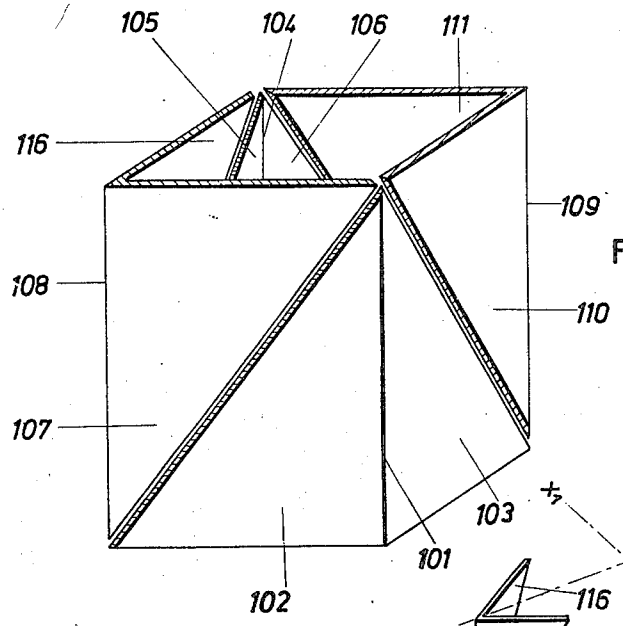


Fig. 16

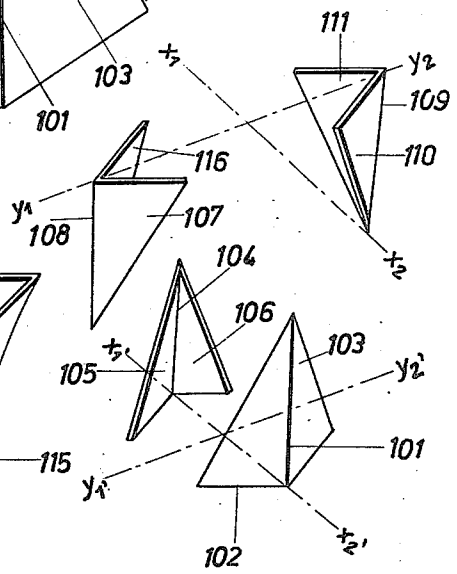


Fig. 17

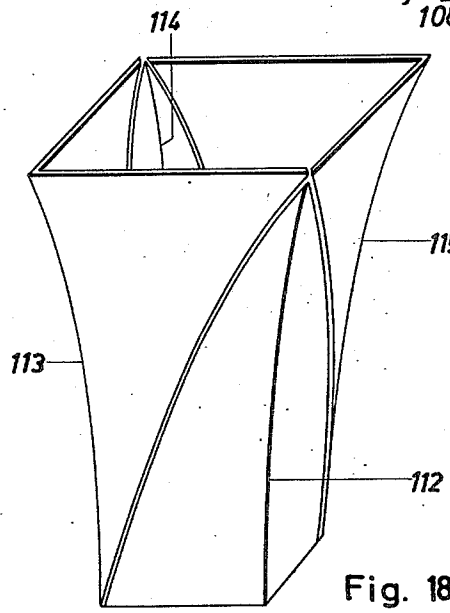


Fig. 18

Inventor:
Hermann Hinderer.
By. Atty.

United States Patent Office 2,817,044
Patented Dec. 17, 1957

2,817,044

UNSYMMETRICAL ELECTROSTATIC DEFLECTION DEVICE FOR ELECTRON RADIATION TUBES

Hermann Hinderer, Munich-Pullach, Germany, assignor to Siemens & Halske Aktiengesellschaft, Munich and Berlin, Germany, a corporation of Germany

Application May 19, 1955, Serial No. 509,499
In Germany June 23, 1949

Public Law 619, August 23, 1954
Patent expires June 23, 1969

25 Claims. (Cl. 315—23)

This invention relates to unsymmetrical electrostatic deflection devices for electron radiation tubes and is particularly concerned with an electrosatic electrode arrangement for corpuscular radiation, which is especially adapted for use as a deflection device for oscillographs, television tubes, grid controlled discharge tubes, electrical lenses for electron microscopes and the like. The problem to be solved is to produce fields by the continuous transition of the fields of two potentials.

In customary deflection systems for electron radiation tubes, there is the problem of effecting in a radiation arrangement two deflections in directions perpendicular to one another and to combine the two deflection fields in such a manner that deflections are produced which are proportional to the voltages connected. The two deflection systems for the two mutually perpendicularly related deflection devices are serially disposed, as seen in the direction of radiation.

It is, however, for the intended purposes often desirable to have the two deflection elements for the mutually perpendicularly related deflection devices disposed at one and the same place, for example, in mutually penetrating spatial position. It is possible in this way to make the deflection sensitivities exactly alike and to make the deflections in both directions mutually independent also so far as the sharpness of action is concerned. In such case, with spatial penetration of the deflection elements, only the terminal point of the electron radiation beam and the place of the apparent deflection have to be considered upon tracing the image.

Three different points have to be considered in the customary arrangements with serially disposed deflection devices for the two mutually perpendicular deflections. It has accordingly been attempted to deviate from the usual designs of the serially disposed deflection systems and to carry out the deflections in both directions at the same place, resulting in advantageous shortening of the length of the corresponding electron radiation tube. Such arrangements, however, produced difficulties. It has been found particularly disadvantageous, in the use of deflection elements of customary structure, that only a small centrally disposed part is useable for the deflection, without incurring ray distortion, which is due to field disturbances at the rims of the plates forming the deflection system. The customary arrangement of the deflection plates also constitutes a complex electron-optical problem especially in the case of unsymmetrical deflection voltages.

The object of the invention is to unite the deflection fields spatially and to form them for unsymmetrical operation.

The invention solves the problem posed by this object by constructing the deflection space which is common to the defletion in both directions so that its limiting points—in a plane as viewed perpendicular to the ray axis—form substantially the corner points of a right-angled triangle.

The invention may be realized in several ways. For example, the deflection space may be formed by a prismatic hollow body with a cross-sectional shape of a right-angled triangle. The three side surfaces of the prism may thereby be formed as resistance surfaces. At the edge at which the two right-angled surfaces of the prismatic body meet, there is connected zero potential, while the two deflection voltages are connected at the edges formed by the hypotenuse surface.

In this manner is formed a deflection system in which the deflection for both directions is carried out at the same place. The invention moreover yields the advantage of small space requirements and practically complete mutual shielding, which is particularly true in the case of deflection systems for multi-ray tubes.

The use of a prismatic hollow body with resistance surfaces for ray deflection has been proposed before. However, the deflection space was in this case of rectangular or square cross-section, with the deflection voltages ground-symmetrically oppositely decoupled always at two oppositely disposed edges. Such an arrangement has the drawback that the connecting devices for the time deflection and the amplifiers must have symmetrical outputs; only very small deviations of the electron beam could otherwise be utilized.

The various objects and features of the invention will now be explained with reference to the accompanying diagrammatic drawings, wherein

Fig. 1 shows a deflection system according to the invention;

Fig. 2 shows an embodiment for using an arrangement according to Fig. 1 for a multi-beam tube;

Fig. 3 indicates an arrangement of deflection elements for a multi-beam tube which delivers in normal condition separate light spots exactly in register;

Fig. 4 shows an arrangement of deflection elements one close to the other;

Fig. 5 illustrates schematically an arrangement of an electrical shutter ahead of the deflection device according to the invention;

Fig. 6 indicates another arrangement employing capacitor plates in place of the hypotenuse surface;

Fig. 7 represents a variant of Fig. 6 employing capacitor plates with an exponential curvature;

Fig. 8 shows an arrangement provided with openings facing the deflection space;

Figs. 9 to 12 indicate embodiments having no resistance surfaces as closure planes on the hypotenuse side;

Fig. 13 shows the principle of a modified embodiment;

Fig. 14 indicates in perspective representation an arrangement similar to Fig. 13;

Fig. 15 shows an arrangement in which the effective parts of the associated electrodes are respectively disposed in the same plane and interlinked with one another; and

Figs. 16 to 18 indicate embodiments in which the deflection electrodes form the inside surfaces of rectangular endwise open hollow bodies of preferably square cross-section.

The numerous embodiments are shown only in their essential parts which are necessary for an understanding of the invention. They illustrate only relatively few of the possibilities of the invention.

In Fig. 1, the deflection space is formed by a prismatic hollow body having side surfaces which constitute resistance layers. These layers have suitably a high resistance in order to permit as low as possible a loading of the voltage sources to be connected. The leads are disposed at the inner edges **1**, **2** and **3**. At the edges **1** and **2**, that is, at the ends of the hypotenuse surface, are connected the deflection voltages which are to act in the two mutually

perpendicularly oriented directions. The edge 3 between the two right-angled surfaces carries the common return line and may be at ground-, or anode- or another potential determined by the normal beam position.

The walls of the prismatic hollow body may be made of insulating material upon which is provided the conductive layer or coating. They may, however, also be made of semiconductor material, in which case the edges of the hollow body are reinforced by or substituted by strips of better conductivity. Another material may be considered for the walls of the hollow body, namely, metal, provided that the resistance layers and leads are separated as against the metallic wall, by insulating intermediate layers, for example, made of enamel.

The entire deflection system is suitably surrounded by a shielding 4, indicated in the coordinate system, the one deflection direction being indicated by x and the other deflection direction by y.

Now, when the voltage between the edges 2 and 3 is assumed to be Ax and that between the edges 1 and 3 is assumed to be By, there will result as a value for the potential at a desired point, with the coordinates x and y:

$$P(x,y)=Ax+By$$

It is thereby assumed that the point P (x,y) is within the three resistance layers. This is the requirement for a homogeneous field characteristic at desired values of A and B, and is fulfilled upon the three resistance layers, provided that they are uniformly formed and that the voltage drop therealong is linearly changed.

At the two right-angled sides $P\ (x,O)=Ax$ and $P\ (O,y)=By$ as a matter of course. However, this requirement is also fulfilled upon the hypotenuse between the edges 1 and 2, for, it must be considered that, for example, the potential at the point 5 is formed by the voltage between the edges 2 and 3 plus the voltage drop along the hypotenuse section 2, 5. The total voltage at the hypotenuse is: 1, 3—2, $5=B-A$. The voltage 2, 5 corresponds to the length of the section. The value thus calculated is the same as is found by determining the value of $P\ (x,y)=Ax+By$ from the coordinates x and y.

The deflection element is in its position relative to the electron beam suitably oriented so that the nondeflected beam extends in its normal position about midway of the space above the hypotenuse. Depending upon the requirements for the individual intended use, the normal position of the beam may be differently located. The sole requirement is that the electron beam remains upon deflection within the deflection space. This requirement is true, above all, in the case of other embodiments, yet to be described, in which the deflection space exhibits apertures on one or more sides. As the deflection space proper is always to be considered the space which is within the triangle points as, for example, indicated in Fig. 1 at 1, 2, 3. The invention provides within this deflection space a homogeneous field characteristics while such is not always assured outside thereof.

Fig. 2 shows an example of using the embodiment of Fig. 1 for a multi-beam tube. The deflection system is in this case for a four-beam tube comprising in a structural unit four individual deflection systems each of which is constructed according to the arrangement shown in Fig. 1. The electron ray beam is indicated in section and marked by numeral 12. It emanates from a common cathode and reaches the multi-deflection system concentrically about the conductor 6 which may be bordering on all cathode edges of the four joined prismatic hollow bodies; the deflection system as an entity is arranged in the beam path in back of the bunching lens of the electron beam in such a manner that the converging bundle 12 permeates all partial systems. The common lens, which may be of the same design as is usual with single-beam electron tubes, causes image-formation of the cathode or the cathode shutter with all four partial beams, upon the viewing screen.

Separate zero points may be advantageously produced by suitable biasing, in order to avoid loss of brightness of the light spots in one direction of deflection by the shutter action. The biases may either be superimposed individually upon the operating voltages or may be impressed in common upon the reference potential at the conductor 6 or along the edges 7, 8, 9, 10 or simultaneously upon the shielding 11 which embraces all systems. If the deflection system of this arrangement is sufficiently small and the cross-section of the electron beam bundle at the deflection system sufficiently great, the originally common zero point for all four beams may be preserved, because in such case, only little of the corresponding bundle will be shuttered out upon deflection over one of the right-angled surfaces.

By combining several unsymmetrical deflection devices, it will be possible to produce a deflection system which, considered as a whole, will be suitable for a single beam tube for connection to symmetrical deflection voltages. Thus, the arrangement according to Fig. 2, may, for example, be utilized as a deflection system for a two-beam tube for symmetrical deflection voltages, by connecting together two diagonally oppositely positioned deflection units. Such tubes may then be operated selectively either symmetrically or unsymmetrically.

If a multi-beam tube is desired which delivers in normal condition separated light spots which lie exactly in alignment, the deflection units may for example be arranged one above the other, as schematically illustrated in Fig. 3. In such a four-beam tube, there is first produced a circular cone-shaped electron bundle, by means of a cathode provided with a Wehnelt-cylinder. In back of this electron bundle producing system, there is further disposed an electron optical cylinder lens for producing a flat electron beam. The flat beam permeates the deflection device with its indivudal superimposed units, in back of which is provided a multicylinder lens which effects together with an acceleration electrode, the image formation upon the viewing screen in four individual superimposed spots.

If the use permits that the sense of deflection in the x-direction varies from one to the other deflection unit, the deflection elements may be arranged close together as is indicated in Fig. 4. This will make it possible to reduce the necessary dimensions of the flat beam as compared with an arrangement according to Fig. 3.

The deflection system according to the invention is also suitable for multi-beam tubes having separate beam generating systems, for example, if the requirement is posed that all electron beam bundles must be independently controllable as to the brightness.

It is suitable to provide ahead of the deflection device according to the invention, an electric shutter for the electron beam, on which is placed a voltage corresponding approximately to the potential at the input point of the deflection device. Such arrangement is diagrammatically indicated in Fig. 5.

The deflection device itself comprises in this case a prismatic hollow body with three resistance surfaces 13, 14, 15. The prismatic body forms cross-sectionally a right-angled triangle. The edge 16 which is of well-conducting material is grounded or on a neutral potential, which is common to both deflection voltages. The edge 17 which is also of well-conducting material, is connected with the input lead 18 and receives a voltage for deflection in one direction. The correspondingly constructed edge 19 is connected with the input lead 20 and receives a voltage for deflection in a direction perpendicular to the first-noted direction. The electron beam, indicated by the arrow 21, radiates through the prismatic hollow body and reaches the deflection device at the imaginary spot 22.

Ahead of the deflection device there is disposed a shutter 23 having a suitable aperture 24. The potential of this electrostatic shutter results from two voltage divider arrangements, one of which comprises fixed resistors 25 and 26 and a variable tap resistor 27, the other compris-

ing the resistors 28 and 29 lying between this tapping point and the zero potential or ground. This voltage divider may for simplification of the circuit be dispensed with, but the potential of the shutter will then be somewhat inaccurate.

It is furthermore possible to provide the deflection device with an end surface and to utilize such end surface as a shutter. For this purpose, the end surface may be advantageously formed as a resistance surface and may be provided, in not illustrated manner, with a suitable aperture which lies approximately at the point 22. With correct distribution of the resistance material, accurate potential conditions will result at the resistance end surface of the arrangement.

If desired, the rim of the shutter aperture may be made of well-conducting material in order to preserve at the inlet of the electron beam a potential which is in similar manner effective in all directions.

The embodiments explained with reference to Figs. 1 to 5 employ deflection elements of substantially similar design. Fig. 6 shows another example of the invention in which two right-angled surfaces are again formed by resistance layers, but instead of using a hypotenuse surface, there are provided two capacitor plates forming with the right-angled surfaces angles of approximately 45°. The two resistance surfaces 30 and 31 abut at the edge 32 and form the right-angled surfaces. The edge 32 is well conductive and forms for the two deflection voltages a common pole which is suitably at zero potential. The two deflection voltages are conducted to the two surfaces 33 and 34 which are made of well-conducting material. These surfaces extend substantially in parallel and form with the resistance surfaces 30 and 31 angles of about 45°. The cathode beam is indicated by the arrows 35 which enters the deflection device at the point 36.

It is not absolutely necessary that the two capacitor surfaces are formed of two parallel plane elements. It is also possible to use two arcuate surfaces exhibiting, for example, an exponential curvature. In the arrangement shown in Fig. 7, numerals 37 and 38 indicate the resistance surfaces representing the right-angled surfaces. The capacitive surfaces 39 and 40 are curved, for example, exponentially. They represent at the same times the output electrodes of two amplifier tube systems, a control grid 41 and a cathode 42 being associated with the surface 39 forming an anode, and a control grid 44 and a cathode 43 being associated with the surface 40 also forming an anode. The cathode beam is represented by a spot 45. The entire arrangement is disposed in an evacuated vessel comprising an envelope 46. The combination of the deflection device with two amplifier means makes it possible to hold the input capacitance particularly low.

While the embodiments according to Figs. 6 and 7 show a deflection space which is open toward the side of the hypotenuse, it is possible to provide an arrangement, such as indicated in Fig. 8, in which the deflection space has openings in the direction of the two right-angled surfaces.

In Fig. 8, the hypotenuse surface is again formed as a resistance surface 47, just like in Figs 1 to 5. At the other edges 48 and 49 of the hypotenuse surface 47, there are connected the two deflection voltages which are conducted thereto over the leads 50 and 51. Instead of having right-angled surfaces, there are provided deflection sheets 52 and 53 which abut at the edge 54, being coordinated or placed on zero potential. The surfaces 52 and 53 are formed by well-conducting material. They are disposed substantially at right angle, and parallel or nearly parallel thereto are arranged similarly formed electrodes 55 and 56 constituting deflection members which are made of well-conducting material and conductively connected with the edges 48 and 49 of the hypotenuse surface.

The electron beam which is indicated by arrows 57 first projects through a shutter 58 which is suitably at a mean potential of the beam entry point in the deflection device. This potential may be tapped from a variable potentiometer 59. It is however also possible to use the resistance surface 47 directly as a voltage divider and to carry voltage thereto from a suitably arranged tap.

As compared with the arrangement according to Fig. 8, there are no resistance surfaces provided as terminal places at the hypotenuse side of the schematically indicated embodiments shown in Figs. 9, 10, 11 and 12. The deflection voltages are in these embodiments connected capacitively.

In Fig. 9, the deflection space is between the three points 60, 61, 62 which are arranged in the form of a right-angled triangle. The deflection surfaces 63, 64 correspond to the surfaces 52 and 53 of Fig. 8. The edge 60 is with these surface-forming sheets grounded and represents the common reference potential for the two deflection voltages. Parallel to the sheets 63 and 64 are disposed sheets 65 and 66 extending from the edges 61 and 62. All deflection sheets are suitably made of well-conducting material. The two deflection voltages for the mutually perpendicular deflection directions are connected at 61 and 62. The hypotenuse surface has been entirely omitted in this case. This results in the advantage that the two deflection voltages are not galvanically coupled. It must be considered in this connection that it is often thought to be a disadvantage to use resistance surfaces traversed by current requiring an input load. In some cases, the heating caused thereby is undesired, and the input resistance requires sometimes a preamplification for the oscillograph tubes.

As compared with this situation, the embodiments shown in Figs. 9 to 12, in which like parts are identically referenced, have the advantage of occasioning merely a capacitive loading of the deflection voltage sources.

In Fig. 10, the two deflection sheets 67 and 68 are provided at the edges 61 and 62. The arrangement of the deflection sheets corresponds substantially to that of the deflection electrodes 33 and 34 of Fig. 6.

In the example shown in Fig. 11, there are provided two flaring apart arcuate surfaces 69 and 70; and in the embodiment according to Fig. 12, there are provided two converging surfaces 71 and 72. The design of these surfaces may be carried out in accordance with considerations to be observed in the dimensioning of the surfaces 39 and 40 of Fig. 7.

The embodiments to be explained with reference to Figs. 13 to 15 are again concerned with arrangements in which is obtained merely a capacitive loading of the deflection voltage sources. The deflection electrodes are so designed that their effective surface is of different magnitude from point to point. The electrode surfaces, at which are connected the field-determining voltages, may have a mutually decreasing width. It is thereby of advantage to bring the electrodes closely together, in some cases, to gear them together. The electrodes may thereby lie in a common plane. It is, however, also possible to form one of the electrodes in the manner of a mesh and to cover the other electrode therewith. If one of the electrodes exhibits a broken surface, a certain penetrating effect will result, which may be made of different magnitude from point to point. For the design of such electrodes there are applied laws as they are known from the design of customary grid electrodes. A steady penetrating variation is possible by respectively enlarging or reducing the vacant spaces or by respectively increasing or reducing the mutual spacing between the electrodes.

This principle is schematically illustrated in Fig. 13. The deflection space which has a cross-sectional shape of a right-angled triangle, is again defined by a right-angled side and hypotenuse side. Instead of resistance surfaces, there are provided electrically well-conducting surfaces which are in the direction of the field to be produced covered with a closely adjacent mesh, the pass of which changes from place to place relatively to remotely

disposed electrodes. The spatial characteristics of the pass corresponds thereby to the voltage curve at the simulated resistance which is traversed by current. The right-angled surfaces 73 and 74 are insulated from one another. They are suitably made of well-conducting material and are connected to the two deflecting voltages over the edges 75 and 76. The second pole of the two deflection voltages which is at zero potential, preferably at ground potential, is connected at 77 to the two grid electrodes 78 and 79. These two grid electrodes 78 and 79 overlie the two right-angled surfaces. The hypotenuse surface 80, suitably likewise made of well-conducting material, is in similar manner associated with a similarly designed grid electrode 81. The mesh openings of the grids 78 and 79 are so dimensioned that they increase in size progressively with the distance from the edge 77. The grid 81 covering the hypotenuse surface 80 exhibits similarly wider mesh openings with the distance from the edge 76. By suitable design of the mesh size of the grids or meshlike structures of the elements 78, 79 and 81, it is possible to obtain the desired field characteristics. The field near the edge 77 is in this manner determined predominantly by the zero potential, while the field at the other end toward the edge 75 is by the wide mesh structure determined by one deflection voltage. The field adjacent the edge 76 is in the same manner predominantly determined by the second deflection voltage.

Fig. 14 shows a similar arrangement in perspective representation. The. grid or mesh electrodes are as compared with Fig. 13 connected to opposite potentials. This arrangement, in which the right-angled surfaces 82 and 83 are connected together along the edge 84, and grounded, provides for a favorable shielding effect. One of the two deflection voltages is conducted to the hypotenuse surface over the terminal 85, being also connected with the mesh electrode 87 The other deflection voltage, which is connected at 88, is on the grid or mesh electrodes 89 and 90. The grid is for the sake of simplified representation shown as a rod grid, the different mutual spacing between the rods providing a pass action which is different from place to place, thereby effecting the desired field distribution.

Such a deflection device need not be built with the individual grid or mesh electrodes designed in the manner customary in the tube technique. A suitable insulating material may, for example, be used having the shape of the desired cage and carrying on the outside a uniform metallic coating, the corresponding grids being formed on the inside by conductive coating with suitable openings therebetween. An extraordinarily stable structure may in this manner be obtained.

Fig. 15 shows an arrangement in which the effective portions of the cooperating electrodes lie in a common plane and are mutually geared or telescoped together. The two deflection voltages are again connected to the outer edges 91 and 92 of the hypotenuse surfaces. The hypotenuse surface comprises two electrically mutually insulated surfaces 93 and 94; the right-angled surfaces are similarly formed by parts 95, 96 and 97, 98, respectively. The electrode parts are formed so that the field characteristics will follow as desired, in accordance with known laws. It is possible in such case to form the surfaces with linearly or otherwise diminishing width. It is moreover possible to provide respectively for tighter or wider gearing of the parts, depending upon whether high homogeneity is desired or slight inhomogeneities are permissible. In the first case, the desired field characteristics may be effected by extraordinarily fine, comblike gearing of the parts. The individual electrodes may also be produced from suitable sheets, in the instant example as well as in the previously described embodiments. It is, however, also possible to use thin conductive layers fastened upon a suitable insulating body serving as a carrier.

Figs. 16 to 18 show embodiments in which the deflection electrodes form the inner surfaces of rectangular endwise open hollow bodies of preferably square cross-section. The electron beam projects through such body longitudinally. The surfaces are along diagonally extending lines subdivided and mutually insulated, so that four corner surfaces result forming with the oppositely disposed similar corner surfaces a deflection system.

The formation of such a deflection system proceeds in simplest manner from a prismatic hollow body with square cross-section. Such a body, with conductive side surfaces and without bottom and lid surfaces may be imagined as being disected by suitable diagonal cuts along its rectangular surfaces, resulting in the formation of eight right-angled triangles of equal size, each of two such triangles always being joined along an edge of the prism. Of the four corner surfaces, always two will form a deflection plate pair with the similar oppositely disposed corner surfaces. One of such plate pairs will receive the deflection voltage for one deflection direction and the other pair will receive the voltage for the deflection in the other direction.

Instead of using the geometrically simplest form of a cross-sectionally square prism, it is possible to utilize a configuration which diverges in funnel-like manner. The corresponding widening may be linear or in accordance with another function, resulting in curved walls. It is suitable thereby to make the cross-sectional form at all points substantially square, but the individual sides of the corresponding rectangle may be curved.

Fig. 16 shows an embodiment in which the prismatic hollow body has a square cross-section. The body is open at each end and the electron beam projects therethrough. The rectangular side walls are by diagonal cuts subdivided, resulting in individual surfaces at each corner, diagonally oppositely positioned surfaces always forming the electrodes for a deflection voltage. Thus, for example, the deflection voltage for one cordinate axis is placed upon the two surfaces 102, 103 which are joined at the corner 101 and also upon the surfaces 105, 106 joined at the corner 104. The deflection voltage for the other deflection direction which is perpendicular to the first direction, is placed on the surfaces 106, 107 joined at the corner 108 and also on the surfaces 110, 111 abutting at the corner 109. The edges of the individual surfaces are shown shaded so as to show them more clearly.

The individual parts of the above-described structure are shown exploded in Fig. 17 so as to aid understanding. Parts corresponding to those in Fig. 16 are similarly numbered. The individual directions are indicated by the dot-dash lines x_1, x_2, and y_1, y_2 and x_1', x_2' and y_1', y_2', respectively.

Fig. 18 shows a further embodiment which is formed of a rectangular prismatic hollow body similar to the one shown in Fig. 16, with the difference, that the body widens funnel-like upwardly. The electron beam enters into the hollow body at its bottom opening and leaves the body in upward direction. The cross-sectionally square area widens at all points of the beam exit. The outer corners 112, 113, 114, 115 extend along curves. The separation lines between the individual electrodes may likewise be curved lines. The cross-sectional configuration may also be such as to provide for bowed sides of the rectangle.

Changes may be made within the scope and spirit of the appended claims.

I claim:

1. Unsymmetrical electrostatic deflection device for corpuscular rays, especially for electron radiation tubes, with ray deflection in two mutually perpendicularly extending directions effected at a single place, comprising wall means forming a common deflection space for the deflection in both directions, the limiting points of said deflection space as viewed in a plane perpendicular to

the electron ray axis forming substantially the corner points of a right-angled triangle, the common pole of the common reference potential for the deflection voltages in both directions being placed on the corner point of the right-angled sides of said triangle, the other poles of the two ground-unsymmetric deflection voltages being placed on the ends of said sides, a continuous transition of the potentials between said ends effecting a substantially homogeneous potential characteristic in said deflection space.

2. A device according to claim 1, comprising wall means forming a three-sided prismatic hollow space constituting said deflection space.

3. A device according to claim 1, comprising wall means forming a three-sided prismatic hollow space constituting said deflection space, wherein the inner surfaces of said wall means forming resistance surfaces of relatively high resistance values.

4. A device according to claim 1, comprising a plurality of deflection devices forming as unsymmetrical multiple deflection system for several rays.

5. A device according to claim 1, comprising a plurality of deflection devices forming a symmetrical multiple deflection system for a single ray.

6. A device according to claim 1, comprising means forming an electrostatic shutter disposed ahead of said deflection device, and means for connecting to said shutter a potential corresponding approximately to that obtaining at the inlet point of the deflection device.

7. A device according to claim 1, comprising means forming an electrostatic shutter disposed ahead of said deflection device, means for connecting to said shutter a potential corresponding approximately to that obtaining at the inlet point of the deflection device, and voltage divider means for producing the potential for said shutter.

8. A device according to claim 1, wherein at least one of said wall means forming a resistance surface, an electrostatic shutter disposed ahead of said deflection device, means for connecting to said shutter a potential corresponding approximately to that obtaining at the ray entry point of said deflection device, voltage divider means for producing the potential for said shutter, and means for connecting said voltage divider to said resistance surface.

9. A device according to claim 1, wherein at least one of said wall means forms a resistance surface, an electrostatic shutter forming an end wall for said deflection device, means for connecting to said shutter a potential corresponding approximately to that obtaining at the ray entry point of said deflection device, voltage divider means for producing the potential for said shutter, and means for connecting said voltage divider to said resistance surface.

10. A device according to claim 1, wherein said deflection space is open at the side of the hypotenuse of said triangle, and a pair of plates at said side, said plates forming an angle of about 45° with the right-angled sides of said triangle.

11. A device according to claim 1, wherein said deflection space is open at the side of the hypotenuse of said triangle, and a pair of plates at said side, said plates forming an angle of about 45° with the right-angled sides of said triangle, and comprising means for connecting said plates with output electrodes of amplifier systems forming part of said tube, at least parts of said plates forming the anodes of said amplifier systems.

12. A device according to claim 1, wherein said deflection space is open along at least one right-angled side of said triangle, and means forming surfaces along said open side extending relative to the deflection space at an angle of about 270°.

13. A device according to claim 1, wherein at least one of the surfaces which borders on said deflection space is formed with the operatively effective field-producing portion thereof varying throughout its corresponding area.

14. A device according to claim 1, wherein the field-producing portion of at least one of said wall means is formed of a plurality of elements having diminishing width.

15. A device according to claim 1, wherein the field-producing portion of at least one of said wall means is formed of a plurality of angular mutually intermeshed elements.

16. A device according to claim 1, wherein at least one of said wall means forms a meshlike electrode.

17. A device according to claim 1, wherein at least one of said wall means is a meshlike structure forming an electrode with differential pass areas cooperating with another electrode.

18. A device according to claim 1, wherein said wall means forms deflection electrodes forming the inner surfaces of a rectangular open-ended hollow body of square cross-section, the electron beam projecting through said hollow body longitudinally thereof, said surfaces being subdivided diagonally and mutually insulated, thereby forming four corner surfaces, each two diagonally oppositely positioned corner surfaces forming a deflection system for one deflection voltage.

19. A device according to claim 1, wherein said wall means forms deflection electrodes forming the inner surfaces of a cross-sectionally square prismatic open-ended hollow body, the electron beam projecting through said hollow body longitudinally thereof, said surfaces being subdivided diagonally and mutually insulated, thereby forming four corner surfaces, each two diagonally oppositely positioned corner surfaces forming a deflection system for one deflection voltage.

20. A device according to claim 1, wherein said wall means forms deflection electrodes forming the inner surfaces of an open-ended hollow body, the electron beam projecting through said hollow body longitudinally thereof, said surfaces diverging funnel-like as viewed in the direction of the beam axis, said surfaces being subdivided diagonally and mutually insulated, thereby forming four corner surfaces, each two diagonally disposed corner surfaces forming a deflection system for one deflection voltage.

21. A device according to claim 1, wherein said wall means forms deflection electrodes having curved surfaces defining an elongated open-ended hollow body, the electron beam projecting through said hollow body longitudinally thereof, said surfaces being subdivided diagonally and mutually insulated, thereby forming four corner surfaces, each two diagonally oppositely positioned corner surfaces forming a deflection system for one deflection voltage.

22. A device according to claim 1, wherein said wall means forms deflection electrodes having curved surfaces defining an elongated open-ended hollow body, the electron beam projecting through said hollow body longitudinally thereof, said surfaces being subdivided along curved diagonally extending lines and being mutually insulated, thereby forming four corner surfaces, each two diagonally positioned corner surfaces forming a deflection system for one deflection voltage.

23. A device according to claim 1, wherein said deflection space is open at the side of the hypotenuse of said triangle, a pair of plates at said side, said plate forming with the right-angled sides of said triangle an angle of about 45°, and means forming surfaces along said open side extending relative to the deflection space at an angle of about 270°.

24. A device according to claim 1, wherein at least one of said wall means forms a gridlike electrode.

25. A device according to claim 1, wherein at least one of said wall means is a gridlike structure forming an electrode having differential pass areas cooperating with other electrodes.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

2,179,097	Law	Nov. 7, 1939
2,185,239	Von Ardenne	Jan. 2, 1940
2,227,135	Hollmann	Dec. 31, 1940
2,229,698	Hollmann	Jan. 28, 1941
2,436,393	Maggio	Feb. 24, 1948
2,617,076	Schlesinger	Nov. 4, 1952
2,617,077	Schlesinger	Nov. 4, 1952
2,681,426	Schlesinger	June 15, 1954

FOREIGN PATENTS

1,026,932	France	Feb. 11, 1953