April 14, 1936. G. JOBST 2,037,168

TUBE CONSTRUCTION AND CIRCUIT ARRANGEMENT

Filed Oct. 27, 1933

Fig. 1.

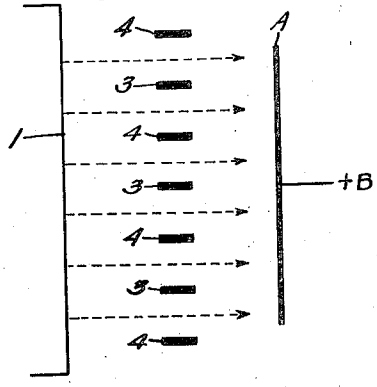


Fig. 2.

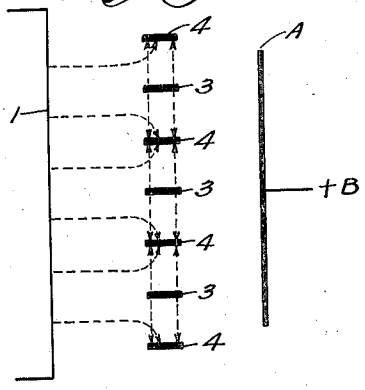


Fig. 3.

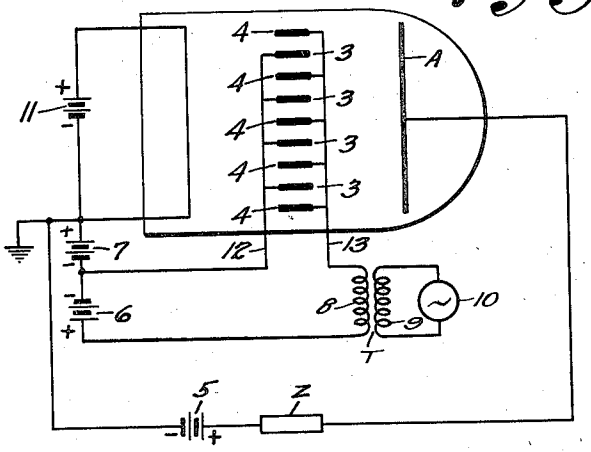
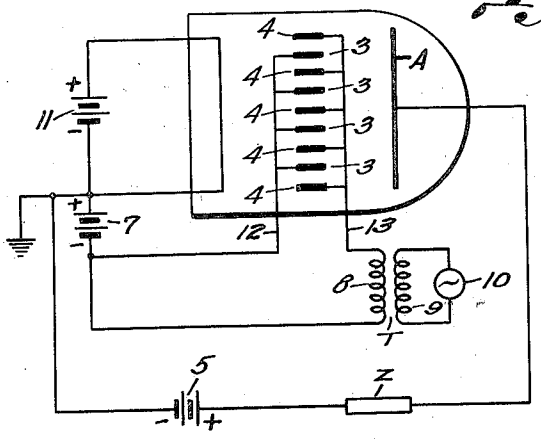


Fig. 4.



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Patented Apr. 14, 1936 2,037,168

UNITED STATES PATENT OFFICE

2,037,168

TUBE CONSTRUCTION AND CIRCUIT ARRANGEMENT

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Application October 27, 1933, Serial No. 695,400
In Germany May 2, 1932

4 Claims. (Cl. 250—27)

An object of this invention is to provide a vacuum or electron discharge tube with a virtual cathode in which a large change of anode current is produced by a small change in the voltage of a control grid.

A further object is to provide a vacuum tube and circuit arrangement in which two sets of grids in the form of rods or flat plates are provided the planes of which are in the path or direction of the electrons as they flow from cathode to anode.

A still further object is to provide such sets of plates within an electron tube with suitable voltages which cause the electrons to move very slowly or actually stop between the plates and to raise the voltage of one set of plates to withdraw the electrons from their path to the anode into a direction substantially normal thereto and into contact with said plates. Other objects of the invention will be apparent to those skilled in the art as the description thereof proceeds. For a better understanding thereof, reference is made to the accompanying drawing in which:

Fig. 1 is a sketch showing the normal path of the electron flow in a tube made according to the invention;

Fig. 2 is a sketch showing the manner in which certain of the electron streams are deviated in the operation of the tube;

Fig. 3 is a schematic diagram of an electron tube arrangement and circuit made according to my invention and,

Figure 4 is a circuit diagram of a slightly modified form of the invention.

In suitably choosing current density and velocity of the electrons as they leave a control cathode it is possible to influence the space charge in front of an opposite electrode, such as an anode or grid placed in front of the anode in such manner that the electrons in front of this opposite electrode form a virtual cathode which, due to the fact that by means of the control of current density and electron velocity, can be placed as close to the electrode as may be desired. Such arrangement admits of an extremely efficient control with respect to changing of the potential of the anode or opposite electrode. Instead of utilizing the controlling capacity of the electrons in the longitudinal direction or path between cathode and anode, it is possible to construct according to the present invention those electrodes in whose vicinity or field the electrons have only small or nearly zero velocity in such a manner that they are suited for transverse control. The most essential requirement for the usefulness of such a control is in any event that the controlling members are in the vicinity or field of the space charge; or in other words, the control cathode must be adapted in such manner that the location of the electrons which are not in motion can be brought near the electrodes provided for transverse control, since the control of the electron stream is at these places considerably more sensitive than at places at which the electrons have a velocity essentially different from the zero velocity. Referred to the same length and the same field strength of the deviating field, the electron in the direction at right angles to the direction of flow is necessarily much more deflected the slower it moves; for slow electrons require very weak fields only which are short in the direction of their movement to cause them to deviate considerably.

Referring now to Fig. 1, the dotted lines represent the path of certain electrons passing from a heated cathode 1 to an anode A, the electrons passing between the grid plates or rods 3 and 4 which are maintained at such negative potential that the electrons are travelling very slowly and some of them at zero velocity in the field of the grids. If now one of the sets of plates such as 4 is impressed with a potential positive with respect to the surrounding electron field, the electrons will be attracted to such plates and pursue a course substantially at right angles to their previous course between cathode and anode. This bending aside or deviation of the electron streams is shown diagrammatically by the dotted lines in Fig. 2.

As shown in Fig. 3 the vacuum tube 2 may contain a cathode 1 heated by a battery 11, an anode A and two sets of grid plates or rods 3 and 4 having their flat surfaces arranged in the direction of flow of the electrons between cathode and anode. The plates 3 are suitably connected together by a lead 12 and to the negative terminal of a battery 7 whose positive terminal is connected to cathode 1 and ground as shown. The plates 3 are situated between a similar set of plates 4 which are in turn connected together by a lead 13 to the positive terminal of a battery or other source 6. The anode A may be connected to the cathode as shown through a load impedance Z and any suitable potential source 5. Any suitable means may be employed to control the potential of one set of plates, that shown being the secondary 8 of a transformer T across the terminals of whose primary 9 a variable voltage may be impressed by any suitable or desired source of variable voltage 10. It will be under-

stood that the currents to be amplified in primary 9 and tube 2 may be of any desired radio or audio frequency.

The negative voltage of the plates 3 produced by battery 7 is such that electrons emitted at definite density and velocity from cathode 1 are slowed down to such an extent that they are at substantially zero velocity in the field of the grid plates 3 and provided there does not exist a substantial potential difference or field between plates 3 and 4, they are attracted through this field by the anode A and pass to it. However, if the plates 4 are made positive with respect to 3, a field exists between the two sets of plates at right angles to the direction of movement of the electrons and they are sharply deviated from this direction with a nearly right angle deflection and following the direction of the field, they pass to the more positively charged plates 4 so that practically none reach the anode A. This diversion of the electrons produces a very large change in anode current for a small change in voltage of plates 4. In certain cases, the battery 6 may be omitted, both sets of plates 3 and 4 being at the same direct current potential as determined by battery 7, the signal voltage as applied to secondary 8 then being sufficient to swing grid 4 positive with reference to grid plates 3 and divert the electron stream thereto. Such an arrangement is shown in Figure 4 of the drawing.

While I have disclosed only one form of my invention it will be understood that it may be embodied in other forms without departing from the spirit thereof and its scope is not to be limited except as defined in the following claims:

What I claim and desire to secure by Letters Patent is:

1. In a device of the class described, the combination of an electron discharge tube having a cathode, an anode and a grid comprising a plurality of plates, means for conductively connecting said plates, a source of potential having its negative terminal connected to said plates and of sufficient voltage to reduce the electron flow to substantially zero velocity in the field of said plates, a set of plates in said field, a source of potential having its negative terminal connected to the negative terminal of said first named potential source and its positive terminal to said set of plates and means for applying a variable signal potential to said set of plates whereby the electrons in said field are periodically diverted thereto.

2. In a device of the class described, the combination of an electron discharge tube having a cathode, an anode and a grid comprising at least one elongated plate whose plane is parallel to a line joining the cathode and anode, means for applying a high positive potential to said anode, means for maintaining said grid at a substantially lower voltage than said cathode, a plurality of grid elements between which said first mentioned grid plate is interleaved, a circuit connecting said grid elements and cathode and including said second named means, and means for causing the voltage of said plurality of grid elements to vary periodically.

3. In combination in a control device, a vacuum tube having a cathode, an anode and a grid comprising a plurality of aligned plates, means for maintaining said plates at a substantially high negative voltage with reference to said cathode whereby the electron stream is substantially retarded in the field about said plates, a second plurality of grid elements arranged adjacent said plates and substantially parallel thereto and means for intermittently applying to said last mentioned grid elements a potential which is positive with reference to the field about said first mentioned grid.

4. An electron discharge tube comprising a containing envelope, a heated cathode, two grids and an anode mounted within said envelope, the first grid comprising a plurality of flat grid members having their planes arranged along a line connecting the anode and cathode, and the second grid comprising a series of conductively connected grid elements interleaved between the members of said first grid, means for applying a positive voltage to said anode and means for applying a negative grid bias to each of said grids of sufficient amount to reduce to substantially zero in the field of said grids the velocity of electrons passing from said cathode to said anode.

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