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[73] Assignee **Thomson-CSF**
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[33] **France**
[31] **157,477**

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[54] **METHOD OF MANUFACTURING TUBES FOR TUBULAR ELECTRON-MULTIPLIERS**
3 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** 316/3, 29/25.11, 29/25.17, 65/60, 65/112, 117/4
[51] **Int. Cl.** **H01j 9/38**
[50] **Field of Search** 29/25.1, 25.11, 25.17; 316/3, 4, 1, 2; 117/4; 65/28, 42, 60, 112

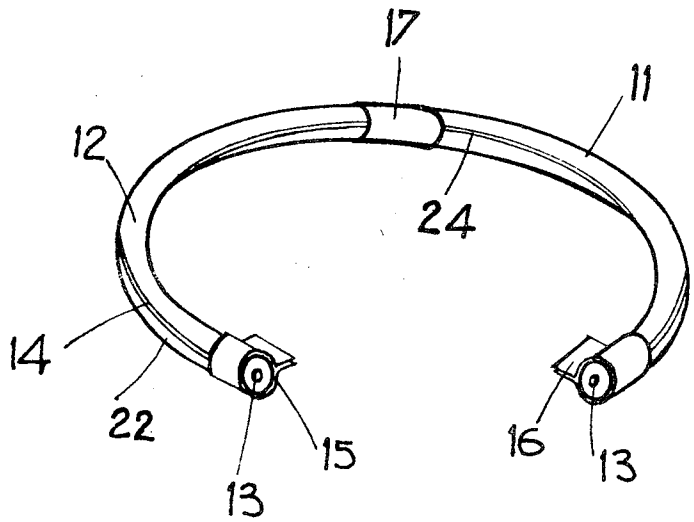
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ABSTRACT: The tube is cut along two of its generatrices 14 and 24, over the whole of its length, and the two halves 12 and 22 thus obtained receive a secondary electron emissive coating on their inner walls. The two halves are then replaced in their initial position relatively to one another.



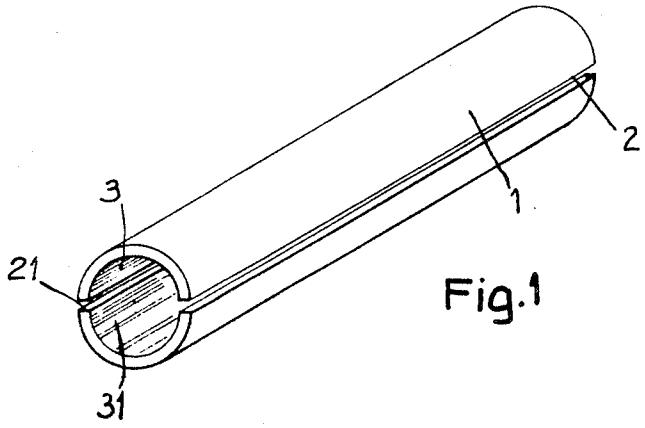


Fig.1

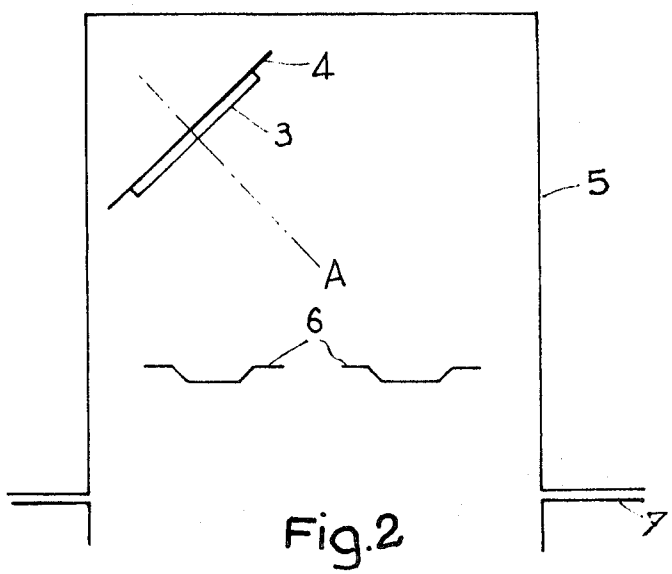


Fig.2

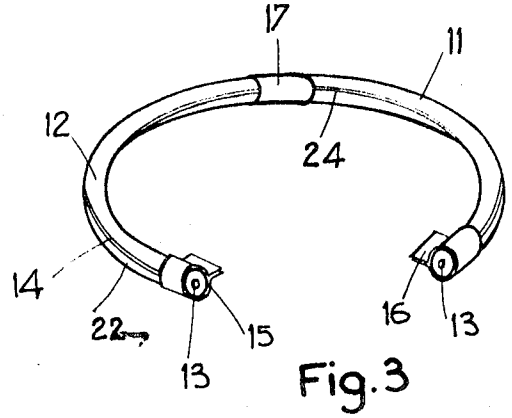


Fig.3

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METHOD OF MANUFACTURING TUBES FOR TUBULAR ELECTRON-MULTIPLIERS

The present invention relates to electron-multipliers and more particularly to devices of this kind in which multiplication of primary electrons forming a beam is effected through a sequence of secondary emissions inside a rectilinear or curved passage in which a longitudinal electric field is present.

It should be recalled that a tubular electron-multiplier comprises one or more rectilinear or curved tubes, generally of insulating material, whose internal walls are coated with a resistive layer capable of secondary electron emission with a coefficient of $\delta > 1$, whilst a potential difference, established between the ends of the coating, develops a longitudinal electric field in the tubular passage. With this kind of arrangement, a beam of primary electrons entering such a passage gives rise to a sequence of secondary electron emissions at the internal coating, so that at the output of the passage the number of electrons is substantially increased in relation to the number of electrons in the primary electron beam.

At the present only two methods of producing emissive coatings in the tubes of tubular electron-multipliers, are generally used. However, experience shows that, with these methods, the deposits obtained lack uniformity if the whole of the tube length is considered. This length is usually about 20 times the internal diameter of the tube and often much longer.

These methods involve:

- the production of deposits from the liquid or gas phase, in which chemical reaction of a gas flow at high temperature, for example tin chloride, is effected during passage through the tube in question in order to produce upon its internal face a layer of tin oxide;
- or a chemical treatment of the insulating material of which the tube is made and which is chosen specifically for the purpose.

It is an object of this invention to avoid this drawback.

According to the invention there is provided a method of manufacturing tubes for tubular electron-multipliers comprising the following steps: cutting the tube over the whole of its length along two of its generatrices, depositing on the inner wall of the two tube halves thus obtained a resistive layer having secondary electron emission properties, replacing, after processing, the two tube halves in their initial position in relation to one another and maintaining them in this position.

For a better understanding of the invention and to show how the same may be carried into effect reference will be made to the drawing accompanying the ensuing description and the attached Figures in which:

FIG. 1 illustrates the tube of an electron-multiplier, ready for the depositing operation in accordance with the invention;

FIG. 2 is a schematic partial view of an example of an installation used in the processing of tubes of the kind shown in FIG. 1; and

FIG. 3 is an example of the finished tube of a tubular electron-multiplier, in accordance with the invention.

In all these Figures, similar reference numbers designate similar elements.

FIG. 1 illustrates an example of a tube for a tubular electron-multiplier, ready for being processed in accordance with the invention. The insulating tube **1** which is straight, is cut over the whole of its length along two diametrally opposite generatrices **2** and **21** into two halves **3** and **31**.

In the installation of FIG. 2, the two halves **3** and **31** of the tube, are fixed to a plate **4** which is made to rotate about the axis A (in this Figure only the half **3** can be seen, in section),

within an evacuated enclosure **5** mounted on a frame **7**. Inside the enclosure **5** there are placed two crucibles **6** containing the product which is to be deposited upon the internal wall of the half-tubes **3** and **31** which face them. In the example of FIG. 2, deposition is effected by vaporization under vacuum. In another embodiment of the invention, this deposition operation is carried out under vacuum by cathode-sputtering of the semiconductor material contained in the crucibles, for example of tin oxide.

The significance of the methods of the invention rests essentially on the fact that it makes it possible to obtain deposits of a precisely controlled thickness, whatever this thickness.

In particular, it may be desirable to stimulate the secondary emission by providing a very thin film of a suitable substance deposited upon a first coating. The method of the invention makes it possible to control precisely the thickness of the layer successively deposited upon each other.

Moreover, with the characteristics arrangement according to the invention, in which the tube is presented to the processing installation in two separate halves, the thickness of the deposit, which is uniform over the whole of the length of the tube, can be monitored in a particularly efficient manner during the operation by means of a crystal as well known in the art: a reference crystal carrying no deposit is made to heterodyne with another crystal placed in the installation in such a position that it receives a deposit of the same thickness as the two parts of the tube, and the heterodyne or beat frequency is compared with a low reference frequency.

The resistance can also be controlled directly by using a glass element equipped with two electrodes and receiving a deposited film at the same time as the two halves of the tube. The operation is halted when the surface resistance required has been reached, and any complementary operations, such as the deposition of a further very thin film is then carried out.

FIG. 3 shows an embodiment of a tube for a tubular electron-multiplier, produced in accordance with the invention.

On the internal faces of the two halves **12** and **22** of a curved glass tube **11**, the coating or film **13** is deposited. After deposition, the two halves **12** and **22**, which have been severed along the generatrices **14** and **24**, are replaced in their initial position and clamped together at their two ends by the crimped collars **15** and **16**, and at their center by the araldite-bonded collar **17**.

In the example of FIG. 3, the tube has a length of 75 mm. overall and an internal diameter of around 1 mm. The coating is constituted by a tin oxide film 2,000 A. thick. For one electron entering the tube at one end about, 10^8 electrons spread over an interval of 10 ns. may be obtained at the other end.

The invention is of course not limited to the examples described and illustrated, which were given solely by way of example.

What I claim is:

1. A method of manufacturing tubes for tubular electron-multipliers comprising the following steps: cutting the tube over the whole of its length along two of its generatrices, depositing on the inner wall of the two tube halves thus obtained a resistive layer having secondary electron emission properties, replacing, after processing, the two tube halves in their initial position in relation to one another and maintaining them in this position.

2. A method of manufacturing the tubes of tubular electron-multipliers as claimed in claim **1**, in which said tubes are rectilinear.

3. A method of manufacturing the tubes of tubular electron-multipliers as claimed in claim **1**, in which said tubes are curved.