Aug. 30, 1960 W. E. BRADLEY 2,951,178

MULTI-BEAM CATHODE-RAY TUBE TRANSDUCER

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Fig. 1.

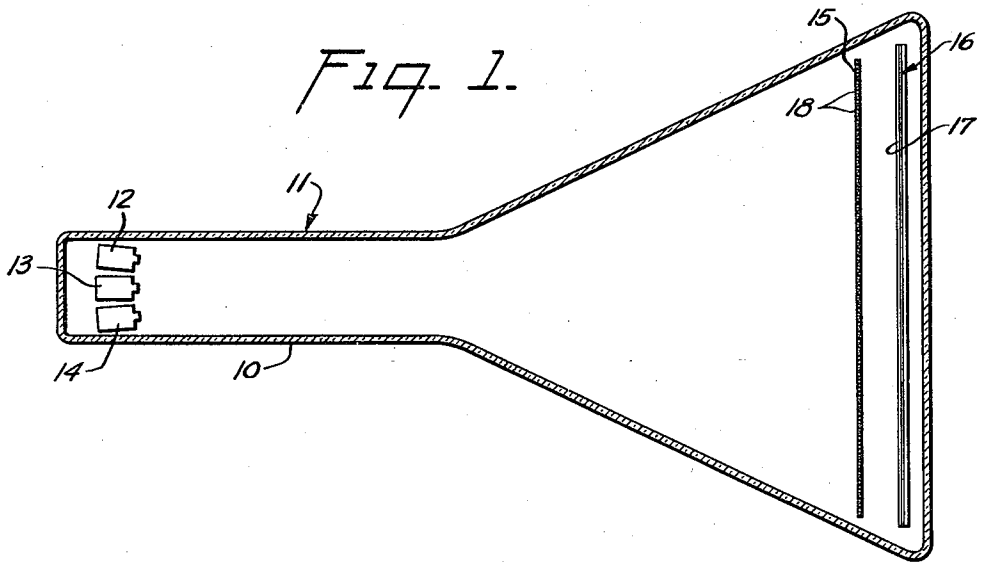


Fig. 2.

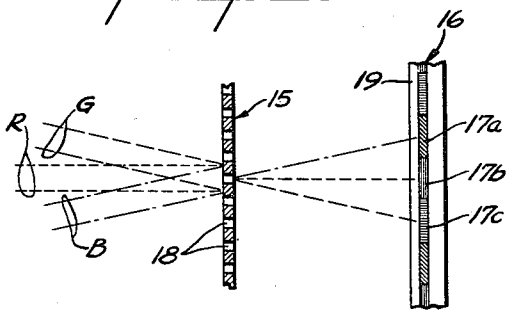


Fig. 3.

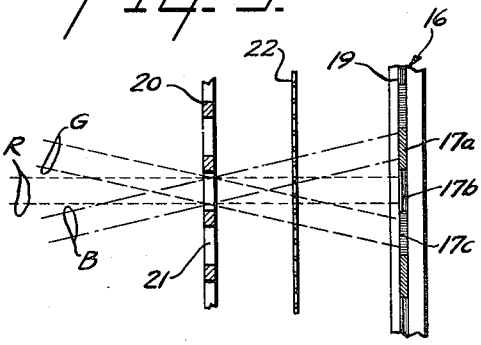
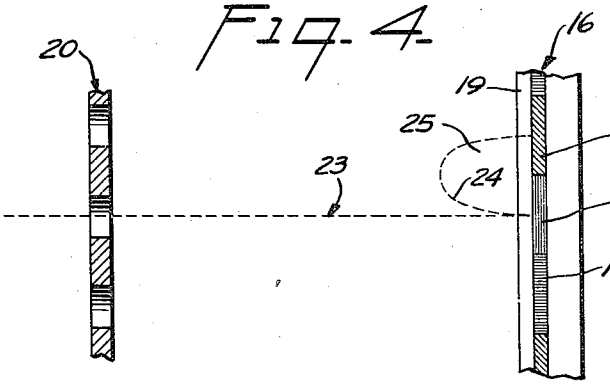


Fig. 4.



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Fig. 5.

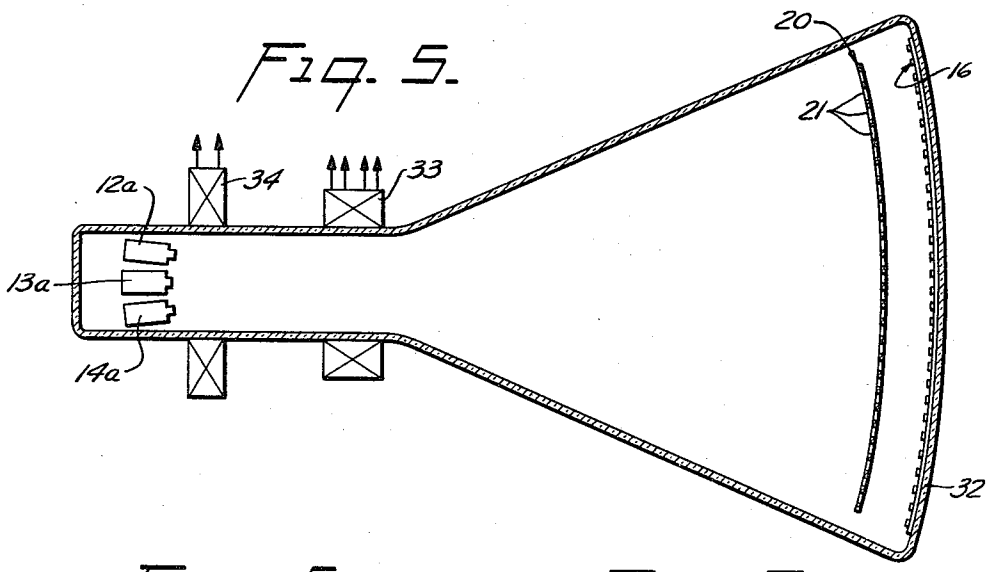


Fig. 6.

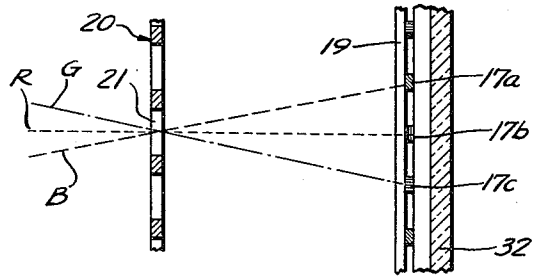


Fig. 7.

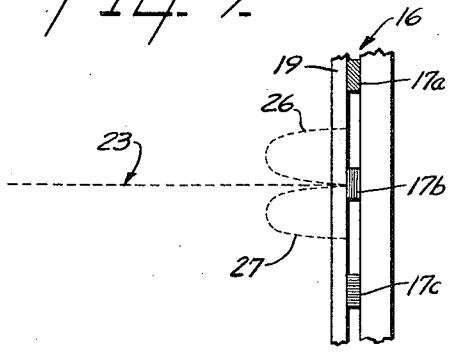
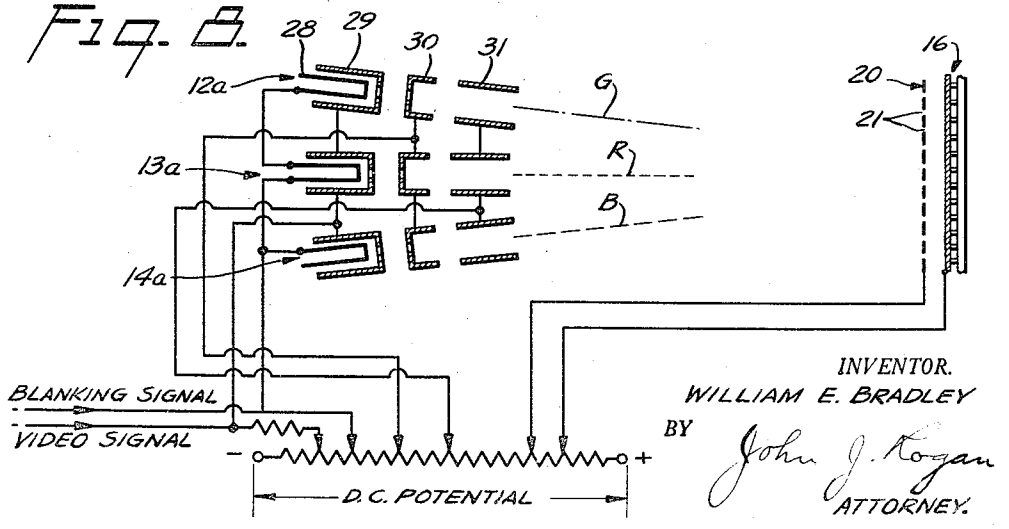


Fig. 8.



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MULTI-BEAM CATHODE-RAY TUBE TRANSDUCER

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17 Claims. (Cl. 315—13)

This invention relates to cathode-ray tubes and more especially it relates to cathode-ray tubes for colored fluorescent displays.

A principal object of the invention is to provide a cathode-ray tube which is capable of producing colored fluorescent displays of high contrast while preserving accuracy of colored hue in the individual elemental areas.

Another object is to provide an improved cathode-ray tube of the multiple color fluorescent display kind employing a perforated or foraminous color display beam focusing element whereby the cathode-ray beam which controls the excitation of the various fluorescent colorations can be used with greatre efficiency in translating its energy content into respective color displays.

Another object is to improve the construction and design of a tri-color television image tube whereby simpler external electron optical means such as beam focusing, beam convergence, and beam deflection elements, and the like, can be used.

Another object is to provide a tri-color fluorescent cathode-ray tube embodying a plurality of separate electron guns, in conjunction with a novel design of fluorescent screen, wherein the useful area of the screen actually coated with phosphor dots or phosphor strips is only a small fraction of the total uncoated useful area of the screen, for example as low as 1/30, while enabling colored displays to be produced with greater contrast and brilliancy as compared with conventional tri-color cathode-ray tubes.

A further object is to improve the operation and transducing performance of a plural beam cathode-ray tube of the kind employing a so-called beam focusing mask, whether of the perforated kind or of the slitted kind.

A feature of the invention relates to a tri-color television image tube employing a set of three electron guns and a tri-color phosphor dot or tri-color strip phosphor screen, together with an apertured or foraminous beam focussing and shadow mask adjacent the screen, wherein the widths of the openings in the mask are much wider than usual so that the major part of each beam is effective in exciting the respective elemental fluorescent color areas.

Another feature relates to a tri-color television image tube of the kind employing a plurality of separate electron beams each of which is modulated to excite only a corresponding fluorescing color dot or strip in each set of tri-color dots or strips of a fluorescent screen, and wherein the beams are converged by the same electron optical convergence system and are deflected by the same deflection system, the dots or strips being provided with an apertured focusing mask operated at a different electrical potential from the screen whereby the individual dots each has a size substantially the same as the image of the exit pupil of the respective gun. Likewise in the case of phosphor strips the width of each strip may have a size substantially the same as the width of the image of the exit pupil of the respective gun. With this arrangement it is possible to

make the phosphor dots or strips much smaller than the corresponding mask openings and to provide a much greater uncoated area on the screen between adjacent dots or strips without deteriorating the desired image contrast and brilliance for a given beam intensity.

A further feature relates to a novel cathode-ray tube whether of the plural color dot or plural color strip, or even monochrome type, wherein so-called undesired cross-area modulation effects at the screen can be greatly reduced.

A still further feature relates to the novel organization, arrangement and relative location and proportioning of parts for providing an improved tri-color television picture tube system.

Other features and advantages, not specifically enumerated, will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing,

Fig. 1 is a schematic view of one known kind of tri-color fluorescent display tube;

Fig. 2 is a magnified section of part of Fig. 1 to explain its operation;

Fig. 3 is a magnified section similar to Fig. 2 of another known kind of tri-color tube;

Fig. 4 is a further magnified view of Fig. 3 to explain its operation;

Fig. 5 is a schematic view of a tri-color tube embodying the invention;

Fig. 6 is a magnified view of part of Fig. 5;

Fig. 7 is a further magnified end view of a section of the screen and focusing mask of Fig. 5 explanatory of the invention;

Fig. 8 is a schematic wiring diagram of a television receiving system embodying the tube of Fig. 5.

Referring to Fig. 1, there is shown one known form of tri-color television picture tube comprising the usual evacuated bulb **10**, which has mounted in its neck portion **11** a set of three electron guns **12, 13, 14**. These guns may be mounted so that their central longitudinal axes define a triangular pyramid of the equilateral type, and they are inclined to each other so that the three focused beams emerging therefrom follow respective trajectories along the three sides of the triangular pyramid. The three beams are focused by a common focusing yoke and are deflected in the desired scanning pattern by means of the usual horizontal and vertical deflection yokes. With such a tube the beams are so emitted from the guns that they converge to a point on the apertured masking plate **15**. This plate is of thin sheet metal containing a large number of holes, one for each of the tri-color dot groups on the fluorescent screen **16**. The fluorescent dots **17** of the screen are laid down in a recurrent triangular array, each group consisting of red, green and blue emitting phosphors with the centers of the dots lying at the corners of an equilateral triangle. Likewise the center of each three dot group lies at the corner of another equilateral triangle of larger size. The shadowing mask **15** has an individual hole for each one of such trios, these holes in the mask being located at the corners of an equilateral triangle. For a detailed description of that type of tube, reference may be had to "RCA Review," volume XII, September 1951, No. 3, page II, pages 466 to 486.

However, in order to prevent the relatively closely adjacent phosphor dots from being improperly overlapped by the wrong beam at any given scanning instant, it has been found necessary in that known type of tube to make the mask openings **18** of much smaller cross sectional size than the cross section of each of the beams. This relation is shown schematically in Fig. 2. Furthermore, it is necessary in this prior known type of tube

to locate the dots closely together. In fact, they are usually tangential so that the reproducing or transducing area of the screen is covered mainly by the fluorescent dot material and only a very small portion, probably ⅕, is uncoated. In Fig. 2 the beam which is arranged to excite the red dots is represented by the dotted outline; the beam for exciting the blue dots is represented by the dashed outline; and the beam for exciting the green dots is represented by the dot-dash outline.

As is clear from Fig. 2, the screen **16** is relatively close to the mask **15**, as compared with the spacing between the guns and the mask, and it is not possible with the known arrangement to have the mask openings **18** approximate the cross sectional area of each beam. In fact, each gun is effective only to about 10% of its cathode emission area in its effect on the excitation of the fluorescent dots. Since it has been found necessary in the prior type of shadow mask tube to have the openings in the shadow mask with a diameter which is only a small fraction of the cross section of the beam, and since the electrons in the beam are traveling at relatively high velocity, a substantial part of the beam energy is undesirably intercepted by the shadow mask **15**. In other words, the transducing efficiency of each beam in producing color brightness in its respective color spot is not very high. If an attempt is made to produce focusing action by operating the mask more negatively than its free space potential to overcome the constricting effect of the shadow mask apertures, other undesirable effects are introduced. One of these is that the return electrons emitted from the phosphor dot or its usual aluminized coating **19** cause a substantial decrease in the contrast ratio of the illuminated screen. Because of the electrical, optical, and constructional parameters of the known arrangement it is not possible, therefore, to obtain the utmost degree of contrast consistent with high transducing efficiency between electron beam energy and color brightness.

In an attempt to overcome the above noted limitations on the tri-color dot tube, it has been proposed to replace the constricted apertured shadow mask **15** with a perforated or foraminous electrode **20** (Fig. 3), which is electrically energized with respect to the electron beam so that each opening **21** acts as an electron focusing lens to concentrate each beam on its respective phosphor dot. While this prior arrangement permits making the openings **21** of larger size as compared with the constricted openings in the conventional shadow mask, it introduces other difficulties. For example, because of the high velocity of the focused electrons in their traveling between the focusing electrode **20** and the aluminized screen **16**, they release a very large number of highly energetic secondary electrons as they strike the screen. A suggested solution for that difficulty has been to use an auxiliary mesh electrode **22** between the electrode **20** and the screen **16** and to bias this auxiliary mesh electrode so that it acts as a collector for the secondary electrons. The theory has been that the aluminized coating **19** will be transparent to the forward moving high speed primary electrons in the scanning beams but will be substantially opaque to any slow moving electrons that may not be collected by the collector electrode **22**. In fact, however, even with this known type of focusing mesh tube there is a decided loss in picture color contrast. I have found the reason for this reduction in contrast, and the present invention provides means for meeting that difficulty.

While the greater part of the slow moving secondary electrons originating at the screen **16** may in greatest part be collected by the electrode **22**, I have found that there is also present a substantial number of high speed electrons mainly in the form of primary electrons which by reason of the deflecting electric fields of the atomic nuclei of the atoms comprising the phosphor and of the atoms of the aluminum film are never terminated at the proper phosphor dot. For example, as schematically illustrated in Fig. 4, the primary forward moving beam **23**, which is assumed to be scanning the phosphor dot **17*b***, is not entirely terminated at the screen. On the contrary, because of the high positive potential of the nucleus of each atom in the aluminized screen **16**, these forwardly moving electrons are accelerated and never actually collide with the positive nucleus, but on the contrary are subjected to an orbital path around the nucleus, and even reverse their trajectory, as indicated by the arrow **24**. Because of the direction of the field between the electrode **20** and the screen, these reversely moving primary electrons are again reversed in trajectory and follow a substantial parabolic path, as indicated by the trajectory **25**. The result is that these high speed reversely moving primary electrons, instead of arriving back at the desired phosphor dot **17*b***, impinge upon adjacent phosphor dots causing them to be undesirably excited.

It will be understood, of course, that while Fig. 4 shows a single parabolic trajectory these reversely moving primary high speed electrons follow substantially parabolic return paths of different parabolic curves so that they in effect spray the screen over an undesirably large area distinct from the particular phosphor dot which at the instant is intended to be scanned by the beam **23**. After considerable study and research, I have determined that this loss in contrast is due mainly to these reverse parabolically moving high speed primary electrons, and I have found ways and means to overcome such prior loss of contrast. The present invention, therefore, is based upon the conception that the cause of the loss of contrast is due in great measure not to the relatively slow moving reverse secondary electrons, but is due to the fast parabolically moving primary electrons derived from the scanning beam itself, which electrons have not had a chance to terminate their trajectories on the desired phosphor dot, and which have sufficient forward velocity to which the aluminized coating **19** is substantially transparent.

I have found that it is possible to make the openings in the electrode **20** of much greater size than is feasible with prior shadow mask tubes while retaining the focusing action of the electrode **20**, and while maintaining the desired degree of contrast, and without using any special collector electrode such as electrode **22** (Fig. 3). In fact, I have found it possible to make the holes **21** (Fig. 6) in the electrode **20** of such a size that at least 50% to 75% of the primary beams pass toward the screen without obstruction and without any substantial reduction in contrast in the reproduced color image, whereas in the prior shadow mask tube of Fig. 2 only as little as 10% of the primary beams passes unobstructed to the tri-color dot screen.

Furthermore, I have found that it is now possible to space the phosphor dots in each tri-color dot set such a distance apart from one another that the adjacent dots **17*a***, **17*b***, **17*c*** (Fig. 6) are outside the return paths of the reverse parabolically moving primary electrons. For example, as illustrated schematically in the highly magnified view of Fig. 7, certain typical parabolic paths are illustrated from which it appears that the beam **23**, which is intended to excite the phosphor dot **17*b***, produces a substantial number of parabolically moving primary electrons whose parabolic paths **26**, **27** terminate not on the adjacent dots **17*a***, **17*c***, but on the metallized coating **19** in areas which are free from phosphor dots.

A tube embodying the invention is diagrammatically and structurally illustrated in Fig. 5 and appropriate circuit connections for a picture reproducing system embodying such a tube are shown schematically in Fig. 8. The tube may comprise three guns **12*a***, **13*a***, **14*a***, each of which is designed so as to have as small a diameter as possible, for example between ⅛ inch and ¼ inch, and with the guns grouped together as closely as pos-

sible inside the neck 10*a* of the cathode-ray tube. The guns, of course, are arranged at the desired triangular convergence consonant with the distance between the focusing mask 20 and the tri-phosphor dot screen 16. Each gun may comprise, for example, an electron emitting cathode 28 with an intensity control grid 29, a first anode 30, and a second anode 31. The focusing mask 20 can be mounted approximately ½ inch from the screen 16 which preferably is deposited directly on the viewing face-plate 32 of the tube. This face-plate 32 is preferably in the shape of a spherical sector of the same curvature and suitably mounted to make it mechanically stable. The positive anode potential (Fig. 8) applied to the screen 16 through the intermediary of the aluminized coating 19 should be approximately five times the positive direct current potential applied to the focusing mask 20. The focusing mask may be operated for example at 4 kilovolts, while the screen 16 can be at approximately 20 kilovolts. These dimensions and voltages, of course, are given merely by way of example.

Since each of the three guns 12*a*, 13*a*, 14*a* projects its beam of electrons upon the screen 16 at a slightly different angle as compared with the remaining two guns, the point of impact of each beam is different with respect to the other two beams, considering any given instantaneous positional setting of the three beams. Since the three beams at any given setting pass through the same opening 21 in the focusing mask 20, each of those openings serves as an electrostatic lens to form an electron image of the exit pupil of the respective gun from which each beam is emitted, this image being focused upon the plane of the phosphor dot screen 16. The potentials on the various electrodes with relation to the distance between the face-plate 32 and the mask 20 are such that said distance is equal to the focal length of the lenses defined by the mask openings 21.

The dots 17 can be circular and for example are 5 mils in diameter; and the holes 21 in the mask 20 can be spaced 50 mils apart between centers. The center-to-center spacing of the phosphor dots of each tri-color dot set could be 6 mils. Since there are three phosphor dots for each hole 21, the area ratio of phosphor coated surface of the face-plate to non-coated surface of the face-plate is approximately 1 to 30. In any event the ratio of dot diameter with respect to center-to-center spacing of the mask holes 21 can be of the order of 1 to 10 or even higher, while maintaining the desired contrast and color intensity for a given intensity of electron beam.

Apart from the advantages of increasing the picture contrast and color intensity obtainable with the reduced diameter and spaced phosphor dots and the enlarged aperture focusing mask above described, is the ancillary advantage that by making the dots even smaller they can be brought closer together with a given amount of contrast, so long as the dot area is only a small percentage of the uncoated area between adjacent dots. This renders it possible to mount the guns 12*a*, 13*a*, 14*a* much closer together, and in turn reduces the volume occupied by the three electron beams. This reduction in the beam volume reduces the probability of misregistry of the scanning coil 33 with respect to the common center of deflection of the three beams and also results in less probability of defocusing of the beams by the focusing yoke 34. The net result is a decided relaxation in the tolerances and power required in the sweep circuits which supply the scanning yoke 33.

More important yet, the small volume occupied by the triple beam improves the registry of the three color pictures produced by the scanning of the three electron beams on the screen 16 especially in the corners of the face-plate 32. In fact, if the reduction in gun diameter is carried far enough so that the group of three guns is within a ¼ inch diameter cylinder, and if the phosphor dots are made correspondingly small enough, it is possible that all dynamic convergence provisions peculiar to tri-color dot tubes can be removed and scanning can be no more difficult or expensive than that used with conventional black and white television receivers. For example, if the guns 12*a*, 13*a*, 14*a*, each has a diameter of the order of ⅛ inch, and if the distance from the center of deflection of the beams to the screen 16 is 15 inches, and the focusing mask 20 is ½ inch from the screen 16, then the images of the exit pupil of each gun on the screen 16 would be 3 mils in diameter. Consequently, the phosphor dots could be approximately 3 mils in diameter and their center-to-center spacing, in equilateral triangular relationship could be approximately 3 mils. With a 40 mil pitch or center-to-center spacing of the holes 21 in the focusing mask, the contrast ratio of such a tube would be excellent and the combined triple section beam would be no larger in cross section at the common deflection center than the single scanning beam used in conventional black and white picture tubes, and no special dynamic convergence circuits or structures would be required for commercial color quality registry.

While the invention has been described in connection with a tube in which the triple beam originates from three separate guns, it will be understood, of course, that the three beams may be generated by a single gun, and by means of suitable beam bending devices the three beams can be given the required relative inclinations towards each other. If desired, a single beam can be generated and this single beam during an initial part of its trajectory immediately adjacent the single electron gun can be successively bent to each one of three different angular trajectories at very high speed compared with the speed of scanning over the screen 16.

While the drawing illustrates the invention applied to a so-called tri-color dot tube, it is obvious that it is equally well applicable to tubes employing two or more color dots per set. The invention is also equally well applicable to tubes wherein the phosphor screen, instead of producing its color displays by means of phosphor dots, produces those displays by means of tri-color phosphor strips. In that case the shadowing focus mask, instead of being formed with sets of perforations, will be in the form of spaced longitudinal slits extending parallel to the length of the phosphor strips. Thus, the elements 17*a*, 17*b*, 17*c* in Fig. 6 may be considered as respective narrow phosphor strips extending perpendicular to the plane of the sheet of drawing, and the windows 21 may be considered as the longitudinal slits in the focusing shadow mask 20. The function of these slots as focusing elements and shadowing elements is substantially the same as that already described in connection with Fig. 6 and further description thereof is not believed necessary at this point.

From the foregoing it will be understood that the invention is not necessarily limited to the use of two or more colored dots or strips. For example, the screen 16 may consist of dots or strips of single color fluorescent material such as conventionally used in monochrome cathode-ray tubes. These monochrome dots or strips are coated with the aluminized coating 19 and since they are spaced apart as above described, the likelihood of cross-area modulation between one dot and the adjacent dots, which tends to result from highly energized reversely moving primary electrons, is possible of reduction.

The invention is not limited to any particular shape for the perforations or windows 20. These perforations may be circular, hexagontal, or other shape consistent with their desired focusing action of the respective beams on the respective tri-color dots.

Various changes and modifications may be made in the disclosed embodiments without departing from the spirit and scope of the invention.

What is claimed is:

1. Cathode - ray transducing apparatus comprising, means to develop a beam of electrons, a phosphor screen

upon which said beam impinges for point-by-point scanning to translate the beam energy into corresponding fluorescent response, said screen having a multiplicity of discrete phosphor-coated areas arranged in mutually spaced relation, said areas collectively having an area which constitutes less than about one-tenth of the uncoated area of the screen, and a single electron masking means interposed between said beam-developing means and said screen, said masking means having a plurality of portions which are relatively opaque to electrons, said portions being spaced from one another by portions which are relatively transparent to electrons, said masking means being constructed to transmit more than about half of said electrons and, in response to energization thereof, to focus said transmitted electrons on predetermined ones of said plurality of phosphor coated areas.

2. Cathode - ray transducing apparatus comprising, means to develop a beam of electrons, a phosphor screen upon which the beam impinges for point-by-point scanning to translate the beam energy into corresponding fluorescent displays, said screen having a multiplicity of discrete phosphor-coated areas widely spaced from one another which collectively constitute less than about one-tenth of the uncoated area of said screen, and multi-apertured beam focusing electrode means to which a negative potential is applied located adjacent the screen to focus the beam upon selected spots during the scanning movement thereof.

3. Cathode-ray transducing apparatus according to claim 2 in which each of the said areas is in the form of a dot and each of the apertures in said focusing electrode is many times larger than the size of each dot.

4. Cathode-ray transducing apparatus according to claim 2 in which each of the apertures in said focusing electrode is of a size commensurate with the cross-section of each beam, as it approaches said focusing electrode, whereby the major portion of each beam can pass through an aperture without obstruction.

5. Cathode - ray transducing apparatus comprising, means including an electron gun to develop a beam of electrons, said gun having a beam exit pupil of predetermined size, a screen upon which the beam impinges for point-by-point scanning to translate the beam energy into corresponding fluorescent displays, said screen having a multiplicity of discrete phosphor areas of substantially uniform dimensions which are widely spaced from one another, said phosphor areas collectively constituting an area which is less than about one-tenth of the uncoated area of said screen, and a multi-apertured beam focusing mask to which a negative potential is applied adjacent the screen for imaging the said exit pupil upon selected phosphor areas during the scanning movement of the beam.

6. Cathode-ray apparatus according to claim 5 in which said negative potential applied to said mask causes the focal length of the lens defined by each mask aperture to be substantially equal to the distance between the mask and screen.

7. A fluorescent display screen for cathode-ray tubes having a negative electrode next-adjacent thereto comprising, a support having a multiplicity of discrete and mutually spaced phosphor dots of substantially uniform size with the phosphor coated area of the screen being less than about one-tenth of the uncoated area.

8. A fluorescent display screen for cathode-ray tubes having an electrode next-adjacent said screen which is negative with respect to the latter and the like comprising, a support coated with a multiplicity of recurrent sets of phosphor areas, having substantially uniform dimensions, adjacent ones of said areas being mutually spaced from one another, said areas being of a size to constitute the total coated area of the screen less than about one-tenth of the uncoated area to reduce the statistical probability of back-moving electrons from one phosphor area that are repelled by said negative electrode from terminating upon adjacent phosphor areas.

9. A fluorescent display screen according to claim 8 in which the said areas are in the form of dots and with the dots of each set arranged in equilateral triangular spaced array and with each dot of each set having a fluorescent color response which differs from that of the other adjacent dots of each set.

10. A cathode-ray tube for color television and the like comprising, means to develop a plurality of discrete but closely adjacent electron beams which have mutually converging trajectories, multi-apertured beam focusing means to which a negative potential is applied having a plurality of apertures through which the beams pass, a phosphor screen having a multiplicity of phosphor dot sets each set being in electron-optical registry with a corresponding aperture in said focusing means, the dots of each set being substantially uniform in size and spaced from one another, said dots of each set also being spaced from the dots of adjacent sets by a distance which is at least several times the diameter of any one of said dots, the total phosphor coated area being less than about one-tenth of the uncoated area.

11. A cathode-ray tube for color television and the like comprising, a fluorescent display screen having a multiplicity of tri-color phosphor dot sets with the dots of each set being substantially uniform in size and being arranged in equilateral triangular array and with all the dots spaced from one another so that the total dot area is at most about one-tenth of the remaining area of said screen, electron gun means to develop an electron scanning bundle, an apertured electron focusing mask to which a negative potential is applied located between said gun and screen, said mask having each aperture in electron optical registry with the center of each dot set whereby each dot of a set can be selectively impinged upon by said electron bundle passing through the corresponding aperture in accordance with a selected direction of the bundle trajectory through said aperture, each aperture having a size which permits more than about one-half of the electron bundle to pass therethrough.

12. A cathode-ray tube for color television and the like, comprising, a fluorescent display screen to which a positive potential is applied and having a multiplicity of sets of tri-color phosphor dots of substantially uniform size, electron gun means to develop three discrete electron beams having mutually converging trajectories, multi-apertured beam focusing means adjacent the screen to which a potential is applied which is negative with respect to said screen, each aperture of said focusing means being large enough to permit the three beams to pass therethrough in intersecting relation without substantial beam obstruction while focusing the beams upon respective dots of each tri-color dot set, said guns being closely spaced and all of said sets of dots being widely spaced from one another by substantial areas devoid of phosphor, and each dot of said sets having a size on the order of the cross-section of one of said beams as it impinges on the screen thereby to enable a single beam deflection system to be used to effect the same deflection on each of the three beams for a given deflection voltage.

13. A cathode-ray tube for color television and the like, comprising in combination, electron gun means to develop a scanning bundle, a fluorescent display screen, a metallized coating on said screen facing said gun means said coating being substantially opaque to relatively slow moving electrons while being substantially transparent to high speed electrons, and means to maintain a high degree of contrast in the reproduced display on said screen, the last mentioned means including a foraminous electrode adjacent the screen arranged to be negatively biased with respect to the screen, and a multiplicity of spaced phosphor dots of substantially uniform size on said screen with the spacing between dots such as to constitute the phosphor area of the screen at most about one-tenth of the area thereof on which there are no phosphor dots.

14. A cathode-ray tube for color television and the like, comprising in combination, electron gun means to develop a scanning bundle, a fluorescent display screen, a metallized coating on said screen facing said gun means, said coating being substantially opaque to relatively low energy electrons while being substantially transparent to high energy electrons, and means to maintain a high degree of contrast in the reproduced display on said screen, the last mentioned means including electrode means having a plurality of longitudinal slits adjacent the screen and arranged to be negatively biased with respect to the screen, and a multiplicity of spaced phosphor strips on said screen arranged substantially parallel to said slits with the spacing between strips such as to constitute the phosphor area of the screen less than about one-tenth of the remaining area thereof.

15. A fluorescent display screen for a cathode ray tube having a negative electrode next-adjacent said screen, comprising a substrate on which a multiplicity of sets of substantially uniform phosphor areas are disposed, the center-to-center distance between adjacent ones of said sets being at least several times that of the width of one of said phosphor areas, said phosphor areas collectively constituting less than about one-tenth of the area of said screen on which phosphor areas are not disposed.

16. Cathode ray transducing apparatus comprising: means to develop a beam of electrons, a fluorescent phosphor screen upon which said beam impinges, said screen having a multiplicity of discrete and substantially uniform phosphor-coated areas arranged in mutually spaced relation, said areas collectively having an area which constitutes less than about one-tenth of the uncoated area of the screen, and means near said screen for producing a field which tends to repel electrons moving from the vicinity of said screen toward said beam-developing means.

17. Cathode-ray transducing apparatus comprising, means to develop a beam of electrons, a phosphor screen upon which the beam impinges for point-by-point scanning to translate the beam energy into corresponding fluorescent displays, said screen having a multiplicity of sets of discrete phosphor-coated areas, said sets being equally spaced from one another by substantial areas devoid of phosphor, the total area of said sets collectively constituting less than about one-tenth of the uncoated area of said screen, and a multi-apertured beam focussing electrode means to which a negative potential is applied located adjacent the screen to focus the beam upon selected spots during the scanning movement thereof, said electrode having one aperture for each of said sets, the distance between the center of one discrete phosphor area in each set and the center of any other discrete phosphor area in that set being only a small fraction of the distance between the centers of any two adjacent apertures in said electrode.

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