United States Patent

Mirsch

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[54] **COLOR PICTURE TUBE BEAM CONVERGENCE APPARATUS**

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[58] **Field of Search** ....335/210, 212, 213; 313/77, 313/70 C; 315/27

[56] **References Cited**

UNITED STATES PATENTS

2,887,598	5/1959	Benway	313/70 C
3,430,099	2/1969	Ashley	315/27
3,553,523	1/1971	Budd	313/77 X
3,453,472	7/1969	Burdick	313/77
3,290,532	12/1966	Lemke et al.	335/212 X
2,854,598	9/1958	Baermann	313/77
2,854,607	9/1958	Niklas et al.	313/77 UX

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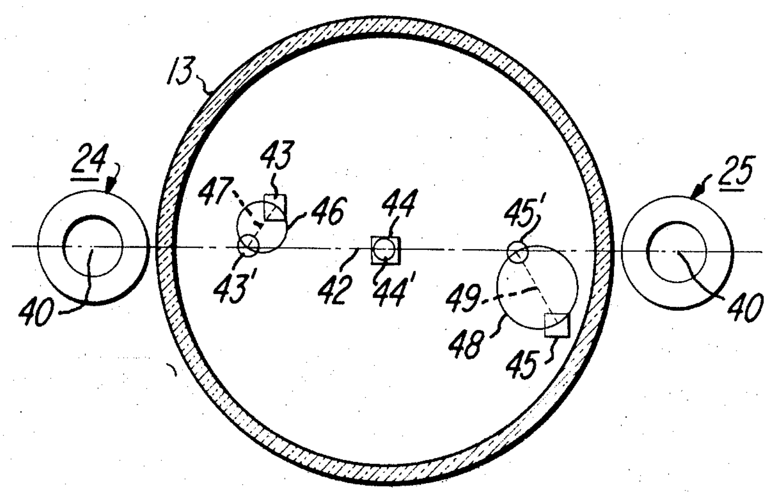
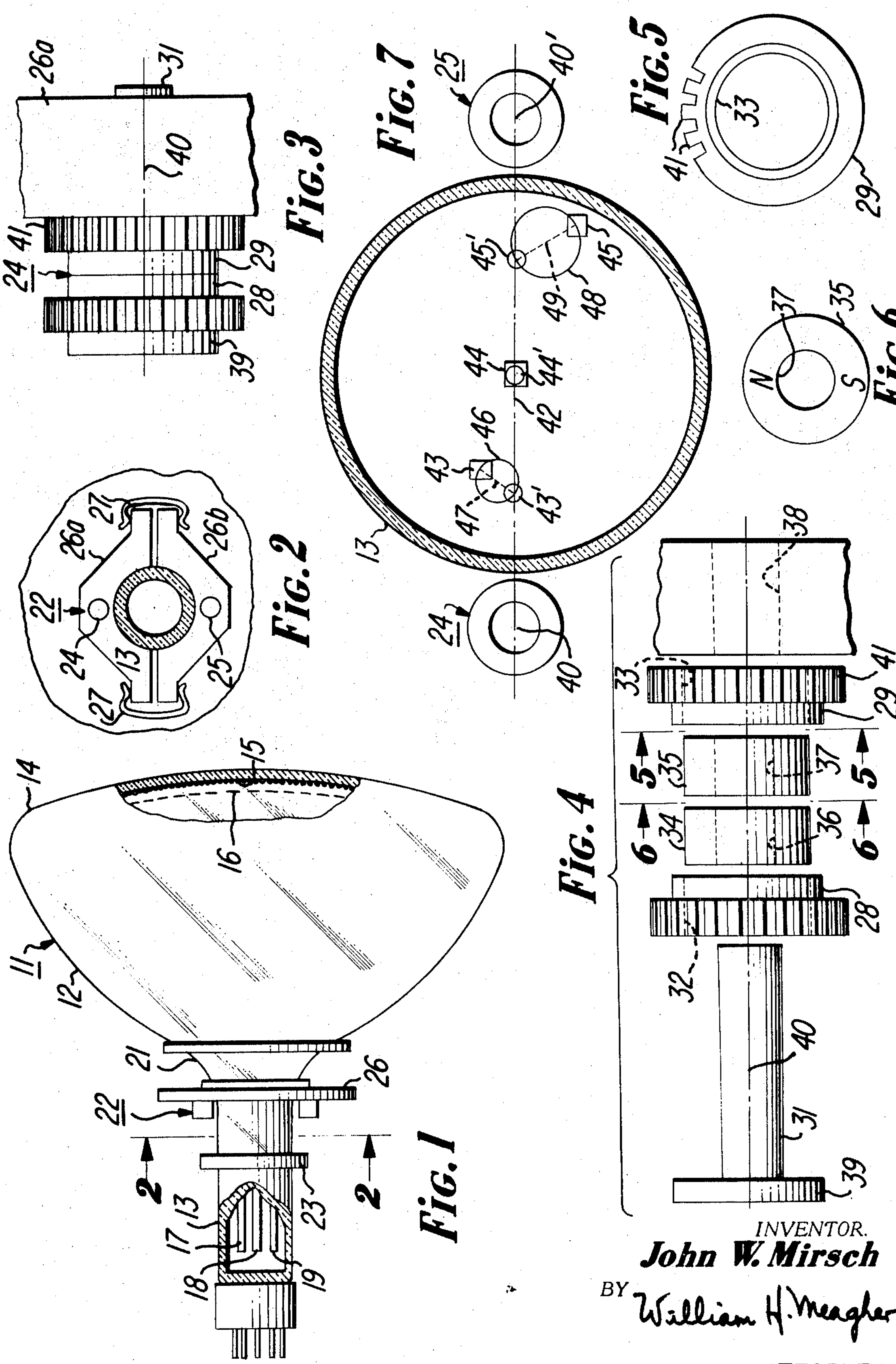
[57] **ABSTRACT**

For a color picture tube having a plurality of electron beams emanating from the neck of the tube in a nominally common plane two pairs of diametrically magnetized ceramic ferrite discs mounted on opposite sides of the tube neck are rotatable to vary the strength and orientation of their respectively produced magnetic fields, thereby converging the beams at the screen of the tube.

10 Claims, 7 Drawing Figures





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COLOR PICTURE TUBE BEAM CONVERGENCE APPARATUS

BACKGROUND OF THE INVENTION

In the operation of a multi-beam color picture tube it is necessary that the plurality of electron beams enter the raster-producing deflection region in such positions relative to one another that they converge at the viewing screen. It is not practically feasible, in the fabrication of such a tube, to position the beam-producing electron guns with such precision that the beams will be automatically converged at the screen. Also, the deflection yoke, particularly one having toroidal windings, produces stray fields that adversely affect the beams, such as by defocusing them. In order to minimize such adverse effects relatively high permeability structures such as internal convergence pole pieces, commonly used in other multi-beam color picture tubes, can be eliminated, thereby reducing the coupling of stray deflection fields into the predeflection region of the beams. It is still necessary, however, to influence the beams so that they will converge at the screen of the tube.

Previously, constant strength permanent magnets have been used to achieve the desired static beam convergence. The necessary effect of the produced magnetic fields upon the beams has been achieved by varying the spacing between the magnets and their associated beams. Such apparatus has two principal disadvantages in a tube with no internal pole pieces; one is that only one linear beam movement is possible; the other is that fringe fields undesirably spray out from such magnets as they are moved away from the beams, thereby adversely affecting the beams in more sensitive areas.

SUMMARY OF THE INVENTION

The beam convergence apparatus of this invention has particular utility with a color picture tube of the so-called "in-line" electron beam type in which a plurality of electron beams emanate from the neck of the tube nominally in a common plane. The convergence apparatus comprises two low permeability permanent magnet structures disposed respectively on opposite sides of the tube neck. These magnet structures produce respective fields by which to influence the electron beams appropriately to effect their substantial convergence at the viewing screen of the tube. In order that the produced fields effect the desired influence, the magnet structures are provided with means for suitably adjusting the strength and the orientation of the produced fields. In a particular embodiment of the invention each of the magnet structures includes a pair of diametrically magnetized ceramic ferrite discs coaxially disposed relative to one another. The discs are rotatable relative to one another to adjust the strength of the produced field. Also, each of the structures is rotatable as a unit about an axis parallel to the longitudinal axis of the tube to adjust the orientation of the produced field.

For a more specific disclosure of the invention reference may be had to the following description of an illustrative embodiment thereof which is given in conjunction with the accompanying drawing, of which:

FIG. 1 is a diagrammatic top view of a color picture tube having three in-line electron guns and showing the general positions of the beam convergence apparatus of this invention in relation to other adjuncts used in the operation of the tube;

FIG. 2 is a fragmentary sectional view taken on the line **2—2** of FIG. 1 and showing the rear end view of the beam convergence apparatus;

FIG. 3 is an enlarged view of one of the permanent magnet structures of the beam convergence apparatus;

FIG. 4 is an exploded view of the magnet structure of FIG. 3 and showing the relationship of the components of the magnet structure;

FIG. 5 is a sectional view taken on the line **5—5** of FIG. 4 and showing the details of one of the magnet-retaining collars of the apparatus;

FIG. 6 is a sectional view taken on the line **6—6** of FIG. 4 and showing the configuration and magnetization of one of the magnet components of the beam convergence apparatus; and

FIG. 7 is a diagrammatic representation of the operation of the beam convergence apparatus of the invention.

DESCRIPTION OF THE INVENTION

In FIG. 1 the three beam shadow mask type of color picture tube **11**, with which the beam convergence apparatus of the invention is used, has a relatively large flared front section **12** and a relatively small cylindrical neck section **13**. The face plate **14** at the front of the flared section **12** has formed on its rear surface a fluorescent screen **15** comprising a multiplicity of triads of phosphor dots which are excitable by respective electron beams to produce light of three different colors such as red, green and blue. A shadow mask **16** having a plurality of apertures aligned with the triads of phosphor dots of the screen **15** is mounted in back of the screen and functions, in cooperation with other elements of the tube, to direct the three electron beams to their respective phosphor dots. Three electron guns **17**, **18** and **19** are mounted in the neck section **13** of the picture tube **11** to produce, when suitably energized, the three electron beams for excitation of the screen **15**. The electron guns **17**, **18** and **19** are located in a common horizontal plane in a so-called "in-line" arrangement.

A deflection yoke **21** is mounted externally of the tube **11** in the region in which the neck section **13** merges with the flared section **12**. The beam convergence apparatus **22** comprising this invention is located on opposite sides of the neck section **13** immediately to the rear of the deflection yoke **21**. A color purity device **23** is mounted still further to the rear on the neck section **13** of the tube **11**. The color picture tube **11** and the described adjuncts, except for the convergence apparatus **22**, are generally known and used and hence need no additional description or explanation.

The general FIG. **2** rear view of the convergence apparatus **22** shows its two magnet structures **24** and **25** on opposite sides of the picutre tube neck **13** and centered, as an example, in the same horizontal plane with the three electron beam-producing guns **17**, **18** and **19**. The magnet structures **24** and **25** are mounted, in a manner to be described presently, in respective halves **26*a*** and **26*b*** of a non-magnetic plate **26** which effectively encircles the tube neck **13**. Because it is desirable to position the convergence apparatus, including the magnet structures 24 and 25, immediately to the rear of the deflection yoke 21 the plate 26 may also serve as the terminal board for the yoke windings. The two mounting half-plates 26*a* and 26*b* may be secured to one another by any suitable means such as a pair of spring clips 27.

In FIG. 3 an assembled profile view (enlarged to approximately four times actual size) of one of the magnet structures 24 is shown as it is mounted on the half-plate 26*a*. Both of the half-plates 26*a* and 26*b* are constructed of non-magnetic material such as lucite for example. Two magnet discs (not shown in this figure) are supported within respective non-magnetic annular retaining collars 28 and 29 and are coaxially mounted on a non-magnetic flanged spindle 31 which extends through the half-plate 26*a*.

In the FIG. 4 exploded view of the magnet structure 24 of FIG. 3 the retaining collars 28 and 29 have centrally disposed holes 32 and 33, respectively, to snugly receive ceramic magnet discs 34 and 35. The thicknesses of the magnet discs 34 and 35 are substantially the same as those of their respective retaining collars 28 and 29 so that the faces of the magnet discs effectively abut one another when assembled as shown in FIG. 3. The magnet discs 34 and 35 have centrally disposed holes 36 and 37 respectively for snug mounting on the spindle 31. With the magnet discs 34 and 35 respectively supported within the holes 32 and 33 of the retaining collars 28 and 29, the spindle 31 extends through the disc holes 36 and 37 into a hole 38 in the half-plate 26*a*. The spindle 31 has a flange 39 so as to securely mount the components of the magnet structure 24 on the half-plate 26*a* as shown in the assembly on FIG. 3. The retaining collars 28 and 29 and their respectively supported magnet discs 34 and 35 are adjustably rotatable about an axis 40 which is parallel to the longitudinal axis of the picture tube 11. It will be understood that the magnet structure 25 of FIG. 2 is similarly constructed.

The FIG. 5 view of the retaining collar 29 shows the peripheral edge of its flange portion to be notched such as by gear teeth 41. The purpose of the gear teeth 41 is to facilitate manipulative rotation of the collar and its supported magnet disc 35 about the spindle 31.

Each of the magnet discs, such as the disc 35 of FIG. 6, may be formed of a ceramic material such as plastic barium ferrite. Such a material has a relatively low permeablility and, when diametrically magnetized as indicated in this figure, is more strongly magnetized on one face than on the other. The mounting of the magnet disc 35 of FIG. 6 in the retaining collar 29 of FIG. 5 should be such that the stronger magnetized face is away from the notched flange 41 of the retaining collar. The magnet disc 34 should be similarly mounted in the collar 29. In this way the stronger magnetized faces of the magnet discs 34 and 35 will abut one another when the structure is assembled as indicated in FIGS. 3 and 4, thereby producing an effective field for electron beam convergence.

In operating of the electron beam convergence apparatus of this invention the strength of the resultant beam-controlling field is adjusted by manipulation of the notched peripheral edges, such as the edge 41 of the collar 29, of the two retaining collars 28 and 29 relative to one another. For example, when the N and S poles of the magnet discs 34 and 35 are aligned respectively with one another, the resultant field has maximum strength. A minimum strength field is produced by aligning the N pole of one magnet disc with the S pole of the other disc. Field strengths of intermediate values are produced by relative positions of the magnet discs 34 and 35 intermediate of the two described extreme positions. The orientation of the resultant field is determined by the angular positioning of the mutually adjusted magnet discs 34 and 35 relative to the supporting spindle 31.

A graphical example of the manner in which the convergence apparatus of this invention enables the accomplishment of the desired result is depicted in FIG. 7. It will be assumed that the desired convergence of the electron beams at the viewing screen can be achieved by positioning the beams symmetrically about the longitudinal tube axis in a common horizontal plane indicated by the broken line 42. It will also be assumed that the beams issue from their respective electron guns in the relative positions represented by the squares 43, 44 and 45. In this assumed example the middle beam is in its desired position substantially at the center of the tube neck 13 and in the common plane 42 as indicated by the circle 44'. The left-hand beam position 43, however, is above the common plane 42 and closer to the center of the tube neck 13 than it should be for effective convergence with the middle beam at the viewing screen. Also, the right-hand beam position 45 is below the common plane 42 and farther from the tube neck center than it should be for convergence with the middle beam.

The rotation of the complete magnet structures 24 and 25 about the respective axes 40 and 40' causes the associated electron beams to be moved in substantially circular patterns. The magnitude of each circular pattern is determined by the rotational adjustment of the two component magnet discs (such as the discs 34 and 35 of FIG. 4) relative to one another. The left-hand beam, for example, may be positioned anywhere on the circular pattern 46 by a suitable rotational adjustment of the magnet structure 24 about the axis 40. Such latter adjustment determines the particular orinentation of the produced field and, thus, controls the direction in which the beam is moved to a selected position on the circular pattern 46. In the case of the left-hand beam, it may be moved from the position 43 to the position 43' effectively along the line 47. The length of the line is determined by the strength of the produced field which is a function of the relative rotational adjustments of the component magnet discs of the structure 24. The angular relationship of the line 47 to the common plane 42 is determined by the orientation of the produced field which is selected by the rotational adjustment of the magnet structure 24 about the axis 40.

In a similar manner the right-hand beam may be effectively moved from position 45 to position 45'. In this case it is necessary to rotationally adjust the component magnet discs of the structure 25 to produce a somewhat stronger field than that produced by the structure 24, thereby to determine a larger circular pattern 48 than the pattern 46. Also, this stronger field must be oriented by a rotational adjustment of the magnet structure 25 about the axis 40' so that the diametral line 49, representing the effective path of beam movement, is angularly related to the common plane 42 in a way to cause the beam to be moved from position 45 to position 45′.

Because of the inherently close spacing of the electron beams within the neck 13 of the picture tube 11 and of the fringe fields produced by the magnet structures 24 and 25 it may be necessary to readjust one or both of the structures after adjustment of the other. Experience with such apparatus has shown, however, that substantial convergence of the three beams at the viewing screen may be achieved with a minimum of effort.

The relatively low permeability of the magnet structures 24 and 25 and the elimination of relatively high permeability structures, such as internal pole pieces, from the vicinity of the electron beams insures an unobjectionable minimum, if any, coupling of the field produced by the deflection yoke 21 into the predeflection region occupied by the beams. Also, because the magnet structures 24 and 25 remain always at the same distance from the electron beams, the fields produced thereby do not spray out to adversely affect the beams in more sensitive areas. While the magnet structures are shown herein mounted in the common plane of the beams, they are not necessarily limited to such positions because of the fact that they operate in such a manner that coordinate X and Y motions of the beams are produced. Hence, the angular positioning about the longitudinal axis of the picture tube 11 of the magnet structures 24 and 25 is not critical.

What is claimed is:

1. The combination comprising:

a tri-beam color kinescope having a screen for display of a color picture in response to the scanning thereof by a plurality of electron beams in a succession of substantially parallel line sweeps, and having a cylindrical neck enclosing a trio of in-line beam paths, a central one of said in-line beam paths substantially coinciding with the longitudinal axis of said neck with the remaining outer ones of said in-line beam paths being substantially symmetrically disposed on opposite sides of said axis, and with all of said in-line beam paths traversing a region of the interior of said neck which is free of readily magnetizable structures;

means for shifting one of said outer beam paths in a selectable one of a plurality of directions inclusive of directions parallel to, perpendicular to, and diagonal to the direction of said line sweeps, said shifting means comprising a first adjustable permanent magnet means, mounted on the exterior of said tube neck for positioning on one side of said tube neck region in a first location closely adjacent one of said outer beam paths, for producing a magnetic field intersecting with primary influence said one of said outer beams with a selectable one of a plurality of directions inclusive of directions parallel to, perpendicular to, and diagonal to the direction of said line sweeps; and

additional means for shifting the other of said outer beam paths in a selectable one of a plurality of directions inclusive of directions parallel to, perpendicular to, and diagonal to the direction of said line sweeps; said additional shifting means comprising second adjustable permanent magnet means, mounted on the exterior of said tube neck for positioning on the side of said tube neck region opposite to said one side in a second location closely adjacent said other of said outer beam paths, for producing a magnetic field intersecting with primary influence said other of said outer beams with a selectable one of a plurality of directions inclusive of directions parallel to, perpendicular to, and diagonal to the direction of said line sweeps;

and wherein each of said first and second permanent magnet field producing means is independently adjustable.

2. Beam convergence apparatus for a color picture tube having a plurality of electron beams emanating from the neck of said tube in a nominally common plane and subject to passage toward the screen of said tube through a region of said neck free of the presence of internal magnetizable pole piece structures, said apparatus comprising:

two permanent magnet structures mounted for respective positioning on opposite sides of said tube neck region for producing respective fields to primarily influence respectively different ones of said plurality of beams; and

means for adjusting the strength and orientation of the field produced by each of said respective magnetic structures, such field orientation adjustments enabling shift of the associated beam in a selectable one of a plurality of directions inclusive of a direction parallel to a diagonal of said screen; and wherein:

each of said magnet structures includes a pair of magnetized discs of low permeability material coaxially disposed relative to one another in a mounting therefor,

each disc being magnetized on a diameter, and

said discs being rotatable relative to one another to vary the strength of the produced magnetic field.

3. Beam convergence apparatus as defined in claim 2, wherein:

each of said magnet structures is rotatable about an axis that is parallel to the longitudinal axis of said tube to vary the orientation of the produced magnetic field.

4. Beam convergence apparatus as defined in claim 3, wherein:

said magnetized discs are ceramic of barium ferrite material with the magnetization being stronger on one face thereof than on the other, and

each of said magnet structures being assembled with the stronger magnetized faces of said respective discs abutting one another.

5. Beam convergence apparatus as defined in claim 4, wherein:

said disc mounting includes a non-magnetic spindle, and

said discs are provided with central transverse holes to snugly fit over said spindle.

6. Beam convergence apparatus as defined in claim 5, wherein:

said disc mounting also includes a non-magnetic annular retaining collar having an inside diameter so related to the outside diameter of said disc that the disc is firmly secured within the collar.

7. Beam convergence apparatus as defined in claim **6**, wherein:

said disc mounting further includes a non-magnetic plate disposed around the neck of said tube normal to the longitudinal tube axis, and

transverse holes through said plate on opposite sides of said tube neck in said common plane to receive said respective disc-supporting spindles.

8. Beam convergence apparatus as defined in claim **7**, wherein:

each of said disc-supporting spindles has a flange at one end to constrain said disc-retaining collars to rotary movements between said flange and said plate.

9. Beam convergence apparatus as defined in claim **8**, wherein:

said disc-retaining collars have notched peripheral edges by which to effect said field strength and orientation varying rotations of said discs.

10. In combination with a multibeam shadow-mask color kinescope having a neck enclosing a plurality of in-line beam sources, said beams passing from said sources toward the screen of said kinescope through a region of said neck free of the presence of magnetizable structures, apparatus comprising:

a first pair of magnetized discs of low permeability material;

a second pair of magnetized discs of low permability material;

an apertured mount of non-magnetizable material for said first and second disc pairs, said tube neck being received within the aperture of said the mount, and said mount being positioned along the neck axis so as to encircle said structure-free region of said neck; and

means for rotatably supporting each of said pair of discs on said mount in respective diametrically opposed positions spaced from said mount aperture, the discs of each pair being coaxially disposed and subject to individual rotation about an axis substantially parallel to the axis of said neck.

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