Feb. 18, 1941. G. A. DEICHMAN 2,232,098

CATHODE RAY TUBE

Filed Feb. 11, 1938 3 Sheets-Sheet 1

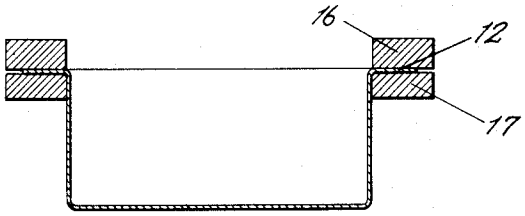



Fig. 1.

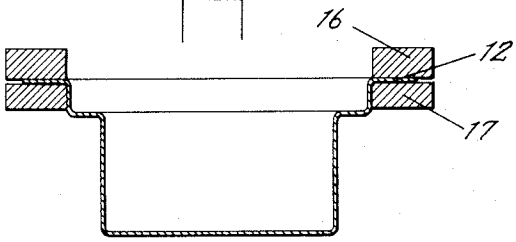



Fig. 2.

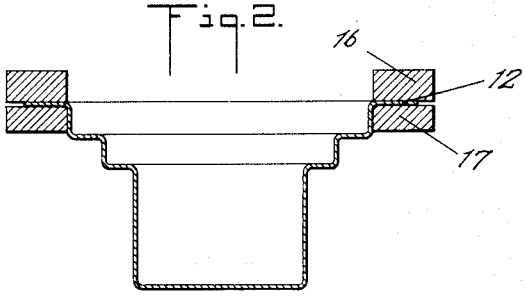



Fig. 3.

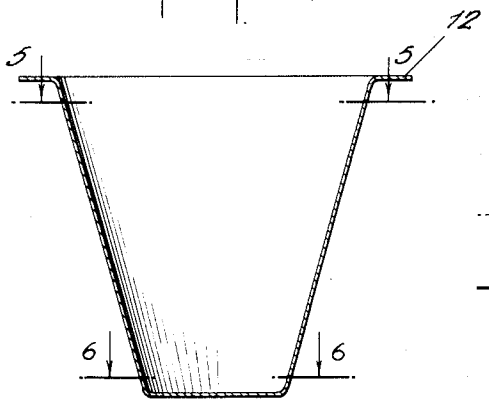



Fig. 4.

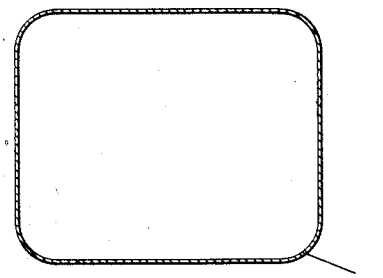



Fig. 5.

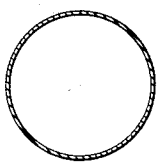


Fig. 6.

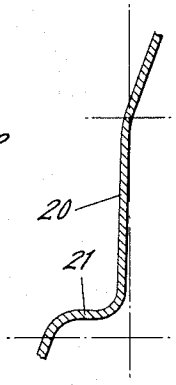



Fig. 9.

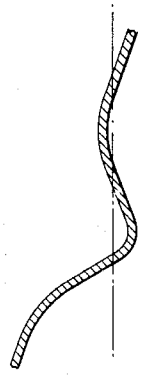


Fig. 10.

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CATHODE RAY TUBE

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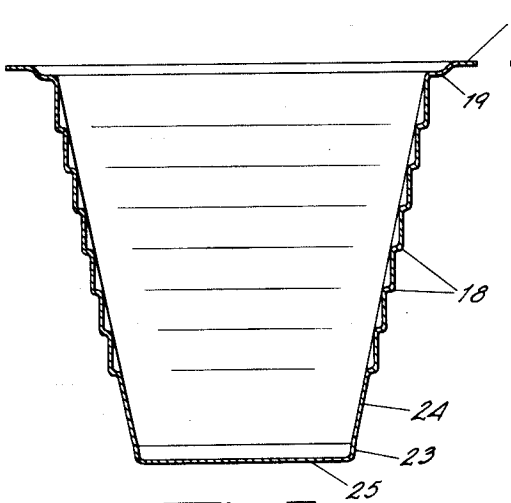



Fig. 7.

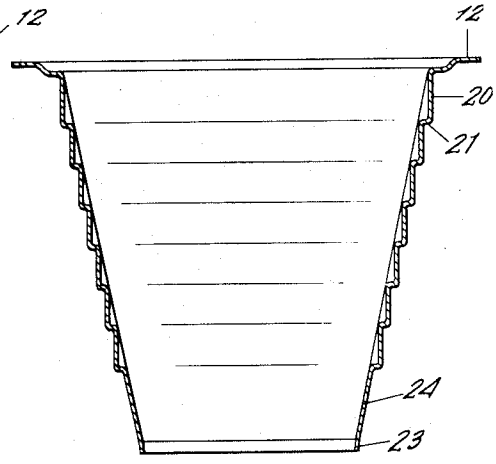



Fig. 8.

Fig. 13.

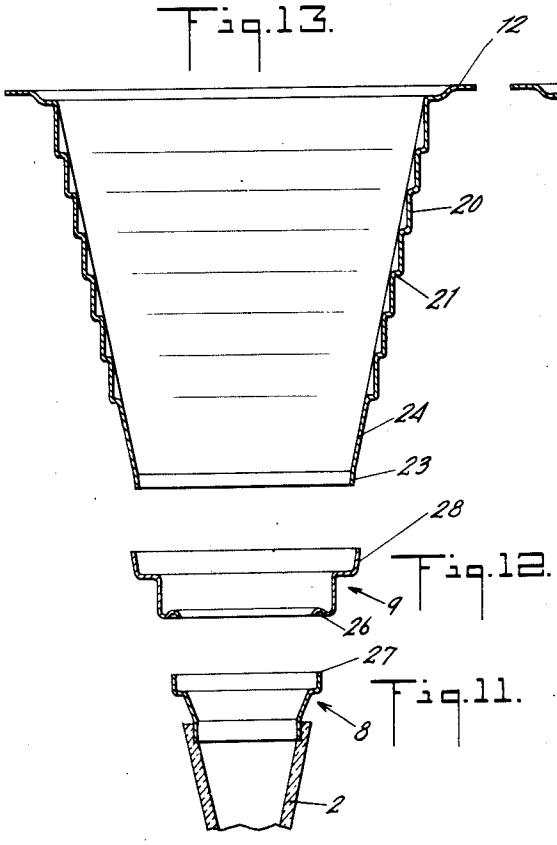
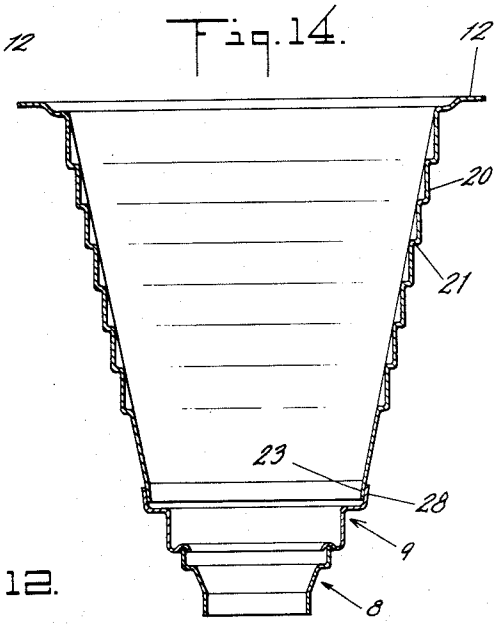



Fig. 12.

Fig. 11.

Fig. 14.




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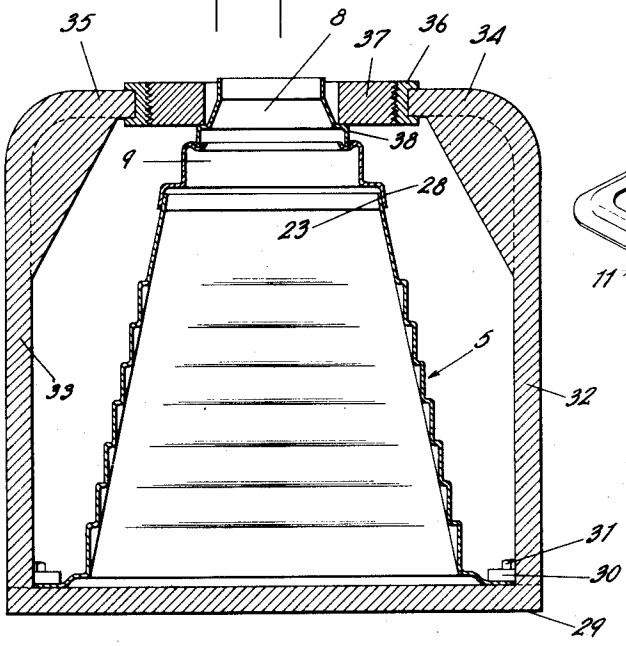
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CATHODE RAY TUBE

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Fig. 15.



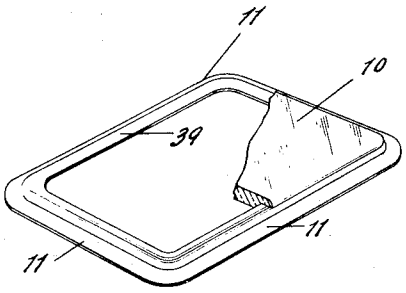




Fig. 16.




Fig. 18.

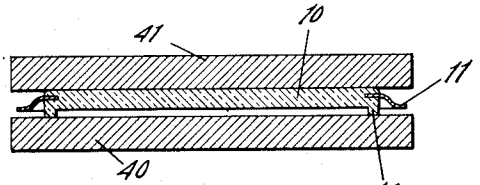



Fig. 12.

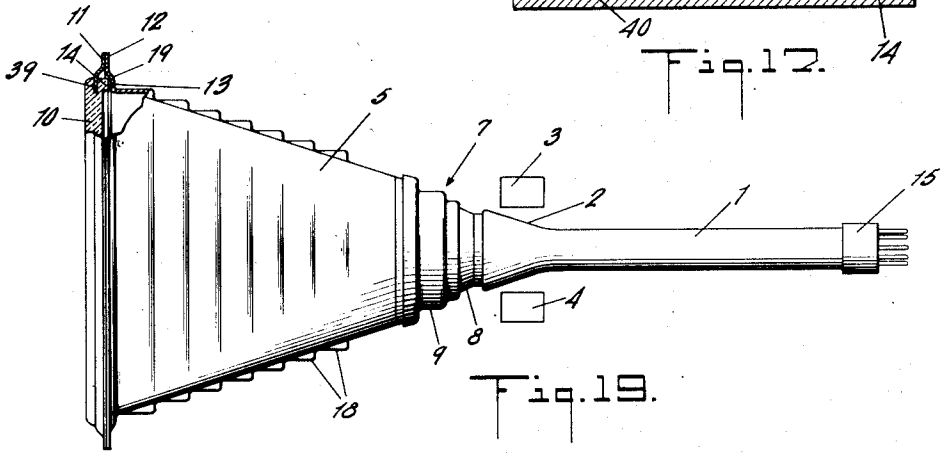



Fig. 19.

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Patented Feb. 18, 1941 2,232,098

# UNITED STATES PATENT OFFICE

2,232,098

## CATHODE RAY TUBE

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Application February 11, 1938, Serial No. 190,016

11 Claims. (Cl. 250—141)

This invention relates to cathode ray tubes and more especially to cathode ray tubes of the composite glass-metal envelope type.

An object of the invention is to provide an improved manner of fabricating and assembling the metal funnel-shaped portion of a metal-glass cathode ray tube.

Another object is to provide a method of making a cathode ray tube envelope in sections whereby the utmost accuracy and positiveness of fit between the sections can be achieved.

Another object is to provide an improved manner of strengthening the funnel-shaped metal wall section of a cathode ray tube and the like.

A further object is to provide a method of fabricating the metal envelope of a large metal cathode ray tube whereby it is free from undesirable strains or localized weaknesses ordinarily caused by the forming and shaping operations. As a result the finished tube can be highly evacuated and is capable of withstanding the outside atmospheric pressure during and after exhaust, while utilizing a minimum thickness of metal stock.

A feature of the invention relates to a cathode ray tube envelope having a metal funnel-shaped portion substantially rectangular in cross section and provided with reenforcing ribs of novel formation.

Another feature relates to an improved method of forming a metal-framed window for a cathode ray tube whereby the existence of local stresses in the glass of the window are substantially eliminated.

Another feature relates to an improved form of resilient gasket for evacuated tubes and the like.

Another feature relates to an improved formation of metal sealing ring for hermetically joining a flared glass neck to the constricted end of the metal funnel-shaped portion of a cathode ray tube or the like.

Another feature relates to a method of forming the seamless metal funnel-shaped portion of a cathode ray tube by a drawing process whereby the enlarged end can be formed with a uniformly flat supporting rim for a relatively massive metal-framed glass window.

A further feature is to provide an improved construction of cathode ray tube of the type having a relatively massive glass window separate from the metal body portion of the envelope, wherein the dimensions and surface contours are formed with a high degree of accuracy and as a result of which the tube is capable of withstanding outside atmospheric pressures without danger of subjecting the sealed joints to unequal strains.

A still further feature relates to the novel organization, arrangement and relative location of parts which constitute an improved cathode ray tube of the composite metal-glass envelope type.

The invention pertains to a tube of the type disclosed in Patent No. 2,178,826, and while the present disclosure refers to a cathode ray tube, it is understood that by this is meant any tube of the composite metal-glass type wherein a glass window or closure member is formed as a separate element from the main body of the tube; and includes such devices as television tubes for reception or transmission, for example Iconoscopes, dissector tubes, as well as oscillographs or the like. In certain of its aspects the invention is not limited to cathode ray tubes and is capable of application to other devices having a composite glass-metal evacuated envelope. Accordingly, other features and advantages not specifically enumerated will be apparent after consideration of the following detailed descriptions and the appended claims. In the drawings:

Figs. 1, 2 and 3 are diagrams explanatory of three successive steps in the formation of the funnel-shaped part of the cathode ray tube envelope according to the invention.

Fig. 4 shows part of the envelope after the final drawing operation.

Fig. 5 is a cross sectional view of Fig. 4 taken along the line 5—5 thereof.

Fig. 6 is a cross sectional view of Fig. 4 taken along the line 6—6 thereof.

Fig. 7 is a sectional view of the member of Fig. 4 after the rib striking and shoulder forming operations.

Fig. 8 is a view of Fig. 7 after the trimming and cutting operations.

Fig. 9 is a magnified view of one of the reenforcing ribs of Figs. 7 and 8.

Fig. 10 is a magnified view of another form of reenforcing rib requiring a collapsible die for formation.

Fig. 11 is a sectional view of one part of the specially shaped sealing ring according to the invention.

Fig. 12 is a sectional view of the other part of the special sealing ring.

Fig. 13 is a view of the finished funnel-shaped portion of the envelope and forming with Figs.

11 and 12 an exploded view of the method of assembly.

Fig. 14 is an assembled view of the parts shown in Figs. 11, 12 and 13.

Fig. 15 is a cross sectional view of a special jig for centering and supporting the parts during certain of the welding operations.

Fig. 16 is a perspective view partly in section of the finished metal framed window according to the invention.

Fig. 17 is a diagrammatic view to explain the manner of forming the flattened rim on the glass window.

Fig. 18 is a view of part of the resilient gasket according to the invention.

Fig. 19 is a view partly in section of a complete cathode ray tube envelope incorporating the various features of the invention.

In general the tube (Fig. 19) according to the invention, comprises an elongated glass neck 1 terminating in a flare 2, wherein or adjacent to which are located the usual beam deflecting means. It will be understood that the deflecting means may be either pairs of coordinate electrostatic deflecting plates mounted within the glass flare 2, or a combination of deflecting plates within the flare 2 and a pair of electromagnetic poles 3, 4 for producing a deflecting field coordinate to that produced by the electrostatic plates. The main body portion of the tube envelope consists preferably of a single-piece seamless funnel-shaped section 5 of sheet steel or other suitable strong metal. Preferably, although not necessarily, section 5 is formed, for the greater part of its length, of rectangular cross section with the corners rounded as shown in Fig. 5, while the reduced end portion of section 5 gradually tapers down to a circular cross section as shown in Fig. 6. In order that the section 5 may be sealed to the glass flare 2 in a vacuum-tight manner, there is interposed a special bi-part sealing ring 7, the part 8 of which has substantially the same coefficient of expansion as the glass 2. For example if the flare 2 is of a glass such as Corning 705 AJ glass, part 8 may be of "Kovar" an alloy consisting of approximately 18% cobalt, 28% nickel and 54% iron, and the part 9 may be of steel or other suitable metal. Preferably, although not necessarily, the flare 2 is preformed to the desired accuracy and is sealed coaxially to the part 8 in the manner described in detail in Patent No. 2,194,418. Part 9 at its enlarged end is welded preferably by seam welding, to the reduced end of section 5. The enlarged end of section 5 is closed off in a vacuum-tight manner by a relatively massive glass window 10 through the intermediary of a metal flange 11 carried by the window, and a cooperating flange 12 on section 5, the flanges 10 and 12 being seam welded to provide a vacuum-tight seal. Preferably a special resilient gasket 13 is provided between the flattened rim 14 on the window and the shoulder 19. It will be understood of course that any well-known form of electron gun or ray-developing means and associated intensity control and focussing electrodes are mounted within the neck 1, and that a suitable pronged contact base 15 is fastened to the end of the tube with the prongs connected to the various electrodes. A typical form of electron gun and electrode assembly that may be used is disclosed in Patent No. 2,211,613.

It will also be understood that a coating of suitable material which fluoresces under impact of the rays, is applied to the inner face of window 10 in any manner well known in the art.

While the invention is not necessarily limited to tubes of any special dimensions it finds its primary utility in tubes of relatively large window area. For example, window 10 may be of the order of 10 inches by 12 inches diagonally, and since the tube is highly evacuated, it is apparent that great precautions must be taken to ensure not only against the collapse of the tube walls under atmospheric pressure, but also to ensure that even though the tube does not collapse, the strains are uniformly distributed throughout the various joints and seals between the metal-to-metal parts, as well as between the metal-to-glass parts. I have found that seemingly minor changes in the shaping and formation of the various parts may mean the difference between tubes which are capable of fabrication and assembly in large quantities with uniform reliability, as against tubes which are unreliable as regards mechanical strength and maintenance of the vacuum.

I have also found that it is highly important to provide a proper mating fit between the sections 5 and 9 if a true coaxial seal is to be made. It is extremely difficult to produce relatively large tubular sheet metal boxes such as section 5 with the desired degree of uniformity as regards inside and outside diameter, to meet the stringent requirements of cathode ray tube technique. If the sections 5 and 9 are made with substantially straight or parallel overlapping fits, it requires exceedingly difficult control of dimensions in order to ensure a vacuum-tight weld, particularly where seam-welding is employed. I have found that by giving the overlapping or mating parts of the sections 5 and 9, a complementary taper which is different from the main taper of section 5, it is possible to compensate for slight differences in inside and outside diameters; to avoid likelihood of the sections not fitting together properly; and to achieve more uniform seam-welding.

Preferably the taper at the overlapping portions of members 5 and 9 to be welded, is slightly less than the taper of the main section 5, so that the inner welding mandrel need contact only with the area to be welded, thus prolonging the life of the mandrel and decreasing its initial cost since it need not be made in segments. Furthermore, the welding operation is simplified since it is not necessary to employ complicated clamping tools to hold the sections in the proper relative positions to each other during the seam welding. I have also found that in order to produce a tube which can be duplicated in large scale production with uniform electrical and mechanical characteristics it is necessary to have the various metal parts as well as the glass flare 2 perfectly coaxial during the seam welding operation. This is accomplished by utilizing a preliminary "basting" welding while the parts are held perfectly coaxial in a specially designed jig.

Preferably the main section 5 is formed as a single piece seamless metal member by a special deep drawing process. For this purpose a sheet steel blank is subjected in successive steps to a plurality of deep drawing operations. I have found that in order to produce a finished section which is substantially entirely free from undesirable recrystallization and oxidizing, it is necessary to effect the drawing operation in separate stages and to subject the section to an annealing and pickling operation before each drawing stage. It is also important that the section 5 be formed with a perfectly flat flange 12 and a perfectly

flat shoulder 14. For this purpose the original sheet steel blank is rigidly clamped around its periphery between flat clamping members 16, 17 (Fig. 1) during each deep drawing stage. Preferably, although not limited thereto, the section 5 is formed in six successive deep drawing steps, the results of the first, second, third and final steps being shown in Figs. 1, 2, 3 and 4 respectively. The deep drawing dies for the successive steps are so designed that the greater part of the length of the finished section is substantially rectangular in cross section with rounded corners as shown in Fig. 5, and at the reduced end it merges into a circular cross section as shown in Fig. 6. In order to avoid recrystallization and incipient oxidation at the surface of the section 5 during its formation, the blank is annealed and pickled in any well-known manner before each deep drawing operation.

The deep drawn member of Fig. 4 is then subjected to a shoulder forming and rib striking operation whereby the section is formed on its flat sides with a series of parallel ribs 18 (Figs. 7 and 19) and the flange 12 is formed with a flat shoulder 19. Preferably the ribs 18 are of the cross sectional shape shown in Fig. 9 from which it will be seen that the face 20 of each rib is almost parallel to the longitudinal axis of the section 5 while the face 21 is substantially at right angles to the longitudinal axis of the section. Because of the extremely small angle the faces 20 make with the longitudinal axis of the section and since they face in the same direction as the overall opening angle of the walls of the section, it is possible to strike out these ribs by employing a non-collapsible die. If the faces of each rib make an angle to each other much less than a right angle as shown for example in Fig. 10, then it becomes necessary to form the ribs by employing a relatively expensive and complicated collapsible die with its attendant likelihood of non-uniformity of the finished ribs. Furthermore, since in the preferred form of rib shown in Fig. 9, the faces 20 are substantially perpendicular to the flange 12, and since the tendency is for the section to collapse along a line drawn between and parallel to the corners 22, the ribs prevent this initial buckling, and subsequent collapse and folding of the section along the said corner portions. While it is preferred to form the ribs in parallel linear shape, it will be obvious that these ribs may be arcuate or any other shape so long as they do not extend around the entire periphery of the metal section. It should be noted of course that the ribs are confined to the flat side portions of the section 5 and do not appear in the rounded end portions of the section.

During the foregoing described rib forming operation the lower circular rim 23 is formed with a slightly smaller taper than the portion 24. In the next two trimming operations, the bottom 25 is cut out and the tapered flange 23 is trimmed straight to remove any excess material. The finished truncated funnel-shaped section is then of the shape shown in cross section in Fig. 8.

The sealing ring 7 as above pointed out is made in two parts 8 and 9, shown respectively in Figs. 11 and 12. The part 8 is sealed to the preformed glass flare 2 of the glass neck, preferably although not necessarily, as described in said Patent No. 2,194,418, and in order that a vacuum-tight seal may be effected the flare 2 may be of Corning 705 AJ glass, and the part 8 may be of "Kovar." The part 9 which may be of steel is preferably provided with an annular grooved rim 26 which is adapted to receive the rim 27 of part 8. The parts 8 and 9 are copper brazed and the copper which lies in the groove 26 serves as a vacuum-tight seal between the parts. Part 9 is provided with an enlarged rim 28 having a slight taper corresponding to and mating with the taper 23 so that these parts overlap each other snugly as shown in Fig. 14.

Before the rim 28 of the sealing ring is seam welded to the rim 23, it must be preliminarily "basted" thereto in a perfectly coaxial manner. This basting may be in the form of four equidistant spot welds around the overlapped rims 27, 28. If this preliminary fastening of the parts by spot welding is omitted the subsequent seam welding may result in the fastening of the sealing ring to the section 5 in a non-coaxial manner, because of the heat and strains attending the seam welding operation which tend to distort the overlapped rims 27, 28. This is particularly important when the flare 2 is preformed by a precision process as described in said Patent No. 2,194,418. I have found that this preliminary basting enables the tube as a whole to be built with the greatest precision, thus adapting it to economical quantity production.

In order to spot weld the sealing ring and section 5 in a perfectly coaxial manner, a special jig such as shown in Fig. 15 is employed. This jig comprises a flat metal base 29 preferably having a smooth machined upper surface against which the flat flange 12 of section 5 rests and against which it may be rigidly clamped by a set of clamping strips 30 and bolts 31. The base 29 is formed with a pair of vertical standards 32, 33, having right-angled top portions 34, 35, which support the internally threaded ring 36 which is thus accurately and rigidly fastened so that it is coaxial with the center of base 29. Removably threaded within ring 36 is an externally threaded ring 37 which is adapted to engage the shouldered portion 38 of the sealing ring. In using the jig, the clamping members 30 are loosened and the section 5 is placed on base 29 as shown, and if desired the base may be provided with gauging lugs to automatically center the section 5 with relation to the center of ring 36, whereupon the members 30 may be tightened to clamp the section 5 against the base. The sealing ring consisting of previously united parts 8 and 9 is then assembled over the rim 23 whereupon the ring 37 is threaded into ring 36 and tightened against the shoulder 38. This tightening automatically centers the sealing ring with respect to section 5. The overlapping tapered rims 23 and 28 may then be spot welded at four equidistant points around the periphery. With the parts 2, 5, 8 and 9 thus fastened together perfectly coaxially, the rims 23 and 28 may then be seam welded around their entire periphery to provide the necessary vacuum-tight seal therebetween.

The next step is the assembly and welding in place of the metal framed window shown in Fig. 16. In order to prevent the setting up of localized strains as pointed out above the flange 11 on the window frame and the flange 12 on section 5 must be perfectly flat so as to present a smooth surface for welding. The uniformity of the strains in the glass window resulting from the outside air pressure during and after exhaustion of the tube, depends also on the flatness of shoulder 19 which receives the thrust of the window which is seated thereon. When it is remem-

bered that the window may be of the order of 10 inches by 12 inches diagonally, in order to prevent the envelope collapsing, it is necessary to employ relatively heavy gauge sheet metal. However by making the section 5 with its shoulder 19 and flange 11 as described above, it is possible to employ relatively lighter gauge metal without danger of distortion of the necessary flat surfaces. As an additional precaution the window should also be provided with a specially flattened rim 14 and a resilient gasket should be inserted between this rim and shoulder 19. I have found that a gasket that is well suited for this purpose consists of a strip or tape formed of woven glass threads such as are employed in so-called woven glass cloth, a section of this gasket being shown in Fig. 18.

The window as shown in Fig. 16 comprises a metal frame having the outer flat rim or flange 11 and a flat inner rim 39 which is sealed into the relatively thick glass 10 in a vacuum-tight manner. For a detailed description of one preferred manner of sealing the frame to the glass, reference may be had to Patent No. 2,178,826. As pointed out in said application, the thrust of the window is against the shoulder 19, and preferably in accordance with the present invention the glass is provided with a marginal ridge or rim 14 which has its bearing face smoothly flattened. Fig. 17 shows a section of the window and the straightening and flattening press for the rim 14. This press consists essentially of two flat plates 40, 41 between which the window is placed. Plate 40 is conveniently placed in an oven whereupon the window with its previously sealed-in frame is placed upon plate 40 and covered by plate 41, a suitable weight, for example 12 to 40 pounds being placed on plate 41. The oven is then heated to the annealing temperature of the glass and annealed through the standard annealing schedule for the particular glass used. At the annealing temperature the glass is soft enough so that the rim 14 takes the flat shape of plate 40. The cooling during the annealing schedule ensures the elimination of residual stresses in the glass. Consequently since the rim 14 is perfectly flat, when the window is welded to flange 12 with the resilient gasket 13 in place, the strains due to atmospheric pressure are uniform around the entire periphery of the window. Inasmuch as it is rather difficult to employ a single length of the woven glass tape 13 without bunching it at the corners, it is preferred to employ four separate lengths which are then inserted only along the straight portions of the window frame. It will be understood that instead of using a gasket in the form of woven glass fibres, well known glass wool may be used for this purpose.

While specific materials and dimensions have been mentioned herein, it will be understood that the invention is not necessarily limited thereto and that various changes and modifications may be made without departing from the spirit and scope of the invention. For example, while certain of the metal parts are sealed together preferably by a seam welding process, it will be understood that they may be sealed by copper brazing or the like.

What I claim is:

1. A cathode ray tube envelope including a funnel-shaped metal body portion having a flat radial flange and a window receiving shoulder at its large end, a glass window having a metal flanged frame sealed around the edge of the window, the flange of said frame being flat and sealed in a vacuum-tight manner to the first mentioned flange, said window having a flat marginal ridge where it rests on said shoulder whereby localized strains on said window are avoided.

2. A cathode ray tube envelope according to claim 1 in which said shoulder is provided with a flat wall to engage said flat ridge on the window.

3. A cathode ray tube according to claim 1 in which a resilient gasket is positioned between the rim of the window and said shoulder to equalize the mechanical stresses in the window.

4. A window for a cathode ray tube or the like comprising a glass body, a metal frame sealed directly into and around the margin of said glass body said frame having a substantially flat supporting flange and a marginal supporting ridge on said window said ridge having a flat smooth face whereby localized strains on the window are avoided.

5. A cathode ray tube envelope including a funnel-shaped metal body section substantially rectangular in shape with rounded corners and having a plurality of spaced ribs on at least one side wall thereof said ribs terminating short of said corners and extending transversely to the length of the tube.

6. A cathode ray tube according to claim 5 in which the corners of the funnel-shaped section are rounded and the said ribs merge into said corners but without extending beyond the said corners.

7. A cathode ray tube envelope according to claim 5 in which the raised faces of the ribs make only a slight angle with relation to the longitudinal axis of the section.

8. A cathode ray tube according to claim 5 in which said ribs are substantially right-angled in cross section.

9. A cathode-ray tube envelope including a funnel-shaped metal body section having a glass window sealed to the larger end thereof, a recessed rim on the said larger end within which said window is fitted to support the window against atmospheric pressure, and a resilient gasket interposed between said window and the bottom of said recess to equalize the strains around the margin of the glass window, said window being sealed to said larger end in a vacuum-tight member independently of said gasket.

10. A cathode-ray tube according to claim 9 in which the said gasket is of a porous vitreous material.

11. An evacuated cathode-ray tube including a funnel-shaped metal body section, the larger end of said section being provided with a shouldered seat, a massive glass window having its margin seated against said shoulder to support the window against atmospheric pressure and a porous resilient gasket interposed between said window and shoulder to equalize the strains in the regions where said window is supported by said shoulder, and cooperating metal flanges surrounding said window and the larger end of said body section, and sealed together in a vacuum-tight manner.

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