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ELECTRON MULTIPLIER TUBE

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Fig. 1

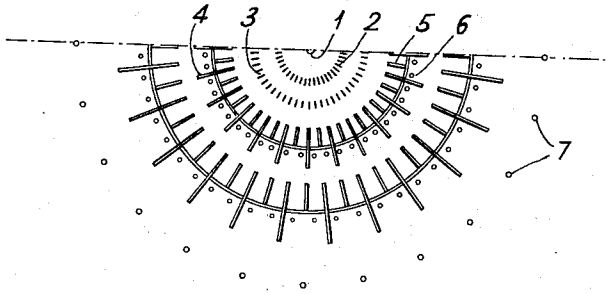


Fig. 2

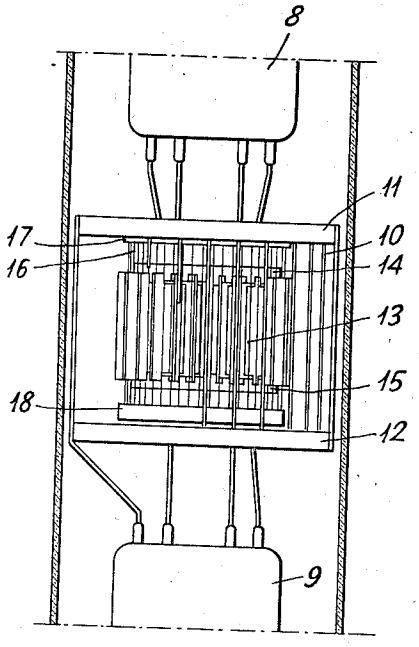
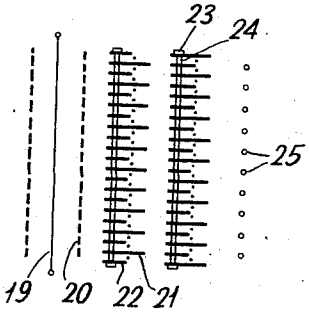


Fig. 3



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ELECTRON MULTIPLIER TUBE

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4 Claims. (Cl. 250—174)

This invention is concerned with a tube adapted to the amplification or multiplication of electronic currents by means of secondary emission. With a view to insuring satisfactory efficency and yield in the use of these tubes it has turned out to be expedient to so choose the configuration or pattern of the field conducting or guiding the electrons from the secondary-emission electrode, or carrying the resultant secondary electrons away from the electrode, that the same would roughly correspond to the optical analog of deflecting or refracting prisms with a variable index of refraction. If, as is true of the majority of instances, the point is to guide the electronic current or a relatively large cross-section thereof in a suitable way towards the secondary-emission electrons, several such refracting prisms would have to be worked with. In the electrical field a row or bank of electrodes being charged positive or negative to one another would correspond to such an arrangement. In this connection it has proved advantageous if in a number of amplifier stages the electrodes in one stage which have a negative charge in reference to the rest of the electrodes of this stage will still be positive in reference to the positive electrodes of the preceding stage.

According to the invention, further advantages are obtainable by using a disposition presenting axial symmetry rather than the planar arrangement just described. Of greatest advantage are arrangements of cylindrical symmetry. Electrode assemblies of this sort offer the merit that due to the logarithmic shape of the potential the field intensity set up at the cathode is very high. This secures a uniform utilization of the entire cathode area for control actions in these arrangements. It is moreover feasible to use indirectly heated cathodes to great advantage. In other words, it is possible to obtain very high gains, under conditions as stated, by the aid of a tube as here disclosed.

According to requirements, the tube may contain a more or less great number of amplifier stages. In tubes of the kind in which the electrode plates are positioned parallel to the cathode, the cross-section which is available for the flow of heat dissipated at the electrodes from the interior in outward direction becomes greater so that the conditions for the abduction of heat are rather favorable. If the electrodes have the shape of rings placed at right angles to the cathode rather than plates placed parallel to the cathode, then the area of the electrodes grows naturally from the inside towards the outside, and the density of the emission current in the various stages will no longer be different. Perfect uniformity of current density is insurable by the provision of plates of different breadth. Hence, the tube here disclosed has high load carrying capacity.

In a form of construction as here disclosed there is a chance to support and anchor the electrodes in a very simple way. For instance, the two ends of the plates could be sealed directly in glass panes, and these could serve to support the whole system. If inside the plates there are in addition wires designed to influence the shape of the field, these could first be fastened, for instance, by welding them on sheet metal rings whereupon the latter could be sealed in glass panes or disks which form the termination or closure of both ends of the system. It will be seen that it is particularly the concentric electrode arrangement which, in constructional respect, offers essential advantages over the rectilinear disposition seeing that a very powerful and efficient system may be crowded together inside a limited amount of space, while yet such difficulties are obviated as are otherwise associated with the supporting, anchoring and accurate spacing apart of such a great number of electrodes.

If the system is of considerable construction length, it is advantageous to suport the electrode plates (targets) not only at their ends, but to provide insulation parts for propping or supporting them at intermediate points. This is accomplishable, for instance, in the manner that about the electrodes of a given group a narrow ring of insulation material is laid, the said ring having slots in which engage the edges of the electrode plates. Such a ring could just as well be mounted inside each plate rim. It will be understood that there are a number of other chances for accomplishing the same thing, though these shall not be dwelt upon at this point.

The concentric arrangement of the electrode plates greatly facilitates also the activating process, seeing that this may be effected from the center of the system. As a matter of fact, it will be remembered that activation was attended with certain difficulties whenever elongated or oblong types of systems are concerned, and these are obviated in an arrangement as here disclosed.

In some instance it is expedient to take into consideration the growth of the current from one stage to the next by broadening the elec-

trode plates from one group to the next, with the consequence that the current density specifically remains unvaried. Suitable adbduction of heat is automatically insured in a form of construction as here disclosed by virtue of the very fact that the cross-sections whereby heat may be carried away, grow from the inside in outward direction. In other words, there is no undesirable accumulation or building up of such heat as is dissipated by the electrode plates, indeed, the heat is readily radiated off towards the outside.

A fundamental form of construction is shown in Fig. 1. 1 denotes a source of electrons, for instance, a heated cathode incandesced either directly or indirectly. 2 is a space-charge grid, and 3 a control grid. Concentrically grouped about these electrodes is the first group of plates which serves for the reinforcement or multiplication of the electronic current by virtue of secondary emission of electrons. This group of plates comprises a certain number of plates or targets 4 on which secondary electrons are released, and a number of plates 5 and a grid-like structure or wires 6 which guide the electrons to the proper paths or courses. Following this inner group in outward direction is a further identically or similarly designed group which distinguishes itself from the one just mentioned only in that correspondingly higher potentials are impressed upon the plates. The sequence of concentric plate systems in outward direction may be fixed at will. The anode consists of a grid-like structure or number of wires 7 which are also disposed concentrically and which form the generatrix of a cylinder.

Fig. 2 shows in more detail an elevation view of the construction of the tube and its mounting. The entire electrode system is supported by and anchored in the squashes or presses 8 and 9. The supporting sticks serve at the same time as current-supply leads for the various plate systems. The anode wires 10 are stretched out between the rings 11 and 12. Following the anode wires in inward direction is a ring of plates 13 which form the targets or electrodes designed to insure secondary emission. They are welded to rings 14 and 15, and they are thus secured. Between the secondary emission electrodes, supported in a similar manner, are mounted guide electrodes which are not shown for greater clearness of illustration. The thin-wired electrode parts 16 are stretched out between two further rings 17 and 18. In a similar manner the mounting of the electrode assembly is continued in inward direction. There are several additional concentric plate systems and finally there is the control grid and a space-charge grid.

Starting from, and predicated upon the principle underlying this arrangement, the supporting and anchoring of the electrodes could be effected in widely varying ways, in fact, it will be obvious that the particular mode of accomplishing this as shown in Fig. 2 is merely an exemplified mode of supporting. What will be found of practical advantage is to secure the electrodes between two parallel glass plates as before described, these glass plates or disks constituting at the same time terminal or closure pieces for the vessel.

Another electrode arrangement which is made feasible by a concentric electrode mounting is shown in Fig. 3, though only one half of the system is really illustrated. The plate-shaped electrodes are here of annular form. The heated cathode 19 which is disposed in the axis of the system is surrounded by a control grid 20 which, in turn, is surrounded by the annular electrodes of the first amplifier stage, that is to say, the secondary emission electrodes 21 and guide electrodes 22. These rings, for instance, are supported by insulation rods 23 on which spacer pieces 24 consisting of insulation material are shifted. The anode wires are designated by 25. Also in this arrangement, thin-wired auxiliary electrodes could be provided in addition to the plate-shaped guide electrodes. The thin wire rings in such a disposition are most preferably supported by a number of longitudinal insulation rods, which have grooves or bores. For the same width of plates, the area of the secondary emission electrodes grows in outward direction so that thus a compensation as regards the density of the emission current and the thermal load of the electrodes is insured. If desired, however, the plates could be widened in outward direction from one stage to the next also in this case.

What I claim is:

1. An electron tube comprising an elongated centrally positioned cathode element, a grid-like collecting anode concentric with the cathode, a plurality of groups of secondary electron emitting elements mounted concentrically in formation and located intermediate the cathode and anode, each of said secondary electron emitting elements being positioned along radial paths relative to the cathode and anode, and electron guiding electrode means positioned between each of the secondary electron emitting elements for controlling the electron path to and from the secondary emitting elements.

2. An electron tube comprising an elongated centrally positioned cathode element, a grid-like collecting anode concentric with the cathode, a plurality of groups of secondary electron emitting elements mounted in concentric formation and located intermediate the cathode and anode, each of said secondary electron emitting elements being positioned along radial paths relative to the cathode and anode, radially extending electron guiding electrode means adjacent the secondary emitting elements, and an additional grid-like electron guiding electrode positioned adjacent the secondary emitting elements for controlling the electron path to and from the secondary emitting elements.

3. An electron tube comprising an elongated centrally positioned cathode element, a grid-like collecting anode concentric with the cathode, a plurality of secondary electron emitting elements mounted in circular formation and located intermediate the cathode and anode, each of said secondary electron emitting elements being positioned along radial paths relative to the cathode and anode, electron guiding electrode means positioned between each of the secondary emitting elements for controlling the electron path to and from the secondary emitting elements, and a control electrode positioned between the electron emitting cathode and the secondary electron emitting elements.

4. An electron tube comprising an elongated centrally positioned electron emitting cathode, an annular grid-like collecting anode positioned externally of the cathode and along a path wherein each elemental section of the anode is substantially equi-distant from the cathode, a plurality of secondary electron emitting elements positioned substantially concentrically with respect to the anode and intermediate the anode and the

cathode, each of said secondary electron emitting electrode members comprising a plurality of sections having their surfaces located along radial paths between the cathode and anode, guiding electrode means adjacent each of the plurality of sets of secondary electron emitting elements and the guiding electrode means extending longitudinally in a direction corresponding to the cathode for a distance substantially equal to the cathode length, and a supporting element supporting all of the secondary emitting electrode elements at each end in a position concentric with respect to each other and with respect to the anode, and a press member supporting the anode and cathode elements.

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