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GLASS TO METAL SEAL FOR HIGH-FREQUENCY ELECTRONIC TUBES

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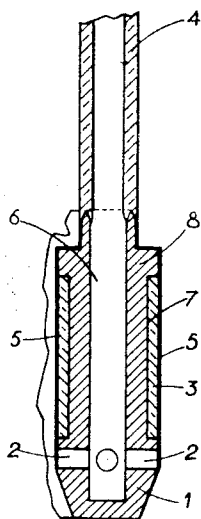


FIG. 1

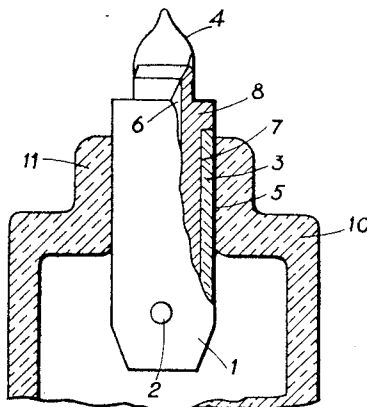


FIG. 2

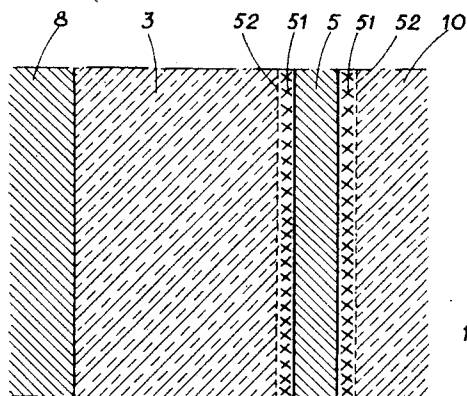


FIG. 3

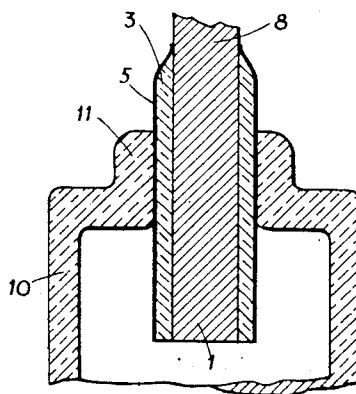


FIG. 4

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GLASS TO METAL SEAL FOR HIGH-FREQUENCY
ELECTRONIC TUBES

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6 Claims. (Cl. 174—50.61)

The invention refers to lead-through arrangements for connecting external electrical conductors to apparatus mounted in air tight enclosures and more particularly it relates to lead-through arrangements for tubes operating at very high frequencies for instance, in the centimeter wave length range. It is particularly applicable to lead-through arrangements of a conductor in Kovar or similar metals passing through glass or any other insulating substance, and sealed to the latter so as to be air tight.

In order to secure an air tight and stable joint, a conductor material is generally used for the lead-through, which practically has the same dilatation coefficient as the glass that it traverses. The metallic material designated by the name of Kovar, which is an alloy of iron, nickel and cobalt, is particularly satisfactory in this respect since it has a relatively low dilatation coefficient. In order to form the joint, the zone of contact is subjected to high temperature by means of a blow pipe in order to melt the glass in contact with the Kovar.

While such joint is perfectly satisfactory in tubes operating on relatively low frequencies, it presents serious inconveniences in case of very high frequencies, inconveniences which are multiplied in case of centimetric waves.

As it is known, for the latter, the "skin effect" intervenes and causes the displacement of the current lines toward the conductor periphery. This effect is the more accentuated as the frequency increases and as the metal offers greater magnetic permeability which is the case with Kovar i. e. a material of relatively great magnetic permeability. Besides, it happens that following the thermic sealing operation, the Kovar will be oxidized on its surface to a great extent, and the current which is located at the conductor surface will find a great resistance therein resulting in disturbing reflections and especially great losses which may even comprise the operation of the tube. Moreover these losses produce excessive local heating whereby even the air tight qualities of the joint are jeopardized.

The primary object of the invention is a new mode of manufacture of such air tight lead-through arrangements, which are not subject to high losses and with which a normal and stable operation of the tube is achieved.

It is also an object of the present invention to provide any kind of vacuum tube with an air tight envelope and more particularly any tube destined for ultra high frequencies, including a lead-through in Kovar—glass or similar combination, made according to the present invention and free from any coat of current flow resisting oxide.

According to the invention, a thin coat or film of silver or any other equivalent metal, not easily oxidizable or completely unoxidizable, is introduced into the joint, between the glass envelope and the Kovar conductor, this coat being disposed with respect to the Kovar and joined

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to it, so as to constitute for the current circulating on the metal surface a path of high electric conductivity through the air tight zone of the joint.

It has been ascertained that when this film is directly laid on the metallic conductor, the contact between silver and Kovar is not always perfect and stable and, after a long while, will often fail to keep tight under high vacuum conditions. To obviate this inconvenience, according to the principal characteristic of the invention, a coat of glass or of similar substance adhering to the conductor in intimate and air tight manner is introduced between the silver film and the conductor, the dilatation coefficient of this coat being adjusted to the coefficients of the conductor and the envelope.

According to a preferred embodiment of the present invention, in order not to deform the trajectories of the current on the surface, and to avoid any discontinuity, this glass coat is inserted into a hollow or groove made in the conductor, the silver film being flush with the surface of the conductor and forming its natural prolongation. This coat of glass will extend along a great part of the length of the joint, and in most of the cases will occupy the whole zone of the joint and even will extend beyond it. It will bear the said silver film in the zone of the joint.

According to another embodiment, a glass sleeve is slipped around the conductor and air tightly sealed to it, the sides of this sleeve having a relatively small thickness and progressively joining the conductor surface at its ends.

These entrances for the current will be more particularly applicable for the anodic feeding and at the same time for constituting the anodes. The conductor may be provided with an internal channel for exhaustion pumping of the tube, and for allowing to secure an efficient cooling, namely during the period of strain of the intermediate coat.

The invention will be better understood with the help of the enclosed drawings, giving its modes of embodiment, as non limiting examples, and in which:

Fig. 1 represents an entrance conductor lead-through provided with a groove filled with a coat of glass having the silver film on its surface, ready to be sealed to the envelope;

Fig. 2 represents the conductor sealed through the envelope and acting as an anode;

Fig. 3 represents the structure of the joint of Fig. 2, in cross section and on a larger scale; and

Fig. 4 represents another embodiment of an air tight lead-through arrangement including an intermediate glass sleeve.

The conductor of the lead-through arrangement shown in Fig. 1 is an anode structure formed of the Kovar part including anode 1, surmounted by Kovar tube 8 whose central canal 6 opens laterally into orifices 2, and which is prolonged at its other end by glass tube 4 soldered onto the edges of tube 8. Tube 8 is formed with a hollow 7 filled with a coat of glass 3 preferably adhering to the Kovar and whose surface is smoothed so as to form a continuous cylindrical surface, with the lateral sides of tube 8. This glass coat has been laid by heating tube 8 and winding softened glass around the groove 7. The softened glass is obtained by simultaneously heating a glass rod so chosen as to possess a dilatation coefficient equal to the dilation coefficient of Kovar and of the tube envelope to which the lead-through will be soldered. Once the groove is full of glass, the latter is smoothed so as to obtain the said cylindrical surface. Then, the part so obtained is covered with a silver coat 5 which provides an uninterrupted electrically conductive path leading over the glass 3 and the metal 8.

The silver coat is made by applying silver in colloidal suspension with a brush, to the surface to be coated, and subsequent drying of the thus-coated surface so as to obtain a hard and adhering metallized coat. This silver coat has a thickness of the order of 10 microns.

Then, as it is seen in Fig. 2, the previously prepared silvered part is introduced into the aperture prepared in advance in glass part 10, this glass being so chosen as to have a dilatation coefficient practically identical to that of the glass coat 3 which is seen in the groove made in the anode. The region 11 of part 10 is then flame heated. This heating is communicated by conductivity to silver coat 5 and to glass 3. The silver is very little oxidized and the little of oxide which is formed is dissolved into the glass. At the same time the silver diffuses in the glass, and thus the joint is formed. In the course of this operation, part 11 is, if needed, pressed so as to deform it and to better apply it against the silver coat.

The structure of the thus obtained joint is shown in Fig. 3 wherein the silver coat 5 is seen inserted between glass coat 3 and glass 10 of the envelope portion. On both sides of 5, some silver is found in diffused state in the glass as indicated by reference numeral 51, as well as traces of dissolved silver oxide indicated by reference numeral 52, thus forming a seal which is at the same time air tight and a good conductor, due to silver coat 5.

The glass 3 is in continuous air tight contact with the metal of the part 8.

After having assembled this joint, one proceeds to assemble the other parts of the envelope which may be sealed by any known method, so as to obtain an air tight enclosure. The evacuation of the enclosure is carried out through glass pipe 4 shown in Fig. 1, which is used as an air exhausting pipe, the air being exhausted through the pipe 6 and orifices 2 which are situated in the air tight enclosure. When the desired degree of vacuum is obtained, the air exhausting glass pipe is sealed as can be seen in Fig. 2 where reference numeral 4 represents the glass pipe sealed at this point. It is to be well understood that the invention is not limited to the laying of glass in the groove of the metallic part.

As can be seen in Fig. 4, it is possible to arrange the glass coat 3 by slipping the glass sleeve 3 on the Kovar conductor 8 and soldering; then the glass surfaces are joined to those of part 8, and it is proceeded further as above described.

In certain cases, glass 3 might be replaced by any other material having a dilatation coefficient like the Kovar and the envelope material. To this effect, enamel for instance may be used.

Any other metal which is not or only slightly oxidizable may be substituted for silver, provided it can be deposited in the form of a thin air tight coat, and adapted to be soldered to the intermediate material and to the envelope.

Moreover, part 11 of the envelope may be formed of any insulating material meeting the condition of having a dilatation coefficient substantially equal to that of the electrode of being adapted to be air tightly soldered to the metal film used.

In any case, it is necessary to adjust the dilatation coefficients of the joint materials by preferably making all these dilatation coefficients be identical to one another. The silver being present in a very thin and plastic coat only, has no effect in this respect, since the silver coat due to its thinness will not destroy the joint by thermic dilatation.

Lead-through arrangements as disclosed herein and especially such anodes are particularly adapted for producing "light-house" tubes or very high frequency transmission tubes, i. e. for tubes whose output is made on a coaxial line. The electrode shown in Figs. 1, 2 and 4

will constitute the end of the central conductor of the coaxial line. The end of the electrode which is outside of the tube is then formed in such a way as to be able to match the central conductor of said coaxial thereon so that this electrode will constitute a prolongation of the same.

What we claim is:

1. Electrical apparatus comprising, in combination, a wall portion of an electrically non-conductive material selected from the group of glasses and ceramics formed with an opening passing therethrough; a metallic conductor having approximately the same coefficient of expansion as said wall portion extending through said opening of said wall portion and being spaced from the latter, said metallic conductor being formed with a groove around the portion of its peripheral surface extending through said opening; a covering of insulating material selected from the group of glasses and ceramics having approximately the same coefficient of expansion as said metallic conductor adhering to said metallic conductor and being located about the same in said groove thereof and extending through said opening; and a silver coating formed by application with a brush of a colloidal silver suspension, said silver coating overlying and adhering to said covering and extending beyond the ends thereof in contact with said metallic conductor, said silver coating being sealed to said wall portion at the opening therein.

2. A lead-in connection for air-tight envelopes made of insulating material for high-frequency electronic tubes, of the type consisting essentially of a metallic conductor comprising a coating of non-oxidizable metal, said conductor having substantially the same coefficient of expansion as that of said envelope and projecting through a bore provided in a wall portion of said envelope, and a sleeve of insulating material having substantially the same coefficient of expansion as said envelope; wherein said insulating sleeve surrounds in an intimate and air-tight manner a bare portion of said metallic conductor extending through said bore; said coating covering said insulating sleeve and the portions of said metallic conductor extending beyond both ends of said sleeve, thereby to cause said coating to conduct high electrical currents on the surface of said metallic conductor, said coating being intimately sealed to said wall portion at said through bore, a diffusion layer of said non-oxidizable metal penetrating into the insulating material constituting said wall portion in contact therewith.

3. An air-tight vacuum seal element as claimed in claim 2, in which said wall portion and said insulating sleeve are made of glass, said metallic conductor being made of an alloy of iron, nickel and cobalt.

4. Electrical apparatus comprising, in combination, a wall portion of an electrically non-conductive material selected from the group of glasses and ceramics formed with an opening passing therethrough; a metallic conductor having approximately the same coefficient of expansion as said wall portion extending through said opening of said wall portion and being spaced from the latter, said metallic conductor being formed with a groove around the portion of its peripheral surface extending through said opening; a covering of insulating material selected from the group of glasses and ceramics having approximately the same coefficient of expansion as said metallic conductor adhering to said metallic conductor and being located about the same in said groove thereof and extending through said opening; and a non-oxidizable metallic coating overlying and adhering to said covering and extending beyond the ends thereof in contact with said metallic conductor, said non-oxidizable metallic coating being sealed to said wall portion and the opening therein.

5. Electrical apparatus as described in claim 1 where-

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in said covering of insulating material fills said groove
in said metallic conductor.

6. Electrical apparatus as described in claim 4 wherein
said covering of insulating material fills said groove in
said metallic conductor.

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