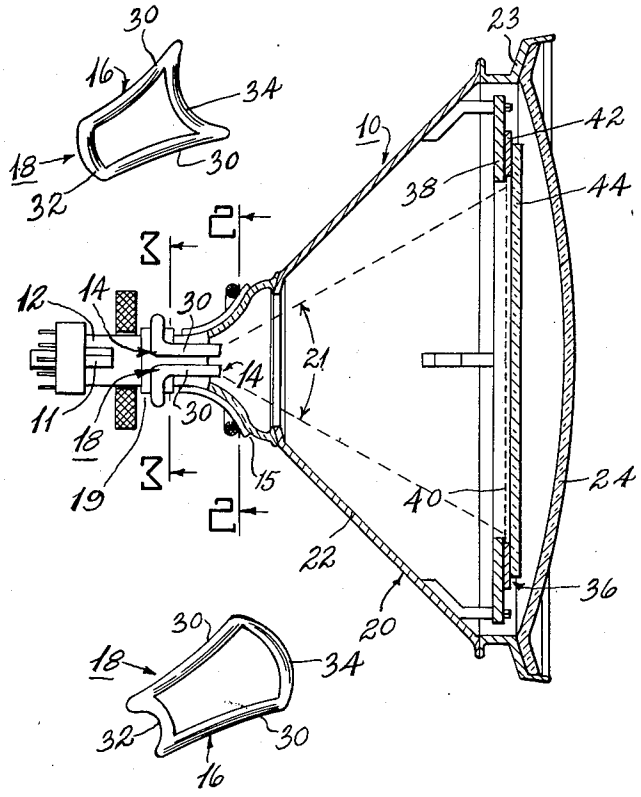
March 12, 1957 A. L. TIRICO 2,785,329

EXPANDED YOKE FOR DEFLECTING CONVERGENT BEAMS

Filed July 10, 1952



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United States Patent Office 2,785,329
Patented Mar. 12, 1957

2,785,329

EXPANDED YOKE FOR DEFLECTING CONVERGENT BEAMS

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Application July 10, 1952, Serial No. 298,118

8 Claims. (Cl. 313—69)

This invention relates to multiple beam cathode ray devices and/or single beam devices so operated as to constitute the equivalent thereof. More particularly it relates to "directional" color-television picture and pick-up tubes, such as those described in U. S. Patent 2,581,-487, in which color-selective cooperation between an electron beam and a color-image transducing surface depends on the direction of convergence of the beam onto said surface.

One very serious problem which has been encountered in developing directional types of color television transducer tubes has been the attainment of uniformity of convergence of a number of electron beams, or of a single beam operated sequentially as the equivalent thereof, toward all parts of an image transducing surface, e. g., toward all parts of a directional dot-phosphor fluorescent screen. Thus whereas the individual beams of a three beam directional kinescope (or individual successive bursts of electrons in the single nutating beam of an equivalent kinescope, like that shown in the above-mentioned patent) may converge accurately upon a picture-element-size area when they are proceeding toward some central portion of the screen, they may fail to do so when proceeding toward a peripheral portion of the screen such as toward one of the corners of the image area. As a result the video information concerning the respective component-colors of a single full-color picture element may be reproduced at the locations of different picture element areas which may actually be dozens of picture-element areas apart. The effect which this causes might be compared to what would happen in color-printing (with inks) if the component images were printed on a somewhat elastic paper and if the paper were slightly and unevenly stretched or otherwise changed to a slightly different shape before each additional color was applied to it.

Early in the development of these tubes it was found that one reason for non-uniformity of convergence is that inasmuch as the image-transducing surface is flat, rather than spherical, all points thereof are not equidistant from the tube's center (or "centroid") of deflection, and a way of compensating for this was quickly devised. This consisted of providing the dynamic convergence correction in which focusing is varied in synchronism with scanning. While this was very helpful, it still did not result in satisfactory uniformity of convergence. Although great efforts have been made to attain a more complete solution they have been rather unsatisfactory. They involved resort to very complicated devices adapted to permit extremely painstaking adjustments requiring great technical skill and intended to offer a trial-and-error way of eliminating, or compensating for, myriads of aberrations supposedly randomly occurring in the magnetic deflection fields. Besides often being ineffectual this was not a practical solution because of the excessively high initial cost of color receivers using the devices and maintenance needs which cannot be met at all with normally available personnel.

Accordingly it is an object of this invention to provide devices of the kind in question which inherently have greatly improved uniformity of convergence and therefore do not require resort to complicated field adjusting and compensating means and painstaking adjustments thereof.

The attainment of this and other objects has been based on the following principles: (1) that the electron optical requirements for accurate and uniform convergence of one or more "directional" beams are similar to, but on a dimensionally larger scale than, those for accurate and uniform focus of a single axial beam; (2) that a principal one among these requirements is that a magnetic deflection yoke have a sufficiently large throat to avoid excessively close skirting of its interior surfaces by any of the electrons in a convergent cone thereof or any of the beams in a convergent bundle thereof, as the case may be; and (3) that in preferred embodiments (but not necessarily) the yoke may be provided with such a sufficiently large throat with a minimum loss in efficiency if it is formed with a tapered configuration approximately conforming to the intended solid angle of deflection.

It should be borne in mind that even the electrons comprising a single axial beam do not constitute a fine pencil-like stream as they pass through the deflection region. Instead they are quite spread out as a result of having diverged for a considerable distance after leaving the gun and then converged for only a short distance after focusing. Thus the beam constitutes a cone of electrons whose dimensionally-finite base-end occupies the deflection region while its sharp apex is directed at the screen where all of the electrons should pass through a small cross-over point if sharp focus is to be achieved. Because the base of the cone subtends a significant amount of space in the deflection region any substantial non-uniformity in the magnetic deflection flux across that region will divert some of the electrons more than others and therefore will prevent them from all meeting at the intended common cross-over point. Such non-uniformity exists close to the inside of the throat of the yoke since magnetic field gradients therein increase at increasing rates within successive small increments of space nearer and nearer to its inside surface, i. e., nearer and nearer to its actual wires. This is particularly important in the case of directional color television transducer tubes wherein the thickness of the entire bundle of convergent beams or beam paths is necessarily quite substantial. However these principles and their relationships do not seem to have been understood or at least, judging by the above-mentioned painstaking expedients which were resorted to in the past, little use was made of them if they were.

In the drawing the single figure represents a side view, partially in longitudinal section, of an embodiment of the present invention comprising a directional color-television transducer having a tapered throat neck and a tapered throat magnetic deflection yoke one half of which is shown in position on the neck, namely one of two pairs of coils which are used for deflecting the beam in rectangularly coordinate directions to produce a television picture raster, and with the two coils comprising the other pair removed to clarify the showing.

The apparatus shown in the figure comprises a three gun wide-angle directional color kinescope **10** having a gun assembly **11** mounted near the closed or socket end of the neck **12** and carrying on said neck a pair of coils (pair **14**) of two pairs thereof (**14**, **16**) which together constitute a tapered throat deflection yoke **18** which is shown herein in a disassembled or "exploded" condition. The kinescope **10** shown herein by way of example is of the composite glass-and-metal type. As such it includes a bulb-portion **20**, consistting of a metal cone **22**, a frame

23 which comprises an extension of the cone 22 and is welded to the large end thereof, a face plate 24 sealed into the frame 23, and a glass neck portion 12 sealed to the small end of the cone.

In the present application the tapered-throat portion of the envelope is deemed to be, and is referred to as, a portion of the envelope neck, e. g., the portion of the neck 12 which in the figure lies between the reference lines 2—2 and 3—3.

While glass is the material shown herein for making the tapered-throat neck portion of the figure, it is only because at present glass is accepted as the preferred and the most practical material for this purpose and not because there is no other suitable material. As an alternative, for example, one may use copper, provided it can be suitably insulated from the cone 22 (to keep the high final anode voltage away from the yoke 18) or that at least the yoke 18 can be suitably insulated from it. In fact if desired the tapered portion may even comprise segments of low-reluctance para-magnetic material to serve as pole pieces for the respective four coils of the yoke, so long as they are separated by gaps or segments of high reluctance to avoid magnetically short-circuiting the deflecting flux around the deflection region.

As noted above the throat of the yoke 18 should be sufficiently larger than the intended solid angle of deflection 21 so that no beam in the convergent bundle thereof will so closely skirt the windings of the yoke near its inside surface as to impart substantially more deflection to it than to any other.

Since the actual spacing in any single case will depend on a plurality of factors such as the amount of convergence to be employed; the focal length of the tube, the size of its emissive cathode area(s), the distance between the focusing electron optic and the deflection yoke, the velocity of the beam electrons, the average flux density within the yoke, etc., it is inadvisable to rely on mathematical computations for determining the minimum and optimum spacings which must be maintained between the inside of the yoke throat and the periphery of the intended solid angle of deflection. In preference thereto an empirical procedure, such as the following, may be followed: using any suitable trial yoke the dynamic convergence correction should be adjusted to secure the best possible uniformity of convergence; the widths of the side and corner areas wherein the convergence is still poor should be measured; a scale drawing may be made to represent the paths of the electrons from the centroid of deflection to points on the screen at the boundaries of the areas of poor convergence; the distance between these paths may be measured in the region of the yoke (wherein 1.5 to 3.0 inches at the screen may correspond to perhaps a very small fraction of an inch); and a new yoke may be made which is larger than the trial one in accordance with these measurements. Where the trial yoke is of a tapered throat configuration conforming to the shape of the intended solid angle of deflection, then it would be advisable simply to enlarge over all of its inside dimensions without employing any change in configuration. On the other hand where the trial yoke is one having a cylindrical throat (i. e., one in which the factor of efficiency is being to some extent disregarded) then it would be possible either to increase over its internal dimensions over all of its length or only to do so over those of the forward end of its throat, thereby employing a change in configuration as well as in size. As a result of this procedure a minimum throat size will be obtained which will in effect afford a substantially uniform deflection flux across the entire solid angle of deflection. In practical utilization of this invention this is important since good deflection efficiency will not be possible if the throat is excessively large. From the foregoing it follows that preferred embodiments of a yoke according to the present invention should utilize the tapered-throat type of configuration and

should employ dimensions for the tapered throat which are neither too small nor too large.

If it should happen that a production model yoke, i. e., one which has already been designed and built, is still a little too small under particular circumstances in which it is used, its tapered configuration will make it possible, and in fact easy, to correct for this in a very simple manner by shimming back the yoke from the neck as shown at 15 in the figure and inserting a tubular element 19 inside the rear end of the yoke to short-circuit the deflection flux for a distance equal to that by which the yoke was moved rearward. This will have the effect of moving the yoke backward along the neck of the tube without doing the same thing to the intended solid angle of deflection and therefore it will effectively increase the clearances between the yoke and said angle. These adjustments may necessitate slight readjustments of the input currents fed to the yoke to preserve the size of the picture.

Where the tapered-throat of a yoke has circular cross-sections, i. e., has the approximately frusto-conical shape shown in the figure, the lumped conductor comprising each coil will be shaped with two nearly straight sides 30, 30 which diverge from one another at points progressively further along the yoke in the mean direction of beam travel, to an extent dependent on the desired steepness of taper, and two substantially semi-circular ends 32, 34 of different inside diameters corresponding to the diameters of the end openings of the tapered throat.

Incidentally if it is desired to have the shape of the deflection region conform even more closely to that of the solid angle of deflection used for television scansion, as contrasted for example to the scansion in polar coordinates used for radar plan-position indicators, both the envelope and the deflection yoke may have their throats shaped to approximately correspond to a truncated rectangular pyramid rather than to a frustum.

An indicated above it would not be the best practice of the present invention to go to extremes in providing abundant space within the throat of the deflection means and therefore a tapered throat configuration should be used so that this space will be relatively small in regions where deflection of the beams has not progressed very far. While the ideal tapered throat configuration is that of a figure of revolution of a parabola, a good compromise shape for a tapered throat is that of a surface of revolution of a line which has a portion which is substantially straight and is divergent from the axis of revolution and a substantially circular portion as a continuation of the divergent end of the straight portion. A further advantage of using a tapered-throat neck of either the frusto-conical or truncated-pyramidal type is that it will afford accurate centering of the yoke on the neck, since two such tapered surfaces when pushed together, tend automatically to center with respect to each other, this being true whether or not spacing-shims 15 are used between the yoke and the neck.

A target assembly 36 is mounted in the large end of the bulb portion 20 directly behind the face plate 24. It comprises a rigid support frame 38; a foraminous masking electrode 40 stretched tautly over the frame 38 in the fashion of a drum head bridging the large picture-area opening surrounded by the frame; a shim-spacer 42 for establishing and maintaining a predetermined spacing between the front surface of the masking electrode and the luminescent screen of the kinescope; a screen plate 44; and a "dot-phosphor" luminescent screen (not shown) carried on the rear surface of the screen plate. The entire assembly 36 is carried on a number of lugs 46 which in turn are welded to the interior surface of the cone 22. As is known such an arrangement offers one of a number of possible ways of affording color-selective cooperation between an electron beam and a luminescent screen in accordance with the direction of convergence of the former onto the latter.

While they are not shown herein because they do not comprise an inventive feature of the apparatus shown herein and are now known in the art, it is to be understood that a tapered throat yoke such as the yoke 18 should preferably be provided with the usual para-magnetic wrappings and/or cores to restrict external fringing of the fields which they produce when in operation and to lower the reluctance of their magnetic return paths.

The term transducer has been employed herein to indicate that the present invention is applicable to multiple beam (or equivalent) pick-up tubes as well as multiple-beam (or equivalent) picture tubes.

It is to be understood that while particularly great advantages may be gained by using the present invention in directional color television transducers nevertheless very significant advantages can also be gained by using it in multiple-gun cathode ray devices having non-directional screens such as certain cathode ray oscilloscopes employing convergently trained guns for presenting a plurality of waveforms in superposed plot on the same coordinate axes.

According to another procedure for empirically approximating the amount of increase required over the throat size of an experimental yoke, measurements are made to determine over what percentage of a given dimension of the screen area the convergence is unsatisfactory, for example if the corner areas of poor convergence each measures 1.5 inches along a 15 inch diagonal, this being the smallest in the above-mentioned range and, as is known, a representative example of the best uniformity of convergence obtained in the past under the then standard conditions of a tight-fitting yoke on a neck two inches in diameter with a one-eighth inch wall thickness, the percentage in question will be 20. If a new yoke is then made with a 20% larger throat diameter, the result will be a 20% increase in the width of the relatively-uniform-density central portion of the magnetic flux field provided within the yoke. If the first yoke was of the cylindrical throat type commonly used in the prior art the increase in width could be limited to the front end of its throat. In fact it is entirely possible that the width of the back end could at the same time be so reduced as to fully compensate for the loss of efficiency occasioned by the increase in the size of its front end.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. Apparatus comprising an envelope including a neck having a central axis and a bulb attached to an open forward end of the neck a source of electrons in said neck near its other end, a focal surface having an image area in said bulb, means for projecting electrons from said source toward said area through a deflection region in the neck along radially-spaced-apart plural beam paths so convergently that if laterally deflected with suitable uniformity throughout a predetermined solid angle in said region they will systematically scan said area over respective terminal portions of said paths and said terminal portions of the paths will continuously overlap at some point on the area during the scansion thereof, a deflection yoke comprising an assembly of coils surrounding a hollow throat containing the part of the neck containing said region and angle, said assembly being adapted to produce in said throat cyclically varying magnetic fields of suitable intensities to deflect the electrons throughout said angle; said assembly having the inherent characteristic that said fields will deflect the electrons with said suitable uniformity in only a limited central portion of the space within said throat as measured in transverse directions therein, and said central portion being surrounded by an annular peripheral portion whose thicknesses on the opposite sides of said central portion along any transversal extending through the yoke at right angles to said axis together comprise a very substantial percentage of the thickness of the entire space within the throat along the transversal, the apparatus being characterized in the following: that said assembly of coils is wide enough in all of its interior dimensions for said limited central portion of the space within its throat alone to fully accommodate all of said angle in said region when the assembly is positioned on the neck with said throat symmetrically disposed about said axis of the neck; that it further comprises means for so positioning the assembly on said neck; that at least a forwardmost portion of said part of the neck which is contained in said hollow space is progressively wider in the same direction as said angle and has exterior surfaces which flare smoothly outwardly toward said bulb; that a forwardmost portion of the yoke is shaped to closely conform to said exterior surfaces which flare outwardly; and that the yoke is positioned on the neck with its said forwardmost portion closely fitting said exterior surfaces to aid in symmetrically disposing said space about said axis and to determine and fix the distance between the yoke and said image area.

2. The apparatus set forth in claim 1 further characterized in that the positioning means includes spacing means positioned between the assembly and said part of the neck and occupying a principal part of said peripheral portion of said space along at least a substantial part of its length for suitably spacing-away respective inwardly-facing surfaces of the assembly from corresponding outwardly-facing surfaces of said part of the neck, including its said exterior surfaces which flare outwardly.

3. The apparatus set forth in claim 2 further characterized in that the two thicknesses of said principal part of said peripheral portion of the space on opposite sides of the neck along any transversal extending through the spacing means at right angles to said axis together comprise at least 20% of the thickness of the entire hollow space along it.

4. The apparatus set forth in claim 3 further characterized in that said spacing means is movably positioned between the assembly and said part of the neck.

5. A yoke for deflecting electrons as they move forward through the envelope-neck of a cathode ray tube about a central axis thereof on their way to a predetermined focal surface therein, in which tube the electrons are made to enter a deflection region in said neck along radially-spaced-apart plural beam paths so convergently that if laterally deflected with suitable uniformity throughout a predetermined solid angle they will systematically scan an image area on said surface over respective terminal portions of said paths and said terminal portions of the paths will continuously overlap at some point on said area during the scansion thereof, said yoke comprising an assembly of coils surrounding a hollow throat for receiving a part of the neck containing said region and angle, said assembly being adapted to produce in said throat suitable magnetic fields for laterally deflecting said electrons throughout said angle, said assembly having the inherent characteristic that said fields will deflect the electrons with said suitable uniformity in only a central portion of the space within said throat as measured in transverse directions therein, said central portion being surrounded by an annular peripheral portion whose thicknesses on the opposite sides of the central portion along any transversal extending through the yoke at right angles to said axis together comprise a very substantial percentage of the thickness of the entire space within the throat along the transversal, said yoke being characterized by the following: that the assembly is wide enough in all of its interior dimensions for said limited central portion of the space within said throat alone to fully accommodate all of said solid angle in said region when the assembly is po-

sitioned on said neck with said throat symmetrically disposed about said axis of the neck; that it comprises spacing means positioned within said throat and occupying a principal part of said peripheral portion of said space therein at at least a plurality of points all around it and along at least a substantial forward portion of its length for spacing-away predetermined inwardly-facing surfaces of the assembly from corresponding outwardly-facing surfaces of said part of the neck to symmetrically dispose said throat about said axis; that the two thicknesses of said principal part of said peripheral portion of the space on opposite sides thereof along any transversal extending through the spacing means at right angles to said axis together comprise at least 20% of the thickness of the entire hollow space along it; that at least a forwardmost portion of said hollow throat is progressively wider in the same direction as said angle to at least partly conform to the widening shape thereof; and that forward-and-inwardly-facing surfaces of at least a forwardmost portion of the yoke, such as of at least a forwardmost portion of its said spacing means, flares smoothly-outwardly in a configuration adapted to aid in symmetrically disposing said throat about said axis and to determine and fix the distance between the yoke and said focal surface by mating with similarly flared exterior surfaces of at least a forwardmost portion of said part of the neck when the yoke is positioned far enough forward thereon to abut tightly against them.

6. Apparatus comprising an envelope including a neck having a central axis and a bulb attached to an open forward end of the neck, a source of electrons in said neck near its other end, a focal surface having an image area in said bulb, means for projecting electrons from said source toward said area through a deflection region in the neck along radially-spaced-apart plural beam paths so convergently that if laterally deflected with suitable uniformity throughout a predetermined solid angle in said region they will systematically scan said area over respective terminal portions of said paths and said terminal portions of the paths will continuously overlap at some point on the area during the scansion thereof, a deflection yoke comprising an assembly of coils surrounding a hollow throat containing the part of the neck containing said region and said angle, said assembly being adapted to produce in said throat cyclically varying magnetic fields of suitable intensities to deflect the electrons throughout said angle but having the inherent characteristics that the fields will do so with said suitable uniformity in only a limited central portion of the space withing said throat as measured in transverse directions therein, and said central portion being surrounded by an annular peripheral portion comprising a very substantial percentage of the volume of said space, the apparatus being characterized in that said assembly of coils is wide enough in all of its interior dimensions for said limited central portion of the space within its throat alone to fully accommodate all of said angle in said region when the assembly is positioned on the neck with said throat symmetrically disposed about said axis of the neck; and that it further comprises means for so positioning the assembly on said neck at a predetermined distance from said image area.

7. The apparatus set forth in claim 6 further characterized in that said positioning means, in maintaining said throat symmetrically disposed about said axis, establishes

a predetermined minimum spacing between any portion of the inwardly facing surfaces thereof and the nearest portion of the periphery of said solid angle as measured along a transversal extending across said throat at right angles to said axis of the neck, said minimum spacing being substantially greater than 20% of the entire space within the throat along the transversal.

8. A yoke for deflecting electrons as they move forward through the envelope-neck of a cathode ray tube about a central axis thereof on their way to a predetermined focal surface therein, in which tube the electrons are made to enter a deflection region in said neck along radially-spaced-apart plural beam paths so convergently that if laterally deflected with a requisite uniformity throughout a predetermined solid angle they will systematically scan an image area on said surface over respective terminal portions of said paths and said terminal portions of the paths will continuously overlap at some point on said area during scansion thereof, said yoke comprising an assembly of coils surrounding a hollow throat for receiving a part of the neck containing said region and angle, and said assembly being adapted to produce in said throat suitable magnetic fields for laterally deflecting said electrons throughout said angle, said yoke being characterized in the following: that the assembly is wide enough in all of its interior dimensions for the thickness of the entire space within said throat as measured along any transversal extending thereacross at right angles to said axis to exceed the thickness of said solid angle therein along the transversal by substantially more than 20%; that it comprises spacing means positioned within said throat and occupying a peripheral part of the space therein at at least a plurality of points all around it and along at least a substantial forward portion of its length for spacing away predetermined inwardly-facing surfaces of the assembly from corresponding outwardly facing surfaces of said part of the neck to symmetrically dispose said throat about said axis; that at least a forwardmost portion of said hollow throat is progressively wider in the same direction as said angle to at least partly conform to the widening shape thereof; and that forward-and-inwardly facing surfaces of at least a forwardmost portion of the yoke, such as of at least a forwardmost portion of its said spacing means, flares smoothly-outwardly in a configuration adapted to aid in symmetrically disposing said throat about said axis and to determine and fix the distance between the yoke and said focal surface by mating with similiarly flared exterior surfaces of at least a forwardmost portion of said part of the neck when the yoke is positioned far enough forward thereon to abut tightly against them.

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