

United States Patent

[11] 3,593,874

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[73] Assignee **Owens-Illinois, Inc.**

3,508,310 4/1970 Eisses 220/2.1 A

FOREIGN PATENTS

6,413,540 5/1965 Netherlands 220/2.1 A

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[54] RESISTANT CATHODE-RAY TUBE 6 Claims, 3 Drawing Figs.

[52] U.S. Cl. 220/2.1 A
[51] Int. Cl. H01J 61/30
[50] Field of Search 220/2.1 A,
2.3 A

[56] References Cited UNITED STATES PATENTS

3,220,593 11/1965 Powell et al. 220/2.1 A

ABSTRACT: A direct-viewing implosion-resistant cathode-ray television picture tube comprising a glass envelope manufactured from a frustoconical funnel portion and a flanged faceplate portion. An annular reinforcing member closely fitted around the peripheral external surface of the faceplate flange and positioned rearwardly of the mold-match line. The faceplate flange having a thickened portion to compensate for the rearwardly positioned reinforcing member. The thickened portion being placed so as to minimize the reduction of the viewing area of the television picture tube.

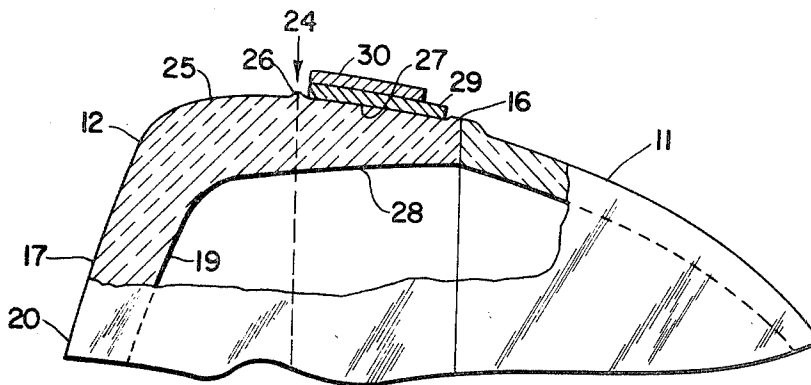


FIG. 1

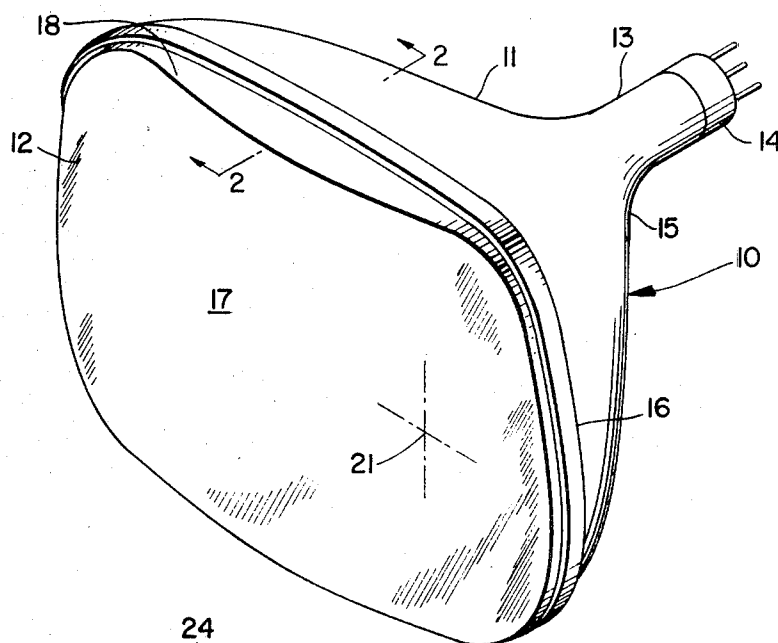


FIG. 2

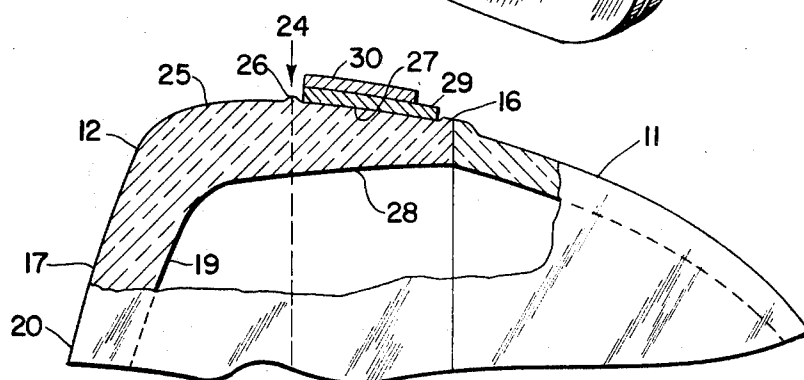
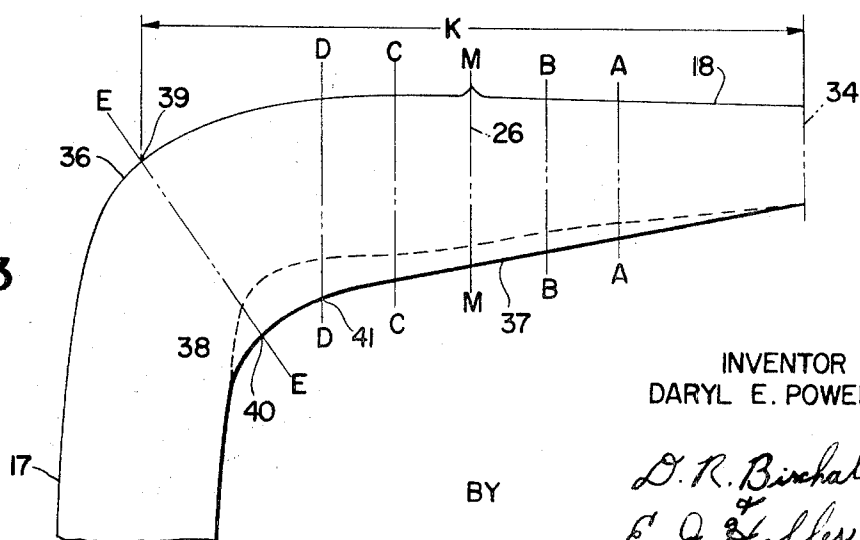


FIG. 3



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RESISTANT CATHODE-RAY TUBE

The present invention relates to cathode-ray tubes and more particularly to the control and prevention of fractures that produce implosions in cathode-ray tubes. More specifically, the present invention sets forth an improved cathode-ray tube anticipated for direct viewing in a television reception set. The present invention provides for an increase in the thickness of the faceplate flange to offset the location of the reinforcing member that is affixed to the exterior of the faceplate flange.

It is well known that cathode-ray tubes are vacuumized to very low pressure and that the breakage of the envelope may result in an implosion of considerable magnitude. As is characteristic of an implosion, an explosion simultaneously accompanies the implosion and in the case of large television picture tubes severe damage can occur where large pieces of the ruptured cathode-ray tube envelope are projected in the direction of the television viewers.

In the not too distant past, it was common practice to install a flat glass plate or a tempered-glass implosion panel in front of the cathode-ray tube in a television receiving set in order to protect the viewers from the effects of an implosion-explosion. Television set manufacturers were able to discontinue the use of the tempered flat glass plate with the advent of the integrally safe cathode-ray television picture tube that employed a reinforcing band around the periphery of the faceplate portion of the television tube. The integrally safe picture tube, like its predecessor employing the separate flat glass plate, was well recessed into the cabinet of the television set. Since the set manufacturer no longer had to be confronted with the flat glass plate in the front of the television set it became possible more recently, to have a construction with more of the cathode-ray tube protruding from the frontal area of the television set. This protrusion of the cathode-ray tube has enhanced the overall appearance of the present day television sets and has also improved the viewability of the television set. Since a greater portion of the frontal area of the cathode-ray tube now protrudes from the front of the television set, it has been necessary to move to a more rearwardly position the reinforcing band that imparts implosion-resistant characteristics to the cathode-ray tube.

U.S. Pat. Nos. 3,220,592 and 3,220,593, both of which issued on Nov. 30, 1965, relate to a basic type of direct-viewing implosion-resistant cathode-ray television picture tube having a glass envelope and method of fabricating such tube envelope for its proper reinforcement. These inventions eliminate sources of fracture originating in or progressing into highly stressed areas, particularly those of substantially maximum cross-sectional dimensions of the envelope, and prevent the deleterious effects which result from sudden violent devacuation. As disclosed in the reference patents, noteworthy results have been achieved in protecting nonviewing areas of the tube envelope in such a manner that damage to the tube envelope from whatever source and wherever caused cannot result in damaging implosion-explosion. The need for a separate implosion plate, either mounted separately from or integrally with the image tube faceplate has been eliminated in such a manner that the tube faceplate may be direct viewing in all conventional sizes of television picture tubes. Also, U.S. Pat. Nos. 3,382,999 and 3,383,000, both issued May 14, 1968, disclose and claim further improvements in the field of reinforcing cathode-ray picture tubes to eliminate implosive effects due to offcenter impact of the tube causing a neckoff at the tube small end which can occur at the beam gun tubulation. Also, U.S. Pat. No. 3,403,805 which issued Oct. 1, 1968, discloses and claims a further improvement in the field of reinforcing cathode-ray image tubes.

Accordingly, the present invention constitutes an improvement of the cathode-ray construction heretofore described in the prior art patents. As has been commented upon before, the faceplate flange must be increased in thickness in order to enhance the reliability of the cathode-ray tube. The increased

thickness has been found necessary because the reinforcing band has been moved farther away from the front of the tube faceplate. It would perhaps appear to be logical to increase not only the thickness of the faceplate flange, but also the entire frontal area of the faceplate. However, an increase in the television tube faceplate thickness has certain disadvantages. The increased thickness, of course, quite drastically increases the overall weight of the television tube. Also, an increase of thickness of the front viewing area of a television picture tube disrupts the balance of construction between the faceplate and funnel portion of the tube. If the faceplate is quite massive as compared to the funnel, the force of an impact directed against the viewing surface of the faceplate will be transmitted back through the funnel toward the apex thereof and the tubular portion of the funnel that houses the electronic components will rupture thus destroying the entire picture tube.

It has become quite apparent during the last few years that if breakage must occur in a television picture tube, that breakage is desirable in the faceplate and not in the funnel or neck portions. If the funnel breaks first, it will collapse inwardly and disengage the entire faceplate which will then be propelled in a direction away from the television set. Thus it can be ascertained that a balanced thickness must be maintained between the faceplate and the funnel portion of the cathode-ray tube.

It would appear that it would not be a very complex problem to increase the overall thickness of the faceplate flange in order to withstand the increased stresses caused by a shift in position of the reinforcing band, however, the problem is not quite as simple as it would appear to be. As discussed heretofore, an increase in the faceplate flange is desirable, however, a corresponding thickness of the viewing area of the faceplate is not desirable. When the faceplate flange is increased in thickness, the transition between the increased flange thickness and the viewing surface thickness becomes quite critical. If a sharp inside corner results because of increased flange thickness, the more reentrant configuration increases the stress concentration beyond a point that can be tolerated during the various thermal cycling through which the television tube must be subjected during its assembly. The high stress concentrations caused by a sharp inside radius can be minimized by increasing the radius, however, the increased glass thickness is carried over into the periphery of the viewing surface thus reducing the overall viewing area. For example, let's assume that there is an increase in the inside corner radius that affects the viewing surface by only 0.1 inch. When the 0.1 inch is multiplied by the entire peripheral of the frontal viewing surface in a 23-inch television picture tube; there will be a viewing surface reduction that amounts to an area of six square inches. Thus it can be seen that a slight increase in the internal radius between the faceplate flange and the frontal viewing area will result in several square inches less viewing surface.

The increased thickness of the faceplate flange has become desirable in order to combat the very high stresses that occur in the juncture area between the frontal viewing surface of the faceplate flange. During normal operating conditions, the entire cathode-ray tube exists with a state of reduced pressure inside the tube. The ambient pressure upon the viewing area of the faceplate has a tendency to move the faceplate in an inwardly direction. This produces a very high bending moment at the corner of the faceplate. The bending moment is further increased by constricting force of the implosion band that is applied on the exterior of the faceplate flange. The coupling of the just mentioned moments causes the corner area between the front of the faceplate and the flange of the faceplate to be one of the most highly stressed areas of the entire cathode-ray tube. Heretofore it has been pointed out that an increase in flange thickness is desirable and that the increased thickness can be attained by the addition of material to the inner wall of the faceplate flange. It, of course, is readily apparent that a corresponding increase in flange wall thickness can be attained by adding the desirable material to the exterior of the

flange. However, the addition of extra glass to the outside of the television picture tube creates manufacturing problems in that strengthened cathode-ray tube is no longer of the same overall exterior dimensions. Consequently, the interchangeability of the strengthened cathode-ray tube for use in existing television sets is drastically reduced.

Accordingly, the present invention constitutes an improvement over the cathode-ray tubes presently constructed. The improvement is realized through a reduction in the likelihood of an implosion caused by an impact to the frontal area of the cathode-ray tube. It is, therefore, an object of the present invention to provide a direct viewing cathode-ray tube with an increased flange thickness that does not affect adversely the overall viewing characteristics when the cathode-ray tube is employed as a viewing screen for a television set.

Another object of the invention is to increase the flange thickness of the cathode-ray tube faceplate by adding extra material to the interior peripheral flange area without causing an increase in the exterior dimensions of a cathode-ray tube.

A further object of the present invention is to provide a cathode-ray tube structure having an essentially all glass tube envelope with a faceplate flange of increased thickness, a frontal viewing surface that has been reduced a minimum in area because of the increased thickness of the flange portions, and a reinforcing band possessed rearwardly of the mold-match line.

A still further object of this invention is to provide a cathode-ray tube that possesses a definite ratio between the glass thickness in the flange to the length of the flange. The specific advantages as well as other objects of this invention will become apparent to those skilled in the art from the following detailed description when taken in conjunction with the included drawings, which by way of example, show the preferred embodiment of the invention.

IN THE DRAWINGS

FIG. 1 is a perspective view of a cathode-ray tube showing the combination of the faceplate, funnel, and neck portions.

FIG. 2 is a view taken along line 2-2 of FIG. 1 and is shown partly in section.

FIG. 3 is a diagrammatic sectional view of the skirt and radius area between the faceplate and the funnel of the cathode-ray tube.

The present invention is described and illustrated hereinafter as specifically applying to, for example, a 23-inch television picture tube. However, it will be quite apparent to those skilled in the art that the present invention is equally applicable to the manufacture of vacuum components of many different types or of which utilize glass as the material for their envelopes. All such envelopes operate under a reduced interior pressure consequently they are subject to implosion and virtually simultaneously explosion on sudden evacuation which may be produced by sudden external loads, temperature variations and stress producing abrasions such as deep scratches.

The term "devacuation" as used herein is intended to mean the converse of vacuumation as in the case where a vacuumized vessel or tube experiences an internal pressure change toward atmospheric upon loss of vacuum. The rate of change may occur rapidly, in which case the deleterious effects can be exceedingly violent, or more slowly over a longer period of time whereby such effects are greatly moderated. Obviously, moderating the rate of devacuation results in a gradual dissipation of the energy forces causative of destructive implosion.

The present invention provides an implosion-resistant system which is capable of being incorporated into all existing types and shapes of conventional cathode-ray picture tubes with only minor alterations or modifications of a portion of the envelope component fabricating procedures. The invention may be incorporated into any selected type of tube using materials and methods capable of supplementing normal bulb

and tube production. The term "bulb" is applied to hollow glass envelopes having virtually none of the image-producing electrical components installed except one or more anode buttons in the funnel sidewall. The term "tube" is used to designate the completed electron-discharge device having all of its electrical components installed in fully evacuated condition capable of displaying a raster on its image-creating screen.

In describing the present invention, a glass cathode-ray tube envelope 10 tube as shown in FIG. 1 is normally manufactured from three primary parts. A funnel member 11, a faceplate member 12, and a neck tubulation 13. The three primary parts 11, 12 and 13 are joined together to form a unitary hollow glass article capable of withstanding the loading of atmospheric pressure when the air is removed from the interior of the cathode-ray envelope. The end of neck tubulation 13 is generally sealed by an end cap 14 which in turn is coupled to one or more electron beam-emitting guns which protrude forwardly into the apex portion of funnel member 11. Funnel member 11 is normally of frustoconical or frustopyramidal configuration. The apex end 15 of funnel member 11 is sealed to the end of neck tubulation 13. The seal is usually effected by fusing the two glass parts together. The larger end of funnel member 11 is likewise fused to the complementary faceplate 12 at a juncture known as the seal line which is represented by numeral 16.

Faceplate 12 is manufactured with a concavo-convex viewing portion 17. Attached to the peripheral edge of view portion 17 is a depending annular side panel or flange 18. The complementary end portions of faceplate member 12 and funnel member 11 are as previously stated sealed along a seal or splice line 16. This seal or splice may also be made by imposing between the complementary ends of funnel member 11 and faceplate member 12 a layer of low-melting glass-sealing composition such as a crystallizable solder glass that is compatible with the thermal and physical characteristics of the glass that has been employed in the parts to be so coupled together.

The basic shape of the heretofore described glass tube 10 may be either circular or rectangular as is conventionally known to those skilled in the art, with the sealing surface being substantially plainer to aid in the attainment of a durable hermetic joint between funnel member 11 and faceplate member 12. The description set forth above applies equally well to television picture tubes employed for monochromatic and polychromatic reception. For purposes of illustration, a rectangular television picture tube fabricated along the lines for monochromatic image creation has been shown in the drawings.

The invention as presently contemplated consists of applying a reinforcing implosion-explosion band around the exterior portion of the side flange 18 of faceplate member 12. In order to assist in making a well balanced television picture tube design that will provide maximum impact protection with the least reduction in the overall cross-sectional viewing area, the thickness of the side flanges 18 have been increased.

FIG. 2, which is shown partly in section, depicts faceplate member 12 fused together with funnel member 11 at seal line 16. Faceplate member 12 contains viewing portion 17 extending in an outwardly convex direction. The interior surface 19 of viewing portion 17 is of concave configuration and closely parallels exterior surface 20 of viewing portion 17. In the manufacture of faceplate member 12 the molten glass is most conventionally formed in a multipart glass mold. Consequently, to aid in the removal of the formed faceplate member 12 from the forming mold, it is necessary to provide a certain degree of angularity to the walls of side flange 18. The exterior 24 of side flange 18 may be divided into two main parts. That portion 25 of the exterior of side flange 18, most closely adjacent to the viewing portion 17, has a slope that enhances the removal of the finished glass part from the small member of the mold. The forward exterior portion 25 is joined at a mold-match line 26 with a rearward exterior portion 27. Portion 27 is of substantially uniform slope from mold-match

line 26 to seal line 16. The interior surface 28 of side flange 18 contains a draft angle that facilitates the removal of the male portion of the mold from the completed face member 12.

In order to protect a television tube from the hazards associated with an implosion-explosion, a one or two piece reinforcing band 29 is placed around and in contact with the exterior of flange 24 of faceplate member 12. The reinforcing band 29 may be placed at different positions relative to the viewing portion 17, the mold-match line 26, and the seal line 16. However, for illustrating the present invention, the reinforcing band has been shown in a position rearwardly of mold-match line 26 and forwardly of seal line 16. Reinforcing band 29 is generally bonded into integral relationship with the exterior of flange 24. Reinforcing band 29 may be augmented by a tension band 30 that is superimposed and contiguous with reinforcing band 29. Tension band 30 is preferably a one piece, two ended band that is installed around the faceplate member 12 and is subsequently tensioned and held in that state by mechanical means of one type or another. However, it is understood that an endless band could equally well be employed to impart a stabilizing effect to the exterior of flange 24 either with or without reinforcing band 29.

FIG. 3 is a diagrammatic sectional view of the corner of glass tube 10. The end of side flange 18 is shown at 34; this coincides for all practical purposes with the center of seal or splice line 16 as shown in FIG. 2. The mold-match line which is shown at 26 is generally that part of flange 18 which is the farthest from the longitudinal axis of the glass tube 10. The area between side flange 18 and viewing portion 17 is known as the corner radius and is represented by numeral 36.

Also shown in FIG. 3 are sections A-A, B-B, M-M, C-C, D-D and E-E. In a 23-inch television bulb, sections B-B and C-C are each located approximately 0.25-inch distance away from the mold-match line which coincides with section M-M. Sections A-A and D-D are located approximately 0.50-inch distance from section M-M. Section E-E is defined infra.

The inner surface of side flange 18 is defined by a line identified by numeral 37 which represents by way of an example a television faceplate flange that has been increased in thickness in order to withstand, in a successful manner, the increased loads directly attributable to the repositioning of the bands 29 and 30 behind the mold-match line 26 as has been commented upon previously and shown in FIG. 2. The dotted line 38 represents the configuration of the glass in the flange area prior to an increase in thickness as taught by the present invention.

By way of example only, dimensions are set forth in Table I for a 23-inch television tube.

TABLE I

Location	Old Dimension	New Dimension
A-A	0.400 inch	0.450 inch
B-B	0.440	0.510
M-M	0.510	0.570
C-C	0.530	0.625
D-D	0.530	0.670
E-E	0.600	0.750

When television picture tubes were constructed according to the old flange thickness dimension shown in Table I, it was discovered that ft.-lb. all television picture tubes so constructed would pass established impact tests. The inability of the television picture tube to pass the impact test was deemed to be directly attributable to the increased bending moment in the vicinity of the juncture between the television viewing portion of the faceplate and the flange that is attached thereto.

The test that caused failure of tubes fabricated according to the old flange thickness dimensions was in the 5-6 ft.-lb. impact energy range. The impact load was applied to the viewing surface 12 at a location shown approximately at 21, FIG. 1. Of

eight television tubes constructed with the reinforcing band and tension band positioned behind the mold-match line and a set of flange dimensions as set forth in Table I, four of the television tubes imploded as a 2-inch diameter steel ball impacted against the viewing surface as previously described.

After the television faceplate flange for a 23-inch picture tube was increased in dimensions according to the teaching of the present invention, 10 tubes were tested without any implosions occurring.

Television picture tubes manufactured according to the old dimensions and the dimensions of the present invention were installed in similar television sets and a visual comparison was made between the two television sets. No discernible decrease in the overall picture viewing area was detected even though the inside flange radius extended a short distance in a direction toward the center of the viewing areas. It is to be understood that while the previously discussed test results apply to a tube that has been banded subsequent to devacuation, it is within the scope of the present invention to band first a faceplate having a geometry as heretofore described and to attach it by welding or solder glass techniques to the remaining portions of the tube.

The present invention can be additionally defined by considering a cross section of a television cathode-ray tube taken though the flange area at the center of one of the longitudinal sides of the tube. FIG. 2 as well as FIG. 3 represents such a cross-sectional view as outlined above. Point 39 is the mid-point of the radius which defines the outside corner of the juncture between side flange 18 and viewing portion 17. In a similar manner point 40 is located at the center of the radius that defines the inside reentrant corner formed by the intersection of the faceplate viewing portion 17 and flange 18. Section E-E is drawn through points 39 and 40.

The dimension K as shown on FIG. 3 represents the distance from point 39 to the free end 34 of flange 18. The dimension K is taken along a line that is normal to the plane defined by free end 34 of flange 18. Point 41 is defined as the point where the sharp reentrant corner radius joins the approximately straight tapered interior wall 37 of flange 18.

Once again by way of example dimension K for a 23-inch picture tube is approximately 2.45 inches. It is also to be noted that according to present day manufacturing dimensions the mold-match line occurs in the vicinity of one-half K.

Since the overall configuration of a 23-inch television tube is similar to smaller television tube sizes such as for example 16- and 10-inch tubes, it is possible to express as a ratio the dimension K and the increase in flange thickness of the present invention.

Referring now to Table I, it can be seen that the thickness of the prior art flange at section M-M is 0.510 inch. Since dimension K is 2.45 inches, the ratio between flange thickness (0.510) and K (2.45) is approximately 1:4.8. Referring to Table I it can also be determined that the flange thickness at section M-M as taught by the present invention is 0.570 inch. The resulting ratio is approximately 1:4.3. It is to be understood that there can be some small variations in the exact ratios as expressed under the present invention because there will be minor dimensions variations between production manufactured parts. Section D-D, for all practical purposes coincides with the point 41, in a 23-inch television picture tube, it is of course possible to express the ratio between the thickness at section D-D and dimension K. Thus the ratio between the prior art thickness, 0.530 inch and K at section D-D is 1:4.6. Since the thickness at section D-D is 0.670 inch as taught by the present invention, the resulting ratio with respect to K is 1:3.7.

From the above discussion, it is evident that the present invention is defined in a manner not heretofore set forth by the prior art.

Various modifications may be resorted to within the spirit and of the claims which are appended hereto.

What I claim is:

1. In combination a cathode-ray envelope comprising: a substantially frustoconical hollow body portion having a viewing portion closing its larger end and a neck tubulation attached to and projecting from its smaller end, said view portion having a light-transmitting concavo-convex viewing panel capable of withstanding normal usage without fracture and an integral cantilevered flange portion attached to the peripheral region of said viewing panel and extending rearwardly therefrom, said flange portion having a circumferentially extending mold-match line on the exterior surface intermediate the edges of the flange, a reinforcing band positioned overlying the exterior surface of said flange and located entirely between the mold-match line and the terminal edge of said cantilevered flange, said flange having a flange thickness to flange length in the ratio of from 1:3.5 to 1:4.5 said ratio existing over the flange in the vicinity of said mold-match line, said flange length being the distance from the terminal edge of the flange to the midpoint of the exterior radius that joins the viewing panel surface to the flange surface.

2. In combination a cathode-ray envelope comprising: a substantially frustopyramidal hollow body portion, a rectangular viewing portion attached at a splice line and closing the larger end of said body portion and a neck tubulation attached to and projecting from the smaller end of said body portion, said viewing portion having a light-transmitting concavo-convex viewing panel capable of withstanding normal usage without fracture and an integral cantilevered flange portion attached to the peripheral region of said viewing panel, and extending rearwardly therefrom to said splice line, said flange portion having a circumferentially extending mold-match line on the exterior surface intermediate the edges of the flange, a reinforcing band positioned overlying the exterior surface of said flange and located entirely between the mold-match line and the splice line of said cantilevered flange, said flange having a thickness to length ratio of from 1:3.5 to 1:4.5, said ratio existing in the vicinity of said mold-match line said flange length being the distance from the approximate center of the

splice line to the midpoint of the exterior radius that joins the viewing panel surface to the flange surface, said thickness ratio existing at a section through the flange at approximately the midpoint of the long side of said rectangular viewing portion.

3. The combination cathode-ray envelope as claimed in claim 2 wherein a tension band is positioned around said envelope and in overlying contact with said reinforcing band.

4. A cathode-ray tube faceplate having a rectangular frontal viewing surface of concavo-convex configuration and a peripheral tapered flange attached in cantilevered fashion thereto and extending rearwardly therefrom, said flange being of a greater thickness at its attached end than at its free end, said flange having a circumferentially extending mold-match line positioned on the exterior surface thereof and located generally at the midpoint between the attached and free ends of the flange, a reinforcing band is positioned contiguous with the exterior surface of said flange and located entirely between the mold-match line and the free end of the flange, the ratio of the flange thickness to flange length being in the range of from 1:3.5 to 1:4.5 said ratio existing in the region of the mold-match line, said flange length beginning with and extending in a direction normal to a plane defined by the free end of said cantilevered flange to a point at the midsection of the exterior radius that defines the junction of the faceplate and the flange, said ratio existing at a section radially through the flange at approximately the midpoint of the long side of said rectangular viewing surface.

5. A cathode-ray tube faceplate as claimed in claim 4 wherein a tension band is positioned around the periphery of said faceplate and in overlying contact with said reinforcing band.

6. A cathode-ray tube faceplate as claimed in claim 5 wherein said flange also has a thickness to length ratio of from 1:3.5 to 1:4.0 existing at a section where the flange interior surface contour joins the curvature of the inside reentrant corner radius between the flange and the viewing screen.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,593,874 Dated July 20, 1971

Inventor(s) Daryl E. Powell

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 66, delete "ft.-lb." and insert
--not--.

Signed and sealed this 11th day of January 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents