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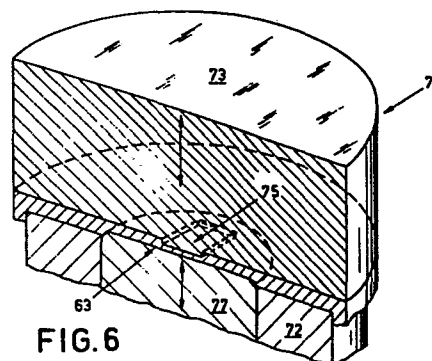
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54 Method of fabricating a cathode-ray tube and an improved electron gun electrode member for a cathode-ray tube fabricated by this method.

57 An electron gun electrode is provided with an improved beam shaping region having an elongated recess coined in the upper electrode surface and an opposed coined depression in the lower surface. The double coining fabrication method assures a sharp perimetrical edge about at least the central portion of the recess, such being an important influence in achieving improved beam shaping lensing.



"Method of fabricating a cathode-ray tube and an improved electron gun electrode member for a cathode-ray tube fabricated by this method".

The invention relates to a method of fabricating a cathode-ray tube comprising in an evacuated envelope an electron gun to generate an electron beam and a target for receiving said electron beam, the electron gun including a cathode and at least two grid electrodes, a discretely configured beam shaping region being fabricated in at least one of the grid electrodes, said region having a one-piece effectual portion evidencing upper and lower surfaces defining a material thickness therebetween.

Such cathode-ray tubes are used to display, for example, television pictures or are used in an oscilloscope. In such cases the target is a display screen having a phosphor layer, for example, in a black-and-white display tube or in an oscilloscope tube, or having a pattern of phosphor elements luminescing in different colours in a colour display tube.

Such a tube may also be used as a camera tube. In that case the target is a photosensitive layer, for example, a photoconductive layer.

In all applications the spot formed when the electron beam impinges on the target must have predetermined, generally small, dimensions and the haze surrounding the target should be minimum.

Such a method is disclosed in the published Netherlands Patent Application 77 12 942 (PHN 8960). In the first grid electrode of the electron gun of the cathode ray tube described in said specification an aperture and a V-shaped or U-shaped groove is provided. This first electrode with groove constitutes, in cooperation with the second grid, a non-rotationally symmetrical electron lens, this asymmetry becoming manifest mainly as a quadrupole lens action focusing the electron beam in two focal lines instead of one concentrated stigmatic cross-over (waist). To permit such grooves to be made, a comparatively thick plate material has to be used.

Some beam shaping electrodes have been manufactured as two-piece structures in an effort to achieve the desired beam forming characteristics. For example, the article "30AX Self-aligning 110°

in-line color TV display" in IEEE Transactions on Consumers Electronics, Vol. CE-24 No. 3, August 1978, pp. 481-487 discloses beam shaping electrodes constructed of two superimposed rectangularly slotted elements affixed in orthogonal relationship to provide a substantially square aperture therethrough. Through these slots the first grid electrode, in cooperation with the cathode, forms a first electrostatic quadrupole lens field and, in cooperation with the second grid electrode, forms a second electrostatic quadrupole lens field rotated 90° with respect to the first electrostatic quadrupole lens field. The electron beam is focused in two focal lines by said lens fields so that the mutual repelling of the electrons (space charge repelling) becomes less than in the case of one concentrated stigmatic cross-over. In fabrication, it is difficult to keep proper alignment between the two slots, and the affixural welding can produce surface imperfections which are deleterious to the forming of the desired beam shaping lensing.

Generally speaking, the use of beam shaping electrodes in electron guns to beneficially modify the lensing of the beams is known in the art. Discrete beam shapings minimize deflected spot distortion, such being especially true when self converging yokes are employed with in-line gun tubes. Electrodes with beam shaping properties provide a lensing field of equipotential lines of force to form the bundle of moving electrons into a beam of desired cross-sectional shaping. Exemplary art is also evidenced in U.S. Patent Nos. 3,852,608, 3,866,081 and 4,143,293. Such prior art techniques are complicated and expensive to fabricate.

Attention is also directed to three previously and concurrently filed U.S. patent applications which are assigned to the assignee of the present invention. These applications are S.N. 94,405, 94,409 and 94,515, all of which were filed November 15, 1979. The respective disclosures in these applications relate to the field of the present invention, but differ markedly therefrom.

It is therefore an object of this invention to reduce and obviate the aforementioned disadvantages and to provide a method of facilely fabricating a cathode ray tube comprising an improved discretely configured beam shaping region in a grid electrode.

Another object of the invention is to provide a method of fabricating a one-piece beam shaping electron gun electrode that evidences improved beam forming properties.

According to the invention such a method is characterized in that said method comprises the steps of coining an elongated recess inward from said upper surface; coining a depression inward from said lower surface in opposed orientation to said recess coining to expedite
5 a flow of electrode material to the upper coining region, thereby promoting the formation of a substantially sharp perimetrical edge in at least the central region of said recess shaping; and forming an aperture through the residual electrode material intermediate the bottoms of said coined recess and said coined depression to complete
10 said beam shaping configuration.

The electrode fabrication procedure utilizing the aforementioned opposed coining makes the electrode material flow in a manner to assure the formation of a beneficially sharp perimetrical edge at least partially about the upper surface related recess. This sharp
15 edge perimeter, in the region of the aperture, markedly augments the beam-shaping properties of the configuration, thereby promoting an improved lensing effect which beneficially modifies the cross-sectional shaping of the beam in the desired manner.

Moreover, the electrode is also comparatively thin in the region of the aperture.
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Fig. 1 is a cross-sectional view of a cathode-ray tube fabricated according to the invention;

Fig. 2 is an enlarged sectional view of a portion of an electron gun showing the initial beam shaping region thereof;

25 Fig. 3 is a sectional perspective view of the improved beam shaping electrode;

Fig. 4 is a plan view of the same, taken along the line 4-4 of Fig. 3;

Fig. 5 is a sectional view of the electrode blank prior to
30 imparting beam shaping properties thereto; and

Fig. 6 is a sectional perspective view illustrating fabrication of the electrode.

For a better understanding of the present invention together with other and further objects, advantages and capabilities thereof,
35 reference is made to the following disclosure and appended claims taken in conjunction with the aforescribed drawings.

For purposes of illustration, a color cathode ray tube employing an apertured mask and an in-line plural gun electron generating

assembly will be initially described in this specification as an exemplary setting for the invention. It is understood that such is not to be considered limiting to the concept of the invention.

With particular reference to Fig. 1, the essentials of a plural in-line beam color cathode ray tube construction 11 are shown. The encompassing envelope is comprised of an integration of neck 13, funnel 15 and face panel 17 portions. A patterned cathodoluminescent screen 19 of color-emitting phosphor areas is disposed on the interior surface of the viewing panel 17 as an array of definitive stripes or dots, in keeping with the state of the art. A multiple apertured structure 21, in this instance a shadowmask, is spatially related to the patterned screen; such being located within the panel by conventional means, not shown.

Positioned within the neck portion 13 of the envelope is an electron gun assembly 23 comprised of several related electron guns, each of which produces a respective electron beam 25, 27 and 29. While not shown, each of these individual guns includes a cathode and a plurality of sequentially arranged cooperating electrode elements which are formed and spaced to provide the source, formation, acceleration and focusing of the respective electron beam in a manner to properly impinge the screen 19.

Positioned externally of the tube 11 is a deflection yoke 31 which deflects the beams in a determined manner to provide an image display raster upon the screen. With the acceptance in the art of self-converging deflection yokes, a need has arisen for improved edge-of-screen focus 33. Thus, an improvement in the beam forming region of each electron gun is of important significance.

In referring to Figs. 2, 3 and 4, there is shown an exemplary enlarged sectional view of the rear beam forming region of one of the electron guns of the gun assembly 23. This shown portion of the gun structure includes a thermionic cathode structure 35 having external electron emissive material 37 terminally disposed thereon, such being activated by an internally positioned heating element 39. Positioned adjacent thereto is a first or control grid electrode (G1) 41 having a one-piece effectual portion 43 transversely oriented to the path of the beam bundle of electrons 45. This effectual portion evidences an upper surface 47 and a lower surface 49, such defining a material thickness "T" therebetween. The shown effectual portion 43 of the control electrode

41 may be an element of several electrode constructions. For example, it can be the bottom part of an individual cup-shaped (G1) member, or a substantially planar dish-shaped portion of an integrated (G1) assembly utilizing a common grid plane for a plurality of guns. The invention relates to the improved beam shaping region regardless of the over-all construction of the electrode.

Formed in the electrode effectual portion 41 of the control electrode is the improved beam shaping region 51, which, in conjunction with the spatially related apertured second or screen grid electrode (G2) 53 in an operating gun, provides an initial beam lensing influence in the inter-electrode spacing 54 therebetween. The contoured configuration of the (G1) beam shaping region 51, adjacent the aperture 55 therethrough, and the related apertured effectual portion 57 of the second (G2) electrode, together influence shaping of the array of equipotential lines of force constituting the lensing in a manner to beneficially modify the shaping of the beam bundle of electrons 45 passing therethrough.

In greater detail, the improved configured beam shaping region in the control electrode 41 has an elongated recess 59 formed, as by coining, inward from the upper surface 47 thereof. The term "coining" as used herein refers to the deformation of material by applied pressure, whether or not the deformed material is contained in a die cavity. This recess, which is free of surface imperfections, has a defined width "W", length "L" and depth "D", and as exemplarily shown, is substantially rectangular in shape. There may be occasions when the desired lensing effects may require a more ovate modified shaping. It is an important lens forming consideration that this recess evidences a substantially sharp perimetrical edge 61 at least partially thereabout. This is usually difficult to achieve in a stamping or coining operation per se since such pressure techniques tend to form a slightly rolled or radiused edge.

To achieve the desired sharp edge 61 about at least the central region of the recess 59, a depression 63 is formed, as by coining, inward from the lower surface 49 of the control electrode 41 in opposed orientation to the upper surface-related recess 59. These upper and lower related coining operations produce a beneficial flow of electrode material. This lower surface depression is exemplarily shown as being circular in shape, but it too, may be of a modified ovate

shaping. Its diameter or longest lateral dimension "B" should be sufficient to provide a flow of material to at least the central perimetrical region of the related recess 59. The residual electrode material 64 intermediate the bottom 65 of the recess and the bottom 67 of the depression
5 evidences a thickness "t". In one example of structural relationships, the depth "D" of the recess 59 does not exceed the thickness "t" of the residual material, and the depth "d" of the depression 63 is less than the thickness "t" of the residual material. As shown in Fig. 2, the depression 63 is dimensioned to accommodate positioning of the cathode
10 35 in close spatial relationship with the bottom surface of the control (G1) electrode. Such accommodation tends to effect a degree of shielding for the emissive surface of the cathode.

An aperture 55 is formed through the residual material 64 in symmetrical relationship with the recess 59 and the depression 63
15 to complete the improved configured beam shaping region 51. This aperture is exemplarily shown as being circular in shaping, but such is not to be considered limiting. Regardless of its shaping, its width or diametrical dimension "A", is slightly less than the width dimension "W" of the recess. Such dimensional relationship, as shown
20 in Figs. 3 and 4, allows a clean aperture to be formed through the residual material 64 without damaging the sharp perimetrical edge 61 of the recess or scarring the sidewalls thereof.

Regarding fabrication of the beam shaping configuration of the electrode, reference is directed to Fig. 5 wherein there is shown
25 a grid blank for the control (G1) electrode 41. The effectual portion is defined by the perimeter 69, in this instance circular, with the upper surface 47 and the lower surface 49 thereof defining a given thickness therebetween. This blank is positioned in a tooling arrangement 71 as shown in Fig. 6. With the blank resting on a bottom anvil member,
30 72 a top forming die 73, having a defined projection 75, is pressured against an appropriate part of the upper surface of the electrode blank 41 in a manner to coin the substantially rectangular recess 59 therein. Preferably simultaneously, a movable coining die 77, contained for sliding operation within anvil member 72, is pressured against the
35 lower surface 49 of the blank to coin the substantially circular depression 63 in the lower surface thereof. The resultant flow of material effected by the coining of the depression, forces some of the flow material to the top forming die to fill in the inherently round edge

about the recess 59, thereby promoting the formation of the substantially sharp perimetrical edge 61 about at least the central portion thereof.

This is an important fabrication consideration, since the sharp edge of the recess, particularly in the region of the aperture, subsequently
5 effects a beneficial improvement in the beam shaping lensing.

The beam aperture 55 is thence provided in the coined region, being oriented as heretofore described. Thus, the forming of the configured beam shaping region is completed.

Utilization of the aforescribed double-coining fabrication
10 procedure and the resultant improved electrode structure formed thereby obviate many of the disadvantages evidences in the prior art.

The electron gun electrode structure of cathode ray tube fabricated by the method according to the invention incorporates the forming of a discretely configured beam shaping region which con-
15 tributes to improved lensing influencing the initial shaping of the beam. The economical and expeditious double coined fabrication procedure assures the achievement of the beneficially sharp perimetrical edge in at least the critical region of the recess portion of the configuration. The one-piece electrode structure reduces manufacturing costs,
20 and overcomes further disadvantages of the two-piece structures of the prior art by eliminating the inaccuracies of multiple piece assembly and the possible presence of weld burrs on critical surfaces.

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CLAIMS

1. A method of fabricating a cathode-ray tube comprising in an evacuated envelope an electron gun to generate an electron beam and a target for receiving said electron beam, the electron gun including a cathode and at least two grid electrodes, a discretely configured beam
5 shaping region being fabricated in at least one of the grid electrodes, said region having a one-piece effectual portion evidencing upper and lower surfaces defining a material thickness therebetween, characterized in that said method comprises the steps of coining an elongated recess inward from said upper surface; coining a depression in-
10 ward from said lower surface in opposed orientation to said recess coining to expedite a flow of electrode material to the upper coining region, thereby promoting the formation of a substantially sharp perimetrical edge in at least the central region of said recess shaping; and forming an aperture through the residual electrode material intermediate
15 the bottoms of said coined recess and said coined depression to complete said beam shaping configuration.
2. The method according to Claim 1, characterized in that the coining of said recess and the coining of said depression are substantially simultaneous operations.
- 20 3. The method according to Claim 1, characterized in that said coined recess is of substantially rectangular shaping.
4. The method according to Claim 1, characterized in that said coined depression is of substantially circular shaping.
5. The method according to Claim 1, characterized in that the depth
25 of said coined recess does not exceed half the thickness of said electrode material.
6. An improved electron gun electrode member for a cathode-ray tube fabricated by the method according to Claim 1, characterized in that it comprises a one-piece effectual portion transverse to the
30 path of the electron beam associated therewith, said portion evidencing upper and lower surfaces defining a material thickness therebetween and having formed therein an improved discretely configured beam shaping region comprising: an elongated recess formed inward from said upper

surface, said recess having defined width, length and depth dimensions and evidencing a substantially sharp perimetrical edge in at least the central region thereof; a substantially shallow depression formed inward from said lower surface in opposed orientation to said upper surface-related recess, the dimensions of said depression being sufficient to provide a flow of material to at least the central region of said recess perimeter; a residual thickness of original electrode material defined intermediate the bottom of said recess and the bottom of said depression; and an aperture formed through said residual material in symmetrical relationship with said recess and said depression to complete said configured beam shaping region.

7. The improved electron gun electrode member of Claim 6, characterized in that said depression is substantially circular in shape.

8. The improved electron gun electrode member of Claim 6, characterized in that said depression has a depth less than the thickness of said residual material.

9. The improved electron gun electrode member of Claim 6, characterized in that the depth of said recess does not exceed the thickness of said residual material.

10. The improved electron gun electrode member of Claim 6, characterized in that said recess is of substantially rectangular shaping.

11. The improved electron gun electrode member of Claim 6, characterized in that said aperture is substantially circular having a diameter slightly less than the width of said recess.

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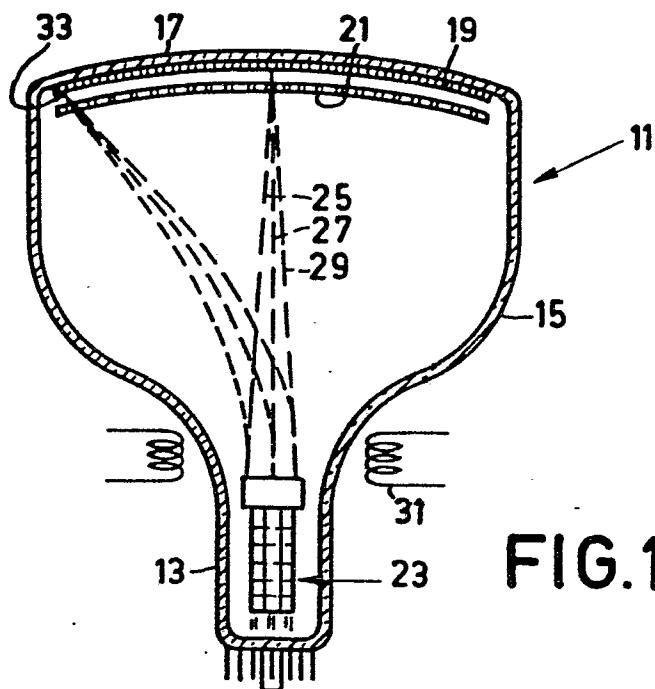


FIG. 1

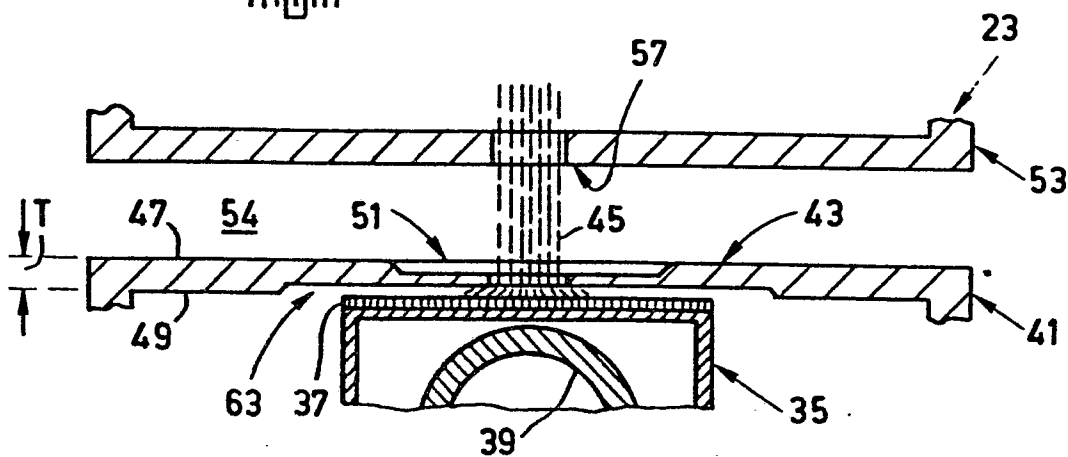


FIG. 2

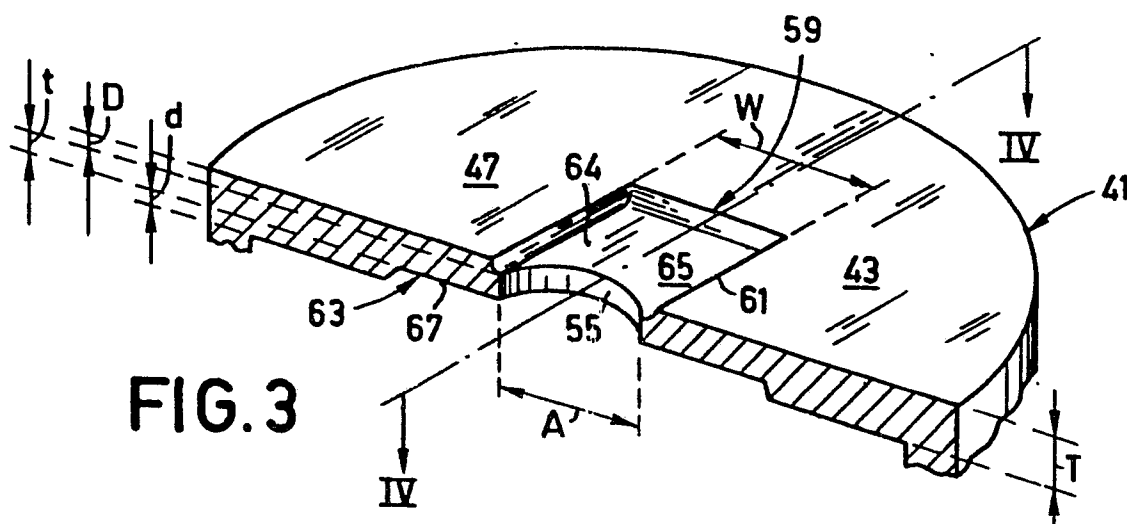


FIG. 3

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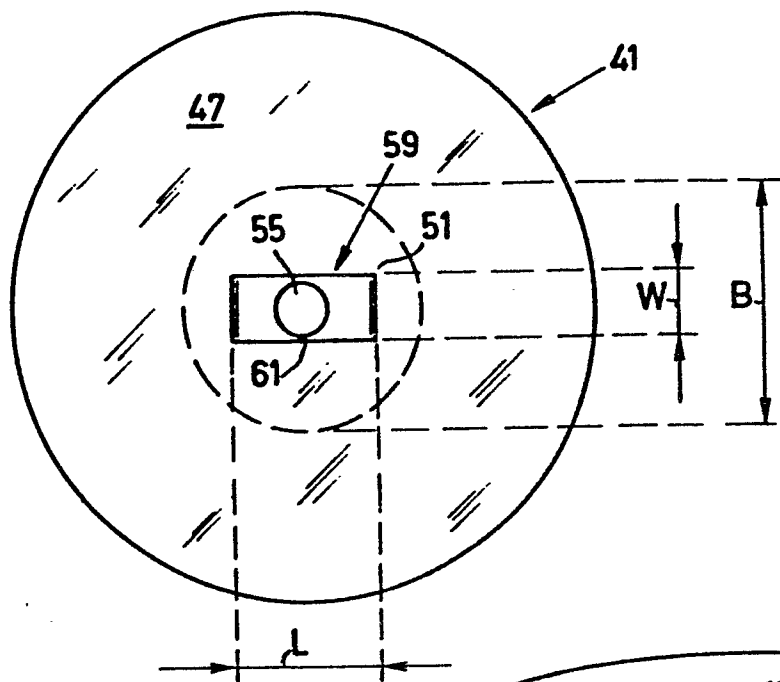


FIG. 4

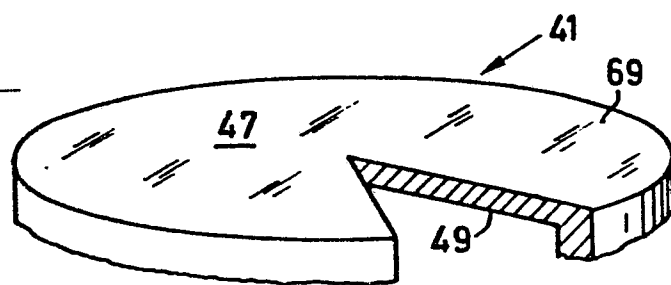


FIG. 5

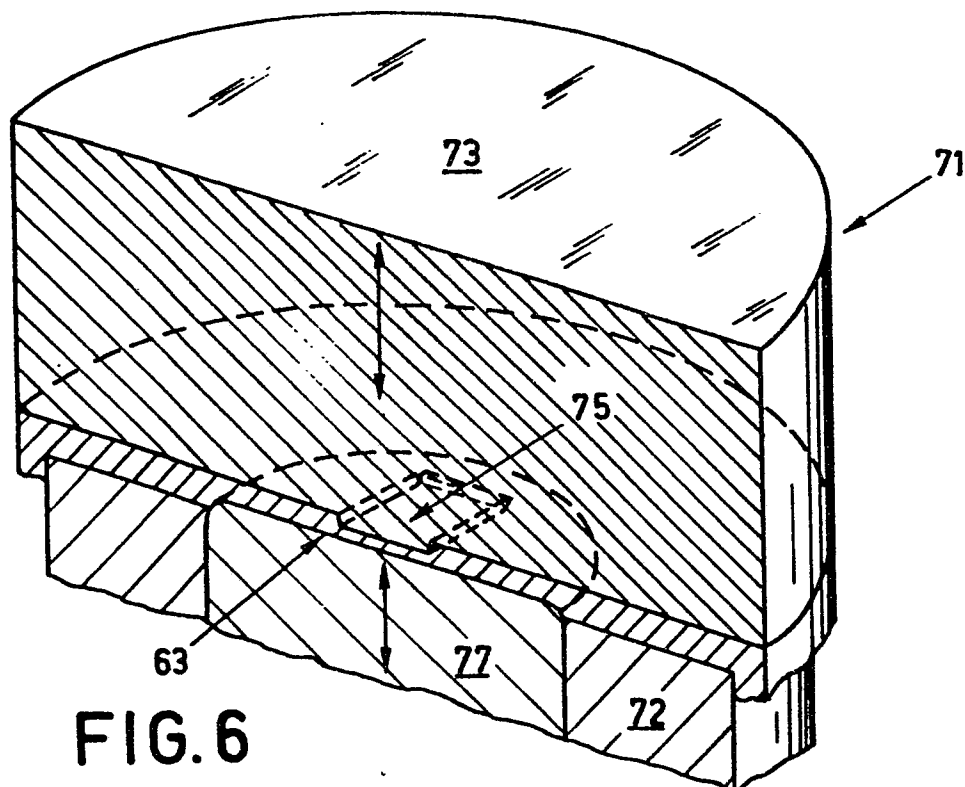


FIG. 6