Jan. 3, 1956 J. K. KRATZ ET AL 2,729,759

BEAM CONTROLLING APPARATUS

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Fig. 1.

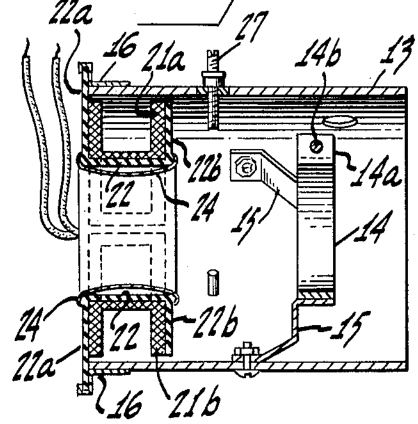


Fig. 3.

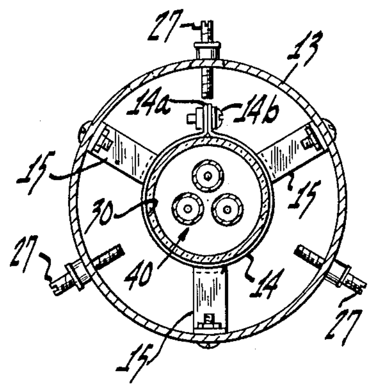
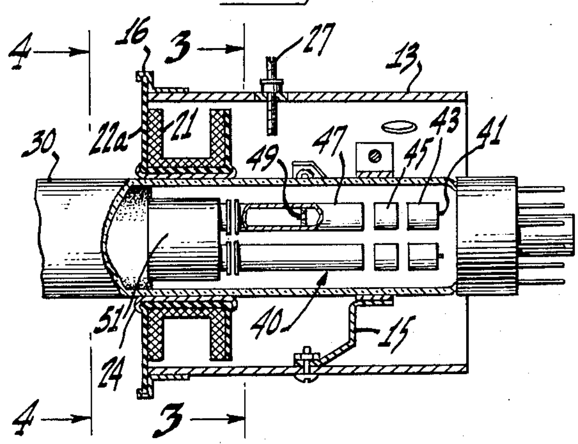


Fig. 2.



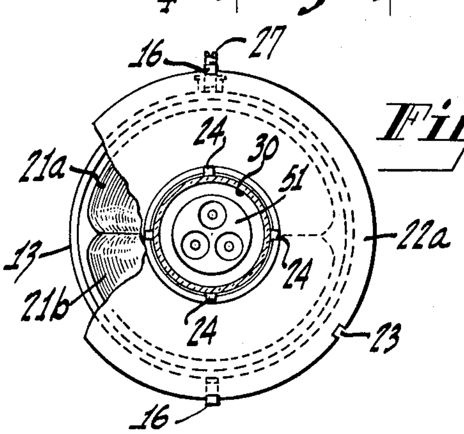


Fig. 4.

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BEAM CONTROLLING APPARATUS

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10 Claims. (Cl. 313—70)

This invention relates generally to image reproduction apparatus for color television, and more particularly to beam controlling apparatus for use with multiple gun kinescopes.

The invention will be described in connection with a three-gun color kinescope of the shadow-mask type, such as described in the article entitled "A three-gun shadow-mask color kinescope" by H. B. Law, appearing in the October 1951 issue of the Proceedings of the I. R. E. However, the applicability of the invention to use with other types of image reproducers should be noted.

In the three-gun shadow-mask color kinescope described in the aforementioned article, three electron beams are used, one for each primary color. The beams strike a phosphor screen composed of a regular array of red-, green-, and blue-emitting phosphor dots. Between the electron gun position and the phosphor screen, there is placed a thin perforated metal sheet for the purpose of partially masking the electron beams. The phosphor screen is made up of closely spaced phosphor-dot trios on a flat glass plate, each trio consisting of a red-, green-, and blue-emitting phosphor dot with the centers of the dots lying at the corners of an equilateral triangle. The trios themselves lie at the corners of an equilateral triangle of large size. Associated with each of the phosphor trios is a hole in the shadow-mask, these holes also being located at the corners of an equilateral triangle. The three beams, located 120° apart about the tube axis, are converged to a point on the mask by a lens system. The electron beam which is to contribute the red part of the picture is prevented, by the mask, from striking those areas on the screen containing blue and green emitting phosphors. Likewise the green and blue beams can strike only the green and blue emitting phosphor dots, respectively.

In an article entitled "Deflection and convergence in color kinescopes" by Albert W. Friend, appearing in the same issue of the Proceedings of the I. R. E., the deflection convergence problems associated with a color kinescope of the above described shadow-mask type are discussed. In describing the convergence operations associated with the three-gun color kinescope it is pointed out that the color kinescope may contain a triangular array of three parallel electron guns which should project their beams symmetrically into a "convergence anode" cylinder. From this anode space they pass through a convergence lens formed by the opening of the end of the convergence anode cylinder and into the final (accelerating) anode portion of the tube neck, which is provided with a conductive coating on the inside. A D.-C. potential (of approximately 10 kv., for example) is applied across the convergence lens elements to cause the three beams to converge at the plane of the apertured mask.

However, as pointed out in the aforementioned Friend article, manufacturing tolerances make it difficult to produce triple-gun assemblies in which the guns are pre-

cisely parallel to each other and to the central axis of the tube. Thus, a uniform transverse magnetic field produced by a "color purity coil" may be applied to all the electron beams to orient the system of beams as desired. This coil uses either a rotatable yoke-like single pair of coils, or two fixed pairs of coils at right angles, fed from an adjustable source of D.-C. The use of such a "purity coil" to deflect the three beams equally so that they may be adjusted to pass through their respective color centers is explained in greater detail in the copending application of Albert W. Friend, Ser. No. 202,185, filed December 22, 1950, and entitled "Beam Alignment Device," now U. S. Patent 2,719,249, issued September 27, 1955.

As also discussed in the aforementioned Friend article, the individual beams can also be adjusted separately by use of small permanent beam alignment magnets. The provision of swivel type adjustable mounts to permit almost complete freedom of positioning of each of the beam alignment magnets within a region where the magnetic effect was greater for one of the beams than for the other beams, and the pattern of adjustment of the magnets in conjunction with the convergence lens energization adjustment to provide complete color raster convergence, are also described.

The present invention is directed toward a novel assembly for the neck of a color kinescope whereby a magnetic shield may be provided to shield the electron beams in their low velocity regions from external fields; the shield thus provided may serve also as a "core" or return magnetic circuit for the "color purity coil"; and the shield thus provided may furthermore serve as a suitable field-limiting mount for the beam alignment permanent magnets. In accordance with an embodiment of the invention, a metal cylinder of high permeability magnetic material, which may be slipped over the neck of the kinescope and clamped thereon, is provided to shield the electron beams in their low velocity region, and thus greatly reduce the undesirable deflections and distortions which might otherwise be caused by external fields. The shield is arranged so that it extends over the purity coil and thus provides a return magnetic circuit for the flux passing transversely through the kinescope neck, thereby improving the deflection sensitivity of the purity coil. Three permanent magnets are adjustably threaded in the shield at fixed points equally spaced about the circumference of the shield, each being in the vicinity of a respective one of the beams.

It has previously been customary to make purity coils without cores, because residual magnetism in the core makes it impossible to obtain proper adjustments of kinescopes which require zero or very near zero purity correction, unless means are provided to reverse the current in the coil. This difficulty is eliminated in the present invention, the shield or core remaining in a fixed position so that any residual magnetism existing can be bucked out by merely rotating the purity coil to a bucking position. As has been previously noted, it has been heretofore customary to mount the beam alignment magnets in such a manner as to provide almost complete freedom of positioning within their respective regions of proximity to the individual beams. Adjustments of the positions of the magnets in conjunction with adjustment of the D.-C. energization of the convergence lens were utilized to obtain the desired degree of center convergence. However, it has been noted that there is a multitude of possible positions where the desired degree of convergence might be obtained, but that many of these positions would be such as to degrade both focus and purity. In accordance with the present invention, the magnets (mounted in the shield) extend radially out from the tube axis so that the effect is to deflect the beams tangentially (with respect to a circle concentric with the tube axis). Each magnet can be inserted with either the north or south pole toward the respectively associated beam so that the desired direction of deflection is obtained, while the desired amount of deflection is obtained by screwing the magnet into the proper proximity to the beam. The proper setting of the magnets for the desired convergence may therefore be limited to one which does not degrade focus or color purity. The arrangement of the beam alignment magnets within the magnetic shield is also advantageous in that the shield limits the magnetic fields so that there is less interaction between the respective magnets than would be normally present.

Accordingly it is a primary object of the present invention to provide improved beam controlling apparatus for color image reproducers.

It is a further object of the present invention to provide a multiple gun kinescope with a novel beam adjustment assembly.

It is an additional object of the present invention to provide a three-gun shadow-mask color kinescope with a novel combination of a color purity coil, beam alignment magnets, and a neck shield whereby color purity and convergence are more readily obtained with simple adjustments and with a minimum of undesirable beam distortion effects.

It is another object of the present invention to provide a tri-color kinescope with a neck shield which may serve additionally as a return magnetic circuit for the kinescope's color purity coil, and as a field-limiting mount for the kinescope's beam alignment magnets. Other objects and advantages of the present invention will be readily apparent to those skilled in the art upon a reading of the following detailed description and an inspection of the accompanying drawings in which:

Figure 1 illustrates a sectional view of a beam control assembly in accordance with an embodiment of the invention.

Figure 2 illustrates a side elevation view of the neck of a triple-gun color kinescope, the neck being partially broken away and sectioned to reveal the gun structure therein, with the beam control assembly mounted in place on the tube neck and illustrated in section as in Figure 1.

Figure 3 illustrates a transverse sectional view of the beam control assembly as mounted on the tube neck, taken along lines 3—3 in Figure 2.

Figure 4 illustrates an additional sectional view taken along lines 4—4 in Figure 2, with a portion of the beam control assembly broken away.

Referring to Figure 1 in greater detail a substantially cylindrical shield **13**, preferably of high premeability material, is illustrated in section. A split ring clamp **14** is mounted within the cylindrical shield **13** by a tripod arrangement of mounting brackets **15**. The end tabs **14*a*** of the clamp **14** are adapted to be drawn into abutment by adjustment of a clamping screw **14*b*** so that the shield **13** may be fixedly mounted on a cylindrical surface, such as the neck of a color kinescope. The interior surface of the ring **14** may be appropriately padded to avoid the possibility of injuring the tube neck.

At equally spaced intervals about the circumference of the cylindrical shield **13**, three externally threaded permanent magnets **27** are adjustably mounted. Each of the magnets **27** may be inserted into the shield **13** with either of its poles toward the interior of the cylinder, and the depth of insertion is readily adjusted by rotation of the threaded magnet in an appropriately threaded receptacle in the shield surface.

A "color purity coil" **21**, which comprises a pair of windings similar to the horizontal or vertical windings of a conventional deflection yoke is supported on a coil form **22**. The coil form **22** is provided with annular end flanges **22*a*** and **22*b*** against which the end turns

of the assembled purity coil may rest. The coil form flange **22*a*** is of the appropriate radial dimension as to permit its seating in the opposed channels formed in the flanges **16**, which are secured to the outer surface of the shield **13** at diametrically opposed peripheral points. There is sufficient play in the seating of the annular flange **22*a*** to readily permit rotation of the coil form **22**, and the purity coil **21** carried thereon, within the cylinder **13**. Several leaf-type springs **24** are clipped onto the coil form **22** so as to extend over the interior surface of the coil form cylinder and provide resilient means for supporting the coil form in the selected position of rotation on the aforesaid tube neck. In Figure 2 the neck shield and purity coil assembly is shown in section as mounted on the neck **30** of a triple gun color kinescope of representative form. A break-away view of the tube neck has been shown to illustrate the positional relationship of the components of the multiple gun structure to the neck shield **13**, alignment magnets **27** and purity coil **21**. For simplicity in the drawing, supports and leads for the various electrodes have not been illustrated. A transverse sectional view taken along the lines 3—3 in Figure 2 is illustrated in Figure 3. As most clearly shown in the latter view, three electron guns **40** are mounted in parallel relationship within the tube neck **30**, the respective gun axes being equally spaced about the circumference of a circle concentric with the tube axis.

Each of the three electron guns includes an indirectly heated cathode **41** enclosed in a cylinder **43** (closed at the target end by an apertured disc) which serves as the control grid, an anode cylinder **45** (having an apertured end plate at its target end), and a second or beam-focusing anode cylinder **47** which includes a limiting aperture disc **49**. The kinescope is also provided with a substantially cylindrical convergence anode **51**, which is common to the paths of all three guns. Another significant part of the electron-optical system of the tube is the final or beam-accelerating anode **53**, illustrated as a conductive wall coating formed on the inside of the kinescope and which extends from the neck thereof in the vicinity of the convergence anode **51** along the flared portion (not illustrated) of the kinescope to a region in the vicinity of the target structure.

Respective focus lenses formed between the individual beam focusing anodes **47** and the common convergence anode **51** when all are suitably energized, function to effect the proper focusing of the individual electron beams so as to have the desired scanning spot sizes at the target. A convergence lens formed between the convergence anode **51** and the beam accelerating anode **53** when both are suitably energized, functions to effect substantial convergence of the respective electron beams suitably in the plane of the apertured mask of the target structure. For a more detailed explanation of a multiple gun structure of the type illustrated, reference should be made to the co-pending U. S. application of Hannah C. Moodey, Ser. No. 295,225, filed June 24, 1952, and entitled "Multiple Beam Tube." In use, the kinescope is conventionally provided with a deflection yoke (not illustrated) seated on the tube neck forward of the neck shield assembly for effecting the desired raster-scanning deflection of the beams, and which may consist of the usual arrangement of pairs of horizontal and vertical deflection coils assembled so that the yoke is substantially anastigmatic.

As illustrated in Figure 2 the positioning of the neck shield on the tube neck is such that the shield encloses the complete gun structure including the common convergence anode **51**. The high permeability cylinder **13** may thus effectively shield the beams in their low velocity regions from the effects of external fields, such as the earth's magnetic field and stray fields such as may be associated with the various transformers which may be in proximity to the tube in a typical receiver.

The rotatable purity coil is situated so as to substantially enclose the convergence anode **51**. Thus the transverse magnetic field developed by the purity coil when energized acts upon the three beams during their passage through the interior of the convergence cup **51** to shift the beam system as a whole in the desired direction and with the necessary magnitude to cause the respective beams to selectively strike the proper phosphors at the screen. While it might be desirable to place the purity coil further forward on the tube neck, this is not feasible, as a practical matter, because of the space necessarily occupied by the deflection yoke assembly.

As is most clearly shown in Figure 3, each of the beam alignment magnets **27** is arranged to extend radially from the tube axis along a radius which passes through the center of a respective one of the electron guns. Figure 2 illustrates a desirable location of the plane passing through the axes of these magnets with respect to the gun structure. Each magnet **27** is arranged so as to act upon its respectively associated beam within the focus anode cylinder **47** at a point in the beam path a short distance past the limiting aperture disc **49**. It will be appreciated that it is desirable to place these magnets on the target side of the limiting apertures so that the proper adjustments may be made for the alignment deflection of each beam without suffering loss of beam energy due to unwarranted masking of the beam by the limiting aperture discs. On the other hand, it is more compatible with selective beam deflection to obtain the respective alignment deflections in a region where the beams are separately enclosed. Therefore the illustrated positioning of the beam alignment magnets appears to be of optimum desirability.

Figure 4 illustrates more clearly the makeup of the rotatable purity coil sub-assembly. The break-away view of the coils **21***a* and **21***b* shows the similarity between the purity coil **21** and the conventional horizontal or vertical windings of a deflection yoke. As illustrated the annular flange **22***a* of the coil form **22** readily rotates in the channels formed in the brackets **16** which are fixed to the outer surface of the neck shield **13**. The coil form flange **22***a* may be provided with a peripheral notch, as at **23**, to permit insertion and removal of the flange with respect to the bracket channels.

With an understanding of the structure and proposed utilization of beam controlling apparatus in accordance with the invention, many of the advantages of the novel apparatus described will now be more readily appreciated. The protection from external fields afforded by the neck shield **13** is significant, since even weak disturbances of the beams by undesired fields, if effected in the low velocity beam-forming regions, may have appreciable effect on the ultimate location and condition of the beams at the target structure.

It will also be readily appreciated that the service of the shield **13** as a high permeability core markedly improves the deflection sensitivity of the color purity coil **21**. By providing the purity coil **21** with a return magnetic circuit through the high permeability material of the cylinder **13**, a more efficient color purity adjusting system is realized than could be obtained with conventional air core purity coils. It should also be noted that the beam controlling apparatus as described is readily applicable to use with virtually all multiple gun tubes even though the required amount of purity correction for given tubes may vary widely or may even be zero. In other words, where the alignments of the guns, target structure, etc., in a given tube are such as to require zero or very nearly zero purity correction, the problem of residual magnetism in the core is no obstacle to use of the novel assembly, since the adjustable purity coil **21** may be rotated with respect to the fixed shield **13** to a bucking position so as to buck out the residual magnetism completely, or partially, as required.

The shield **13** additionally performs the services of providing an accurate positioning mount for the beam alignment magnets **27**, and localizing the respective fields associated with each of the magnets **27** so as to reduce interaction therebetween and insure the selectivity of the required individual beam alignment deflection. The novel arrangement of the beam alignment magnets **27**, by limiting the alignment deflections to what is effectively only a tangential deflection rather than permitting an almost universal range of alignment deflections as has been heretofore conventional, greatly simplifies the operations necessary to obtain optimum tube performance via related adjustments of focus, convergence, purity etc. The operator may "home" to the proper setting of the beam alignment magnets to obtain a desired degree of convergence without degrading focus and purity more readily with the disclosed apparatus than with the conventional universally adjustable alignment magnet type of apparatus.

It should also be noted that the invention provides what is effectively a compact unitary assembly for the purity correction and beam alignment apparatus associated with a multiple gun kinescope, which should simplify production problems when assembly line techniques are applied to multiple gun kinescopes and color receivers.

Having thus described our invention, what is claimed is:

1. In color image reproducing apparatus utilizing a color kinescope including a neck portion, apparatus comprising the combination of a shield of magnetic material adapted to fit over said neck portion of said kinescope, means for fixedly mounting said shield on said neck portion, a plurality of permanent magnets, means for adjustably mounting said permanent magnets in said shield in symmetrically located positions about the circumference of said shield, said latter means permitting adjustment of the proximity of each of said permanent magnets to said neck portion and reversal of the polarity of the magnetic field produced by each of said permanent magnets relative to said neck portion, and a color purity coil adapted to provide a substantially uniform transverse magnetic field through said neck portion, said shield being adapted to extend over at least a portion of said color purity coil when both said shield and said coil are mounted on said neck portion.

2. In apparatus for utilizing a color kinescope, a plurality of electron guns being included in the neck of said kinescope for developing a plurality of electron beams, the combination comprising a color purity coil providing a substantially uniform transverse magnetic field through said neck portion of said kinescope, said coil being rotatably mounted on said kinescope neck, means for providing said color purity coil with a return magnetic circuit for the flux of said transverse field, means for fixedly mounting said first-named means on said kinescope neck such that said first-named means serves also to shield said beams from external fields throughout a substantial portion of said kinescope neck, a plurality of permanent magnets, and means for adjustably mounting each of said plurality of permanent magnets in respective positions spaced about said first-named means.

3. Apparatus in accordance with claim 2 wherein said first-named means comprises a substantially cylindrical shield of magnetic material which encloses a portion of said kinescope neck and extends over at least a portion of said coil.

4. Apparatus in accordance with claim 3 wherein each of said permanent magnets is threaded for screw adjustment of its proximity to a respective one of said plurality of beams.

5. Apparatus comprising the combination of a color kinescope including a neck portion, a multiple gun structure mounted within said neck for developing a plurality

of independent electron beams, means for shielding said plurality of electron beams from undesired external fields, said means comprising a cylinder of magnetic material adapted to slip over the neck of said kinescope and be fixedly mounted thereon, a color purity coil, means for rotatably mounting said coil within said cylinder, a plurality of permanent magnets for selectively deflecting each of said plurality of beams, said cylinder serving as a field-limiting mount for said plurality of permanent magnets.

6. Apparatus in accordance with claim 5 wherein means are provided for adjusting the direction and magnitude of deflection imparted by each of said magnets to the respective one of said plurality of beams.

7. Beam controlling apparatus for a multi-beam color kinescope comprising the combination of a substantially cylindrical shield of high permeability magnetic material adapted to enclose a portion of the beam paths in said kinescope, a plurality of threaded permanent magnets, said shield including means symmetrically spaced about its circumference for radially positioning said magnets with respect to the longitudinal axis of said shield, a color purity coil rotatably positioned within said cylindrical shield, and means for mounting said shield on said kinescope.

8. Apparatus comprising the combination of a color kinescope having a neck, a multiple electron gun structure enclosed in said kinescope neck, a shield of magnetic material, a coil form mounted for rotational adjustment within said shield, a pair of deflection windings mounted in diametric opposition on said coil form, a plurality of permanent magnets, each of said magnets being mounted on the surface of said shield and extending therethrough in a respectively different radial direction with respect to the longitudinal axis of said shield, and means for fixedly mounting said shield on said neck such

that said shield substantially surrounds said multiple gun structure.

9. The combination in accordance with claim 8 wherein said multiple gun structure includes a plurality of individual electron beam sources, a corresponding plurality of individual beam focusing electrodes, and common beam convergence electrode, wherein the number of said plurality of magnets corresponds to the number of said plurality of beam sources, and wherein said fixedly mounted shield is positioned such that said rotatable coil form surrounds a substantial portion of said common convergence electrode, and said radial directions of extension of said magnets substantially correspond to the respective radial directions of location of the longitudinal axes of said individual beam sources and focusing electrodes with respect to the longitudinal axis of said kinescope neck.

10. The combination in accordance with claim 9 wherein each of said individual beam focusing electrodes includes means for forming a beam limiting aperture, and wherein the position of each of said magnets is intermediate the locations of said common convergence electrode and said aperture forming means.

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