July 19, 1938. R. T. ORTH 2,123,957

ELECTRON TUBE

Filed June 2, 1934

Fig. 1

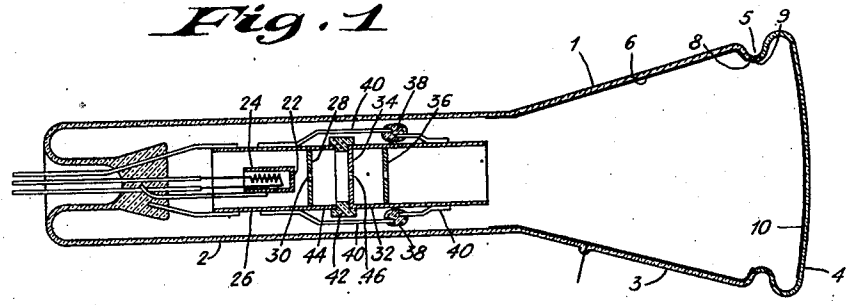


Fig. 2

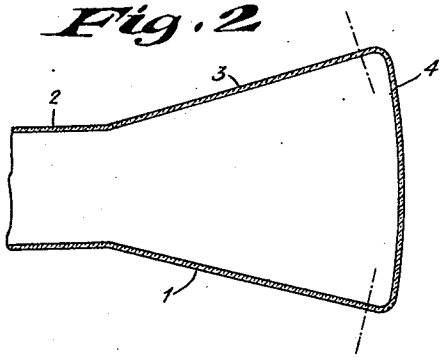


Fig. 5

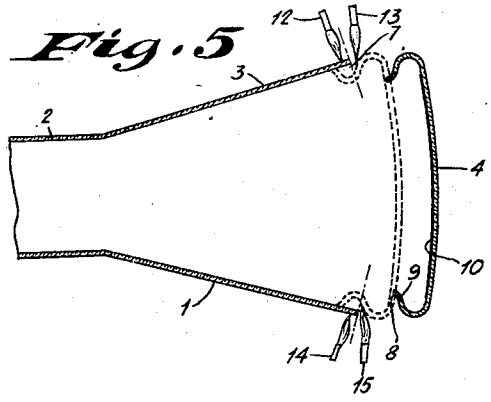


Fig. 4

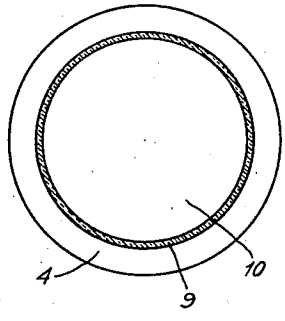


Fig. 6

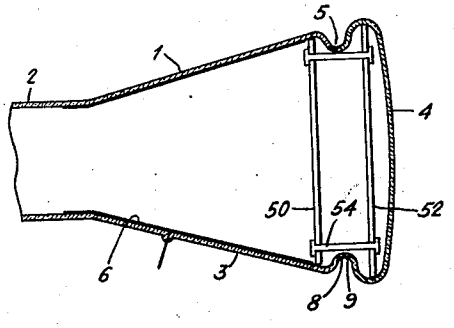
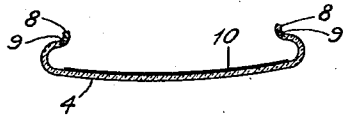


Fig. 3



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ELECTRON TUBE

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Application June 2, 1934, Serial No. 728,686

5 Claims. (Cl. 250—27.5)

The present invention relates to a method of manufacturing glass or other vitreous material vessels.

One of the particular aspects of the invention is in its application to the fabrication of envelopes used for enclosing electronic apparatus.

In one of the preferred forms, the invention is particularly adapted to the manufacture of cathode ray oscillograph and television tubes of the type where one end section, for example, is covered or coated with a material which is adapted when subjected to the influence of an electron beam or stream to become fluorescent. Tubes of this type also usually have another section provided with a conductive coating. The coating may serve as one of the electrodes within the tube and thereby aid in accelerating the electron beam prior to the time when it strikes or impinges upon the fluorescent screen structure. The coating may also serve as a leak path to prevent accumulation of electron charges on the screen material. In addition, such a conductive coating may serve to reduce or eliminate internal reflection in the tube.

One of the more important objects of the invention is that of facilitating a uniform distribution of the fluorescent material on the plane, curved or irregular shaped surface which is to form one end of the tube envelope.

Still another object of the invention is to provide a method of manufacturing electron tubes, principally of the cathode ray type, wherein it is possible to obtain an end wall having a more uniform optical surface. Such an end wall then is used, when suitably coated, as the fluorescent screen upon which the electrical pattern traced by the cathode ray beam developed within the tube may be viewed.

Another object of this invention consists in providing ways and means for uniformly depositing a conductive coating, such as silver, aquadag or other substance, upon the interior surface of the tube without the possibility of the coating material touching or contacting parts previously coated with similar or dissimilar substances.

A still further object of the invention is to provide a tube envelope structure of such a form that auxiliary elements may be rigidly supported within the tube and in proximity to the screen structure in a simpler manner than has heretofore been possible.

Other and further objects of the invention are to provide a tube structure of such a type that greater uniformity in manufacturing is obtainable, whereby the cost per tube manufactured, and thus the selling price, may be substantially reduced.

Still other objects and advantages of the invention will become apparent and at once suggest themselves to those skilled in the art by reading the following specification and claims in connection with the drawing accompanying this disclosure, wherein:

Fig. 1 is a longitudinal section of a tube herein illustrated as of the cathode ray type which incorporates one modification of the invention;

Fig. 2 represents a longitudinal section of a glass vessel in the process of manufacture;

Fig. 3 represents a sectional view of a fluorescent screen section processed in accordance with the method of this invention;

Fig. 4 represents a plan view of the screen structure disclosed by Fig. 3 and located in the direction of the arrow on Fig. 3;

Fig. 5 represents a view of a tube such as that shown by Fig. 2 during a subsequent step in the manufacturing process; and

Fig. 6 represents a modification of the invention showing its application in supporting elements within the tube envelope and in proximity to the end wall of the vessel.

While the invention is herein to be described in connection with a cathode ray type of tube as used in the television art, and as used for oscilloscope purposes, it is to be understood that the invention is not confined to this particular field, but should be construed broadly as applying to all general fields of tube manufacture and allied arts.

If reference is now made to the drawing, and first to Fig. 1 thereof, it will be seen that the envelope 1 is preferably formed of glass or other vitreous substance (although metal might under some conditions be used) and is of a general form having a neck portion 2 and a frusto-conical portion 3. The end section 4 of this tube and the annular indentation 5 are fabricated in a manner which will hereinafter be explained principally in connection with the description of Figs. 2 through 5 of this disclosure.

The frusto-conical section 3 and a portion of the tube neck 1 are preferably coated with a precipitated metallic layer 6 of some substance such as silver, or aquadag, for example. The end of the tube which terminates in the frusto-conical portion is coated on the inner surface with a substance 10 which is fluorescent to the action of a pencil or stream of electrons emanating from a heated cathode located in the neck portion of the tube.

The neck portion of the tube also houses the electron gun structure, which may, for example, be of the general form disclosed by John C. Batchelor in copending application Serial No. 584,924, filed January 6, 1932, or, for example, may be the general form disclosed in the patent to Vladimir K. Zworykin, Number 2,084,364 of June 22, 1937 both of which applications are assigned to Radio Corporation of America. Of course, it will be apparent that other forms of gun structure may be substituted where desired, provided such gun structure includes a source of electrons and a means, such as an anode, for drawing the electrons from the source and projecting the electrons toward the fluorescent screen structure 10. Where the gun structure is of a different type than that disclosed in the above mentioned applications of Messrs. Batchelor and Zworykin, any appropriate form of intensity control arrangement may be provided. Various ways and means to control the beam intensity are known and may be, for example, a grid of the type disclosed by Nicolson Patent 1,470,696, a velocity modulation scheme of the general type disclosed by Rosing Patent 1,161,734, or the beam control may be of the type wherein predetermined sections of the generated electron pencil are masked from the screen structure by way of a shield interposed between the electron source and the screen structure, such as has been disclosed, for example, by Rosing British Patent 27,570 of 1908, or, for example, by Clay Patent 1,719,756.

However, for the purpose of this disclosure, it will be assumed that the gun structure is of the general type disclosed by the Batchelor application, Serial No. 584,924, and thus that it comprises an electron source in the form of a cathode 22 which is heated in any suitable manner by means of a filament 24. A control electrode 26 is arranged to surround the emitting cathode 22 and is provided with an apertured disk 28 and is so supported that the aperture 30 of the disk 28 is in close proximity to the source of electron emission at the adjacent end of the cathode 22. The electron gun structure also includes an anode portion 32 which is provided with apertured disks 34 and 36 and which is supported from the control electrode 26 by a number of glass beads 38 and the associated wires 40 attached as shown to the parts.

For the purpose of maintaining alignment of the grid electrode 26 with the anode 32 an insulating spacing ring 42 is interposed as shown between the adjacent ends of the grid and anode structures and the ring is resized, as shown, to receive the adjacent ends of these parts.

In the construction shown, the skirt portion 44 of the grid electrode 26 extends beyond the apertured disk 28 of the control electrode and has its edge portion in close proximity to the disk 34 of the anode structure. These features have already been explained in the above mentioned application of Batchelor, and involve, among other features, the important principle of focusing the emitted electrons passing through the grid aperture 30 upon the aperture 46 of the disk 34 and at the same time permits the control voltage of the ray to be maintained at relatively low voltage, for example, voltages of the order of 20 volts applied to the control grid. The ratio of the voltages applied to the first anode 32 and to the second anode formed from the metallic coating 6 may vary from that of the order of 1 to 3 to that of the order of 1 to 8, for example, although it, of course, is within the scope of this invention to use other ranges of variance in voltages of the first and second anodes.

In the past, great difficulty has been experienced in applying the conducting film 6 to the wall of the frusto-conical section of the tube and also in applying the fluorescent substance 16 on the inner end wall of the tube. This has been due to the fact that it is impractical from a manufacturing viewpoint first to precipitate the conducting material, such as silver, upon the sides of the vessel for by doing so it is difficult to introduce the liquid from which the screen material is precipitated upon the end section of the tube. It has, therefore, in the past been customary first to screen the tube by spraying or settling the fluorescent material and then to precipitate the metallic coating of silver upon the side walls of the tube.

One method of performing the silvering operation in the past was to provide equipment which was designed to roll the bulb at a relatively low speed while holding the bulb at such an angle that when the specified quantity of the silvering solution was applied to the tube wall only that portion of the bulb which it is intended to coat will be in contact with the liquid. With this method of the prior art used, difficulty was found to arise due to the fact that the aqueous solutions run or drip upon the end surface of the tube and thus substantially ruin that surface for its intended use as a fluorescent surface.

The present tube, when formed according to the process to be described in connection with Figs. 2 through 5 inclusive, has provided ways and means by which these difficulties existing in the prior art may be overcome so that, for example, the metallic solution which is to be precipitated upon the inner surface 6 of the frusto-conical portion 3 of the tube may be deposited while the tube is in a vertical position by rotating the tube and providing a suitable means for causing the liquid coating material to be limited as to the area it can coat by means of the annular indentation 5.

If reference is now made particularly to Fig. 2 of the drawing, it will be seen that the section of the tube above the lines designated A—A will be the area of the tube upon which the fluorescent coating is to be applied, while that section below the section lines A—A and continuing down into the neck portion 2 of the tube will be that portion of the tube to which it is desired to apply the conductive coating. In the past it has usually been customary to form this tube as a single section and to deposit the fluorescent material 16 upon the inner surface of the end portion 4 of the tube by spraying the fluorescent material from an orifice within the bulb. This method resulted in a great variation in screen thickness because of the fact that air eddy currents are set up within the closed vessel when the fluorescent material is sprayed. Another method of the prior art for depositing the fluorescent material on the inner surface of the end portion 4 of the tube was that of settling the screening material from an aqueous solution. Such a method is reasonably satisfactory but requires from eight to sixteen hours elapsed time for the production of a screen in order that the fluorescent material may settle out of the aqueous solution and deposit itself upon the inner wall of the tube. According to the present invention, both of these methods of the prior art for forming the screen structure

have been avoided and the screen structure is formed as an independent glass disk having an outer convex surface, for example, as is shown in section by Fig. 3. The fluorescent material 10 may then be applied directly upon this disk while the disk is separate and detached from the tube.

According to this invention, the disk, as shown by Fig. 3, may be sprayed without introducing the complications of conflicting air eddy currents, experienced heretofore by following the methods of the prior art because with the disk portion of the tube removed from the frusto-conical section any air eddy currents set up do not interfere with the proper deposit of the material 10 upon the glass. When such a disk illustrated in Figs. 3 and 4 has been substituted for the end section 4 of the tube shown, for example, by Fig. 2, considerable advantage is obtained by such a substitution due to the fact that optical imperfections which frequently exist in the end portion of the tube when it is blown integrally with the envelope are avoided, since with a section formed entirely separate from the tube it is possible to form the end wall of the tube of a quality of glass in which the heretofore usually inherent imperfections are not present. Further than this, by forming the end section independent of the tube it is possible to use special glass sections either as luminescent screens or as optical lenses. For example, if the end section shown in Fig. 3 is of high quality glass and a special glass composition is used for the central screen sections, considerable saving in expense of manufacture may be effected as it is then unnecessary to construct the entire envelope of a particular quality glass. When resorting to such constructions it is usually desirable to use one or more transition sections such as are represented by the numerals 8 or 9 of Figs. 1, 3, 4, 5 and 6. When so used, the transition sections should preferably have progressively increasing or decreasing coefficients of expansion with respect to the conical section 3 and the end section 4.

If, now, a tube of the type above described is to be assembled, it will be seen by referring to Fig. 5 that both the closed sections forming the cone portion 3 of the tube and the end portion 4 must be sealed together. Such sealing may be accomplished by placing both portions in a machine known as a glass worker's lathe, not herein shown but well known in the art. The conical section 3 is secured and held in one rotatable head of the lathe, whereas the screen section 4 is held in the other rotatable lathe head, in a relative position shown in Fig. 5. Suitable glass working fires 12, 13 and 15 are brought to bear upon the annular edges, such as 7, of the cone portion 3 and 8 of the end portion 4, whereupon the glass forming these annular sections or edges 7 or 8, after reaching a plastic state, are brought together and joined due to the plastic and workable nature of the hot glass. Compressed air may then be introduced into the neck section 2 of the tube, thereby facilitating the working of the plastic glass. This results in a more uniform glass structure at the seal and consequently reduces the strain following solidification and cooling.

The annular indentation 5, as has been previously indicated, and shown for example by Fig. 1, which represents the complete and assembled tube, is used for the purpose of limiting the contact area of the solution from which the metallic screen 6 is precipitated upon the conical section 3 and the tube neck 2. This annular indentation is formed by suitably heating the section 5 by the sealing fires 12, 13, 14 and 15, and following the sealing operation and at time when the glass is still in a plastic state a tool composed of carbon or other suitable material is brought to bear upon the glass envelope. The envelope then assumes the shape shown in Fig. 5 by the dotted lines and more clearly shown in Fig. 1 in the assembled form.

If reference is now made to Fig. 6 of the drawing, it will be seen that the annular indentation 5 may be used very conveniently for the purpose of securing and positioning auxiliary elements such as are conventionally illustrated at 50 and 52, for example. The element 50 may be, for example, a mosaic type structure having photo-electric portions, or it may take the form of an auxiliary anode, or the element 52 may be used as a means of support for the element 4 or it may also serve a useful function in the operation of the device as a whole. Any other suitable means, such as the spacing element 54, may be positioned so as to support and locate the elements 50 and 52 with respect to each other in assembling tubes of this general type. Caution must be exercised to prevent the sealing fires from playing directly upon the screen structure 10 formed within the tube, but so long as the fires do not directly contact with the screen structure no difficulties result and the tube is easily formed as above described.

Having thus described the invention, what is claimed and desired to secure by Letters Patent is the following:

1. The method of fabricating electron tubes of the cathode ray type which are formed from a plurality of sectional vitreous parts which comprises the steps of coating one sectional part with a material adapted under the influence of cathode rays to become fluorescent, and fusing the sectional coated part to a second part to form thereby a complete tube envelope in which suitable electrodes may be mounted.

2. The method of manufacturing electron tubes of the cathode ray type which are formed of a plurality of separate vitreous portions which comprises the steps of coating one of the separate portions with a fluorescent material, fusing this coated portion to a second portion to form thereby a tube envelope, placing within the tube envelope electrodes capable of generating upon the application of suitable potentials thereto cathode rays to cause the coated section to become fluorescent, and evacuating the envelope.

3. The method of forming a cathode ray tube having a fluorescent screen structure initially independent of the remainder of the tube envelope which comprises coating a glass end section of the tube with fluorescent material on one surface thereof, fusing the coated glass section to a second glass section to form a complete tube envelope, positioning electrodes within the formed envelope so that cathode rays may be generated when voltages are applied to the electrodes so that the screen is caused to fluoresce, and subsequently evacuating the formed tube envelope.

4. An electron tube formed of independent sectional parts which comprises a vitreous end member of one predetermined optical quality, a vitreous main body member of a different predetermined optical quality, a sealing ring including a plurality of different quality vitreous sections between said members to compensate for different coefficients of expansion of the two members,

said combined members being recessed annularly at substantially the location of the sealing ring, an electrode member mounted within the assembled members and supported at said recessed section, and electrode members supported within the combined structure so that when voltages are applied to said electrode members a cathode ray will be developed.

5. In a cathode ray oscillograph tube, an envelope formed of two cooperating sections of dissimilar vitreous materials, one of said sections being an end section and having a coating of fluorescent material upon the inner surface thereof, a sealing ring between said two sections to which each of said sections is fused, said combined members being recessed annularly at substantially the location of the sealing ring to form a section having a reduced diameter.

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