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AMPLIFIER WITH SECONDARY ELECTRONIC EMISSION

Filed Jan. 16, 1937

Serial No. 120,900

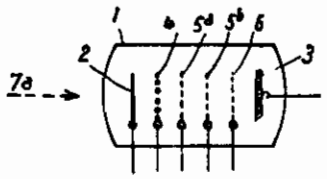

Fig. 1

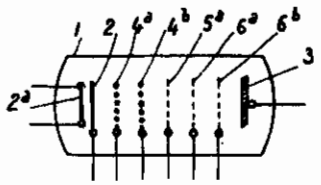

Fig. 2

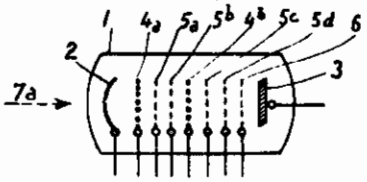

Fig. 3

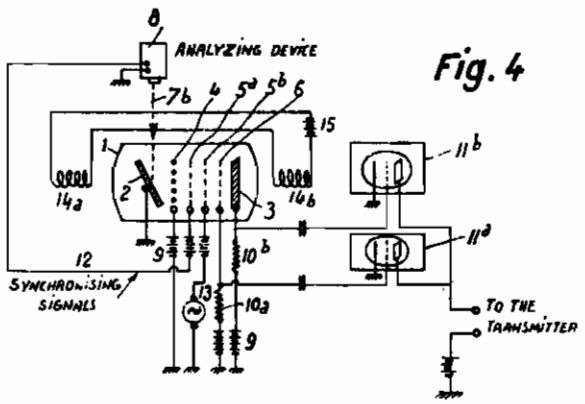

Fig. 4

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ALIEN PROPERTY CUSTODIAN

AMPLIFIER WITH SECONDARY ELECTRONIC EMISSION

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It is known to use the emission of secondary electrons by auxiliary electrodes with the object of amplifying a flux of primary electrons in a predetermined ratio. The subject of the present invention is an amplifying tube based on this principle and characterised essentially by the use of successive grids or diaphragms brought to suitably chosen potentials, and focussing the secondary electrons emitted towards a receiving electrode, an image of the emitting electrode being thus formed on said receiving electrode.

These grids or diaphragms are disposed between the cathode and the anode of the tube perpendicularly to the electric field which is set up in the tube when a potential difference is applied between the said cathode and anode. By reason of this arrangement of the auxiliary electrodes, it is possible to use one of these auxiliary electrodes for acting on the beam of electrons, either to interrupt it periodically or to modulate it to a given frequency, or, generally speaking, to produce any desired fluctuation in the intensity of this beam and of the current supplied by the tube.

Such as to increase the amplifying ratio of the tube, it is possible to constitute said tube with several groups of electrodes connected in series, each group comprising a secondary electronic emissive electrode, one or several focussing electrodes, and a receiving electrode. Two successive groups may have one or more electrodes in common. For instance, the receiving electrode of the first group is the emitting electrode of the second group, or the first focussing electrode of the first group is the emitting electrode of the second group.

The invention also covers devices in which use is made of these particular amplifying tubes, and which will hereinafter be described, as well as the said tubes, with reference to the accompanying drawings, in which:

Figures 1, 2 and 3 shows types of amplifying tubes according to the invention, and

Figure 4 shows a device for the utilisation of another type of such a tube.

According to Figures 1, 2 and 3, the amplifying tube comprises a casing 1 in which are enclosed a cathode 2, an anode 3 and a plurality of auxiliary electrodes 4, 5 and 6. The cathode 2 is emissive of primary electrons. It is either constituted or covered by a photosensitive substance, and emits electrons when receiving a luminous flux 7^a, or is heated to emit electrons by thermo-electronic effect. Any other device producing electrons may be utilised. In the case of Figure 1, the cathode 2 is photosensitive and disposed perpendicularly with reference to the axis of the tube. It may also be inclined on the axis of the tube (Figure 4), or have an incurved form (Figure 3). The cathode of the tube in the Figure 4 is intended to be excited either by reflection of the luminous flux 7^b or by transparency by the luminous flux 7^a. The tube in the Fig. 2 is provided with a thermo-electronic cathode.

The casing 1 has any form, but it is preferable to give it an elongated form, in order to dispose the cathode and the anode at each of the extremities, and the auxiliary electrodes in the centre part between the cathode and the anode.

The auxiliary electrodes 4, 5 and 6 are constituted by grids or by diaphragms. The grids are formed either of plates having holes bored therein, or by wires stretched between supports, or in accordance with any arrangement adopted, for examples in the grids of radioelectric tubes, and composing meshes of any dimension.

A modification of the invention concerns a tube in which both grids and diaphragms are arranged in any order.

In the tube of the Fig. 1, the electrode 4 is constituted or covered by any known photo sensitive substance or substance of high secondary electronic emissivity. The electric field in the tube drives the primary electrons emitted by the cathode 2 towards the electrode 4. The shock of each primary electron on the electrode 4 generates several secondary electrons which are emitted in all the directions. The secondary electrons are driven and made to converge towards the receiving electrode 6, which may be the anode, by means of the electric fields created by the focussing electrodes 5^a, 5^b. These focussing electrodes are in any number. A good result is obtained with two of such electrodes.

The tube in the Fig. 2 is provided with two amplifying groups of electrodes. The first group comprises the emitting electrode 4^a, two focussing electrodes 4^b, 5^a and the receiving electrode 6^a. The second group comprises the emitting electrode 4^b, two focussing electrodes 5^a, 6^a, and the receiving electrode 6^b. Any number of groups of electrodes may be disposed in this manner, in series and overlapping each other. Secondary electrons are emitted by the electrode 4^b under the shock of the secondary elcctrons emitted by the elcctrode 4^a.

In the tube of the Fig. 3, the successive groups of electrodes have only one electrode in common. The electrode 4^b is the receiving electrode of the first group and the emitting electrode of the following group.

In order to be able to control the beam of electrons, it is possible to apply to the electrodes having no secondary radiation, potentials which may or may not be periodical. By reason of these electrodes, it is possible to interrupt or modulate the current supplied by the tube. It is also possible by these means to introduce into the current signals such as the synchronising signals in a long-distance transmission device. For this introduction of signals, it is obviously necessary for the signals to be set up at moments when the electronic flux, and consequently the incident luminous flux, with a photo sensitive cathode, is not zero.

These control electrodes having no secondary radiation may be separated from the system by screen grids as is frequently the case, for example, in radio-eleetric tubes.

Figure 4 illustrates a teletransmitting apparatus using a tube according to the invention. This apparatus comprises a device 8 for analysing objects or images to be transmitted. The analysing device 8 sends a luminous flux 7^b on to the cathode 2 of the tube 1. The suitable tensions are applied to the various electrodes of the tube 1 by electric source 9. The latter may be entirely or partially replaced by a single source and a potentiometer (not shown) from which are taken the required tensions, or may be connected in series.

A resistance 10^a is inserted in the circuit of the receiving electrode 9 of the tube, and the variations of tension at the extremities of the resistance 10^a are amplified by the device 11^a. Use may be made of the current traversing the anode circuit of the tube, with the aid of the resistance 10^b, and the variations of tension to the terminals of the resistance 10^b may be amplified by the device 11^b. The current provided by the amplifiers are then transmitted. If the tube has several receiving electrodes, as in Fig. 2, the currents in the receiving electrode circuits are amplified and transmitted in the same manner.

According to Fig. 4, the synchronising signals produced by the device 8 are applied by the connection 12 to one of the focussing electrodes having no secondary radiation 5^a. Moreover, a source of alternating electromotive force 13 is inserted in the circuit of another focussing electrode 5^b in order to modulate the current fed by the tube. The source 13 may also be constituted by a source producing current impulses or by a switch permitting of interrupting regularly or at will the current supplied by the tube.

It is obvious that the circuits of Figure 4 could be modified so as to apply both synchronising and modulating signals to the same electrode.

Finally, means 14^a, 14^b fed by a source 15, produce a longitudinal magnetic field inside the tube in order to concentrate the electrons emitted by the cathode and by the auxiliary electrodes. These means are not essential, but they permit of obtaining more concentrated beams of electrons.

By reason of the effect of these electric and magnetic fields, and if the tensions applied to the auxiliary electrodes, grids or diaphragms, are suitably chosen, the functioning of the tube is as follows. The electrons emitted by the cathode 2 are accelerated by the electric field and accessorily concentrated by the magnetic field. These electrons encounter the auxiliary electrode 4, and secondary electrons are emitted in all directions. They are directed by the field existing beyond 4 in the direction of the positive potentials, that is to say, towards 5^a. According to the potential of 5^a, the secondary electrons of 4 will form in the enclosure an image of the cathode, or they will impinge on 5^b. It is the latter alternative which is adopted, and it will be seen that the auxiliary electrodes become virtual cathodes, the emission of which increases in intensity as their order increases. The auxiliary electrodes such as 4^b in the Fig. 2 are brought to sufficiently high potentials in order that the electrons may in turn produce therein a secondary emission, thus increasing the efficacy of the system in considerable proportions. The phenomena set up is similar to that known in discharges in gases under the name of "ionisation by impact." It will be seen that if each impact liberates a number p of secondary electrons, the amplification of the initial flux at the end of n stages is p^n.

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