June 10, 1941. G. F. BRETT 2,244,672

OSCILLATORY DISCHARGE TUBE

Filed Feb. 15, 1938

Fig. 1

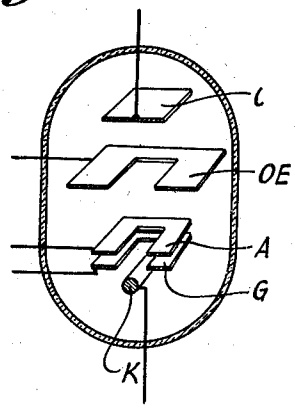


Fig. 2

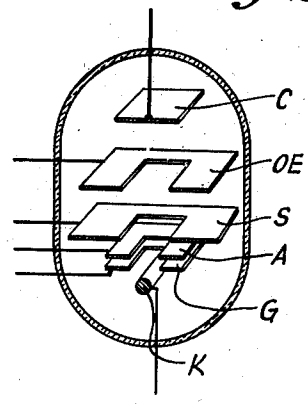
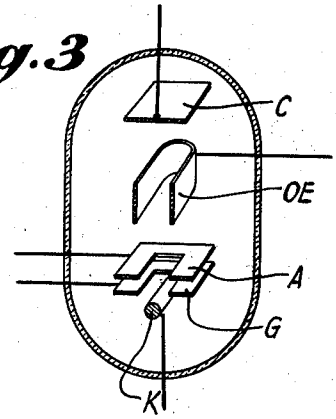


Fig. 3



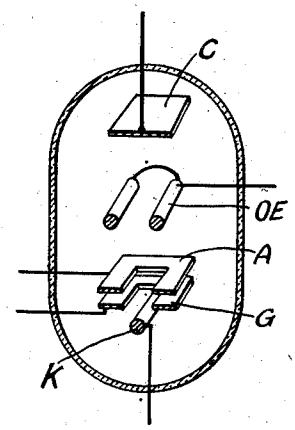
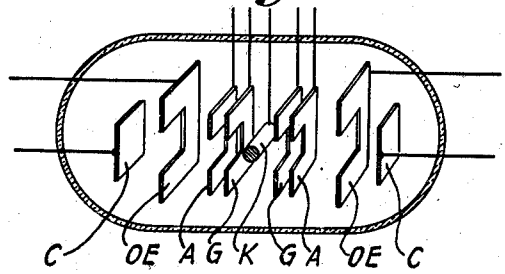


Fig. 5.

Fig. 4



INVENTOR.
GEORGE FAIRBURN BRETT

BY H. S. Brown

ATTORNEY.

Patented June 10, 1941 2,244,672

UNITED STATES PATENT OFFICE

2,244,672

OSCILLATORY DISCHARGE TUBE

George Fairburn Brett, London, England, assignor to Radio Corporation of America, a corporation of Delaware

Application February 15, 1938, Serial No. 190,545
In Great Britain February 20, 1937

4 Claims. (Cl. 250—27.5)

This invention relates to electrical oscillation generators and more particularly to very high frequency oscillators operating on the so-called Barkhausen-Kurz or Gill-Morell principle, i. e., the retarding field principle.

High frequency oscillators operating on the retarding field principle are, of course very well known, the usually employed form of oscillator of this kind comprising the triode whose grid is maintained at a high positive potential with respect to both the anode and cathode. Oscillatory energy, which is taken from a tuned circuit connected between the grid and the anode, is generated by reason of the action of electrons which, after passing through the grid and being retarded by the anode field, oscillate back and forth through the grid before being finally collected thereby. Such oscillators as at present known have, however, the important defect that a relatively large proportion of the cathode emission passes straight to the grid from the cathode without contributing to oscillation generation, and accordingly, such electrons represent waste energy which merely assists in heating the grid so that, in practice, the grid may become very hot and must be made of refractory metal such as molybdenum. Further, the problem of dissipating the energy at the grid is very serious, more especially since, in the usual construction of valve employed, the grid is practically enclosed by the anode.

The object of the present invention is to provide improved oscillators of the retarding field type which shall not present the defect or disadvantage above referred to.

According to this invention an oscillation generator of the retarding field type comprises means for generating a jet or beam of electrons (as distinct from a mere stream); an electrode (hereinafter termed the oscillator electrode) through which said jet or beam is projected; a further electrode (hereinafter termed the retarding electrode) towards which said jet or beam is projected; means for maintaining the oscillator electrode at a positive potential with respect to the retarding electrode and also with respect to a point in the electron path which may be regarded as the location of a virtual cathode; and means for collecting oscillations generated by the action of electrons which are retarded by the field of said retarding electrode and oscillate back and forth through the oscillator electrode before being collected thereby.

The invention is illustrated in the accompanying diagrammatic drawing, in which

Figure 1 shows a suitable arrangement of electrodes within an electron discharge tube;

Fig. 2 shows a modification with an additional electrode;

Figs. 3, 4 and 5 show still further modifications.

In one way of carrying the present invention into practice there is employed a so-called electron beam valve as represented in Fig. 1. In certain respects this valve is of conventional design; that is, it comprises a linear cathode K, an adjacent electrode G having the form of a slotted plate, and an accelerator anode A having the form of a second slotted plate, the slots in G and A being aligned with the cathode. These electrodes constitute an electron gun which projects electrons toward a collector electrode C which acts as the retarding electrode in an oscillator in accordance with the present invention. The novel arrangement includes, however, an electrode OE through which the electron jet or beam is projected. This electrode is also a slotted plate with its slot aligned with those in G and A. As will be appreciated, in an oscillation generator, in accordance with this invention and employing a valve as represented in Fig. 1, electrons oscillate through the oscillator electrode OE in much the same way as they do through the positive grid of an ordinary Barkhausen-Kurz or Gill-Morell oscillator of the triode type, the electron gun system K—G—A, however, replacing the cathode of the ordinary triode oscillator, the oscillator electrode OE replacing the grid of the ordinary triode oscillator and what is normally the collecting electrode C replacing the anode of the ordinary triode oscillator. In fact, in carrying out the present invention, the actual circuits connected to K, OE and C may be as known per se for ordinary Barkhausen-Kurz or Gill-Morell oscillators of the triode type and for this reason are not shown. The important difference, however, is that in an oscillator, in accordance with this invention, a jet or stream of high speed electrons is projected through the oscillator electrode OE and accordingly none, or at any rate only a very small proportion, of the electrons will pass direct to the said electrode without contributing to the oscillation generation process.

The retarding electrode C may be maintained at the same potential as the virtual cathode of the electron discharge device, or it may be at a slight positive or negative potential with respect thereto. Where, as in Fig. 1, the electron gun system of the electron discharge device employed consists merely of a cathode K, a control or grid

electrode (the electrode G) and an accelerator anode A, the virtual cathode will be situated at or substantially at the said accelerator anode A. If desired, however, and as represented in Fig. 2, the gun system may include, in addition, a screen electrode S also constituted by a slotted plate with its slot aligned with those of G and A positioned on the side of the accelerator anode A remote from the cathode K and in such a case the virtual cathode will be situated at or substantially at this screen electrode S.

Almost any form of electron beam valve suitably adapted (by the provision of a suitable oscillator electrode) for the purposes of the present invention may be employed. In each of the electron beam valves shown in Figs. 1 and 2 the control electrode G is in the form of a plate having a slot of approximately the same length as the emitting cathode surface and of a width approximately equal to the projected width of said surface, the cathode K being disposed behind the slot. The accelerator anode A is in the form of a similar slotted plate parallel to and close to the control electrode G, the oscillator electrode OE being in the form of a widely slotted plate parallel to the accelerator anode but at some distance from it, and the retarding electrode C being in the form of a plate parallel to the other plate-like electrodes and at about the same distance from the oscillator electrode OE as is the said oscillator electrode from the accelerator anode A.

Another suitable form of valve is shown in Fig. 3, this valve differing from those of Figs. 1 and 2 mainly in that the plate-like oscillator electrode OE is in the form of a flattened cylindrical electrode so arranged that the electron jet or beam from the electron gun is passed through it. Alternatively the said oscillator electrode OE may be constituted by a pair of parallel wires between which the jet or beam may pass.

The expedient of providing (as shown in Fig. 2) a screen electrode S in the form of a further slotted plate with a wide aperture, situated parallel to and close to the accelerator anode A and on the side thereof remote from the cathode K is applicable generally, for example, to the valve of Fig. 3.

If desired, any of the valve constructions so far described may be made of double form; that is to say, the various electrodes of the electron gun system (except the cathode) may be duplicated so as to provide what is in effect a double gun structure adapted to project two electron jets or beams in two opposite directions, the other electrodes being also duplicated so that each electron jet or beam passes through an oscillator electrode towards a retarding electrode. This novel arrangement is shown in Fig. 4 where the various electrodes are given the same reference characters as in the other figures. The diagram is, therefore, self-explanatory. Such a double construction of valve may have its two systems operated in push-pull or in parallel.

A modification of the invention as shown in Fig. 5 is similar in many respects to the embodiment of Fig. 3. The oscillator electrode OE, however, instead of being in the form of a flattened cylinder is in Fig. 5 shown as a pair of wires one on each side of the path of the electron beam and substantially parallel to the cathode. In other respects the similarity of the embodiment of Fig. 5 to that of Fig. 3 will be apparent.

A further advantage of oscillators in accordance with this invention is that modulation of the oscillations generated may be very easily and efficiently effected by applying modulation to the control electrode of the gun or (in the case of an embodiment employing a double electrode system) to both control electrodes of the gun.

I claim:

1. An electron discharge tube for an oscillation generator of the retarding field type comprising an electron gun including a cathode, a control electrode adjacent thereto and an accelerator anode adjacent the control electrode and on the side thereof remote from said cathode, said electrodes in combination constituting means operative when suitably polarized for producing a jet of electrons; an oscillator electrode having a single orifice therein through which said jet is to be projected; a retarding electrode toward which said jet is to be projected; said oscillator electrode being adapted to be maintained at a positive potential with respect to the retarding electrode and also with respect to a point in the electron path which may be regarded as the location of a virtual cathode; said oscillation generator tube constituting means for generating oscillations by the action of electrons which are retarded by the field of said retarding electrode and oscillate back and forth through the orifice of said oscillator electrode before being collected thereby.

2. A device in accordance with claim 1 wherein the cathode is linear and said oscillator electrode is in the form of a flattened cylinder with its axis disposed along the path of the electron beam and with the major diameter of its base disposed parallel to the cathode.

3. A device in accordance with claim 1 wherein said cathode is linear and said oscillator electrode has the form of a pair of wires one on each side of the path of the electron beam and substantially parallel to the cathode.

4. An electron discharge tube for the generation of ultra-high frequency oscillations comprising a linear cathode, two opposing systems of electron beam focussing electrodes, the cathode being intermediate between said systems, a pair of target electrodes one associated with each of the beam focussing electrodes, and a pair of oscillator electrodes each adapted to be maintained at a high positive potential relative to the potential applied to said target electrodes, said oscillator electrodes being orificed and being adapted to collect pulsatively traveling clouds of electrons which result from an interaction of said oscillator electrodes with the other electrodes when said clouds accumulate in the orifices of said oscillator electrodes.

GEORGE FAIRBURN BRETT.