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ELECTRON MULTIPLIER

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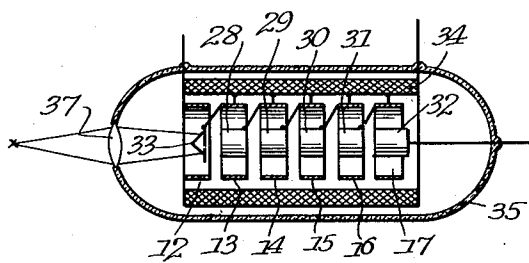
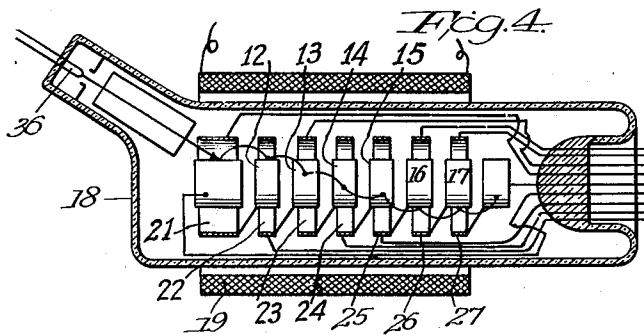
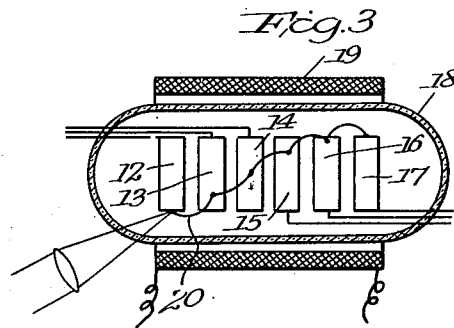
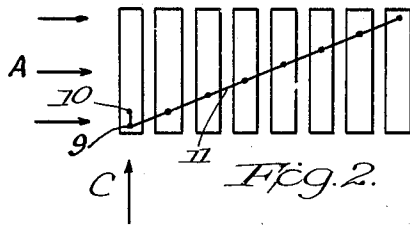
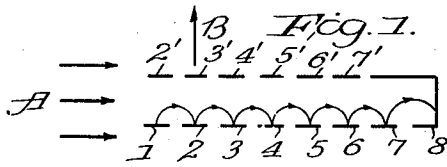


Fig. 5.

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ELECTRON MULTIPLIER

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2 Claims. (Cl. 250-175)

This invention relates to multistage electron multipliers. It is the object of this invention to produce a multiplier of great simplicity and small dimensions.

5 Multistage electron multipliers are known in which electrons emitted from an emitting electrode are accelerated by an electrode opposite to the emitting electrode and travel along arc-shaped paths under the influence of a magnetic field and impact a second electrode adjacent to the first emitting electrode. This process, of course, can be repeated. In such an arrangement the magnetic field which creates the desired electron paths is vertical to the plane of the drawing of Fig. 1, which diagrammatically shows a series of emitting electrodes, 1 to 3, and a series of accelerating electrodes 2' to 7'. Thereby the electrodes 2, 2' and 3, 3', etc., are held at the same potential. For production of such a magnetic field either permanent magnets are used, the poles of which are parallel to the plane of the drawing, or elongated rectangular coils are provided to both sides of the electron arrangement. The application of permanent magnets is undesirable in many cases, especially if the arrangement is to be housed in a vacuum or if the stray fields cause interferences. Also, the production of rectangular coils is inconvenient. Especially if a multiplier of this kind is to be combined with a picture analyzing tube it is desirable to employ simple coil forms which require very little space.

35 Figs. 1 and 2 are two views illustrating schematically, the principle underlying the operation of the present invention.

Figs. 3, 4 and 5 are views in section, of various embodiments of the invention.

40 This invention is based on the idea that a magnetic field parallel to the plane of the drawing of Fig. 1 in the direction of the arrow A may produce arc-shaped electron paths under certain conditions, viz., if the electrons emitted from an electrode do not travel in the direction of the arrow A because of an accelerating field, but in a transverse direction, i. e., in the direction of the arrow B. Thus, considering the transverse component of the electron velocity one will see that a magnetic field in the direction of the arrow A will produce a deflection which results in an arc-shaped path of the electrons perpendicular to the plane of the drawing. Fig. 2 shows a view from the top of the arrangement shown in Fig. 1. In this figure the electrons would travel in the direction of the arrow C, so that electrons starting at the point 9 would im-

5 pact in a point 10. However, the electrostatic field also causes a velocity component in the direction of the arrow A, so that the resulting electron path 11 is obtained which reaches from the lower left corner of the arrangement in Fig. 2 to the upper right corner and which consists of individual arc-shaped sections.

10 The electrode arrangement must expand sufficiently in the direction of the arrow C so that that the electrons will still be able to impact the last electrode. In order to achieve a compact construction, it is an object of the invention to use ring-shaped electrodes, whereby this difficulty is eliminated. The electrons travel in helices around the ring-shaped electrodes, the diameter of which can be made very small because it is possible to allow the electrons to make one or several complete rotations around the ring-shaped arrangement.

25 Several embodiments of the invention are shown in the Figs. 3, 4 and 5. In Fig. 3 the electrodes 12 to 16 are ring-shaped. The electrodes are disposed in the interior of a cylindrical tube 18, which is surrounded by a coaxial cylindrical coil 19. The electrodes are held at increasing potentials whereby the electrode 12, which may be a photocathode, is held at the lowest and the anode 17 at the highest potential. The longitudinal magnetic field influences the electrons of primarily transverse velocity in such a manner that they travel in a helix-shaped path 20 from one electrode to the other. In order to make uniform use of the ring-shaped electrodes it is advisable to produce an emission from the entire outer area of the primary electrode 12. In this manner a symmetrical arrangement is obtained which may be placed in a long narrow tube. Such an arrangement is especially preferable if the amplifier receives its primary electrons through the scanning aperture of a picture-analyzing tube. The voltage drop along the coil 19 can be simultaneously employed to produce the electrostatic accelerating field. The coil in this case, is not layer wound, but wound from one end to the other so that the windings next to the anode 17 possess the highest potential, and the windings next to the first electrode 12 possess the lowest potential. The coil can be arranged inside or outside of the vacuum. If it is not possible to produce the required magnetic field and electrostatic field by means of the same coil, it is advisable to provide special accelerating electrodes 21 to 27, which also are ring-shaped and which concentrically surround the emitting electrodes 12 to 17, as is illustrated in Fig. 4. Each

emitting electrode is connected with the accelerating electrode of the previous stage. In this case the primary electrons are produced by a thermionic cathode 36.

- 5 As Fig. 5 shows, this arrangement may also be reversed, i. e., the emitting electrodes 12 to 17 are placed outside and the accelerating electrodes 28 to 32 are placed inside. In such an arrangement a helix-shaped path of electrons is also ob-
 10 tained, which path consists of individual arc-shaped sections. In the embodiment shown in Fig. 5 the magnetic coil 34 is placed in the interior of the vacuum receptacle. In order to save leads, the voltage drop along the coil is
 15 given such a value that the potentials for the electrodes may be taken from the coil. By doing so only three sealed-in leads are necessary for any number of electrodes. The first accelerating electrode, from which no liberation of electrons
 20 takes place, is a cone-shaped mirror 33 coaxial to the tube inside of the ring 12. A coaxial ray of light is directed upon this mirror by means of the lens 37 so that the electrode 12 is uniformly illuminated.

25 I claim:

1. An electron multiplier comprising an electrode assembly involving a plurality of electrodes having electron emissive properties, a series of

accelerating anodes each disposed in proximity to an electron emissive electrode, leads connected to said assembly for enabling establishment of potentials of increasing values on successive anodes in said series, a connection from each of
 5 said anodes to the electron emissive electrode associated with the anode of next higher potential in the series to enable setting up a potential gradient between successive electron emissive
 10 electrodes, and means for providing a magnetic field in the direction of said potential gradient.

2. An electron multiplier comprising an electrode assembly involving a plurality of electrodes having electron-emissive properties, one of said electron-emissive electrodes being photosensitive;
 15 lead connections to said electrode assembly for enabling a potential gradient to be established between successive electrodes; means for providing a magnetic field in the direction of said potential gradient; an accelerating anode disposed
 20 in proximity to each of said electron-emissive electrodes; and light-reflecting means symmetrically located with respect to said photosensitive electrode for providing a substantially uniform distribution of reflected light over the surface of
 25 said photosensitive electrode.

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