Sept. 26, 1961 B. R. CLAY 3,002,120

BEAM CONVERGENCE APPARATUS FOR TRI-COLOR KINESCOPE

Filed Aug. 2, 1954

Fig. 1.

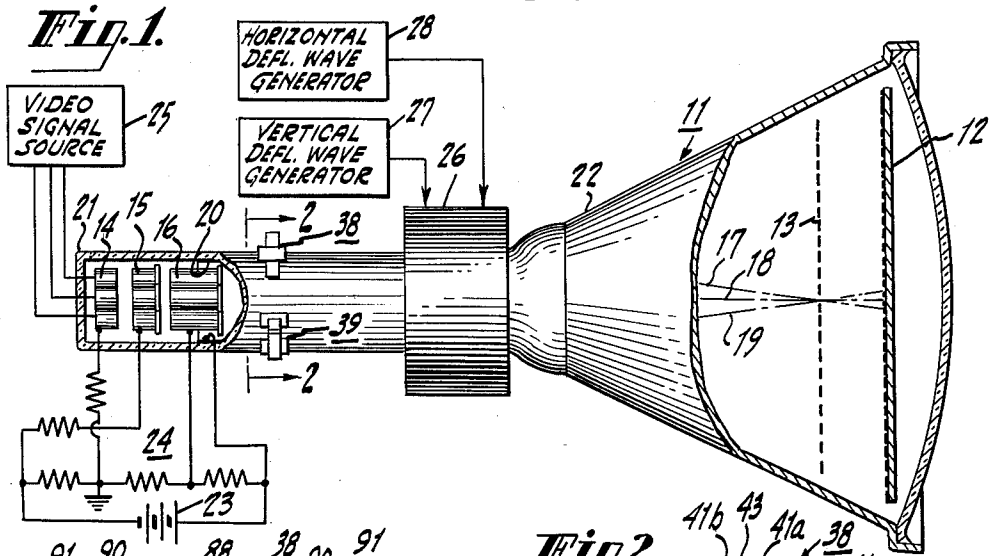


Fig. 4.

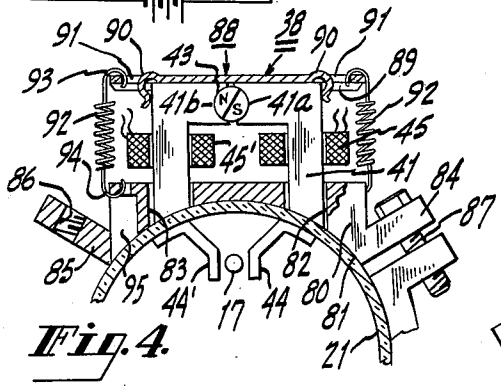


Fig. 2.

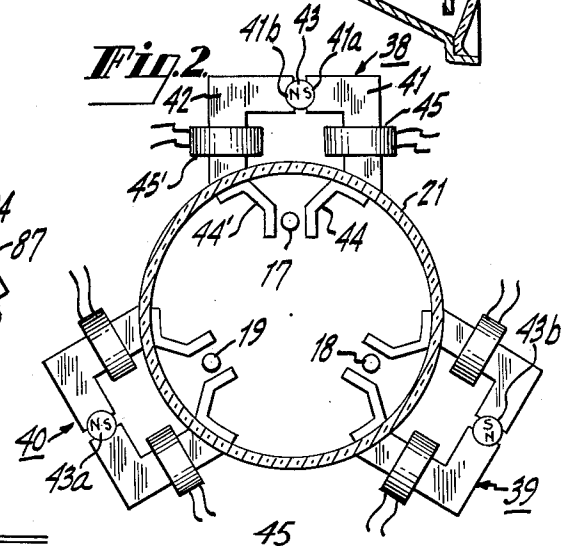
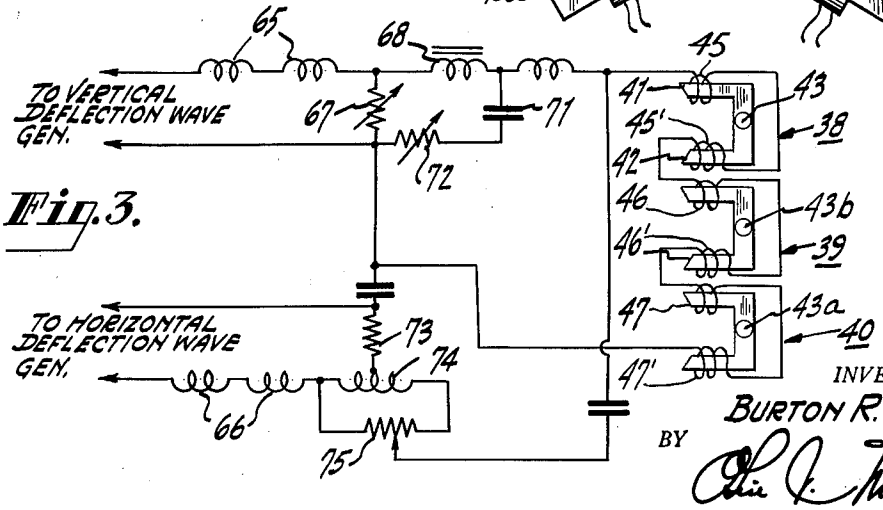


Fig. 3.



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United States Patent Office 3,002,120 Patented Sept. 26, 1961

3,002,120
BEAM CONVERGENCE APPARATUS FOR TRI-COLOR KINESCOPE

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Filed Aug. 2, 1954, Ser. No. 447,330
7 Claims. (Cl. 313—77)

This invention relates to systems for controlling the electron beams of cathode ray tubes and particularly to systems in which a plurality of beams is deflected by a common deflection apparatus.

One type of cathode ray tube with which the present invention may be successfully employed is a color kinescope of the general type described in an article titled "A Three-Gun Shadow-Mask Color Kinescope," by H. B. Law published in the Proceedings of the I.R.E., vol. 39, No. 10, October 1951, at page 1186. Such a tube is described in Patent No. 2,595,548, issued May 6, 1952, to Alfred C. Schroeder, for "Picture Reproducing Apparatus" and has a luminescent screen as part of a target electrode in which different phosphor areas produce differently colored light when excited by electron beam components impinging upon it from different angles, the angle of impingement determining the particular color of the light produced by the phosphor areas. The invention also pertains, for example, to a kinescope of the type described in another article titled "A One-Gun Shadow-Mask Color Kinescope," by R. R. Law, published in the Proceedings of the I.R.E., vol. 39, No. 10, October 1951, at page 1194.

It is necesary for the satisfactory operation of such kinescopes to effect substantial convergence of the different electron beam components at all points of the raster scanned thereby at the target electrode. In general, this convergence may be effected by means of apparatus such as that disclosed in an article titled "Deflection and Convergence in Color Kinescopes" by A. W. Friend, published in the Proceedings of the I.R.E. vol. 39, No. 10, October 1951, at page 1249. Such beam convergence apparatus includes an electron-optical system by which to control the beam convergence angles. The electron-optical system is variably energized as a function of the radial angle of beam deflection.

Another type of apparatus for controlling the convergence of a plurality of electron beam components and with which the present invention is more particularly concerned comprises, in general, means for producing a plurality of electron beam components which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube and individual electromagnetic means located respectively adjacent to the predeflection beam paths and of such character as to be energizable directly from the beam deflection circuitry in a manner to effect the desired beam convergence. In this manner the beam convergence angle may be varied in a manner suitable to maintain the desired beam convergence in the predetermined plane at all points in the scanned raster. Heretofore, in the type of apparatus which is alluded to, it has been customary to provide a convergence control for the several beam components in the nature of a direct current convergence (i.e. static convergence) in order to effect proper convergence of the several beam components at the center of the screen. That is to say, in addition to the electromagnetic means described supra which are provided for dynamic convergence of the beam components, it has also been found necessary to compensate for misalignment of the electron beam components which result from manufacturing variations and the like. Such compensating means for applying a unidirectional current to the electromagnetic means for the purpose of static convergence control have, of necessity,

required rather complex circuitry including expensive potentiometers for varying the unidirectional current and specialized circuitry for preventing undesirable interaction of the direct current field with the alternating current field of the dynamic convergence control.

It is a primary object of the present invention to provide improved beam convergence controlling apparatus for use with cathode ray tubes such as a tricolor kinescope.

Another object of the invention is that of providing improved electromagnetic beam convergence controlling apparatus which is simpler and utilizes less complicated apparatus than that heretofore employed, while being substantially as efficient as the more complicated circuitry.

A further object of the invention is to provide an improved magnetic beam convergence controlling arrangement in which a substantial decrease may be effected in the energizing power consumption requirements.

Still another object of the invention is to provide novel and improved beam convergence apparatus for effecting individual control of a plurality of electron beam components, both statically as well as dynamically.

In general, the present invention, as employed in conjunction with a tri-color kinescope of the type having means for directing a plurality of electron beam components toward a tri-color screen and means including internal magnetic pole pieces for cooperation with individual electromagnets for dynamic beam convergence, provides a permanent magnet device in association with each of the electromagnets for the purpose of providing a variable permanent magnet field which serves to afford a controllable static convergence function and which is adjustable from a maximum value to zero. As will be appreciated, the permanent magnet device associated with each of the electromagnetic pole piece exciters provides static convergence control without any undesirable interaction with the dynamic convergence function.

As used herein, it will be understood that the term "beam components" denotes either a plurality of individual electron beams emanating respectively from a plurality of electron guns or from a single electron gun provided with suitable apparatus for forming several individual beams and, in addition, those components of a single electron beam to which is imparted a spinning motion so as to trace a substantially conic locus at different positions thereof.

Additional objects and advantages of the present invention will become apparent to those skilled in the art from a study of the following detailed description of the accompanying drawing, in which:

FIG. 1 is a view showing the general arrangement of image reproducing apparatus embodying electron beam convergence means in accordance with the invention;

FIG. 2 is a vertical sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged view, partially in section, of a novel mechanical form which the present invention may take; and

FIG. 4 is a schematic circuit diagram of a typical circuit arrangement for energizing the electromagnetic beam convergence apparatus with which the present invention is associated.

Reference first will be made to FIG. 1 for a general description of an illustrative embodiment of an electron beam convergence system in accordance with the present invention. The system includes a tri-color kinescope 11 which may be of the same general type as that disclosed in the H. B. Law paper previously referred to. It will be understood, however, that the kinescope, alternatively, may be of other types such as that shown in the R. R.

Law paper. In either case, however, the kinescope has a luminescent screen **12** provided with a multiplicity of small phosphor areas arranged in groups and capable respectively of producing light of the different primary colors in which the image is to be reproduced when excited by an electron beam. In back of and spaced from the screen **12** there is an apertured masking electrode **13** having an aperture for and in alignment with each group of phosphor areas of the screen **12**.

In the particular tube illustrated, the kinescope also has a plurality of electron guns, equal in number to the number of primary colors in which the image is to be reproduced. Each of these guns may be conventional, consisting of a cathode, a control grid and a focusing electrode. Since the three guns are identical, the different parts thereof will be referred to collectively as the cathode **14**, the control grids **15**, and the focusing electrodes **16**. The three electron guns produce schematically represented beams **17**, **18** and **19** by which to energize, respectively, the blue, red and green phosphor areas of the screen **12**. When these electron beams are properly converged in the plane of the masking electrode **13** they pass through the apertures thereof from different directions and impinge upon different phosphor areas of the various groups so as to produce blue, red and green light. It is to be noted that the size of the phosphor areas, the angles between the beams and the spacing of the mask **13** from the screen **12** as compared with the length of the tube are exaggerated for better illustration of the operation of the kinescope.

The electron-optical apparatus of the kinescope **11** also includes a beam-accelerating electrode consisting, in the present instance, of a conductive wall coating **20** formed on the inner surface of the tubular glass neck **21** of the kinescope extending from the region adjacent to the outer end of the focusing electrodes **16** to the conical section **22** of the tube which in this case is metallic. Suitable electrical connection (not shown) is made at the junction of the wall coating with the metal cone **22**. Preferably, the target electrode structure, including the masking electrode **13** and the luminescent screen **12** which for this purpose may be metallized, is electrically connected to the metal cone **22** by suitable means (not shown). Metallization of a luminescent screen of the character described may be effected in the manner disclosed in a paper by D. W. Epstein and L. Pensak titled "Improved Cathode Ray Tubes with Metal-Backed Luminescent Screens," published in the RCA Review, vol. III, March 1946, at pages 5 to 10.

The described electrode structure of the kinescope may be energized in a conventional manner such that illustrated. The source of energy is represented by a battery **23** across the terminals of which there is connected a voltage divider **24**. The cathodes **14** are connected to the grounded point of the voltage divider and the control grids **15** are connected to a point which is somewhat negative relative to ground. Similarly, the focusing electrodes **16** are connected to a point on the voltage divider which may conventionally be at a high potential of positive relative to the grounded cathodes. Also the beam-accelerating anode, including the wall coating **20** and metal cone **22**, is connected to the voltage divider **24** at a point which may conventionally be substantially more positive relative to the grounded cathodes.

The electron beams **17**, **18** and **19** are modulated suitably in intensity under the control of color-representative video signals derived from a source **25**. It will be understood that video signal source is represented herein entirely diagrammatically since it does not form an essential part of the present invention. The signal source **25** usually will be part of a signal receiver and may be understood to include a signal detector, or equivalent device, together with one or more stages of video signal amplification. Alternatively, the video signal source may be a color television camera in the event that the kinescope **11** is employed as a monitor, for example. Also, it will be understood that the illustrated connection of the video signal source **25** to the electron guns of the kinescope **11** is merely diagrammatic and accordingly these connections may or may not be made directly to the cathodes **14**. Instead, it will be understood, they may be made to the grids **15** or, in accordance with some modes of operation of color image reproducing apparatus, the video signal source may be connected both to the cathodes and to the control grids of the electron guns.

Also associated with the color kinescope **11** is a deflection yoke **26** which may be entirely conventional including two pairs of suitably placed coils electrically connected together in such a manner that, when properly energized, electromagnetic fields are produced, whereby to effect both horizontal and vertical angular deflections of the electron beams so as to scan the usual rectangular raster. Energization of the deflection coils comprising the yoke **26** may be effected by conventional vertical and horizontal deflection wave generators **27** and **28**, respectively. Such apparatus will be understood to function suitably to produce substantially sawtooth energy at both horizontal and vertical deflection frequencies so that the fields produced by the yoke **26** are varied in a substantially sawtooth manner.

The beam convergence system, in accordance with the present invention, also includes a plurality of electromagnetic field producing elements such as the magnets **38** and **39** mounted around the neck **21** of the color kinescope adjacent to the predeflection paths of the electron beam components. It is to be understood that the precise location of these magnets is not necessarily indicated in this figure. Instead, as will appear in greater detail from a subsequent portion of the specification, it is to be understood that each of these magnets is located relative to one of the electron beam components so as to influence its associated beam component to the substantial exclusion of the others. Furthermore, it is to be understood that these magnets are of a character which, when suitably energized, produce respective fields which are transverse to the associated beam paths, as will appear more fully hereinafter.

Before describing the details of the convergence system with which the present invention is related, a brief description will be given of the general manner in which the apparatus functions to produce the desired result. The convergence magnets such as **38** and **39** are energized by unidirectional energy from permanent magnets so as to effect an initial convergence of the electron beam components substantially in the plane of the apertured masking electrode **13**. In order to do this, the unidirectional energization of these permanent magnets is effected in such a way that the magnets may be individually energized in different magnitudes. In effecting this initial beam convergence, it is to be understood that the beams may be in any desired one of their different deflected positions. For example, they may be initially converged at the center of the raster to be scanned. Alternatively, they may be initially converged at one corner of the raster.

The convergence magnets such as **38** and **39** also are dynamically energized by the control wave energy derived from a suitable generator (not shown in FIG. 1) so as to effect a variation in the magnitude of the transverse fields produced respectively thereby. These field strength variations are in accordance with a predetermined function of the beam deflection. Variations in the strength of the fields produced by the convergence magnets such as **38** and **39** effect corresponding variations in the paths of the electron beam components relative to the longitudinal axis of the tube. Hence, suitable variations are made in the convergence angles between the various beam components so as to produce the desired convergence of

the beam components substantially in the plane of the masking electrode **13**.

For a further description of the beam convergence apparatus of the invention, reference now will be made to FIG. 2 of the drawings. This figure shows more clearly the relative positions of the convergence magnets, such as **38** and **39** and, additionally, **40**, relative to one another and to the electron beams with which they are respectively associated. Inasmuch as all of these magnets are substantially the same, only one of them will be described in detail.

The convergence magnet **38** which is associated, by way of illustration, with the blue electron beam **17** is provided with a core comprising two pole pieces **41** and **42**, each of which is substantially L-shaped so that the combination of the two pieces **41** and **42** forms a generally U-shaped assembly. Each of the pole pieces **41** and **42** is provided with corresponding legs in alignment and the ends thereof in registry. The faces of the registered ends each are provided with an arcuate recess. Thus the pole piece **41** has an arcuate recess **41***a* facing an arcuate recess **41***b* in the pole piece **42**. Rotatably supported by the pole pieces by means of the recesses **41***a* and **41***b* is a cylindrical magnet **43** which is magnetized permanently along its diameter as indicated by the designations "N" and "S." The pole pieces **41** and **42** and their associated permanent magnet **43** are mounted so as to form a continuous U-shaped magnetic path which is in close association with the tube neck **21**. In accordance with a specific embodiment of the invention herein the convergence magnets are associated with a tri-color kinescope having "internal pole pieces" of the type described in the copending U.S. application of A. M. Morrell, Serial No. 364,041, filed June 25, 1953, now Patent No. 2,752,520 issued June 26, 1956. There is illustrated, for each of the magnets **38**, **39** and **40**, a pair of radially and inwardly extending internal pole pieces. The magnet **38**, for example, is provided with a pair of internal pole pieces **44** and **44'** associated respectively with the external pole pieces **41** and **42**. It will be understood that, by such means, the reluctance of the magnetic circuit is considerably decreased and that the flux distribution of the field produced between the internal pole pieces **44** and **44'** is considerably improved. While the present invention is illustrated herein in conjunction with a kinescope having internal pole pieces, it will be understood that its principles are also applicable to other forms of tri-color kinescopes.

The external pole pieces **41** and **42** of the convergence magnet **38** are provided with electromagnetic windings **45** and **45'**, respectively, for their dynamic energization in a manner to be described. As indicated in FIG. 2, the convergence magnet **38** is adapted to produce a field which, in the vicinity of the electron beam **17**, may be moved in a radial direction toward or away from the longitudinal axis of the tube. The static convergence field which is produced in accordance with the permanent magnet arrangement of the present invention will be described in detail subsequently. Prior to describing the static convergence control of the invention, however, reference will be made to FIG. 4 of the drawing for a description of a purely illustrative circuit by means of which the magnetic, dynamic convergence apparatus may be energized. Since the apparatus for providing the dynamic convergence control of the electron beams does not per se constitute a part of the present invention, it will be understood that the circuitry shown in FIG. 4 and described herein in the interest of completeness of description is intended merely to serve as an example of suitable dynamic convergence apparatus.

In FIG. 4, the energizing coils of the convergence magnets **38**, **39** and **40** include the electromagnetic windings **45**, **45'**, **46**, **46'** and **47**, **47'** connected serially in pairs and wound about the pole pieces of the magnets. That is to say, the windings **45**, **45'** of the magnet **38** are connected in series with each other and to the corresponding windings of the magnets **39** and **40**. All of the dynamic windings are, moreover, connected in series with the vertical and horizontal electron beam deflection circuits substantially as indicated. As shown, the windings are coupled effectively in series with the vertical windings **65** of the deflection yoke **26** and also with the horizontal windings **66** of the yoke. Thus, the convergence magnets may be energized dynamically as a function of both vertical and horizontal beam deflection angles.

In the operation of the convergence magnet energizing apparatus of FIG. 4, the vertical deflection current traversing the vertical yoke winding **65** produces a sawtooth voltage across the resistor **67** which, as indicated, preferably is made variable so as to control the amplitude of the convergence control wave. Inductance means, such as an inductor **68** coupled to the resistor **67**, has the property of performing a current integrating action whereby, a substantially parabolic current wave at vertical deflection frequency traverses the dynamic windings **45**, **45'**, **46**, **46'** and **47**, **47'** of the convergence magnets **38**, **39** and **40** respectively.

The resistive components of the integrating inductor **68** and another inductor **69**, or horizontal frequency choke coil, in series therewith, together with the relative components of the dynamic convergence magnet windings **45**, **45'**, **46**, **46'** and **47**, **47'** produce a small sawtooth component in the substantially parabolic current wave traversing these circuit elements. As a result of this sawtooth component, the peaks of the parabolic wave are slightly advanced in phase or displaced slightly to the left on a time base running from left to right. The capacitor **71**, connected effectively across the resistor **67** and the integrating inductor **68**, has the effect of producing an opposite, or retarding, phase shift by which to move the peaks of the parabolic wave slightly to the right, relative to a time base. Accordingly, a variable resistor **72** in series with the capacitor **71**, is provided so as to provide a symmetry control for the substantially parabolic wave at vertical deflection frequency in order that the convergence apparatus may be suitably operated to effect the desired result with different deflection yokes.

In a somewhat similar manner, a sawtooth voltage at horizontal deflection frequency is developed across a resistor **73**, which preferably is made variable so as to provide an amplitude control for the horizontal convergence wave. This voltage is also impressed upon the dynamic windings of the convergence magnets **38**, **39** and **40** by means including a center-tapped inductor **74**, at least a portion of which is connected in series with the horizontal yoke winding **66** and the resistor **73**. Inductance means, which in this case comprise the dynamic windings **45**, **45'**, **46**, **46'** and **47**, **47'**, function to integrate the sawtooth voltage wave to produce a substantially parabolic current wave for energization of the dynamic convergence magnet windings.

The deflection current in the horizontal winding **66** of the yoke also produces a voltage pulse during flyback or retrace intervals. This voltage pulse is developed across the lefthand portion of the inductor **74** as viewed in the drawing. This pulse also is impressed upon the dynamic windings of the convergence magnets by means including a potentiometer **75** connected across the inductor **74**. The inductance of the dynamic windings causes an integration of the voltage pulse to form a small sawtooth current component through these windings. The potentiometer **75** provides a facility for controlling the magnitude and polarity of the voltage pulses impressed upon the convergence magnet and thereby functions as a symmetry control for the substantially parabolic current wave at horizontal frequency by which the convergence magnets are excited.

Although the illustrative circuitry of FIG. 4 shows an

arrangement in which the vertical and horizontal convergence wave forms flow through the same windings of the electromagnets, it should be understood that other arrangements in which the vertical and horizontal convergence wave forms flow through separate windings may be satisfactorily employed. Additionally, while the windings **45** and **45'** are shown as separate coils serially connected, it should be understood that a single vertical winding may be used in their stead. Various other types and combinations of windings for the dynamic convergence control circuit may also be substituted for that shown without departing from the scope of the present invention.

Throughout the foregoing description of the operation of the magnets **38**, **39** and **40** in effecting dynamic convergence control of the several electron beams within the kinescope, it has been assumed that the pole pieces **41** and **42** and the cylindrical magnet **43** of the magnet **38** merely form a continuous magnetic core for the electromagnetic windings. In actuality, those elements do provide such a core for the windings; additionally, however, the permanent magnet **43** provides a permanent field for traversal of the space between the lower extremities of the internal pole pieces **44** and **44'**, which field has as its function that of effecting static convergence of the beam components. That is to say, and as has been pointed out above, some static control of the electron beams in their predeflection paths is necessary in order to bring about proper convergence of the beams at the center of the target, for example. In the past, such static convergence control has been accomplished through the agency of complicated and costly circuitry for impressing a direct current component upon the electromagnetic windings of the magnets which effect the dynamic beam convergence.

In the operation of the apparatus of FIGS. 1 and 2 with respect to static convergence control, it will be recognized that the permanent magnet **43** which is rotatably supported by the pole pieces **41** and **42** affords a variable magnetic field which is adjustable between a maximum value and zero and which is also reversible in direction. That is to say, with the permanent magnet **43** in its position shown in FIG. 2 (i.e. with its north and south poles oriented as indicated), it will be understood that a permanent magnetic field of maximum strength will be produced in the region of the electron beam **17** and with the flux lines so oriented as to cause the beam **17** to be deflected a certain amount radially and inwardly toward the longitudinal axis of the tube. Conversely, rotation of the magnet **43** to the position shown at **43*a*** (i.e. the position of the permanent magnet forming a part of the convergence magnet **40**) results in a reduction of the permanent convergence field to zero since the north and south poles of the permanent magnet are effectively short circuited by means of the magnetic material of the pole pieces. An intermediate position of adjustment of the permanent magnet is illustrated by the magnet **43*b*** associated with the convergence magnet **39** in which the north and south poles lie along a line which is intermediate the angular positions of the corresponding north-south lines of the magnets **43** and **43*a***. With the magnet **43*b*** in this position, the permanent magnetic field will produce a static deflection of the electron beam **18** toward the longitudinal axis of the tube but in an amount less than that resulting from the position of the magnet **43**.

The reversibility of the permanent magnetic convergence field will be understood from the fact that, if the cylindrical magnet **43** were to be rotated about its own longitudinal axis by 180°, the direction of the flux lines in the space between the internal pole pieces **43** and **44** would be reversed, so that the beam **17** would be deflected radially and outwardly from the longitudinal axis of the tube. From the foregoing description of the convergence magnets of the present invention in which static convergence control of the several beam components is accomplished by the controlled action of a permanent magnet device, those skilled in the art will recognize that the invention permits extreme simplification of existing convergence apparatus. Although the invention is described herein as a permanent magnetic arrangement which may obviate the use of direct current fields for static control, it should be borne in mind that, where necessary, suitable direct current fields may additionally be produced in the dynamic windings or in an auxiliary winding to serve in conjunction with the fields of the permanent magnets.

Referring now to FIG. 3, there is shown a novel structural arrangement for supporting the beam convergence magnets in operative relationship about the neck of the kinescope **21**. In FIG. 2, reference numerals indicative of elements described herein above will be the same as the preceding figures for ease of correlation. The two external pole pieces **41** and **42** of the magnet **38** have wound about their longer legs the electromagnetic coils **45** and **45'** for effecting dynamic beam convergence. The permanent, cylindrical magnet **43** is supported rotatably within the recesses **41*a*** and **41*b*** in the ends of the other legs of the L-shaped pole pieces **41** and **42**. In order to retain the two pole pieces **41** and **42** and the cylindrical magnet **43** in their illustrated relationship so that they form a generally U-shaped assembly, there is provided the following apparatus: a foot or mounting member **80** of a suitable plastic insulating material and having an arcuate inner surface **81** is provided with a pair of spaced apertures **82** and **83** for the reception of the legs of the L-shaped external pole pieces **41** and **42**. Each foot **80** is provided at its extremities with radially extending flanges **84** having tapped holes **86** for threadedly receiving a bolt **87**. That is to say, each of the magnets **38**, **39** and **40** is located in a foot such as that indicated at **80** and the three foot members are secured to each other by means of the bolts **87** passed through their adjacent flanges, thereby forming a rigid assembly surrounding the neck **21** of the kinescope. The bracket **88** of Phosphor bronze or other suitable non-magnetic material has downwardly extending flanges **89** along its longitudinal edges to form a channel for the reception of the pole pieces **41** and **42** and is additionally provided with a pair of bent ears **90** which, for simplicity of construction, may be struck out from the edge of the bracket, leaving the apertures **91**. The spring ears **90** clampingly engage the magnetic pole pieces **41** and **42**, as shown, to urge the pole pieces against the cylindrical magnet **43**, thereby securing those three members in their proper relationship. A tension coil spring **92** which may also be of Phosphor bronze, for example, is provided at each end of the bracket **88** and the foot **80** and resiliently urges the bracket **88** toward the foot **80**. Specifically, each of the springs **92** may be provided with a hook portion **93** at one end and a second hook **94** at its other end, such that the hook **93** may engage the aperture **91** of the bracket and the hook **94** may engage an aperture **95** formed in the plastic foot **80**. Since, in the specific tri-color kinescope described herein by way of illustration, the several beam components **17**, **18** and **19** are equi-spaced about the longitudinal axis of the tube the three foot members are shown as subtending equal arcs of substantially 120°, so that the external pole pieces **41** and **42** of the magnet **38** are in the proper physical location with respect to the internal pole pieces **44** and **44'**, respectively, of the kinescope to provide a low reluctance magnetic path.

Those skilled in the art will recognize that the structure of FIG. 3, while simple and inexpensive to produce, affords an effective arrangement for holding the external pole pieces and cylindrical magnet in their desired U configuration and for urging that assembly against the neck of the kinescope. While the structure of FIG. 3 illustrates one specific operative arrangement, it will be recognized that various changes in the shape of the several elements and materials may be made to fit varying circumstances.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A magnet assembly for adjusting beam convergence in a multibeam picture receiving tube, comprising a frame having a section for each beam symmetrically disposed about a common center, magnets supported within each frame section, each magnet comprising a pair of pole pieces movably supported on a frame section radially of said center, a permanent magnet bridging two adjacent ends of said pole pieces, said permanent magnet being adapted to be rotated with respect to said pole pieces.

2. A magnet assembly for adjusting beam convergence in a multibeam picture receiving tube, comprising a frame having a section for each beam symmetrically disposed about a common center, electromagnets supported within each frame section, each electromagnet comprising a stationary coil, a pair of pole pieces movably supported within said coil, a permanent magnet bridging two adjacent ends of said pole pieces, spring means disposed between a portion of the frame section and said permanent magnet for constantly engaging said permanent magnet with the adjacent ends of said pole pieces and for pressing said pole pieces into engagement with the neck of a picture receiving tube, said permanent magnet being adapted to be rotated with respect to said pole pieces.

3. A magnet assembly for adjusting beam convergence in a multibeam picture receiving tube, comprising a frame having a section for each beam symmetrically disposed about a common center, electromagnets supported within each frame section, each electromagnet comprising a stationary coil, a pair of pole pieces movably supported within said coil, a permanent magnet bridging two adjacent ends of said pole pieces, said permanent magnet being adapted to be rotated with respect to said pole pieces.

4. Convergence means for a plurality of electron beams of a cathode ray tube having a tubular neck portion, said convergence means comprising a plurality of pairs of L-shaped pole pieces arranged with corresponding legs of each pair in alignment with each other and the ends of said aligned legs of each pair being closely spaced and in registry, said ends being formed each with an arcuate concave surface, a cylindrical permanent magnet rotatably held by and between said arcuate surfaces of each pair of pole pieces with its longitudinal axis generally parallel to said tubular neck portion, said magnet being magnetized along a diameter, the other legs of each of said pole pieces being spaced and parallel to each other, the ends of said other legs of each pole piece each being shaped with an arcuate concave surface adapted to fit the common surface of said tubular neck portion, removable means joining said pairs of pole pieces in a circular arrangement symmetrically spaced about a common axis.

5. The invention of claim 4 including a coil winding around a plurality of said other legs of said pole pieces.

6. Convergence means for a plurality of electron beams of a cathode ray tube having a tubular neck portion, said convergence means comprising a plurality of pairs of

L-shaped pole pieces arranged with corresponding legs of each pair in alignment with each other and the ends of said aligned legs of each pair being closely spaced and in registry, said ends being formed each with an arcuate concave surface, a cylindrical permanent magnet rotatably held by and between said arcuate surfaces of each pair of pole pieces with its longitudinal axis generally parallel to said tubular neck portion, said permanent magnet being magnetized along a diameter, the other legs of each of said pole pieces being spaced and parallel to each other, removable means joining said pairs of pole pieces in a circular arrangement symmetrically spaced about a common axis, said removable means including a plurality of mounting members each having a pair of apertures extending into said respective mounting member from one surface thereof, said other legs of one of said pair of pole pieces positioned within said pair of apertures, each of said mounting members having an arcuate inner surface oppositely disposed from said one surface thereof, said arcuate inner surfaces forming a common cylindrical surface to fit said tubular neck portion when said mounting members are joined together.

7. An electron beam convergence yoke for mounting on the tubular neck portion of a cathode ray tube, said convergence yoke comprising a pair of L-shaped pole pieces mounted with corresponding legs in alignment with each other and the ends of said corresponding legs closely spaced and in register, said ends being formed each with an arcuate concave surface, a permanent magnet rotatably held within said arcuate surfaces with its longitudinal axis generally parallel to said tubular neck portion, said magnet being magnetized along a diameter, the other legs of said pole pieces being spaced from each other, removable means joining said pairs of pole pieces in a circular arrangement symmetrically spaced about a common axis, said removable means including a plurality of mounting members each having a pair of apertures extending into said respective mounting member from one surface thereof, said other legs of one of said pair of pole pieces positioned within said pair of apertures, each of said mounting members having an arcuate inner surface oppositely disposed from said one surface thereof, said arcuate inner surfaces forming a common cylindrical surface to fit said tubular neck portion when said mounting members are joined together.

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