United States Patent [19]

Aber

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[54] **COLOR CATHODE RAY TUBE DEFLECTION YOKE EVALUATION**

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[52] **U.S. Cl.** ..... **315/13 C**, 315/27 R, 315/8

[51] **Int. Cl.** **H01j 29/70**

[58] **Field of Search** ..... 315/13 C, 8, 13 R, 315/21 C, 21 R, 27 R; 324/44; 313/84; 178/7.5 TE

[56] **References Cited**

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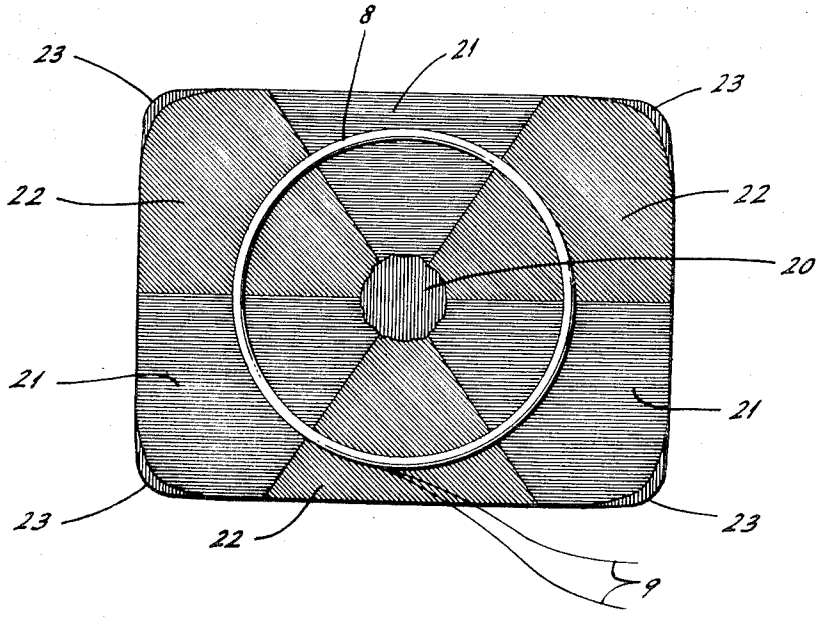
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[57] **ABSTRACT**

A method for evaluating the deflection center error between horizontal and vertical deflection coils in a deflection yoke for use with a shadowmask color cathode ray tube. The yoke to be evaluated is supplied with the usual vertical and horizontal deflection currents, and is placed in position on an operating cathode ray tube. The blue and green guns of this tube are turned off to establish a red raster, and an axial magnetic field is applied to the tube at the faceplate. Field intensity is adjusted to produce a color pattern having a red bullseye surrounded by alternating areas or sectors of blue and green, with small red color areas in the corners of the screen. The purity magnets are adjusted to center the bullseye. While maintaining a constant axial location, the yoke is rotated by at least a quarter turn. As the yoke is rotated any video patterns present will appear to rotate but the color pattern will remain essentially fixed. Any error in deflection centers between the horizontal and vertical coils will be manifested by motion in the blue and green color areas and the red corner spots. A yoke with no error in deflection centers will produce no motion of the color pattern during rotation.

6 Claims, 2 Drawing Figures



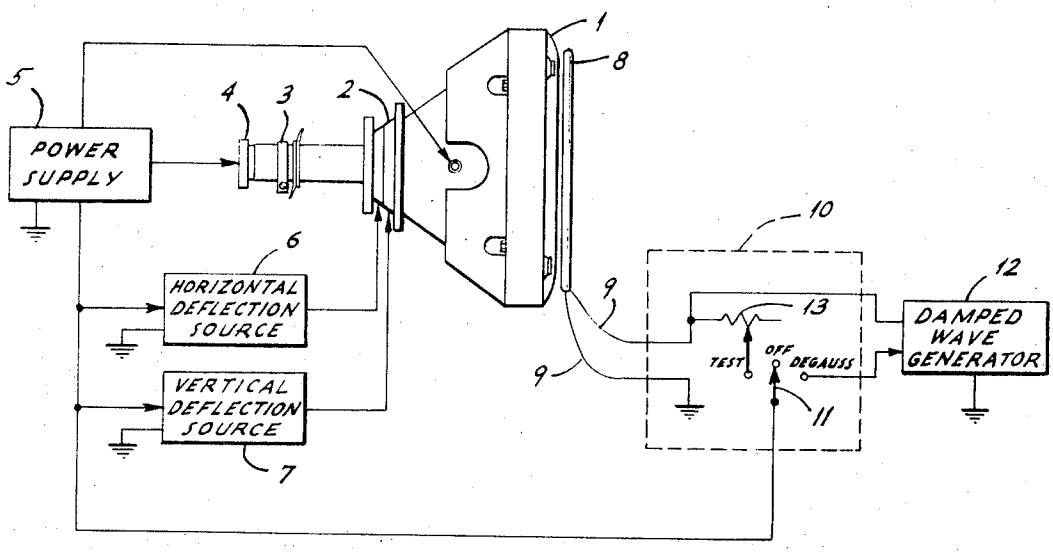

POWER SUPPLY
HORIZONTAL DEFLECTION SOURCE
VERTICAL DEFLECTION SOURCE
DAMPED WAVE GENERATOR
TEST
OFF
DEGAUSS
1
2
3
4
5
6
7
8
9
10
11
12
13

FIG. 1.

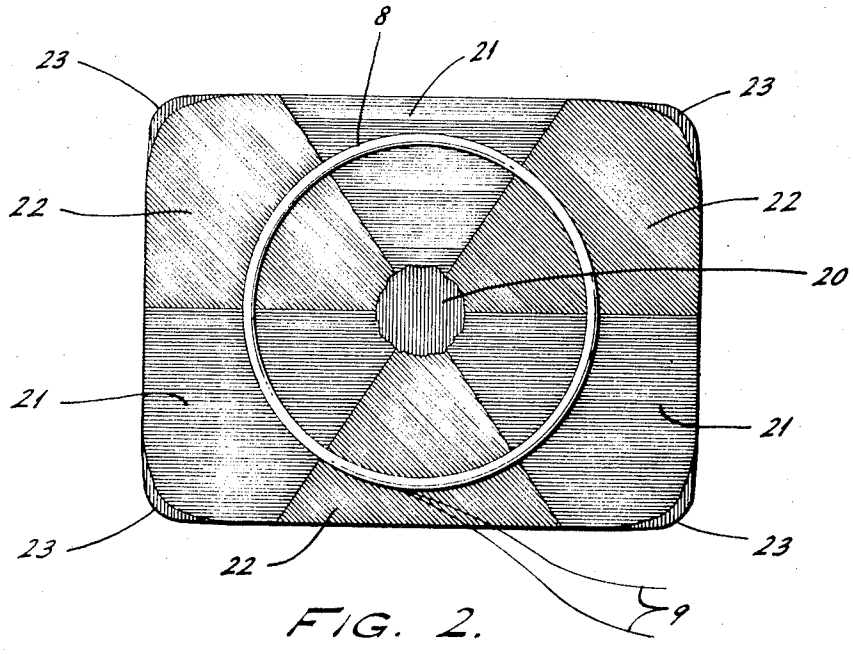

8
21
23
23
22
22
20
21
21
23
23
22
9

FIG. 2.

COLOR CATHODE RAY TUBE DEFLECTION YOKE EVALUATION

BACKGROUND OF THE INVENTION

In a color cathode ray tube (CRT) of the shadow-mask variety, as is currently used in the majority of color television receivers, three separate electron guns excite three separate phosphors on the faceplate. The phosphors are broken up into small dots arranged in triads of triangular form. Each triad includes a red, blue, and green dot and is aligned with a mating hole in the shadowmask so that each color dot is energized by the correct electron gun. The relationship between the shadow-mask and the phosphor dots is such that when an electron beam emanates from the correct point in the neck of the tube, its angle of arrival at the shadow-mask will be such as to project through the hole in the shadowmask and fall on the correct phosphor dot. This same condition will prevail for all deflection angles. This geometrical condition will be satisfied only if the electron beams are oriented to pass along the axis of the tube and if their center of deflection is made to coincide with that center for which the tube was designed.

Color purity is the term used to describe the ability of an electron gun to activate only phosphor dots of the intended color. In a color CRT display two adjustments are ordinarily applied to achieve color purity over the scanning raster. The first adjustment, for electron beam centering, is provided by a purity magnet assembly that ordinarily mounts just ahead of the CRT socket. This device provides a magnetic field normal to the tube axis and adjustable in magnitude and direction. This field compensates for CRT assembly errors and is adjusted so that the undeflected electron beams fall in the center of the faceplate. The second adjustment is the provision for moving the CRT deflection yoke along the neck of the tube in an axial direction. When the actual center of electron beam deflection coincides with the tube design center, the deflected beams will also fall on the correct phosphor dots.

Clearly, to achieve good color purity, the horizontal deflection coil must produce a center of deflection that registers with that of the vertical deflection coil. Thus color CRT yokes have a further critical assembly requirement not found in monochrome yokes. It has been found that for good color purity the deflection centers should be no more than about thirty thousandths of an inch apart. If the deflection centers do not coincide, the yoke cannot be adjusted to achieve color purity over the entire raster. For example if the horizontal coil is aligned so that its deflection center falls at the tube design center, correct beam landings will be observed on that horizontal line that passes through the center of the faceplate. Any vertical deflection will result in incorrect beam landing and if the error is sufficiently great, an incorrect phosphor can be excited thereby contaminating the color purity. This effect will be more pronounced at greater deflection angles. In practice the yoke position will be compromised to achieve the best possible color purity over the entire raster. This will occur for a yoke position that places the tube design deflection center somewhere between the actual deflection centers of the vertical and horizontal coils.

The additional performance requirement imposed on color yokes has produced the problem of how to measure the coil deflection centers to evaluate yokes. This can be important in quality control in yoke manufacturing and at incoming component inspection in TV receiver manufacturing.

The standard measurement method involves connecting the yoke to be tested to a conventional display. Only one gun is operated during the test. The system is first degaussed, the purity magnets adjusted for correct beam landing in the center of the display, and the yoke positioned for best color purity for deflected beams. Then a microscopic examination of beam landing points is made. The center dot beam landing is centered on the phosphor dot by observing the dot through a microscope and precisely adjusting the purity magnet so that the illuminated portion falls in the exact center of the dot. The vertical deflection coil is evaluated by observing a dot a measured distance above (or below) the center dot and the lack of beam landing concentricity measured. Knowing the CRT geometry, the location of the deflection center can be computed. The same procedure is applied to the horizontal deflection coil by observing the beam landing a measured distance to the right (or left) from the center dot. It can be seen that very careful measurements must be taken accurately to compute the deflection center. This can best be done by making the measurements on an enlarged calibrated photograph of the beam landing. Other measurement methods are available, some employing special CRT structures and equipment. However the methods of measuring are practically the same.

The above methods, while acceptably accurate, are very time consuming and will only operate on CRT designs where the phosphor dots are substantially larger than the electron beams. In the recently developed black matrix tubes, where the electron beams are larger than the phosphor dots, the above nethods cannot be used at all. The methods are clearly not amenable to mass production.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a simple means of indicating the degree of coincidence between deflection centers of the horizontal and vertical coils of a color CRT deflection yoke.

It is a feature of the invention to permit rapid evaluation of yokes without resorting to precision measurement.

It is a further feature to permit evaluation of yokes on CRT's of the type having phosphor dots smaller than the electron beams.

These and other objects and features are accomplished by operating the yoke to be tested on a test jig comprising a color CRT display that could be a conventional color TV receiver. The display is operated with little or no video to produce flat background and two of the CRT electron guns are turned off leaving a single color (usually red is preferred). An axial magnetic field of suitable magnitude is applied at the CRT faceplate. The radial components of this field will have the effect of rotating the scanning raster so that non axial electron beams will be deflected in proportion to the off-center distance. This produces a display having a central red bullseye surrounded by six wedge shaped color regions arranged in an alternating blue-green progression around the bullseye. At the extremes of deflection the beam landing shift is sufficient to pass beyond adjacent blue and green dots back into the red dot of the adjacent triads so that red corner spots are present.

At this point the purity magnets are set to center the red bullseye on the faceplate, following which the yoke is pushed up against the CRT bell.

While maintaining a fixed axial position against the bell, the yoke is rotated on the neck of the CRT and the color pattern is observed. If the yoke has coincident horizontal and vertical deflection centers, the above-described color display will remain unchanged during yoke rotation. (However video modulation patterns, if any, will rotate with the yoke.) Lack of deflection center coincidence will be indicated by motion of the color regions, particularly the red corner regions. Such motion will be related to the difference in (or error of) the deflection centers.

This method can be applied to any known form of shadow-mask color CRT, including those having electron beams larger than the phosphor dots.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** shows in partial schematic-block diagram form the elements required for practicing the invention; and

FIG. **2** shows the pattern of the preferred display of the CRT used in FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1** a conventional shadowmask color CRT is shown at **1.** It will be located in a cradle (not shown) as part of a test jig. It is preferred that the tube be in the 19V to 25V size range for convenient observation but other sizes will serve. The deflection yoke to be evaluated is shown at **2.** Aside from the purity magnet assembly at **3,** mounted forward of socket **4,** other CRT components, such as the blue lateral magnet, the convergence assembly, and centering magnets are dispensed with. A power supply **5** provides operating potentials for the CRT including high voltage, focus, and the electron gun voltages necessary to operate at least the red gun. Power supply **5** also powers two deflection sources, one at **6** for producing a sawtooth of current at the horizontal frequency, and one at **7** for producing a sawtooth of current at the vertical frequency. These waveforms do not need to be synchronized and may be of only approximately correct frequency.

All of the components described thus far are found in a conventional color TV receiver or display monitor and these devices can be employed for the yoke testing.

Coil **8,** which could consist of 200 close wound turns of number 25 wire, may have an outside diameter of about 12 inches. This coil is secured to the faceplate of CRT **1,** by means not shown, so that the coil axis is aligned with the axis of the CRT. Coil leads **9** connect to control box **10** which contains a switch and rheostat. Switch **11** has three positions, the center position being the "off" position. The right hand position of switch **11** is the "degauss" position. As the switch is thrown to the right, a damped wave generator **12** applies an alternating current to coil **8** of diminishing value which, after a short time, decays to zero. This action will degauss adjacent magnetic structures, including the CRT shadowmask and associated parts.

When switch **11** is thrown to the left or "test" position, power supply **5** supplies direct current to coil **8.** The magnitude of the current is adjusted by rheostat **13.** Because of the coil location, the magnetic field produced by this current coincides with the CRT axis and the undeflected central electron beam but forms an increasing angle for beams farther off axis. It can be seen that this field appears at the interior of the CRT and will effectively rotate the electron beam scanning raster about the center of the CRT faceplate. The amount of rotation is proportional to the field intensity and radial distance from the center of the CRT.

At the preferred field value, and with the deflection yoke located in its correct position, the display will appear as shown in FIG. **2.** With only the red gun on, central region or bullseye **20** will be red. Regions **21** are those where the magnetic field has shifted beam landings off of the red phosphor dots to the adjacent dots which will be blue or green depending upon the polarity of the field. If regions **21** are blue, regions **22** will be green. Regions **23** are still farther from the axis and represent still more beam landing shift. These regions will be red because the dot in the triad adjacent blue or green is a red one.

The yoke test sequence will be as follows. First yoke **2** is located in approximately its normal position on the CRT and the CRT is degaussed. Then, with the red gun on and switch **11** in the "test" position, rheostat **13** is adjusted for the desired pattern. Purity assembly **3** is adjusted to center the red bullseye **20** on the CRT face. Yoke **2** is then pushed up against the CRT bell. This may cause the color field regions to assume a somewhat asymmetrical shape and the edges may not be straight. However the CRT bell provides a convenient means for holding the yoke in a constant axial position and prevents yawing. The yoke is then rotated about the tube axis by at least 90°. The color pattern, particularly in regions **23,** is observed during yoke rotation. Lack of motion of the color pattern indicates coincidence of the horizontal and vertical deflection centers. Motion therefore is related to the error in deflection center coincidence.

If desired the yoke can be held in a mechanical device that permits the yoke to be rotated without yawing. This allows the test to be made at the desired yoke axial position and avoids distortion of the color pattern. However this refinement is not necessary.

The above process can be performed quickly and the character of a defective yoke ascertained immediately. The test could be used to screen incoming yokes to a receiver production line and this could be done on a 100-percent or a lot-sampling basis.

If desired, the color pattern could be outlined on a particular tube with grease pencil or crayon. If, upon yoke rotation, a particular yoke produces more than a prescribed amount of motion, it is rejected. If the motion remains within tolerance the yoke is accepted.

Calibrated markings can be achieved using test yokes of known characteristics. For example a given test setup can be first calibrated with a yoke having negligible deflection center error and the color areas marked on the tube face. Then a yoke having a known error that is considered barely acceptable is connected to the test device. The motion of the color regions is then observed and marked with a second set of outlines defining the limits of acceptability. Such a test yoke can be obtained by employing the laborious prior art method of measurement. The acceptable limit can be established by selecting a yoke where the microscopic beam landing observation shows that the error in landing, if

increased further, will result in color purity degradation.

After the yoke test, switch 11 can be moved to the "degauss" position and the damped wave train will remove any residual magnetic field that the test might have produced.

While the above preferred embodiment teaches the invention, alternatives will occur to a person skilled in the art. For example an adjustable permanent magnet could be used in place of the coil. Also, the degaussing function could be accomplished with a spinning permanent magnet and operated by removing it while spinning from the vicinity of the CRT. While the coil 8 is shown as round other shapes could be used. It is intended that the scope of the invention be limited only by the following claims:

I claim:

1. A process for evaluating the coincidence of deflection centers of the horizontal and vertical deflection coils of a magnetic deflection yoke for use with a shadowmask color cathode ray tube; said process being carried out on an operating shadow-mask cathode ray tube display including a shadowmask cathode ray tube having a neck portion and a bell portion, a power supply for producing the currents and potentials to operate said tube, horizontal and vertical deflection current supply sources, and an externally mounted adjustable color purity magnet assembly; said process comprising:

a. mounting the yoke to be tested in approximate position on said neck portion of said tube,
b. connecting said yoke to said deflection current supply source,
c. operating said tube so that only one of the three electron guns in said tube is functional,
d. establishing a magnetic field having an axial direction in said bell portion of said tube,
e. adjusting the magnitude of said field to produce a color pattern having a central bullseye surrounded by six, generally wedge-shaped alternating color regions,
f. adjusting said purity magnet assembly on said tube to produce a bullseye color corresponding to the desired color for the energized electron gun and to center said bullseye on the screen of said tube,
g. rotating said yoke around the axis of said tube while maintaining a fixed axial position to produce at least a 90° rotation, and
h. observing the motion of said color pattern and the motion of the juncture between said alternating color regions as said yoke is rotated, said motion being indicative of the degree of lack of coincidence between said horizontal and vertical deflection centers.

2. The process of claim 1 wherein said yoke is rejected as defective when the observed motion of said color regions exceeds a predetermined value.

3. The process of claim 1 wherein the CRT is degaussed prior to the process steps recited in clause (d).

4. The process of claim 3 wherein the CRT is again degaussed following the yoke evaluation.

5. The process of claim 1 wherein the magnitude of said field is adjusted in the process step recited in clause (e) to produce a color pattern further characterized as having corner color regions of the color of said bullseye, and the observing step identified in the process step recited in clause (h) includes observing the motion of said corner color regions.

6. The process of claim 1 wherein said fixed axial position identified in the process step of clause (g) is maintained by pushing said yoke up against said bell portion of said tube.

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