PATENT SPECIFICATION

733,683

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COMPLETE SPECIFICATION

Improved Method of Sealing a Thick-walled Glass Exhaust Tube of a Glass Vacuum Vessel

We, PHILIPS ELECTRICAL INDUSTRIES LIMITED, of Spencer House, South Place, Finsbury, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with a method of sealing a thick-walled glass exhaust tube of a glass vacuum vessed, more particularly a cathode-ray tube.

Thin-walled exhaust tubes of the kind used with wireless receiving tubes can be fused without particular measures being taken by heating them locally with a pointed flame and, after the tubule is contracted, drawing it down so that it melts through at the heated point and a thickened glass drop is formed. The heating operation may be effected electrically, as indicated in British Patent Specification No. 559,753. Such exhaust tubes presented no appreciable difficulty since the thickened seal of the tubule did not give rise to cracking.

However, it is quite otherwise when sealing off thick-walled exhaust tubes, as may be used with cathode-ray tubes. If in this case the seal is simply treated in the manner indicated hereinbefore, cracking of the thickened seal nearly always ensues subsequently by reason of the greater wall thickness. For this reason care was taken that, subsequently to the drawing down and melting through of the tubule, the excess of glass was removed from the hot seal, for example, by pulling off glass wires with the use of tweezers. However, this method is tedious and hence expensive and a certain skill is required to provide correct sealing-off so that automatic operation is substantially impossible.

The said disadvantages can be obviated if, according to the invention, in a method of sealing a thick-walled glass exhaust tube of a glass vacuum vessel by locally heating the exhaust tube and melting the glass, the seal and its adjoining part comprising the wall of the tube, subsequent to the sealing of the exhaust tube, is stress-free cooled, without being drawn down and the redundant part of the exhaust tube is then removed mechanically. This removal may be effected with advantage by severing or scratching at about half the length of the sealed part.

The expression "stress-free cooled" means, in this specification, cooling of the sealed part of the exhaust tube so that it becomes solid but simultaneously heating the adjoining part to that temperature which lies just above the lower strain release temperature of the glass, so that stresses are removed, whereafter both parts are allowed to cool down simultaneously so that the seal will be stress-free.

It has been found that, although such an exhaust tube comprises an appreciable thickening at the end, cracking no longer occurs. The entire process can be effected quickly enough for sealing to be completed at one work station of a rotary machine, whilst cooling free from stress can be effected at the next station. Since during heating and sealing, the vacuum vessel is connected to the vacuum pump the gas set free from the thick-walled exhaust tube by the heating process does not find its way into the vacuum vessel, the more so because cooling is effected directly upon sealing the exhaust tube, in contradistinction to the known method according to which heating has still to be effected a considerable time after the tube is sealed for pulling out the seal, melting it through and removing the redundant glass.

Sealing preferably is effected in a small electrically heated furnace but as an alternative it may be effected by dielectric losses which are produced in the glass by a high-frequency field.

In order that the invention may be readily carried into effect, an example will now be

described in detail with reference to the accompanying drawings, in which:—

Fig. 1 shows an exhaust tube sealed off in known manner, and

Figs. 2, 3, 4 and 5 show the last four stages of the method of sealing-off an exhaust tube in accordance with the invention.

Referring to the figures, 1 designates the bottom of a vacuum vessel, in the present instance a cathode-ray tube. Since such a tube has a comparatively high weight the use of a thick-walled exhaust tube 2 is required. According to the known method shown in Fig. 1, subsequent to the exhaust tube being sealed, pulled out and melted through, glass wires 5 are pulled off the seal with the use of tweezers 4 until this seal no longer has a thickened wall. Not until then is the flame 6 removed and the seal ready. Gas set free subsequent to the sealing of the exhaust tube can no longer be drawn off.

In the present invention, the sealing-off time is adjusted to conform with the duration of the work stations of the rotary machine on which the cathode-ray tube 1 is exhausted and sealed. In such a machine the duration of each station is frequently 6 minutes. At the point at which the sealing off operation has to be effected the exhaust tube 2 is surrounded by an annealing furnace consisting of an insulating body 7 in which a heating coil 8, 9 is housed. The lower end 3 of the exhaust tube communicates in the usual manner with the vacuum pump by means of a locking device 10. The heating coil is constituted by two components 8 and 9 which are adapted to be heated separately or together owing to the fact that three current leads are provided which at *a*, *b* and *c* are connected to a current bus-bar. In the position shown in Fig. 2 coil 8 is heated due to that fact that firstly a voltage of 3.2 volts at 13 amp. (40 watts) is connected for 6 minutes between *a* and *b*. The seal is thus slowly heated to about 380°C. The machine then travels to the next position in which the seal is completed due to the fact that between *a* and *b* the voltage is caused to assume a value of 5 volts at 21 amp. (105 watts). After about 16 to 24 seconds the exhaust tube collapses at 11 and heating is then lessened due to the fact that a voltage is applied betweeen *a* and *c* such that the two coils 8 and 9 have jointly supplied to them 28 watts. This results in that the union between the glass wall of the exhaust tube 2 and the sealed part 11, which is located in the middle of the entire coil 8, 9, is cooled evenly and without stress in contradistinction to the union between 11 and the lower end 3 of the exhaust tube, which union is located at the lower limit of coil 8. After a total of 6 minutes this position is left and the vacuum vessel can be removed from the machine, the exhaust tube being shaped in the form shown in Fig. 4. Slight scratching for example with the use of a file, at the point of the arrow enables the exhaust tube end 3 to be broken off with the result that the seal is completed, the exhaust tube being thus shaped in the form shown in Fig. 5. By reason of cooling being effected without stress cracking does not occur in spite of the fact that the tubule has a thickening 12.

Instead of using a double coil 8, 9, use may alternatively be made of a single coil which during the cooling to avoid stresses, may be raised to such level that the union between the exhaust tube 2 and the seal 11 is at the centre of the coil. However, the mechanism for raising the small furnace 7 is more intricate than the provision of a double heating coil. Heating may alternatively be effected directly by means of gas burners but the use of gas burners is not advisable since heating to a given constant temperature is more difficult.

It is found that the method according to the invention can be carried out quite automatically since the time for sealing the exhaust tube is not critical but may be adjusted between 16 and 24 sec., the time during which the powerful current is passed through the coil being preferably adjusted to 20 sec. Scratching the part 11 may be effected automatically but since the vacuum vessel is required to be removed from the machine it is more simple to effect this scratching by hand with the use of a small file. This does not require any particular skill. As a matter of fact the above-mentioned data depend on the construction and size of machine, exhaust tube, annealing furnace and so forth.

Instead of the coil itself being heated by the passage of current so that the exhaust tube is largely heated by heat radiation it is also possible to pass a high-frequency current through the coil, the exhaust tube being heated by dielectric loss heat produced in the glass itself.

What we claim is:—

1. A method of sealing a thick-walled glass exhaust tube of a glass vacuum vessel, according to which the exhaust tube is heated locally and the glass melted, characterized in that subsequent to the exhaust tube being closed by sealing, the seal and its adjoining part comprising the wall of the tube is stress-free cooled, as hereinbefore defined, without being drawn down and the redundant part of the exhaust tube is then removed mechanically.

2. A method as claimed in Claim 1, characterized in that local heating, melting and stress free cooling of the exhaust tube is effected in an electrical annealing furnace.

3. A method as claimed in Claim 2, characterized in that the electrical furnace has a heating coil constituted by two parts, one part being used for melting and both

parts jointly for stress free cooling.

4. A method as claimed in Claim 3, characterized in that the exhaust tube is heated due to the fact that the coil itself is heated by the passage of current.

5. A method as claimed in Claim 3, characterized in that heating is effected by heat produced in the glass itself due to a high-frequency current in the heating coil of the electrical furnace.

6. A vacuum vessel, more particularly a cathode-ray tube, produced by the method claimed in Claims 1 to 4, and 5.

7. The method of sealing a thick-walled glass exhaust tube of a glass vacuum vessel substantially as described with reference to Figs. 2 to 5 of the accompanying drawing.

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733,683 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

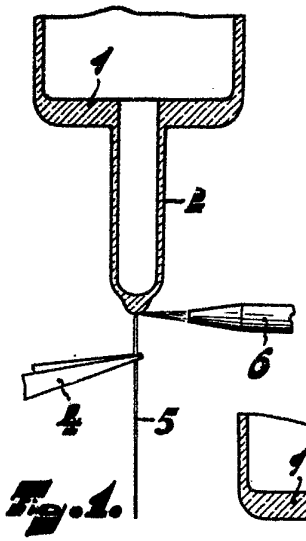

Fig. 1.

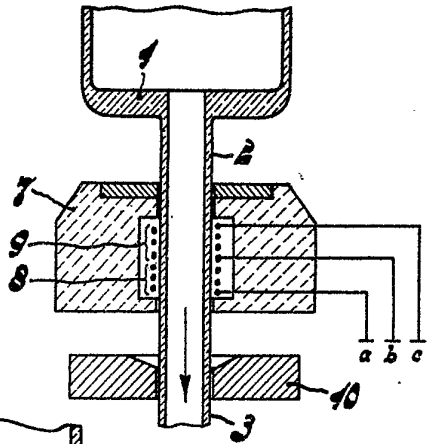

Fig. 2.

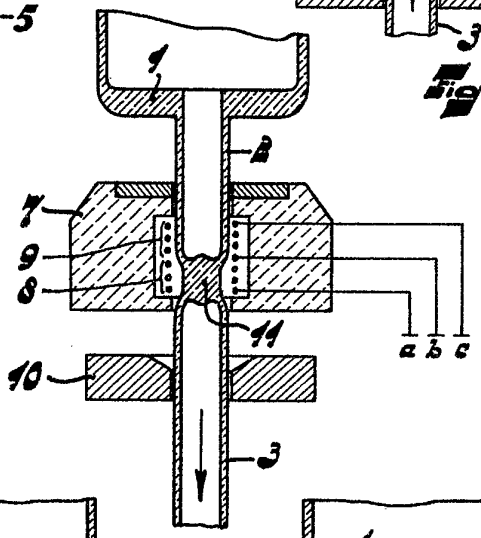

Fig. 3.

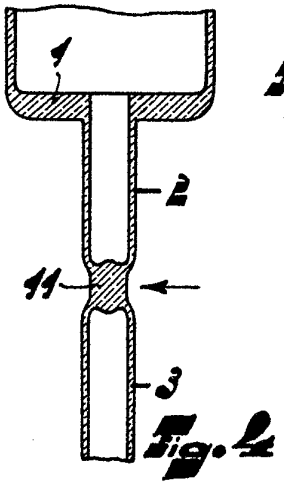

Fig. 4.

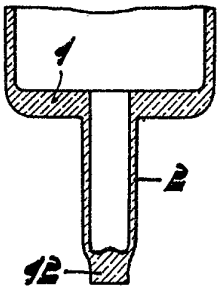

Fig. 5.