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NON-SYMMETRICAL CATHODES IN CATHODE RAY TUBES

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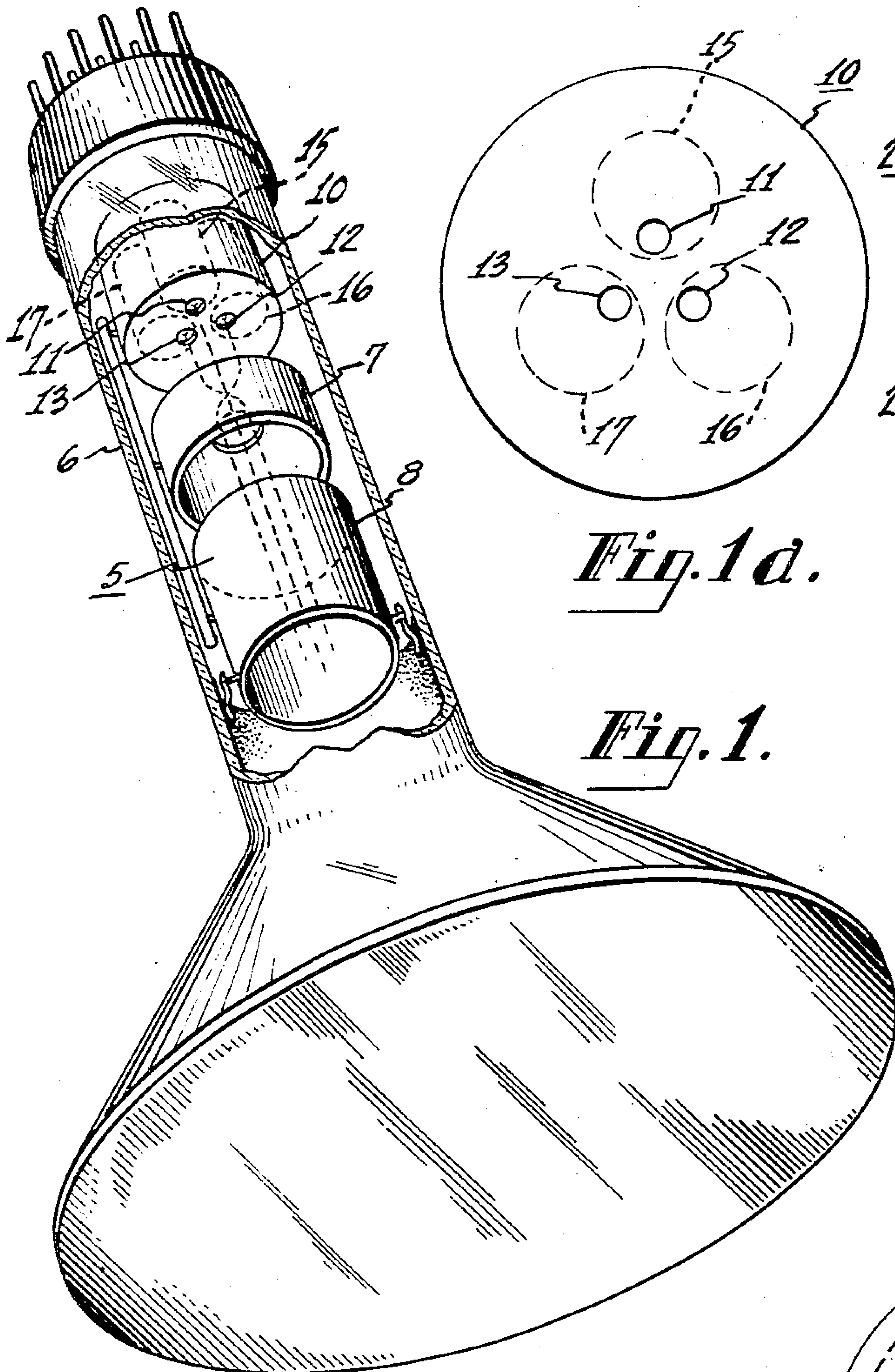


Fig. 1.

Fig. 1a.

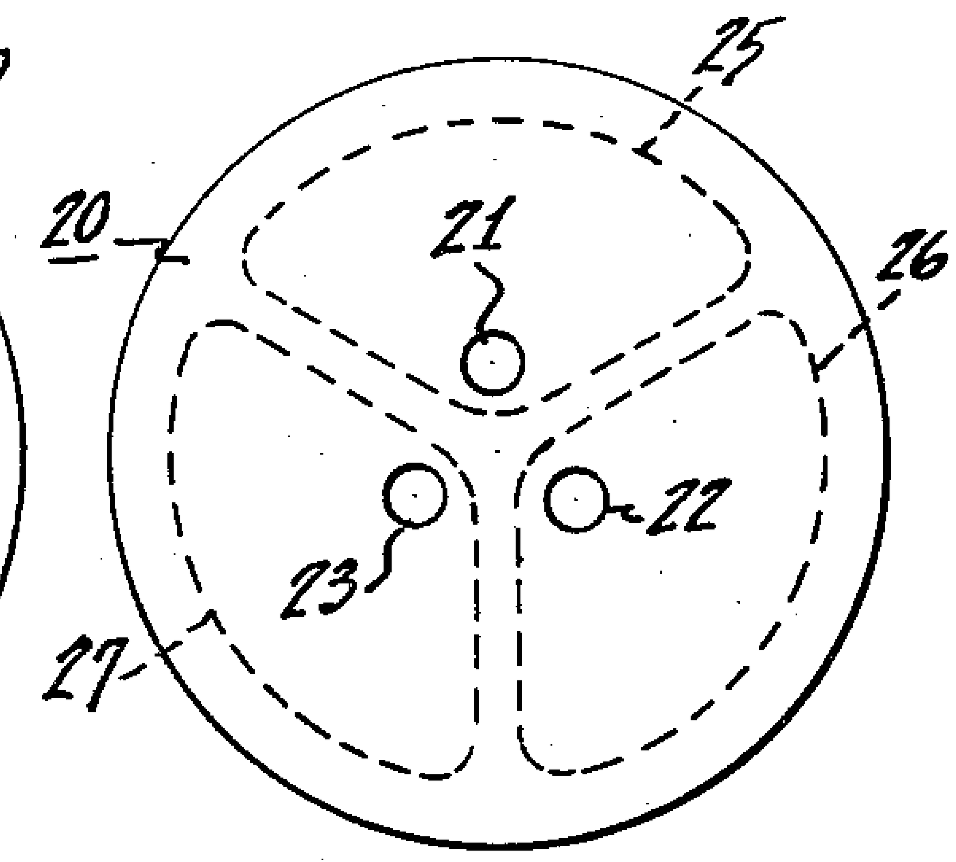
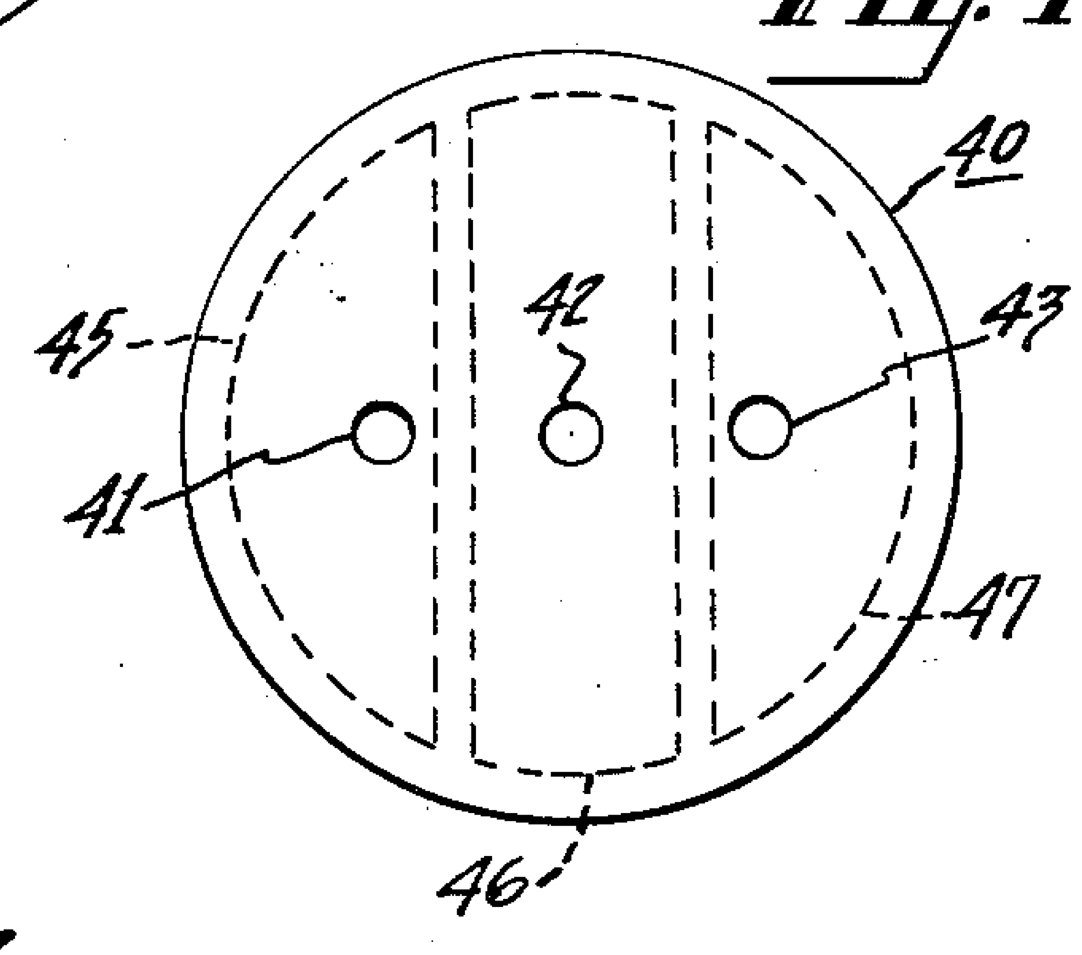


Fig. 2.

Fig. 4.



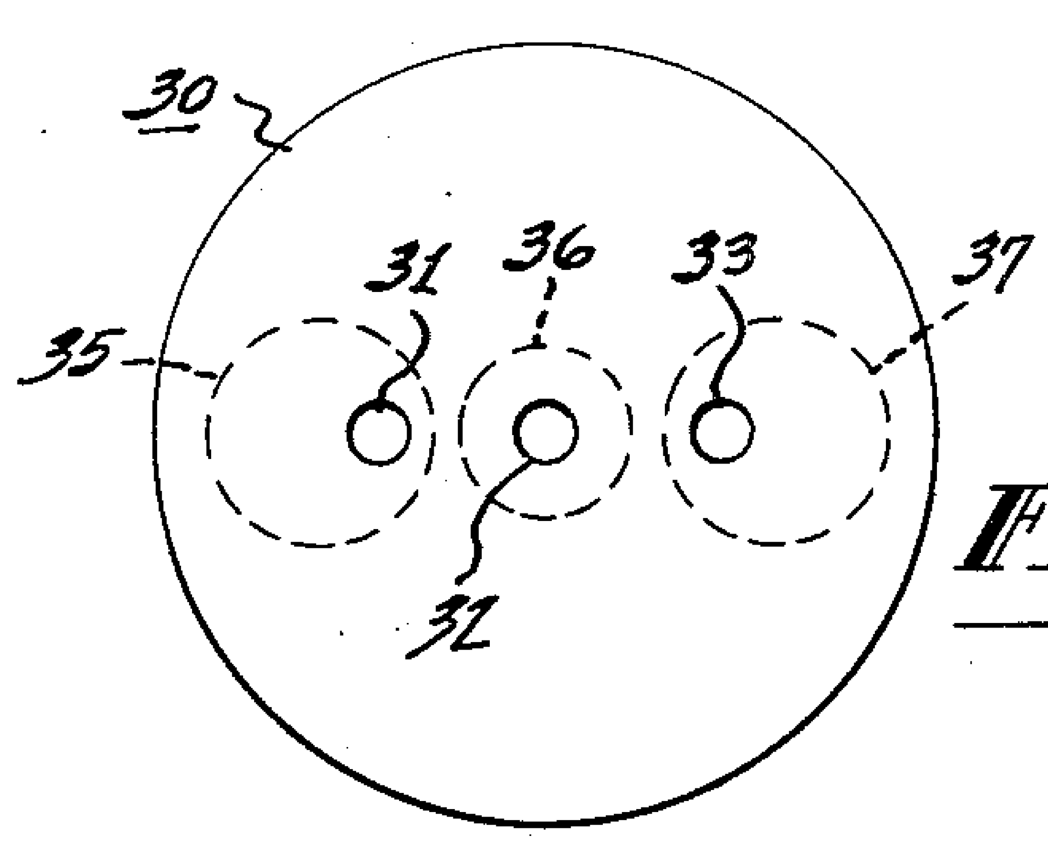


Fig. 3.

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NON-SYMMETRICAL CATHODES IN CATHODE RAY TUBES

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7 Claims. (Cl. 313—70)

This invention relates to a multi-beam electron gun construction for cathode ray tubes. A typical such electron gun has a plurality of cathodes, one for each electron beam. Each cathode is usually in the form of a hollow cylinder and contains a heater, one end of the cylinder being closed and coated with oxides to form an electron emitting surface. The cathodes are grouped side by side with their electron-emitting ends in a single plane. An apertured disk, the control grid, is positioned close to the emitter ends of these cathodes. It has one aperture for each cathode, each aperture being much smaller than its cathode. Each aperture normally is positioned opposite the center of its respective cathode surface.

In some applications of electron guns of this type it is important to have the electron beams originate from areas located close together. The usual way of achieving close spacing is to position the several cathodes correspondingly close together, at the same time keeping each corresponding grid aperture centrally aligned with its cathode. When that is done, the diameters of the cathodes become a limiting factor in determining how close together the beam sources can be located. In order to have the beams originate still closer together, it is necessary, in accordance with that practice, to use smaller diameter cathodes so their centers can be closer to each other. It might appear that nothing is sacrificed by thus using smaller size cathodes since the electrons which go to make up a beam come almost entirely from that portion of the cathode emitting surface which is substantially directly opposite the control grid aperture. (Actually this portion may be delineated as a slightly enlarged vertical projection of the aperture onto the cathode emitting surface. For convenience of reference, this portion will be referred to as the "primary area," and the rest of the cathode emitting surface will be referred to as the "secondary area.") It has been found, however, that actually the cathode life is considerably reduced when much smaller cathodes are used, even though the grid apertures, the primary areas of the cathodes, and the other conditions of use are all unchanged. It has been found, for instance, that the life of a 0.050 inch cathode is less than half as great as that of a standard 0.120 inch cathode when both are used with 0.020 inch control grid apertures, and both are operated to give one milliampere continuous beam current.

I have found that I can provide closely spaced electron beams, and at the same time so relate the parts as to achieve the longer cathode life. Heretofore, those skilled in the art have held to the tacit belief that optimum operational conditions were best obtained by using perfectly symmetrical cathodes. When a secondary area was provided, it was provided symmetrically about the primary area. Therefore, when the secondary area was reduced in an attempt to achieve closer beam spacing, it was reduced symmetrically, so that as spacing

became closer and closer the amount of secondary area became less and less.

My invention consists in locating the grid apertures, and hence the primary areas, close to an edge of their respecive cathodes; spacing the grid apertures as close together as desired for close-spaced electron beams; and at the same time departing from symmetry of cathode secondary area in such manner as to provide large secondary areas as a reservoir for replacement barium for each cathode primary area. As such, a primary area either may or may not coincide with the centroidal axis of its cathode. An explanation of the principles involved in the operation of my invention can best be set forth in terms of theory as presently understood.

In normal use barium is slowly evaporated from the surface of a heated oxide coated cathode, particularly in that area where electrons are actually being emitted. If this evaporation continues long enough, the resulting depletion of barium from the coating causes electron emission to drop. However, barium is able to migrate slowly from one part of a heated cathode to another part. Therefore, it appears that the presence of a secondary area, although not directly contributing to emission, can extend cathode life by supplying the barium atoms which migrate to the primary area, there replacing those barium atoms which were lost through evaporation. In this manner the secondary area acts as a barium reservoir and enables the cathode to have a useful life much longer than it would have if the cathode surface did not extend beyond the primary area.

Various embodiments of my invention as pictured in the drawings are detailed below. In the drawings, Figure 1 shows a typical three-beam electron gun **5** embodying my invention, the view being a perspective with parts broken away. The gun **5** is shown disposed in the cylindrical portion of a cathode ray tube envelope **6**, and may include an accelerating anode **7** and a focusing anode **8**, in addition to a control grid **10** having three apertures **11**, **12**, and **13**, and three separate cylindrical cathodes **15**, **16**, **17**. The relative positioning of cathodes and control grid of such a gun is more clearly illustrated in Figure *1a* which shows the control grid **10** with its three apertures **11**, **12**, and **13**, and the three cathodes **15**, **16**, and **17**, as viewed from the accelerating anode side of the control grid. The apertures **11**, **12**, and **13** of the control grid **10** are in triangular arrangement close together so as to provide closely spaced beams. The three cylindrical cathodes **15**, **16**, and **17** are positioned parallel to each other behind the control grid with an electron-emitting end of each of them opposite one of the grid apertures. In accordance with my invention, the cathodes are spaced close together, though not actually in contact with each other. The grid apertures are opposite the cathode electron-emitting surfaces in those regions where they can be closest together, be symmetrically positioned with respect to each other and to the cathode array, and still permit the primary areas to fall fully upon the corresponding cathodes. Thus it will be seen that the grid apertures are spaced closer to each other than are the longitudinal axes of the three cathodes but they are still opposite their respective cathode surfaces.

Many other cathode shapes and arrangements within the scope of my invention are possible. Figure 2 shows an embodiment having a control grid **20** with apertures **21**, **22**, and **23** in triangular arrangement but using wedge-shaped cathodes **25**, **26**, and **27**. Figure 3 shows an embodiment with a control grid **30** having apertures **31**, **32**, and **33** and three circularly cylindrical cathodes **35**, **36**, and **37** but rather than the triangular arrangement these cathodes have an in-line arrangement which is better adapted for some needs. In this embodiment the central cathode **36** may be slightly smaller than the two outer cathodes **35** and **37**. By having the central cathode's primary area centered within its surrounding area, a more efficient barium reservoir action is achieved since migration takes place from all directions toward the primary area. As a result, the relative sizes of the three cathodes are made so that the life of the three cathodes are equal to each other. This design adjustment permits closer beam spacing than would otherwise be possible in this embodiment, and at the same time equalizes cathode life.

Figure 4 shows another form for use when three in-line beams are desired. Here the beams are kept close together, the over-all diameter small, and the total cathode areas large by extending the cathode end areas to nearly fill a circle described about the three aligned primary areas opposite the aligned grid apertures. Here the grid **40** is shown as having three in-line apertures **41**, **42**, and **43**, while three cathodes **45**, **46**, and **47** lie opposite the grid apertures and nearly fill the full circular space opposite the overlying grid. The central cathode **46** is nearly rectangular in cross-section, having two slightly curved sides; while the two outer cathodes **45** and **47** have a cross-section shaped like a segment of a circle.

The cathodes shown in Figures 2 and 4, though not circularly cylindrical like the cathodes of Figures 1*a* and 3, are however, cylindrical in the broad sense of the word.

In all cases relative positioning of cathode and grid aperture is such that at least some of the primary areas fall close to an edge of their cathodes and the electron beams are formed very close to the central longtudinal axis of the cathode array. Yet, in each case there is provided sufficient cathode area to give long cathode life.

It should be noted that while I have described my invention as being incorporated in an electron gun having a single control grid common to all cathodes, it could also be applied to guns having a separate control grid for each cathode or cathode primary area emitting surface.

I claim:

1. In a multi-beam cathode ray gun, a plurality of cylindrical cathodes all having an end in a common plane, and a control grid next adjacent said cathode ends and having a corresponding plurality of apertures, one aperture located opposite each cathode end, a projection of each said grid aperture defining a corresponding cathode primary area, each cathode end being substantially larger than its primary area whereby to provide a reservoir area for each cathode, the grid apertures being located to put the primary areas substantially at edges of the cathodes, the cathodes being located to put those edges closely adjacent each other, and the reservoir areas being located non-uniformly about their cathode primary areas and predominantly in directions away from the cluster of primary areas.

2. An electron gun having a plurality of cathodes with relatively large electron emitting surfaces, said surfaces lying in a single plane, a control grid opposite and next adjacent to them having a corresponding plurality of relatively much smaller apertures severally opposite the three cathodes, said apertures being spaced closer to each other than are the longitudinal axes of the three cathodes but still opposite their respective cathode surfaces.

3. A three-beam electron gun for a cathode ray tube comprising: a control grid having three apertures therethrough positioned in triangular arrangement; and three cylindrical cathodes disposed parallel to each other, each having an electron-emitting end arranged opposite and next adjacent to a different one of said apertures, and each of said cathodes having its center positioned radially outward of the corresponding aperture center.

4. An electron gun for developing three separate electron beams, including three closely spaced circular cylindrical cathodes each having an electron-emitting end, said ends lying in a single plane and being spaced electrically apart in triangular arrangement, and a control grid next adjacent said cathode ends having three apertures therethrough in triangular arrangement and spaced such that each of said apertures is opposite a different one of said cathode ends and that the circle defined by the centers of said apertures is smaller than and concentric with the circle defined by the centers of said cathode ends.

5. A three-beam electron gun producing three electron beams which are side by side in a single plane, said gun including a control grid having three spaced apertures along a transverse line, three cylindrical cathodes disposed with their separate longitudinal axes parallel to each other and lying in a single plane, each of said cathodes having a relatively large electron-emitting end opposite and next adjacent to a different one of said grid apertures, the central grid aperture being concentric with the central cathode, and the outer grid apertures being inward of the longitudinal axes of their corresponding cathodes.

6. A three-beam electron gun producing three electron beams which are side by side in a single plane, said gun including a control grid having three spaced small apertures along a transverse line, three circularly cylindrical cathodes disposed parallel to each other side by side along a transverse line, each having a relatively large electron-emitting end opposite and next adjacent to a different one of said grid apertures, the central grid aperture being concentric with the central cathode whereby optimum barium reservoir effect is achieved, the outer apertures being opposite a portion of the end surface near the inner edge of their corresponding cathodes whereby minimum beam spacing for a given size of central cathode is achieved, the outer cathodes being larger than the central cathode whereby to compensate in size of barium reservoir for their less efficient shape of reservoir whereby to tend to equalize effective cathode life.

7. An electron gun for developing three separate electron beams comprising three cylindrical cathodes, said cathodes having an approximate cross-section the shape of a 120° sector of a circle, said cathodes disposed with their ends in a single plane in triangular arrangement with their apexes adjacent each other; and a control grid next adjacent said ends and having three apertures therethrough positioned in triangular arrangement and spaced such that each of said apertures is opposite a different one of said cathode ends closer to the apex of said end than to its curved edge.

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