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FIELD EMISSION TUBE WITH LOW TEMPERATURE GAS ADSORPTION

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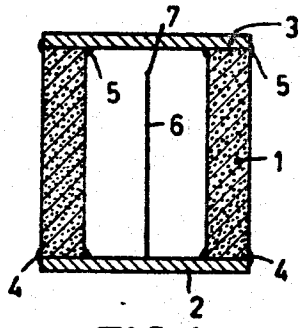

FIG.1

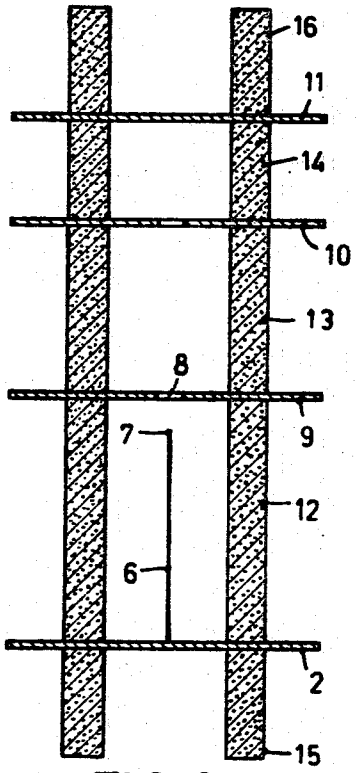

FIG.2

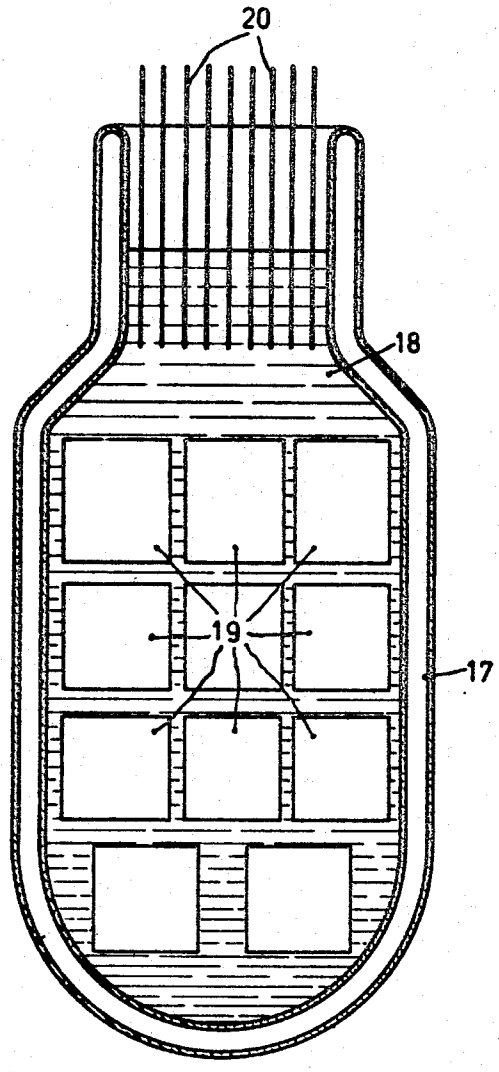

FIG.3

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FIELD EMISSION TUBE WITH LOW TEMPERATURE GAS ADSORPTION

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2 Claims. (Cl. 313—11)

The invention relates to a device employing an electric discharge tube in which the cathode consists of a conductive part having a very small radius of curvature on which the field of the anode is operative, a field emission cathode which is not heated. The invention further relates to an electric discharge tube for such a device and to a method of manufacturing such a discharge tube.

As a result of their small proportions, high current densities and the absence of a heating element field emission cathodes have the advantage that the dimensions of a discharge tube may be very small. In this case, the anode voltage need not be extremely high to obtain nevertheless sufficient field strength at the cathode. As a result of this, such tubes would be highly suitable, for example, for assembly in large numbers in compact logical networks.

A drawback of such tubes, however, is that the required vacuum is so extreme, namely pressures lower than 10^{-13} torr, that this is hardly obtainable with the normal means. Even if right after the manufacture of a tube, the pressure would be sufficiently low, the pressure would soon have become too high, in particular as a result of the small volume of such small tubes with respect to the area.

A difficulty with the small dimensions is that the presence of an exhaust tube increases the dimensions disproportionately. Although it is possible to solder a discharge tube together in vacuum from the component parts, this has the disadvantage for a tube with a field emission cathode that soldering material evaporates at the required high soldering temperature and precipitates on the cathode. As a result of this, these cathodes usually become useless.

The object of the invention is to provide a device and a discharge tube for such a device which do not have the above drawbacks.

In a device with an electric discharge tube in which the cathode consists of a conductive part with a very small radius of curvature on which the electric field is operative, according to the invention, the discharge tube is located in a space having such a low temperature that the residual gas possibly present in adsorbed to such an extent that the requirements for field emission from a non-heated cathode are satisfied, while in the tube argon is available with a pressure of a few tens torr at room temperature and this tube consists of metal and ceramic parts soldered together.

The tube according to the invention is soldered together in an argon atmosphere at a pressure of the order of ten torr, which has the advantage that the possible evaporation of the solder is no longer harmful. The argon may first have been used as a cleaning gas. The argon of low pressure left in the tube after soldering does not disturb the operation of the tube at the low temperature, for example that of liquid helium, because the gas which is condensed then has a sufficiently low vapor pressure.

In order that the invention may be readily carried into effect, an embodiment thereof will now be described more fully, by way of example, with reference to the accompanying drawing, in which:

FIG. 1 is a cross-sectional view of a diode according to the invention,

FIG. 2 is a controllable discharge tube, and

FIG. 3 diagrammatically shows a device employing a number of the tubes according to the invention.

In FIG. 1, reference numeral **1** is a cylinder of pure aluminum oxide against which the cathode plate **2** and the anode plate **3** are soldered by means of soldering edges **4** and **5** respectively. The plates consist of molybdenum. They are soldered to the cylinder metallized with molybdenum manganese powder by means of silver. A tungsten wire **6** of 0.1 mm. thickness is welded to the cathode plate **2**, the tip **7** of said wire having a radius of curvature 2×10^{-5} mm. The distance from the tip **7** to the plate **3** is 0.3 mm. The diameter of the cathode and anode plates is 3 mms. and the height of the cylinder is 4 mms. The tube is sealed by soldering after degassing in an atmosphere of argon of 20 torr. If the tube is dipped in liquid helium, a current of 10μa. may be obtained at an anode voltage of 0.75 kv.

In FIG. 2, the cathode **6, 7** is arranged in the same manner as in the case of FIG. 1. The tip of the cathode is located opposite an aperture **8** in the plate **9** on which, in the direction of movement of the electrons, follow the perforated plate **10** and finally the anode **11**. The cathode plate **2** and the plates **9, 10** and **11** are insulated from one another by the cylinders of aluminum oxide **12, 13, 14** soldered thereto in a vacuum-tight manner, while on the outside cylinders **15** and **16** are soldered so as to decrease the tension in the soldering points.

The plate **9**, as was the case in the tube of FIG. 1, has a voltage of 0.75 kv. with respect to the cathode. The plate **10** is approximately at cathode potential. With this plate the electron current, which is accelerated by the plate **9** operating as the first anode, may be controlled, as a result of which consequently the anode current is determined.

In FIG. 3, the cryostat is diagrammatically shown by means of the single Dewar flask **17** which contains liquid helium **18** nearly to the rim. In this liquid helium, components **19** are located each comprising a number of tubes **19** of the type described in FIG. 2. The electric supply wires **20** for the tubes **19** are passed through the neck of the Dewar flask. The passive switching elements are located in the components.

What is claimed is:

1. An electric discharge device comprising an envelope containing an anode and a cathode, said cathode comprising a wire-like element having one end spaced from the anode with a relatively small radius of curvature whereby electrons are emitted from said cathode by the action of an electric field produced by the anode, said envelope comprising metal portions separated by and joined to ceramic portions by a solder material, an argon atmosphere in said envelope at a pressure of the order of ten torr at room temperature, and means to cool said envelope to a temperature substantially below room temperature and at which the argon gas is substantially adsorbed by said envelope.

2. An electric discharge device as defined in claim **1** in which the cooling means is a vessel substantially filled with liquid helium surrounding said envelope.

No references cited.

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