

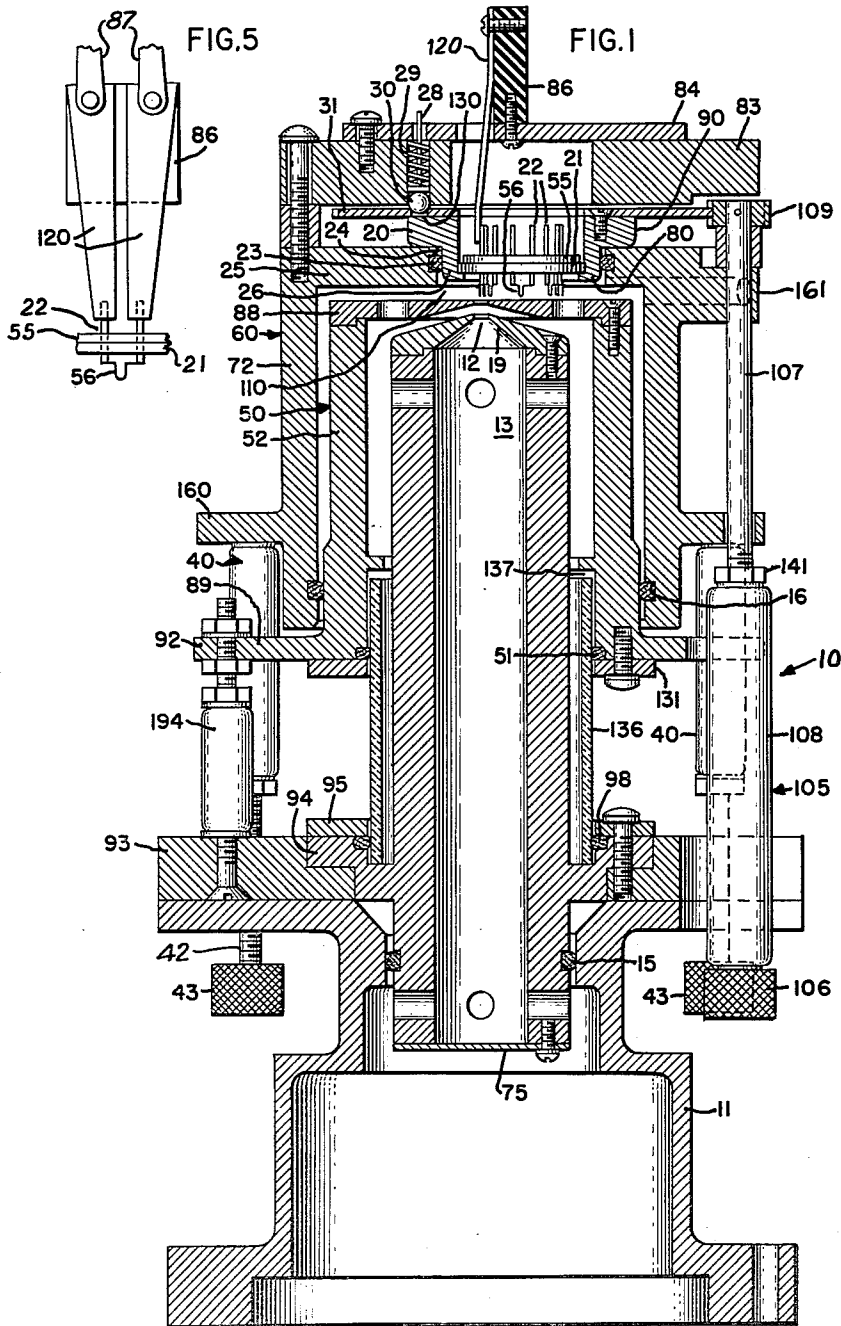
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CATHODE RAY TUBE HAVING A PLURALITY
OF INTERCHANGEABLE CATHODES

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2 Sheets-Sheet 1



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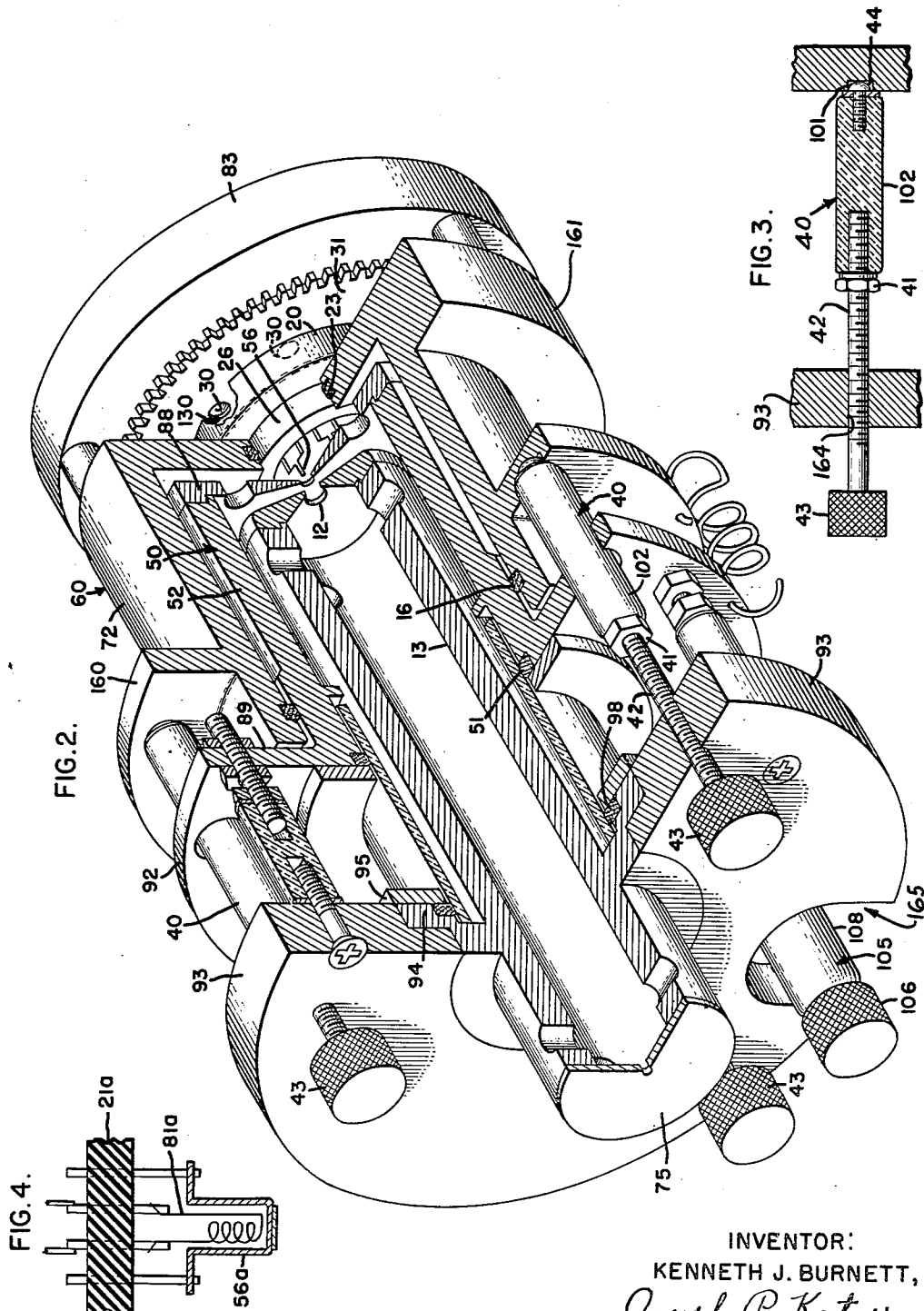
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CATHODE RAY TUBE HAVING A PLURALITY OF INTERCHANGEABLE CATHODES

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6 Claims. (Cl. 313-236)

The present invention relates to a cathode ray tube incorporating a plurality of interchangeable cathodes and means for changing these cathodes so that as used out, different cathodes are aligned with the grid and anode in operative relationship within the tube. More particularly the invention relates to switching cathodes in a cathode ray tube wherein deterioration requires a plurality of alternate cathodes by a device enabling quick changing of these cathodes.

The invention is useful where impurity is required within the tube and where tubes at relatively low vacuum pressures are required. Such requirements occur in electron microscopes, in optical light valve projection systems, in electron tape writing devices employing electron beam writing; and also in fluorescent, phosphorescent, and direct viewing and evaluating tubes. Often in such tubes an impurity must be introduced. This extra impurity introduced to the cathode causes rapid deterioration of the cathode. It is applicable also where long and intensive use deteriorates the cathode.

The invention is useful further for applications such as public display or military use where it is essential that the device be 100% operative when needed. For such uses in the event of failure due to cathode deterioration, time cannot be spent to demount a tube and substitute another in its place. In public viewing or in other uses requiring urgent display the facilities may not be readily available. Also, it is not practical to change the tube under such conditions. For such uses, without the invention it might be required that two complete systems be continuously available because of embarrassment of inability for display when necessary. The present invention solves the problem in that it removes the most frequent cause of deterioration and breakdown, namely, the deterioration of cathodes. Two complete systems, one a standby, are no longer as necessary, and reliability is increased.

The prior art does not provide multiple cathodes in a cathode ray tube with means for their ready interchange upon deterioration of a cathode.

The prior art device of G. J. Hooper, Patent No. 2,740,916, issued April 3, 1956, for Vacuum Tube With Replacement Filaments shows a separate vacuum enclosure which houses a filament only, and which can be inserted without losing the vacuum in the envelope itself. This device permits changing of the filament only.

The Cathode Ray Oscilloscope of Patent No. 2,175,582 to Vogel et al., issued October 10, 1939, provides a disk cathode which can be rotated where a particular emission spot appears on the disk. This permits adjustment for evenness of emission from the different portions of the cathode.

The present invention improves tubes such as cathode ray tubes in that it provides a plurality of interchangeable cathodes and hence permits substantially continuous operation of equipment. It also enables adjustment of positioning and use of hairpin cathodes. It provides features of replacement and adjustment of lateral positioning for alignment with the grid and anode of the tube.

Accordingly, an object of the present invention is to provide apparatus for changing cathodes in cathode ray tubes without losing the vacuum and whereby elimination of appreciable shutdown time for such changes is effected.

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Another object of the invention is to provide substantially continuous display where required such as for military and public entertainment without necessity for substantial standby equipment in addition to the operating equipment.

Another object of the present invention is to provide a means for changing cathodes in a cathode ray tube to permit substantially continuous operation and which means is adapted for various kinds of cathodes including point source emitters such as of the hairpin tungsten filament type.

While the novel and distinctive features of the invention are particularly pointed out in the appended claims, a more expository treatment of the invention, in principle and in detail, together with additional objects and advantages thereof is afforded by the following description and accompanying drawing in which:

FIG. 1 is a cross-sectional view of a tube incorporating a rotatable turret holder arrangement for demountable cathodes illustrative of a preferred embodiment of the present invention;

FIG. 2 is an isometric partially cut-away view illustrative of details of features of the interior mechanism and adjustment means of the preferred embodiment of FIG. 1;

FIG. 3 is a detail view illustrating insulating type adjustment means whereby fine positioning of the cathode to laterally align it with the grid and anode may be made upon rotation of the turret on which the cathodes are mounted;

FIG. 4 is a sectional view of a form of indirectly heated cathode mountable in the turret of the FIG. 1 embodiment; and

FIG. 5 is a side elevational view of a hairpin tungsten filament point source emitter mountable in the turret of the FIG. 1 embodiment.

Referring to the drawings and in particular to FIG. 1, a demountable cathode ray tube generally designated 10 is mounted on a supporting stand 11. The tube 10 comprises an anode 13, a control electrode 50 and a cathode assembly 60.

Anode 13 is of elongated generally cylindrical shape and has an anode tip 12. The anode end portion including tip end 12 and the opposite anode end 75 are attached to anode 13 by means such as screws (not numbered).

The cathode assembly 60 comprises a ribbed, apertured, inverse cup-shaped member 72, a turret assembly 20, a spring retaining ring 83 and a cover member 84. The open end of cup member 72 faces the grid 50. The top end of the inverse cup-shaped member 72 comprises apertured turret support end wall 25. Disposed in the central aperture 110 of turret support 25 is a turret ring member 90 having a flange or boss 26. Ring 90 comprises the rotatable ring of the turret. Ring 90 is counterbored from the end opposite the flange 26 end to define a tip turret plate retaining portion 80. An insulating plate member 21 and a feedthrough insulator member 55 superimposed on member 21 in adjacent relationship provide cathode retaining means. Insulating plate 21 is of size to be received by the counterbored portion of member 26 in bearing relationship, and is seated on the inner surface of turret retaining tip 80. Feedthrough insulating member 55 is of slightly reduced diameter with respect to member 21.

Protruding through the feedthrough insulator 55 and support plate 21 are the cathode support rods 22 of a plurality of cathodes 56 (see FIG. 5). The cathodes 56 are disposed in circular array under plate 21 in a ring of lesser diameter than plate 21. The plate 21 and the feedthrough member 55 are axially aligned with the axis of turret 20 and they are eccentric with respect to the axis

of the grid 50 and the anode 13. The displacement in axes of grid 50 and anode 13 and of members 55 and 21 is the radius of the circular array of cathodes 56 so that upon rotation of turret 20 and hence of the plate 21 and feedthrough 55 about their central axis the cathodes 56 are in turn disposed in aligned relationship with the central axis of the grid 50 and the anode member 13.

The turret end wall 25 of the cathode assembly cup 72 supports the turret 20. Rotating turret 20 comprises also flange 26, the feedthrough plate 55, a turret gear 31 and cathode mounts 22. The turret gear 31 is attached to the turret 20 by fastening means, for example, screws (not numbered). The upper surface of gear plate 31 contains a plurality of grooves (not numbered) indented therein in circular array.

Secured to the cylindrical ribbed cathode assembly cup member 72 is a spring retaining ring member 83 which is suitably fastened to the wall of cathode assembly cup 72. Ring 83 has an aperture therethrough aligned with the aperture in turret ring 90.

A cover member 84 is superimposed adjacent the ring 83 by fastening means (not numbered). The cover member 84 supports a block member 86 to which are attached a pair of terminals 87 (see FIG. 5), and a pair of contact fingers 120. Contact fingers 120 are flat spring conductors yieldably engaging the respective anode aligned cathode support rods 22. A cathode 56 is suspended from each pair of support rods 22. Cover member 84 is suitably apertured to permit protrusion of the contact fingers 120 therethrough to make contact with successive respective cathode support members 22, as members 22 are rotated into position opposite the grid 83 and anode tip 12. In this manner a single pair of contact arms 120 successively engages the cathode support rods 22 of successive cathodes 56.

The ball member 30 is successively locked into the plurality of detent grooves or slots 130 of gear plate 31 upon indexing the turret 20. The ball member 30 is yieldingly urged against the respective detent 130 of the plate member 31 with which it is aligned at the time by spring member 29. An indexing pin 28 is attached to spring 29.

Upon lifting of indexing pin 28, spring member 29 to which it is attached, is lifted also. This permits the ball 30 to rise upon indexing of the turret plate 31 to bring the next successive cathode 56 in line with the anode tip 12.

A neoprene O-ring 23 is set into a recess 24 of turret support 25. Neoprene O-ring 23 provides vacuum seal and also yieldingly and bearingly retains the outer flange surface portion of the turret member 20 in slidable relationship to provide a proper surface for rotation therearound.

The control grid 50 comprises a generally cylindrical grid support body 52, a grid portion 88 and a lower increased diameter annular portion 89. The grid portion 88 of the control grid assembly 50 is disposed normal to the axis of the anode and cathode and has a central aperture aligned with the axis of the anode 13.

Attached underneath and adjacent to control electrode support body 52 is a plate 131 which with a recess counterbored in the enlarged end 92 of control electrode body 52 forms a recess pocket to contain a neoprene deformable O-ring 51 between the separating insulator ring 136 disposed externally of and spaced from anode 13 and body 52 of control electrode 50. Separating ring 136 is in turn supported around anode 13 by ring member 137 and anode flange 94. Deformable O-ring 98 is disposed in the recess formed by anode flange 94, separating ring 136 and ring 95.

Thus, the anode member 13, the control grid assembly 50 and the cathode assembly 60 are separated and positioned with respect to one another. A plurality of neoprene O-rings are provided which fit into recesses in these members. For example, separating the turret support member 25 and the turret 20 is deformable O-ring mem-

ber 23. Disposed between the control electrode assembly 50 and the cathode assembly 72 in a recess (not numbered) in the cathode assembly is an O-ring 16. Disposed between insulator 136 and a recess in the control electrode assembly 50 is a deformable O-ring 51. Disposed in a recess formed between the flange 94, insulator 136 and hold down ring 95 is a deformable O-ring 98. Disposed between the supporting stand 11 and a recess in the anode 13 is a deformable O-ring 15. The O-rings 15, 16, 23, 51 and 98 are vacuum seals for the cathode ray tube 19.

The control grid 50 is further held in fixed position by screw means (not numbered) which screw grid flange member 92 to anode connected flange member 93. Ring 93 is supported on the surface of support 11.

A plurality of alignment adjusting members 40 (see FIG. 3) are provided. Each has a fingerhold knurled portion 43, a threaded shaft or screw portion 42, an internally threaded insulating rod member 102, a locking nut 41 and a threaded seating member 101.

The spacing portion of the plurality of adjusting members 40 are disposed between the underface of the flange 160 of the cathode structure 72 and the ring 93 surrounding the anode structure 13 in order to provide adjustability for alignment and spacing of the cathode with respect to the grid and anode for initial setting and on turret rotation. A portion of threaded shaft 42 extends through and terminates in knurled fingerhold 43 underneath ring 93. The spacing and alignment is particularly important for hairpin tungsten filament type cathodes as shown in FIGS. 1 and 5. The point of the hairpin tungsten filament requires exact positioning. Transverse motion of the entire cathode assembly and turret holding unit is provided by the adjusting means 40.

Referring particularly to FIGS. 2 and 3 the hemisphere-shaped seat 101 is seated in recess 44 in the cathode assembly flange member 160.

Adjusting means 40 provides an insulating rod 102. In rod 102 are threaded end counterbores (not numbered). Seat member 101 is threadedly fastened axially into one counterbored end at rod 102. Screw shaft 42 is fastened into its other threaded counterbored end. Lock nut 41 holds the threaded shaft 42 attached fixedly into rod 102. An aperture 164 in flange 93 is threaded to receive screw member 42 in threadedly adjustable engaging relationship. Member 42 is threaded substantially along its length. Upon rotation of knurled member 43 thread 42 is retracted from or inserted further through aperture 164 to adjust spacing of the cathode elements 56 (or cathodes 56a as in the FIG. 4 embodiment) with respect to the anode 13. Hemisphere-shaped member 101 is bearingly thrust within recess 44 against the underside of flange member 160. Upon rotation of knurled knob 43 and of the thread portion 42 within the corresponding threaded aperture 164 of anode rib member 93 through which it extends the rib member 160 is caused to be displaced with respect to the anode rib or flange member 93 and its attached anode. This causes the cathode assembly 60 and hence the cathode holding turret 20 and thus the cathode 56 to become laterally displaced with respect to the anode 13.

A turret rotating means 105 is provided comprising a shaft 107 terminating in a gear 109. Gear 109 is positioned and sized to mate with and drive turret gear 31 to rotate turret 20 upon indexing to change cathodes. Shaft 107 extends through and is aligned by apertures (not numbered) in cathode flange 160 and an eccentric flange portion 161 of cathode assembly 60. The lower portion of shaft 105 comprises a sleeve 108, a knurled fingerhold 106 to rotate shaft 107 and a locknut 141 to secure sleeve 108 in locked position against the shaft portion 107. Hence, by rotating fingerhold means 106 the turret 20 may be made to rotate to desired cathode position. Sleeve 108 of shaft 105 is disposed within a substantially semicircular groove 165 extending into an edge sector

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of ring 93 and aligned with the cathode flange 160 and cathode eccentric flange portion 161 apertures.

The invention thus provides a display tube in which electron emitting cathodes may be interchanged with minimum interruption to operation. Upon rotating to index the turret which contains a circular array of cathodes, they are successively brought into position opposite the grid and anode. Detent releasable locking means are provided to lock each successive cathode in place as the previous one is replaced. Upon such indexing to rotate the turret a new cathode is inserted opposite anode 13 as needed so that tube operation is continued despite destruction or deterioration to the former current emitter or cathodes utilized.

In the case of an indirectly heated cathode fine adjustability is not critical (see FIG. 4). However, for a point source emitter such as the hairpin tungsten filament of FIG. 5 exact positioning must be obtained. Lateral alignment means for optimum position for emission of the cathode 55 to a position opposite the anode 13 is provided.

This is accomplished by means of the cathode position adjustment members 40. Members 40 are adjusted by threadedly advancing or retarding screw members 42 by grasping and hand turning fingerhold 43. This causes the seating members 44 disposed in recess 191 to displace the O-ring 16 along grid support body 52 in accordance with the adjustment of the adjustable means 40. This effect tilts cathode assembly 60 with respect to grid support 50, thus causing lateral displacement the small amount necessary to align the cathode 55 for optimum emission of electron energy toward the anode 13.

Turning the fingerhold 43 rotates the screw 42 of cathode portion adjustment means 40. Displacement of the cathode body member 72 follows by urging thereagainst to a corresponding degree the adjustment member 40 in recess 44 to cause cocking of the structure. This is permitted by the slidably bearing, deformable O-ring 16. This provides adjustment for fine alignment. The plurality of adjustment members 40 are disposed in circular array through the ring 93 for cocking the cathode assembly with respect to the grid and anode to effect lateral displacement in the required direction.

Upon indexing the turret to successive positions ball 30 falls into the successive detent receiving groove means 130 where it locks sequential cathodes into operative position.

Various modifications of the invention are contemplated as within its scope. For example, in one embodiment of the invention contemplated and put into practice the turret was disposed in angular position with respect to the remaining body and the turret axis of the anode.

While a specific embodiment of the invention has been shown and described, it should be recognized that the invention should not be limited thereto. It is accordingly intended in the appended claims to claim all such variations as fall within the true spirit of the invention.

What is claimed is:

1. A cathode ray tube comprising an anode and a control electrode positioned in aligned relationship, a turret structure for supporting a plurality of spaced cathodes arranged in a ring such that successive cathodes are movable to aligned relationship with said anode and said control electrode, a turret retaining body member for rotatably supporting said turret, a vacuum seal means set between said body member and said turret for vacuum enclosing said anode, cathodes and control electrode and

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providing a slidable bearing for rotation of said turret, and means to rotate said turret so as to successively position said cathodes in alignment with said anode and said control electrode.

2. The apparatus of claim 1 including fine adjustment means to adjust said cathodes laterally with respect to said anode to cause substantially optimum alignment and optimum cathode to control electrode spacing.

3. The apparatus of claim 2 wherein said adjustment means comprises a plurality of shaft members, each shaft member comprising a screw member, an insulating rod and a seat member in aligned fastened together relationship, a pair of annular rings fixed to each of said anode and said turret retaining body respectively, one of said annular rings having a plurality of groove seats formed therein, an end of the seat member of each of said shaft members being seated in one of said groove seats, control electrode support means, said control electrode support means and said turret retaining body having a recess therebetween, a deformable bearingly slidable O-ring disposed in said recess, the other of said annular rings having a plurality of threaded apertures therethrough dimensioned to receive said shaft screw members in threaded relationship, said shaft members being turned to longitudinally displace said O-ring to change the position of said turret and hence its aligned cathode with respect to said anode.

4. A cathode ray tube comprising an anode, a turret retaining body member, a turret, means to support a circular array of spaced cathodes in said turret, O-ring means disposed between said body member and said turret such that said turret is rotated bearingly against said O-ring means, said O-ring means maintaining a vacuum sealed relationship between said body member and said turret, said turret being mounted on an axis parallel to and eccentric to the axis of said anode, the distance between anode and turret axes being the radius of the circle of said cathode array so that upon rotation of said turret successive cathodes are aligned with said anode, and means to fixedly retain said turret member in successive cathode-anode aligned positions.

5. The apparatus of claim 4 including means to effect lateral displacement of said turret with respect to said anode such as to provide fine adjustment and to enable optimum alignment of each of said cathode as successively disposed in alignment with said anode with respect to said anode.

6. The apparatus of claim 5 having tube support means including means to support said anode and means to support said turret retaining body member and wherein said adjustment means comprises a plurality of annularly spaced threadedly adjustable shaft members disposed in moveably threaded engagement with said anode support means and in abutting bearing relationship to said body member and including a second O-ring disposed between said body member and a portion of said tube support means such that rotation of said threaded shafts adjusts said turret with respect to said body member and thereby slides said O-ring in accordance with rotation of said shafts to enable said alignment while retaining vacuum sealed relationship between said body member and said tube support means portion.

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