Oct. 21, 1969 M. BETOULE ET AL 3,474,276

ELECTRON MULTIPLIER TUBE WITH INTERPOSED DYNODES SUPPORTED BY DISCS AND INSULATING RINGS

Filed Jan. 15, 1968 3 Sheets-Sheet 1

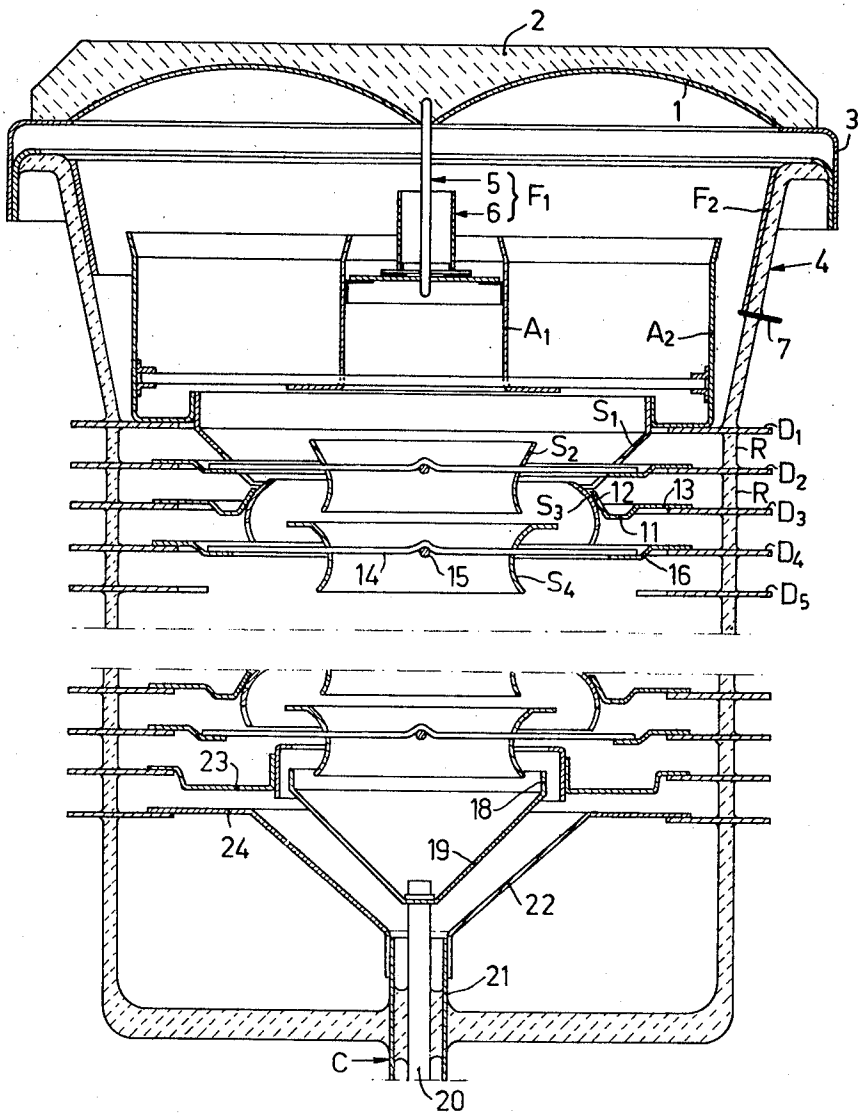

FIG.1

INVENTORS
MICHEL BETOULE
PIERRE L'HERMITE
RENE PETIT

BY Frank R. Trifari

AGENT

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Filed Jan. 15, 1968 3 Sheets-Sheet 2

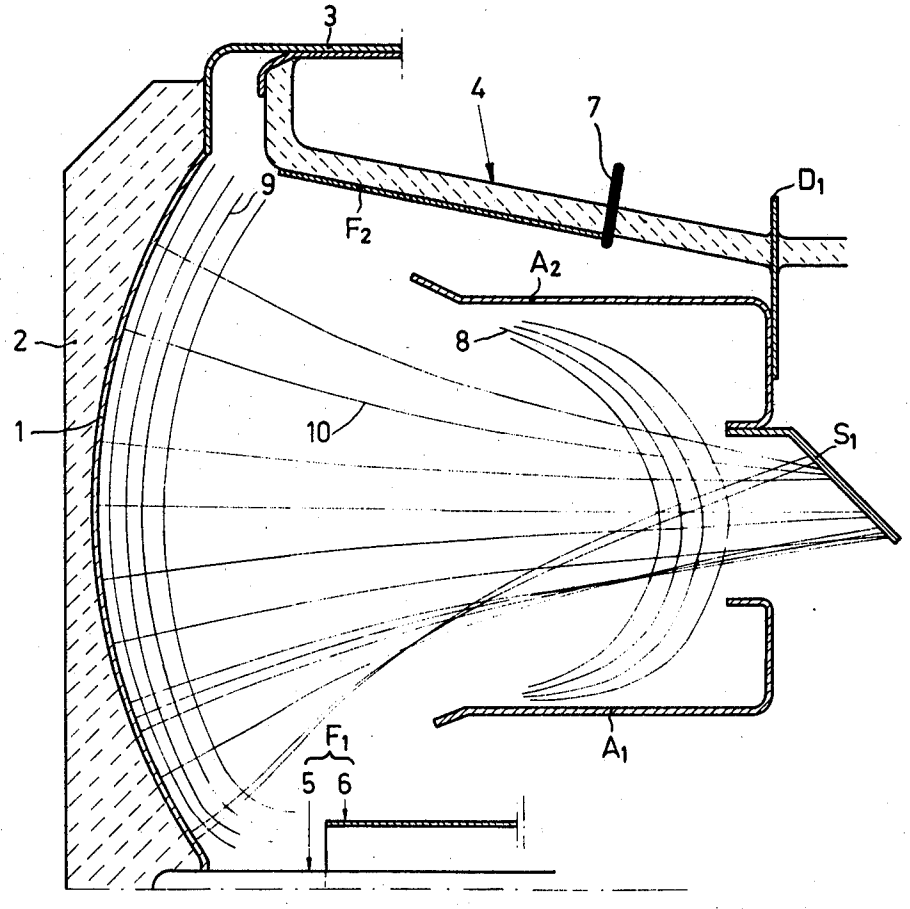

FIG.2

INVENTORS
MICHEL BETOULE
PIERRE L'HERMITE
RENE PETIT
BY
Frank R. Sinfani
AGENT

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Filed Jan. 15, 1968 3 Sheets-Sheet 3

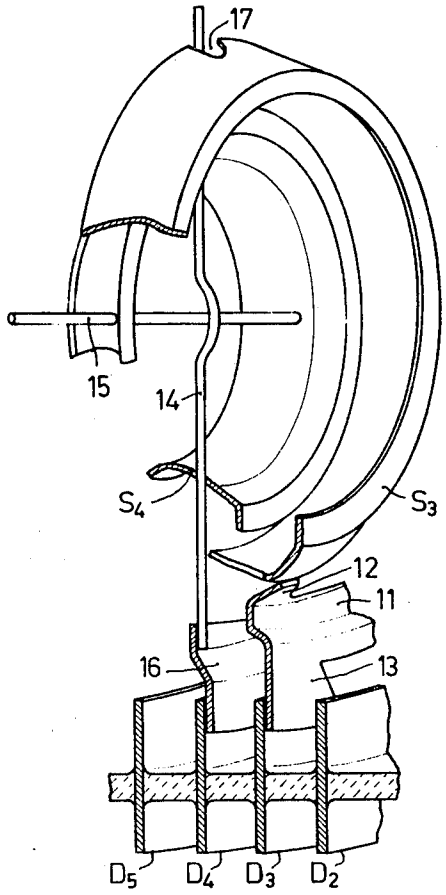

FIG.3

INVENTORS
MICHEL BETOULE
PIERRE L'HERMITE
RENE PETIT
BY
Franck P. Trifari
AGENT

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3,474,276

ELECTRON MULTIPLIER TUBE WITH INTERPOSED DYNODES SUPPORTED BY DISCS AND INSULATING RINGS

Michel Betoule, 7 Rue Jules Renard; Pierre L'Hermite, Residence Maillard, Avenue Maillard; and René Petit, 7 Rue Charles Peguy, all of Brive, Correze, France

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Claims priority, application France, Jan. 13, 1967, 91,004
Int. Cl. H01j 43/18
U.S. Cl. 313—105 3 Claims

ABSTRACT OF THE DISCLOSURE

An electron multiplier employing outer and inner dynodes of the front surface type which are supported by discs alternating with insulating rings to form an outer wall. The inner dynodes are further supported by crossed, rod-shaped members which are connected to diametrically opposite points of a disc member to provide a more rigid support for the inner dynode.

The invention relates to an electron multiplier tube whose wall comprises a pile of insulating rings and electrically conductive, annular discs supporting dynodes, which form coaxial bodies of revolution, and at least one of which is an inner dynode located partly inside an outer dynode.

Electron multiplier tubes whose dynode structure forms a coaxial structure of revolution usually comprise a great number of inner dynodes alternating with outer dynodes, the dynodes being supported in common from insulating supports, while separate electrically conductive wires taken through the tube wall establish the connection with an external voltage source. These electron multipliers have, however, electric connections of high capacitance and have only low resistance to mechanical shocks.

There is known an electron multiplier tube in which the dynodes, which form a coaxial structure of revolution, are supported from electrically conductive, annular discs forming part of the tube wall. The tube wall comprises a sealed pile of the discs and insulating rings. The discs serve not only for supporting the dynodes but also for establishing electrical connections between the dynodes and a voltage source, while they form means for an effective heat exchange. In this known electron multiplier tube inner dynodes are connected by means of cylindrical lengths of tubes with the discs so that the number of dynodes and their geometry are restricted. The lengths of tubes form a detrimental screening for the flow of electrons.

The invention has for its object to provide an electron multiplier tube in which dynodes of revolutions are secured to electrically conductive, annular discs in the wall of the tube, in which the aforesaid disadvantages are mitigated.

According to the invention, in an electron multiplier tube whose wall comprises a pile of insulating rings and electrically conductive, annular discs supporting dynodes forming coaxial bodies of revolution, at least one of which dynodes is an inner dynode located partly inside an outer dynode, said inner dynode is connected with the disc supporting the same by means of at least one rod-shaped, electrically conductive support, which extends at least substantially transversely of the axis of revolution of the dynodes. In this tube said inner dynode is firmly supported and the connection is satisfactorily resistant to mechanical shocks. The outer electrode may be supported from an annular support bearing on the disc holding the outer electrode. Such an annular support preferably has connecting tabs on the inner side and on the outer side. The rod-shaped electrically conductive support may bear on an annular support on the disc holding the inner electrode. The outer electrode is preferably provided with passages for the rod-shaped support.

The invention will be described more fully with reference to the accompanying drawing, in which:

FIGURE 1 is a sectional view of the upper part and the lower part of one embodiment of an electron multiplier tube according to the invention.

FIG. 2 shows part of the input stage of the tube of FIG. 1.

FIG. 3 shows an amplifying stage of the tube of FIG. 1.

The input stage comprises a photocathode **1** provided on the rear side of a front plate **2** of glass. The front plate **2** is sealed to a metal ring **3**, to which the further part **4** of the tube envelope is secured, and which serves for the electrical connection of the photocathode **1**. A first focusing electrode F_1 is formed by a wire **5**, which is secured to the center of the photocathode **1**, and a tube **6**. A second focusing electrode F_2 is formed by the application of aluminum from the vapor phase to the tube envelope. The focusing electrode F_1 is at the potential of the photocathodecathode **1** and the focusing electrode F_2 is connected to a voltage source (not shown) via a through-connection **7**. A first acceleration electrode A_1 and a second acceleration electrode A_2 are at the potential of the first dynode S_1. The shape of the photocathode **1**, which is a body of revolution about the tube axis, is accurately indicated in the drawing. The shape of the photocathode and the position of the focusing electrodes permit obtaining by means of a circle-section beam of radiation, a flow of photoelectrons of annular section, which is collected substantially completely by the first dynode. The active surface of the photocathode is an annular surface having circles of diameters of 90 mm. and 3 mm., respectively. In theory 99.9% of the photoelectrons are collected in this case. FIG. 2 shows the configuration of the electric field in the input stage of the tube of FIG. 1 in the form of a number of equipotential lines (**8** and **9** for example). FIG. 2 shows more accurately the trajectories of the photoelectrons (for example, **10**).

The part of the tube of FIG. 1, which is essential for this invention, is formed by the amplifying stages. As is shown in FIG. 1, these stages comprise outer dynodes designated by odd ordinal numbers S_1, S_3, etc., and inner dynodes designated by even ordinal numbers S_2, S_4, etc. The dynodes S_1, S_2, S_3, S_4, etc., are supported by electrically conductive discs D_1, D_2, D_3, D_4, etc. The discs are sealed to the rings R, lying between them and serve as electrical conductors for the dynodes. The supply conductors are connected in a known manner to increasingly positive voltages, which are adapted to obtain satisfactory characteristics of linearity and fastness of response. FIG. 3 is an elevation of the amplifying stage of the tube of FIG. 1, partly shown broken away. This amplifying stage comprises the outer dynode S_3 and the inner dynode S_4. The outer dynode S_3 is secured to an annular support **11**, having a tab **12** for the connection with the dynode S_3 and a tab **13** for the connection with the disc D_3. The shape of the support **11** ensures an excellent mechanical rigidity. The inner dynode S_4 is supported from two crossed wires **14** and **15** of metal, secured to a support **16**, which bears on the disc D_4. The dynode S_3, has passages **17** for the metal wires **14** and **15**. The connection of the inner dynode also ensures a good mechanical rigidity, while the connecting means will substantially not affect the flow of electrons.

The output stage of the tube of FIG. 1 is subject matter of copending patent application Ser. No. 697,751, filed Jan. 15, 1968. As is shown in FIG. 1 the output stage comprises a cylindrical anode **18**, having a conical pro-

longation **19** which is connected mechanically and electrically to the inner conductor **20** of a coaxial output lead C, sealed in the tube bottom. The outer conductor **21** of the coaxial output lead C is connected to a conductive truncated cone **22**, which surrounds the anode coaxially. At **23** and **24** the tube comprises an integrated capacitance for decoupling the electrodes. The members **19** and **22** form a coaxial line having a characteristic impedance of 50 ohms so that the output of the electron multiplier can be easily connected to signal detection apparatus.

What is claimed is:

1. An electron multiplier tube having a wall comprising a pile of alternately arranged insulating rings and electrically conductive, annular discs, a plurality of outer dynodes having a forward emissive surface and being supported from the rear surface thereof by said discs, a plurality of inner dynodes each of which is located partly within one of said outer dynodes and having a forward emissive surface, and crossed rod-shaped members the ends of which are connected to diametrically opposite points of each disc supporting said inner dynodes from the rear surface thereof.

2. An electron multiplier tube as claimed in claim **1** in which the outer dynode is supported from an annular support having a tab on the inner side for connection with the outer dynode and a tab on the outer side for connection with the disc supporting the outer dynode.

3. An electron multiplier tube as claimed in claim **2** in which the outer dynode has apertures for the rod-shaped members.

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JAMES W. LAWRENCE, Primary Examiner

DAVID O'REILLY, Assistant Examiner

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