April 2, 1968 R. A. PETIT 3,376,447

CATHODE-RAY IMAGE SCANNING TUBE USING LOW-VELOCITY ELECTRON BEAM WITH ELECTROSTATIC DEFLECTION AND ANAMORPHOTIC LENS FOR IMPROVED FOCUSSING

Filed Dec. 17, 1964 2 Sheets-Sheet 1

Fig. 1

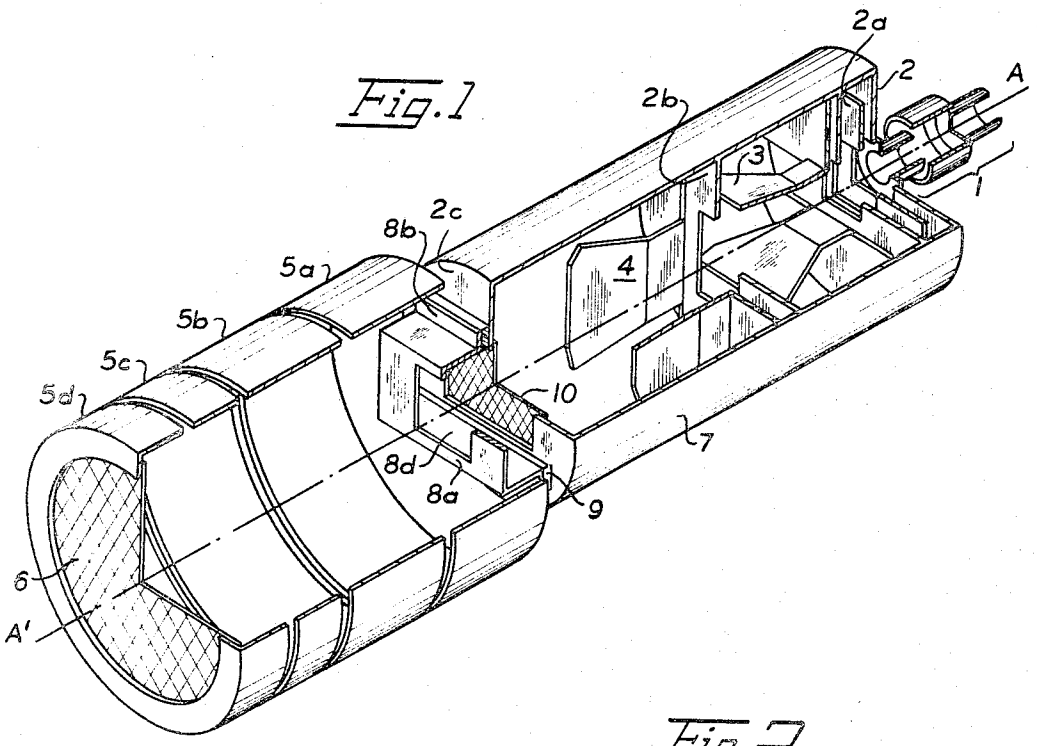


Fig. 2

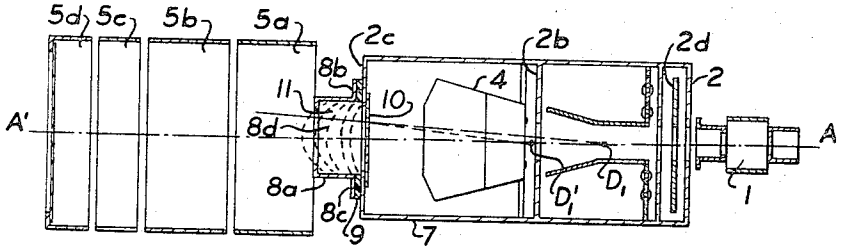
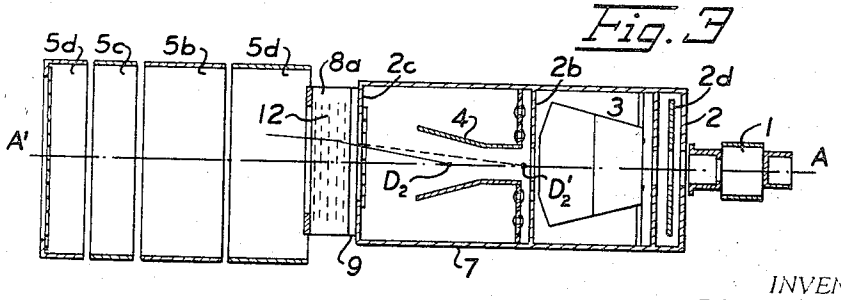


Fig. 3



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Fig. 4a

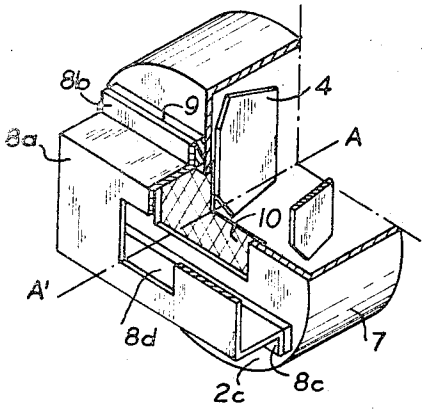


Fig. 4b

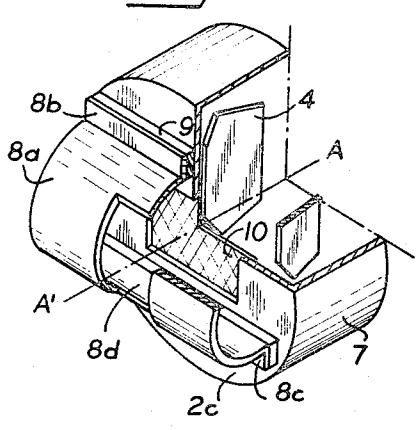
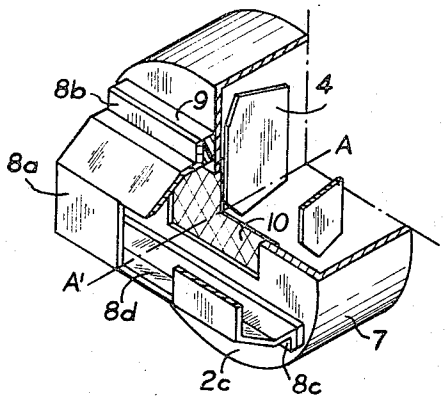


Fig. 4c



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ABSTRACT OF THE DISCLOSURE

A cathode-ray image scanning tube, e.g., camera tube, storage tube and the like, employing a low velocity electron beam for scanning a target at right angles to the axis of the beam and employing an electrostatic deflection system and an electrostatic collimation lens between the deflection system and the target. An anamorphotic electrostatic lens is employed after the deflection system and between it and the collimating lens to make the virtual deflection centers of the vertical and horizontal deflection electrodes substantially coincide with the focus of the collimation lens.

The present invention relates to cathode-ray tubes for scanning images, in which a beam of low-velocity electrons scans a flat surface or target arranged at right angles to the axis of the electron gun, the resultant signal being taken from said target (for example, a tube provided with a photoconductive layer or with a mosaic or photosensitive granules).

Owing to the low-velocity of the electrons it is necessary to obtain a scanning beam which strikes the target at right angles. To attain such a result the collimation of the beam would have to be effected by means of a lens of revolution having its focus at the deflection centre of the beam. Unfortunately, in an electrostatic deflection system, the advantages of which are well-known and which particularly permits high-impedance and high-velocity scanning, two separate beam deflection centres are involved which correspond to the two deflector-plate systems.

Hence, in the known scanning tubes using low-velocity electron beams, of the orthicon or vidicon type and the like, it has hitherto been preferred to resort to the use of an electromagnetic deflecting system, the lines of force of the uniform magnetic field parallel to the axis of the tube being followed by the beam.

However, these tubes have the same limitations as the conventional magnetic systems, that is to say, bulkiness, large weight of the tube and the supply system, considerable energy consumption, comparatively low scanning velocity.

It is an object of the invention to obviate the above mentioned disadvantages and particularly to permit the manufacture of a scanning tube of small weight and consumption, which is especially of interest, for example, for tubes to be used aboard space vehicles.

The scanning tube according to the invention, which is provided with an electrostatic collimation lens in the forms of a body of revolution with respect to the axis of the tube, is mainly characterized in that, the deviation

system being electrostatic, there is associated with the collimation lens an anamorphtic system which comprises at least one additional electrode arranged at the output of the said deflection system and the shape, dimensions and potential of which are so chosen that the virtual deflection centre of the beam is situated in the focus of the said collimation lens.

Thus, the anamorphotic system, which modifies the convergence of the beam in one direction, causes the two deflection centres of the beam, which correspond to the two pairs of deflector plates, to correspond to two virtual deflection centres which may merge into one another in the focus of the collimation lens owing to the characteristics (shape, potential, relative positions) of the various elements, so that the collimated beam strikes the target at right angles.

The invention may further be characterized by various arrangements which will become evident from the description and particularly:

Thus, the anamorphotic system may comprise a channel-shaped electrode which is provided with an aperture and is secured to the front-face of a flat electrode which is permeable to electrons and is centered in known manner about the tube axis at the exit end of the deflection system, the channel-shaped electrode facing the collimation lens and being centered about the axis of the tube, its longitudinal axis being at right angles to said tube axis, while the said two electrodes are electrically insulated and the channel-shaped electrode is at a higher potential.

The invention will be better understood by perusal of the following description, which is given by way of non-limitative example, with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view of a scanning tube according to the invention which is partially broken away;

FIGURE 2 is a vertical sectional view of the above tube.

FIGURE 3 is a horizontal sectional view of the same tube.

FIGURES 4*a*, 4*b* and 4*c* show modifications of the anamorphotic system.

FIGURE 1 shows the various component elements of a conventional scanning tube which has a longitudinal axis AA′ and comprises an electron gun **1**; accelerating electrodes such as **2** which are provided with central apertures, the shape and dimensions of which may be chosen so as to permit any corrections of astigmatism which may be required; an electro-static deflection system which consists of two pairs of plates, namely a pair **3** of vertical deflector plates and a pair **4** of horizontal deflector plates, which pairs are separated by an electrode **2***b* and to which correspond two deflection centres D_1 and D_2, respectively; an electrostatic collimation lens comprising a series of (for example four) cylindrical metal rings **5** having the same diameter as the tube, which are centered about the axis AA′ and disposed between the deflector plates and the target **6** (which is either a photoconductive layer or a mosaic of photosensitive granules).

The accelerating electrodes **2**, with the exception of the electrode **2***a*, and the deflector plates are secured to the inner wall of a metallic cylinder **7** which has a diameter equal to that of the tube and forms a closed space. This space is closed at both ends by electrodes of the type **2**. Thus, the assembly of the cylinder and the accelerating

electrodes is at the same potential, which is also the mean potential of the deflector plates. The electrode **2***a* is at a slightly different potential to permit corrections of astigmatism. To the electrode **2***c*, which closes the above-mentioned enclosed space, is secured, at the side of the focussing lens, an anamorphotic system **8**. This system comprises an electrode in the form of a channel **8***a* which is bounded in the longitudinal direction by two flat portions **8***b* and **8***c* which enable the electrode to be secured to the electrode **2***c* so as to be centered about the axis AA′ of the tube, the lonigtudinal axis of the channel being at right angles to the said axis AA′.

The channel electrode **8***a* may be given a rectangular, cylindrical or polygonal cross-section (these forms are shown in FIGURES 4*a*, 4*b* and 4*c*, respectively). The anamorphotic system **8** is electrically insulated from the electrode **2***c* by a thin layer of mica **9** (for example 0.5 mm. thick) disposed between the flat portions **8***b* and **8***c* and the electrode **2***c*. Thus, the said system may be given a potential which is considerably higher than that of the electrode **2***c*.

The electric field within the channel electrode is then defined by the cylindrical equipotential surfaces, the radii of curvature of which decrease with the voltage and are shown, in cross-sectional and longitudinal sections at **11** and **12** in FIGURES 2 and 3, respectively.

In the aperture of the electrode **2***c*, which is the above-mentioned "electrode permeable to electrons" is braced a grid **10** having the same potential and intended to avoid "bulges" of the equipotential surfaces (which penetrate into the aperture) which may give rise to unfavourable converging effects.

The channel electrode **8***a* has a central rectangular window **8***d*, which is long enough to maintain the cylindrical form of the equipotential surfaces.

This system imparts to the collimation lens an astigmatism such as to be capable of compensating for the defect due to the non-coincidence of the deflection centres D_1 and D_2 of the two pairs of plates.

In FIGURES 2 and 3 a real path of the beam issuing from the deflection centres D_1 and D_2 is partially shown by a full line and the virtual path by a broken line, viewed from the collimation lens. The anamorphotic system causes a virtual deflection centre D'_1 and D'_2 respectively, to correspond to each of the deflection centres D_1 and D_2, respectively, namely D'_1 for the vertical deflector plates, which is shifted forward with respect to D_1 (lens effect), and D'_2 for the horizontal deflector plates, which is moved backward with respect to D_2 (effect of a plate having parallel faces).

Suitable relative positions of the deflector plates and the cylindrical rings which constitute the collimation lens and a suitable choice of the potentials ensure that the virtual deflection centres D'_1 and D'_2 merge in the focus of the collimation lens so that the collimated beam strikes the target at right angles.

By way of information the dimensions and potentials characteristic of a practical embodiment of a tube according to the invention will now be given.

For chosen shapes of the electrodes their potentials are determined by means of the electrolytic trough method (a method whereby an electrostatic field can be determined electrostatically):

Diameter of the tube, 50 mm.

Length of the tube, 250 mm.

Characteristic features of the deflection system:

Distance between the two pairs of plates measured from the point of the attachment, 30 mm.

Distance between the attachment of the plates **4** and the electrode **2***c*, 45 mm.

Means potential, 1000 volts.

Characteristic features of the collimation lens:

Distance between the first collimation ring and the electrode **2***c* of the deflection system, 10 mm.

Distance between cylindrical rings, 2 mm.

Height and potential of the successive rings:

	Volts
Ring **5***a*: 20 mm.	1500
Ring **5***b*: 20 mm.	200
Ring **5***c*: 10 mm.	130
Ring **5***d*: 10 mm.	50

The high-velocity electrons (from 1500 to 2000 volts) are subjected to a deceleration in the collimation lens so as to produce a beam issuing with an energy of 50 ev. The focus of the collimation lens is spaced from the target by a distance of 122 mm.

Characteristic features of the anamorphotic system:

	Mm.
Depth	10
Length	40
Height at the level of the electrode, **2***c*	20
Aperture in electrode **2***c*:	
Height	14
Length	20
Aperture in electrode **8***a* opposite the electrode **2***c*, a square having sides of	12

The potential of this anamorphotic system depends upon the geometrical shape imparted to the channel electrode:

	Volts
Electrode of rectangular cross-section	1500
Electrode of semi-circular cross-section	1400
Electrode of polygonal section	1400

The correction produced by the anamorphotic system enables a target of large diameter (40 mm.) to be scanned using the above described collimation lens while retaining the advantages of a completeiy electrostatic scanning system: low energy consumption, light weight of the tube and the supply system, reduced volume, and especially high-impedance electrostatic scanning which may readily be effected and adjusted and permits high scanning velocities.

The invention is not limited to the above-mentioned embodiment, and hence modifications, particularly with respect to the relative dimensions, the potentials of the various elements and of the shape of the anamorphotic system, may be provided without departing from the scope of the invention.

The addition of correcting electrodes or a modification of the correcting electrode described in order to correct for the slight astigmatism introduced by the anamorphotic system, and any alterations made in order to correct (geometrical) or other aberrations may be effected within the scope of the invention.

What is claimed is:

1. A scanning tube comprising an electron gun for producing low-velocity electrons, a target to be scanned extending at right angles to the electron gun, an electrostatic collimation lens in the form of a body of revolution about the tube axis, which lens is arranged between two pairs of plates constituting an electrostatic electron deflection system, and the target, an anamorphotic lens system which comprises at least one additional electrode having a central aperture and given shape and dimension placed at the exit end of the said deflection system and means to apply a potential to said lens at which said beam has a virtual deflection center which is situated in the focus of the said collimation lens.

2. A scanning tube as claimed in claim **1**, in which the anamorphotic lens system comprises a channel-shaped electrode which is provided with an aperture and is secured to the front face of a flat electrode which is permeable to electrons and, is centered about the tube exit end of the deflection system, the channel electrode facing the collimation lens and being centered about the tube axis, the longitudinal axis of the channel electrode extending at right angles to the said tube axis, while the said two electrodes are electrically insulated, the channel electrode being at the highest potential.

3. A scanning tube as claimed in claim 2, in which the central aperture of the channel electrode is rectangular, its length exceeding its height.

4. A scanning tube as claimed in claim 1, in which a fine-meshed grid is braced in the central aperture of the electrode of the anamorphotic lens system at the axis end of the deflection system.

5. A scanning tube as claimed in claim 1 in which the cross-section of the channel electrode is rectangular.

6. A scanning tube as claimed in claim 2 in which the cross-section of the channel electrode is semi-circular.

7. A scanning tube as claimed in claim 2 in which the cross-section of the channel electrode is polygonal.

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