Dec. 22, 1953 H. B. LAW 2,663,821

MASKED TARGET KINESCOPE

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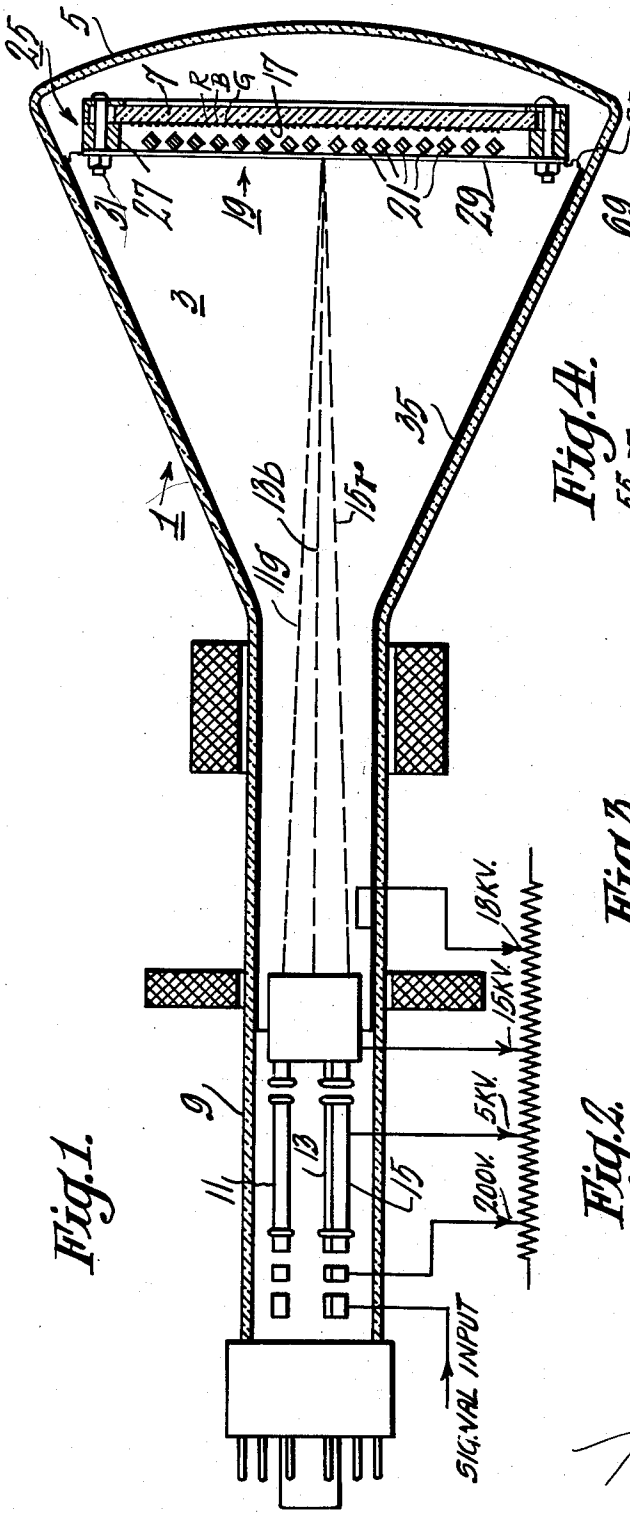

Fig. 1.

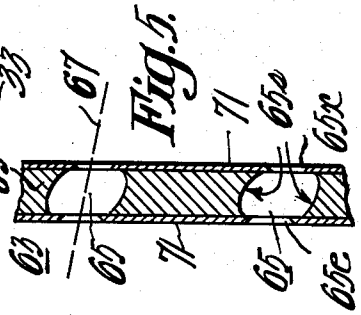

Fig. 5.

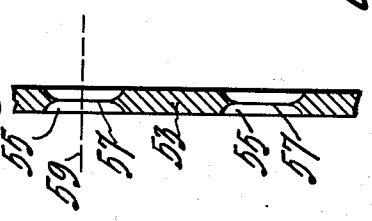

Fig. 4.

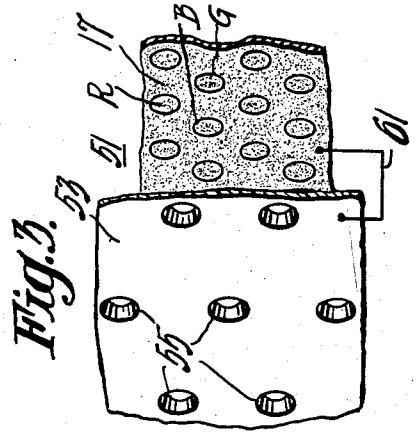

Fig. 3.

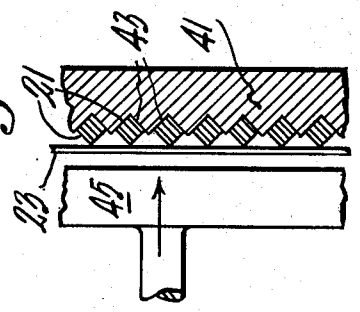

Fig. 2.

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MASKED TARGET KINESCOPE

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10 Claims. (Cl. 315—1)

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This invention relates to improvements in cathode-ray tubes and has for its principal object to provide an improved color-television tube of the "masked-target" type and one characterized, in operation, by its substantial freedom from "color-dilution."

There are two varieties of "masked-target" kinescopes; (1) the "line-screen" variety, exemplified by German Patent 736,575, and its French equivalent 866,065 and (2) the "dot-screen" variety claimed by Alfred N. Goldsmith in copending application, Serial No. 548,239, filed August 5, 1944, which was refiled on July 19, 1947 as Serial No. 762,175, now U. S. Patent No. 2,630,542.

The color-screen or "target" of a masked-target kinescope comprises an orderly array of narrow phosphor-lines, or small phosphor-dots, arranged in groups of three colors, usually red, blue and green. The target-assembly includes an apertured "shadow mask" through which electrons travel in the form of a beam in their transit to the tri-color screen. The particular line-like or dot-like color-phosphor illuminated at any given instant is determined by the angle at which the scanning beam (or beams) pass through the apertured shadow mask and approaches the screen. Should the beam, or electrons derived therefrom, strike a color-phosphor other than one toward which the beam was originally directed, the purity of the color of the emitted light is adversely affected. This phenomenon is known as "color-dilution" and may appear to the observer either as a weakening or "dilution" of the hue of the selected color, or as a hue of the same or of another intensity but of a different color (e. g. "red" for "blue").

The present invention is applicable to masked-target kinescopes of both the "line-screen" and "dot-screen" varieties and it is predicated upon an appreciation of the fact that color-dilution may be attributed to the presence of stray electrons within the area circumscribed by the mask and screen assembly. The stray electrons may be either "primary" or "secondary" electrons. Ordinarily, the primary-electrons and some of the secondary-electrons are normally endowed with a velocity component substantially parallel to the axis of the beam and were it not for the presence of undesired electric or electromagnetic deflecting forces adjacent to the screen area would impinge upon the same phosphor "dot" or "line" as the beam itself.

Accordingly, the present invention contemplates, and its construction provides, a target assembly wherein the mask and screen are electrically connected and operate at the same potential to provide a "field-free" space between the apertured mask and the phosphor screen.

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The present invention recognizes that color-dilution may also result from the presence, in the region of the screen, of secondary-electrons of random trajectories. Such secondary-electrons are released by impact of the high-velocity primary-beam or beams upon various parts of the target assembly. Since electrons of random trajectories maintain their random direction of travel in a field-free space (and thus eventually impinge upon whichever color-phosphor is in their path), the present invention provides a target-assembly of a construction calculated to minimize the production of secondary-electrons.

More specifically, it has been observed that, in the masked-target tubes of the prior art, the principal sources of disturbing secondary-electrons are (*a*) the boundary walls of the mask's apertures and (*b*) the inner surface of the metal frame within which the screen and its mask are mounted. The production of secondary-electrons resulting from cause (*a*) is minimized, in accordance with the present invention, by the provision of an electrically conductive mask wherein the apertures, through which the primary-beam passes, are of a special "tapered" construction, and the production of secondary-electrons resulting from cause (*b*) is minimized, in accordance with the invention, by the provision of an "oversized" supporting frame wherein the inner surface of the frame is out of the path of the scanning beam.

The invention is described in greater detail in connection with the accompanying one sheet of drawings wherein:

Fig. 1 is a longitudinal sectional view of a tri-color masked-target kinescope of the "line-screen" variety, embodying the invention;

Fig. 2 is an end view of a jig or die used in the fabrication of the wire-like tapered-aperture masking element of the screen-assembly of the kinescope shown in Fig. 1;

Fig. 3 is an enlarged fragmentary view of a dot-like mask and screen assembly, constructed in accordance with the principle of the present invention for use in masked-target kinescopes of the "dot-screen" variety.

The color kinescope shown in Fig. 1 comprises an evacuated envelope 1 having a main chamber in the form of a frustum 3 which terminates in a window 5 through which a transparent viewing screen 7 is visible. The other or small end of the frustum terminates in a neck portion 9, which, in

the instant case, contains a battery of three electron-guns, 11, 13 and 15 arranged 120° apart (delta fashion) about and parallel to the long axis of the tube, as described and claimed by Alfred C. Schroeder in U. S. Patent 2,595,548, (See also Hanhah C. Moodey's copending application Serial No. 166,416, filed February 10, 1950; and since re-filled on June 24, 1952, as Serial No. 295,255).

The screen 7, here illustrated, is of the line-screen variety shown in German Patent 736,575, previously referred to. It is provided on its rear or target surface with a multiplicity (say 1500, or more) of parallelly disposed phosphor lines R (red), B (blue), G (green) of different color-emissive characteristics, arranged in groups of three. An electron-transparent, light reflecting, film 17, applied over the phosphor lines, covers the entire target surface of the screen 7. The several functions of this conductive film 17 are described later on in this specification.

There is a shadow mask 19 mounted in the path of the electron beams 11*g*, 13*b*, 15*r* and (from the guns 11, 13 and 15), in spaced relation with respect to the target surface of the screen 7. This mask 19 is made up of a multiplicity of spaced apart wires 21, which extend in a direction parallel to the direction of extension of the phosphor lines R, B and G, and a number of very fine cross-wires 23 (see Fig. 2) which maintain the longitudinal wires 21 in their predetermined spaced relationship. (In the instant case the wires 21 of the mask 19 and the phosphor lines, R, B and G on the screen 7 extend in a direction perpendicular to the plane of the drawing. In Fig. 1 the cross wires 21 are concealed by the clamping strips 29 which hold the mask 19 to the base 27 of the supporting frame 25.)

It will be observed upon a close inspection of Fig. 1, that, the mask wires 19 are square (instead of circular) in cross-section and are so mounted, in accordance with the invention, that the long edge of one wire is presented across an intervening space to the long edge of the next adjacent wire. Thus the "entrance" and "exit" of each of the mask apertures may be said to taper outwardly in opposite direction from a central opening whose boundaries are defined by the sharp-edges of the juxtaposed wires. This novel form of mask construction has two advantages:

(1) Irrespective of the instantaneous scanning position of the electron beam (say the "red" beam 15*r*), or beams (11*g*, 13*b*) the surfaces of the wires 19 have substantially the same shadowing effect upon the beam. That is to say, the diameter of the beam as it approaches the outer edge of the screen 7, is substantially no smaller than can be expected from the "cosine relation."

(2) The secondary-electrons which are released by impact of the scanning-beam upon the inclined plane faces of the square wires are, for the most part, directed away from the aperture, instead of toward it, as though the said faces comprised a "mirror."

Reference has heretofore been made to the electron-transparent, light-reflecting film 17 that covers the entire target surface of the screen 7. This film is preferably constituted of aluminum (applied, by a thermal-evaporation process, in vacuo) and, in addition to its light-reflecting function, has two other functions: (1) it prevents the accumulation of static charge upon the face of the screen and (2) when, as dictated by the present invention, it is connected to the electrically conductive mask 19, it renders the space between the screen 7 and the mask 19 free from any electric field capable of deflecting the electron beam or beams from their normally straight paths.

Referring still to Fig. 1, the connection between the conductive coating 17, on the screen 7 and the metal mask 19 (which is required to establish a field-free space between said elements of the screen-assembly) is established through a metal frame 25 upon which said parts 7 and 19 are supported. The frame 25 here shown comprises a rectangular base 27 to which the terminals of the mask's wires 19 and 21 are affixed, as by welds or solder (not shown), and four clamping strips 29 which urge the conductive film 17 on the screen 7 into contact with the metal base 27 of the frame 25 under the force exerted thereon by screws 31. The length and breadth dimensions of the inner boundaries of the metal frame 25 must be substantially greater than the corresponding dimensions of the areas of the mask 19 and screen 7 which lie in the path of the scanning beams 11*g*, 13*b* and 15*r*, in order to prevent the beams from striking any part of the frame 25 and releasing disturbing secondary-electrons therefrom.

A lead 33 connects the frame 25, and hence the screen 7 and mask 19 to the "second-anode," which is here shown in the form of a conductive coating 35 on the inner surface of the main chamber 3 and neck 9 of the envelope 1. The screen assembly itself may be supported in the desired position within the chamber 3 as by means of studs or other suitable means, not shown. The operating potential of the second-anode 35 and of the metalized screen 7 and its mask 19 may be of the order of from, say, fifteen to twenty kilovolts. Appropriate operating voltages for the other electrode elements in the tube are marked on the drawing.

Fig. 2 illustrates a preferred method of manufacturing the tapered-aperture line-like masking electrode 19 of Fig. 1. In this drawing, 41 designates a jig or block of metal having a multiplicity of contiguous V-shaped 90° grooves 43, arranged in parallel relation on a surface thereof, for receiving the square wires 21. The diameter of the grooves 43 is somewhat larger than that of the wires 21, hence the said wires do not touch each other while in the jig, but are separated one from another a distance corresponding to the diameter of the line-like openings in the finished screen. This spacing between the square wires 21 is maintained by the fine cross-wires 23 which are simply stretched across the exposed apices of the former and pressed into said apices as by a hammer or other suitable tool 45. As previously mentioned, the ends of the square wires 21 and the ends of the cross-wires 23 may be affixed to the base 27 of the supporting frame 25 (Fig. 1) by a soldering or welding operation.

Referring now to Figs. 3 and 4. When the invention is applied to a screen and mask assembly (51, 53, Fig. 3) of the "dot" variety, the desired tapered contour (see Fig. 4) of the dot-like apertures 55 in the mask 53 may be achieved by any of several "two-way" etching methods. In accordance with one method, the metal blank from which the apertured mask 53 is made, is first coated on both sides with a photosensitive material (not shown) which hardens when exposed to light. The pattern of the dot-like aper-

tures 55 is then applied, photographically, to each of the two photosensitized faces of the blank, and the unhardened dot-like portions of the photosensitive material removed by washing. The exposed dot-like surface areas of the metal are then etched, about half-way through, from one side of the blank and the rest of the way through from the other side.

As shown more clearly in Fig. 4, the knife-edge apex 57 of the two-way tapered walls of each aperture preferably (but not necessarily) lies in the mid-plane of the metal and the said edge and walls are substantially symmetrical about a line 59 drawn perpendicular to the major faces of the mask 53. Here, as in Fig. 1, the boundary walls of the apertures are inclined with respect to the axes of the paths of the beam-electrons irrespective of the instantaneous scanning positions of the beam or beams. The location of the "knife-edges" 57 can best be controlled by applying the acid (e. g. ferric chloride) first to one side of the metal and then to the other by means of one or more spray guns, not shown. When the acid resisting material has been removed, the mask 53 and the metalized phosphor-dot screen 51 are mounted in a suitable frame (not shown, but which may be similar to the one shown in Fig. 1) and are electrically connected together, as symbolically indicated by the lead 61 shown in Fig. 3.

Referring now to Fig. 5: In some cathode-ray tubes of the "masked-target" variety it is advantageous to provide the mask, which is here designated 63, with "tapered" apertures 65 that are each centered about a median line 67 which is tilted (usually toward the "center-of-deflection" of the tube) with respect to a line drawn perpendicular to the planes of the major faces of the mask. In such cases it may also be advantageous to make the exit 65*x* of each aperture slightly larger than its "entrance" 65*e*. A mask containing apertures of such a peculiar shape and orientation may be made from a sheet 69 of copper (or other readily etchable metal) by first plating or otherwise coating both sides of the sheet with a thin layer 71 of metal, e. g. chromium, which is at least slightly more resistant to the etching fluid. The relative size and location of the "entrances" 65*e* and the "exits" 65*x* of the apertures 65 may be plotted (e. g. by the "lighthouse method" described in copending application of Harold B. Law, Serial No. 158,901, now U. S. Patent 2,625,734) and then photographically recorded upon the oppositely located plated faces of the blank.

The etching material is applied as before (e. g. by means of a spray gun), first to one face and then to the other. When the etching liquid has penetrated the surface layers 71, or one of them, it attacks the less resistant base metal 69 and forms a cavity therein of a diameter larger than that of the hole in the chromium surface-layer. The cavity, thus formed, is converted into a "tapered opening," extending through the mask, by applying the etching material to the other surface of the blank.

One advantage of such an odd-shape mask-aperture is that an electron beam in passing therethrough cannot strike the "bulbous" inner surfaces 65*s* thereof and release secondary-electrons. Furthermore, the relatively few secondary-electrons which are released when the beam strikes the knife-like edges surrounding the entrance of each aperture are, for the most part, prevented from emerging from the "exit" thereof by reason of the small solid angle subtended by said "exit."

From the foregoing detailed description it is apparent that the present invention provides an improved color-television tube of the "masked-target" variety and one characterized, in operation by its substantial freedom from "color-dilution."

What is claimed is:

1. In the operation of a cathode-ray tube of the masked-target variety containing a beam-source of electrons and an apertured electrically conductive mask through which electrons pass in the form of a beam to a metallized viewing screen, the improvement which consists in applying a common potential to said mask and screen whereby to establish therebetween a "field free" space through which said beam passes in its transit to said screen.

2. In the operation of a cathode-ray tube of the type comprising a beam-source of electrons, a "second-anode," an apertured electrically conductive target and a metallized viewing screen mounted in the order named within an evacuated envelope, the improvement which consists in applying a common operating potential to said "second anode," to said apertured mask and to said viewing screen, whereby to establish within said envelope a "field free" space through which said beam passes in its transit from said source to said screen.

3. A cathode-ray tube of the "masked-target" variety comprising an evacuated envelope containing a beam-source of electrons, a target assembly comprising a metallized viewing screen and an apertured electrically conductive mask through which said beam passes in its transit to said screen, and a conductive connection between said mask and the metallized surface of said screen for applying a common operating potential to said target-assembly and thereby to establish a "field free" region, within said assembly, through which said beam passes in its said transit to said screen.

4. The invention as set forth in claim 3 and wherein said conductive connection comprises a metal frame upon which said mask and screen are supported.

5. In a cathode-ray color-tube of the kind containing a screen electrode having a target surface consisting effectively of a multiplicity of duplicate groups of sub-elemental image areas of different color-response characteristics, a source of electrons, means for deriving beam-electrons from said source and for projecting said beam-electrons along a plurality of discrete angularly related paths to respective ones of the sub-elemental image areas in each of said groups, and an electrically conductive mask mounted adjacent to said target surface and containing a multiplicity of apertures disposed in a pattern corresponding to the pattern of distribution of said groups of sub-elemental colored image-areas, the improvement which comprises means for obstructing the passage through said apertures of secondary-electrons released by impact of said beam-electrons upon said mask, said means comprising: boundary-walls for said apertures which are inclined with respect to the axes of the paths of said beam electrons.

6. The invention as set forth in claim 5 wherein the boundary walls of the apertures in said mask are of tapered contour.

7. The invention as set forth in claim 5 and wherein said metallized viewing screen is of the

phosphor-line screen variety and said apertured mask comprises a multiplicity of spaced apart wires mounted in equally spaced relation with respect to the target surface of said screen parallel to the direction of said phosphor-lines, adjacent ones of said wires having angularly disposed plane faces defining the boundary walls of the apertures in said mask.

8. The invention as set forth in claim 5 and wherein said metallized viewing screen is of the phosphor-dot variety and said apertured mask comprises a thin-metal plate-like member containing a multiplicity of apertures having boundary-walls defined, at least in part, by a "knife-edge."

9. The invention as set forth in claim 8 and wherein the "knife-edge" on the boundary walls of said apertures lies substantially in the midplane of said plate-like mask.

10. The invention as set forth in claim 8 and wherein the "knife-edge" on the boundary-walls of said apertures lies in the plane of a surface of said plate-like mask.

HAROLD B. LAW.

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