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APPARATUS FOR THE REPRODUCTION OF IMAGES IN COLOR

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FIG 1

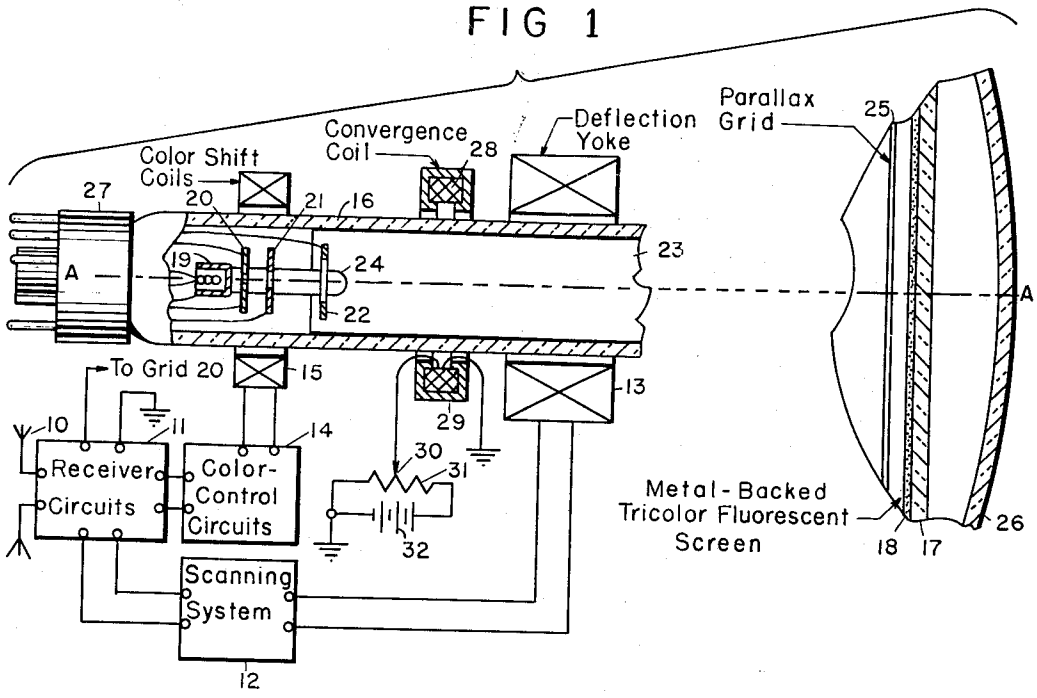
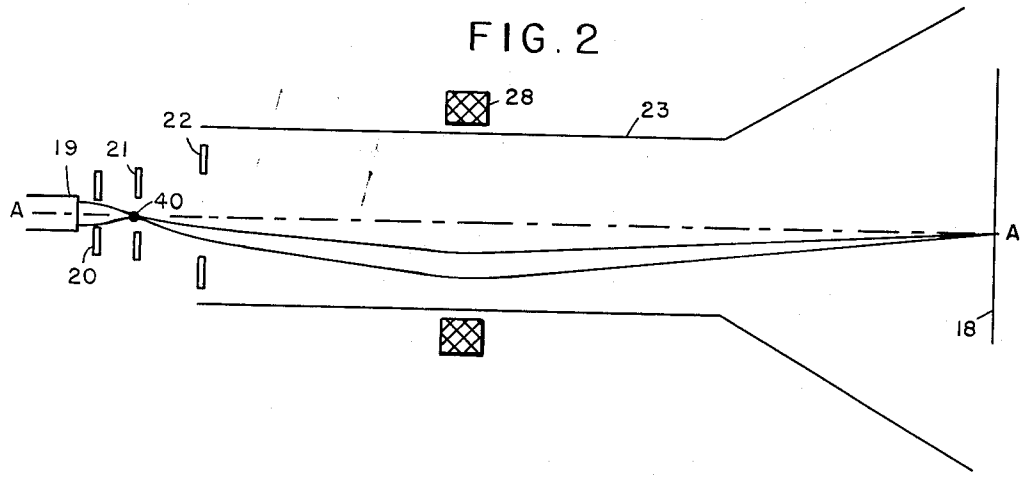


FIG. 2



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APPARATUS FOR THE REPRODUCTION OF IMAGES IN COLOR

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4 Claims. (Cl. 313—77)

This invention relates to color television and more particularly to new and improved image-reproducing apparatus for color television receivers and the like.

Several types of cathode-ray tubes for reproducing images in natural color have been proposed, of which perhaps the most widely known employs a tricolor fluorescent screen cooperating with a parallax grid so that the color reproduced at a particular picture point is dependent upon the angle at which the electron beam approaches the parallax grid-fluorescent screen assembly. Customarily, the screen comprises three interspersed groups of target areas having different color radiation response to electron bombardment, so that three different approach angles are required to permit individual reproduction of the primary colors. In some tubes of this type, three separate electron guns are employed for projecting separate beams at different angles toward the parallax grid, and each of these beams is controlled in intensity to determine the relative proportions of the primary-color components of the reproduced image. In other tubes, a single electron gun is employed, and the beam is subjected to a color-shift deflection field to effect the desired variation in the angle at which the beam approaches the parallax grid. It is a primary object of the present invention to provide a new and improved image-reproducing apparatus of the single-gun type.

In the single-gun parallax-grid type of color tube, the single electron beam is first deflected by the color-shift coil system and is then returned to center by a convergence system, embodying either an electrosatic electron lens or an external coil sometimes referred to as a convergence coil. The purpose of the convergence system is to return to a common point at the fluorescent screen electron rays which originate at the effective center point of the color-shift coil system. Consequently, the focal length of the convergence system is so adjusted that it images the effective center of deflection of the color-shift coil system on the fluorescent screen. This adjustment is incompatible with the production of a focused spot unless the electron beam is focused at the effective center of deflection of the color-shift coil system. Because of the small aperture angles involved, this requirement may be violated in practice to some extent, with attendant imperfections in convergence and/or spot focus; in general, however, it is necessary that the beam diameter at the effective center of deflection of the color-shift coil system be as small as possible.

To satisfy these requirements, it has been conventional practice to operate the electron gun at a short focal length so that a beam constriction or crossover is produced just beyond the last gun electrode. The color-shift coil system is positioned at or near this beam constriction or crossover which is imaged on the screen by the convergence system. Because of the small distance between the electron gun and the color-shift coil system, the beam angles are relatively large leading to undesirable spherical aberration and occasionally to color contamination. Moreover, the

operating potentials of the gun electrodes are quite critical for any particular location of the color-shift coil system.

It is an important object of the present invention to provide a new and improved color tube of the single-gun type in which improved spot focus is achieved, while substantially avoiding spherical aberration and color contamination.

In accordance with the present invention, new and improved apparatus for the reproduction of images in color comprises an elongated envelope containing a fluorescent screen and an electron gun. The fluorescent screen is substantially normal to the longitudinal axis of the envelope and includes a plurality of interspersed similar groups of similar elemental target areas, the elemental areas of each of the groups exhibiting a color radiation response to electron bombardment which is different than that of each of the remainder of the groups. The electron gun comprises a cathode and at least one apertured-disc electrode substantially perpendicular to the longitudinal axis of the envelope for projecting a divergent electron beam toward the fluorescent screen, the beam having a first region of minimum diameter near the apertured-disc electrode. The image-reproducing apparatus also comprises means responsive to applied color-control signals for subjecting the beam to a transverse magnetic-deflection field having an effective center of deflection at the region of minimum beam diameter near the apertured-disc electrode. A convergence system is provided between the electron gun and the fluorescent screen for subjecting the beam to an electrostatic or magnetic convergence field to image the effective center of deflection on the fluorescent screen.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in connection with the accompanying drawing, in the several figures of which like reference numerals indicate like elements, and in which:

Figure 1 is a fragmentary view, partly in cross-section and partly schematic, of an embodiment of the invention; and

Figure 2 is a schematic representation illustrating the electron-optical properties of the image-reproducing device of Figure 1.

Figure 1 is a schematic representation of a color television receiver embodying an image-reproducing device constructed in accordance with the invention. Incoming composite color television signals are received by means of an antenna **10** and impressed on conventional receiver circuits **11** which may include stages of radio-frequency amplification, frequency conversion, intermediate-frequency amplification, video detection, and video-frequency amplification, as well as the customary circuits for reproducing the sound components of the received signal. A scanning system **12** of conventional construction, actuated by receiver circuits **11**, is employed to supply suitable deflection currents to a deflection yoke **13** associated with the image-reproducing device. Color-control circuits **14**, which may also be of conventional construction, are employed to derive suitable color-control signals from the detected composite video signal from receiver circuits **11**, and the color-control signals from circuits **14** are impressed on a suitable color-shift coil system **15** associated with the image-reproducing device.

The image-reproducing device is of the single-gun parallax-grid type and comprises an elongated envelope **16** enclosing a transparent target **17** which is substantially normal to the longitudinal axis A—A of the envelope. The target is provided with a fluorescent screen

18 including a plurality of interspersed similar groups of similar elemental target areas, the elemental areas of each of the groups having a color radiation response to electron bombardment which is different from that of each of the remainder of the groups. For example, the fluorescent screen may be of the tricolor type in which each group of elemental target areas is formed of a phosphor exhibiting a peak color radiation response for one of the three primary colors red, green and blue. Envelope 16 also encloses an electron gun comprising a cathode 19, an intensity-control grid 20, and a pair of accelerating electrodes 21 and 22. A suitable conductive coating 23, preferably of colloidal graphite known as aquadag or the like, is provided on the inner wall of envelope 16 to provide a field-free space between accelerating electrode 22 and the fluorescent screen 18. Cathode 19, control grid 20 and accelerating electrodes 21 and 22 may be supported by means of common glass support pillars 24, of which only one is shown, or in any other suitable manner. Electrodes 20, 21 and 22 are all formed as apertured discs substantially perpendicular to the tube axis A—A for a purpose to be hereinafter explained.

A parallax grid 25 is positioned within envelope 16 between the electron gun and fluorescent screen 18. Parallax grid 25 comprises a structural member of electron-impervious material provided with a plurality of apertures corresponding in configuration and space distribution to the elemental target areas of one of the target-area groups. For example, if fluorescent screen 18 is formed as a continuum of triangular clusters of phosphor dots individually exhibiting different peak color radiation response to electron bombardment, parallax grid 25 may be formed as a conductive metal sheet provided with circular apertures having a space distribution which corresponds to that of the phosphor dots of any one color radiation response on the fluorescent screen 18. If on the other hand, fluorescent screen 18 is of the line type, comprising a plurality of phosphor lines having a repetitive color sequence, parallax grid 25 is provided with slots corresponding in space distribution to that of the phosphor lines of any one color radiation response and may be formed as a grid structure consisting of suitably spaced parallel wires. Since the particular type of phosphor distribution employed on fluorescent screen 18 is immaterial for the purposes of the present invention, parallax grid 25 and fluorescent screen 18 have been illustrated schematically rather than in detail; suitable constructions for each of these types are well known in the art and require no further description.

A transparent face plate 26 is provided at the screen end of envelope 16 to permit direct viewing of the color image formed on fluorescent screen 18. Suitable means (not shown) are also provided for absorbing residual gases after evacuation in a manner well known in the art, and the tube is provided with a conventional base 27 to facilitate external circuit connections.

A convergence system is provided between color-shift coil system 15 and deflection yoke 13, preferably, this convergence system comprises a convergence coil 28 surrounded by an incomplete yoke 29 of magnetic material to reduce the reluctance of the external flux path. Convergence coil 28 is connected to a variable tap 30 associated with a potentiometer 31 which is connected in parallel with a battery 32 or other suitable source of unidirectional operating potential.

In the more general aspects, the operation of the receiver of Figure 1 is quite conventional. Detected composite video signals from receiver circuits 11 are applied between control grid 20 and cathode 19 of the image-reproducing device to control the intensity of the electron beam in accordance with the received picture signals. Color-control signals from color-control circuits 14 are supplied to color-shift coil system 15 to subject the electron beam to a transverse magnetic-deflection field in accordance with the color-signal components of the received composite television signal. The deflected rays are returned to a common point on the fluorescent screen 18 by means of convergence coil 28, and the beam is caused to scan fluorescent screen 18 to reproduce the entire image by means of deflection yoke 13 which is energized by scanning system 12. The color of each image point is determined by the angle at which the beam approaches parallax grid 25, which in turn is dependent upon the instantaneous color-control signal applied to color-shift coil system 15.

In particular, the present invention resides in the construction of the electron gun and in the location of the colorshift coil system and the convergence system with respect to the cathode and the parallax grid. All of the gun electrodes with the exception of cathode 19, including control grid 20 and accelerating electrodes 21 and 22, are constructed as apertured discs which are positioned substantially perpendicular to the longitudinal axis A—A of the envelope. The color-shift coil system 15 is so positioned that the effective center of deflection of the transverse color-shift magnetic-deflection field substantially coincides with the region of minimum beam diameter associated with first accelerating electrode 21. The intensity and space distribution of the magnetic-convergence field established by convergence coil 28 are adjusted to image the effective center of deflection of the color-shift coil system 15 on fluorescent screen 18. In this manner, all electron rays are returned to a common point on the fluorescent screen, and optimum spot focus is obtained by virtue of the fact that the transverse color-shift magnetic-deflection field is impressed on the beam at the first beam crossover or region of minimum beam diameter. Moreover, the aperture angles and the location of the first beam constriction are substantially independent of the operating voltages of the several gun electrodes, within a relatively large operating range, so that the desired condition of optimum spot focus and convergence is assured.

The electron-optical properties of the system are apparent from a consideration of the representation of Figure 2, which illustrates the path of the electron beam in the absence of a scanning field from yoke 13. The electron beam originating at cathode 19 converges to a region 40 of minimum beam diameter near first accelerating electrode 21 and thence diverges toward fluorescent screen 18. The transverse color-shift magnetic-deflection field is impressed with an effective center of deflection substantially coinciding with the beam crossover 40. The representation of Figure 2 illustrates an instantaneous condition of maximum transverse deflection in one direction to obtain a pure primary color at a particular image point. After passing through crossover point 40, the deflected electron beam is bent toward the tube axis A—A under the influence of the accelerating field established by electrode 22 and conductive coating 23 but still remains slightly divergent. Upon encountering the magnetic-convergence field established by convergence coil 28, the beam is redirected toward the tube axis A—A. The magnetic-convergence field also has a focusing effect upon the beam, so that in addition to returning all electron rays to a common point on the fluorescent screen, the initially divergent beam is focused to image the beam constriction at the effective center of deflection 40 of the color-shift magnetic-deflection field. The focal length of the convergence system comprising convergence coil 28 is adjusted, by means of variable tap 30, so that the beam is refocused at the plane of the fluorescent screen. The instantaneous position of the beam on the fluorescent screen is determined by the field established by the deflection yoke which in turn is energized by the scanning system of the receiver.

In order to obtain the advantages of the invention, it is essential that there be no conductive surfaces of substantial longitudinal extent within the field established by the color-shift coil system. Any such longitudinal conductive

surfaces serve to suppress the color-shift magnetic-deflection field by functioning as short-circuited turns. To avoid this effect, all of the gun electrodes are constructed as apertured discs rather than as cylindrical members having apertured diaphragms. Moreover, the gun electrodes are preferably constructed of nonmagnetic material to avoid distorting the color-shift field.

While the tube illustrated in Figure 1 comprises two accelerating disc electrodes **21** and **22**, satisfactory operation may be achieved with an electron gun employing only a single accelerating electrode in addition to the intensity-control grid and the cathode. Second accelerating electrode **22** is included primarily for the purpose of added flexibility, to permit convenient control over the maximum deviation of the beam from the tube axis, so that it is insured that the beam enters the convergence system within the effective aberration-free aperture of that system. Indeed, it may even be possible to omit both accelerating electrodes, relying on the accelerating field established by conductive coating **23** to produce the desired beam constriction at the effective center of deflection of the color-shift coil system.

Thus, the present invention provides a new and improved apparatus for the reproduction of images in color which affords optimum beam focus coupled with accurate convergence and which is substantially free of color contamination. The system does not require any additional apparatus but only a simple modification of a presently known structure. The advantages of the invention are obtainable with any single-gun paralax-grid type of color-reproducing tube, regardless of the phosphor distribution pattern employed at the fluorescent screen. Moreover, the invention is also applicable to color tubes of other types wherein color switching is effected by varying the angle at which the electron beam from a single gun approaches the composite fluorescent screen, as for example color tubes in which the screen is formed by depositing different phosphors on the lateral surfaces of elemental pyramids to circumvent the necessity of a parallax grid.

While a particular embodiment of the present invention has been shown and described, it is apparent that various changes and modifications may be made, and it is therefore contemplated in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. Apparatus for the reproduction of images in color comprising: an elongated envelope; a fluorescent screen within said envelope substantially normal to the longitudinal axis thereof and including a plurality of interspersed similar groups of similar elemental target areas, the elemental areas of each of said groups having a color radiation response to electron bombardment which is different from that of each of the remainder of said groups; an electron gun within said envelope comprising a cathode and at least one electrode consisting of an apertured disc substantially perpendicular to said axis for projecting a divergent electron beam toward said fluorescent screen, said beam having a first region of minimum diameter near said apertured-disc electrode; means responsive to applied color-control signals for subjecting said beam to a transverse magnetic-deflection field having an effective center of deflection at said first region of minimum beam diameter; and a convergence system between said electron gun and said fluorescent screen for subjecting said beam to a convergence field to image said effective center of deflection on said fluorescent screen.

2. Apparatus for the reproduction of images in color comprising: an elongated envelope; a fluorescent screen within said envelope substantially normal to the longitudinal axis thereof and including a plurality of interspersed similar groups of similar elemental target areas, the elemental areas of each of said groups having a color radiation response to electron bombardment which is different from that of each of the remainder of said groups; an electron gun within said envelope comprising a cathode and at least one electrode consisting of an apertured disc of nonmagnetic material substantially perpendicular to said axis for projecting an electron beam which converges from said cathode to a first region of minimum diameter near said apertured-disc electrode and thence diverges toward said fluorescent screen; means responsive to applied color-control signals for subjecting said beam to a transverse magnetic-deflection field having an effective center of deflection at said first region of minimum beam diameter; and an electron-lens system between said electron gun and said fluorescent screen for subjecting said beam to a convergence field to image said effective center of deflection on said fluorescent screen.

3. Apparatus for the reproduction of images in color comprising: an elongated envelope; a fluorescent screen within said envelope substantially normal to the longitudinal axis thereof and including a plurality of interspersed similar groups of similar elemental target areas, the elemental areas of each of said groups having a color radiation response to electron bombardment which is different from that of each of the remainder of said groups; an electron gun within said envelope comprising a cathode and at least one electrode consisting of an apertured disc substantially perpendicular to said axis for projecting a divergent electron beam toward said fluorescent screen, said beam having a first region of minimum diameter near said apertured-disc electrode; a color-shift coil system responsive to applied color-control signals for subjecting said beam to a transverse magnetic-deflection field having an effective center of deflection at said first region of minimum beam diameter; and a magnetic electron-lens systems between said electron gun and said fluorescent screen for subjecting said beam to a convergence field to image said effective center of deflection on said fluorescent screen.

4. Apparatus for the reproduction of images in color comprising: an elongated envelope; a fluorescent screen within said envelope substantially normally to the longitudinal axis thereof and including a plurality of interspersed similar groups of similar elemental target areas, the elemental areas of each of said groups having a color radiation response to electron bombardment which is different from that of each of the remainder of said groups; an electron gun within said envelope comprising a cathode, an intensity-control electrode consisting of an apertured disc substantially perpendicular to said axis, and at least one additional electrode consisting of an apertured disc substantially perpendicular to said axis for projecting a divergent electron beam towards said fluorescent screen, said beam having a first region of minimum diameter near said additional electrode; means responsive to applied color-control signals for subjecting said beam to a transverse magnetic-deflection field having an effective center of deflection at said first region of minimum beam diameter; and an electron-lens system between said electron gun and said fluorescent screen for subjecting said beam to a convergence field to image said effective center of deflection on said fluorescent screen.

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