

Feb. 15, 1938.

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2,108,523

CATHODE RAY TUBE

Filed Nov. 10, 1936

2 Sheets-Sheet 1

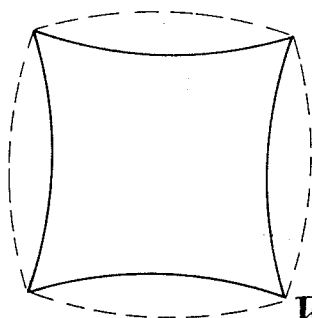


Fig. 1.

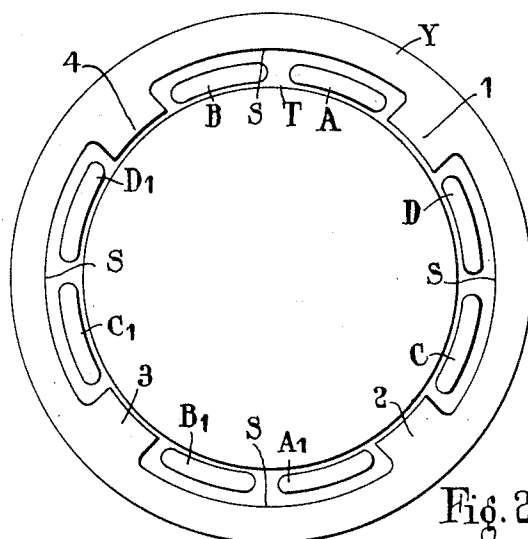


Fig. 2.

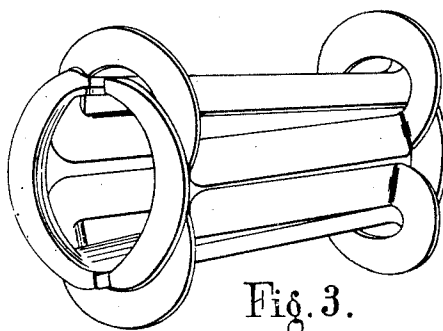


Fig. 3.

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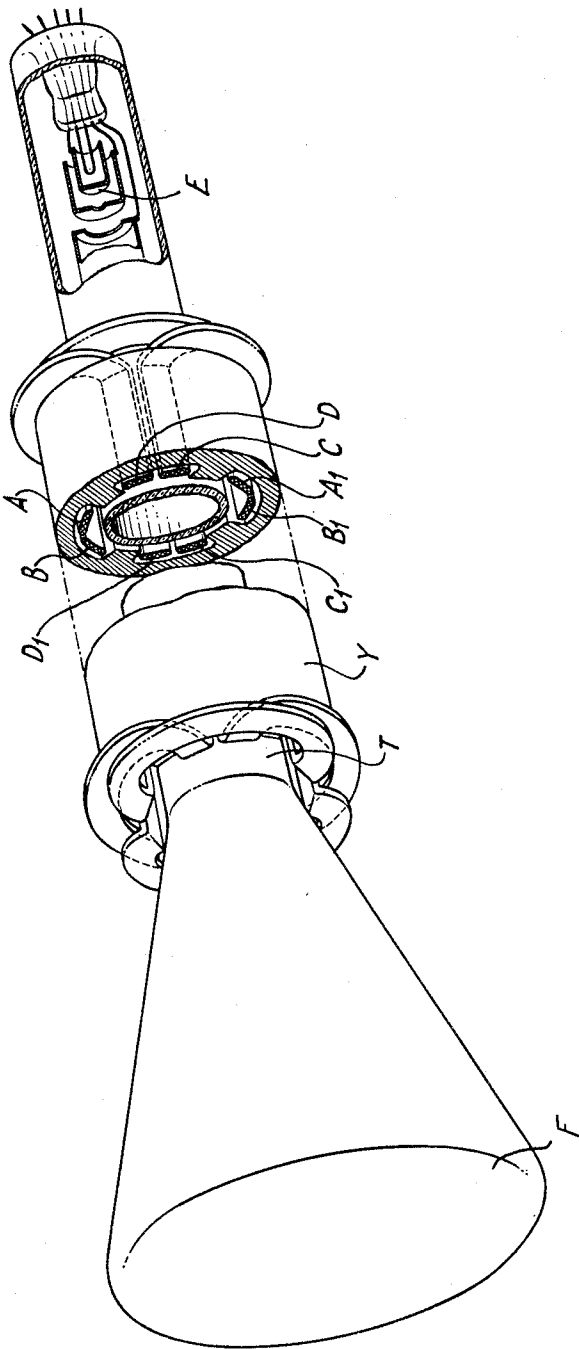
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Fig. 4



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CATHODE RAY TUBE

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tries Limited, Middlesex, England, a company
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3 Claims. (Cl. 250—27.5)

The present invention relates to deflecting means of the electromagnetic type for cathode ray tubes. Cathode ray tubes are used for television and also as oscillographs for the study of electrical wave forms and in both cases it is usually desired to trace upon the screen a figure which is as nearly as possible a graph, in rectangular co-ordinates, of two independent sets of current or potential values. For the sake of convenience the case usually met with in television will be discussed in detail and it will be understood that the invention is applicable in other cases also.

In television the cathode ray beam is usually deflected by magnetic fields set up by currents of saw-tooth wave form and constant peak amplitude, one of high frequency (strip or line frequency) and the other of low frequency (frame or picture frequency). Each cycle of the saw-tooth wave form consists of a portion which produces the scanning stroke and another portion which produces the relatively rapid return stroke. It is usually desired that the area of the screen over which the beam is swept should be of rectangular form. The magnetic fields used to deflect the beam are effective over a considerable length of the path of the beam, and the volume swept out by the beam over the length of this path, where the magnetic fields are effective in producing the deflection, is usually termed the deflection region. The cathode ray beam as it impinges on the screen appears to originate at a point on the normal undeflected path of the beam, which is usually along the longitudinal axis of the tube. This point, which usually lies within the deflection region, is often termed the effective center of deflection.

If the two deflecting magnetic fields be uniform in the deflection region through which the ray passes, and if the screen has a surface which is part of a sphere having its centre at the effective center of deflection, the area swept out on the screen when viewed from a distant point upon the axis of the tube will be of the required rectangular shape. If however, the screen is flat or has a curvature which is less than that of the sphere above mentioned, the area of the screen swept out by the beam will be bounded by lines which are convex towards the centre of the area. The area swept out may then be said to be of the pin-cushion shape. Secondly, there will be non-linearity of scale resulting in crowding of scanning lines in the central part of the area relatively to the outer parts of the area.

It is the object of the present invention to pro-

vide deflecting means in which these disadvantages are reduced.

According to the present invention a cathode ray tube is provided with electromagnetic means for deflecting the electron beam of the tube in two mutually perpendicular directions over a surface within the tube, said surface having a curvature which is less than that of a sphere having its centre at the effective center of deflection, said electromagnetic deflecting means being so constituted and arranged that they produce magnetic fields the lines of force of which are convex towards the longitudinal axis of the deflection region. A field of this shape would cause the area swept out on a spherical screen surface to be barrel-shaped, that is to say the lines bounding the area would be concave to the centre and thus the distortion of the boundaries arising from the use of a flatter screen than this can be neutralized.

The non-linearity of a scale may be corrected for by using a scanning current wave-form which is suitably non-linear as will be described hereinafter.

In order that the invention may be more clearly understood and readily carried into effect alternative forms of cathode ray tube deflecting coils will now be described by way of example with reference to the accompanying drawings in which

Fig. 1 illustrates the nature of the distortion of a scanning field known as pincushion distortion,

Fig. 2 shows an arrangement of coils designed to compensate for such distortion,

Fig. 3 illustrates the shape of separate coil sections in a particular constructional example, and

Figure 4 shows a cathode ray tube incorporating a deflection system such as shown in Figure 2.

Referring to Fig. 1 of the drawings, the figure in full lines shows the pincushion shape of the area scanned on a curved surface, the curvature of which is less than that of a sphere having its centre at the effective center of deflection. The figure shown in dotted lines represents the barrel shape of the scanning patch which the ray would describe on a screen having a curvature equal to its distance from the effective centre of deflection so that the pincushion distortion on the flatter screen is compensated.

Referring to Fig. 2 and Fig. 4 of the drawings, the cylindrical portion T of a cathode ray tube, having a cathode ray beam source E, is shown provided with an electromagnetic coil system

comprising an annular yoke Y of magnetic material formed with four symmetrically disposed slots around its inner circumference. The center line of the pairs of opposite magnetic poles 1, 3 and 2, 4 are arranged at 45° to the direction in which the beam is to be deflected in scanning a strip of the picture area on the fluorescent screen F of the cathode ray tube. A coil A, A₁ encircles the poles 1 and 2, a second coil B₁ encircles the poles 3 and 4, a third coil C₁ encircles the poles 2 and 3 and a fourth coil D₁ encircles the poles 1 and 4. The pairs of opposite coils AA₁, BB₁, and CC₁, DD₁ are connected in series in the examples shown but they may be connected in parallel. The arrangement is in either case such that when strip deflecting currents are passed through the pair of opposite coils AA₁ and BB₁ and frame deflecting currents are passed through the other pair of coils CC₁ and DD₁, the poles 1 and 3 are energized by the sum of the strip and frame ampere-turns whilst poles 2 and 4 are energized by the difference between the line and frame ampere-turns.

For convenience it will be assumed that the direction of the lines is horizontal and therefore that the field effecting the line deflection runs in an approximately vertical direction. The line deflecting field produced by the arrangement above described is such that, proceeding from the center of the field in the direction of the lines of force, the magnetic field falls progressively in strength whilst proceeding from the longitudinal axis of the deflection region in a direction transverse with respect to the lines of force the field strength increases, and for an oblique deflection the direction of the field changes, the lines of force being more nearly parallel to the nearest diagonal at 45° to the axes of the magnetic poles 1, 3 and 2, 4, as the distance from the center is increased. The result of these changes in strength and direction is that an electron which is deflected from the axis in an oblique direction mainly horizontal, will as a result of the vertical component of its displacement, move into a portion of the field where the vertical field is less than if there had been no vertical displacement, thus making the horizontal displacement less. The component lines of force which on the axes are vertical, will at the point where the deflected electron passes through them, be inclined. This inclination produces an additional reduction of horizontal displacement.

Similarly, if the deflection is mainly vertical, the vertical displacement will be less than if, for the same vertical-deflecting current, there had been no horizontal displacement. These effects will therefore tend to neutralize the pincushion distortion above referred to.

A further effect of the field above referred to is that deflection from the longitudinal axis of the deflection region in a horizontal direction by means of the vertical field moves the electron into a stronger part of this vertical field so that the deflection per unit deflecting current is greater at a distance from the center than at the center. This effect adds to the non-linearity of scale due to the low curvature of the screen. The two non-linearity effects can be compensated for by using deflecting currents in which the scanning stroke is represented by a current wave form which changes at a decreasing rate as the distance from the center line of the waveform increases.

In Figure 3 the shape of separate coil elements intended for a frusto-conical assembly is shown.

It will be seen that the coil ends are turned away radially from the tube axis and iron wire or laminations forming a magnetic yoke, not shown in the figure, is arranged in the space between the cheeks formed by the radially turned coil ends. The coil system shown in Fig. 3 is intended to be disposed upon the frusto-conical part of the tube envelope. The degree of compensation provided for the pincushion distortion is dependent upon the ratio of the length to the diameter of the magnet constituting the deflecting system and upon the grouping of the turns of the coils.

Figure 4 shows a cathode ray tube having a cylindrical neck section and a frusto-conical section closed at one end by a surface having a curvature less than that of a sphere having its center at the center of the deflection of the electron beam. An electron source for generating a beam of electrons is positioned at the end of the cylindrical section opposite the frusto-conical section, and the magnetic coils and yoke structure, such as shown in Fig. 2, are positioned intermediate the electron source and the end of the frusto-conical section which is closed by the curved surface.

While in the examples described the use of a magnetic yoke has been referred to, it is to be understood that such a yoke is not essential to the successful operation of the coils. Again, although the use of coils has been described in connection with the control of an electron beam incident upon a curved screen it will be understood that the coils may be used to produce a rectangular patch on an oblique flat screen. The deflecting currents in such a case are modulated so that they would form a rectilinear but key-stone-shaped patch on a screen normal to the axis of the electron gun. The intentional distortion of the magnetic field prevents the scanned patch from being a figure bounded by curved lines.

I claim:

1. A cathode ray tube including an electron source for generating a beam of electrons, magnetic deflecting means for deflecting said electron beam along parallel paths mutually displaced in a direction perpendicular to each other, and a surface to be scanned by said beam, said surface having a curvature less than that of a sphere having its center at the effective center of deflection of said magnetic means, said magnetic deflecting means consisting of coils arranged to set up oppositely disposed magnetic poles the center lines of which make an angle of substantially 45° to the direction of the scanning paths on the said surface to be scanned.

2. A cathode ray tube including an electron source for generating a beam of electrons, magnetic deflecting means for deflecting said electron beam along parallel paths mutually displaced in a direction perpendicular to each other, and a surface to be scanned by said beam, said surface having a curvature less than that of a sphere having its center at the effective center of deflection of said magnetic means, said magnetic deflecting means consisting of a magnetic yoke having four slots formed in the inner portion of said yoke with four pole pieces each between adjacent slots, the center lines of said pole pieces being at an angle of substantially 45° to the direction of the scanning paths on the said surface to be scanned, and of coils disposed within the slots.

3. A cathode ray tube including an electron source for generating a beam of electrons, magnetic deflecting means for providing a line de-

deflecting field for deflecting said electron beam along parallel paths, and a frame deflecting field for shifting the beam in a direction perpendicular to said paths, and a surface to be scanned by said beam, said surface having a curvature less than that of a sphere having its center at the effective center of deflection of said magnetic means, said magnetic deflecting means consisting of a magnetic yoke having four slots formed in the inner portion of said yoke with four pole

faces each between adjacent slots, the center lines of said pole pieces being at an angle of substantially 45° to the direction of the scanning paths on the said surface to be scanned, and at least two sets of coils disposed within the slots, one set of said coils providing a line deflecting field and another set of said coils providing a frame deflecting field.

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