CATHODE RAY TUBE ENVELOPE

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Fig. 1

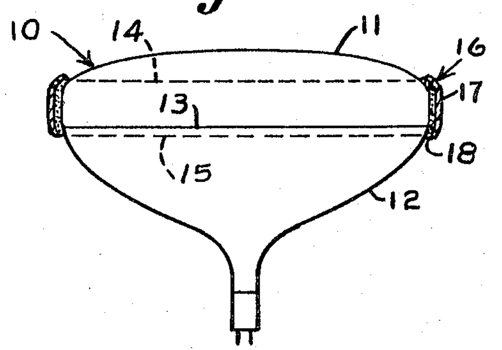

Fig. 2

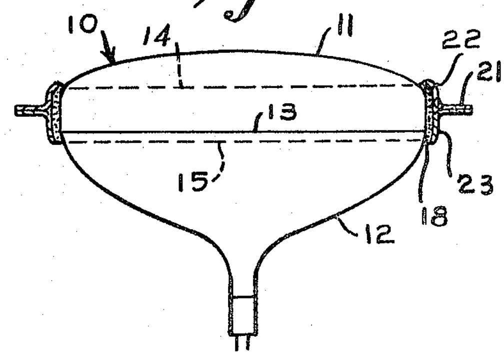

Fig. 3

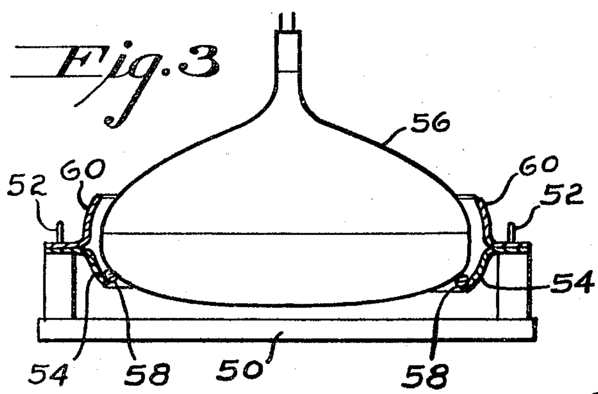

Fig. 4

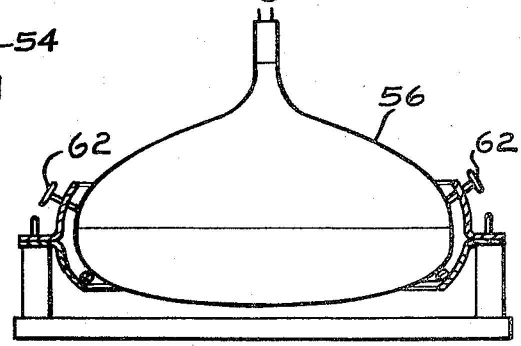

Fig. 5

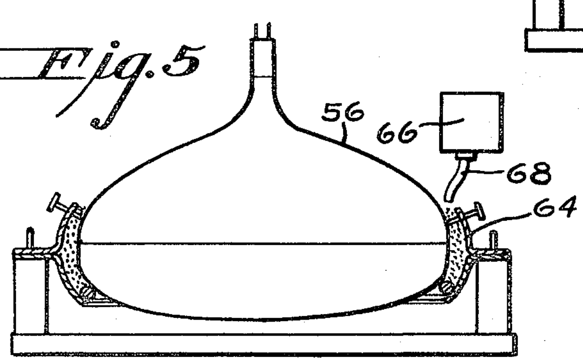

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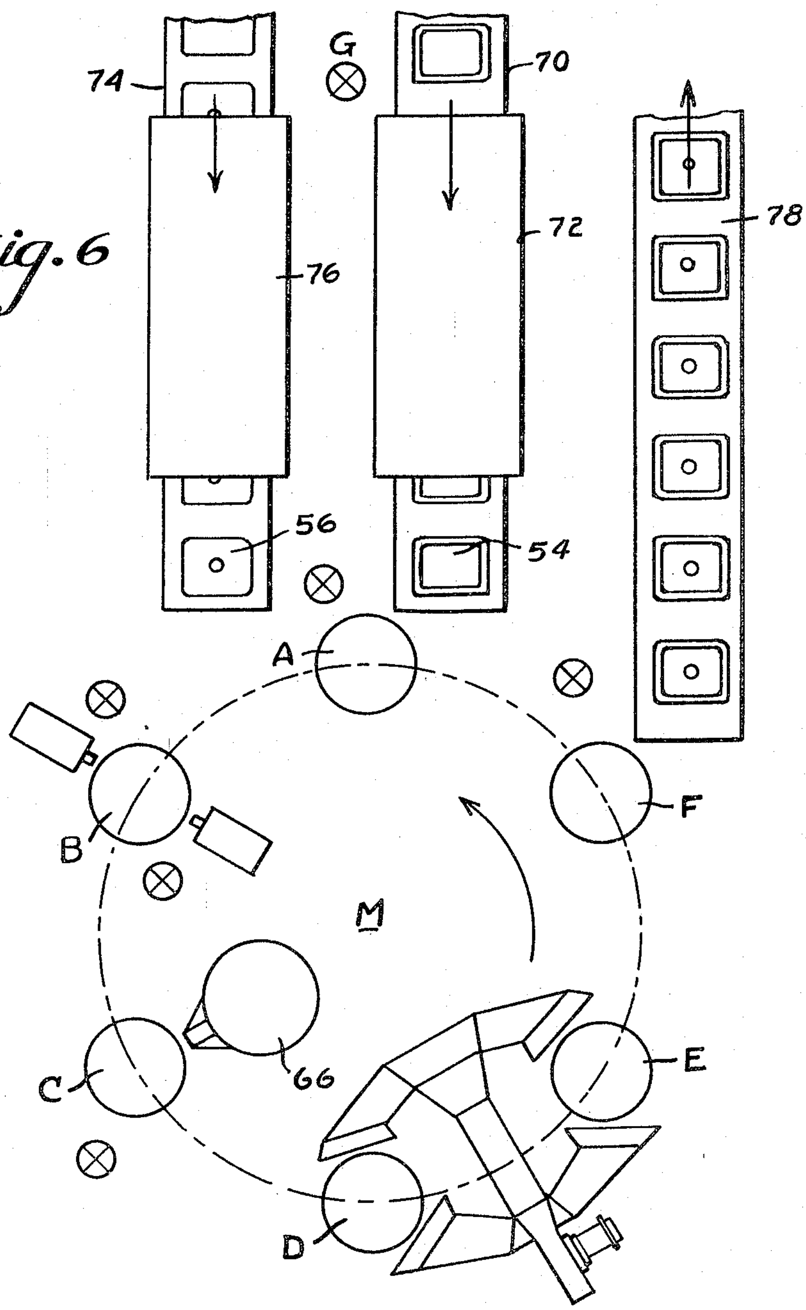
Fig. 6



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CATHODE RAY TUBE ENVELOPE

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3 Claims. (Cl. 220—2.1)

The present invention relates to improvements in electron tubes of the cathode ray type such as the familiar television picture tube. It is particularly concerned with tubes embodying a glass envelope and with a method of protecting such tubes against implosion.

Large size glass envelopes, particularly those used in production of modern television tubes, are customarily molded in separate parts which are then sealed together to form a complete envelope. Thus, a television tube envelope is normally composed of a screen portion, a funnel portion and a neck portion. The screen portion is a relatively flat panel having a depending skirt to which is sealed the funnel portion, a hollow, open-ended glass body of generally conical shape. The complete tubes additionally include a neck portion, various internal components, and an electron gun mounted and sealed in the neck portion of the tube. The envelope parts are customarily sealed together to provide a complete envelope. Thereafter, the required internal components are provided, the tube envelope is baked out under vacuum and is then sealed off to produce a completed tube.

It is known that, in such tubes, fracture or breakage of the glass envelope may occur. Such fractures may be generated by an accidental mechanical or thermal shock at any point on the tube surface. They may also be occasioned by glass fatigue at a point of continuous strain in the glass. Experience has shown that such tube breaks or fractures are of a violent nature accompanied by projection of shattered glass, thus giving rise to the designation "implosion." The flying glass not only damages tube components, but, more important, presents a hazard to viewers.

As a safety measure to protect television viewers from injury, it has been necessary to mount a protecting glass plate in front of the television tube. The presence of this protective glass sheet is a complication in assembly of the television receiver and appreciably increases the depth dimensions. Further, it creates problems in observation of the televised picture, for example due to light reflections as well as the collection of dust on the inside of the plate.

It has been proposed to control implosions by mechanically tightening or thermally shrinking a rigid metal band in direct contact with the external surface of a television tube envelope to produce a compressive stress on the envelope. Successful use of such stress procedures present certain product and technical difficulties. Thermal shrinking normally requires assembly of the bulb and band while both are at a high temperature. It also requires that at least a major portion of the band be of a closely controlled dimension that only slightly exceeds the maximum bulb dimension at the elevated temperature. The primary problem, however, in either thermal or mechanical compression loading, is that of providing perfect conformity of band and envelope to avoid point loading on the latter.

It is a primary object of the invention to avoid these prior problems arising from use of either a protective shield in front of a television tube or a rigid metal band in direct contact with the tube envelope surface. A further object is to provide an improved method of protecting such a tube against implosion, and thereby to provide an improved tube. Our invention, which accomplishes these and other objects, is based on the dual discoveries that (1) glass envelope fractures occur largely in the sidewall zone in the vicinity of the funnel-panel seal, and (2) a tube can be adequately protected against occurrence of implosion by applying a rigid band, especially a composite band, to the glass surface in this area without developing compressive stress.

Our invention resides in an improved cathode ray tube comprising a glass envelope composed of a viewing screen portion and a funnel portion of generally conical shape, wherein the improvement consists in a rigid band encircling the envelope. In particular, this band may comprise a shell of rigid material spaced from the envelope wall and an intermediate layer of a settable material provide between the spaced shell and the glass surface, the composite band extending from a plane passing through the viewing screen periphery to a plane adjacent the larger end of the funnel. It further resides in a method of protecting such a tube against implosion, by applying and setting or molding such a rigid band over the defined zone of the tube envelope.

Various features and advantages of the invention are hereafter described in greater detail with reference to the accompanying drawings wherein:

FIGS. 1 and 2 are side views in axial section schematically showing a television tube in accordance with the invention,

FIGS. 3, 4 and 5 illustrate, in schematic section, steps in a method of producing a banded tube such as that of FIG. 2, and

FIG. 6 illustrates schematically the method and apparatus employed in a continuous commercial practice of the method illustrated in FIGS. 3–5.

FIGS. 1 and 2 show a conventional television tube having a glass envelope, generally designated by the numeral **10**. Envelope **10** includes a screen portion **11** and a funnel portion **12** of generally conical shape, screen portion **11** and funnel portion **12** being sealed together along a line **13**. The zone wherein such a glass envelope is particularly vulnerable to fracture, and which is banded in accordance with the present invention, is shown as extending between dotted lines **14** and **15**. Respectively, these lines correspond essentially to the circumference or periphery of the viewing zone or area of screen **11**, and to a line defining a plane adjacent to but spaced slightly into the funnel from seal line **13**. It will be appreciated that the exact location of the latter line, and its corresponding plane, will vary somewhat with the particular geometry of the cathode ray tube envelope.

In accordance with prior practice, a rigid metal band has been mounted directly on the envelope surface in such manner that the banded zone of the envelope and adjacent areas are placed under compression. With such direct banding, there is a possibility of non-conformity of the rigid band to the glass wall and consequent point loading as compression is developed either mechanically or thermally.

We have found that the primary purpose of the invention, that is elimination of implosions, may be accomplished with a band of material that is not compressively tightened on the tube wall. Thus, as shown in FIGS. 1 and 2, composite band **16** may be formed from a spaced shell and a settable material applied directly to the desired zone of the tube envelope.

In tubes produced in accordance with our invention, an accidental mechanical or thermal shock at any point on the tube surface, or a continuous strain, or, in general, any phenomenon that may provoke an implosion in an unprotected tube, does not lead to an implosion, that is a violent rupture with projection of glass splinters. On the contrary, progression of a crack in the glass, resulting from accidental shock or continuous strain, is slowed up by the band in a manner that assures, without implosion, the establishment of equilibrium pressure between the exterior and interior of the tube.

It is known that evacuation of a large hollow glass article, such as a television tube envelope, develops a considerable amount of potential energy in the glass envelope. This results in a stress condition with the stress distribution depending on the particular geometry of the tube, wall thickness, surface condition and other known factors. It may be theorized that, as a minute crack occurs in the glass, the stress energy redistributes itself and concentrates at the crack apex. This in turn results in extremely rapid propagation of the crack by minute elastic glass movements. It has been observed that cracks tend to double back, thereby releasing a section of glass before any substantial entry of air to establish pressure equilibrium has occurred. As a result, there is a sudden rush of air into the tube with a consequent disintegration of the tube accompanied by flying glass splinters.

We believe that a rigid band, in accordance with our invention, constrains the envelope periphery and absorbs the energy that otherwise is released by high speed crack propagation. This in turn slows down the crack propagation sufficiently to permit establishment of pressure equilibrium without violent collapse of the envelope, that is an implosion.

In practicing our invention, we space an annular shell **17** (FIG. 1) a slight distance from the envelope wall. We then provide in the intervening space a moldable sealing material **18** that sets to a rigid state or form, and conforms to the glass wall as it sets. While compression is unnecessary, it may, if desired, be provided by using, as sealing material **18**, a material that expands or swells as it sets. For this purpose there may be used various materials known in the art, such as, metal alloys capable of expanding during their passage from the liquid state to the solid state and being non-compressible in the solid state such as lead-bismuth alloys of low melting points (120° to 130° C.). Such alloys expand during cooling. The composite band may be formed on the envelope either prior to or subsequent to its evacuation. If the band is applied to the tube envelope prior to tube evacuation, there is a tendency, as the tube is evacuated, for the glass envelope to flatten slightly across the screen face and, at the same time, enlarge slightly in the banded region. This has the effect of expanding the glass against the band and creating a compressive or loading effect. Sealing material **18** may, for example, be any thermal setting organic or inorganic sealing materials or mixtures. The essential requirement is that it sets to a rigid state in conformity with the glass surface, thus assuring substantially continuous contact with the envelope wall.

In order to simplify molding, it is convenient to use a modified form of molding shell **21** as shown in FIG. 2. This shell is originally composed of two annular sections, **22** and **23**, adapted to have meeting surfaces along which they are united to form a single encircling shell **21**. The two annular sections may be composed of metal and may be produced either by stamping or by casting. In the prior instance, it is convenient to unite the sections by mechanical clamping, pinching, or welding. Cast sections may likewise be united by welding or soldering, or by means of screws or bolts. A molding shell formed in this manner has the further advantage that it provides a flange section of utility in mounting the tube in a cabinet or other viewing set.

FIGURES 3–5 illustrate, largely schematically, the detailed steps of a particularly convenient method of practicing this preferred embodiment of the invention. In accordance with the method, a pair of annular shell-like members are assembled slightly spaced from the tube wall. The intervening space is filled with a material which sets or rigidifies in conformity with the tube wall surface.

As shown in FIGURE 3, a support member **50** is provided with centering fingers **52**, usually four in number. A preformed annular flanged ring **54**, hereafter designated the screen ring, is mounted on centering fingers **52**, conveniently by means of holes punched in the flange. Following this, tube **56** is vertically mounted on ring **54** with the inner edge of ring **54** coinciding with the periphery of the viewing surface of the tube screen. A sealing ring **58** is also provided intermediate the tube **56** and ring **54**. At this point, a corresponding funnel ring member **60**, adapted to function with ring **54** in providing a containing shell for the rigid banding material, is mounted on centering fingers **52**.

The flanges of rings **54** and **60** may then be united, preferably by electrical welding to form a single annular shell. This composite shell is then drawn tightly against the lower face of the tube **56**, for example by applying pressure intermediate the funnel wall and the upper wall of the composite shell. This may be accomplished, as shown in FIGURE 4, by screws **62** introduced through the upper portion of the shell and bearing against the funnel wall.

Following this, filling material **64** is cast into the intervening space between the shell and the tube wall in fluid form and allowed to set to a rigid state. As illustrated in FIGURE 5, the filling material may be liquid sulfur melted from flowers of sulfur in a melting chamber **66**, having a controlled feed channel **68** adapted to cast a desired amount of sulfur into the intervening space between tube **56** and the composite shell. After complete solidification of the sulfur to form a molded band about the tube, the latter may be removed from the support member.

The rings **54** and **60** forming the composite shell may be of metal, metal alloys, glass, a resin-glass fiber mixture, or any material of such a nature as to present suitable mechanical characteristics, especially from the viewpoint of rigidity. The material intended to assure the filling between the shells and the tube may be composed of sulfur, thermosetting resins, a composite glass-resin cement, etc. A condition that the material must fulfill is that it provide a rigid molded band after casting and setting.

The apparatus represented schematically in FIG. 6 provides for continuous practice of this method with the aid of several positions, for example six, references A, B, C, D, E, F, arranged on a table M.

This installation includes a conveyor **70** passing through a preheating tunnel **72** (at about 60–80° C.) which prepares the rings **54** and **60** and a conveyor **74** passing likewise through a preheating tunnel **76** (at about 60–80° C.) that likewise prepares the tubes **56**.

The table M includes suitable means (not shown) to provide for rotation of the support members and the supported tubes for sulfur casting. Also suitably controlled activating and stop means are providde permitting control of rotation.

The tubes and the shells, preheated at about 60–80° C., thereafter undergo the various operations set forth below.

At position A: Operations represented in FIG. 3;

At position B: The welding operation uniting rings **54** and **60**;

At position C: The operations illustrated in FIGS. 4 and 5;

At positions D and E: Complete solidification of the sulfur with cooling by air pressure;

At position F: Removal of the tube, protected by the band, without the support, and centered on the support of the screen shell (FIG. 4). The protected tubes are carried away by conveyor **78**.

The invention has utility not only in television cathode ray tubes but in all other types of cathode ray tubes wherein the envelope is composed of a screen and a cone sealed together, for example, in radar and oscilloscope tubes.

What is claimed is:

1. In a cathode ray tube comprising a glass envelope composed of a viewing screen portion and a funnel portion of generally conical shape, the improvement that consists in a band encircling the envelope and extending from a plane passing through the viewing screen periphery to a plane adjacent the larger end of the funnel, the encircling band comprising a metal outer shell member having an inner surface spaced from the envelope and a congealed sulphur sealing material filling the space between the envelope and the inner surface of said shell member.

2. In a cathode ray tube comprising a glass envelope composed of a viewing screen portion and a funnel portion of generally conical shape, the improvement that consists in a band encircling the envelope and extending from a plane passing through the viewing screen periphery to a plane adjacent the larger end of the funnel, the encircling band comprising a substantially rigid outer shell member having an inner surface spaced from the envelope and a sealing material filling the space between the envelope and the inner surface of said shell member, said sealing material comprising an expanded material which is non-compressive after expansion.

3. The cathode ray tube of claim 2 wherein said metal shell member is composed of two metal bands united to provide an outwardly extending flange.

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