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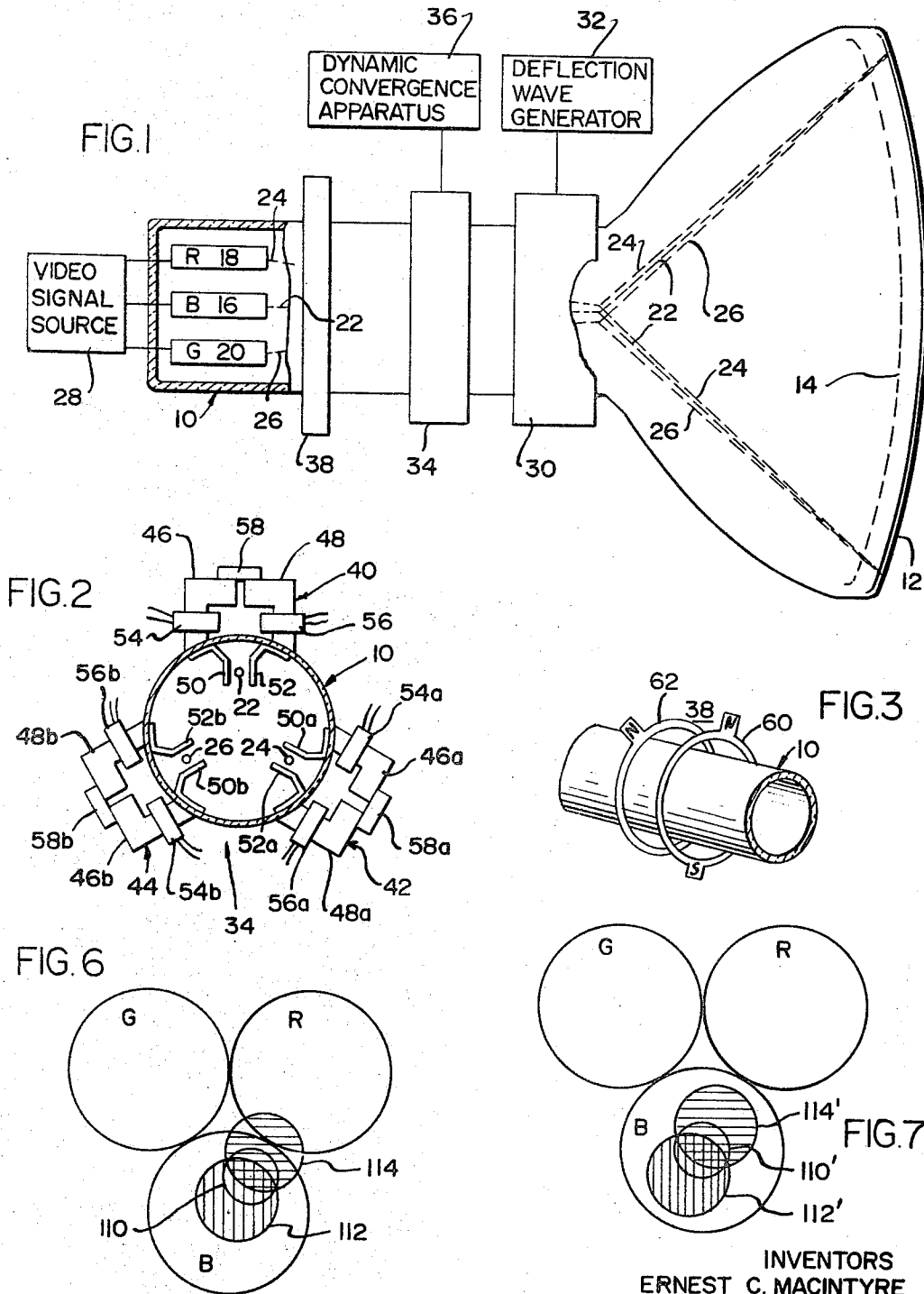
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METHOD AND APPARATUS FOR ADJUSTING PURITY

Filed April 28, 1967

Sheet 1 of 2



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FIG. 4

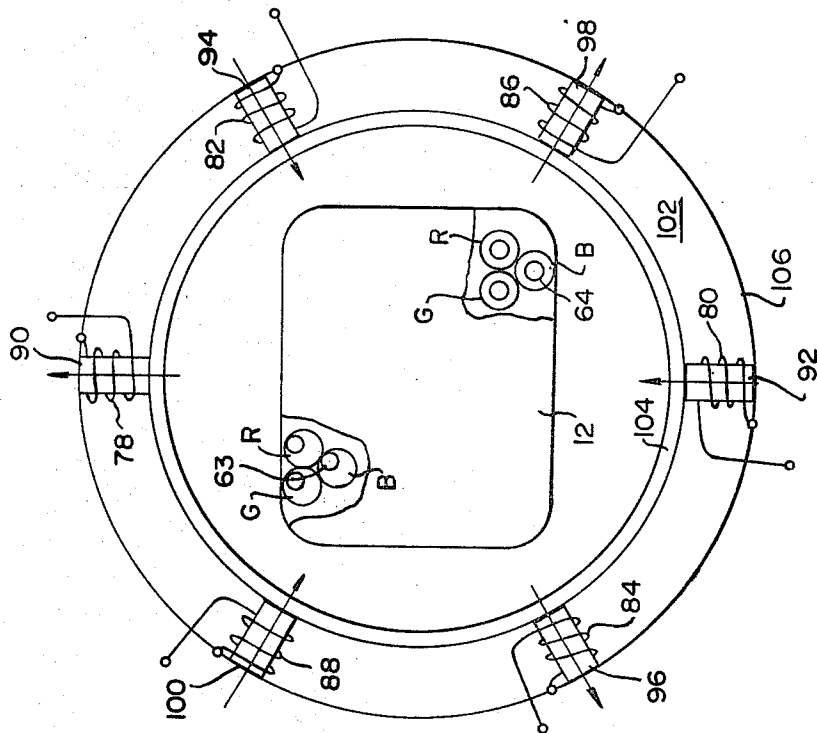
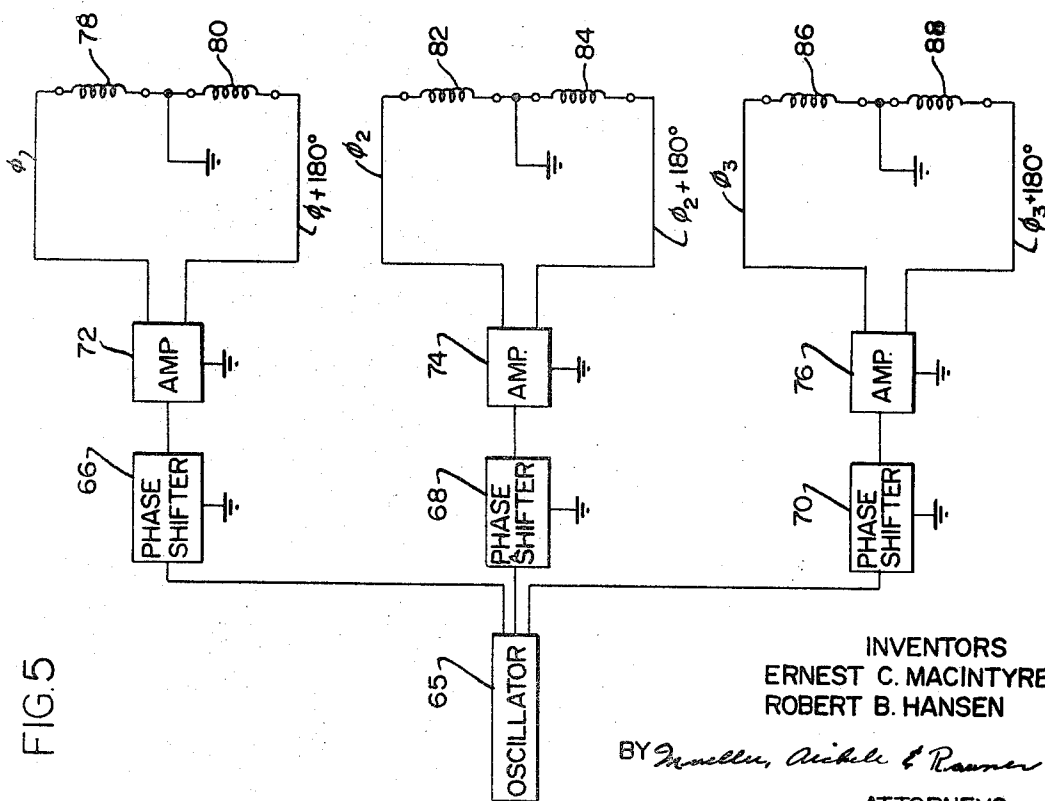


FIG. 5

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METHOD AND APPARATUS FOR ADJUSTING PURITY

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11 Claims

ABSTRACT OF THE DISCLOSURE

The method includes rotating at least one of the electron beams in a cathode ray tube along the beam's axial path so that it may illuminate other than its associated fluorescent dots on the tube screen. During rotation, the axial path of the beam is shifted by purity magnets or the like, in a direction to minimize illumination by the one beam of other than its associated dots. When the rotation is then terminated, there is a maximum guard band surrounding the areas of associated dots illuminated by the one beam over the entire screen.

Background of the invention

The cathode ray tube generally used in color television receivers is of the type which has a screen composed of a multiplicity of fluorescent dots arranged in geometrically similar groups, and a shadow mask mounted between the screen and a plurality of electron guns. Each of the different fluorescent dots in each group possesses a response characteristic and is capable of emitting light of a particular primary color when impinged by an electron beam. The guns are arranged with respect to one another so that they individually direct a beam through the common apertures of the shadow mask from different angles so the beams impinge associated ones of the fluorescent dots. The beams are swept across the screen by horizontal and vertical deflection apparatus to produce a multi-colored reproduction of a televised scene.

Because of imperfect placement of the various elements in the cathode ray tube, such as the guns and the mask, the cathode ray beams may undesirably impinge other than their associated fluorescent dots. In order to preclude this, it is common practice to provide a set of purity magnets or the like to simultaneously shift the axial paths of the cathode ray beams. This may be done by turning on and deflecting only one beam, such as the one associated with the blue portion of the image, and adjusting the magnets for the best blue field, or it may be done by turning on all the beams and adjusting for the best white field. It is desirable to permanently adjust the magnets at the factory where the earth's magnetic field is in a given direction and of a given magnitude. If, then the color television receiver is used in another location where the earth's magnetic field is different, the axial paths of the cathode ray beams may be affected to such an extent that they impinge on other than their associated fluorescent dots which adversely affects the purity of the reproduced picture.

Since only portions of the areas of the dots are illuminated, the ideal procedure would be to adjust the purity magnets so that the cathode ray beams illuminate precisely the center portions of their associated dots over the entire screen. If the earth's magnetic field changes when the receiver is used in a new location, the beam impingements move outwardly toward the peripheries of their fluorescent dots but are still contained therein so that there is no loss in purity. However, with present practices, such central placement of the beams is purely a matter of chance because if, for example, purity

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is adjusted when the blue gun is on, the technician will simply adjust the magnets for the best blue field. With this procedure, the blue beam may impinge the peripheries of the blue dots throughout the screen and, therefore, it is quite possible that such beam will impinge other than its associated dots by a slight change in the earth's magnetic field. Another possible effect of such an alignment procedure is that certain areas of the screen will have the central portions of the blue dots illuminated while in other areas, the peripheral portions of such dots will be illuminated. In such case it is desirable to effect a compromise so that there is at least some tolerance or guard band over the entire screen.

Summary of the invention

It is, therefore, an object of this invention to adjust purity in a given receiver location and thereby optimize purity for all locations.

Another object is to provide a maximum tolerance or guard band between the areas of fluorescent dots illuminated by an associated electron beam and fluorescent dots not associated therewith.

In a specific form of the invention a cathode ray tube to be aligned is of the type which has a screen covered by fluorescent dots of a plurality of different color response characteristics. The tube contains a shadow mask having a multiplicity of systematically arranged apertures through which a plurality of cathode ray beams pass along different angularly related paths to impinge upon and illuminate a portion of the areas of associated fluorescent dots. The circumferential spacing or guard band between such areas and non-associated fluorescent dots over the entire screen is to be maximized by rotating, or deflecting in a given path, at least one of the beams about its axial path to subject other than its associated dots to be illuminated thereby. The axial path of the one beam is then shifted by static purity adjustment in a direction to minimize the total screen illumination of the fluorescent dots not associated with the one beam. When the rotation is then terminated the guard band of beam landing on the intended phosphor dots is at a maximum over the entire screen.

Description of the drawings

FIG. 1 is a plan view representation of a tri-gun cathode ray tube with the beam shift apparatus, convergence assembly and deflection yokes shown in block form;

FIG. 2 schematically illustrates the convergence assembly of FIG. 1;

FIG. 3 illustrates the purity magnets which may comprise the beam shift apparatus in FIG. 1;

FIG. 4 schematically illustrates the screen of the cathode ray tube of FIG. 1 with enlarged fragmentary portions and illustrative apparatus for rotating the cathode ray beams;

FIG. 5 is a block diagram of the type of circuitry which may be used to energize the beam rotating apparatus of FIG. 4;

FIG. 6 is an enlargement of a color dot triad illustrating the effect of rotating one of the cathode ray beams; and

FIG. 7 illustrates the effect of shifting the axial path of the cathode ray beam while it is rotating.

Detailed description

Referring now to the color television receiver of FIG. 1, the tri-gun cathode ray tube 10 has a screen 12 provided with a multiplicity of fluorescent dots arranged in groups of three, and capable respectively of producing light of a different primary color such as red, blue and green when impinged by an electron beam. In back of and spaced from the screen 12 there is a shadow mask

14 having an aperture for and in substantial alignment with each group or triad of fluorescent dots on the screen 12. The tube has a plurality of electron guns such as a blue gun 16, a red gun 18, and a green gun 20, equal in number to the number of primary colors in which the image is to be produced. When the "blue beam" 22, the "red beam" 24 and the "green beam" 26 from these guns properly converge at the shadow mask 14, they simultaneously pass through each aperture from different directions and impinge upon associated fluorescent dots so as to produce blue, red and green light. The electron beams are modulated in intensity under the control of color representative video signals derived from a source 28. Also associated with the cathode ray tube are a set of horizontal and vertical deflection yokes indicated generally by block 30 which are energized by a deflection wave generator 32 to scan the screen 12. A convergence assembly 34 shown in some detail in FIG. 2 is energized by dynamic convergence apparatus 36 to converge the three electron beams at all points of the shadow mask 14. Beam shift apparatus 38 may comprise a pair of magnets as shown in FIG. 3 and as explained in more detail hereinafter, serve the purpose of simultaneously shifting the axial paths of the three cathode ray beams.

Referring now to FIG. 2, the convergence assembly 34 includes convergence magnets 40, 42 and 44 each consisting of a pair of external pole pieces 46 and 48 and a pair of internal pole pieces 50 and 52 to increase the effectiveness of the magnets. (The letters *a* and *b* on the reference numerals indicate similar parts on magnets 42 and 44.) The coils 54 and 56 are energized by the dynamic convergence apparatus 36 (FIG. 1) to converge the electron beams 16, 18 and 20 to all points on the screen 12. Also associated with each convergence magnet is a static convergence magnet 58 to independently displace the electron beams 22, 24 and 26 radially to insure that they are initially converged at a selected position on the shadow mask 14. However, due to imperfect location of the elements within the cathode ray tube, such as the electron guns 16-20 or the mask 14, the central axis of the guns may not be aligned with the center of a given dot group behind the aperture at such selected position. This may cause the beams to impinge upon other than associated dots.

In order to compensate for this, the beam shift apparatus 38 of FIG. 1 is provided which may consist of a pair of purity magnets 60 and 62 as shown in FIG. 3. They are magnetized in a manner such that when they are rotated with respect to each other to a position where the flux fields are aiding, the beams are displaced the greatest amount, and when they are turned so that the flux fields are subtracting, the beams are not affected. Any desired degree between zero and maximum may be obtained by rotating one magnet with respect to the other. The direction of movement may be altered as desired by rotating both magnets together. Thus, by properly adjusting the position of the magnets, the axial paths of the three beams may be simultaneously shifted so that they land only on their associated dots and thereby provide optimum purity. The use of magnets is merely illustrative and other known means to simultaneously shift the paths of three beams may be employed. Preferably the deflection yokes are axially movable to aid in purity adjustments. This purity adjustment procedure may be effected in a variety of ways, but generally, only one of the guns, such as the blue gun 16, is turned on. As the blue beam 22 is deflected across all of the associated dots on the screen 12, by the deflection wave generator 32, the magnets are adjusted until there is no red and green showing. Since the three beams are similarly affected by the magnets, such adjustment should optimize purity for all three.

Referring now to FIG. 4, the screen 12 comprises a multiplicity of triads of red, blue and green color fluorescent dots, the color response characteristics being indi-

cated as R, B and G with a pair of enlarged triads shown in opposite corners. In the following description, although only one triad at a time may be considered, it should be remembered that the beams will illuminate other triads at the same instant in time due to the beam having a size larger than the apertures in the shadow mask 14.

Suppose after adjusting the magnets the blue beam 22 illuminates an area 63 in the upper left hand corner of the screen 12, and an area 64 in the lower right hand corner thereof. As far as the technician who adjusts the magnets can see, the purity is optimized because although the blue beam 22 lands near the periphery of its associated dot in the upper left hand corner, it still appears blue. If, with this setting, the television receiver is used in a different location where the intensity and/or direction of the earth's magnetic field is different, the blue beam 22 may move to the right to undesirably impinge part of the red dot. Since the purity magnets and the earth's magnetic field affect all three beams simultaneously, the red and green beams 18 and 20 will move in the same direction by corresponding amounts.

It is desirable, therefore, that when the technician is adjusting for purity, he should adjust it in such a way that the blue beam 22 lands precisely in the center of the blue dot throughout the screen 12. Then when the set is moved to a different location, the blue beam, and thus the other beams, will still land on their associated dots. Even in the case shown in FIG. 4, where the blue beam (and the green and red beams) cannot be placed in the central portion of its dots throughout the screen, if the axial paths of the beams were moved slightly to the left by the beam shift apparatus 38, they would no longer be centered in the lower right hand corner of the screen 12, but, more important, they would not land on the periphery of the dots in the upper left hand corner. Now, a change in the earth's magnetic field will shift the beams but since there is some guard band or circumferential spacing between the area illuminated by an associated beam and a non-associated dot, there is less possibility of a loss in purity. The object then is to center the electron beam on their associated dots throughout the screen, to thereby provide the maximum possible guard band for each dot, or if that is not possible, at least effect a compromise so that the circumferential spacing between the areas illuminated by an associated beam and fluorescent dots not associated with that beam is maximized over the entire screen. This is accomplished by using the method of the invention which includes rotating the beam to make it more susceptible to impinge on other than associated dots and then adjusting the beam shift apparatus 38 to minimize this latter impingement.

Exemplary apparatus for providing such rotation is shown in FIG. 5 and includes an oscillator 65, three phase shifters 66-70 to produce three signals having a selected phase relationship such as 0°, 60° and 120°, which are then amplified by amplifiers 72-76 and applied to three pairs of windings 78-88 having the junction between each pair grounded. Thus the windings will have the following phase relationship: winding 78 at 0°, winding 80 at 180°, winding 82 at 60°, winding 84 at 240°, winding 86 at 120°, and winding 88 at 300°.

As shown in FIG. 4, the windings are respectively wound on iron cores 90-100 in a direction to cause the flux to be as indicated by the arrows. The cores are mounted within an annular frame 102 encircling the portion of the cathode ray tube 10 adjacent the shadow mask 14 (FIG. 1). The frame has a non-conductive innerpart 104 and a conductive strap 106 to help contain the magnetic field created by these windings and to provide a convenient common ground connection. By using three phase analysis, it can be shown that a beam on a path to impinge the screen 12 will be rotated at a frequency determined by the frequency of the signal devel-

oped by oscillator 63 with the radius of rotation determined by the amplitude of the signals in the windings. The six pole scheme is merely illustrative and either more or less poles or other means to develop a rotating field such as electrostatic means may be utilized and yet come within the scope of the invention. Alternately instead of encircling the portion of the tube adjacent the shadow mask, as shown, the frame 102 may be placed at any convenient location all the way back to the electron guns 16-20.

To understand the effect of the rotating field, reference is made to FIG. 6 which illustrates the fluorescent dot triad in the upper left hand corner of the screen 12 of FIG. 4 on an enlarged scale. It is assumed here that the blue beam 22 initially impinges and illuminates the upper right hand area of the blue dot. When the rotating field is applied, the beam moves in a circular path indicated by numeral 110 with the radius thereof determined by the amplitude of the signals in the windings 78-88. At one instant of time during such movement, the blue beam will land in a position to illuminate an area 112 (vertically hatched (entirely within the blue dot and at another instant, it illuminates an area 114 (horizontally hatched) where a portion of the red dot is also illuminated. The technician seeing that the blue beam 22 is impinging other than its associated dot, will adjust the magnets 60 and 62 shown in FIG. 3 so as to move the rotating blue beam down and to the left to the position shown in FIG. 7 where the respective illuminated areas are 112' and 114', both being within the blue dot. In such position, the blue beam 22 will rotate along the circular path 110 and illuminate only areas within the blue dot. When the rotation is terminated, the blue beam 22 will land precisely in the center of the blue dot. However, it will be noted that such adjustment of the magnets 60 and 62 will shift the blue beam so that it will now impinge the lower left hand side of its associated blue dot in the lower right hand corner of the screen 12 of FIG. 4. Thus, instead of moving the blue beams as far over as indicated in FIG. 7, the final position should be somewhere between that shown in FIGS. 6 and 7 to effect a compromise.

Since the magnets simultaneously affect the axial paths of all three beams, what has been said with respect to the areas illuminated by the blue beam 22 is similarly applicable to the red and green beams 24 and 26. It is, of course, possible that when the static convergence magnets 58, 58a and 58b of FIG. 2 are adjusted to converge the beams at a given position on the mask 14, and the dynamic convergence apparatus 36 converges the beam over the entire mask, the placement of the guns 16-18 and the mask is such that each beam illuminates the same area of their associated dots over the entire screen. In such case after rotating and shifting the beams, they will illuminate the center of their associated dots. In any case whether or not the elements are ideally placed, the beams are shifted, while rotated in a direction and by an amount such that the tolerance or guard band between the area of an associated dot illuminated by an associated beam and a non-associated dot is maximized over the entire screen 12.

Although an impure blue field is more easily detected, purity could be adjusted with either the red or green guns 18-20 on and maximizing the red or green fields respectively. Or, all three guns 16-20 may be turned on simultaneously rotating the beams 22-26, and shifting the axial paths of the beams by the permanent magnets 60 and 62 of FIG. 3 to produce a white field on the screen 12.

Preferably in order that this rotating field be more perceptible that is, easier for the technician to see the beam movement from blue to green to red, etc., the frequency of rotation of the beam should be a few cycles per second. Since the frame frequency is 60 cycles per second, that is, a given dot will be energized every 60th of a second, it is desirable that the oscillator be a few cycles off such frequency or a multiple thereof so that a strobo-

scope effect does not occur. If, for example, the frequency of the signal from oscillator 65 is 62 cycles per second, the beam will appear to rotate at a 2 cycle rate. When the magnets are improperly adjusted, the technician will see color "flashing" over those areas of the screen where the beam is impinging other than associated dots. For example, if the rotation was clockwise, he would see a flash of blue, followed by a flash of blue-green, then possibly all three colors, etc. As the deviation from the frame frequency increases, the speed of rotation is also increased. The rotation of a beam may also be viewed as an effective way to increase the diameter of its "landing." It should be remembered, however, that at each instant of time, a number of triads will be impinged due to the diameter of each beam being large enough to pass through several apertures in the shadow mask 14. Thus, "landing" means the landing of one beam as it passes through a given aperture. If the area of landing of a non-rotating beam is a given percent of the area of a fluorescent dot, when the beam is then rotated the effective area of the beam landing will increase proportional to the amplitude of the signals applied to the windings 78-88 of FIG. 4, in turn proportional to the amplitude of the signal from oscillator 65. Assuming perfect cathode ray tubes could be manufactured, it would be desirable to select the amplitude of the signals in the windings such that the circular path 110 of the rotating beam is large enough that the beam landing has an area substantially equal to the area of a fluorescent dot. In such case when the technician adjusts the purity magnets 60 and 62, the blue beam will entirely fill up each blue dot to thereby provide the best blue field and at the same time an optimum guard band over the entire screen 12. If any imperfections exist in the cathode ray tube, however, flashing colors will appear on certain areas of the screen 12, irrespective of the adjustment of the purity magnets 60 and 62. It is possible to utilize such a large amplitude or even a larger one, in which case the purity magnets would be adjusted to minimize the amount of flashing. However, it is preferable to reduce the amplitude of the signals through the windings 78-88 to a point where most tubes will provide no flashing when the purity magnets are properly set. In such case the technician has the simple task of turning on the rotating field and adjusting the magnets 60 and 62 until he sees a blue field.

The method disclosed herein is not only useful in aligning a color television receiver but may be also useful in incoming inspection to determine the quality of color cathode ray tubes. In such case the amplitude of the signal from oscillator 65 would be selected to provide a given radius of the rotating beam. If the technician could not adjust the purity magnets 60 and 62 to cause the beam to impinge only its associated dots, such tube would be rejected. It may be seen that as the signal amplitude is decreased, the radius of the beam rotation decreases, and less tubes will be rejected, but the average size of guard bands would probably be less.

The invention is not limited to circular rotation of the beams, but rather may involve a complex rotation, for example, to compensate for beam shift due to temperature changes in the cathode ray tube elements.

We claim:

1. In the method of aligning a cathode ray tube of the type which has a screen covered by fluorescent dots of a plurality of different color response characteristics, and which tube contains a shadow mask having a multiplicity of systematically arranged apertures through which a plurality of cathode ray beams pass along different angularly related paths to impinge upon and illuminate a portion of the areas of associated fluorescent dots, the method of maximizing the circumferential spacing between such areas and non-associated fluorescent dots over the entire screen, which method includes the steps of: rotating at least one of said beams about its axial path towards the screen to subject other than its associated dots to be il-

luminated thereby, shifting said axial path in a direction to reduce the illumination of other than the fluorescent dots associated with said one beam, and terminating the rotation of said one beam.

2. The method of aligning a cathode ray tube according to claim 1 wherein the axial path of said one beam is continually deflected so that during one complete scan of the screen it impinges substantially all of its associated dots, the rotation of said one beam being performed while the one beam is being deflected.

3. The method of aligning a cathode ray tube according to claim 1 wherein said plurality of different color response characteristics of the fluorescent dots and the plurality of cathode ray beams number three, simultaneously rotating said three beams about its axial path, shifting said axial paths in a direction to produce a maximum white field on the cathode ray tube screen.

4. The method of aligning a cathode ray tube according to claim 1 wherein the rotation of said one beam is circular.

5. The method of aligning a cathode ray tube according to claim 1 wherein said one beam is vertically deflected across the cathode ray tube screen at a 60 cycles per second rate, rotating said one beam in a circular motion simultaneous with the deflecting of the axial path at a frequency at least one cycle per second removed from said 60 cycles per second rate.

6. The method of aligning a cathode ray tube according to claim 1 wherein the rotation increases the effective area of impingement by the one beam passing through a given aperture in the shadow mask, the radius of rotation of the beam selected to cause the effective area to be no more than the area of a fluorescent dot.

7. In the method of aligning a cathode ray tube of the type which has a screen covered by fluorescent dots of a plurality of different color response characteristics, and which tube contains a shadow mask having a multiplicity of systematically arranged apertures through which a corresponding plurality of cathode ray beams is passed along different angularly related paths to impinge upon associated fluorescent dots, with a given beam subject to illuminate approximately the central area of some of its associated dots and a peripheral area of other of its associated dots, the method of maximizing the number of dots having areas intermediate said peripheral and central areas illuminated by the given beam, which method includes the steps of: continually deflecting the axial path of said given beam so that during one complete scan of the screen it impinges substantially all of its associated dots, rotating said given beam in a circular motion about such path to increase its effective size at the screen to subject other than its associated dots to be illuminated by said given beam to thereby indicate the number of dots having peripheral areas illuminated by said given beam when it is not rotating, shifting said axial path in a direction to minimize the illumination of other than the dots associated with said given beam over the entire cathode ray tube screen and thereby reduce the number of associated dots having a peripheral area illuminated by said given beam and increase the number of dots having approximately the central area illuminated thereby, and terminating the rotation of said given beam.

8. The method of aligning a cathode ray tube according to claim 7 wherein said plurality of different color response characteristics of the fluorescent dots and the plurality of cathode ray beams number three, statically converging said three beams at a selected position on the shadow mask prior to rotation of said given beam.

9. The method of aligning cathode ray tube according to claim 7 wherein the axial path of said given beam is vertically deflected at a 60 cycle per second rate, and wherein the rotation of said given beam is at a frequency at least one cycle per second removed from an integral multiple of 60 cycles per second.

10. In the method of determining the quality of a cathode ray tube of the type which has a screen covered by fluorescent dots of a plurality of different color response characteristics, and which tube contains a shadow mask having a multiplicity of systematically arranged apertures through which a plurality of cathode ray beams pass along different angularly related paths to impinge upon and illuminate a portion of the areas of associated fluorescent dots, the method of determining whether the circumferential spacing between such areas and non-associated fluorescent dots meets a predetermined standard, which method includes the steps of: rotating at least one of said beams about its axial path towards the screen to subject other than its associated dots to be illuminated thereby, shifting said axial path in a direction to reduce the illumination of other than the fluorescent dots associated with said one beam, and rejecting as being of insufficient quality those cathode ray tubes which have a predetermined degree of illumination of non-associated dots during such rotation.

11. In combination with a cathode ray tube of the type which has a screen covered by fluorescent dots of a plurality of different color response characteristics, and which tube contains a shadow mask having a multiplicity of systematically arranged apertures through which a plurality of cathode ray beams pass along different angularly related paths to impinge upon and illuminate associated fluorescent dots, means for manually adjusting color purity by shifting the axial path of at least one of the beams, purity adjustment apparatus comprising, field producing means adapted to be mounted adjacent the path of the one beam for shifting its axial path, signal producing means coupled to said field producing means to provide a signal therefor of a frequency on the order of 60 cycles per second and of an amplitude to shift the axial path of said one beam so that the same falls on an area of the screen larger than the area thereof impinged with said purity adjustment apparatus disabled, whereby optimum adjustment of the means for manually adjusting color purity is more apparent.

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