Dec. 24, 1957 H. R. SEELEN 2,817,456

METAL CONES FOR CATHODE RAY TUBES

Filed Feb. 24, 1951 2 Sheets-Sheet 1

Fig_1

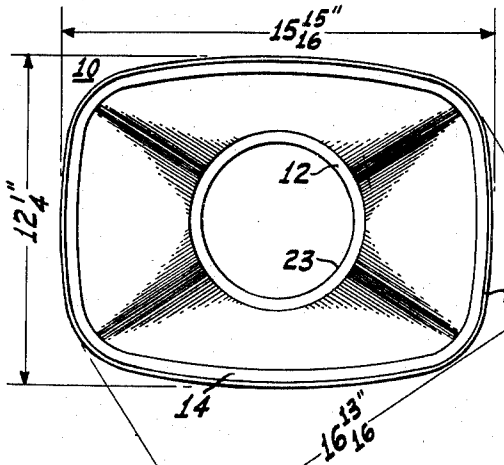
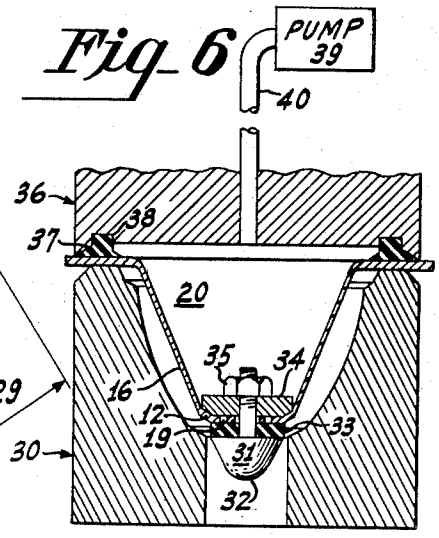


Fig_6



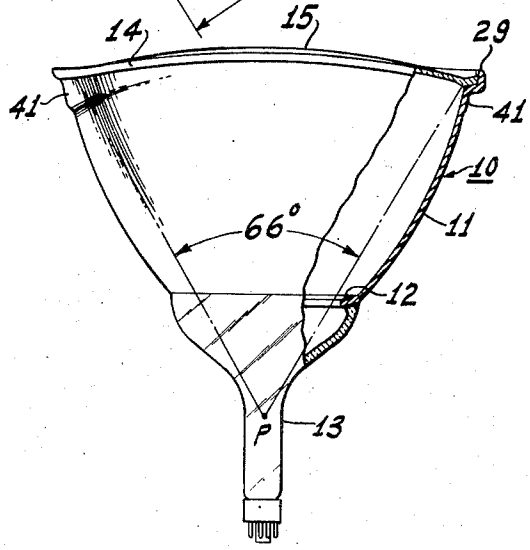


Fig_2

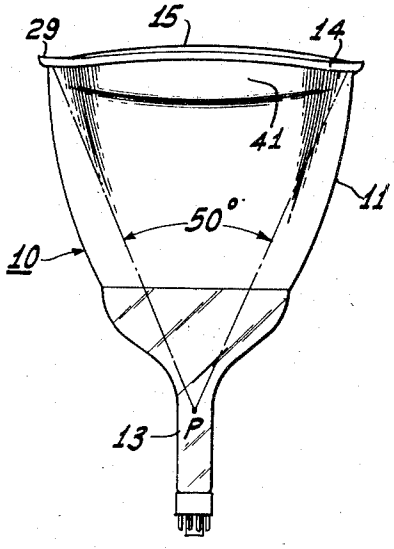


Fig_3

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METAL CONES FOR CATHODE RAY TUBES

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Fig_4

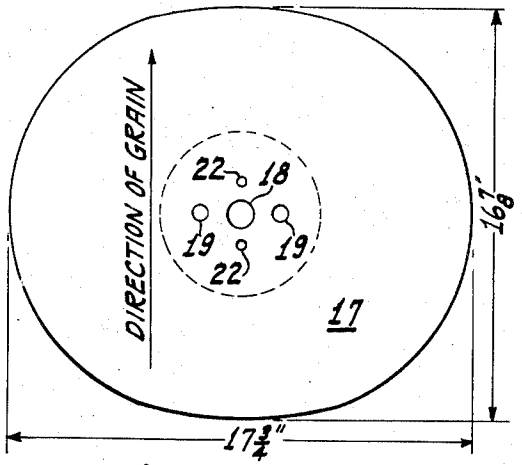
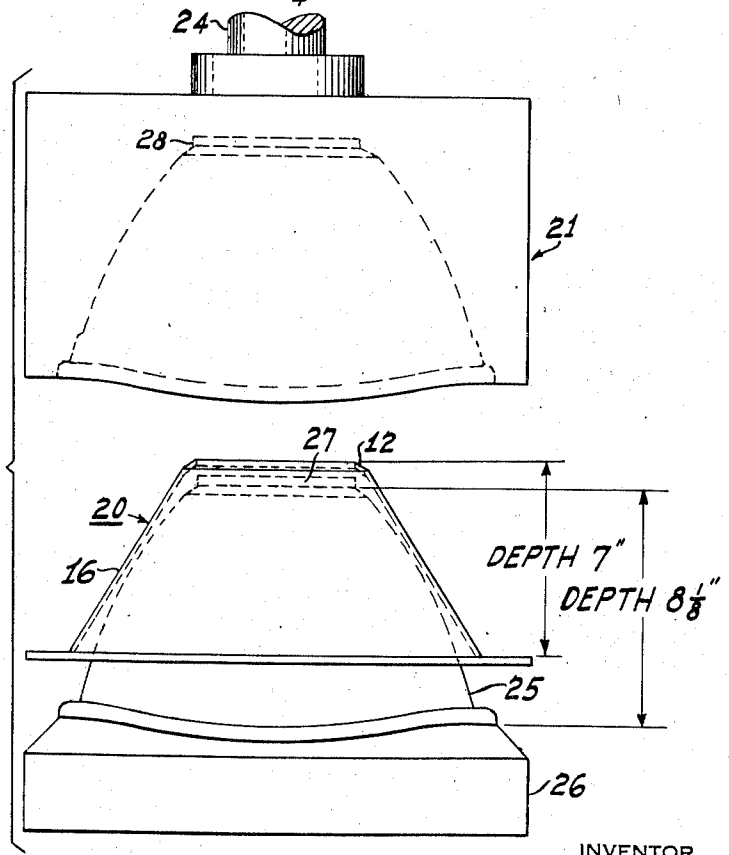


Fig_5



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METAL CONES FOR CATHODE RAY TUBES

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Application February 24, 1951, Serial No. 212,546

12 Claims. (Cl. 220—2.3)

This invention relates to improvements in cathode ray tubes having composite glass and metal envelopes. More particularly it relates to improvements in metal cones for the bulb portions of such tubes.

Recently, as for example, in the invention described in copending application of Richard D. Faulkner Serial No. 120,400, now U. S. Patent 2,682,963 filed on October 8, 1949, and assigned to the assignee hereof, certain advances have been made in the cathode ray tube art resulting in the successful commercial production of such tubes with composite metal and glass envelopes. The bulb portion of any of the presently available composite types usually comprises two parts: a "round" metal cone, i. e. one which has circular transverse cross-sections, and a circular glass face-plate sealed into a rim or "lip" at the large end of the cone.

These prior art composite structures involve a number of disadvantages. A principle disadvantage is that cabinet space is wasted. This results from the inherent inefficiency of using a round cone and a circular face-plate where the electron beam is to scan through a rectangular solid angle and to trace a rectangular raster. This waste of space becomes progressively more serious as screen sizes increase. It makes cabinets needlessly expensive and complicates their design. Another disadvantage is that "round" tubes are difficult to mount.

Therefore, it is desirable to provide "rectangular" types of metal cones and to make with them cathode ray tube envelopes with "rectangular" bulbs and face-plates.

In general, these and other objects are attained by using in combination two metal-working operations of different kinds: (1) spinning the central portion of a sheet metal blank over the outside of a hard-surfaced "round" frustum; and (2) forcing the partially formed blank by an outwardly acting means to assume the internal shape of a rectangular female die. In spinning the center portion of a flat metal blank sufficient pressure should be used to reduce it in thickness while imparting to it the shape of the frustum. In this step the peripheral portion of the blank may be left undisturbed extending in its original full thickness from the spun portion like the brim of a hat. The outwardly acting means may be hydrostatic pressure or a male punch having the conjugate shape of the die. This combination of steps results in efficient use of material since the spinning step thins out a portion of the blank which eventually forms the part of the cone, its "mantle," where the least strength is needed, while the other step forms the other portion into the rim, the sealing flange and a peripheral portion of the mantle adjacent thereto, forming them with sections as thick as the original material and thus providing maximum strength where it is most needed. This process also results in an economy of machine operations since most of the needed stretching of the blank is easily effected by the spinning step whereby it is possible to accomplish the rest in a single operation, such as in one deep draw. The present invention minimizes: the loss of metal as scrap; the required number of machine and machining

operations and of annealing steps; and the amount of "shrinkage" due to cracked and/or otherwise imperfect cones. In addition it results in a cone shape which is highly desirable both for its appearance and strength and because it simplifies a later-required step of settling phosphor material on the inside surface of the face-plate.

In the drawing:

Figure 1 is a front view into a rectangular metal cone, embodying the present invention, as seen through the face-plate sealing flange;

Figure 2 is an exterior plan view of a cathode ray tube, partially cut away, which comprises a cone as shown in Figure 1 with a face-plate sealed into the rectangular flange on the front thereof and a neck fused onto a round flange at its back;

Figure 3 is an exterior side view of the tube shown in Figure 1;

Figure 4 shows a "developed" flat metal blank of an approximately oblately circular or eliptical shape which is preferred in making a cone as in Figures 1 and 2 in accordance with the present invention for reducing to a minimum the amount of trimming of excess material from the front edge of the sealing flange which will be necessary after the second metal-working operation has been completed; and

Figures 5 and 6 show apparatus suitable for re-forming a partly spun blank into a rectangular cone.

The cone **10** shown in Figures 1, 2, and 3 comprises a principal portion herein designated as the "mantle" **11**, and two other portions between which the mantle extends, namely a small round sealing flange **12**, at the back of the cone, to which a neck **13** may be fused, and a large rectangular flange **14**, at its front, into which the face-plate **15** may be sealed. In Figures 2 and 3 there is shown a point P which represents the center of deflection of the electron beam.

Unlike a round cone, cone **10** does not have the same included angle all around, i. e. an angle large enough to provide for the largest amount of deflection required at any point to scan a rectangular raster with a 3 to 4 aspect ratio. Instead, as examples, three of its included angles having their apices at P are respectively subtended by the highest part of the screen, its widest part, and its diagonal. These angles are of different sizes, namely 50°, 66°, and 70°, respectively.

Because of this it is difficult, especially with the rather refractory chrome bearing alloys which are preferred for kinescope cones, to reform a partially spun round blank, e. g. by a drawing or punching operation, without causing excessive stretching in some areas, resulting in splits or cracks, and/or excessive "gathering" of the incompressible material in others, resulting in folds and pleats. However, according to the present invention, this can be accomplished provided the included angle of the frustum **16** (Figs. 5 and 6) which is produced by the spinning operation is appropriately smaller than the largest included angle of the rectangular cone and larger than its smallest included angle, e. g., if it is 60° for the cone shown in Figures 1–3. If this is so, then in the reforming operation the slack developed by pushing the top and bottom nearer together can be taken up by the pulling of the sides apart.

At the present state of the art certain chromium bearing alloys are the preferred materials for kinescope cones, even though they are more difficult to work and more expensive than other materials such as cold rolled steel. One reason for which they are preferred is that their expansion-contraction characteristics are appropriately related to those of suitable types of glass for generating certain useful compressive forces, therein, during the manufacturing process, and for not generating certain harmful tensile forces. For example, useful com-

pressive forces are produced in the face-plate by shrinkage of the sealing flange around it after sealing-in. This causes the face-plate to bulge outward improving its ability to oppose the inwardly acting force of atmospheric pressure which becomes effective upon evacuation. Another reason is that the chromium in these alloys produces an oxide film on the sealing flanges when they are heated for sealing-in, and, due to the solubility of chromium oxide in molten glass, this strengthens the seals. However, this element not only is an expensive ingredient in these alloys but also makes them difficult and expensive to roll into sheet material and to work into finished articles. As a result the cone is usually the principal item in the over-all cost of glass-and-metal picture tubes, particularly those having large screens since their cones may easily weigh 12 to 15 pounds. Obviously, therefore, in these tubes it is very important to avoid using more cone material than is really necessary. The problem was met for the manufacture of round cones first by the use of high pressure spinning. As is well known the effect of high pressure spinning over a round conical mandrel is to thin out the material, by an amount which is a function of the sine of the included angle, thereby effectively causing a given weight of material to extend over a larger portion of the area of the cone than if it were fabricated in some other way such as by drawing. In general, the blank material must be thick enough so that the face-plate sealing flange as formed without thinning will be strong enough. Because of this, and since the amount of thinning obtainable in the mantle is limited, many cones, even though they were spun under high pressure have had thicker side walls then necessary and therefore have been somewhat wasteful of material. However, further economy was made possible, as taught in the above-mentioned copending application, Serial No. 120,400, by an improved structural design which permits fabrication of the cone from a thinner blank than formerly. In a cone of this design the walls of the mantle as formed of the thinner blank and as further thinned by spinning are no longer too heavy and yet the sealing flange is sufficiently strong because it is reinforced by an adjacent portion of the mantle which is spun at a sufficiently reduced pressure to be approximately as thick as the flange.

According to the present invention it is possible to make a rectangular cone so as to attain the advantages both of sine law spinning and of the feature set forth in the above-mentioned copending application.

An apparatus used to practice the presently disclosed method of making rectangular cones comprises a rotatable frustum of hard-surfaced material, onto the small end of which a flat blank may be attached and keyed so as to be rotated therewith, and one or more rollers for progressively urging successive portions of the blank under very great pressure against the outside surface of the frustum starting near its small end and progressively advancing down the side thereof toward its base to force material ahead of it and to spin it into the shape of the frustum. According to the present invention such apparatus is not utilized for processing as much of the flat blank as in forming a round metal cone. Instead only a center portion of the blank is spun to form thereof a hollow frustum **16** (Figs. 5 and 6) of a depth which is smaller than, and preferably bears a predetermined relationship, to the desired depth for the finished rectangular cone. Among different specific cones this relationship will vary as a function of differences in a number of their parameters such as the aspect ratios of their face-plates, their respective included angles, their maximum heights, widths, etc. However, for a cone proportioned as in Figures 1–3 the preferred ratio of the depth of the spun frustum **16** to that of the complete cone, **10**, is of the order of 7 to 8⅛.

Apparatus for the spinning operation of the present

invention is not shown herein since a number of suitable kinds are already known. However, two kinds of apparatus for performing the other operation are shown in Figures 5 and 6 respectively. The manner in which they are used is explained below.

The oblately circular or elliptical blank **17** is cut from sheet metal stock so that the "grain" thereof, as represented by an arrow in Figure 4, extends in the direction of its minor axis. This is done because the second metal working operation can be accomplished with more uniform results and less "shrinkage" losses if the partially formed blank **20** is so oriented with respect to the female die that a line corresponding to the original grain of the stock extends crosswise to the large open end of the die rather than lengthwise thereto. A round hole **18** is provided at the center of blank **10**, i. e. at the intersection of its major and minor axes. This hole is intended to fit snugly over a short cylindrical arbor which protrudes from the small end from the hard surfaced frustum used in the spinning operation and which, as shown in the abovementioned copending application, may be threaded to provide a means for clamping the blank onto the frustum. Two other holes, **19**, are provided for engaging off-center pins which may also protrude from the small end of the frustum, which serve for keying the blank thereto so that they will rotate together. A small hole, **22**, or a row thereof, may be provided to indicate the direction of the grain. Since the blank is very nearly round, this will be helpful for an operator and will tend to shorten the time he will require to properly orient a partially formed blank **20** in the stamping mill. In the stamping mill represented in Fig. 5, a female die **21** is mounted on the bottom, free end of an hydraulically actuated piston **24** with its hollow interior directed downward. A male punch **25** is rigidly supported on a base **26** so that it points upward with its axis coinciding with that of the piston **24**.

Before reforming the blank **20** on the stamping mill, it is preferable to anneal it and to provide it with a surface lubricant or "drawing compound." Satisfactory annealing of a partially formed blank of $\frac{1}{10}$ inch stock has been accomplished in 6 minutes at 1650 degrees Fahrenheit. This sufficiently eliminates a tempering effect which is incurred in the spinning operation. Water soluble soap types of lubricant are quite suitable and have the advantage that they are readily removable from the finished product by washing it in water.

After the partially-formed blank, **20**, has been annealed and dipped in lubricant it is placed on the punch **25** as shown in Fig. 5 and then the female die is brought down upon it with a sufficient pressure to reform it in a single draw.

It has been found that a 500 ton impact or mechanical type of stamping mill is adequate for reforming a partially-formed blank, **20**, which has a maximum wall thickness of .1 inch at the flange and consists of 17 percent chromium bearing iron alloy, into a rectangular cone whose sealing flange has a 17 inch diagonal. However, if an hydraulic stamping mill is used, it should be heavier. Moreover, whatever the type of mill, faster and more satisfactory results will be obtained if its capacity substantially exceeds the permissible minimum. If desired the male punch **25** may include as a protrusion from the center of its top surface, a short cylindrical cutter **27** which in cooperation with a sharp-edged cylindrical socket **28** correspondingly located in the female die may serve for piercing the neck opening **23**. This opening, which corresponds to the area enclosed in a dotted circle in Fig. 4, is about 5½ inches in diameter in the 17 inch diagonal cone mentioned above. However, the preferable way of practicing the present invention is to pierce the center hole in a separate operation following the reforming one. The reason for this is that if the piercing of this hole is accomplished as part of

the reforming operation in mass production, a certain inefficiency will result from the necessity of periodically taking these important machine tools out of operation in order to resharpen the cutter **27** and the socket **28**. Moreover, the partially-formed blank will be somewhat less free to shift about so as to accommodate itself to the progressively lessening space between the punch and die during reforming if any part thereof becomes captive too early in the operation as may be the case where the piercing operation is combined with reforming.

In order most successfully to form a rectangular cone without cracks and/or pleats and with smooth contours as shown in Figures 1–3, the following are some of the precautions which should be taken: the included angle of the spun frustum **16** should bear the proper relationship to certain reference included-angles for the desired rectangular cone; the depth of the frustum **16** should bear the appropriate ratio to the depth of the desired finished cone; and the die and punch should be shaped to impart to the top, bottom, and side panels of the rectangular cone a degree of convexity whereby they will constitute outwardly curved panels.

The last of these precautions offers several advantages: it helps to take up slack, "gathering," which tends to develop in the reforming operation; it results in a geometrical shape which affords great side wall strength to withstand atmospheric pressure and to minimize flange distortions and seal ruptures as a result thereof; and it provides a bulb shape, for the finished envelope, which does not complicate the operation of applying a fluorescent screen to the face plate by a corner-settling problem.

If these precautions are taken a smooth mantle will result. However, it is difficult to produce the rather complex configuration of the face-plate sealing flange in a single drawing operation without incurring the formation of small irregularities on its inside sealing surface, i. e., such as small wrinkles and folds. For this reason it is advantageous to perform a "coining" operation for reforming the large sealing flange. The punch and die employed for coining may be very much like those shown in Figure 5 with appropriate portions of their surfaces cut back to clear the cone in the region of its mantle and small sealing flange. As a result the full pressure of the stamping mill will be brought to bear on the large sealing flange to provide the very high pressure per unit area needed for "coining." After coining the drawing compound may be washed off with water.

While it may seem desirable to anneal the cone after the reforming operation in order to "relax" strains built up in that operation, this has the disadvantage that it may affect the shape of the cone. However, where such a second annealing is used, if it is followed by the coining operation, the flange will be at least partly restored to the desired shape.

By using a blank **17** having the shape shown in Fig. 4 and by properly orienting it in the stamping mill, there will be very little "fringe" protruding from the "lip," or rim, **29** of the face-plate sealing flange after the cone has been processed to the point thus far described. However, the small amount of fringe which does protrude should be removed. Since the amount which needs to be trimmed is small, it is possible to remove it by burring and/or finish-grinding. However, it has been found to be preferable to saw it from the lip on a high speed metal band saw. In doing this, it is advantageous to mount the rectangular cone in a fixture permitting the entire cone to be rotated about an axis corresponding to that of the neck **13** whereby to progressively feed the lip into the saw blade at the point where it passes through the band-saw table. This axis of the fixture should be angularly movable in a vertical plane about a pivot which is spaced back from the intersection of the saw blade and the table by a distance substantially equal to the radius of curvature of the face-plate **15**, i. e., 30 inches for a 17 inch diagonal tube, to permit the rim to rest on the table for all rotational positions of the cone. The result of trimming with such a fixture will be that the lip **29** will have the smoothly undulant edge shown in Figs. 2 and 3. This operation should be followed by a step for removing the burr left by the bandsaw, a suitable cutting means for doing this being a conventional canvas hard wheel charged with abrasive.

Fig. 6 shows an alternative apparatus for the operation of reforming the partially formed blank **20**. It comprises a die **30** which has the same interior configuration as the die **21** but which, as shown, is employed with its large opening facing upward. A plug **31** is used for closing the holes **18**, **19**, and **22**. The plug comprises a somewhat mushroom-shaped bolt **32**, a rubber gasket **33**, a heavy washer **34**, and a nut **35**. The head of the bolt **32** may be shaped as shown to guide the direction of expansion of frustum **16** into the die. The apparatus of Fig. 6 also comprises a heavy cover **36** carrying a rubber sealing ring **37** fitted into an ovately circular groove **38** in its lower surface. To reform the blank **20** the plug **31** is attached to it; it is placed in the die **30** as shown; and the cover **36** is forced heavily down against it whereby the space inside of the frustum **16** is entirely sealed. Then liquid, such as thick oil, is forced under extremely high pressure from a pump **39**, thru a passageway **40**, and into the frustum **16** to force it to expand outwardly until it fills the die **30**.

As is most clearly shown in Figs. 2 and 3 one result of producing a rectangular cone according to the present invention is that a portion, **41**, of the mantle **11** adjacent the face-plate sealing flange **14** is formed without thinning, i. e., it is as thick as the original flat blank **17**. According to the teachings of the above-mentioned copending application this structural feature lends such support to the sealing flange that in making the cone it is possible to start out with thinner material than would otherwise be possible and therefore wastage of metal in the mantle can be avoided.

Since every point of the perimeter of the sealing surface of the flange **14** is equidistant from a point corresponding to the center of curvature of the face plate **15**, this plate may be preformed with the configuration of a true spherical section. If this is done, its shape will be only slightly affected when it settles down into the flange **14** during sealing-in and the resulting glass-and-metal structure will have great strength to withstand external air pressure.

The spinning step of the method set forth above may be modified by employing a mandrel, the hardening working surface of which has approximately, rather than exactly, the shape of a frustum. That is to say, while the working surface must be a figure of revolution, the slope of the sides does not have to be along a straight line but instead may be along a line which curves either inward or outward with respect to the axis of rotation. Moreover, the slope of the sides may be straight for part of the way and then curved. For example, the sides may slope downward along a straight line in the fashion of a true frustum and then curve outward so that it merges gradually into the rim portion of the hat-like partially formed blank.

While the face-plate sealing flange presents an undulant profile as the cone is viewed laterally, it is within the scope of the present invention to form the flange with a flat edge. A cone with such a flange if laid on a flat surface with its large opening facing downward would rest uniformly on the surface all the way around the flange. Obviously, if the cone is to be made this way, the die used for reforming a partially formed blank would have to be modified accordingly and this would also be true for a die and punch used for coining. While a flat face-plate can be used with such a cone if it is made thick enough to have the requisite strength, it is pref-

erable to provide the needed strength by forming the plate to be outwardly curved. Such a plate can be made by supporting a flat glass blank on a flat rectangular frame by its edges only and heating it until the center of the blank sags down within the frame. Of course, such a plate is turned over before it is placed in the cone sealing flange preparatory to sealing in.

Another possibility is to form the cone with outwardly undulant profiles for the two short sides of its face-plate sealing-flange and straight profiles for the two long sides thereof. In this case the face-plate has the shape of a rectangular section cut out of a cylinder of glass rather than out of a sphere. This form has the advantage that almost all of any ambient room light which may fall on the outside surface of the television picture tube face-plate will be reflected either upward or downward and hence out of the field of vision.

What is claimed is:

1. A television tube body of substantially frusto-pyramidal form; a substantially circular opening at the smaller end; a substantially rectangular opening at the larger end; a substantially rectangular seating ledge for receiving a spherically curved viewing screen at said rectangular opening; the four sides of the inner boundary of said seating ledge lying on the intersection of a sphere with said frusto-pyramidal body, the center of the sphere and the generating point of a conical surface which includes the smaller circular opening and which intersects at least two opposite boundaries of the rectangular opening both lying along the axis of the tube body with the generating point of said conical surface lying between the center of the sphere and the smaller end of the tube body.

2. A television tube body of substantially frusto-pyramidal form; a substantially circular opening at the smaller end; a substantially rectangular opening at the larger end; a substantially rectangular seating ledge for receiving a spherically curved viewing screen at said rectangular opening; the four sides of the inner boundary of said seating ledge lying on the intersection of a sphere with said frusto-pyramidal body, the center of said sphere and the generating point of a conical surface which includes the smaller circular opening and which intersects at least two opposite boundaries of the rectangular opening both lying along the axis of the tube body with the generating point of said conical surface lying between the center of the sphere and the smaller end of the tube body; retaining lip extending beyond said seating ledge.

3. A television tube body of substantially frusto-pyramidal form; a substantially circular opening at the smaller end; a substantially rectangular opening at the larger end; a substantially rectangular seating ledge for receiving a spherically curved viewing screen at said rectangular opening; the four sides of the inner boundary of said seating ledge lying on the intersection of a sphere with said frusto-pyramidal body, the center of said sphere and the generating point of a conical surface which includes the smaller circular opening and which intersects at least two opposite boundaries of the rectangular opening both lying along the axis of the tube body with the generating point of said conical surface lying between the center of the sphere and the smaller end of the tube body; a retaining lip extending beyond said seating ledge, and a reinforcing band between said seating ledge and the body of the tube.

4. A metallic television tube body of substantially frusto-pyramidal form; a substantially circular opening at the smaller end; a substantially rectangular opening at the larger end; a substantially rectangular seating ledge for receiving a spherically curved viewing screen at said rectangular opening; the four sides of the inner boundary of said seating ledge lying on the intersection of a sphere with said frusto-pyramidal body, the center of said sphere and the generating point of a conical surface which includes the smaller circular opening and which intersects at least two opposite boundaries of the rectangular opening both lying along the axis of the tube body with the generating point of said conical surface lying between the center of the sphere and the smaller end of the tube body; a retaining lip extending beyond said seating ledge, and a reinforcing band between said seating ledge and the body of the tube; said seating ledge, retaining lip and reinforcing band being substantially of equal regular thickness and being substantially thicker than the main wall of the tube body.

5. A television tube body of substantially frusto-pyramidal form; a substantially circular opening at the smaller end; a substantially rectangular opening at the larger end; a substantially rectangular seating ledge for receiving a spherically curved viewing screen at said rectangular opening; the four sides of the inner boundary of said seating ledge lying on the intersection of a sphere with said frusto-pyramidal body, the center of said sphere and the generating point of a conical surface which includes the smaller circular opening and which intersects at least two opposite boundaries of the rectangular opening both lying along the axis of the tube body with the generating point of said conical surface lying between the center of the sphere and the smaller end of the tube body; a retaining lip extending beyond said seating ledge, and a reinforcing band between said seating ledge and the body of the tube; said seating ledge, retaining lip and reinforcing band being substantially of equal regular thickness and being substantially thicker than the main wall of the tube body, and a supporting ledge at the boundary of said circular opening; said last-mentioned supporting ledge having a thickness substantially equal to that of the seating ledge at the first-mentioned portion of the tube body.

6. A television tube body of substantially frusto-pyramidal form; a substantially circular opening at the smaller end; a substantially rectangular opening at the larger end; a substantially rectangular seating ledge for receiving a spherically curved viewing screen at said rectangular opening; the four sides of the inner boundary of said seating ledge lying on the intersection of a sphere with said frusto-pyramidal body, the center of the sphere lying along the axis of the tube body, said tube axis being substantially normal to the plane of said circular opening at the center thereof.

7. A metal shell for a discharge tube, said shell comprising a plurality of walls joined to form a hollow substantially frusto-pyramidal body, said body having a large opening at one end thereof, said shell including a sealing surface at said opening, said sealing surface being determined by the intersection of said walls with a spherical surface.

8. A metal shell comprising a plurality of walls joined to form a hollow substantially frusto-pyramidal body, said body having a large opening at one end thereof, said shell including a sealing surface at said opening, said sealing surface being determined substantially by the intersection of said walls with a spherical surface, and a spherical glass plate sealed to said sealing surface.

9. A metal shell for a discharge tube, said shell comprising a plurality of walls joined to form a hollow substantially frusto-pyramidal body, said body having a large opening at one end thereof, said shell including a sealing surface at said opening, said sealing surface being determined substantially by the intersection of said walls with a spherical surface, and a spherical glass plate sealed around its periphery to said sealing surface, said glass plate conforming substantially with said spherical surface.

10. A shell for a cathode ray tube, said shell comprising a plurality of metal walls joined together to form a substantially frusto-pyramidal body, said body having a large opening at one end and a small opening at the opposite end thereof, said openings each having a center positioned on a common axis, said body having at said large opening a sealing surface determined by the inter-

section of said metal walls with a spherical surface whose center of curvature is on said axis.

11. An envelope for a cathode ray tube, said envelope comprising a plurality of metal walls joined together to form a substantially frusto-pyramidal body, said body having a large opening at one end and a small opening at the opposite end thereof, said openings each having a center positioned on a common axis, said body having at said large opening a sealing surface determined by the intersection of said metal walls with a spherical surface whose center of curvature is on the portion of said common axis extending through the other of said openings, and a spherical glass plate sealed at its periphery to said sealing surface.

12. An envelope for a cathode ray tube, said envelope comprising a plurality of metal walls joined together to form a substantially frusto-pyramidal body, said body having an opening at each end thereof, said openings each having a center positioned on a common axis, said body having at one of said openings a sealing surface

determined substantially by the intersection of said metal walls with a spherical surface whose center of curvature is on the portion of said common axis extending through the other of said openings, a spherical glass plate substantially conforming to said spherical surface sealed around its periphery to said sealing surface, and a tubular glass element sealed to said body at the other of said openings.

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