United States Patent [19]

de Vere Krause

[11] **3,875,452**

[45] **Apr. 1, 1975**

[54] **CATHODE RAY TUBE WITH LONGITUDINALLY SEAMED BODY PORTIONS**

[76] Inventor: **Anthony Victor de Vere Krause**, 3 Beechcroft, Ashtead, England

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[21] Appl. No.: **377,778**

Related U.S. Application Data

[63] Continuation of Ser. No. 123,279, March 11, 1971, abandoned.

[30] **Foreign Application Priority Data**

Mar. 12, 1970 United Kingdom 11794/70
Mar. 12, 1970 United Kingdom 11793/70
Feb. 23, 1971 United Kingdom 5214/71

[52] **U.S. Cl.** **313/482,** 313/317
[51] **Int. Cl.** **H01j 29/00,** H01j 31/00
[58] **Field of Search** ..... 313/82 R, 32 TS, 317, 318

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Primary Examiner—Robert Segal

[57] **ABSTRACT**

A vacuum tube comprising an envelope and at least one electrode within that envelope, wherein the envelope includes two portions joined together along a seam and the required electrical connection is made to the electrode from outside the envelope by means of at least one conductor which passes through the seam. Preferably, the conductor serves to locate and support the electrode in the tube.

6 Claims, 38 Drawing Figures

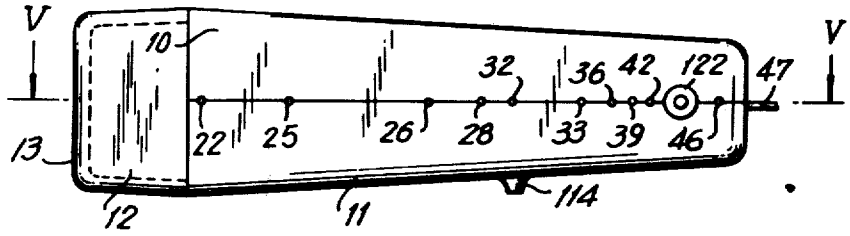


FIG. 1

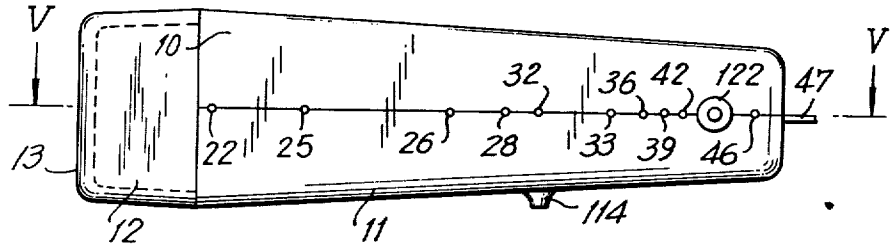


FIG. 2

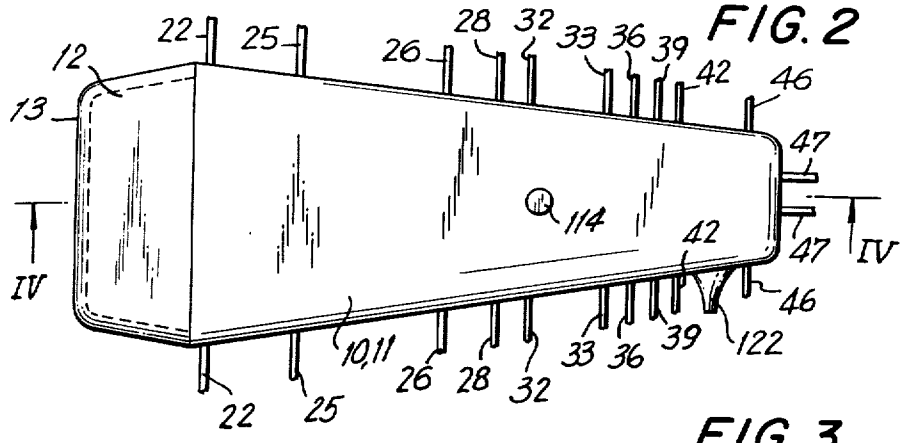


FIG. 3

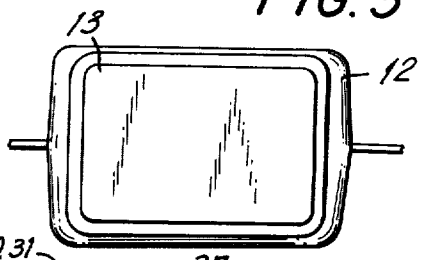


FIG. 4

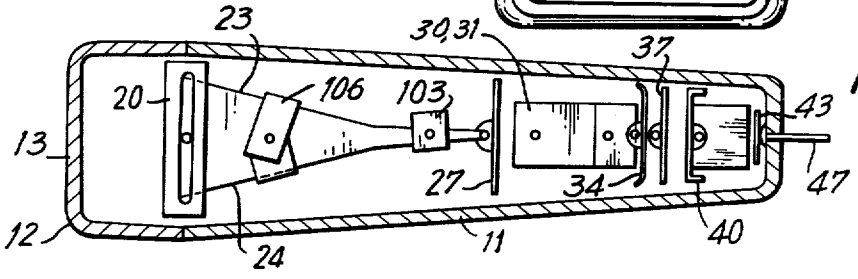


FIG. 5

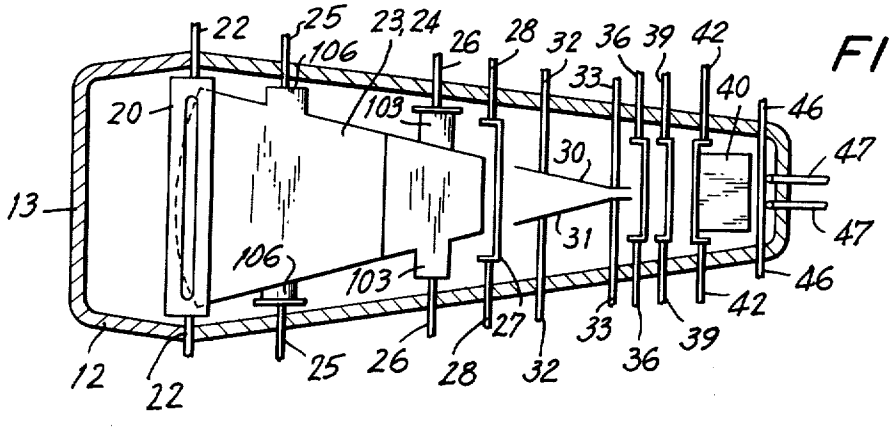


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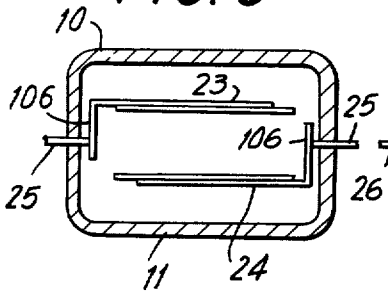


FIG. 7

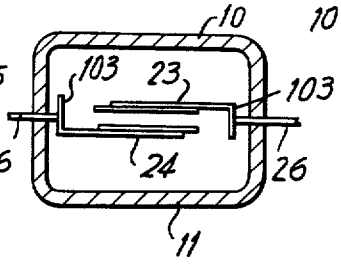


FIG. 8

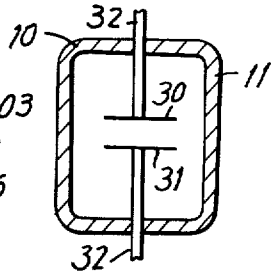


FIG. 9

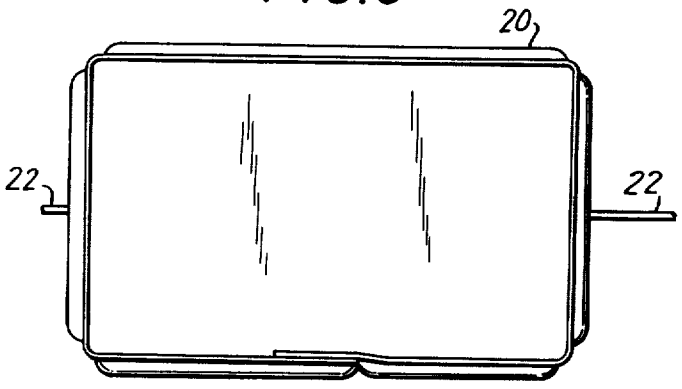
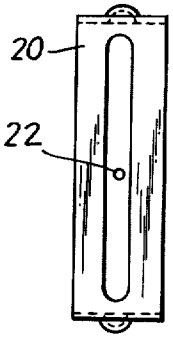


FIG. 10



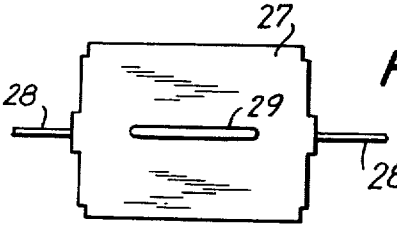


FIG. 13

FIG. 11

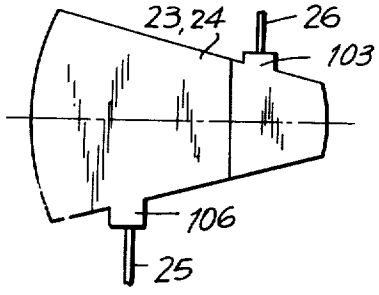


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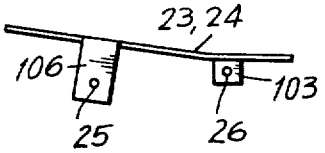


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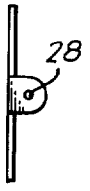


FIG. 15

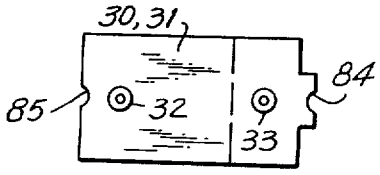


FIG. 16

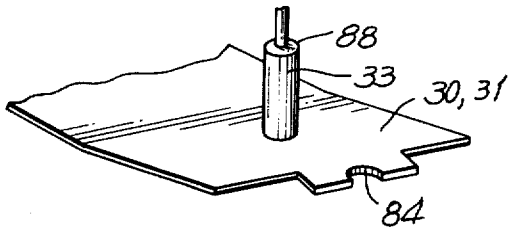


FIG. 17

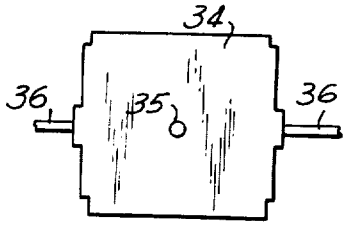


FIG. 18



FIG. 19

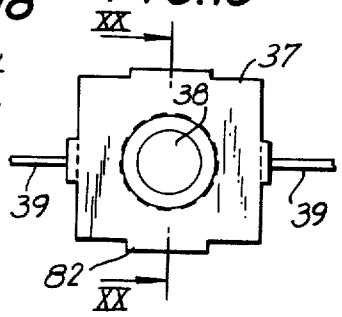


FIG. 20

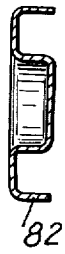


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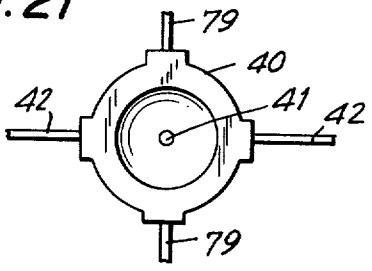


FIG. 22

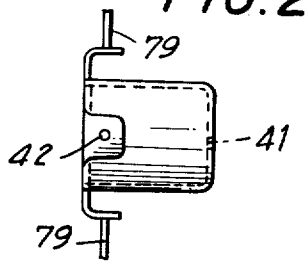


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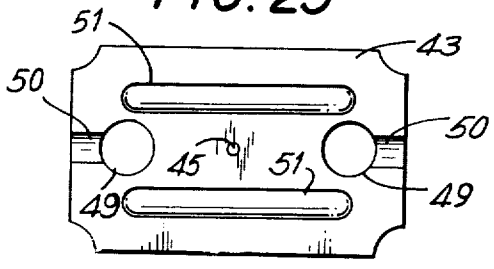


FIG. 24

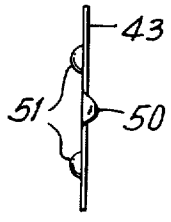


FIG. 25

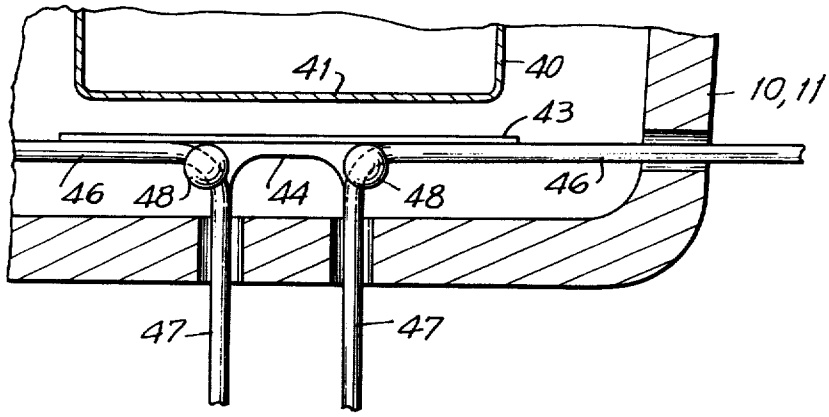


FIG. 26

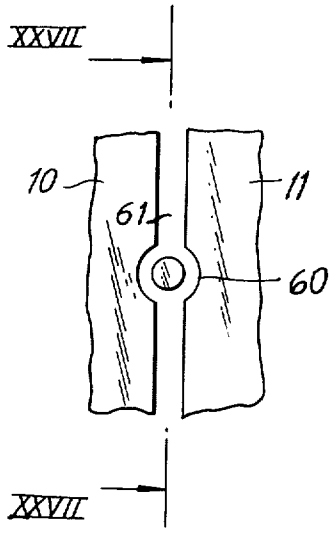


FIG. 27

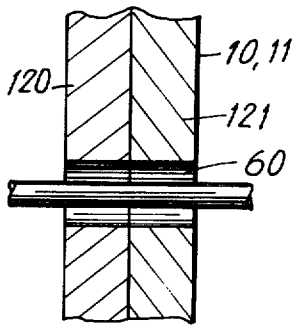


FIG. 28

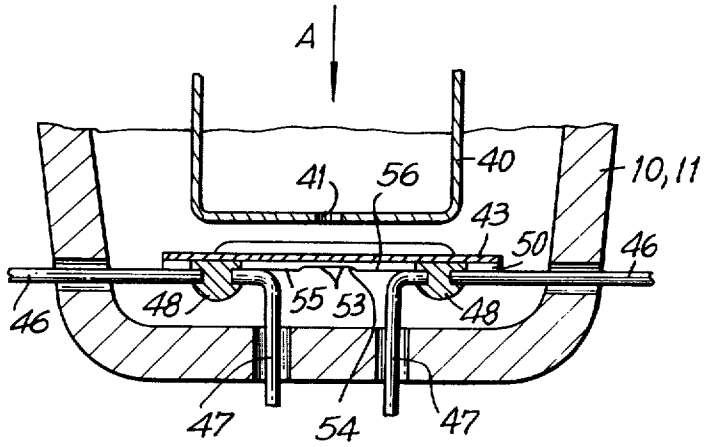


FIG. 29

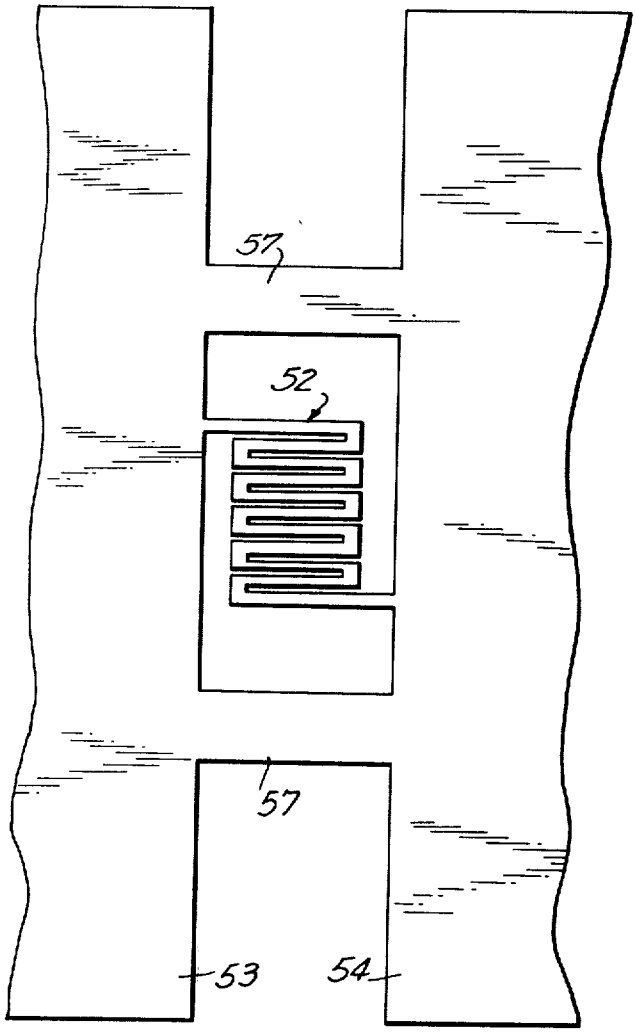


FIG. 30

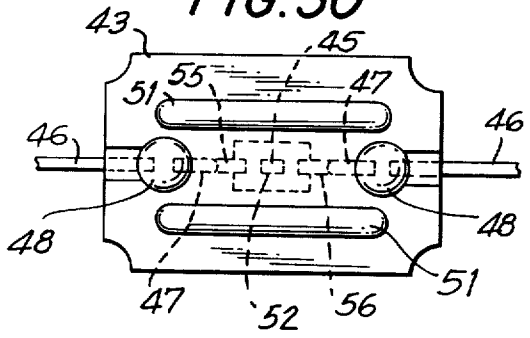


FIG. 31A

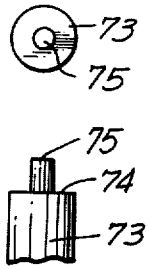


FIG. 31

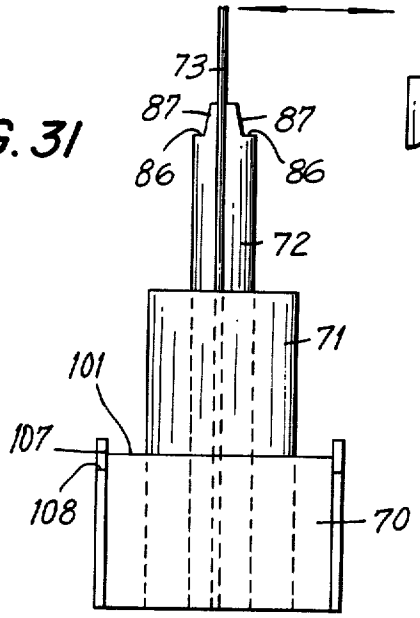


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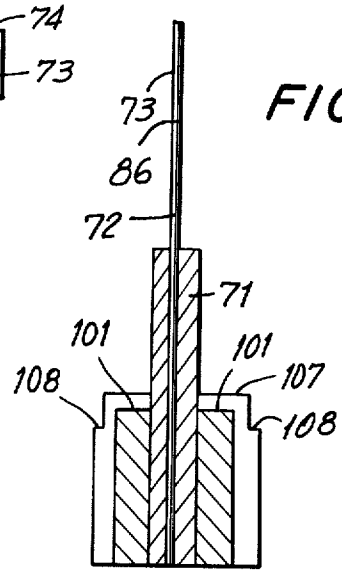


FIG. 33

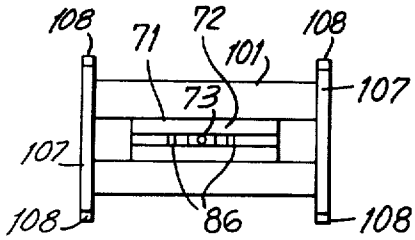


FIG. 32A

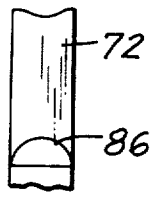


FIG. 34

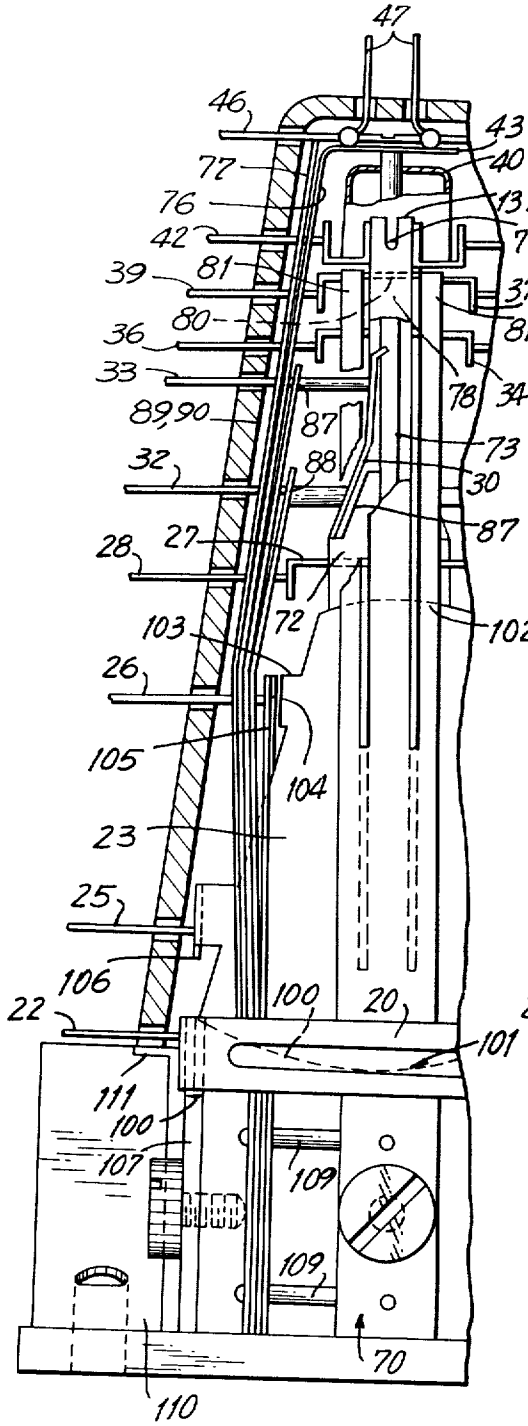

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FIG. 35

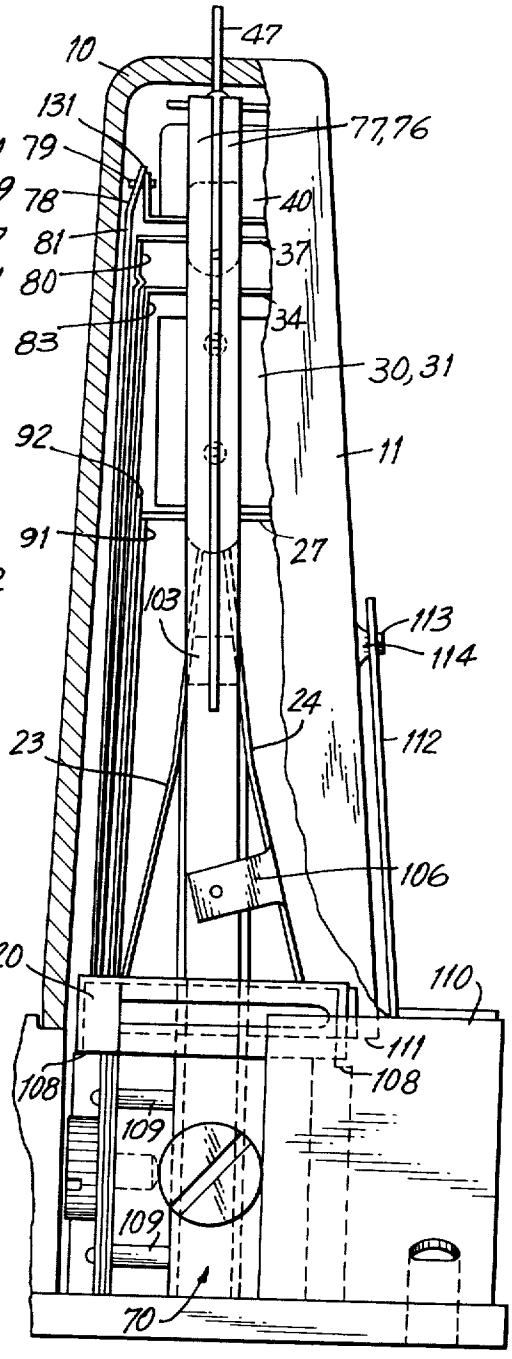
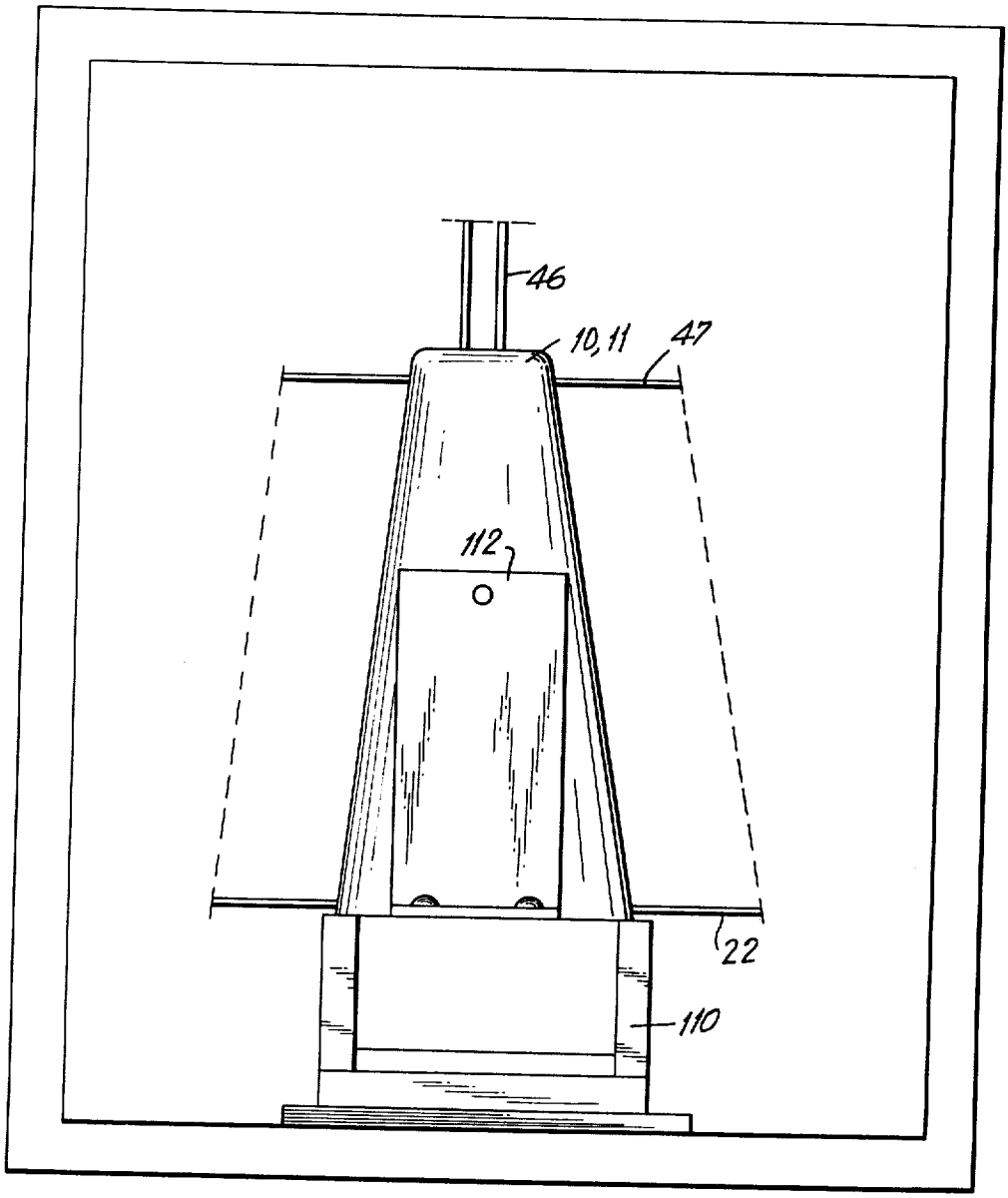

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FIG. 36



CATHODE RAY TUBE WITH LONGITUDINALLY SEAMED BODY PORTIONS

This application is a continuation of Ser. No. 123,279; filed Mar. 11, 1971, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to vacuum tubes, and is particularly, although not exclusively, concerned with improvements in the construction and manufacture of a cathode ray tube such as may be used in a television display apparatus.

The development of miniature televisions, particularly those small enough to be carried in the pocket, has been retarded by a number of factors. Among these factors has been the design and manufacture of a cathode ray display tube which is of suitably small physical dimensions and which requires a low power supply for its operation, enabling the use of small and light batteries to power a portable set.

Further from the commercial point of view, the market for such televisions has been limited in view of the cost of manufacturing such a television, the cathode ray display tube contributing a significant part of that cost.

It is therefore an object of the present invention to provide a cathode ray display tube suitable for use in a television apparatus which is small in physical size, is of low power requirement, while still being cheap to manufacture.

It is to be understood however, that the construction and method of manufacture of the invention is applicable to other types of vacuum tube.

SUMMARY OF THE INVENTION

Accordingly, in one aspect, the present invention provides a vacuum tube comprising an envelope and at least one electrode within that envelope, wherein the envelope includes two portions joined together along a seam and the required electrical connection is made to the electrode from outside the envelope by means of a conductor which passes through the seam.

Preferably in such a tube, the conductor serves to locate and support the electrode in the tube.

In a further aspect the invention provides a cathode ray tube comprising an envelope and a plurality of electrodes therein forming an electron gun assembly, said envelope including two body portions joined together along a seam, the electrodes of said gun being supported and located in the envelope by means of conductors through which the required electrical connection is made to the respective electrode said conductors passing through the seam.

In a preferred arrangement of such a cathode ray tube, the screen is formed on a face of a cup portion of the envelope which is joined to said two body portions along a further seam.

According to a further aspect of the invention, there is provided a method of manufacturing a vacuum tube comprising an envelope and at least one electrode therein, with electrical connection to the electrode from outside the envelope by means of a conductor, including the steps of locating said electrode with the conductor in a jig, providing the envelope in at least two portions, locating the two portions around the electrode in the jig and joining the two portions together along a seam with the conductor passing through the seam.

In such a method as applied to the manufacture of a cathode ray tube comprising an envelope and a plurality of electrodes therein forming an electron gun assembly, said envelope may preferably be provided in two body portions with a screen cup to be joined to the body portions to complete the envelope after said two body portions have been assembled around the electrodes in the jig.

Preferably in the above methods the completion of the envelope is carried out in a vacuum thereby eliminating the need for subsequent evacuation of the envelope.

BRIEF DESCRIPTION OF THE DRAWING

In order to promote a fuller understanding of the above, and other, aspects of the present invention, embodiments will now be described, by way of example only, with reference to the accompanying drawings in which:-

FIG. 1 is a side elevation of a cathode ray tube,

FIG. 2 is a plan view of the tube of FIG. 1,

FIG. 3 is a face view of the tube of FIG. 1,

FIG. 4 is a schematic cross-sectional view taken on the line IV—IV of FIG. 2,

FIG. 5 is a schematic cross-sectional view taken on the line V—V of FIG. 1,

FIG. 6 is a schematic cross-sectional view taken on the line VI—VI of FIG. 4,

FIG. 7 is a schematic cross-sectional view taken on the line VII—VII of FIG. 4,

FIG. 8 is a schematic cross-sectional view taken on the line VIII—VIII of FIG. 5,

FIGS. 9 and 10 show the screen potential control electrode of the tube of FIG. 1,

FIGS. 11 and 12 show one of the Y deflection plates of the tube of FIG. 1,

FIGS. 13 and 14 show the interplate screen of the tube 1*f* FIG. 1,

FIGS. 15 and 16 show the X deflection plates of the tube of FIG. 1,

FIGS. 17 and 18 show the No. 3 anode of the tube of FIG. 1,

FIGS. 19 and 20 show the No. 2 anode of the tube of FIG. 1,

FIGS. 21 and 22 show the No. 1 anode of the tube of FIG. 1,

FIGS. 23 and 24 show the grid of the tube of FIG. 1,

FIG. 25 shows the assembly of the grid and filament of the tube of FIG. 1,

FIG. 26 shows a typical portion of the seam of the envelope of FIG. 1,

FIG. 27 shows a schematic cross-section on the line XXVII—XXVII of FIG. 26,

FIG. 28 shows a similar view to that of FIG. 25 of a further assembly of grid and filament,

FIG. 29 shows an enlarged view of the filament of FIG. 28,

FIG. 30 shows a part schematic view on the arrow A of FIG. 28 with anode No. 1 omitted.

FIG. 31 shows a mandrel assembly for use in the assembly of the tube of FIG. 1,

FIG. 31A is an enlarged fragmentary plan and side view of the upper end portion of FIG. 31,

FIG. 32 shows a side view of the assembly of FIG. 31,

FIG. 32A is an enlarged fragmentary view of the upper end portion of FIG. 32,

FIG. 33 shows a plan view of the assembly of FIG. 31,

FIG. 34 shows the mandrel assembly of FIG. 31 together with retaining fingers in use in the assembly of a tube of FIG. 1,

FIG. 35 shows a side view of the apparatus of FIG. 34 and,

FIG. 36 shows a typical oven arrangement for sealing a tube in the apparatus of FIG. 34.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1, 2 and 3 show the external arrangement of the cathode ray tube of this embodiment.

The glass envelope of cathode ray tube is formed in three parts, as best seen in the side view of FIG. 1, the parts comprising two body halves 10 and 11, and a screen cup 12 having a screen end face 13. The three body parts 10, 11 and 12 are joined together to form a complete envelope by soldering with a low melting point glass frit in a manner to be described in more detail below.

As best seen in FIGS. 4 and 5 which are cross-sectional views of the cathode ray tube, the various electrodes of the electron gun of the tube which is of the electrostatic deflection type, are supported individually on a series of supporting wires, the supporting wires passing through the envelope along the seam where the two body halves 10 and 11 are joined together. The supporting wires also serve for electrical connection to the respective electrodes.

The electrodes of the gun will now be described in brief detail. The first electrode immediately behind the screen of the tube is a screen potential control electrode 20 which is shown on an enlarged scale in FIGS. 9 and 10. It is provided with supporting wires 21 and 22 and is positioned towards the front of the tube immediately behind the joint between the screen cup 12 and the two body halves 10 and 11. The next electrodes are the two Y deflection plates 23 and 24, the plate 23 being shown in more detail in FIGS. 11 and 12, each is provided with supporting wires 25 and 26. The next electrode is the interplate screen 27 shown in more detail in FIGS. 13 and 14 and provided with supporting wires 28. The screen 27 is provided with a central slit 29 through which the electron beam may be directed from the X plates. The next electrodes are the X plates 30 and 31 shown in more detail in FIGS. 15 and 16, and provided with supporting wires 32 and 33. The next electrode is an anode, referred to as No. 3 anode, indicated at 34 and shown in more detail in FIGS. 17 and 18. The No. 3 anode is provided with a central aperture 35 through which the electron beam may pass, and supporting wires 36.

The next electrode is an anode referred to as No. 2 anode indicated at 37 and shown in more detail in FIGS. 19 and 20. It is to this anode that a beam focusing potential is applied to the tube when in use, and it is provided with an aperture 38 for the beam and with supporting wires 39. The next electrode is an anode referred to as No. 1 anode indicated at 40 which is shown in more detail in FIGS. 21 and 22 and which is provided with an aperture 41 for the beam and supporting wires 42. To complete the electron gun assembly is the grid indicated at 43 and shown in more detail in FIGS. 23 and 24, which forms an assembly with a directly heated cathode filament 44, the assembly being shown in more detail in FIG. 25. The grid electrode 43 is provided with a central aperture 45 through which electrons emitted from the directly heated cathode 44 may pass.

The assembly of grid 43 and filament 44 forms a rigid structure, the supporting wires 46 being rigidly attached to the grid electrode 43 to support it and the assembly in the envelope of the tube. Attached to the supporting wires 46 are two further supporting wires 47 to which the ends of the filament 44 are rigidly attached. The respective wires 46 and 47 are rigidly attached to one another but electrically insulated from one another, by means of glass beads 48 into which the respective supporting wires are fused. The grid electrode 43 is provided with apertures 49 to afford clearance for these glass beads, and may be provided with depressions 50 for attachment to the support wires 46 in an alternative assembly to be discussed below. The grid electrode 23 is also provided with stiffening grooves 51.

Thus it can be seen that all the electrodes of the electron gun of the cathode ray tube are located and supported in the envelope of the tube by means of the supporting wires. This transfers the location of the various electrodes in the gun assembly to the actual envelope of the tube as opposed to the location by separate internal spacers and supports as in tubes of previous construction where the gun was a separate assembly independent of the envelope. This feature enables a considerable reduction in the overall size of the envelope to accommodate the particular assembly of electrodes resulting in a smaller size of tube envelope for a given gun and screen size.

In the embodiment shown particularly in FIG. 25, the filament 44 is of a coiled coil tungsten construction. In an alternative arrangement, shown particularly in FIGS. 28, 29 and 30, the filament may be of a foil strip type which is more particularly disclosed in our co-pending British Patent Application No. 5214/71. In this arrangement, the filament indicated at 52 is in the form of a strip of thin foil material, such as nickel which is arranged in a zig-zag pattern to cover an area behind the aperture 45 in the grid 43 as particularly shown in FIG. 30. The foil pattern of the filament 52 extends between conductor members 53 and 54 which are in turn attached rigidly to the supporting wires 47 by the intermediary of members 55 and 56. Again, in this arrangement the grid 43 is attached to the supporting wires 45 by means of the indentations 50 mentioned above, and the supporting wires 46 and 47 are connected together by means of the glass beads 48 to complete a rigid assembly as before. The conductor members 53 and 54 are temporarily joined by bars 57 during the formation of the assembly, and the bars 57 are severed either mechanically or electrically only when the assembly has been completed, thus eliminating the possibility of strain to the filament pattern 52 during the formation of the sub-assembly. In this way it can be seen that the filament pattern 52 is again correctly located beneath the grid aperture 45 and located axially at the same time. The foil construction of the filament arrangement is particularly advantageous in providing a filament of sufficient electrical resistance to achieve a low power consumption while still enabling an adequate surface area of filament material to be disposed within the are covered by the grid aperture 45.

The portions of the envelope of the tube are preferably joined together along their respective seams by means of a low melting point glass frit. As particularly seen in FIG. **26**, the edges of the body halves **10** and **11** may be provided with grooves **60** at the appropriate points where the supporting wires for the electrodes pass through the joint between them. The glass frit indicated generally at **61** apart from serving to join the two portions together, also serves to form a seal around the supporting wire where it passes through the seam.

In order to assemble the tube envelope with the electrodes inside, the electrodes of the electron gun are first assembled in a jig. The jig arrangement is particularly shown in FIGS. **31, 32, 33, 34,** and **35.** The jig comprises a central mandrel assembly (FIGS. **31, 32** and **33** which serves to locate the electrodes along the axis of the electron gun. The mandrel comprises a base indicated at **70,** a shoulder **71** extending upwardly from the base, a wide strip mandrel **72** extending upwardly from the shoulder **71,** and a central circular cross-section mandrel **73** extending upwards from the strip mandrel **72.** The mandrel **73** actually extends as a rod through the whole height of the mandrel assembly and is replacable in case of damage.

The mandrel is arranged in a jig assembly as particularly shown in FIGS. **34** and **35,** as a central support for the electrodes of the electron gun, and means are provided to individually locate and retain the various electrode components in their correct disposition along the mandrel.

The top of the cylindrical mandrel portion **73** is provided with a shoulder **74** (FIG. **31A**) and a spiggot **75.** The grid filament assembly discussed above is located on the spigot **75** by means of the grid aperture **45.** In order to prevent the grid assembly tilting on the spiggot **75** it is supported from below by a pair of spring fingers **76** on each side as shown in FIG. **34** which abut below its edge and angularly located by a pair of spring fingers **77** on each side, the fingers **77** being arranged to pass and engage on either side of the supporting wires **46.** The tops of the fingers **76** and **77** are lipped to hold the grid down, but allow subsequent withdrawal of the jig after assembly, as indicated at **131.**

The No. **1** anode **40** is located on the cylindrical mandrel **73** by its aperture **41** and supported in its correct vertical position by means of spring fingers **78** on either side as seen in FIG. **35,** the fingers **78** being provided with a notch at the top to receive a spigot **79,** appropriately provided on the anode **40** as shown in FIGS. **21** and **22.** The support wires **42** also pass between the fingers **77** and **76** on each side as seen in FIG. **35.** The fingers **78** are also lipped to hold the anode down with the spigot **79** in the notch.

The No. **2** anode **37** is supported vertically by spring fingers **80** which are positioned behind the finger **78** as seen in FIG. **34** and is located sideways as seen in FIG. **34** by two spring fingers **81** which engage on either side of the shoulders **82** formed on the No. **2** anode as seen in FIG. **19,** and by the support wires **39** passing between the fingers **76** and **77.** The tops of the fingers **81** are lipped as above to hold the anode down.

The No. **3** anode **34** is again located by its aperture **35** on the cylindrical mandrel **73,** angularly located by its support wires **36** passing between the pairs of fingers **77** and **76** and is supported vertically by fingers **83** abutting beneath it, the fingers **83** being positioned behind (as seen in FIG. **34**) the fingers **81** and **80,** the fingers **80** being provided with projections **130** to hold the anode **34** down.

The X deflection plates **30** and **31** are supported on the mandrel with a notch **84** on the upper edge engaging the cylindrical mandrel **73,** and a notch **85** in the lower edge engaging on a shoulder **86** formed at the top of the strip mandrel **72.** The strip mandrel **72** is chamfered at a point **87** at its upper end to correspond with the angle of the adjacent part of the X deflection plates. The support wires **32** and **33** of the X deflection plates are provided with shoulders **87** and **88** respectively, these shoulders being formed by tubes fixed over the support wires, and spring fingers **89** and **90** are provided on each side (as seen in FIG. **34**) to engage on those shoulders and retain the Y plates in the position as discussed above. The fingers **89** and **90** lie behind (as seen in FIG. **35**) the fingers **77** and **76.** The tops of the fingers **89** and **90** are also lipped to hold the plates down in position.

The inter-plate screen **27** is located with its slit **29** over the strip mandrel portion **72,** and it is supported vertically by spring fingers **91** which lie behind (as seen in FIG. **34**) the fingers **83** and abut below the screen. The supporting wires **28** pass, on each side, through the slot between the fingers **77** and **76, 89** and **90** and an additional locating finger **92** is provided to abut each side of the screen as seen in FIG. **35,** again lipped to hold the screen in place.

The Y deflection plates are supported with their lower edge **100,** that is to say the radiused edge nearest the screen of the tube, resting on a surface **101** provided on the base **70** of the mandrel assembly, and with their upper edges **102** resting on the respective sides of the strip mandrel **72.** The support wires **26** of the Y deflector plates pass out on either side through the slot between the fingers **76** and **77, 89** and **90** respectively, and the arms **103** by which the support wires **26** are attached to the actual deflector plates, are received on each side in a slot **104** formed at the top of a rigid finger **105** extending out from the mandrel assembly base **70.** The arms **106** by which the support wires **25** are attached to the plates extend outside the fingers extending from the base **70** of the mandrel assembly and are not supported. In order to locate the bottom of the X plate sideways (as seen in FIG. **34**) the bottom corners engage on abutment plates **107** provided at each side of the mandrel base **70.**

The screen potential control electrode **20** rests on the base **70** of the mandrel assembly, being located sideways (as seen in FIG. **34**) by the plates **107,** and supported vertically by shoulders **108** formed on those plates.

The various spring fingers used to locate the various electrodes as discussed above are removably attached to the base **70** of the mandrel with screws and accurately located relative to the mandrel proper by means of dowels **109** so as to be replacable when damaged.

Thus it can be seen that the electrodes can be assembled progressively on the mandrel, and once so assembled will be accurately located relative to one another in the correct position which they should assume in the finished cathode ray tube.

The mandrel assembly base **70** is provided on either side (as seen in FIG. **35**) with a removable outer base portion **110** which are each provided with a recess **111** to receive the then lower edges of the body portions **10** and **11** of the tube. Thus the body portions **10** and **11**

can then be positioned around an assembly of electrodes on the mandrel, with the various supporting leads extending between the joint of the two body portions, and spring clips **112** are provided on the outer base portions **110** to retain the body portions in position, the clips having an aperture **113** to engage a pip **114** formed on the side of the body portions **10** and **11**. The pips **114** also serve to support the finished tube so that it will lie on a flat surface with the screen face **13** vertical.

Two basic procedures may be adopted for joining the body portions **10** and **11** together. The first is to coat the abutting edges of the body portions with a water suspension of a low melting point glass frit before placing them together around the electrodes on the assembly jig; and then to place the whole assembly of electrodes and body portions on the jig in a suitable oven as typically shown in FIG. **36**, to heat the whole and thus fuse the glass frit and join the body portions together, at the same time sealing in the various supporting wires passing through the joint. The assembled pair of body portions together with the various electrodes are then removed vertically from the jig, the various spring fingers deflecting to allow this, thus to leave a completed assembly of the two body portions **10** and **11** with the electrodes of the gun located correctly in position therein. As a next step the end face of the thus formed assembly is coated with glass frit, and the screen cup **12** held in position while the whole is again heated to fuse the glass frit to join the screen cup to the remainder of the assembly. In this instance, the frit used for the second joint is preferably of a lower melting point than that used to join the body portions **10** and **11** together.

In an alternative procedure, the body portions **10** and **11** are coated with a suitable adhesive material, along the inner part of their edges as indicated at **120** in FIG. **27**, the body portions are then positioned on the jig as discussed above, and the adhesive is allowed to set to hold the two body portions together while at the same time holding the various supporting wires of the electrodes in a similar manner to that described above. The adhesive assembled body portions together with the electrodes are again removed from the assembly jig, and the remainder of the joining faces of the body portions **10** and **11** coated with a low melting point glass frit suspension as indicated at **121** in FIG. **27**, and the end faces to receive the screen cup **12** are also coated with frit. The screen cup **12** is then held in position with the assembled body portions and the whole again placed in an oven to fuse the glass frit, thus achieving a completion of the joint between the body portions **10** and **11**, the sealing of that joint, the assembly of the screen cup **12** to the body portions and the sealing of that joint in a single operation.

Once the complete envelope has been sealed in either of the above methods, it is subsequently evacuated by means of a spew indicated at **122** in FIGS. **1** and **2**, which is formed for the purpose in known manner per se and sealed off after evacuation.

In yet a further precedure which is applicable to either of the above basic methods, after the body portions **10** and **11** have been sealed together with glass frit or adhered together with adhesive, in each case with the electrodes assembled between them and removed from the assembly jig, the screen cup **12** may be attached to the body portions with a suitable glass frit between the surfaces and the whole fused for final assembly and sealing in an evacuated oven so that the envelope is sealed in an evacuated condition. This eliminates the need for subsequent evacuation.

In either instance suitable getters may be provided within the envelope in known manner per se to trap any residual gases which may be left within the envelope after it has been sealed.

In either instance, a suitable jig and retaining device (not shown) is provided to hold the screen cup on the end faces of the assembled body portions during the heating cycle in an oven to fuse the glass frit.

In an alternative method of assembling the electron gun electrodes in the body portions **10** and **11**, they may be located in a similar manner by a jig (not shown) which holds them by means of their respective supporting wires at a point outside the wall of the envelope. In this alternative method, the joints between the body portions **10** and **11** and between them and the screen cup **12** may be completed simultaneously either at atmospheric pressure with the envelope subsequently being evacuated as discussed above, or in a vacuum as discussed above. With such a method of assembly it is desirable to use more substantial supporting wires in order to achieve rigidity and accuracy of location of the electrodes, than is the case with the method of assembly discussed above where the electrodes themselves are located by the jig.

It will be appreciated that a number of materials may be used for the construction of the electrodes of the cathode ray tube, stainless steel, titanium or nickel copper alloys being suitable for the grid, anodes, screen, deflection plates, and screencontrol electrodes while a nickel iron alloy is preferred for the support wires for the electrodes. The coefficient of thermal expansion of the support wires is preferably of the same order to that of the glass frit used for sealing the envelope portions in order to make a good strain free seal between the supporting wires and the frit. The support wires are copper plated and borated in known manner per se to improve their compatability with the glass of the fit.

For the envelope portions the preferred material is a barium lithium glass of medium melting point and a preferred glass frit for sealing the portions is a devitrifiable frit such as "Pyroceram" frit as made by Corning Glass Company. The preferred adhesive for use in holding the body portions **10** and **11** together in accordance with one of the methods discussed above, prior to sealing with glass frit, is the adhesive "Insalute" manufactured by Sauerisen Company, Pittsburg, Pa., U.S.A.

The inside of the face **13** of the screen cup is coated in known manner per se with a phosphor suitable to the purpose for which the cathode ray tube is intended such as in television display apparatus.

While the above discussion has been related particularly to embodiments of the invention in the form of cathode ray tubes, it is to be understood that the invention is applicable to other types of vacuum tubes, and finds particular application in any vacuum tube where a number of electrodes or other items are to be located relative to one another with accuracy within the envelope thethe tube.

Thus it can be seen that the invention provides a construction and method of manufacture of vacuum tubes, particularly cathode ray tubes which enables a compact unit to be manufactured. The supporting wires from the

electrodes which also serve to make electrical connection to them may be connected into a conventional type of base plug, but are preferably left as flying leads by which the tube may be connected directly into a circuit, particularly a printed circuit.

What we claim is:

1. A cathode ray tube comprising a glass envelope and a plurality of electrodes therein forming an electron gun assembly; said envelope including two body portions joined together along a seam, conductors supporting and positioning the electrodes of said gun assembly within said envelope, said conductors forming electrical connections to the electrodes from exteriorly of the envelope, said conductors passing through the seam, said envelope including a screen cup having a phosphor-coated face of the tube formed therein, and a second seam joining said screen cup to said body portions; said tube including a directly heated cathode filament and a grid electrode including a metal plate with a grid aperture therein, at least one grid conductor wire supporting said grid plate in the envelope and passing through the seam between the body portions, and two filament conductor wires supporting said filament in the envelope and passing through the seam between the body portions.

2. A cathode ray tube as claimed in claim 1, comprising an insulating member for fastening said grid conductor wire to respectively one of the filament wires so as to form a rigid filament and grid sub-assembly.

3. A cathode ray tube as claimed in claim 1, comprising a glass frit joining and sealing said envelope body portions together, said glass frit having a lower melting point than said body portions.

4. A cathode ray tube as claimed in claim 3, said glass frit being constituted of de-vitrifiable glass material.

5. A cathode ray tube as claimed in claim 1, comprising an adhesive for joining together said envelope body portions, and a glass frit for sealing said body portions, said glass frit having a lower melting point than said body portions.

6. A cathode ray tube as claimed in claim 1, said body portions and said screen cup each being formed of barium lithium glass.

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