Nov. 23, 1948. S. V. FORGUE 2,454,378

CATHODE-RAY TUBE APPARATUS

Filed May 28, 1945

Fig. 1

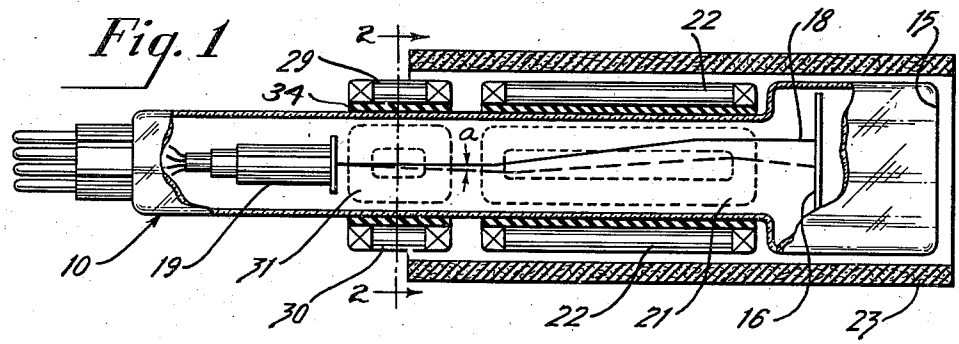


Fig. 3

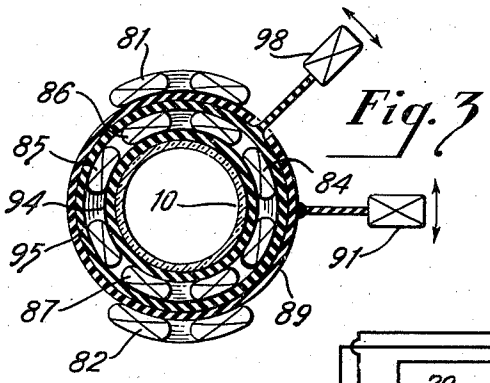


Fig. 2

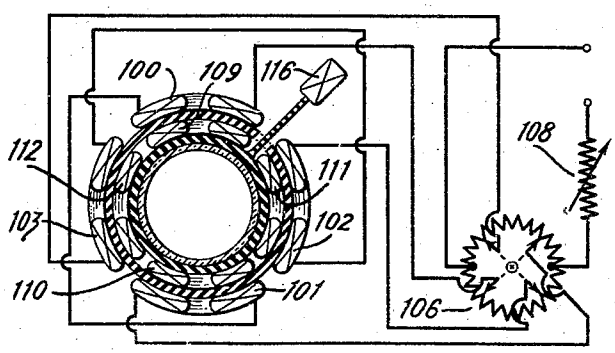


Fig. 4

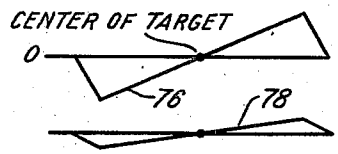


Fig. 5

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CATHODE-RAY TUBE APPARATUS

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7 Claims. (Cl. 315—31)

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The present invention relates to cathode ray tube apparatus and more particularly to an arrangement for obtaining combined static and dynamic alignment, or dynamic alignment separately, of the cathode ray scanning beam in a cathode ray tube.

In a cathode ray tube, particularly of the low beam velocity type, it is desirable for proper operation of the tube that the electrons composing the cathode ray beam approach the target in a direction which is substantially normal to the surface of the target. This requirement holds for tubes in which the electrons actually land on the target, usually with substantially zero velocity at the time of landing, or in tubes, the elements of which are so biased that all of the electrons in the beam do not actually land on the target but in which some of the electrons are selectively deflected from the target to provide an image signal. Mechanical non-uniformity of manufacture and possible arbitrarily imposed operating conditions prevent uniform normal landing of the beam over all parts of the target electrode of the tube. At any one part of the target, normal incidence of the beam is obtained in accordance with the present invention by introducing a distortion at the electron gun to provide a departure from normal incidence which is equal and opposite to the departure caused by non-uniformity of manufacture or by arbitrarily imposed operating conditions. Application of an external field for another purpose is described in United States Patent No. 2,224,933, granted to Kurt Schlesinger on December 17, 1940. The present invention provides for phasing the corrective distortion of the scanning beam so that normal incidence is insured for all points of the target. Electrical currents which produce this distortion may, in general, have the same form as the scanning currents. In some cases, arbitrary current configurations may be desirable, and the provision of such currents and their use is within the scope of the present invention. The arrangement of the present invention may be employed with any cathode ray tube in which deflection is symmetrical about the axis and, also, in other tubes where there is a change in wave form of the deflecting currents or voltages to correct for distortion of the scanning pattern. A common form of distortion which is corrected by a wave form change is known as "keystoning."

For each position of the scanning electron beam on a cathode ray tube target there is an optimum value of the beam alignment as it leaves the electron gun. The dynamic alignment arrangement or system of the invention, mentioned generally above, makes it possible more nearly to obtain this optimum value than is possible with conventional static alignment systems.

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The primary object of this invention is to produce normal incidence of a cathode ray beam at all points of a scanned target within a cathode ray beam tube.

Another object is to provide a dynamic alignment system for the cathode ray beam in cathode ray tubes.

Still another object is to provide a combined static and dynamic alignment system for the cathode ray beam in cathode ray tubes.

A further object is to provide an arrangement for producing a resultant magnetic flux in a direction substantially perpendicular to the cathode ray beam of a cathode ray tube, the radial direction of the resultant being adjustable to compensate for initial misalignment of the beam source and/or its associated parts.

A still further object is to produce a periodically varying resultant field in a direction substantially at right angles to the cathode ray beam of a cathode ray tube for the purpose of accomplishing static and dynamic alignment of a cathode ray beam.

Other and more specific objects of the invention will become apparent and suggest themselves to those skilled in the art to which the invention is directed upon reading the following specification and claims in connection with the drawings in which:

Fig. 1 shows, conventionally, one type of cathode ray tube provided with a combined static and dynamic alignment system in accordance with the invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1, together with a schematic showing of operating circuits for the combined alignment system;

Fig. 3 is a sectional view of a modification;

Fig. 4 is a sectional view of another modification together with its operating circuits; and

Fig. 5 is a series of curves referred to in the operation of apparatus embodying the invention.

Referring for the present to Figs. 1 and 2 of the drawings, an alignment system in accordance with the invention is shown as being applied to a camera tube 10. The tube 10, selected for purposes of illustration, is of the high sensitivity low beam velocity type known as the "Image Orthicon." The image type of "Orthicon" is disclosed and claimed in the copending application for U. S. Letters Patent of Albert Rose, Serial No.

407,132, filed August 16, 1941, now Patent #2,403,239. An "Orthicon" of the low beam velocity type is disclosed in United States patent to Rose, No. 2,213,176, granted August 27, 1940, and "Orthicons" of the return beam type are shown in United States patents to H. A. Iams, Nos. 2,213,177 and 2,288,402, granted August 27, 1940, and June 30, 1942, respectively. In the tube 10, a target 16 is to be scanned by a low velocity electron beam 18 produced by an electron gun 19. The target 16 may be of the type disclosed in the copending Rose application above referred to operating in conjunction with a photocathode 15 provided in the end wall of the tube.

Fig. 1 includes a schematic showing of a magnetic deflecting yoke including horizontal and vertical deflecting coils 21 and 22, respectively. A focusing coil 23 surrounds the tube and provides an axial focusing field for the low velocity beam 18 in a manner which is by now well known and is discussed in the copending application and the patents above referred to. Also, the functions and connections of the several electrodes of a tube such as the tube 10 are disclosed in the patents above referred to and more particularly in a copending application for U. S. Letters of Patent of Paul K. Weimer, Serial No. 544,494, filed September 16, 1944, now Patent No. 2,433,941. A further and more detailed description of the tube 10, therefore, is deemed unnecessary since the present invention is concerned with the alignment of the beam 18 after it emerges or is projected from the gun 19.

It is preferred in a tube of this kind that the undeflected beam approach the target 16 at the center thereof or at least in the center of a desired scanning raster. It will be understood that electrons of the beam also may land upon the target with substantially zero velocity. As pointed out above, non-uniformities of tube manufacture can in many cases cause the undeflected beam to approach or land at some angle to the normal at a point other than the center of the target or the center of the scanned raster, and when the beam is deflected, cause the beam to approach the target from an angle other than the desired right angle. A misaligned beam may still land at the center of the target if the latter is biased to a sufficiently positive potential. However, the beam possesses helical motion as a result of the misalignment which causes it to approach the target at non-normal incidence, so that with a normal positive bias on the target, the beam may fail to land because of the transverse velocity components it possesses as a result of this helical motion.

The beam 18, as shown in Fig. 1 of the drawings, is indicated as having been deflected by the magnetic deflecting yoke previously referred to, the solid line designating the desired normal landing of the beam. The dashed line indicates a departure of the beam to an exaggerated degree for the sake of illustration. Such a departure might occur because of unavoidable misalignment of the tube parts during manufacture. The angle a indicates the degree of this departure, and in accordance with the invention, four coils 29, 30, 31, and 32 are arranged to surround the neck of the coil near the position where the cathode ray beam leaves the gun 19. The function of these coils is to introduce transverse velocity components which cancel objectionable transverse velocity components introduced elsewhere, for example, because of beam misalignment. The coils 29 to 32 are arranged in

pairs and are carried so as to be mechanically rotatable as a unit in any desired manner known in the prior art, for example by being embodied in a yoke structure such as is used to provide deflection of a cathode ray beam in a "Kinescope" or an "Iconoscope." The mounting shown is illustrative and comprises a tubular member 34, preferably, although not necessarily, of insulating material which closely surrounds the neck of the tube 10. Means indicated as a finger piece or handle 36 provides for rotating the tubular member 34 and the coils located thereon as a unit to give the best adjustment for obtaining the most uniform beam landing over the entire raster. Rotation of the coils 29 to 31 as a unit provides "dynamic alignment" of the beam as this function will be referred to hereinafter. Direct current is fed into the coils 29 to 32 as well as alternating currents having a desired wave form in a manner now to be described.

A multi-contract potentiometer 38 comprises a continuous circular resistor having sections 39 and 40 which are oppositely disposed geometrically. These sections are connected in parallel across any suitable source 43 of direct current. The pair of coils 29 and 30 are joined together in series and are connected to the slidable contacts 46 and 47 over conductors 48 and 49. A choke coil 52 is included in the D. C. path through the coils 29 and 30 in series to block out alternating currents introduced in these coils in a manner to be described. The pair of coils 31 and 32 is connected to potentiometer contacts 54 and 55 over conductors 56 and 57, this connection including a choke coil 59. The contacts 46, 47, 54 and 55 are rotatable together by any suitable means such as indicated schematically at 60. Rotation of these contacts will vary the position of the resultant field produced by the two sets of coils and continued rotation of these contacts will vary the phase or sense of the resultant. "Static alignment" is provided by changing the position and/or sense of the resultant field.

A variable resistor 62 may be used to vary the current flowing through the potentiometer resistors which, in turn, determines the voltage difference across these resistors.

In place of the multi-contact potentiometer, shown by way of example, direct current may be fed into each pair of coils through variable resistors and reversing switches.

A sawtooth current from the source which supplies the coils 21, for example, is fed through the coils 31 and 32 in series. This may readily be accomplished as shown in Fig. 2 of the drawings, for example, by providing a variable resistive shunt 64 across terminals 66 which are in communication with the horizontal deflection source for the tube 10. A condenser 68 prevents shortcircuiting of the direct current path through the coils. A vertical sawtooth wave applied to terminals 70 is fed to the coils 29 and 30 under control of a shunt-connected variable resistor 72. A condenser 73 prevents short circuiting of the D. C. path through the coils 29 and 30.

In operation of the arrangement disclosed in Figs. 1 and 2 of the drawings, the pair 29 and 30 and the pair 31 and 32 of coils are mechanically rotated as a unit to an approximate rotational position previously determined by successive approximations for best beam landing at the edges of the target. In general, for like tubes the rotational position of these dynamic alignment coils should not have to be altered appreciably

in going from tube to tube, other things relevant to the tube operation remaining unchanged.

The rotational position of the resultant of the flux set up by the coils 29 and 30 and the coils 31 and 32 provides for static alignment and this resultant is adjusted electrically by means of the multi-contact potentiometer 38 to give the best operation at the center of the target. The center operation of the undeflected beam is further improved by varying the current through the coils by changing the setting of the variable resistor 62. The magnitude of the sawtooth current in the coils 31 and 32 which produces a flux to serve for horizontal dynamic alignment purposes is adjusted for the best operation at the edges of the target. This adjustment is performed by changing the setting of the variable resistor 64. The edge operation is further improved by suitably adjusting the magnitude of the sawtooth current component in the coils 29 and 30. This is accomplished by adjusting the resistor 72. The steps set forth immediately above are repeated until the best over-all operation is obtained.

Referring to Fig. 5 of the drawings and considering either the horizontal or vertical deflection voltage wave as being shown by curve 76, when this wave or the deflecting effect on the cathode ray beam of the flux produced by this wave passes through zero, then in a theoretically perfect tube 10 of the type shown in Fig. 1, the beam will be at the geometrical center of the raster which is to be traced on the target 16. Moreover, the beam will approach or land on the target from a direction normal thereto. Curve 78 indicates the current, or its magnetic effect on the cathode ray beam, which is supplied to a pair of coils, either coils 29 and 30 or coils 31 and 32, simultaneously with the wave represented by the curve 76. The point on the wave 78 which corresponds with the zero point of the deflection wave 76, is given a value which is determined by the degree of static misalignment of the beam and is positive or negative depending upon the direction of displacement of the point at which the scanning beam impinges relative to the center of the scanned raster. This change in polarity or phase is accomplished by rotating the contacts of the potentiometer 38, the magnitude of the displacement of the curve 78 being determined by adjustment of the resistor 62. Movement of the entire yoke by the handle 36 accomplishes mechanical rotational alignment for the dynamic alignment system. The angular position of the potentiometer contacts accomplishes rotation of the resultant field which provides static alignment as a result of the application of the sawtooth waves.

Fig. 3 of the drawings indicates an arrangement in which both the static alignment system comprising a pair of coils 81 and 82 and the dynamic alignment system comprising two pairs of coils 84 and 85, and 86 and 87 are rotated mechanically. The static alignment coils 81 and 82 may be mounted upon a tube or yoke 89 which may be rotated by a handle or thumb piece 91. The dynamic coils 84 to 87 are carried by a yoke comprising the tubes 94 and 95 rotatable upon movement of a thumb piece or a handle 98. The coils 81 and 82 are supplied with direct current which may be varied at will for adjustment in any suitable manner. The coils 86 and 87, corresponding to the coils 29 and 30 of Fig. 1, are fed from the vertical sawtooth input with means, such as the means 72, shown in Fig. 2 for adjusting the strength of the field produced by the sawtooth current in these coils. The coils 84 and 85 likewise carry an adjustable current derived from the horizontal sawtooth input.

It will be seen that the arrangement of Fig. 3 provides a pair of coils, namely coils 81 and 82, for static alignment with mechanical rotation of this separate pair and mechanical rotation of the two sets of dynamic alignment coils as a unit.

Fig. 4 of the drawings shows an arrangement which is similar to Fig. 3 except that electrical rotation of the static alignment field is provided by a pair of coils 100 and 101, operating in conjunction with an associated pair of coils 102 and 103. The resultant field produced by these two pairs of coils is rotated by adjustment of a multi-contact potentiometer 106 similar to the potentiometer 38 of Fig. 2. A variable resistor 108 provides for independent adjustment of the magnitude of the resultant field which provides static alignment of the beam. Dynamic alignment is provided by a pair of coils 109 and 110 operating in conjunction with a pair of coils 111 and 112. The coils 109 and 110 correspond to the coils 86 and 87 of Fig. 3, while the coils 111 and 112 correspond to the coils 84 and 85 of Fig. 3. A finger piece or handle 116 serves to rotate the dynamic alignment coils as a unit.

While magnetic arrangements for securing static and dynamic alignment have been shown by way of example, it will be understood that voltage deflection plates rather than coils may be used. These plates will be located in the same region as the coils, several examples of which have been described above, and will preferably be short as compared with the distance between two successive focal points of the beam. A set of oppositely disposed plates may be employed to which is fed the vertical deflecting sawtooth voltage wave after amplification in an amplifier having a readily operated gain control. Likewise, a cooperating pair of oppositely disposed plates displaced 90° from the plates having the vertical deflecting signal applied thereto would be provided. The horizontal deflecting signal is fed also by way of a controlled amplifier to these cooperating plates. Both sets of plates are preferably rotated as a unit.

Having now described the invention, what is claimed and desired to be secured by Letters Patent is the following:

1. In combination, a cathode ray tube having a target and means for producing and directing a cathode ray beam toward said target, means for producing scanning deflection of said beam to cover a bidimensional pattern, means for insuring the landing of said beam when a deflection effect is absent at substantially the center of said target whereby said bidimensional pattern will be centered upon said target comprising means for producing a beam influencing field transversely of said tube, means to change the direction of said field, and means to change the polarity of said field.

2. The combination of claim 1 wherein means to change the strength of said beam influencing field are present.

3. In combination, a cathode ray tube having a target and means for producing and directing a cathode ray beam toward said target, means for producing scanning deflection of said beam to cover a bidimensional pattern, means for insuring the landing of said beam at substantially the center of said target whereby said bidimensional

pattern will be centered with respect to said target, opposed pairs of coils to provide a resultant magnetic field transversely of said tube, connections for energizing said pairs of coils, and a multi-contact potentiometer included in said connections for reversing the direction of the current flowing in said coils and for controlling the strength thereof whereby to alter the direction and polarity of said resultant transverse field.

4. In combination, a cathode ray tube having a target and means for producing and directing a cathode ray beam toward said target, means for producing scanning deflection of said beam to cover a bidimensional pattern, means for insuring the landing of said beam at substantially the center of said target whereby said bidimensional pattern will be centered upon said target comprising opposed pairs of coils to provide a magnetic field transversely of said tube, an operative connection for energizing said pairs of coils with unidirectional current, means for supplying one pair of coils with alternating currents of a wave form similar to that which produces one component of the bidimensional pattern, means for supplying the other pair of coils with alternating current of a wave form similar to that which produces the other coordinate of the bidimensional pattern whereby to add in insuring perpendicularity of said beam to said target at all points of the bidimensional pattern.

5. In combination, a cathode ray tube having a target and means for producing and directing a cathode ray beam toward said target, means for producing scanning deflection of said beam to cover a bidimensional pattern, two pairs of oppositely disposed coils, each pair of coils being positioned on an axis substantially at right angles to the axis of the other pair of coils, a mounting for said coils surrounding said tube and being rotatable with respect thereto, terminal connections for supplying said coils with unidirectional current whereby the locus of the scanning pattern of the beam with respect to the target may be adjusted, said pairs of coils being rotatable as a unit whereby the portion of the beam adjacent to the target is brought normal to the target at the edges of the target.

6. In combination, a cathode ray tube having a target and means for producing and directing a cathode ray beam toward said target, means for producing scanning deflection of said beam to cover a bidimensional pattern, two pairs of oppositely disposed coils, each pair of coils being positioned on an axis substantially at right angles to the axis of the other pair of coils, means for supplying one pair of coils with alternating currents

of a wave form similar to that which produces one coordinate of the scanning movement, and means to supply the other pair of coils with alternating current of a wave form similar to that which produces the other coordinate of scanning movement of the beam whereby to insure perpendicularity of the beam with respect to the target.

7. In combination, a cathode ray tube having a target and means for producing and directing a cathode ray beam toward said target, means for producing scanning deflection of said beam to cover a bidimensional pattern, two pairs of oppositely disposed coils, each pair of coils being positioned on an axis substantially at right angles to the axis of the other pair of coils, a mounting for said coils surrounding said tube and being rotatable with respect thereto, terminal connections for supplying said coils with unidirectional current whereby the locus of the scanning pattern of the beam with respect to the target may be adjusted, means for supplying one pair of coils with alternating currents of a wave form similar to that which produces one coordinate of the scanning movement of the beam, means to provide the other pair of coils with alternating currents of a wave form similar to that which produces the other coordinate of scanning movement of the beam, said pairs of coils being rotatable as a unit with said mounting whereby the portion of the beam adjacent to the target is brought normal to the target at the edges of the target, the magnetic components produced by said alternating currents in said coils further influencing the angle of approach of said beam to said target adjacent the edges of said pattern.

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