Nov. 12, 1940. G. B. BANKS 2,221,070

ELECTRON MULTIPLIER TUBE

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Fig. 1

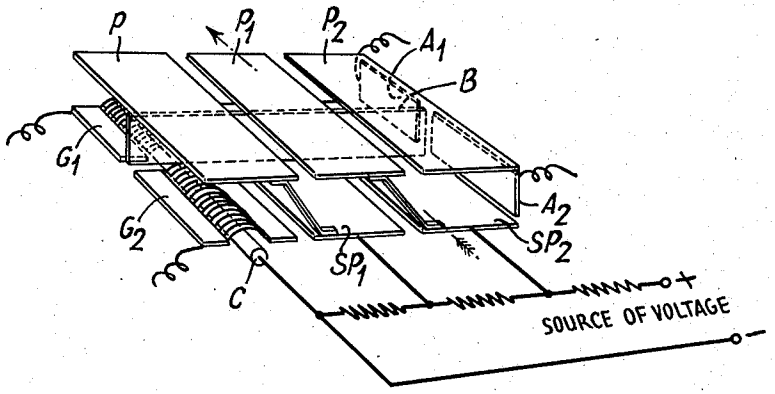
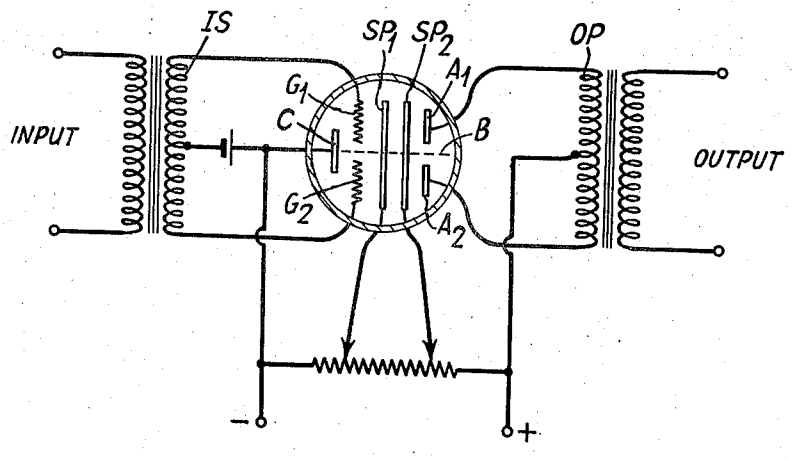


Fig. 2



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ELECTRON MULTIPLIER TUBE

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2 Claims. (Cl. 250—175)

This invention relates to electron multiplier discharge tubes, i. e. to discharge tubes of the type wherein an initial electron stream is multiplied as to its electron content one or more times by secondary emission effects. The invention has for its main object to provide a grid controlled electron multiplier tube capable of giving very high gain without instability.

According to this invention an electron multiplier discharge tube comprises within an evacuated envelope, a pair of output electrodes, one or more secondary emitting or "multiplier electrodes," a primary electron source, two or more field electrodes, one opposite each multiplier electrode and one opposite the said primary electron source, an electron impermeable barrier situated between the field electrodes and the multiplier electrodes and so positioned and of such extent as effectively to separate the series of paths which proceed from the primary electron source (via the multiplier electrode or electrodes) to one output electrode from the similar series of paths terminating at the other output electrode, and independent means for controlling the electron streams on the two sides of said barrier.

The invention is illustrated in the accompanying drawing in which:

Figure 1 shows, in schematic perspective the electrode system of one embodiment of the invention and

Figure 2 is a diagram showing the embodiment of Figure 1 connected in a suitable operating circuit.

Referring to the drawing there is provided within an evacuated envelope a series—for example two—of flat plate-like co-planar secondary emissive multiplier electrodes SP1, SP2 of any form known per se. Opposite each multiplier electrode is a field electrode P1, P2. A cathode C, for example an indirectly heated thermionic cathode is fitted to one side of the series of multiplier electrodes SP1, SP2 approximately co-planar therewith. There are two control electrodes G1, G2 each in the form of a slotted plate fitted over one or the other half of the length of the cathode C, these control electrodes being insulated from one another and being also co-planar with the multiplier electrodes. The slots in the control electrodes are positioned to allow electrons to emerge, under the control of said control electrodes, and proceed in roughly circular or cycloidal paths to the first multiplier electrode SP1. Grid wires are shown fitted across the slots in the control electrodes G1, G2. A field electrode P, co-planar with the other field electrodes P1, P2 is positioned opposite the cathode and control electrode structure. A mica or other suitable barrier B is positioned between the two planes of electrodes perpendicularly to said planes and extends at right angles to the direction of length of cathode, this barrier being central so as to divide the slab-like space between the two said planes into two equal parts. Situated between these two planes and at right angles thereto are two co-planar output electrodes A1, A2, these electrodes being at the end of the "slab" remote from the cathode and one each side of the barrier.

A tube as above described is admirably suited for and is primarily intended for use in a push-pull operating circuit. For example as shown in Figure 2 the two control electrodes G1, G2 may be connected to the two ends of a center-tapped push-pull input transformer secondary IS and the two output electrodes may be similarly connected to the two ends of a center tapped push-pull output transformer primary OP. In use increasingly positive potentials are applied to the field, multiplier and output electrodes (increasing in the direction of the output electrodes) and a magnetic field is applied to thread the field electrode-multiplier electrode space in a direction (represented by the arrow in Figure 1) at right angles to the cathode-output electrode direction, the lines of force running substantially parallel to the field and multiplier electrode planes.

It will be seen that with the tube above described both branches of a push-pull system are provided in the one envelope but the secondary emission stages are common to both branches, i. e. the system is bifurcated only as regards the control electrodes, the output electrodes and, of course, the electron paths. Accordingly great freedom from feed-back and good stability are obtained. The current taken from any multiplier electrode remains—when the tube is used in a push-pull circuit—sensibly constant, for the control electrode potentials being 180° out of phase a current increase in one branch is accompanied by an equal decrease in the other. Accordingly a multiplier electrode when fed for example from a potentiometer, remains at substantially constant potential this again increasing stability.

Finally, by employing a high value of negative bias on the control electrodes it is possible to limit the steady direct current to a very small value and thus obtain so-called "quiescent push-pull" operation. Consequently very high gains,

not subjected to the at present usual close limitation by heating effect of the steady current on the multiplier electrodes, is obtainable.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. An electron discharge tube of the multiplier type comprising a source of primary electrons, a plurality of longitudinally spaced grids for controlling the intensity of the flow of electrons from said source to produce a plurality of separately modulated primary electron streams, a single planar accelerating electrode common to all of the electron streams, said accelerating electrode being mounted in a predetermined plane and adapted to attract the electrons constituting the electron streams, a single planar secondary electron emissive surface positioned in the path of the primary electron streams to produce separate secondary electron streams, and a plurality of electron collector anodes for independently collecting the separate secondary electron streams, the secondary emissive electrode and the source of primary electrons being mounted substantially co-planar and in a plane substantially parallel to the plane of the accelerating electrode.

2. An electron discharge tube of the multiplier type comprising a source of primary electrons, a pair of control electrodes adjacent said source whereby two independently modulated streams of electrons may be produced, a pair of co-planar electron accelerating electrodes for the electron streams, a secondary electron emissive surface positioned in the path of and common to both streams of electrons to produce separate secondary electron streams, and a collector anode for each stream of secondary electrons, the secondary electron emissive surface and the source of primary electrons being positioned in a plane substantially parallel to the plane of the accelerating electrodes.

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