Jan. 9, 1940. A. B. DU MONT ET AL 2,186,635

CATHODE RAY TUBE

Filed Nov. 7, 1938 2 Sheets-Sheet 1

Fig. 1

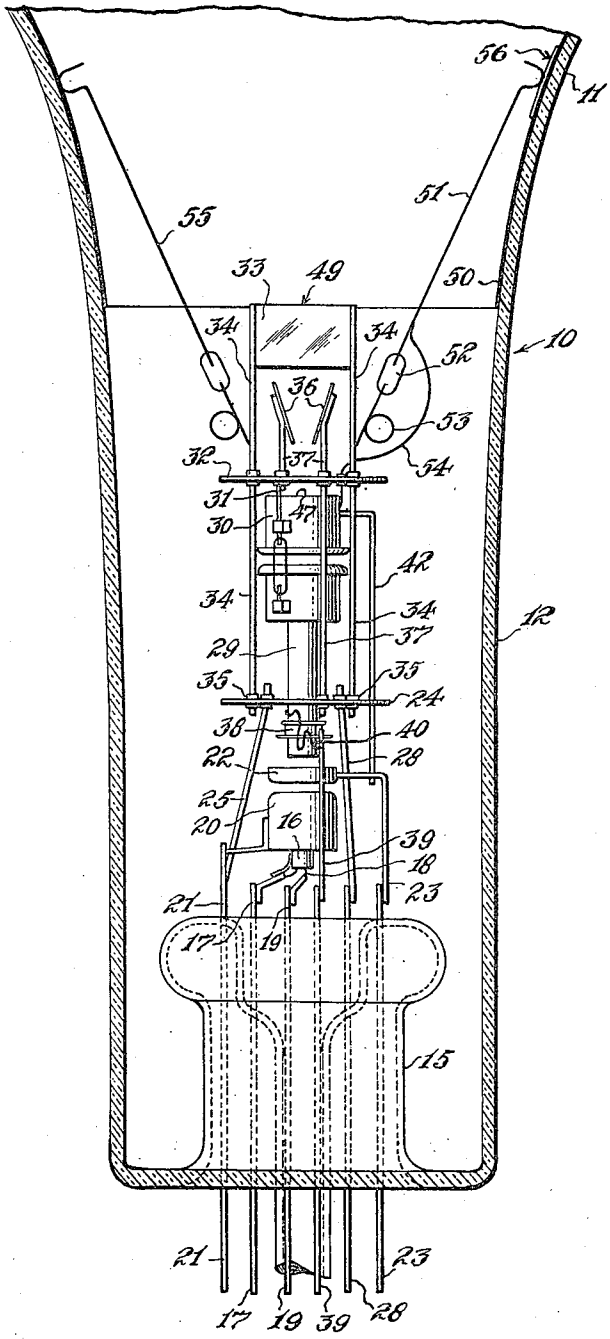


Fig. 2



Fig. 3

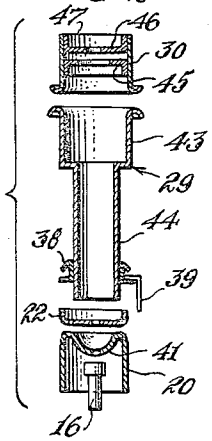
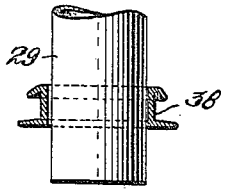


Fig. 4



INVENTORS
Allen B. Du Mont
Alfred J. Hinck Jr
BY
H. DeSales Spear
ATTORNEY

Jan. 9, 1940. A. B. DU MONT ET AL 2,186,635

CATHODE RAY TUBE

Filed Nov. 7, 1938 2 Sheets-Sheet 2

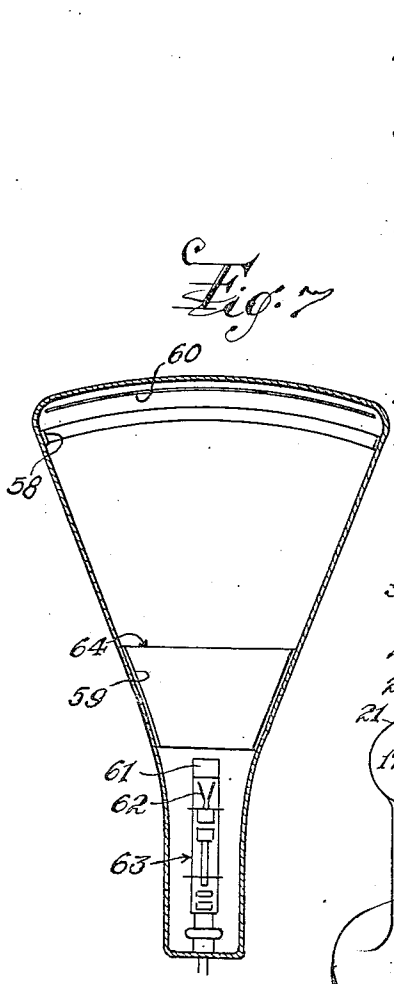


Fig. 7

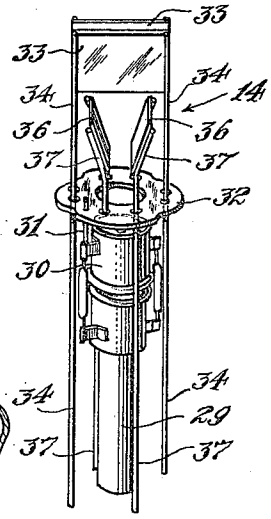


Fig. 5

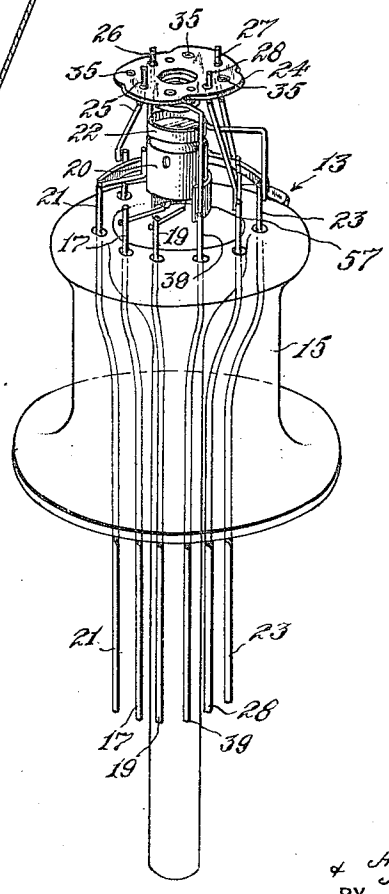


Fig. 6

INVENTORS
Allen B. Du Mont
Alfred J. Hinman, Jr.
BY
ATTORNEY

Patented Jan. 9, 1940 2,186,635

UNITED STATES PATENT OFFICE

2,186,635

CATHODE RAY TUBE

Allen B. Du Mont, Upper Montclair, and Alfred J. Hinck, Jr., Montclair, N. J., assignors to Allen B. Du Mont Laboratories, Inc., Passaic, N. J., a corporation of Delaware

Application November 7, 1938, Serial No. 239,330

9 Claims. (Cl. 250—155)

Our invention relates to improvements in cathode-ray tubes of the general type more particularly adapted for television reception.

One of the objects of our invention is the provision of an improved cathode-ray tube of the character referred to which has advantages over those used heretofore in the way of clearer and brighter pictures to be obtained, greater simplicity of construction and of assembly in manufacturing, and more favorable disposition of the various parts and leads with respect to each other to withstand the high differences of potential within the tube.

Other objects and advantages will hereinafter appear.

For the purpose of illustrating our invention, an embodiment thereof is shown in the drawings, wherein

Figure 1 is an enlarged fragmentary, sectional view of the gun end of a cathode-ray television receiving tube constructed and operating in accordance with our invention, some of the parts and connections or leads being removed for the sake of clearness;

Figs. 2 and 3 illustrate more clearly the relative position and spacing of the electrodes and deflecting plates comprising our improved gun construction or mount, Fig. 3 being in section to show the construction of the electrodes;

Fig. 4 is an enlarged fragmentary view, partly in section, showing a detail of the construction and assembly;

Figs. 5 and 6 are perspective views showing respectively the two sections of our improved gun mount; and

Fig. 7 is a simplified elevational view showing a modification.

Our improved cathode-ray tube comprises a tube 10 of a conventional construction and having a bulbous portion 11 on the end wall of which is a fluorescent screen (not shown). In the neck portion 12 of the tube is the gun for developing the ray of electrons directed at and focused on the screen. The gun mount comprises a first section designated generally by the reference numeral 13, and a second section designated generally by the reference numeral 14.

The first or press section 13 comprises a stem or press 15 which is sealed to the open end of the neck 12, a cathode 16 supported from the stem by a lead wire 17, a cathode-heater 18 supported from the stem by the lead wire 17 and a lead wire 19, a modulating electrode 20 supported from the stem by a lead wire 21 and in which the cathode 16 is disposed, a first accelerating electrode 22 supported from the stem by a lead wire 23, and a mica disc 24 supported from the stem by the four lead wires 25, 26, 27 and 28 which pass through the stem to the exterior of the tube.

The second section 14 comprises a focusing electrode 29 supported by glass beads from a second accelerating electrode 30 which in turn is supported by a wire 31 from a mica disc 32. Deflecting plates 33 are supported by wires 34 from the mica disc. Two of these wires, one from each of the plates 33, are extended and welded to eyelets 35 set in the mica disc 24. A second set of deflecting plates 36 is supported by wires 37 from the disc 32. Two of these wires, one from each of the plates 36, are extended and welded to eyelets set in the mica disc 24.

An important aspect of our invention resides in the fact that each of the gun sections 13 and 14 can be made separately, with the respective parts in perfect alignment. When the two sections are united, as shown in Fig. 1, the free end of the foscusing electrode 29 passes loosely through the central opening in the mica disc 24 but does not touch the same, and is received with a sliding fit by a collar 38 supported from the stem 15 by a lead wire 39. A light, flexible coupling 40 provides a good electrical connection from the electrode 29 to the lead wire 39. The reason for this arrangement is to allow for expansion of the focusing electrode while it is being heated during processing, and to insure that when the two sections are united, the adjacent electrodes 22 and 29 will be in perfect alignment. In the various constructions proposed heretofore, no provision was made for expansion on processing, which resulted in the mount being forced out of line.

We have found that by putting a spherical-shaped depression at the aperture of disc 41, forming the top of the modulating electrode 20, better high-light detail is obtained, and there is less tendency for the spot size to change during modulation.

The first or preaccelerating electrode 22 above the modulating electrode 20 is operated at the same voltage as the second accelerating electrode 30. For this purpose, a connection 42 is made from the electrode 30 to the lead wire 23. By applying a high voltage to the electrode 22, a brighter spot is obtained, and there is less tendency to defocus during modulation.

The focusing electrode consists of two hollow cylinders fastened together as shown. The portion 43 of the focusing electrode at the free end

of the gun and the other electrodes 20, 22 and 30 are of the same diameter, but the diameter of the remaining portion 44 of the focusing electrode is substantially less. We have found that by making the lower portion 44 of the focusing electrode 29 of less diameter than any of the other electrodes, considerably better focusing is obtained.

The second accelerating electrode 30 consists of a hollow cylinder with two apertured discs 45 and 46 in it, the diameter of the aperture in disc 45 being greater than that in disc 46. The purpose of this electrode is to bring up to a maximum the velocity of the electrons which have been slowed down somewhat by the focusing electrode and also to reduce background illumination caused by stray electrons. The discs 45 and 46 are primarily to reduce this undesired illumination.

The respective adjacent edges of the modulating electrode and the first accelerating electrode are rounded to prevent voltage breakdown between these electrodes which operate at a large difference of potential. For the same reason, the respective adjacent edges of the focusing electrode 29 and the second accelerating electrode 30 are rounded as shown.

An important aspect of our invention resides in the fact that there is a relatively large distance A from the tip 47 of the gun to the adjacent edges 48 of the second set of deflecting plates 36. The relation

$$A=\frac{C}{2.5B}$$

exists approximately, where A is measured in inches, C is the effective diameter in inches of the flourescent screen, and B is the distance in inches from the screen to the adjacent edges 49 of the first set of deflecting plates 33. Satisfactory results have been obtained by making A equal to .4 inch with C and B both 14 inches. Satisfactory results have also been obtained, in the so-called "14 inch" tube, by making A equal to ⅜ inch, C equal to 12 inches, and B equal to 15 inches; and in the so-called "9 inch" tube by making A equal to ¼ inch, C equal to 8 inches, and B equal to 12 inches. In the constructions used heretofore, the distance A is much less. We have found that by making the distance A greater, and using the relation above expressed, defocusing of the spot during deflection is eliminated. The reason for this is that in our improved construction no appreciable bending or deflection of the beam or ray within the gun structure takes place. Heretofore it has been generally supposed that no motion or deflection of the ray occurs below the deflecting plates. Actually, this is not true, and the motion of the ray in the gun during deflection has been the cause of poor focusing in the prior constructions.

For the purpose of making good contact between the second acceleration electrode 30 and the aquadag coating 50 on the inside surface of the tube, a spring connection element 51 is used. One end of this element contacts the electrode 50, the other end being fixed to the gun structure, but insulated therefrom by a glass bead 52 and provided with a coil spring 53. The element 51 is therefore spring-biased laterally outwardly with respect to the gun to hold its outer end in firm contacting engagement with the electrode 50. A flexible connecting wire 54 from the element 51 makes connection between the electrode 50 and the second accelerating electrode 30. A similar element 55 acts in opposition with respect to the connection element 51 whereby the tendency for the latter to move the gun out of alignment is compensated for. We have found that it is best to have only one connection to the aquadag coating, because if the connection to electrode 30 is made through both elements 51 and 55, the high frequency heating current used in processing the tube tends to burn these elements and the aquadag coating, as a closed circuit is formed. For this reason, a glass insulating bead is inserted in the element 55, as shown. The connection of the element 51 to the aquadag can be greatly improved by providing a metal surface 56 for it to rest on. This is accomplished by painting very finely divided silver mixed in a nitrocellulose binder onto the aquadag at the place where contact is to be made. The bulb is then heated to 425 degrees centigrade, decomposing the binder and leaving a metallic deposit. The bulb is heated long enough so that the silver partly fuses to the glass walls of the bulb.

Our improved construction of mount has a mica disc on the top and bottom sections for the purposes of alignment and added mechanical strength. Because of the very high differences in potential between the elements it is not practical to use mica discs unless they are of very large diameter when these high potential differences are applied to the leads through the mica. For this reason, in our improved mount no high potential differences are applied to the mica. As shown in Fig. 5, only the leads holding the deflecting plates and the second anode 30, which is at substantially the same potential, are attached to the mica disc 32. The four leads 25, 26, 27 and 28 go through the mica disc 24 and are used to carry the voltages to the four deflection plates, straps being used to make proper connections with the leads 34 and 37. Our improved mount is stronger mechanically by using the bottom mica disc 24, than if the lead wires from the deflection plates were taken directly to the stem. Furthermore, the straps can be connected as desired to facilitate basing.

As shown in Fig. 6, a shield 57 is placed between the cathode 16 and the high voltage lead 23 to prevent a flow of current from the cathode to this lead and also to prevent breakdown. The shield 57 is electrically connected to the modulating electrode 20. The advantage of this is that a retarding field is set up between the cathode and the second anode lead 23 to further minimize current flow from the cathode 16 to lead 23.

We have found that under certain conditions when a very intense trace or picture is desired which would necessitate an extremely high second anode voltage, it is possible to add a ring electrode 58 as shown in Fig. 7. This ring electrode is made of silver, as is the lower ring electrode 59. We then can apply say 10,000 volts to the top ring electrode 58 and obtain intensity corresponding to this voltage, but instead of cutting the deflection sensitivity by 50% it is only reduced by approximately 18%. We have found, in this connection, that aquadag rings are not satisfactory for this purpose because an electrical discharge occurs from the edges.

We have found that if the potential applied to the ring electrode 58 nearer the fluorescent screen 60 is more than twice that on the lower ring electrode 59, it is not possible to obtain full scale deflection because of the masking effects of the electrostatic field.

The ring electrode 59 extends along the tube

for a distance of approximately two inches, and beyond the deflecting means or plates 61 and 62 in the direction toward the screen 60. The second electrode 58, in the form of a relatively narrow ring approximately one-quarter of an inch in width, is in proximity to the screen 60, that is, about one-half of an inch therefrom. The electrodes 58 and 59 operate respectively at voltages one of which is of the order of twice the other. Satisfactory results have been obtained with the ring electrode 58 operating at 10,000 volts and the ring electrode 59 operating at 5,000 volts. A gun 63 of a suitable, conventional design, operates to develop a ray of electrons directed at and focused on the screen 60. We believe ourselves to be the first to obtain the desired results referred to, and we attribute this to our novel construction, arrangement and relations as just described. That is, with an extremely high second anode voltage in order to get a very intense trace or picture, with our improved tube it is possible to deflect the ray to cause the same to scan substantially the entire area of the screen 60, since the deflection sensitivity is only reduced by approximately 18%, as against 50% reduction in the cathode-ray tubes of the prior art.

The following voltages applied to the electron gun have been found to give satisfactory results:

Heater volts	2.5
Modulating electrode voltage	−30
Focusing electrode voltage	+1250
Preaccelerating voltage	+5000
Second accelerating voltage	+5000

The voltage applied to the deflection plates depends upon the deflection desired and may be as much as 1500 volts.

It will be understood that various modifications within the conception of those skilled in the art, are possible without departing from the spirit of our invention or the scope of the claims.

We claim as our invention:

1. In a cathode-ray tube, a tube, means disposed in said tube for developing a ray of electrons, said means including a plurality of electrodes, one of said electrodes at one end thereof being supported in spaced relation and in alignment with respect to an adjacent electrode at the other end of said first-named electrode, said first-named part being free to expand and contract in the direction longitudinally thereof from the supported end of the same, and means engaging said first-named electrode in proximity to said other freely movable end thereof and operating to guide and hold said other end in aligned relation with respect to said second-named electrode.

2. In a cathode-ray tube, a tube, means disposed in said tube for developing a ray of electrons, said means including a plurality of electrodes, one of said electrodes at one end thereof being supported in spaced relation and in alignment with respect to an adjacent electrode at the other end of said first-named electrode, said first-named part being free to expand and contract in the direction longitudinally thereof from the supported end of the same, and a collar supported rigidly with respect to and independently of said second-named electrode and receiving said other freely movable end of said first-named electrode with a sliding fit and operating to guide and hold said other end in aligned relation with respect to said second-named electrode.

3. In a cathode-ray tube, a tube having a press at an end thereof, and means for developing a ray of electrons, said means comprising a press section and a second section disposed in alignment with respect to each other, said press section comprising said press and electrodes supported therefrom in spaced relation with respect to each other, said second section comprising electrodes supported in spaced relation with respect to each other and being attached directly to and only directly to said press section and being accordingly supported directly from and only directly from said press section.

4. In a cathode-ray tube, a tube, means for developing a ray of electrons, said means comprising a first section having an electrode and a second section having an electrode and disposed with the latter adjacent to and spaced from and in alignment with respect to said first-named electrode, said first section being attached directly to and supported directly from the wall structure of said tube, said second section being attached directly to and only directly to said first section and being accordingly supported directly from and only directly from said first section, said second-named electrode at the end thereof adjacent said first-named electrode being freely movable in the longitudinal direction, and means supported from and rigid with respect to said first section and engaging said end of said second-named electrode and operating to hold the latter in aligned relation with respect to said first-named electrode while still permitting the free longitudinal movement of said end of said second-named electrode with respect to said first-named electrode.

5. In a cathode-ray tube, a tube, means for developing a ray of electrons, said means comprising a first section having an electrode and a second section having an electrode and disposed with the latter adjacent to and spaced from and in alignment with respect to said first-named electrode, said first section being attached directly to and supported directly from the wall structure of said tube, said second section being attached directly to and only directly to said first section and being accordingly supported directly from and only directly from said first section, said second-named electrode at the end thereof adjacent said first-named electrode being freely movable in the longitudinal direction, and a collar supported from and rigid with respect to said first section and receiving said first section and receiving said end of said second-named electrode with a sliding fit and operating to hold the latter in aligned relation with respect to said first-named electrode while still permitting the free longitudinal movement of said end of said second-named electrode with respect to said first-named electrode.

6. In a cathode-ray tube, a tube provided with a screen and with means in the form of a gun for developing a ray of electrons directed at and focused on said screen, a first set of deflecting plates, and a second set of deflecting plates disposed between said first set and the tip of said gun, said tube being characterized by the fact that

$$A \text{ approximates } \frac{C}{2.5B}$$

where A is the distance in inches from the tip of said gun to the adjacent edges of said second set of deflecting plates, C is the effective diameter in inches of said screen, and B is the distance in inches from said screen to the adjacent edges of said first set of deflecting plates.

7. In a cathode-ray tube, a tube provided with

a screen and with means in the form of a gun for developing a ray of electrons directed at and focused on said screen, said tube being provided with an electrode in the form of a coating of electrically-conductive material on the inside surface of the tube and at least part of which is between said screen and the adjacent tip of said gun, a connection element having one end thereof contacting said electrode, the other end of said element being fixed to the gun structure, said element being spring-biased laterally outwardly with respect to said gun to hold said one end thereof in firm contacting engagement with said electrode, and an element having one end thereof pressing against the inside surface of said tube and having its other end fixed to the gun structure, said second-named element being spring-biased laterally outwardly with respect to said gun and acting in opposition with respect to said connection element whereby the tendency for the latter to move said gun out of alignment is compensated for, the construction being characterized by the fact that there is an electrically non-conductive path from the gun structure to said electrode by way of said second-named element.

8. In a cathode-ray tube, a tube having a screen at the end wall thereof, a gun disposed in said tube for developing a ray of electrons directed at and focused on said screen, means for deflecting said ray to cause the same to scan substantially the entire area of said screen, an electrode extending along said tube and beyond said deflecting means in the direction toward said screen, and one and only one electrode in the form of a relatively narrow ring in proximity to said screen for minimizing defocusing of the ray-spot on said screen and for miniminzing reduction of deflection sensitivity, said electrodes operating respectively at voltages one of which is of the order of twice the other.

9. In a cathode-ray tube, a tube having a screen at the end wall thereof, a gun disposed in said tube for developing a ray of electrons directed at and focused on said screen, means for deflecting said ray to cause the same to scan said screen, an electrode extending along said tube and beyond said deflecting means in the direction toward said screen, and one and only one electrode in the form of a ring disposed between said screen and said first-named electrode for minimizing defocusing of the ray-spot on said screen and for minimizing reduction of deflection sensitivity, said second-named electrode operating at a potential higher than the potential of operation of said first-named electrode.

ALLEN B. DU MONT.
ALFRED J. HINCK, JR.