Sept. 2, 1952 L. E. FLORY 2,609,516

ART OF FORMING AND UTILIZING ELECTRON-BEAMS OF NONCIRCULAR CROSS SECTION

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Fig_1

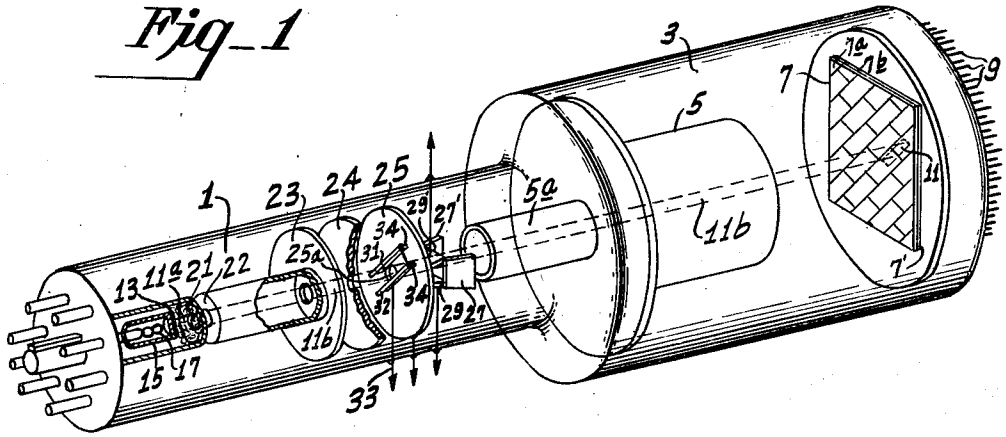
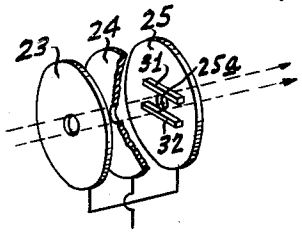


Fig_2



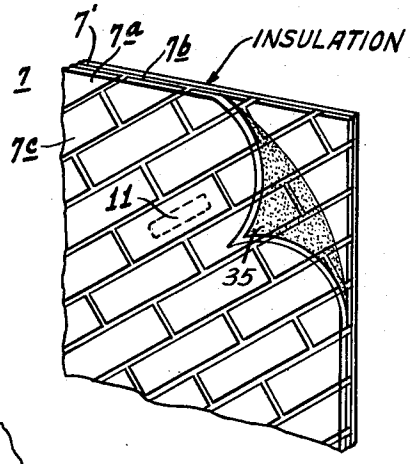
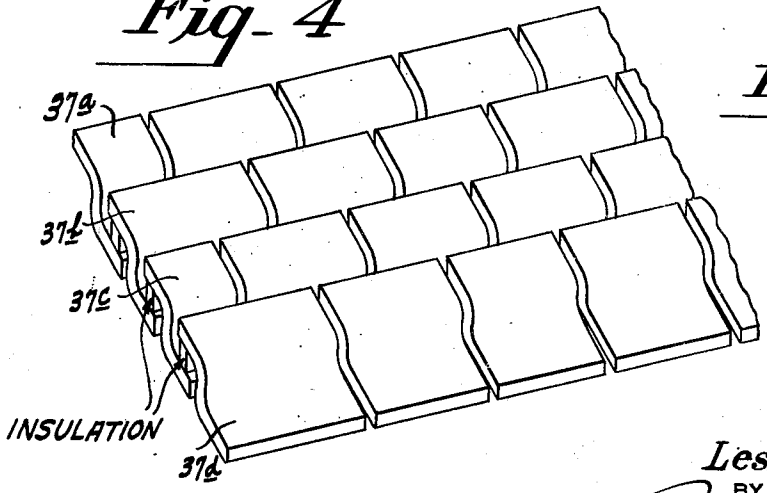


Fig_3

Fig_4



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ART OF FORMING AND UTILIZING ELECTRON-BEAMS OF NONCIRCULAR CROSS SECTION

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7 Claims. (Cl. 313—82)

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This invention relates to the art of forming and utilizing electron-beams of non-circular cross-section.

The electron-beams used in conventional cathode-ray tubes are circular in cross-section. The present invention is predicated upon an appreciation of the fact that a non-circular beam can be used to advantage in any type of scanning tube wherein it is desirable to provide an abrupt change in current when the beam is moved in one direction of scan and a gradual change in current when the beam is moved in another direction, e. g. at a right angle with respect to the first.

It would appear that a stream of electrons could be endowed with any desired cross-sectional contour simply by passing the stream through a mask-aperture of the desired shape and dimensions. Such indeed is the case. However, this more or less obvious way of shaping the beam has several disadvantages; (I) the electrons that strike the masking surface are effectively lost, hence the electron current available on the far side of the mask may comprise a mere fraction of that available at the source or vertual source of the beam; (II) it is not easy to cut and to align rectangular or other "odd-shape" apertures of the minute dimensions normally used in cathode-ray tubes, (III) any inaccuracies in the contour of the beam, thus shaped, can not be corrected during the operation of the tube or, in fact, at any time subsequent to the assembly of the tube elements.

Accordingly, the principal object of the present invention is to obviate the foregoing and other disadvantages of present day beam-shaping methods and to provide an improved method of and apparatus for achieving an electron-beam of a non-circular cross-sectional contour.

Another object of the invention is to provide a novel way of converting a stream of electrons into an electron spot having a length-to-width ratio that may be altered or varied while the beam is "on."

Another and important object of the present invention is to provide an improved electron-beam tube of the kind provided with a "mosaic" target electrode and one wherein changes in the output current of the tube shall be achieved without the generation of parasitic currents or "transients" such as might be occasioned by the presence of insulating material between the elemental conductive areas of the "mosaic."

Stated generally, the foregoing and other objects are achieved in accordance with the invention by subjecting an electron-beam of conventional circular cross-section contour to the action of an electron-lens of a special construction calculated to endow the beam with a desired degree or amount of cylindrical asymmetry. No odd-shape masking apertures are employed. The lens-elements that do the trick may form part of the "gun" of the tube and may be electrically insulated from its other lens elements so that the degree of cylindricity or asymmetry introduced into the beam-shaping lens-field may be varied while the device is in operation. When applied to a cathode-ray tube of the "coding" variety the advantages of the invention are fully realized when mosaic target toward which the non-circular beam is directed comprises a plurality of conductive elemental areas which are interconnected in a novel manner to prevent the generation of transient currents during the movement of the beam from one area to another.

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The invention is described in greater detail in connection with the accompanying single sheet of drawings, wherein:

Fig. 1 is a view in perspective showing the invention applied to a cathode-ray tube of the so-called "coding" variety;

Fig. 2 is a partly broken-away view in perspective of an alternative form of beam-shaping lens assembly within the invention;

Fig. 3 is a view in perspective of a part of the mosaic target electrode of the tube of Fig. 1 and;

Fig. 4 is a similar view of another form of a mosaic target electrode which may usefully be employed in practicing the invention.

In Fig. 1 of the drawing the invention is shown as applied to a cathode-ray tube of the "coding" variety described by Sziklai and Jensen in copending application Serial No. 119,135, filed October 1, 1949. Such tubes may be used, by way of example, in a color television system to render the system compatible with "black and white" transmission. In such a system, the level of the transmitted signal represents the total intensities of the component colors of the scanned image. As described in detail in said earlier filed disclosure, color information is transmitted by coding the transmitted wave within predetermined levels. As above indicated, the cathode-ray tube here illustrated comprises an improved "coding" device.

The cathode-ray "coding" tube shown in Fig. 1 comprises an evacuated envelope having a hollow neck portion 1 and a bulbous portion or main chamber 3. The vacuous space in the neck 1 and main chamber 3 is continuous and there is an electrostatic shield within said

space. This shield here takes the form of a metal funnel 5 disposed about the central axis of the tube with its spout 5*a* extending a limited distance into the neck 1. As in the tube of the Sziklai et al. disclosure, the main chamber 3 contains a "coding" electrode 7. This target electrode comprises an insulating foundation plate 7' having a "mosaic" target surface made up of from say, twenty to one hundred, spaced-apart conductive areas 7*a*, 7*b*, etc. Each conductive element of the mosaic will be understood to be provided with its own external connection, exemplified by the leads 9. As will hereinafter more fully appear, the mosaic surface of electrode 7 comprises the target for an electron-beam 11 of non-circular cross-section (see Fig. 3).

The non-circular electron beam 11 is derived from an electron stream or "cloud" 11*a* of indifferent contour and dimensions that emanates from the oxide coating 13 on the "thimble" 15 of a conventional indirectly heated cathode, when the filament 17 within the thimble is energized. Prior to assuming its ultimate non-circular form the electron stream 11*a* is converted into a beam 11*b* of circular cross-section by projecting the electrons through a symmetrical electrostatic field provided by a series of apertured lens elements or diaphragms 21 to 25, inclusive. The diaphragm 21 nearest the cathode 13 preferably comprises the signal control grid of the tube. The grid 21 and the other apertured diaphragms 22 to 25 are mounted in spaced apart relation along the axis of the tube with their circular apertures in register with each other, as in a conventional electron gun. As is also conventional the tube is provided with means, exemplified by "horizontal" and "vertical" pairs of deflecting plates 27—27' and 29—29', for imparting a scanning movement to the beam after it emerges from the aperture in the last diaphragm 25.

The circular beam 11*b* is converted into a beam of substantially rectangular cross-section by introducing a controlled amount of cylindricity into the otherwise symmetrical electrostatic field normally present between the last two diaphragms 24 and 25 of the "gun." The added cylindricity, or asymmetric field, is provided by a pair of lens elements in the form of short wire-like or rod-like risers 31 and 32 disposed in parallel relationship on opposite sides of the aperture 25*a* in the last diaphragm 25. It may here be noted that the beam does not acquire its ultimate "rectangular" (or elliptical) cross-sectional contour until it reaches a point adjacent to the target 7.

Any desired ratio (e. g. 10 to 1 or more) of length-to-width of the beam spot can be achieved either electrically, as in Fig. 1, by controlling the potential applied to the common lead 33 of the lens elements 31, 32, or mechanically, as in Fig. 2, by a proper selection of the elevation of said elements with respect to the plane of the inner surface of the diaphragm 25.

If the length-to-width ratio of the beam spot is to be varied electrically, the lens elements 31 and 32 must be insulated from the metal diaphragm 25. As shown in Fig. 1, the necessary insulation and support is provided by insulating inserts 34. These insulators 34 are affixed to the inner surface of the diaphragm 25 intermediate the diaphragm and said lens elements 31 and 32.

The insulating inserts 34 and lead 33 may be omitted in tubes wherein the length-to-width ratio of the beam spot is "fixed". In this case, referring to Fig. 2, if the elevation and spacing of the risers 31' and 32' is made substantially equal to the diameter of the circular aperture *a* in the diaphragm 25 the length-to-width ratio of the spot (at its point of impingement upon the target) is about 50 to 1.

It has been found that the beam 11 in moving over the target will generate transient parasitic currents if there is any insulating material in the path of the beam, between the conductive elementary-areas 7*a*, 7*b* etc. of which the mosaic is comprised. Thus, if the mosaic electrode is of the type (shown in Figs. 1 and 3) wherein the separate conductive areas 7*a*, 7*b* etc. are supported upon an insulating foundation 7', the finite spaces between the conductive pieces expose parts of the foundation material to the beam. Since the secondary-emission ratio of this insulating material is different from that of the conductive areas 7*a*, 7*b* etc., and since ordinarily there is no control over the potential of the insulator, the secondary-emission current released by the beam will vary as determined by the instantaneous position of the beam with respect to the conductive and non-conductive parts of the mosaic. The transient current generated when the beam passes over the insulation between the conductive areas has the appearance (as viewed on an oscilloscope) of a "spike" on the edge of the tread of a square wave (not shown). This objection to present day mosaic "coding" electrodes (of the construction above described) is overcome, in the practice of the present invention, by the application of a microscopically thin film 35 of (Fig. 3) of evaporated metal (e. g. aluminum) over the entire target surface of the mosaic. This surface film or layer 35 should be thick enough to form a slightly conductive path between the individual elemental areas 7*a*, 7*b* etc., of the mosaic yet not thick as to interfere with the application of proper direct current potentials to said areas or elements. Evaporated metal of a thickness corresponding to a resistance of about 10 ohms (between adjacent elemental areas) is recommended. The space between the elements 7*a*, 7*b*, etc., is thus held to a potential which varies smoothly from the potential of one element to that of the next. Furthermore, the secondary-emission ratio of the entire target is substantially uniform since the surface layer 35 upon which the beam impinges is the same throughout.

It should be noted that the present invention is not especially concerned with the relative arrangement of the elementtal conductive areas 7*a*, 7*b*, etc., that make up the target surface of the mosaic electrode. In this connection, attention is called to the fact that the arrangement of the conductive areas along parallel diagonals of the target, as shown in Figs. 1 and 3, is claimed by Sziklai and Jensen in co-pending application Serial No. 119,135 filed October 1, 1949.

The horizontal and vertical pattern of the conductive elements of the mosaic, shown in Fig. 4, is similar to the pattern employed in the target electrode shown in the sole application of Sziklai, Serial No. 113,318 filed August 31, 1949. In this case, in order to provide direct transition of the beam from one conductive element to the next without the generation of transient currents, the conductors, which are here designated 37*a*, 37*b*, etc. are disposed shingle fashion, i. e., with the

marginal edges of the conductors of one row overlapping the adjacent marginal edges of the conductors of the next row, but electrically isolated therefrom by insulating strips **39** disposed between said marginal edges out of the path of the beam.

The orientation of the long and short cross-sectional axes of the rectangular beam spot **11** may be fixed as determined by the particular pattern of conductive areas of the mosaic. Thus, where the mosaic has a diagonal pattern as in Figs. 1 and 3, the auxiliary lens elements **31** and **32** should be tilted with respect to the horizontal, as shown in Fig. 1, so that the long axis of the spot falls parallel to the diagonally inclined edges of the conductive areas *7a*, *7b* etc. When the conductive areas of the mosaic target electrode are arranged in parallel horizontal and vertical rows, as in Fig. 4, the auxiliary lens elements **31** and **32** should preferably be disposed with their long edges parallel to either the horizontal or the vertical edges of the conductive areas.

It will now be apparent that the present invention provides a novel way of forming and utilizing an electron-beam of non-circular contour, and one which finds especially useful application in the construction and operation of electron beam tubes of the type employing target electrodes of the "mosaic" variety.

What is claimed is:

1. An electron-discharge device comprising a source of electrons, an electron-lens including a plurality of metal diaphragms containing aligned apertures of duplicate shape for deriving from said source a beam of electrons of a cross-sectional shape corresponding to the shape of said apertures, and electrode means supported upon one of said diaphragms adjacent to the aperture thereof for altering said cross-sectional shape of said beam.

2. The invention as set forth in claim 1 and wherein said electrode means is electrically insulated from the metal diaphragm upon which it is supported.

3. The invention as set forth in claim 1 and wherein said electrode means comprises a pair of rod-like metal elements disposed in parallel relationship on opposite sides of said aperture.

4. The invention as set forth in claim 3 and wherein the elevation of said rod-like elements with respect to said diaphragm and the spacing of said elements with respect to each other are each substantially equal to the diameter of said aperture.

5. A cathode-ray tube comprising, an evacuated envelope containing a source of electrons, a mosaic target electrode mounted in the path of electrons from said source, said mosaic electrode having a target surface constituted, at least in part, of a plurality of symmetrically disposed rectangular elemental conductive-areas, a plurality of electron-lens elements disposed in the space between said source and said target for deriving an electron-beam of circular cross-section from said source, an auxiliary electrostatic lens system disposed to the path of said circular electron-beam for converting said beam into an electron-beam having substantially straight sides parallel to the edges of said rectangular elemental areas, and beam deflecting means for moving said straight-sided beam from one elemental to any other elemental area on said target surface.

6. The invention as set forth in claim 5 wherein said rectangular elemental areas extend along lines parallel to a diagonal of said target surface.

7. A cathode-ray tube comprising an evacuated envelope containing a source of electrons, an electron-lens including a plurality of spaced-apart diaphragms containing aligned apertures of duplicate shape and dimensions for deriving from said source a beam of electrons of a cross-sectional shape corresponding to the shape of said apertures, an auxiliary electrostatic lens system disposed in the space between said diaphragms for altering said cross-sectional shape of said beam, and a mosaic electrode upon which said altered electron-beam impinges, said mosaic electrode having a target surface made up of elemental areas of an orientation corresponding to that of said beam at its point of impact upon said mosaic electrode.

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