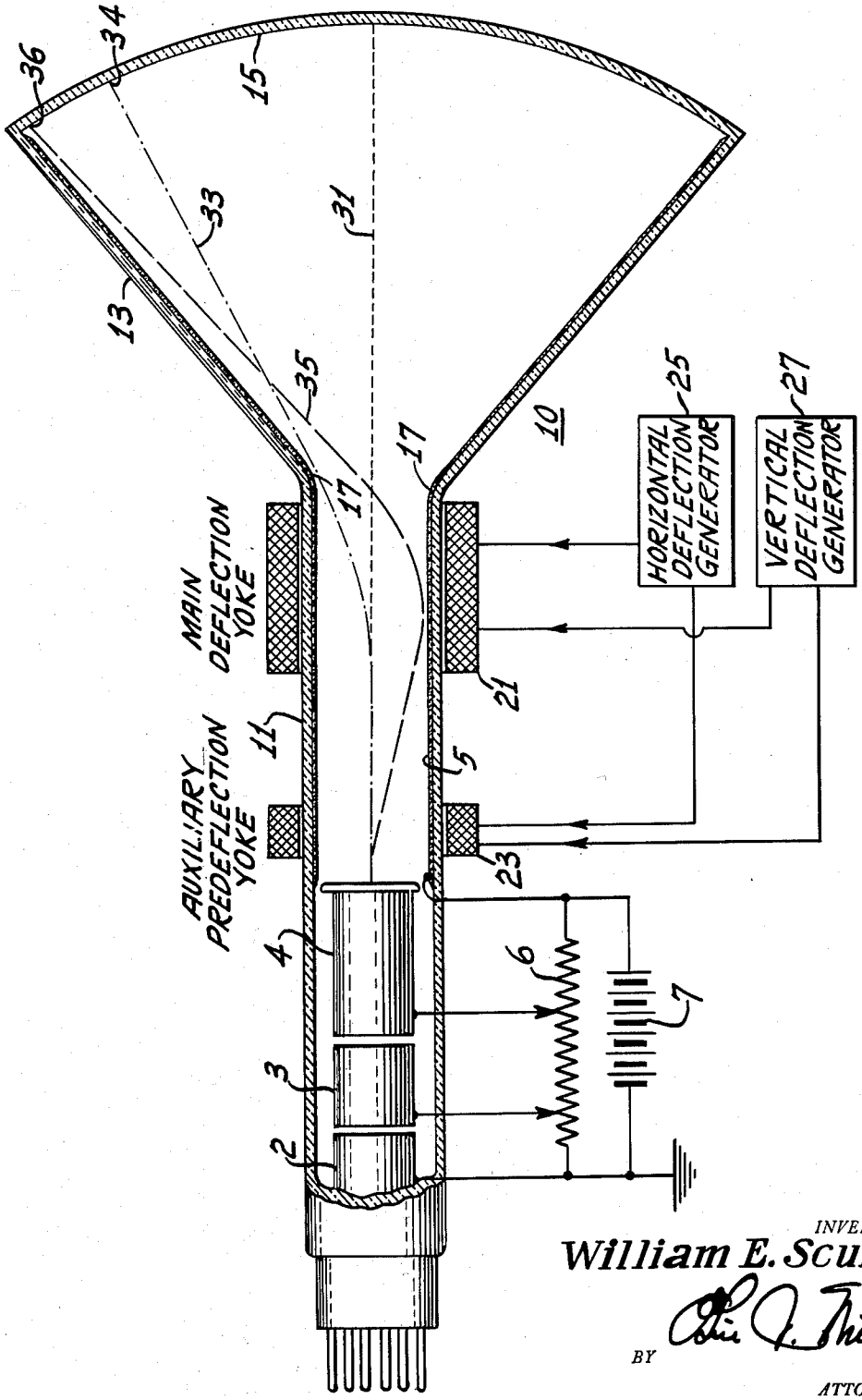
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CATHODE RAY DEFLECTION SYSTEMS

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# CATHODE RAY DEFLECTION SYSTEMS

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This invention relates to cathode ray tube devices and systems, and more particularly, to cathode ray beam deflection systems and methods for use with or in cathode ray tube devices and systems, such as television receivers and the like.

In the use of cathode ray tubes for certain purposes, such as television, there has been an ever increasing desire for wider angles of beam deflection to facilitate the design of kinescopes with larger screens without increasing other critical tube dimensions to unwieldy proportions. In conventional deflection systems, a limiting factor on the magnitude of deflection angle obtainable has been the width of the neck aperture of the tube, since the deflected beam must clear the "corners" at the junction of the neck and flared portions of the tube. One approach to the problem of obtaining wider deflection angles for a given order of neck aperture width has been to cut down the length of the deflection yoke to encompass a very short distance along the beam path as closely adjacent to the "corners" as possible. A serious disadvantage to this approach is that deflection efficiency is considerably reduced by such a decrease in the yoke's operating length, and considerably more power is needed to achieve the desired deflection. Also, deflection linearity tends to be adversely affected as the yoke length is decreased.

In accordance with the present invention, extremely wide deflection angles may be obtained for a given order of neck aperture width without decreasing deflection efficiency and, in some cases, accompanied by increased deflection efficiency. The present invention rather than shortening the deflection yoke from conventional length permits an increase in deflection yoke length to obtain a more efficient yoke requiring less driving power. The essence of the present invention, whereby a more efficient wide-angle deflection system is achieved, lies in the provision for preliminary deflection of the electron beam between the electron gun and the main deflection yoke in a sense synchronously opposite to the main scanning deflection of the beam.

The effect of the "reverse" sense preliminary deflection is a substantial increase in the effective neck aperture width, with consequent assurance of beam clearance of "corners" over an exceptionally wide range of deflection angles. If the present invention is applied to conventional cathode ray tube devices of the present day, whereby the extremes of the thus available deflection angle range are not utilized, the invention nevertheless provides considerable leeway for redesign of deflection yokes to longer, more efficient, lengths. Also, the present invention will provide considerable leeway in the heretofore exceptionally critical adjustments of the positions of various components, such as the focusing coil, scanning deflection yoke, ion trap, etc. on the neck of conventional tubes.

Accordingly, a primary object of the present invention is to provide an improved cathode ray beam deflection system.

Another object of the present invention is to provide an efficient wide-angle electron beam deflection system.



A further object of the present invention is to increase the effective neck aperture width for the scanning beam in cathode ray tube apparatus, such as television receivers and the like.

An additional object of the present invention is to provide a cathode ray tube device with an improved beam deflection system whereby exceptionally large angles of deflection may be satisfactorily obtained.

Another object of the present invention is to improve the deflection efficiency in cathode ray tube apparatus, such as television receivers and the like.

A further object of the present invention is to provide an improved cathode ray beam deflection system whereby beam clearance of the tube neck "corners" is assured over a wide range of deflection angles, and whereby positional adjustment of components on the tube neck is rendered less critical.

An additional object of the present invention is to provide an efficient method of deflecting cathode ray beams over a wide range of deflection angles.

Other and incidental objects of the present invention will be apparent to those skilled in the art from a reading of the following description and an inspection of the accompanying drawing which illustrates an embodiment of the present invention in which an auxiliary predeflection yoke, preceding the main deflection yoke in position along the cathode ray beam path, is adapted to impart a preliminary deflection to the beam in a sense synchronously opposite to that imparted by the main deflection yoke.

In the accompanying drawing there is shown a partially sectional view of a cathode ray tube **10** of conventional type. The tube **10** includes a neck portion **11** integral with or joined to a flared portion **13** which terminates in a target **15** which may comprise a phosphor screen of a well-known function. The periphery of the junction of the neck and flared portions of the tube presents the effect of "corners" **17** in the sectional plane illustrated.

An electron beam source **2, 3, 4**, is positioned at the remote end of the neck section **11** to provide a beam of electrons which may be deflected to trace suitable scanning rasters on the target **15**. The electron beam source may be in the well-known form of an electron gun, which may include a cathode **2**, a beam intensity control electrode **3**, and a first anode **4**, in cooperation with a second anode **5** (shown as a conductive coating on the inner-surface of the neck portion **11** and extending into the flared portion **13** to a limit adjacent the screen **15**). The several electrodes described are, during tube operation, connected to a source of D. C. potential, which may be a voltage divider **6** connected between the positive and negative terminals of a battery **7**.

It will be appreciated that the particular configuration of elements which constitute the electron gun in the accompanying drawing is illustrative only, and that the electron beam source in the present invention may take any of a variety of forms known to the art. Electron guns are discussed in detail in an article entitled "Factors governing performance of electron guns in television cathode-ray tubes," by R. R. Law beginning on page 103 of the "Proceedings of the Institute of Radio Engineers" for February 1942, and in an article entitled "Improved electron gun for cathode-ray tubes," by L. E. Swedlund, appearing in "Electronics" for March 1945.

A main deflection yoke **21**, which is mounted in a conventional manner on the tube neck **11** closely adjacent to the junction of the neck and flared portions, includes suitable horizontal and vertical deflecting means, such as deflection coils. An auxiliary deflection yoke **23**, also including horizontal and vertical deflecting means such as deflection coils, which may be similar in structure to the main deflection yoke assembly but is prefer-

ably smaller in size, is similarly mounted on the tube neck **11** in a position spaced from and preceding the main deflection yoke **21**.

Deflecting waves of line frequency, developed by the horizontal deflection generator **25**, energize the respective horizontal deflecting means of the main and auxiliary deflection yokes. The energizations are so related as to synchronously impart deflections in mutually opposite senses; that is, as energization of the horizontal deflecting means of the auxiliary deflection yoke **23** imparts deflection to an electron beam passing through the tube neck in one direction, the synchronous energization of the horizontal deflecting means of the main deflection yoke **21** imparts deflection to the electron beam in the opposite direction.

Deflecting waves of field frequency, developed by the vertical deflection generator **27**, energize the respective vertical deflecting means of the main and auxiliary deflection yokes **21** and **23**, respectively. Again, the energizations are so related as to synchronously impart deflections in mutually opposite senses; that is, as energization of the vertical deflecting means of the auxiliary deflection yoke **23** imports deflection to the electron beam in one direction, the synchronous energization of the vertical deflecting means of the main deflection yoke **21** imparts deflection to the electron beam in the opposite direction.

It will be appreciated that the net effect of conjoint energizations of the vertical and horizontal deflecting means will again be impartation of deflections by the two energized yokes **21** and **23** in mutually opposite senses; that is, as conjoint energizations of the horizontal and vertical deflecting means of the auxiliary deflection yoke **23** impart a net deflection to the electron beam in one direction, the respectively synchronous energizations of the horizontal and vertical deflecting means of the main deflection yoke **21** impart a net deflection to the electron beam in the opposite direction.

Thus, for example, when the electron beam is being deflected by the main deflection yoke **21** to strike a point in the upper right hand segment of the screen **15**, the preliminary deflection imparted by the auxiliary deflection yoke **23** is causing the beam to enter the operating region of the main deflection yoke **21** at a point in the lower left hand segment of the tube neck cross-section. Similarly, when the electron beam is being deflected by the main deflection yoke **21** to strike a point in the lower left hand segment of the screen **15**, the preliminary deflection imparted by the auxiliary deflection yoke **23** is causing the beam to enter the operating region of the main deflection yoke **21** at a point in the upper right hand segment of the tube neck cross-section. The entire width of the tube neck is thus available for sweeping the electron beam to these deflection extremities, as contrasted to half the neck width which is the width available for extremes of beam sweep when the beam conventionally enters the deflection yoke region at a point on the tube neck axis. It is therefore seen that the effective width of a tube neck aperture for deflection purposes is substantially increased by the use of the predeflection principles of the present invention.

Only a small degree of preliminary deflection need be imparted to effect a maximum displacement from the tube neck axis of the point of entry of the electron beam into the main deflection region, particularly if there is some spacing between the positions of the auxiliary and main yokes **23** and **21** along the beam path.

Therefore, the auxiliary deflection yoke **23** may be considerably shorter than the main deflection yoke **21** and may take only a small fractional portion of the energy outputs of the deflection generators **25** and **27**. To achieve the desired "reverse" effect in the preliminary deflection, the auxiliary yoke-generator connections may be made in a manner reverse to that employed in making the main yoke-generator connections, or phase reversers may be included in the auxiliary yoke-generator connections, or the auxiliary yoke coils **23** may be oppositely wound as compared with the main yoke coils **21**. If the inter-yoke spacing and auxiliary yoke energization values are selected to effect the maximum entry point displacement for sweep extremes, exceptionally large deflection angles, extending well into the obtuse angle range, may be achieved without the beam striking the tube neck "corners." However, it will be appreciated that in many utilizations, such exceptionally large deflection angles will not be required. In these utilizations, particularly where conservation of component spacing and conservation of deflection energy are of importance, the inter-yoke spacing and auxiliary yoke energization values may be restricted to effect somewhat less than maximum entry point displacement for sweep extremes, and reasonably large deflection angles may still be achieved without the striking of tube neck "corners."

To illustrate the effect on an electron beam of the "reverse" preliminary deflection, a pair of beam paths **33** and **35** have been shcwn in the accompanying drawing, one beam path **33** (shown by dot-and-dash lines) illustrating one path taken by a beam subject only to the deflection field of the main yoke **21**, and the other beam path **35** (shown by dash lines) illustrating a path taken by a beam subject to the deflection field of the auxiliary yoke **23** as well as the deflection field of the main yoke **21**. In both instances the electron beam emanating from the electron beam source **2**, **3**, **4**, originally follows an axial path coincident with the tube axis **31**.

For purpose of explanation, it will be assumed that the illustrated beam paths lie in a horizontal sectional plane, and show the effects of an extreme of horizontal deflection only. However, it will be appreciated that the explanation is equally applicable to vertical deflections due to vertical deflection energization only, or to "diagonal" or other deflections due to conjoint vertical and horizontal deflection energizations.

In conventional apparatus, the beam path **33** follows the tube axis **31** until reaching the main deflection region. Therein, under the influence of the main deflection field, it follows an arcuate path, the effective diameter of which is inversely proportional to the instantaneous strength of the transverse deflection field. Upon passing out of the deflection field region, an essentially straight line path is resumed terminating at a point **34** on the tube screen **15**.

It is seen that in the achievement of a deflection angle sufficiently large to permit the beam to reach point **34** on the screen, the conventional beam path **33** just barely clears the "corner" **17**. Greater deflection angles, such as one sufficiently large to permit the beam to reach point **36** on the screen **15**, are not achievable using conventional deflection principles as the beam will strike the "corner" **17** enroute. Also if the main deflection yoke **21** was substantially lengthened to improve deflection efficiency, the masking effect of the "corners" **17** would restrict conventional deflection to maximum deflection angles even smaller than that necessary to reach point **34**.

The more desirable performance achieved by utilizing the principles of the present invention is illustrated by the beam path **35**. As the beam enters the field of the auxiliary deflection yoke **23** it is deflected from its axial path to follow an arcuate path (curving in a "right-hand" direction in the illustrated instant of the deflection cycle). Upon leaving the auxiliary deflection field the beam continues in a straight line path, at an angle to the tube axis, until entering the main deflection field at the right-hand side of the illustrated section of the tube neck **11**. Under the influence of the main deflection field, opposite in effect to the auxiliary deflection field, the beam follows an oppositely curved arcuate path. Upon passing out of the main deflection field, the beam continues in a straight line path terminating at point

36 at the extreme left end of the illustrated section of the screen 15.

It is seen that this deflection extreme is achieved with considerable clearance of the "corners" 17. It will also be appreciated that much greater deflection angles than that necessary to reach point 36 could be achieved in accordance with the invention's predeflection principles without the problem of "corner" masking arising at all. Also, the main deflection yoke 21 could be substantially lengthened to improve deflection efficiency, and deflection angles of a magnitude sufficient to reach point 36 would still be easily attainable without fear of the interfering effect of "corner" shadows. Also, with such great leeway in beam clearance of the tube neck "corners" in all utilizations of the present invention (except perhaps those that might require exceptionally large obtuse angles of deflection) the positional adjustment of the tube neck of components such as deflection yokes, focusing coils, etc., is rendered much less critical if the cathode ray tube apparatus is adapted to employ the improvements embodied in the present invention.

While the foregoing explanation has only illustrated the effect of the present invention on one extreme of deflection in a given plane, it will be appreciated by those skilled in the art that, with energization of the horizontal and vertical deflecting means in the revealed manner, complete rasters of any desired type may be developed with the above-discussed freedom from "corner" masking problems and the accompanying efficiency advantages prevailing throughout the scanning cycles.

In another form of this invention, electrostatic deflecting means mounted inside the tube neck are employed to effect a similar solution to the "corner" masking problem. Main and auxiliary deflection plates (or electrostatic deflection yokes) are secured within the tube neck in positions along the beam path corresponding to those of the main and auxiliary deflection yokes 21 and 23, in the illustrated embodiment. With energizations of the main and auxiliary deflection plates so related as to produce mutually opposite deflection effects as in the illustrated embodiment, deflection angles over an exceptionally wide range may be achieved with a high degree of deflection efficiency.

It will be appreciated that the present invention is applicable to sundry types of cathode-ray tube apparatus, such as television receivers, television pick-up systems, oscilloscopes, facsimile scanners, radar-display systems, etc., and will provide for efficient wide-angle beam deflection in various forms of cathode-ray tubes, such as kinescopes, iconoscopes, image orthicons, "flying-spot" scanners, P. P. I. scopes, etc., with freedom from "corner" masking problems therein.

What I claim is:

1. In a cathode ray tube assembly including a cathode ray tube having a neck, and an electron gun located at one end of said neck, the combination of a main electromagnetic deflection yoke surrounding a region of said neck at the opposite end thereof, an auxiliary electromagnetic deflection yoke surrounding said neck at a position intermediate the location of said main deflection yoke and the location of said electron gun, said auxiliary deflection yoke being spaced from said main deflection yoke by a distance along said neck comparable to the length of said region, and means for synchronously energizing both of said deflection yokes, the energization of said auxiliary deflection yoke regularly causing preliminary deflection of the electron beam from said electron gun in a direction opposite to the direction of beam deflection caused by energization of said main deflection yoke.

2. In cathode ray tube apparatus including a cathode ray tube comprising an electron beam source, an electron target, and an enclosed beam path between said source and said target, the combination including a main electromagnetic deflection yoke operating over one region of said beam path for imparting scanning deflections to said beam, an auxiliary electromagnetic deflection yoke preceding and appreciably spaced from said main deflection yoke for displacing the point of entry of said beam into said region, and means for energizing both of said deflection yokes, the energizations of both of said deflection yokes being so related that the direction of the displacement imparted by said auxiliary deflection yoke is continually opposite to the direction of the deflection imparted by said main deflection yoke whereby said main deflection yoke is provided with an effective center of deflection located at a point in said beam path subsequent to said one region.

3. In cathode-ray tube apparatus including a cathode-ray tube comprising an electron beam source, an electron target, and an enclosed beam path between said source and said target, said cathode-ray tube including a neck portion enclosing said electron beam source and a segment of said beam path, the combination comprising a main electromagnetic deflection yoke surrounding said neck and operating over a given region of said beam path for imparting scanning deflections to said beam, an auxiliary electromagnetic deflection yoke also surrounding said tube neck but spaced from said main deflection yoke for displacing the point of entry of said beam into said given region, the spacing between said auxiliary and main deflection yoke being of appreciable length with respect to the length of said auxiliary deflection yoke, and means for synchronously energizing both of said deflection yokes such that the direction of displacement imparted by said auxiliary deflection yoke is continually opposite to the direction imparted by said main deflection yoke.

4. In cathode-ray tube apparatus including a cathode-ray tube comprising an electron beam source, a luminescent target, and an enclosed beam path between said source and said target, said cathode-ray tube including a neck portion enclosing said electron beam source and a segment of said beam path, the combination comprising a main electromagnetic deflection yoke surrounding said neck and operating over a given region of said beam path for imparting scanning deflections to said beam, an auxiliary electro-magnetic deflection yoke also surrounding said tube neck but spaced from said main deflection yoke for displacing the point of entry of said beam into said given region, the spacing between said auxiliary and main deflection yoke and said given region being of a length substantially greater than the length of said auxiliary deflection yoke, means for energizing said main deflection yoke with scanning waves of predetermined amplitude and periodicity, and means for energizing said auxiliary deflection yoke in synchronism with the energization of said main deflection yoke but with scanning waves of reduced amplitude relative to said predetermined amplitude, the energizations of both of said deflection yokes being related such that the direction of displacement imparted by said auxiliary yoke is continuously opposite to the direction of the deflection imparted by said main yoke.

5. In a cathode-ray tube assembly including a cathode-ray tube having a neck portion and a flared portion, and including an electron gun located at one end of said neck, and a luminescent target located in said flared tube portion, said neck providing an enclosure for the path of an electron beam generated by said electron gun and directed toward said target, the combination comprising a main electromagnetic deflection yoke surrounding said neck at the end thereof adjacent to said flared tube portion for imparting deflections to said beam over a given region of said beam path, an auxiliary electromagnetic deflection yoke surrounding said neck at a position intermediate the location of said main deflection yoke and the location of said electron gun for displacing the point of entry of said beam into said given region, said auxiliary deflection yoke being spaced from said main deflection yoke by a distance along said beam path comparable to the length of said given region, such spacing providing

an essentially field free region of said beam path intermediate said auxiliary deflection yoke and said given region, means for energizing said main deflection yoke with sawtooth current waveforms of predetermined amplitude and periodicity, and means for synchronously energizing said auxiliary deflection yoke with sawtooth current waveforms of similar periodicity but reduced amplitude relative to said predetermined amplitude, the energizations of both said yokes being so related as to cause the direction of the displacement imparted by said auxiliary yoke to be continually opposite to the direction of the deflection imparted by said main yoke.




References Cited in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,053,537 | Schlesinger | Sept. 8, 1936 |
| 2,098,390 | Iams | Nov. 9, 1937 |
| 2,164,555 | Truell | July 4, 1939 |
| 2,197,523 | Gabor | Apr. 16, 1940 |
| 2,214,729 | Hickok | Sept. 17, 1940 |
| 2,253,355 | Taylor | Aug. 19, 1941 |
| 2,395,966 | Goldberg | Mar. 5, 1946 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 866,058 | France | Mar. 31, 1941 |