

Dec. 17, 1940.

P. S. CHRISTALDI

2,225,099

CATHODE-RAY TUBE

Filed June 10, 1939

2 Sheets-Sheet 1

Fig. 1

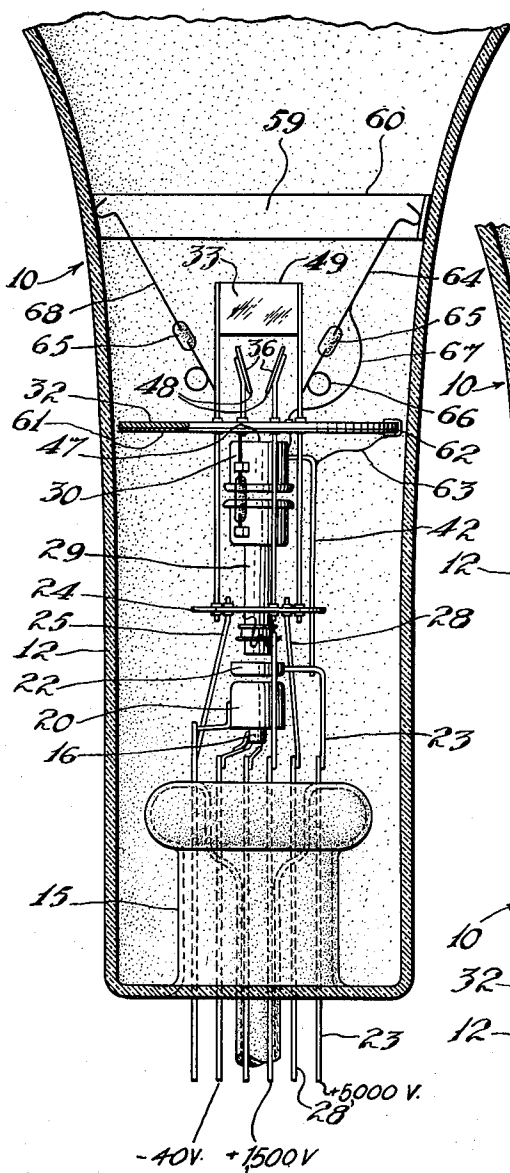


Fig. 2

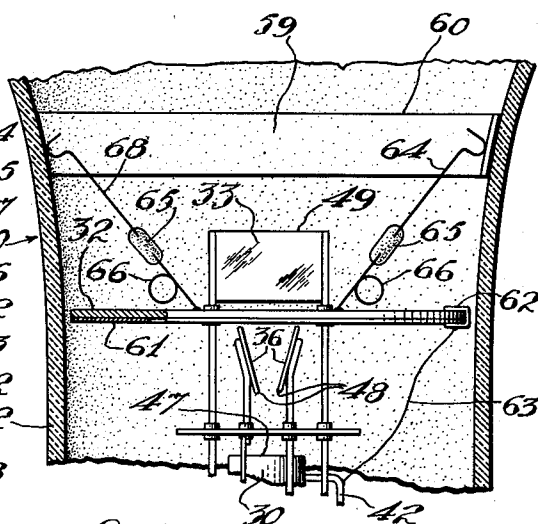
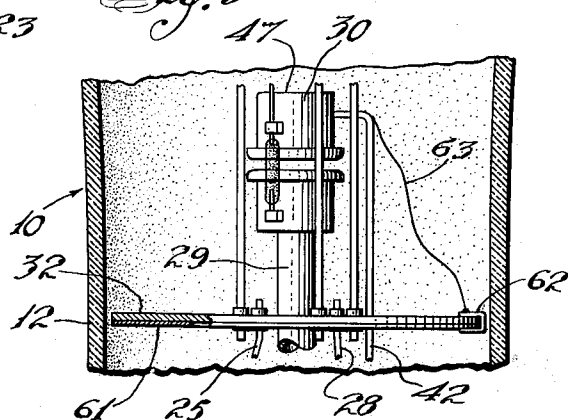


Fig. 3



INVENTOR

Peter S. Christaldi

BY

H. Colance Gregory

ATTORNEY

Dec. 17, 1940.

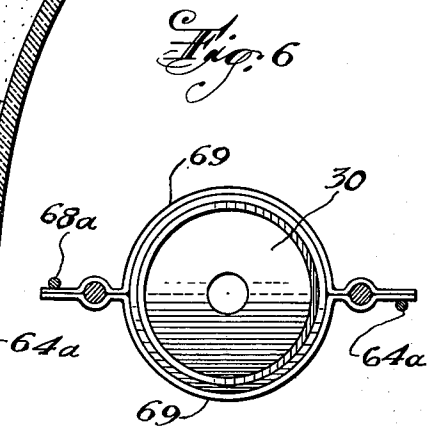
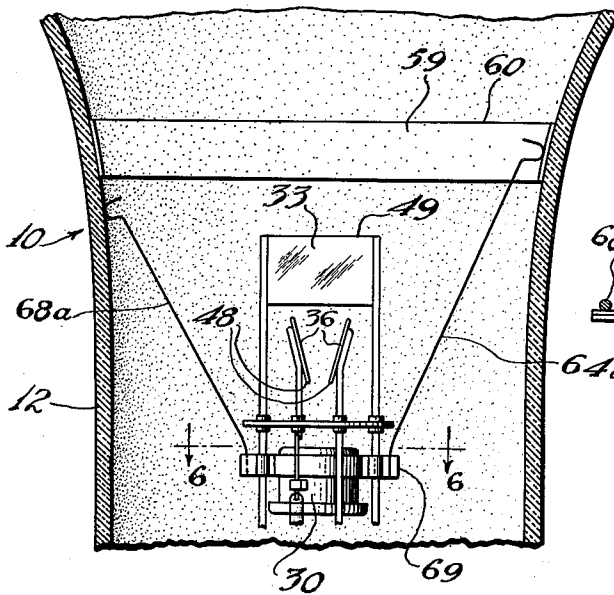
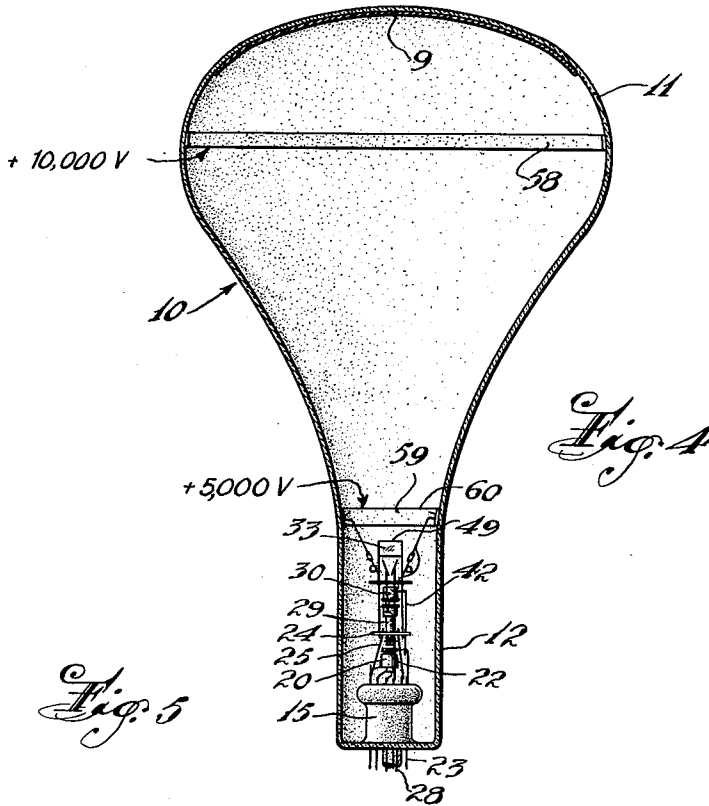
P. S. CRISTALDI

2,225,099

CATHODE-RAY TUBE

Filed June 10, 1939

2 Sheets-Sheet 2



INVENTOR
Peter S. Cristaldi
BY
H. Vance Gregory
ATTORNEY

UNITED STATES PATENT OFFICE

2,225,099

CATHODE-RAY TUBE

Peter S. Christaldi, Clifton, N. J., assignor to
Allen B. Du Mont Laboratories, Inc., Passaic,
N. J., a corporation of New Jersey

Application June 10, 1939, Serial No. 278,389

11 Claims. (Cl. 250—27)

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

As a result of development of the so-called Braun tube for television reception, it has been definitely determined that certain values, whether they be of operating potentials or certain electrodes, or of dimensions in the tube structure itself, must be properly correlated in order to obtain the desired operating action. For example, it is known that by increasing the operating potential on an accelerating anode of a conventional cathode-ray tube, the intensity or brightness of the trace or picture is increased. A point or potential range is finally reached, however, whereat the sensitivity of deflection is reduced a prohibitive amount, so that it is not practical to further increase the brightness of the picture by this method alone. Another difficulty has been found to reside in the matter of maintaining the scanning electron ray at a good focus on the fluorescent screen. That is, in making certain changes or variations in some of the operating potentials or in the structure of the tube itself to correct for or improve upon certain operating conditions, the result has been to impair, at the same time, the operating action in other ways, such as by causing some form of distortion of the pattern or by causing some degree of defocusing of the electron ray on the fluorescent screen. Along with this development work, the subject of electron optics has been given considerable attention, in an attempt to formulate some working basis or formulae for use in the most efficient design of cathode-ray tubes for television reception. In putting this theoretical information to practice, however, it has been found that there are still limitations in the way of an occurring decrease in efficiency of operation of the tube in one important sense if certain changes are made to cause an increase in efficiency of operation of the tube in another sense.

Many different types of cathode-ray tubes have been constructed in which there is post-deflection acceleration of the electron beam. In most of these various constructions, however, an elaborate system of electrodes has been necessary which makes these tubes impractical.

A simplified construction or system, employing a single electrode in the form of a ring disposed in proximity to the fluorescent screen, is disclosed in Patent No. 2,186,635 issued January 9, 1940, to Allen B. Du Mont and Alfred J. Hinck. This novel construction makes feasible com-

mercial production of cathode-ray tubes having the desired operating characteristics referred to.

Heretofore, the importance of electrode position, and size, shape and spacing of the same, has been overlooked in cathode-ray tubes of the general type disclosed in the patent referred to. As a result, the uses to which such tubes can be put, and the theoretical advantages to be enjoyed with certain types of operation, are sharply curtailed.

In order to gain high intensity, while maintaining high deflection sensitivity, it is desirable to make as large as possible the ratio of post-acceleration to pre-acceleration potential. I have found that unless certain designs are applied, defocussing of the fluorescent spot occurs, distorting fields are set up, and it may be impossible to utilize more than thirty per cent of the effective fluorescent screen area.

With the foregoing in mind, it is one of the objects of my invention to provide an improved construction of cathode-ray tube of the character referred to in which the operating potentials, and dimensions in the tube structure itself, are such that a picture of the desired brightness on the fluorescent screen can be obtained without necessarily or unduly interfering with the focus or the sensitivity of deflection.

Another object of my invention resides in the provision of an improved construction of cathode-ray tube of the character referred to, which has advantages over those proposed heretofore in the way of a brighter or more intense picture on the fluorescent screen for similar operating conditions, higher picture detail, and greater uniformity of the pattern.

Another object of my invention resides in the provision of a simplified construction for a cathode-ray tube in which there is post-deflection acceleration of the electron beam or ray, and which overcomes the disadvantages and the limitations of the various designs proposed heretofore.

Other objects and advantages will hereinafter appear.

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

Figure 1 is an enlarged, fragmentary, sectional view taken from Fig. 4, showing details of the gun construction;

Figs. 2 and 3 are views similar to Fig. 1, showing modifications;

Fig. 4 is a longitudinal, central sectional view

of a cathode-ray tube constructed and operating in accordance with my invention;

Fig. 5 is a view similar to Fig. 1, showing a modification; and

Fig. 6 is an enlarged, sectional view, the section being taken on the line 6—6 in Fig. 5.

The drawings show a cathode-ray tube having a gun construction similar to that described in the patent referred to. For convenience of comparison, the various parts have been designated by the same reference numerals as the corresponding and respective parts in this pending application.

With reference to Figs. 1 and 4, my improved cathode-ray tube comprises a tube 10 having a bulbous portion 11 on the end wall of which is a fluorescent screen 9. 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 is supported from the stem 15 which is sealed to the open end of the neck 12, and comprises a cathode 16, a modulating electrode 20 in which the cathode 16 is disposed, a first accelerating electrode 22 supported from the stem 15 by a lead wire 23, and a mica disc 24 supported from the stem by lead wires 25 and 28 which pass through the stem to the exterior of the tube.

The gun comprises further a focusing electrode 29 supported by glass beads from a second accelerating electrode 30 which in turn is supported from a mica disc 32. Deflecting plates 33 are supported by the wires shown from the mica disc 32. A second set of deflecting plates 36 is supported by the wires shown from the disc 32.

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.

In my improved construction, 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 diameter in inches of the fluorescent 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. In the constructions used heretofore, the distance A is much less. 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 my 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.

Important and novel characteristics of my improved tube reside in the provision of the ring electrodes 58 and 59, which may be in the form of silver coatings on the inside surface of the tube 10, and in the dimensions and relations herein-after specified. By this means, it is possible with

my improved tube to obtain a very intense trace or picture by using an extremely high final accelerating voltage, but without, at the same time, reducing the deflection sensitivity by about 50%, when the final accelerating voltage is doubled, for example, as would be the case in the various television receiver tubes used heretofore. The reason for this is that in my improved tube the deflection sensitivity is not an inverse function of final accelerating voltage or potential, as is the case in tubes of the prior art.

In the case of my improved tube, a potential of say 10,000 volts can be applied to the top ring electrode 58, 5,000 volts to the electrode 30, and a picture intensity corresponding to 10,000 volts will be obtained accordingly, but instead of cutting down the deflection sensitivity by about 50% as heretofore, it is only reduced by approximately 18% in my tube. It will be understood that a wire (not shown) sealed into the glass wall of the tube provides an external connection for application of potential to the ring electrode 58.

In the sizes of tubes commonly referred to as a "14 inch" tube, and a "9 inch" tube, respectively, the following dimensions, relations and values have been found to give very satisfactory results.

	14-inch tube	9-inch tube
Distance from edges 49 to screen 9.....	Inches 16½	Inches 13½
Mean diameter of electrode 59 (E).....	3½	4
Mean diameter of electrode 58.....	13½	9½
Distance from edge 60 to edges 49 (Z).....	1	1
Diameter of screen 9.....	11½	8
Width of ring electrode 59 (Y).....	½	½

In either case, Y may be made equal to Z.

In either case, with E from 2 to 4 inches, Z may be made from ½ inch to 1½ inches.

The following voltages, measured with respect to cathode, have been found to give satisfactory results for the 14 inch tube.

	Volts
Grid (16).....	-40
Preaccelerator (22).....	+5,000
First anode (29).....	+1,500
Second anode (30).....	+5,000
Deflection plates.....	+5,000 ± respective signal voltages
Ring electrode 58.....	+10,000
Ring electrode 59.....	+5,000

The ring electrode 58 may be about one-quarter of an inch or more in width, and may be disposed a distance of about one-half of an inch from the screen 9 or even about mid-way between the screen and the edge 60 of electrode 59.

It is possible with my improved tube, embodying the structural features and using the relations and values given above, to employ an extremely high final accelerating voltage in order to get a very intense trace or picture, and still deflect the ray to cause the same to scan substantially the entire area of the screen 9, since the deflection sensitivity is only reduced by approximately 18%, as against about 50% reduction in the cathode-ray tubes of the prior art, should the final accelerating voltage be doubled.

It has been found that when the distance from the edges 49 to the edge 60 is too great, electrostatic fields are set up such that the useful area of screen 9 is reduced as a strong function of the ratio of potentials on electrodes 58 and 59. In addition to the reduction of possible, effective

screen area, a radial distortion is introduced, and the outer ends of normally straight lines off the axis are caused to return toward or through the axis of the tube.

On the other hand, when the distance from 49 to 60 is too small, the electrostatic lines of force that would normally terminate in 59 to produce a spherical field within the intervening space, terminate instead on the deflection plates 33 and, to some extent, on the deflection plates 36. As a result, the accelerating field in that space is no longer spherical and produces a distortion of the fluorescent spot. Thus a normally round spot would become elliptical with its major axis parallel to the edges 49.

Another important structural feature of my improved television receiver tube resides in the provision of a conducting shield for collecting stray electrons which otherwise would form or set up a halo on the screen 9 in the absence or presence of signal voltage. Such a halo, when signal is present, would reduce contrast. This shield also acts as a light shield to prevent the heater-cathode from interfering with the picture. As shown in Fig. 1, the shield may be provided for by making the supporting mica disc 32 relatively thick to impart sufficient rigidity, and of a large diameter so that its edge is in close proximity to the wall of the neck of the tube. On the cathode side of the mica disc is a coating 61 of conducting material, in the form of an annular ring to provide adequate insulation from the lead wires through the disc. By means of a small metal clip 62 crimped to the disc 32, and a wire 63, the coating 61 is connected to the second anode 30, to be at the same potential as the latter.

In Fig. 2, the conducting shield 32, 61 is shown disposed between the deflecting plates 33 and 36. In this case, the shield has a third function, which is that of shielding one set of plates from the other to reduce interaction or coupling between the two orthogonal systems, which interaction would be seen as pattern distortion and/or defocusing of the trace. The annular coating 61 is electrically connected to the second anode 30, as in Fig. 1.

It would also be possible to place the electron shield 32 beyond the deflecting plates 33, or to associate it with the first or focusing anode 29 as shown in Fig. 3. In the latter case, the shield would replace and in addition serve the function of the supporting mica disc 24 in Fig. 1. In the arrangement shown in Fig. 3, the shield would be connected to the first anode 29 or to the lead wire 42 connecting to the second anode 30.

For the purpose of making good contact between the second acceleration electrode 30 and the ring electrode 59, a spring connection element 64 is used. One end of this element contacts the electrode 59, the other end being fixed to the gun structure, but insulated therefrom by a glass bead 65 and provided with a coil spring 66. The element 64 is therefore spring-biased laterally outwardly with respect to the gun to hold its outer end in firm contacting engagement with the electrode 59. A flexible connecting wire 67 from the element 64 makes connection between the electrode 59 and the second accelerating electrode 30. A similar element 68 acts in opposition with respect to the connection element 64 whereby the tendency for the latter to move the gun out of alignment is compensated for. It is best to have only one connection to the electrode 59, because if the connection to electrode 30 is made through both elements 64 and 68, the high fre-

quency heating current used in processing the tube tends to burn these elements and the coating 59, as a closed circuit is formed. For this reason, a glass insulating bead is inserted in the element 68, as shown.

In Fig. 5 a simplified construction is shown. The elements 64a and 68a correspond to and serve the same purposes as the elements 64 and 68, respectively, in Fig. 1. However, the elements 64a and 68a are fastened to the holding straps 69 for the second anode 30, or they may be fastened directly to the second anode. The element 68a falls short of the electrode 59 and engages the adjacent, bare glass surface, as shown, so that no insulating bead is necessary. Also, the glass bead 65 and the coil springs in Fig. 1 are omitted. Considering a plan view of Fig. 5, it is contemplated to dispose the elements 64a and 68a as they would be if rotated through 45 degrees to place them respectively at opposite ends of a diagonal. By this arrangement, possibility of distortion of the pattern would be reduced.

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

I claim as my invention:

1. 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outermost edges of said first set of plates in the direction toward said screen a distance in the range substantially from one-half inch to one and one-half inches, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

2. 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outermost edges of said first set of plates in the direction toward said screen a distance of substantially one inch, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

3. 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said

gun, an electrode extending along said tube and beyond the outermost edges of said first set of plates in the direction toward said screen a distance in the range substantially from one-half inch to one and one-half inches, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the mean diameter of said second electrode being greater than the effective diameter of said screen by substantially two inches, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

4. 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outermost edges of said first set of plates in the direction toward said screen a distance in the range substantially from one-half inch to one and one-half inches, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the distance from the tip of said gun to said screen being substantially seventeen inches, the diameter of said second electrode being substantially fourteen inches, the effective diameter of said screen being substantially twelve inches, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

5. 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outermost edges of said first set of plates in the direction toward said screen a distance in the range substantially from one-half inch to one and one-half inches, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the distance from the tip of said gun to said screen being substantially fourteen inches, the diameter of said second electrode being substantially ten inches, the effective diameter of said screen being substantially eight inches, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

6. In a cathode-ray tube, a tube having a screen at the end wall thereof, a gun having a cathode and 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outermost

edges of said first set of plates in the direction toward said screen a distance in the range substantially from one-half inch to one and one-half inches, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respects to the potential of operation of said first-named electrode, the potential of said second electrode with respect to said cathode being substantially twice the potential of said first-named electrode with respect to said cathode, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

7. In a cathode-ray tube, a tube having a screen at the end wall thereof, a gun having a first preaccelerating anode and a second accelerating anode and 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and said second anode, and a shield in the form of an electrically-conductive disc disposed between said second anode and said second set of plates with its edge in close proximity to the wall of said tube, said shield being electrically connected to one of said anodes.

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 said screen, an electrode extending along said tube and beyond said deflecting means in the direction toward said screen, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the diameter of said tube at a plane in proximity to said screen being substantially greater than the maximum effective diameter of said screen.

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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outermost edges of said first set of plates in the direction toward said screen a distance in the range substantially from one-half inch to one and one-half inches, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, the diameter of said tube at a plane in proximity to said screen being substantially greater than the maximum effective diameter of said screen, the mean diameter of said first-named electrode being in the range substantially from two inches to four inches.

10. In a cathode-ray tube, a tube having a screen at the end wall thereof, a gun having a first preaccelerating anode and a second accelerating anode and 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 and comprising a first set of deflecting plates and a second

set of deflecting plates disposed between said first set and said second anode, and a shield in the form of an electrically-conductive disc associated with the gun structure and disposed with its edge in close proximity to the wall of said tube, said shield being electrically connected to said second anode.

11. 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 and comprising a first set of deflecting plates and a second set of deflecting plates disposed between said first set and the tip of said gun, an electrode extending along said tube and beyond the outer-

most edges of said first set of plates in the direction toward said screen, and a second electrode disposed between said screen and said first-named electrode, said second electrode operating at a potential positive with respect to the potential of operation of said first-named electrode, said tube being characterized by the fact that the ratio of the mean diameter, expressed in inches, of said first-named electrode to the distance, expressed in inches, from said edges of said first set of plates to that edge of said first-named electrode nearer said screen is in the range substantially from two to four.

PETER S. CHRISTALDI. 15