March 12, 1957 C. V. FOGELBERG ET AL 2,785,330

INTERNAL POLE PIECE ARRANGEMENT FOR A MAGNETICALLY-FOCUSED CATHODE RAY TUBE

Filed Oct. 19, 1953

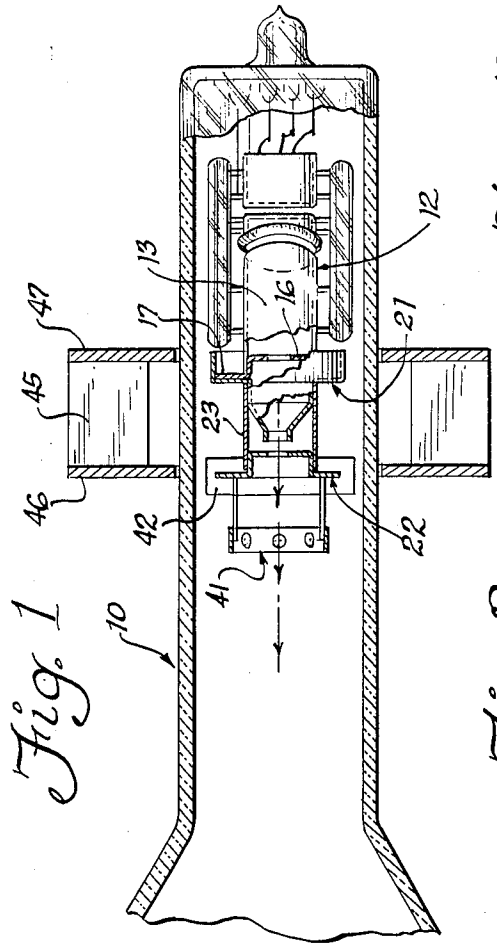

Fig. 1

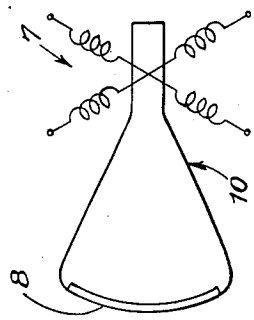

Fig. 3

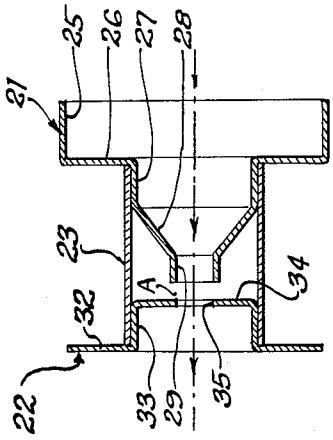

Fig. 2

INVENTORS
Clement V. Fogelberg &
BY Edgar W. Morse
Leonard S. Thumfeel
Atty

United States Patent Office 2,785,330 Patented Mar. 12, 1957

2,785,330

INTERNAL POLE PIECE ARRANGEMENT FOR A MAGNETICALLY-FOCUSED CATHODE RAY TUBE

Clement V. Fogelberg and Edgar W. Morse, Chicago, Ill., assignors to National Video Corporation, Chicago, Ill.

Application October 19, 1953, Serial No. 386,964

11 Claims. (Cl. 313—84)

This invention relates to an internal pole piece construction and arrangement for a magnetically-focused cathode ray tube or the like.

In the foregoing connection the use of internal pole pieces for concentrating the flux emanating from the magnet placed exteriorly of the tube at the tube axis, i. e. the electron beam axis, is well known. United States Letters Patent No. 2,619,607 shows some typical arrangements of such internally disposed pole pieces.

Since the space externally available along the neck of the tube is somewhat limited and is occupied by the deflecting yoke and ion trap magnet, if any, the exterior magnetic focusing arrangement is limited as to extent and position. Preferably magnetic focusing should occur as far forward in the tube as practical construction will permit. Consequently, and since the deflection yoke must be positioned intermediate the junction of the tube neck and tube body and the electron gun, the magnetic focusing means including the beam centering means is confined to a very short region of the neck.

In previous magnetic focusing systems which located the focusing device near the deflection system, interaction between the focusing field and the deflection field was unavoidable. In a tube having internal pole pieces the focus field is largely confined to the low-reluctance pole-piece region, and interaction between the focus field and deflection field is materially reduced. Shortening of the anode barrel of the gun further reduces field interaction.

In addition to energy requirements, consideration of the relative centering motion available with different forms of pole piece is important. Centering of the beam is often obtained by shifting the axis of the magnetic field by the use of an exterior shiftable pole piece. When a device of this kind is used the shielding effect of the pole pieces tends to smooth the effect of shifting the outside pole to the point where insufficient centering motion is available. Longer gap lengths between the internal pole pieces tend to increase centering motion but increase the energy requirements for focusing. This difficulty may be avoided by displacing the exterior focusing device toward the face of the tube. By such expedient there is provided flux sufficient for beam centering without substantial increase in the energy requirements for focusing and centering of the beam.

The present invention contemplates the provision of internal pole pieces which fulfill the above objective of positioning the point of interaction of the magnetic field and the beam as far forward in the tube as possible to effect isolation of the magnetic field while still confining such point within the magnetic portion of the last electrode. Where, herein, we refer to the last electrode we intend to encompass the foremost electrode (G3) to which maximum beam accelerating potential is applied and do not include other elements which may also occupy forward positions on the gun assembly but which are without substantial effect on the forward velocity of the beam.

A preferred mode of carrying the invention into practice is shown in the drawing, in which:

Fig. 1 shows a portion of a cathode ray tube incorporating the invention;

Fig. 2 is a detail, somewhat enlarged, of the pole piece unit apart from the electron gun; and

Fig. 3 is a schematic representation of a cathode ray tube of the type to which the invention is adapted.

Regarded broadly, the invention contemplates the provision of a pair of pole pieces of magnetic material carried on the forward end of a substantially conventional electron gun. The rearward pole piece comprises a cup-shaped part and a frusto-conical part, the smaller diameter of which is forward. The forward pole piece is cup-shaped with a flat bottom. Essentially it is the frusto-conical part and the disc part, the gap formed therebetween and the forward positioning of the gap which constitute the gist of the improvement. The cup-shaped portion of each pole piece is adapted to be supported by a non-magnetic sleeve which, in effect, forms a part of the last accelerating anode. The cup-shaped portion of each of the pole pieces is extended diametrically to lie closely adjacent the wall of the tube neck in order to minimize the annular air gaps intermediate the internal and external pole pieces, which latter are associated directly with the source of flux. The invention, as has already been alluded to, contemplates the provision of an external source of magnetic flux of any suitable character and which forms no part of the invention as such.

Turning to the drawing we have shown the glass neck **10** of a cathode ray tube, e. g. a television picture tube, closed at the base, and supporting in any customary manner an electron gun **12**. This latter includes a forward anode **13**, referred to in this art as electrode G3 constituting the forward electrode of a so-called "slashed gun" of a well-known type. Appropriate means **7** are included for deflecting the beam of electrons emanating from the gun **12** in directions orthogonal to the beam axis as is customary in the art—a raster or image appearing on the screen **8**. Although electromagnetic beam-deflecting means are shown by way of example in Fig. 3 it will be understood that the same may comprise electrostatic means.

The conventional stop **16** for defining the circular cross section of the electron beam prior to focusing thereof desirably includes a flange **17** protruding beyond the periphery of the anode **13** and serving as a support for the pole piece structure to be described.

Such structure includes a rear pole piece **21** and a front pole piece **22** mutually spaced and integrated by a sleeve **23**. The pole pieces are of material from 0.010" to 0.020" in thickness and having the desired high magnetic permeability, e. g. ordinary cold rolled steel, whereas the sleeve **23** is of non-magnetic material to avoid shunting of the flux.

Pole piece **21** comprises a cup-shaped part including a rim **25** and annulus **26** which is secured to the flange **17** by spot welding or otherwise. Sleeve **23** fits snugly over and is secured to, a cylindrical portion **27** of the pole piece **21**, which latter continues in a frusto-conical portion **28** terminating in a cylindrical portion **29**.

Front pole piece **22** comprises an annulus **32**, a cylindrical portion **33** over which the sleeve **23** fits snugly and to which it is secured, and an annular disc **34** having its circular aperture **35** substantially equal in diameter to the internal diameter of the cylindrical portion **29**. It will be noted that the inter-pole space A is defined at a point toward the front end of the pole piece assembly (Fig. 2) and thus sufficiently far away from the magnetic field used for ion separation located near the elec-

trode 12 to avoid interaction of the fields user respectively for focusing and ion separation.

Any conventional getter assembly 41 may, if desired, be supported on the fore part of the pole piece assembly. To assist in locating the gun assembly coaxially with the tube neck, spring 42 or other customary expedient may be incorporated with the flange 32. However, since these form no part of the invention they will not be elaborated upon.

Magnetic flux may originate from any suitable source. For example, one presently preferred type comprises essentially a plurality of permanent magnets 45, e. g. Alnico V, equipped with annular pole pieces 46 and 47 having an aperture fitting as closely as practicable about the neck 10 of the tube. One commercial arrangement thereof which includes permanent magnets, adjustment features and means for shifting the axis of the field is disclosed in Patent No. 2,640,868. Any electro-magnetic focusing device of known construction may be used equivalently.

Ideally the axial spacing of the pole pieces 46 and 47 corresponds with or is somewhat greater than the distance between the extremities of the pole-piece assembly, as seen in Fig. 2. Thus flux originating at the magnets 45 finds a path through the pole pieces 46, 22, 21 and 47 with the usable flux concentrated across the gap A. In particular the rim 25 will reduce the reluctance of the gap defined between it and the outer pole piece 47 thereby further to reduce the energy required.

Centering of the beam in a tube incorporating internal pole pieces requires that displacement of the beam be accomplished as close as possible to the face of the tube. If this requirement is not satisfied and centering is done further back there exists the possibility that the beam may be cut by the several apertures of the gun. By "centering action" we refer to the use of an eccentrically adjustable external pole piece portion, for example, as shown in said Patent No. 2,640,868. When centering the beam by means of the character disclosed therein we have found that maximum range of centering adjustment is attained when the forward pole piece is substantially a flat plate. Internal pole piece arrangements which use a pair of opposed truncated cones, while generally slightly more efficient magnetically, do not allow adequate centering motion. By constituting the internal pole pieces in accordance with the principles of the invention the bundle of flux lines finds its greatest density in the gap A at a point sufficiently forward in the tube to avoid the shortcomings incident upon the use of prior art constructions.

It will be comprehended from the foregoing that the invention is equally applicable to tubes including a plurality of electron guns, e. g. the three-gun tube of the RCA color television system. Hence, where in the claims we refer to a "gun" or "gun means" we intend to encompass assemblies other than those using a single gun.

While we have shown a particular embodiment of our invention, it will be understood, of course, that we do not wish to be limited thereto since many modifications may be made, and we therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

We claim:

1. In combination with a cathode ray tube having electron gun means for providing a beam of electrons for impingement on a luminescent, substantially planar, target area, said gun including a foremost cylindrical anode, means for traversing said beam in directions orthogonal to the beam axis and magnetic flux-producing means externally of the tube for focusing said beam on the target surface, the tube envelope in the region of said magnetic means being non-magnetic; magnetic pole pieces within the envelope surrounding said beam to receive flux through the envelope to provide a concentrated bundle of magnetic flux lines of predetermined strength and direction coactive with the electron beam to focus the same at the target, one of said pole pieces comprising a disc positioned with its principal plane normal to the axis of the beam and having an aperture for passage thereof and the other said pole piece comprising a frusto-conical shell and a cylindrical portion unitary therewith at the larger diameter thereof and having an axis substantially coincident with the beam axis, the end of the shell of smaller diameter confronting said disc to define a magnetic gap therewith, said disk and cylindrical portion being secured within said anode for mutual axial alignment, said pole pieces being carried with said gap toward the forward end of the anode.

2. The combination in accordance with claim 1 wherein said disc and the larger end of said shell are of substantially the same diameter as the interior of the adjoining portion of the tube envelope.

3. The combination in accordance with claim 2 further characterized in that the external flux-producing means includes a pair of pole pieces of annular form spaced apart along the beam axis closely fitting the exterior of the tube envelope and said disc and the larger end of said shell are respectively substantially co-planar with the exterior annular pole pieces.

4. The combination in accordance with claim 1 further characterized in that the smaller end of said shell also includes a hollow cylindrical portion protruding forwardly of the tube to confront the disc and to define the magnetic gap therewith.

5. The combination in accordance with claim 4 in which the diameter of the disc aperture and of the interior of said hollow cylindrical portion, are substantially equal.

6. In combination with a cathode ray tube having means for providing a beam of electrons for impingement on a luminescent, substantially planar, target area, said gun including a foremost cylindrical non-magnetic anode for accelerating said beam in its passage from the beam-producing means toward the target area, means for traversing said beam in directions orthogonal to the beam axis and magnetic flux-producing means including annular elements axially spaced along the beam and externally of the tube for focusing said beam on the target surface, the tube envelope in the region of said magnetic means being non-magnetic; magnetic pole pieces within the envelope surrounding said beam to receive flux through the envelope to provide a concentrated bundle of magnetic flux lines of predetermined strength and direction coactive with the electron beam, one of said internal pole pieces comprising a disc carried in the forward end of the anode and spaced inwardly thereof, and having an aperture for passage of the beam, and the other of said internal pole pieces comprising a frusto-conical shell having its large end adjacent the rear end of said anode, the smaller end of said shell being spaced away from said disc to define a magnetic gap therewith disposed within the forward half of the anode.

7. The combination in accordance with claim 6 wherein the smaller end of said shell also includes a hollow cylindrical portion extending forwardly and, confronting said disc.

8. The combination in accordance with claim 7 wherein the diameter of the disc aperture and of the interior of the smaller end of the shell are substantially equal.

9. In combination with a cathode ray tube having a non-magnetic neck, a body portion diverging therefrom, a luminescent target area, an electron gun within said neck for providing a beam of electrons which includes a source of electrons and a foremost electron-accelerating electrode of hollow cylindrical form, magnetic means external to said neck for providing a bundle of flux lines within the zone encompassed by the electrode for focusing the beam at the target area; pole means for concentrating the flux lines within the electrode in a predetermined configuration to provide the principal field of interaction of the beam and flux in the forward portion

of the electrode, said pole means comprising a disc normal to the beam having a central circular aperture and having its plane substantially at the foremost margin of the electrode and a shell magnetically separated from said disc including a frusto-conical portion and a cylindrical portion extending forwardly from the smaller end of the frusto-conical portion, the end of the cylindrical portion having an internal diameter substantially equal to the diameter of the disc aperture whereby the flux available internally of the neck is substantially entirely concentrated between the margin of the aperture and the free end of the cylindrical portion.

10. In combination with a cathode ray tube having electron gun means for providing a beam of electrons for impingement on a luminescent, substantially planar, target area, said gun including a foremost cylindrical anode, means for traversing said beam in directions orthogonal to the beam axis and magnetic flux-producing means externally of the tube for focusing said beam on the target surface, the tube envelope in the region of said magnetic means being non-magnetic; a forward, magnetic pole piece including a cylindrical rim and a radially-disposed disc portion having a central aperture for passage of the beam; a rearward magnetic shell-like pole piece including a frusto-conical part, a cylindrical rim at the larger diameter of said part and a cylindrical rim at the smaller diameter of said part, said part and rims being coaxial with said aperture for passage of the beam; the respective cylindrical rim of said forward pole piece and of the larger end of said rearward pole-piece snugly fitting and being secured to the anode, the respective edges of said rims being substantially in alignment with the ends of the anode.

11. In combination with a cathode ray tube having electron gun means for providing a beam of electrons

for impingement on a luminiscent, substantially planar, target area, said gun including a foremost cylindrical anode, means for traversing said beam in directions orthogonal to the beam axis and magnetic flux-producing means externally of the tube for focusing said beam on the target surface, the tube envelope in the region of said magnetic means being non-magnetic; a forward magnetic pole piece including a cylindrical rim, a radially disposed disc portion having a central aperture and coterminous peripherally with one end of the rim and an annular portion coterminous on its inner circumference with the other end of said rim; a rearward magnetic pole piece including a frusto-conical portion, with its smaller diameter facing forwardly, a first cylindrical portion extending rearwardly from the larger diameter of said frusto-conical portion, an annular portion extending radially outwardly of the rear edge of said first cylindrical portion, and a second cylindrical portion extending forwardly of the smaller diameter of said frusto-conical portion, the end of said second cylindrical portion defining with said disc aperture a magnetic gap, said two annular portions terminating closely adjacent the internal surface of the tube neck, said rim and first cylindrical portion fitting snugly within and supported by the anode, and the axially disposed faces of said annular portions abutting the respective ends of the anode.

References Cited in the file of this patent

UNITED STATES PATENTS

2,149,101	Ploke	Feb. 28, 1939
2,212,206	Holst et al.	Aug. 20, 1940
2,619,607	Steers	Nov. 25, 1952
2,664,514	Reiches et al.	Dec. 29, 1953