June 7, 1960 S. L. REICHES 2,939,979

COLOR PURE CATHODE RAY TUBE DISPLAY MECHANISM

Filed April 26, 1957 3 Sheets-Sheet 1

Fig. 1

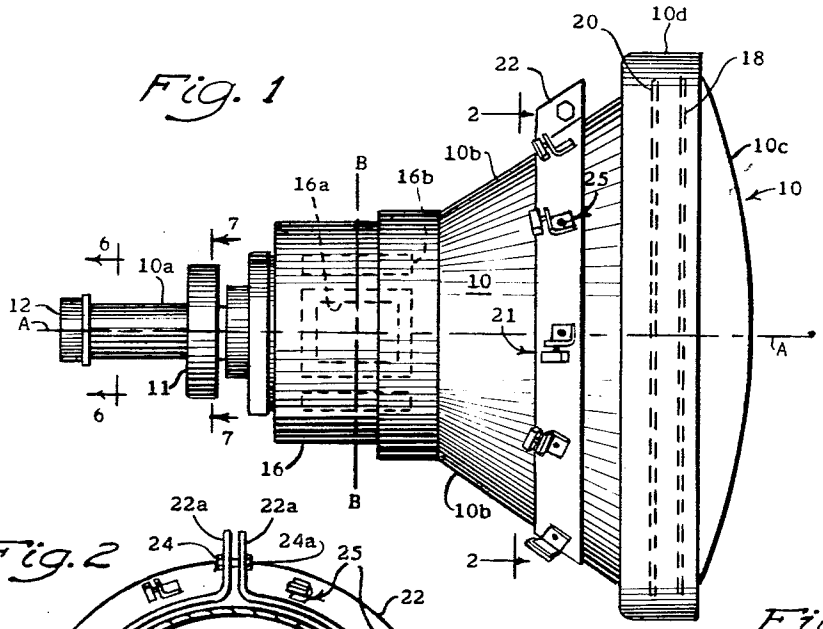


Fig. 2

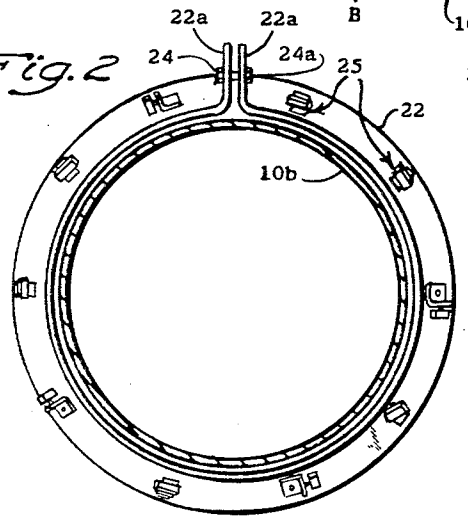


Fig. 3

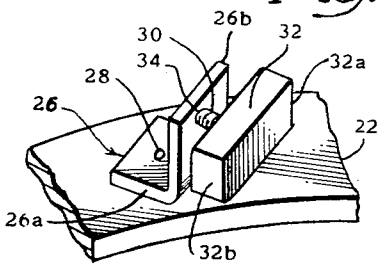
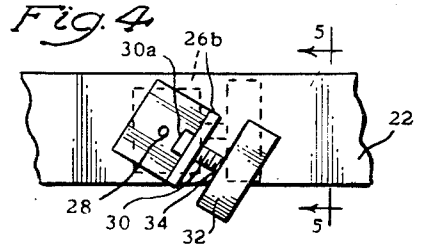


Fig. 4



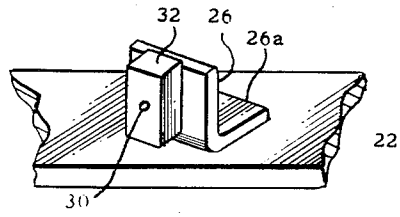


Fig. 5

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COLOR PURE CATHODE RAY TUBE DISPLAY MECHANISM

Filed April 26, 1957 3 Sheets-Sheet 2

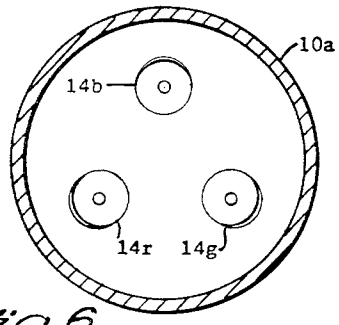


Fig. 6

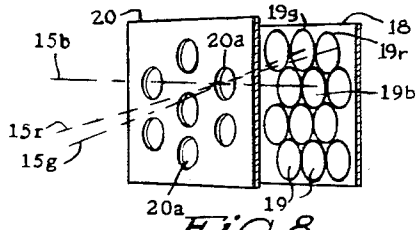


Fig. 8

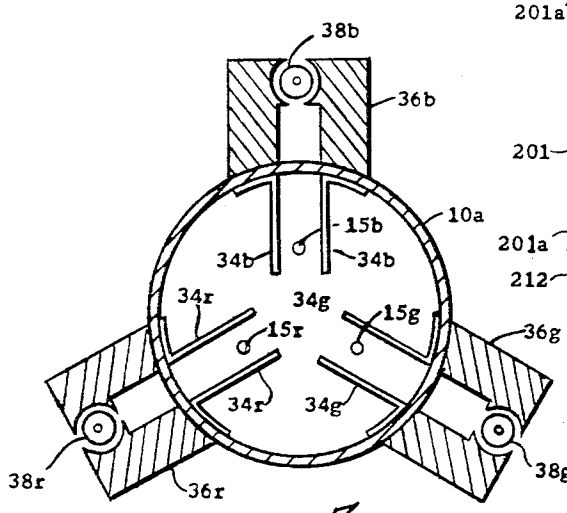


Fig. 7

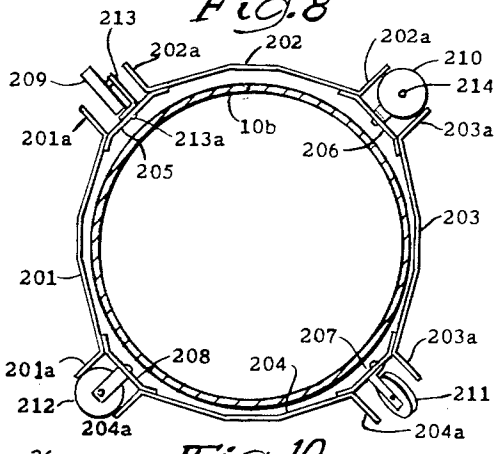


Fig. 10

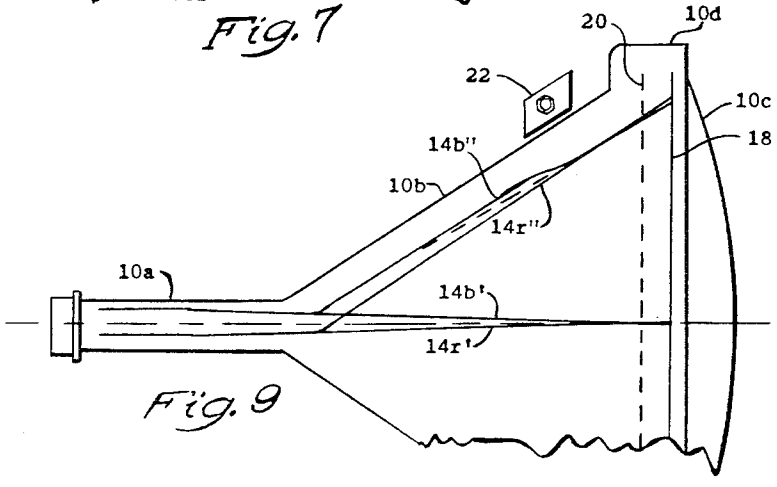


Fig. 9

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COLOR PURE CATHODE RAY TUBE DISPLAY MECHANISM

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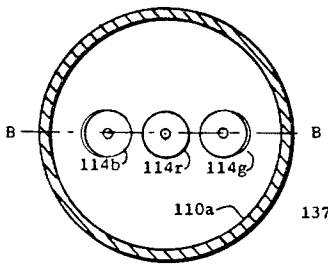


Fig. 12

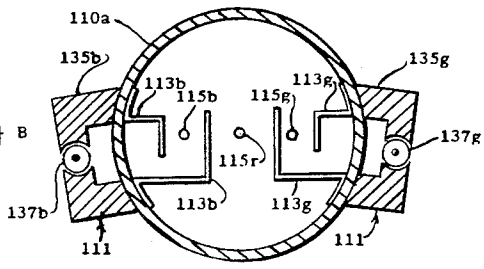


Fig. 14

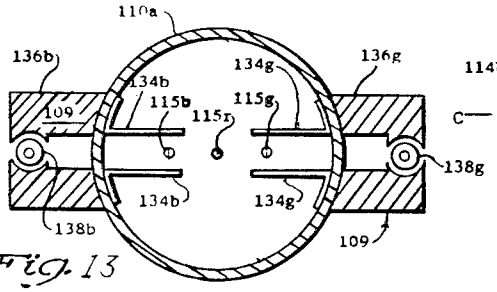


Fig. 13

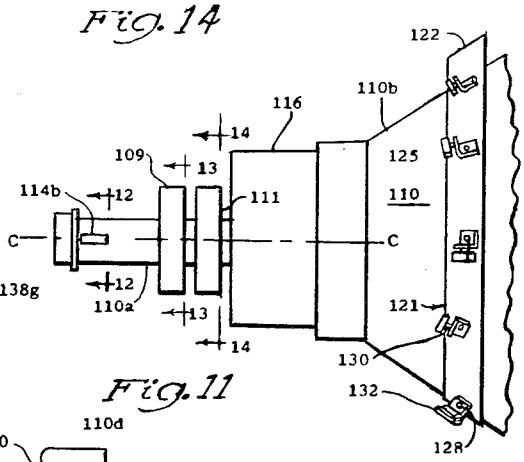


Fig. 11

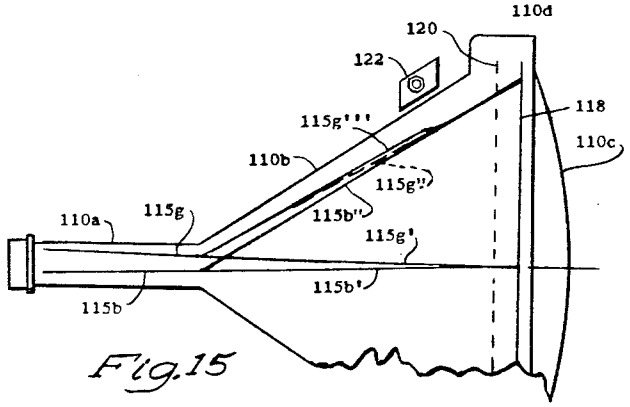


Fig. 15

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BY Fraser and Verhoeven

ATTORNEYS

United States Patent Office 2,939,979
Patented June 7, 1960

2,939,979

COLOR PURE CATHODE RAY TUBE DISPLAY MECHANISM

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Filed Apr. 26, 1957, Ser. No. 655,272

1 Claim. (Cl. 313—77)

The present invention relates to an improved cathode ray tube display mechanism capable of reproducing color television images in full and pure color. It is a continuation in part of my copending patent applications S.N. 600,314, filed July 26, 1956, entitled "Post Deflection Color Purity Correcting Device for a Color TV Cathode Ray Tube and System Using the Same," and S.N. 648,471, filed March 22, 1957, entitled "Post Deflection Color Purity Correcting Device for a Color TV Cathode Ray Tube and System Using the Same," both assigned to the same assignee as the present invention. Application S.N. 600,314 is a continuation in part of application S.N. 564,197, filed February 8, 1956, bearing the same title, assigned to the same assignee now abandoned.

In one method of producing a cathode ray image in full color, the phosphor screen has small spaced deposits of phosphors divided into color groups, usually groups of three called triads. The individual phosphor deposits making up each group produce one primary color when energized, so that when all are activated the illusion of a full color reproduction is created. A cathode ray gun is provided for each group of phosphor deposits and is energized in accord with the time variations of the intensity of that color to be reproduced during scanning movement of the ray beam. The ray beams are swept in unison to reproduce the respective color images simultaneously for blending in the eye of the observer to achieve the desired effect.

Faithful color reproduction by the above method demands that at all times the respective ray beams actuate only the corresponding phosphor deposits. Thus, for example, one beam should only energize the red light producing phosphor deposits, another only the green, and the third only the blue. In the shadow mask type tube, this is accomplished by the use of an apertured plate positioned to permit electrons to reach the phosphor screen only through the apertures. Since the ray beams are initially spaced, this makes it possible to position a triad or group of phosphor deposits behind the shadow mask in such position that each deposit is in the zone of action of only the corresponding cathode ray beam.

In actual cathode ray tube construction, a number of tolerance factors preclude the faithful reproduction of the respective colors. These tolerance factors include errors in the positioning and orientation of the respective cathode ray beams; deviations of deflection yoke action from the theoretically perfect deflection; errors in the positions of the respective phosphor deposits; variations in the distance between the shadow mask and phosphor screen; and the effects of stray and the earth's magnetic field. In order to overcome these deviations from the theoretical ideal, it has heretofore been the practice to provide various forms of color purity devices effective to reorient the respective cathode ray beams prior to sweep and thereby provide some measure of restoration of the color purity.

Heretofore it has been considered essential to direct the cathode ray beams through the so-called color centers of the tube—that is the points from which the respective ray beams are assumed to come when the phosphor deposits are made. In consequence, the efforts to correct for the various deviations from ideal tube performance have been confined to reorienting and shifting the cathode ray beams prior to sweep. For this reason a variety of convergence or color purity magnet devices have been used; windings have been provided to vary the effect of these devices in unison with the sweep action to achieve dynamic correction, and a wide variety of adjustments have been provided in an effort to achieve some acceptable measure of color purity by a process of repeated adjustment.

Contrary to the conception heretofore applied, the present applicant has found that it is possible to correct for deviations from ideal performance by the use of magnets effective on the ray beams after they are swept. Applicant accepts the fact that in many tubes the respective cathode ray beams do not travel through the color centers of the tube. Instead of attempting to make the ray beams pass through the color centers applicant, in accordance with the present invention, reorients the electron beams by the use of magnetic fields located between the deflection yoke and the phosphor screen. These fields are conveniently created by the use of a plurality of universally rotatable permanent magnets disposed in a ring encircling the bell of the tube. In the use of a color purity mechanism of this kind, the beams are initially converged on the center of the viewing screen by suitable convergence magnets effective on the ray beams before they reach the deflection yoke. The red, green, and blue fields are then separately energized and the magnets adjusted to provide maximum color purity with each. While theory would not indicate that this relatively simple and straight-forward technique would lead to adequate color purity, experience has shown that it provides color purity far superior to that heretofore achieved; it makes possible the use of cathode ray tubes with deviations from design standards greater than heretofore permitted; it makes possible larger openings in the shadow mask (especially with a coplanar electron gun type tube) and the incident increased efficiency; and it makes the coplanar gun type shadow mask tube especially effective. Moreover, since the apparatus of the present invention permits use of the central (and most readily controlled) part of the yoke's field, the yoke design is not as critical as is otherwise required and—in addition—the position of the yoke along the neck of the tube is not as critical as with other arrangements.

It is therefore a general object of the present invention to provide an improved color pure cathode ray tube display mechanism that does not require the ray beams to pass through the respective color centers.

A further object of the present invention is to provide a color pure cathode ray tube display mechanism in which the cathode ray beams are reoriented by magnetic means effective after sweep action.

Another object of the present invention is to provide an improved color pure cathode ray tube display mechanism which utilizes a time constant magnetic field of space-varying orientation and intensity to selectively redirect the respective cathode ray beams which thereby provide a high degree of color purity despite imperfections in the tube, the deflection yoke, and otherwise.

Still another object of the present invention is to provide an improved color pure cathode ray tube display mechanism that requires only a few adjustments and permits a relatively unskilled operator to adjust a color television receiver for color pure full color operation.

It is yet another object of the present invention to provide an improved color pure cathode ray tube display mechanism that is especially applicable to cathode ray

tubes having electron guns located on a common plane.

An additional object of the present invention is to provide an improved color pure cathode ray tube display mechanism that utilizes inexpensive components, lends itself to television receiver construction, accommodates tube and deflection yoke errors not heretofore permissible, permits the use of shadow mask apertures of increased size with the incident improvement in efficiency, acts on the ray beams uniformly to some extent and differentially to some extent and can be designed to fix these respective extents at desired values, and is otherwise a highly effective, practical, construction.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawing in which:

Figure 1 is a top-plan view of a multi-ray beam cathode ray tube of the shadow mask type with the deflection yoke in place and one form of color purity correction mechanism constructed in accordance with the present invention;

Figure 2 is a view through axis **2—2**, Figure 1;

Figure 3 is a fragmentary view in perspective showing one of the color purity magnets of the mechanism of Figures 1 and 2;

Figure 4 is a fragmentary top-plan view of a portion of the structure shown in Figure 3 and showing an alternative magnet position by dashed lines;

Figure 5 is a cross-sectional view through axis **5—5**, Figure 4 showing still another position of adjustment of the magnet of Figures 3 and 4.

Figure 6 is an enlarged cross-sectional view through axis **6—6**, Figure 1, showing the positions of the electron guns of the tube of Figure 1;

Figure 7 is a somewhat diagrammatic view through axis **7—7**, Figure 1, showing the magnetic radial ray beam convergence adjusting mechanisms of the apparatus of Figure 1;

Figure 8 is a somewhat schematic drawing showing the mode of operation of the shadow mask type tube;

Figure 9 is a somewhat diagrammatic view in vertical cross-section showing how the cathode ray beams travel in the structure of Figure 1;

Figure 10 is a view like Figure 2 to a different scale and showing an alternative form of the color purity magnet device which may be used in the apparatus of Figure 1;

Figure 11 is a view like Figure 1 but showing a fragmentary portion of a planar gun type shadow mask type cathode ray tube;

Figure 12 is a greatly enlarged cross-sectional view through axis **12—12**, Figure 11 and showing the location of the electron guns in the apparatus of Figure 11;

Figure 13 is an enlarged cross-sectional view through axis **13—13**, Figure 11, and showing the horizontal static ray beam convergence adjusting mechanism of the apparatus of Figure 11;

Figure 14 is an enlarged cross-sectional view through axis **14—14**, Figure 11, and showing the static vertical cathode ray beam convergence adjusting mechanism of the apparatus of Figure 11; and

Figure 15 is a horizontal cross-sectional view in somewhat diagrammatic form showing how the outer two ray beams of the apparatus of Figures 11–14 are directed.

The apparatus shown in Figures 1–9 is the form of the present invention which is specifically described and claimed in my co-pending application, Serial Number 600,314 entitled "Post Deflection Color Purity Correcting Device for a Color TV Cathode Ray Tube and System Using the Same," filed July 26, 1956, and assigned to the same assignee as the present invention. In this apparatus the cathode ray tube indicated generally at **10** has a neck portion **10*a***, a bell portion **10*b***, and a face portion **10*c***. These define a closed evacuated space and have a common axis A—A. A group of three electron guns **14*b***, **14*r*** and **14*g*** are positioned in the neck **10*a*** in a delta or equilateral triangular configuration as shown in Figure 6. These electron guns are electrically connected to the base **12** to receive the heater current to warm the cathodes to electron emitting temperatures and the voltages required for the various accelerating and focusing electrodes and the control electrodes. The guns have a slight inward tilt as shown in Figure 6 to cause the ray beams to converge approximately on the axis A—A, Figure 1, at the shadow mask **20**.

The neck **10*a*** receives the radial static convergence mechanism **11** described in detail hereafter and the deflection yoke **16**, also described hereafter. To the right of the deflection yoke **16** the bell **10*b*** of the tube flares in conical conformation to the sleeve **10*d*** which defines the tube portion of maximum diameter. Toward the front of the sleeve portion **10*d*** and internally of the tube a flat phosphor screen **18** is located. Immediately in front of this phosphor screen and in the path of electrons from the respective guns **14*b***, **14*r***, and **14*g***, the shadow mask **20** is located to provide the action hereinafter described in detail. The bell portion **10*b*** of the tube receives the color purity magnet assembly indicated generally at **21** which is described in further detail hereafter.

The radial ray beam static convergence mechanism **11** is shown in detail in Figure 7. As shown, the ray beams **15*b***, **15*g***, and **15*r*** travel from the respective guns toward the face of the tube and at the time they reach the unit **11** these ray beams have slightly converged towards the axis of the tube. The neck **10*a*** of the tube has three sets of internal magnetic plates **34*b***, **34*g*** and **34*r*** which, as shown in Figure 7, straddle the respective cathode ray beams. As shown, each of these plates has an arcuate portion which seats against the inner face of the neck **10*a***. Three convergence magnet units **36*b***, **36*g***, and **36*r*** define pole faces in juxtaposition with the respective arcuate portions of the magnetic plates **34*b***, **34*g***, and **34*r***, respectively. Each unit **36*b***, **36*g***, and **36*r*** has a cylindrical opening in which is rotatably disposed a permanent magnet **38*b***, **38*g***, and **38*r***, respectively. Each such magnet is magnetized to define diametrically opposed poles, so that by rotating the magnets about their respective axes the intensity and direction of the poles defined by units **36*b***, **36*g***, and **36*r*** can be adjusted. This effects a corresponding field between the plates of the respective pairs **34*b***, **34*g***, and **34*r*** which fields encompass the respective ray beams **15*b***, **15*g***, and **15*r***. It will be noted that the fields between the pairs of plates **34*b***, **34*g***, and **34*r*** are tangential in relation to the axis of the neck **10*a***. Since the ray beams are deflected in directions transverse to both the direction of ray beam travel and the direction of the magnetic field in each instance, the adjustment of the magnets **38*b***, **38*g***, and **38*r*** serves to converge the ray beams **15*b***, **15*g***, and **15*r*** as desired, and to overcome any lack of convergence resulting from deviation of the physical orientations of the electron guns from that providing the desired convergence. As is described in further detail hereafter, the magnets are initially adjusted to converge the ray beams on the axis A—A Figure 1, and on the shadow mask **20**. This convergence is also shown in Figure 9.

The deflection yoke **16** includes vertical and horizontal pairs of coils straddling the neck **10*a*** to produce vertical and horizontal fields in neck **10*a*** and the most narrow portion of the bell **10*b***. A horizontal coil is indicated diagrammatically at **16*a***, Figure 1. It (and its mate, not shown) receives the 60 cycle saw-tooth current flow required to generate a horizontal magnetic field of sufficient intensity to sweep the ray beams in unison in the vertical direction over the shadow mask **20** and the phosphor screen **18**. A pair of vertical coils **16*b*** is shown in diagrammatic view in Figure 1. These are energized with the 16 kilocycle saw tooth sweep current required

to sweep the ray beams in unison cross-wise of the shadow mask **20** and viewing screen **18** to provide the necessary horizontal sweep for reproducing the image. It will be noted that the horizontal coils **16***a* and the vertical coils **16***b* are centered upon the plane B—B which, as is described hereafter, is approximately the plane at which the ray beams may be considered to bend sharply during sweep action.

The action of the deflection yoke **16** is approximately to rotate the ray beams about centers defined by the intersections of the plane BB with the respective ray beams. However, in actual practice the yoke deviates from this ideal and tends to introduce color impurities into the system.

The phosphor screen **18** has three sets of phosphor deposits **19**. One such set is indicated at **19***g*, Figure 8, one at **19***r*, Figure 8, and the third at **19***b*, Figure 8. These sets of phosphor deposits are in the form of triads or groups of three, one group corresponding to each opening **20***a* in the shadow mask **20**. It will be noted in Figure 8 that when the respective ray beams **15***b*, **15***g*, and **15***r* converge and pass through the shadow mask opening **20***a* they diverge in the region between the shadow mask **20** and the phosphor screen **18** so that each strikes a different phosphor deposit, the ray beam **15***r* striking the deposit **19***g* and the ray beam **15***b* striking the deposit **19***b*. The phosphor deposits **19***r* produce red light when struck by the electrons, the phosphor deposits **19***b* produce blue light, and the phosphor dots **19***g* produce a green light when struck by these electrons. It will be observed, therefore, that the electron streams **15***b*, **15***r*, and **15***g* produce points of red, blue, and green light, respectively, when they converge upon the shadow mask **20** and travel in the correct diverging directions therefrom to strike the intended phosphor deposits.

The respective phosphor deposits on the phosphor screen **18** are positioned in a manner calculated to produce the above action during the entire sweep action of the ray beams. In one method of so positioning the phosphor deposits, a light source is located on the plane BB, Figure 1, at the points where the respective light beams **15***b*, **15***g*, and **15***r* should intercept that plane. When the electron guns are thereafter affixed to the complete tube and are located at their intended positions, the tube should, in theory, produce the desired effect, namely the ray beam **15***b* should create blue light only, the ray beam **15***r* should create red light only and the ray beam **15***g* should create green light only. In actual practice this ideal condition is not achieved because, in actual tube manufacture, there are always deviations from the ideal conditions and, as well as deviations in the deflection yoke action from the ideal. The result is that the image produced is not pure in color but rather is deficient in its color content and is otherwise unsatisfactory.

In the structure of Figures 1–7, a conical strap **22**, Figures 1–5, is received over the bell **10***b* of the tube **10** and is held thereon by the bolt **24** and the nut **24***a* which clamp the two outwardly extending ears **22***a* together as is shown in Figures 1 and 2 to grip the tube. This strap is of a non-magnetic material, such as aluminum. About its periphery a series of adjustable permanent magnet units **25** are mounted. In the particular form shown, a total of eight such units are shown and are located at equally spaced distances about the periphery of the strap **22**. The structure of each of these units is best seen in Figures 3, 4, and 5. Each consists of an angle bracket **26** formed of non-magnetic material, such as aluminum. Each such bracket has a foot portion **26***a* which seats against the base of the strap **22** and is riveted thereto by a rivet **28**, Figures 3 and 4. The rivets secure the portions **26***a* to the strap **22** while permitting the brackets to rotate about the axes defined by the respective rivets. Each angle bracket **26** has an upstanding portion **26***b* which is at right angles to the base **26***a* and in spaced relation to the strap **22** receives a pin **30** upon which the magnet **32** is mounted. Each pin **30** is normal to the plane defined by the portion **26***b* of the bracket. The pin **30** is fixedly secured to the magnet **32** (as by embedding therein) and has a headed end **30***a* which seats against the inside face of the bracket **26***b* as is shown. Springs **34** are interposed between each magnet and the supporting bracket to urge the magnet to maximum spaced relation with the bracket and thus frictionally hold each magnet in supported position and against rotation under normal shock and vibration.

Each of the magnets **32** is magnetized to form diametrically opposed poles with respect to the support pins **30**. That is, in the structure shown in Figure 3 the end **32***a* of the magnet is a north pole and the end **32***b* is a south pole.

It will be observed that each of the magnets **32** may be rotated about the axis of the pin **28** supporting the corresponding bracket, and may be rotated about the axis of the pin **30** which serves to support the magnet itself. The former axis is generally normal to the outside face of the bell part **10***b* of the tube, and the latter axis is generally transverse to the former. It will be further noted that rotation of the magnets about the rivet or pins **28** brings the magnetic field into more or less alignment with the electron streams, whereas rotation of the magnets **32** about the pins **30** tends to orient the tilt of the magnetic field as it is traversed by the electron streams. The former rotation primarily varies the degree of coincidence of the magnetic field with the direction of ray beam travel and hence the extent the ray beam is deflected. The latter rotation primarily varies the direction of ray beam deflection.

In the use of the apparatus shown in Figures 1 to 7, inclusive, the magnets **32** are first rotated to generally parallel relationship with the axis of the tube by rotating the same about the rivet **28**. The receiver is then energized without any sweep current flow (or with a signal providing a cross hatch pattern) and the respective ray beams converged on the shadow mask **20** at the axis A—A. This is accomplished by rotating the magnets **38***b*, **38***g*, and **38***r*, Figure 7, until the beams are thus positioned. The blue and green electron guns **14***b* and **14***g* are then deenergized and the beam **14***r* energized. With the sweep system operating (yoke **16** energized with vertical and horizontal sweep currents) the respective magnets **32** are thereupon rotated about their axes **28** and about their axes **30** as is necessary to provide a raster of rectangular shape and uniform red color. It will be noted that to the extent that the sweep system—acting in conjunction with errors in the tube construciton—tends to cause the red beam to deviate from its intended function, this will show up at this time in the form of other than red color on the viewing screen. When the magnets **32** have been adjusted as is necessary to give the required red color over the entire viewing screen, the red electron gun **14***r* is then suppressed and the blue electron gun **14***b* energized. The process is then repeated as is necessary to produce a color pure blue raster by the action of the blue gun **14***b*. Guns **14***b* and **14***r* are thereupon suppressed and the gun **14***g* energized and the process repeated to obtain the maximum color purity with the green color only.

In the above process a degree of dependence exists between the corrections for the red, blue, and green electron beams. Indeed, it would theoretically seem that the magnet units **32** would be incapable of providing adequate color purity correction inasmuch as when any magnet is adjusted to correct impurities with respect to one color it also would seem to affect adversely the color purity with respect to the other colors. Nothwithstanding this seeming dependence of each color on the other, it has been found that the apparatus shown in Figures 1 to 7 is capable in practical cases of providing selectivity as between the respective electron streams, a high degree of color purity, and a much more satisfactory

operation than can be achieved with the previous neck color purity correction devices. This action is believed to be due, in part at least, to the fact that the electron guns are spaced from each other and to the fact that the magnetic fields created by the respective magnets **32** extend within the bell **10***b* of the tube **10** only to limited extents. When the ray beams are swept in unison by the action of the deflection yoke **16**, they accordingly enter into the fields of the respective magnets to varying degrees and because of this variation the ray beam shift associated with the action of the respective magnets is different for each of the guns. This action is shown in Figure 9 which is a somewhat diagrammatic view showing how the magnets **32** tend to act upon the ray beams differentially insofar as the top edge of the image is concerned. As is shown, the ray beams in the absence of sweep, converge on the shadow mask **20** and pass through the axial or central opening therein to spread thereafter and form the center triad of illuminated dots on the viewing screen **18**. These undeflected ray beams are shown at **14***b'* and **14***r'*, respectively, in Figure 9. Neither ray beam is at this time affected by the action of the magnets **32**, inasmuch as in the undeflected condition the ray beams remain outside of the zone of influence of the magnets.

The paths of the ray beams at maximum upward vertical sweep are shown at **14***b''* and **14***r''*, respectively. In this condition, the ray beams are now deflected close to the bell **10***b* and are within the zones of influence of the magnets **32**. However, the blue ray beam **14***b''* tends to be closer to the magnets than the red ray beam **14***r''*. Because of this closeness the magnetic field from the magnets **32** that influences the path of travel of the ray beam **14***b''* is more intense than the field acting on the ray beam **14***r''*. Since the ray beam **14***b''* thus is influenced in its travel to a greater degree than the ray beam **14***r''*, it follows that the magnets **32** tend to influence the ray beam travel to differing extents and, accordingly, they make it possible by repetitive adjustment of the magnets with the various ray beams energized to achieve by a process of the successive compromises a color image having a high degree of color purity.

The extent the magnetic fields act differentially on the ray beams is determined by the physical separation of the ray beams where they pass through the zones of influence of the magnets. By moving the magnets closer to the neck of the tube the effect of the fields on the ray beams is made less uniform—if the magnets are located nearer the shadow mask (where the ray beams converge) the effect on the respective beams is made more uniform.

Figures 11 to 15, inclusive, show an alternative form of the present invention in which the electron guns are in spaced positions on a single plane. As shown in Figure 11, the cathode ray tube **110** is like the tube **10**, Figure 1, in that it has a neck portion **110***a*, a bell portion **110***b*, a shadow mask (**120**, Figure 15, not shown in Figure 11), a face plate **110***c* (shown in Figure 15 but not shown in Figure 11). The neck **110***a* of tube **110** has a horizontal ray beam convergence unit **109** and a vertical ray beam convergence unit **111** as are described in further detail hereafter. The front portion of the neck **110***a* and the rear portion of the bell **110***b* receive the deflection yoke **116** which has horizontal and vertically oriented windings to receive the sweep current flow to deflect the ray beams in unison as is above described in connection with yoke **16**, Figure 1.

Figure 12 shows electron guns of the unit of Figures 11–15. These guns are indicated at **114***b*, **114***r*, and **114***g*, respectively. As is shown, these guns are located on a common horizontal plane B—B, extending through the neck of the tube. The gun **114***r* is additionally located on the axis C—C, Figure 11, of the cathode ray tube **110**. As is seen in Figure 12, the electron guns **114***b* and **114***g* are oriented with a slight inward tilt so that in the absence of any magnetic or other ray beam deflection devices, these beams will tend to converge at the point on the shadow mask **120**, Figure 15, where the axis C—C crosses the shadow mask.

Figure 13 is a cross-sectional view showing the positioning and operation of the horizontal ray beam convergence devices of the apparatus of Figure 11. As is shown, the pair of plates **134***b* straddle the ray beam **115***b* in the same general fashion as do plates **34***b*, Figure 7. These plates each have arcuate surfaces seated against the interior of the neck **110***a* which mate with the poles of the magnet core **136***b* to be energized thereby. A diametrically magnetized permanent magnet **138***b* is rotatably disposed in the core **136***b* as is shown in Figure 13, thereby permitting adjustment of the polarity and intensity of the magnetic field between the plates **134***b*. Since this is a vertical magnetic field it shifts the ray beam **115***b* in the horizontal direction and thus provides an adjustment by which the ray beam **115***b* may be adjusted to converge with the ray beam **115***r* on the point the shadow mask **120** crosses the axis C—C. The internal pole pieces **134***g* straddle the ray beam **115***g* just as the pole pieces **134***b* straddle beam **115***b*. These pole pieces are energized from the diametrically magnetized rotatable magnet **138***g* through the core **136***g* to vary the intensity and polarity of the vertical field through which the ray beam **115***g* travels. This provides adjustment of the horizontal position of the ray beam **115***g* to cause the same to converge on the shadow mask **120** with the ray beam **115***r* and the ray beam **115***b*.

Figure 14 is a cross-sectional view through axis **14—14**, Figure 11, showing the mechanism **111** by which the blue ray beam **115***b* and the green cathode ray beam **115***g* are aligned and converged with the red ray beam **115***r*. It will be observed that the internal pole pieces **133***b*, when magnetized by the diametrically magnetized rotatable permanent magnet **137***b* acting through the core **135***b*, serve to produce a horizontal magnetic field in the region traversed by the ray beam **115***b*. This field is of adjustable intensity and polarity and—since it is horizontal—it shifts the ray beam **115** in the vertical direction. By appropriately adjusting the magnet **137***b* it is accordingly possible to orient the ray beam **115***b* to converge on the shadow mask **120** with the central ray beam **115***r*.

The internal pole pieces **113***g* coact with the core **135***g* and the rotatable diametrically magnetized permanent magnet **137***g* to produce a horizontal magnetic field of adjustable intensity and direction through which the ray beam **115***g* travels. By rotating the magnet **137***g* the vertical position of the ray beam **115***g* may be accordingly adjusted and that beam converged on the shadow mask **120** with the ray beams **115***r* and **115***b*. Thus, by adjustment of the magnets **138***b*, **138***g*, **137***b*, and **137***g*, the three ray beams emanating from the electron guns **114***b*, **114***r*, and **114***g*, may be brought to coiincidence or convergence on the shadow mask **120** in the absence of sweep current flow in the deflection coil **116**.

In the apparatus of Figures 11–15 a post deflection color purifier indicated generally at **121** is provided. This purifier is of construction similar to the post deflection color purifier of Figures 1 to 5. In brief, it includes a non-magnetic strap **122** which is secured about the bell portion **110***b* of tube **110** and carries a plurality of spaced magnets **132**, each of which is rotatable about the axis of the bracket support pin **128** and about an axis transverse thereto defined by its own support pin **130**.

In use, the apparatus of Figures 11 to 15 is first energized without applying sweep current flow to the deflection windings **116**. Preferably, either the blue beam **115***b* or the green beam **115***b* is deenergized and the other brought to convergence on the shadow mask **120** with the red beam **115***r* which, in the form of the structure shown, is not subject to adjustment. Then, the third beam is adjusted to convergence at the center of shadow

mask 120 with the other two ray beams to provide a triad of red, blue, and green colored dots at the center portion of the viewing screen 118. The color purity adjustments are then performed in the same general fashion as with the apparatus of Figures 1 to 5 until the color pure red, green and blue rasters are provided. It will be noted that with the structure of Figures 11–15, the ray beams are on a common horizontal plane. Such deviations as occur from this horizontal plane are very minor once the horizontal adjustment is achieved by adjusting magnets 137*b* and 137*g*. Consequently, there is little tendency for the ray beams to lose convergence as they are swept in the vertical direction and there is a corresponding small need for adjustment of the color purity magnet 132 with respect to the vertical sweep. However, the ray beams 115*b* and 115*g* are relatively distant from each other in the neck of the tube and these beams accordingly tend to depart from theoretical perfect performance when swept horizontally of the tube. This is shown in the view of Figure 15 where the ideal path of the beam 115*g* as deflected is shown at 115*g*'' and the actual path at 115*g*''. Proper adjustment of the color purity device 121 serves to bring the ray beam 115*g*'' into the intended path of travel shown by lines 115*g*'', Figure 15. Thus the effect is to overcome the deviation from the desired path of travel that would otherwise tend to cause loss of color purity. It might be added that since, during the sweep operation, the beam 115*g* is closer to the bell of the tube than the beam 115*b* when the deflection is in the direction shown in Figure 15 and is farther away when deflected in the opposite direction, the color purity correction device acts differentially on the ray beams and thus permits a substantial degree of selective adjustment or correction of the ray beam travel. In this fashion the unit provides color purity even though, as in the case of the unit of Figures 1–9, would seem that color purity would not be improved.

It should be noted that with the coplanar gun arrangement of Figures 11–15 the outer ray beams (115*g* and 115*b*) are spaced by a greater distance in the horizontal plane than any of the ray beams with the delta gun arrangement. This accents the selective action of the color purity corrector 121 and is believed to be the reason the unit is more effective with this type construction than with the delta gun arrangement. Moreover, since the coplanar gun arrangement exhibits less tendency for loss of convergence and color purity under vertical sweep, the adjustment with this type gun arrangement is facilitated.

Figure 10 shows a modified form of the color purity correcting device useful for either the form of the invention shown in the Figures 1–9 or that shown in Figures 11–15. This form is shown in my co-pending patent application entitled "Post Deflection Color Purity Correcting Device for a Color TV Cathode Ray Tube and System Using the Same," Serial No. 648,471, filed March 22, 1957, assigned to the same assignee at the present invention. In this device four magnetc straps 201, 202, 203, and 204 are joined together by the nonmagnetic members 205, 206, 207, and 208 to form a ring encircling the bell portion 10*b* of tube 10 as is shown. The straps have outwardly extending ears 201*a*, 202*a*, 203*a*, and 204*a* at their ends. The diametrically magnetized magnets 209, 210, 211, and 212 are sandwiched between the ears 201*a*, 202*a*, 203*a*, and 204*a*, as shown, and are held in position by the L-shaped brackets 213 and the pins 214. Each magnet 209–212 is rotatable about its own axis by reason of the respective pin 214 and is bodily rotatable about an axis radially disposed in relation to the bell 10*b* by reason of the rivet 213*a* that carries each of the brackets 213.

With the unit of Figure 10 the influence of each of the magnets 209 to 212, respectively, on the travel of the ray beams is adjustable by rotating the same about its radial axis defined by the pin 213*a*. The direction of the ray beam deflection is adjusted by rotating each of the magnets 209 to 212 about the axis of its supporting pin 213.

The apparatus of Figure 10 is adjusted to provide color purity in the same fashion as the apparatus of Figures 1–9 and 11–15. However, since the magnetic straps 201 to 204 are employed, it is possible with the apparatus of Figure 10, to provide a field component of uniform intensity and orientation extending through the entire bell of the tube. This effect takes place when the orientation of the magnets 209 to 212 is such that the strap 202, for example, becomes a north pole and the strap 204 becomes a south pole. Alternatively, the polarity of straps 202 and 204 may be the opposite, or the straps 201 and 203 may be opposing poles. The straps 201, 202, 203 and 204 may be saturated by the magnets 209, 210, 211 and 212 to make possible opposed poles at their opposite ends to define the uniform field components. To the extent the magnet adjustment provides such a uniform field through the tube 10, the unit of Figure 10 serves to shift all the ray beams uniformly at all positions of shift. It thus provides some correction for deviations in the direction of ray beam travel that are uniform—such as those due to a misalignment of the neck of the tube in relation to the bell and viewing screen. Also, such a field tends to overcome and compensate for stray magnetic fields within the tube, including the earth's magnetic field.

It will, of course, be understood that numerous forms of the color purifier magnet assemblies 21, 121, and that of Figure 10 may be used. For example, the magnets may be detachably connected on some support which encircles the bell of the tube and simply adjusted by adding the same in somewhat the same fashion as wheel weights are used to provide static and dynamic balance of automobile wheels. The significant feature is that the magnets are effective on the respective ray beams after the same have been deflected, and that the magnets extend generally around the periphery of the tube and be capable of independent adjustment as to orientation and intensity so that the respective red, blue and green color rasters can be made pure in color.

Apparatus constructed in accordance with the present invention has been highly successful. Heretofore, it has been standard practice to attempt to make all ray beams pass through the "color centers" of the tube. These are the points where the ray beams—if in perfect aligned condition—would intersect the plane of the field of the deflection yoke (plane B—B, Figure 1). In efforts to secure this orientation and positioning, complicated color purity correctors have been provided on the necks of the cathode ray tubes. The result has been a plurality of adjustments and in addition it has been necessary to provide on the convergence magnets both static and dynamic fields (as by the use of windings on the cores 36*b*, 36*g*, and 36*r*, Figure 7) so that the ray beams are, in effect, recorrected as the sweep progresses. This not only increases the expense of the unit but in addition it entails a great number of adjustments and demands the generation of varying forms of voltages that otherwise would not be necessary. Also, the dynamic convergence coils take power from the ray beam sweep mechanism and thus demand components of increased size.

The advantages of the apparatus of the present invention are particularly marked in the form of the invention shown in Figures 11–15 where the electron guns are in a common plane. For example, in one receiver construction the number of dynamic convergence adjustments was reduced from 12 to 8 with the incident reduction in adjustment time and an improvement in color purity. Moreover, the shadow mask type tube when so constructed can be used with shadow mask openings of greater diameter. In any shadow mask type tube there is a substantial loss of efficiency due to the fact that the shadow mask serves to prevent some electrons from reaching the phosphor screen and creating illumination.

The extent of this loss of efficiency is determined by the size of the openings in the shadow mask, the larger each opening, the greater the efficiency. However, one of the limiting factors in determining the size of these openings is the extent to which convergence error causes the respective ray beams to deviate from their intended position on the viewing screen. The smaller the openings are in the shadow mask the less degradation in color purity results from such error. Conversely, when the degree of convergence is increased—as by the apparatus of the present invention—the size of the openings can be increased without causing electrons from any electron gun to strike the phosphor screen at a point producing the wrong color. The efficiency of the tube is accordingly increased.

In addition to the foregoing advantages, the apparatus of the present invention has provided a reduction in the number of rejected tubes, since it makes possible to shift the raster as much as 1½ inch without undue degradation of color purity. Moreover, the focus of the respective ray beams is improved and localized deviations from color purity not correctable by the prior apparatus has been found correctable. In addition, the problem of neck shadow is greatly reduced. This is exceedingly important in connection with the form of the invention shown in Figures 11 to 15, since one of the problems of having the ray beams at a substantially spaced position is that the greater spread of the beams makes the outside beams strike the bell of the tube at a comparatively small angle of sweep, thus making the neck shadow problem more acute. It may be added that the apparatus also provides a correction for stray magnetic fields such as the earth's magnetic field.

A measure of the practical advantages provided by the apparatus of the present invention is that with the delta type gun arrangement of Figures 1–9, it usually takes an expert particularly skilled in color purity adjustments a period of 20 to 30 minutes to converge a receiver and obtain a reasonable degree of color purity. The problem has been so troublesome that most television receiver manufacturers have a relatively few men who concentrate upon this work and become the local "experts" in converging the receivers to provide optimum color purity. The average serviceman cannot effectively adjust such receivers for convergence—except on the basis of an intolerable amount of adjustment, test, readjustment, etc. With the apparatus of the present invention it has been found possible for a reasonably skilled technician to provide adequate color purity in a few minutes, which means not only that the cost of manufacture is greatly reduced but—of equal importance—it has been possible to have a reasonably skilled television repairman make the necessary adjustments so that color television receivers heretofore not serviceable in the field can be serviced.

While I have shown and described specific embodiments of the present invention it will, of course, be understood that various modifications and alternative construction may be used without departing from the true spirit and scope thereof. Thus the positions of the magnets may be moved towards or away from the shadow mask to alter the extent the ray beams are deflected selectively, the phosphor screen may be curved and perhaps coextensive with the face of the tube, the guns in a planar type tube may be aligned vertically, and other variations may be employed. I therefore intend by the appended claims to cover all such modifications and alternative construction as fall within their true spirit and scope.

What I claim as new and desire to secure by Letters Patent of the United States is:

The process of adjusting a color television receiver for color purity, the receiver having a multi-gun tube in which the color pure operation requires the electron streams to approach the screen as if from predetermined color centers, means to adjust the orientation of the electron streams prior to deflection, and a series of universally rotatable magnets disposed in a ring about the ball of the tube, the process comprising: operating the receiver with deflection and with said magnets parallel to the direction of ray beam travel and adjusting the orientations of the electron streams by said first means to produce light of their respective colors at the center of the viewing screen; operating the receiver with sweep and with all but one electron stream suppressed and adjusting said magnets to provide a color pure raster of the color of said one stream; repeating this adjustment for each of the other electron streams to obtain rasters of the respective colors; and repeating the above two adjustments to compensate for interactions between the successive steps.

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