April 4, 1939. A. J. YOUNG 2,153,223

CATHODE RAY TUBE

Filed Aug. 23, 1935

Fig. 1

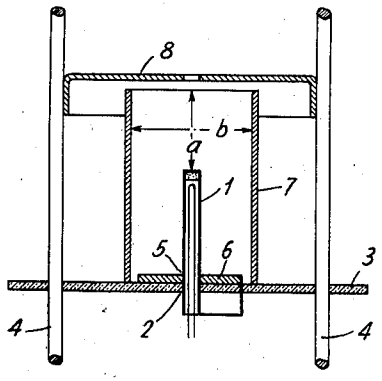


Fig. 2

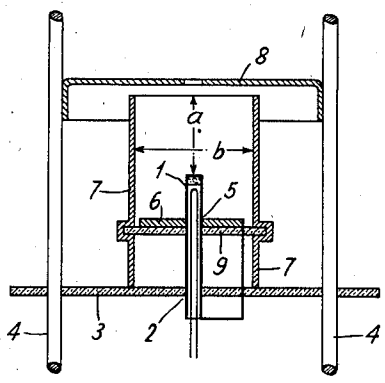
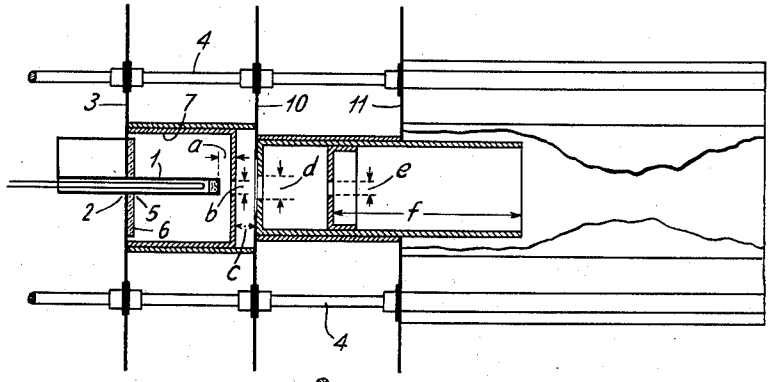


Fig. 3



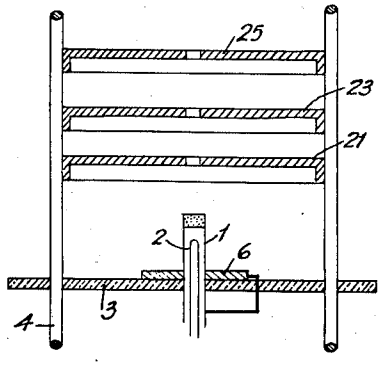


Fig. 4

INVENTOR
ARTHUR J. YOUNG
BY H. S. Grover
ATTORNEY

Patented Apr. 4, 1939

2,153,223

UNITED STATES PATENT OFFICE

2,153,223

CATHODE RAY TUBE

Arthur James Young, Putney, London, England, assignor to Radio Corporation of America, a corporation of Delaware

Application August 23, 1935, Serial No. 37,462
In Great Britain August 30, 1934

9 Claims. (Cl. 250—162)

This invention relates to cathode ray tubes suitable for use for television and similar oscillograph purposes and wherein the cathode ray beam is required to be brought to a sharply focussed spot which is as small as possible. The invention has for its general object to provide an improved focussing electrode arrangement.

It is common in gas-filled cathode ray tubes to supplement the focussing action of the gas filling by electrostatic means and a usual arrangement of such electrostatic means comprises a Wehnelt cylinder which surrounds the cathode and has at or near its outer end, i. e. the end farthest away from the cathode in the direction of the cathode ray stream, an apertured anode electrode. A common arrangement is one wherein the apertured anode is a dished disc arranged at the outer end of the cylinder and at right angles to the axis thereof, the cylinder being concentric with and surrounding the cathode.

It has been found highly desirable for practical reasons to provide an insulator for centering the cathode (whether the cathode be of the indirectly heated or of the filamentary type) and the introduction of such an insulator leads to difficulties which are not at first sight obvious. The need for a centering insulator arises in the case of an indirectly heated cathode mainly owing to the fragility of the heater coating while in the case of a filamentary cathode this need arises mainly owing to the likelihood of a filament to vibrate or otherwise move its position. If, however, a centering insulator or insulators be provided in most known arrangements the accumulation of charges thereon tends to cause serious loss of focus especially where a negatively biased Wehnelt cylinder is employed, and accordingly where such a centering insulator has been employed hitherto the Wehnelt cylinder has been positively biased—a somewhat troublesome arrangement inter alia because it prevents the cylinder bias from being obtained by means of a self-biasing resistance in the cathode circiut.

Again, where a negatively biased Wehnelt cylinder is used for focussing purposes, it has been found that for accurate focussing the distance a between the effective point of emission of electrons from the cathode and the outer end of the Wehnelt cylinder should be co-related to the diameter b of the Wehnelt cylinder. The actual co-relation to be adopted in any case depends upon the diameter of the Wehnelt cylinder and on the general geometry of the tube and its electrodes. In general, with a negative Wehnelt cylinder a should not exceed somewhere about $\frac{1}{2}b$ though in some cases actually tested optimum results have been obtained with $a=.68b$. However, since in any given case with a negative Wehnelt cylinder there is some fraction of b which a must not exceed for best results, obviously the requirements for accurate centering become more stringent as the distance a is decreased. Similarly for positively biased focussing cylinders the distance a should not be less than some fraction of the internal diameter of the cylinder—generally about one half.

Another defect which arises with known cathode ray tube arrangements comprising only a Wehnelt cylinder and an apertured anode is that the gas pressure in the tube must be made objectionably high if satisfactory focussing is to be obtained.

The object of the present invention is to provide an improved focussing arrangement wherein the above difficulties and disadvantages are all avoided and wherein a reasonably low gas pressure may be used in conjunction with a Wehnelt cylinder which may be either negatively or positively biased in relation to the cathode or be at cathode potential. In carrying out the invention a Wehnelt cylinder can be dispensed with altogether and satisfactory focussing can be obtained with the aid merely of disc-like electrodes. The invention has been found to be applicable not only to gas filled tubes but also to so-called "hard" cathode ray tubes.

According to this invention the cathode of a cathode ray tube is held accurately in its desired position by means of a centering insulator or insulators and between this insulator or insulators and the effective point of emergence of electrons is arranged a disc-like electrode which operates as a focussing device. Preferably the disc-like electrode is in contact with the centering insulator and is at cathode potential.

The invention is illustrated in the accompanying schematic sectional drawing of which:

Fig. 1 shows an electron gun embodying my invention;

Fig. 2 shows a modification of the electrode structure;

Fig. 3 shows a further modification; and

Fig. 4 shows yet a further modification of my invention.

Referring to Figure 1 a cathode ray tube (not shown as a whole) has a cathode 1 which projects through a central aperture 2 in a mica, steatite, or other centering insulator 3 of disc-like form and which is mounted upon rods 4 of the usual supporting frame of the "electron gun"

assembly of the tube. The cathode also projects through a central aperture 5 in a shield or focussing disc 6 which lies against and in contact with the insulator disc 3 and is on the side thereof adjacent the "tip" of the cathode. This shield or focussing disc may be either positively or negatively biased but is preferably directly connected inside the tube to the cathode as shown. The shield or focussing disc is of somewhat smaller diameter than the internal diameter of a Wehnelt cylinder 7 which is arranged concentrically about the cathode, one end of the Wehnelt cylinder lying approximately in the same plane as the shield or focussing disc 6. This Wehnelt cylinder is carried by supporting rods (not shown) as in the usual way, and its outer end projects into a dished-disc-like apertured anode 8 also as in the usual way. In the case of a cathode ray tube for television reception purposes a fluorescent screen (not shown) is provided at the far end of the tube envelope. The Wehnelt cylinder may be either negatively or positively biased according to the particular spacing of the electrodes employed and the aforesaid distance *a* may be made as much as three-quarters of the internal diameter of the Wehnelt cylinder and satisfactory focussing may still be obtained with these dimensions even with a negatively biased cylinder. The focussing disc or shield substantially assists focussing action and enables a quite small gas filling to be used with satisfactory results. Furthermore with the system shown a large cathode ray mean current may be obtained.

In another embodiment of the invention shown in Fig. 4 the embodiment of Figure 1 is modified by dispensing with the Wehnelt cylinder 7 and the single apertured disc anode 8 and employing instead two or more disc or similar anodes 23 and 25 in conjunction with a suitable control electrode 23, said anodes being, of course, arranged at right angles to the mean direction of the cathode ray beam and with their apertures in said mean direction, said anodes being one behind the other across the path of the beam.

In the modification shown in Figure 2 the shield electrode 6, which is again connected to the cathode, is mounted on a mica or other suitable insulating disc 9 which is carried in a peripheral groove formed in the Wehnelt cylinder 7. If, instead of using an indirectly heated cathode it were preferred to employ a filament, the construction of Figure 2 should be modified in such manner as to allow the tip of the filament to project through the disc 6 without touching it, support for the filament being given by the mica or other insulating disc 9 and not by the insulator 3.

Figure 3 shows a further modification suitable for a hard cathode ray tube. Here again the cathode 1 is centered by an insulating disc 3 with an apertured shield disc 6. In Figure 3 additional insulating discs 10, 11, are shown for supporting the rest of the electron gun system. Suitable practical values of dimensions are: length of cathode structure .625", diameter of cathode structure .050", thickness of cathode material in the end of the cathode structure .005", dimensions *a*, *b*, *c*, *d*, *e*, and *f*, .020", .050", .070", .100", .030" and .800" respectively.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:—

1. A cathode ray tube comprising a symmetrical positioning planar insulator, a cathode projecting through and beyond the insulator and supported only therefrom, a symmetrical electrode positioned upon said insulator, said electrode serving as a focusing member, and means for electrically connecting said electrode to said cathode.

2. A cathode ray tube comprising a cathode, an annular cylindrical electrode surrounding said cathode, a positioning insulator supporting said cathode co-axially with said electrode, a disk electrode mounted on said insulator, and means directly connecting said last named electrode to the cathode.

3. A cathode ray tube comprising a cathode, an annular cylindrical electrode surrounding said cathode, a positioning insulator, supporting said cathode co-axially with said electrode, a disk electrode mounted on said insulator, and a direct metallic connection within the tube from said disk electrode to said cathode.

4. A cathode ray tube comprising a positioning insulator, a cathode projecting through and beyond the insulator and supported only therefrom, and conducting means upon the insulator for preventing the accumulation of charges upon the insulator.

5. A cathode ray tube comprising a positioning insulator, a cathode projecting through and beyond the insulator and supported only therefrom, and an electrostatic shield in contact with the insulator for preventing the accumulation of charges upon the insulator.

6. A cathode ray tube comprising a symmetrical positioning insulator, a cathode projecting through and beyond the insulator, and supported only therefrom, and a single symmetrical focusing and shielding electrode positioned upon the insulator.

7. A cathode ray tube comprising a positioning insulator, a cathode projecting through and beyond the insulator and supported therefrom, conducting means upon the insulator for preventing the accumulation of charges upon the insulator, and a coaxial annular cylindrical electrode surrounding the cathode and conducting means.

8. A cathode ray tube comprising a positioning insulator, an indirectly heated cathode projecting through and beyond the insulator and supported therefrom, a disk electrode mounted upon the insulator and in electrical conductive relationship to the cathode, and a coaxial annular cylindrical electrode surrounding the cathode and disk electrode.

9. A cathode ray tube comprising a positioning insulator, a cathode projecting through and beyond the insulator and supported only therefrom, a disk electrode mounted upon the insulator and connected electrically directly to the cathode, and a plurality of apertured electrodes in register with the cathode.

ARTHUR JAMES YOUNG.