

July 6, 1937.

G. JOBST ET AL
ELECTRON DISCHARGE DEVICE

2,086,271

Filed July 10, 1935

Fig. 1

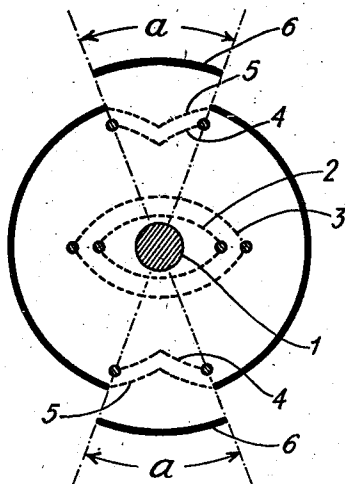


Fig. 2

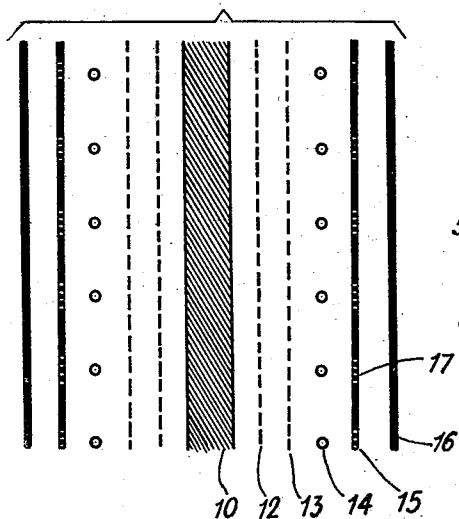
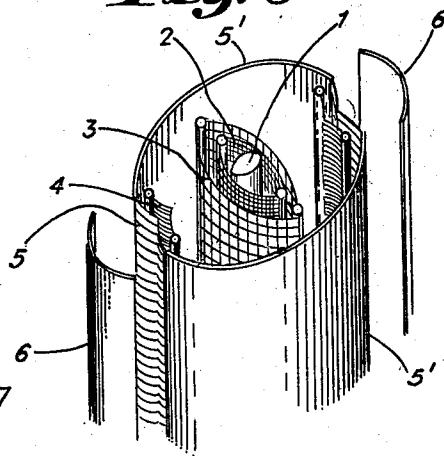


Fig. 3



INVENTORS
GUNTHER JOBST
HORST ROTHE
BY
Charles McClure
ATTORNEY

UNITED STATES PATENT OFFICE

2,086,271

ELECTRON DISCHARGE DEVICE

Günther Jobst and Horst Rothe, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application July 10, 1935, Serial No. 30,598
In Germany July 4, 1934

6 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices for superheterodyne reception and more particularly to a multi-electrode electron discharge device in which local oscillations of a predetermined frequency and input oscillations of a different frequency are mixed to provide oscillations of another predetermined frequency.

In order that the frequency change necessary in heterodyne receivers may be accomplished efficiently, a number of special types of tubes known as mixer tubes have been recently developed. The general principle underlying these known mixer tubes is as follows: Electrons emitted by a thermionic cathode are controlled by a first control grid positioned directly around the cathode. The electron current then passes thru a screen grid positioned around the control grid and kept at a fixed potential, the electron current thereupon entering into another control system positioned around the said screen grid. This last named control system, in analogy with the primary control system, likewise comprises a control grid and an anode or else a system consisting of a control grid, a screen grid, suppressor grid and the plate or anode. If the second control grid is at zero potential then the effective potential in the plane of this control grid is adequately high and most of the electrons that pass thru the first screen grid are able to pass thru the second control grid and reach the anode. If a negative potential is applied to the second control grid, the effective potential in the second control grid plane decreases and a part of the electrons penetrating thru the first screen grid will no longer pass thru the second control grid and reach the anode, but are turned back and flow towards the first screen grid thru which they passed or flow directly back to the cathode. The more negative the potential of the second control grid has been made, the greater will be the number of returning electrons. By providing a sufficiently high negative voltage for the second control grid, the current of electrons to the anode could be blocked entirely. The electron current which is able to reach the plate is therefore subject to a control action from two control grids which are entirely distinct and independent of each other. It will be noticed that the first control action influences the intensity of the electron current from the cathode, while the second control action affects the distribution of the electron current to the anode, the inner screen grid and cathode. In the constructional development of this basic principle, a number of modifications have been

adopted. In addition to the electrodes hereinbefore mentioned, further auxiliary electrodes have been provided which are used for the production of the heterodyne wave. These auxiliary electrodes, however, do not alter the function and operation of the tube as before described.

In connection with the practical use of the double control action on the plate current, a number of practical objections have been found. For example, where sensitive receiver sets are concerned, these tubes tend to cause disturbing noises. When these tubes are used for short waves ranging between 20 and 30 meters approximately, the electrons absorb energy from radio frequency fields and are therefore capable of flowing against negative potentials so that the control grids, even when a negative biasing potential is impressed thereon, take a current with the result that the associated circuits are damped. As has been shown by investigations all of these disturbing and troublesome actions found to arise in mixer tubes of the kind heretofore known are due to the reversal of the electrons ahead of the second control grid and the appreciable transit time of the electrons and the space-charge effects associated therewith.

The principal object of our invention is to provide an improved electron discharge device of the so-called mixer type for superheterodyne reception.

According to the present invention these objections are overcome by adopting special forms of construction and certain dimensions for the electrodes, so that such electrons as are unable to reach the anode, will not be reversed or returned to the inner screen grid, but are merely deflected out of their course by action of the second control electrode so that, as a result of such deflection or deviation they can be made to flow to any desired auxiliary electrode. In this arrangement the second control system is so constructed that the deflected electrons will lose very little speed, at least they will not be stopped before reaching the auxiliary electrode. Now, if this chief requirement is satisfied all of the electrons will have transit times which are comparable with the transit times in normal pentodes, and moreover, no unduly intense electron space charges will be developed in the neighborhood of the second control electrode. In this manner the cause of the disturbing effects above outlined has been eliminated.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims, but the

invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a schematic section transverse to the longitudinal axis of an electron discharge device embodying our invention; Figure 2 is a schematic longitudinal section of a modification of the electron discharge device shown in Figure 1; and Figure 3 is a partial view in perspective of the electrodes of the electron discharge device shown in Figure 1.

The basic idea underlying this invention will be best explained by reference to the following specification and the drawing. In Figure 1, the electron discharge device is provided with a thermionic cathode 1 having around it the elliptical control grid 2 and a similarly shaped screen grid 3. The grids are preferably biased and controlled so that the electrons from the cathode are confined to a path measured by the angle α . Outside of the screen grid 3, and preferably within the angular space α , there is mounted an additional control grid 4 and another screen grid 5, the latter being foraminous and permeable to electrons only inside the angles α , while for angles other than α the shield is solid as shown at 5' with the result that electrons are unable to pass thru it at these parts. On the outside of the permeable part of the screen grid 5, a suppressor (not shown) grid may be positioned between the screen grid 5 and the plates 6. The control grid 4 and the screen grid 5 should be so made that upon the application of predetermined negative potentials to the control grid 4 such electrons as emerge inside angles α will be laterally deflected onto the solid part of electrode 5. Such a control action prevents any appreciable reversal of electrons onto the system consisting of electrodes 1, 2 and 3. In the formation of the electrodes 4, 5, and 6 there is a good deal of latitude, and by choosing suitable forms for the primary electrode system 1, 2, 3, conditions can be made so that the electrons will be concentrated or focused inside a certain limit (i. e., only inside angular space α) and are thus made to enter into the secondary discharge system.

In the embodiment shown in Figure 2 the distribution of the electrons in the second control system is not over different radial segments, but in paths distributed longitudinally of the cathode. The cathode 10 has positioned around it the first control grid 12 and the screen grid 13, these electrodes constituting the primary control system. On the outside of the screen grid 13 is positioned the second comparatively coarse-meshed second control grid 14, and another screen grid 15. This screen grid is so formed that it will be permeable to electrons only at the perforated portions 17 adjacent the wires of control grid 14, but not in the intermediate solid portions. On the outside of the screen grid 15, a suppressor grid (not shown) may be positioned, followed by the anode or plate 6 which either extends over the full length of the electrode system or else may be built up of parts which are positioned on the outside of the apertured portions of the screen grid 15.

In this system, the operation is as follows: If the control grid 14 is at zero potential, then the electrons coming from the cathode are able to pass thru comparatively uniformly and they reach, under conditions of comparative uniformity, the screen grid 15. Part of these electrons will pass thru the openings 17 of the screen grid 15 and reach the plate 16. If there

is impressed a negative voltage on the control grid 14 the electrons which pass thru the screen grid 13 are concentrated in the gaps or apertures between the wires of the grid 14 and will impinge upon the solid portions of the screen grid 15 so that the plate current is diminished. A control action is produced upon the plate current by the grid 14; but the control action is predicated not upon a reversal, but upon a more or less marked concentration of the electrons over the different parts of the screen grid 15, resulting from a proper choice of the distances between the electrodes 13 and 14 and 14 and 15, as well as of the spacing of the grid wires 14 and suitable potentials on the electrodes 13, 14 and 15.

The two embodiments have merely been cited and described to explain the underlying idea of this invention without placing any limitation upon possible forms of construction. The chief feature of the invention is that the second control action upon the electronic current reaching the anode or plate is accomplished by proper current distribution between the plate and another auxiliary electrode, in such a manner that the electrons are not caused to reverse and return towards the first screen grid thru which they have passed into the second control system. This end is attained by concentration or focusing of the electrons and action upon the sharpness or the direction of the rays in the pencil by the agency of a second control grid, though such concentration or focusing effect could be brought about inside the primary system comprising the cathode, first control grid, and screen grid or else only inside the secondary system.

While we have indicated the preferred embodiments of our invention of which we are now aware and have also indicated only one specific application for which our invention may be employed, it will be apparent that our invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of our invention as set forth in the appended claims.

What we claim as new is:—

1. An electron discharge device having a cathode for emitting electrons, a control electrode, and a first screen electrode surrounding said cathode and control electrode, a second control electrode and an anode for receiving electrons from said cathode outside of the first screen electrode, and a second screen electrode positioned between said second control electrode and said anode and having an imperforate portion and a foraminous portion, said second control electrode positioned only between the first screen electrode and the foraminous portion of said second screen electrode for deflecting electrons from said cathode to the imperforate portions of said second screen electrode when a predetermined potential is applied to said second control electrode.

2. An electron discharge device having a cathode, a control electrode and a screen electrode in succession, another electrode having perforated portions and solid portions and a second control electrode positioned only between the perforated portions of the last mentioned electrode and the screen electrode for deflecting electrons from said cathode to the solid portions of the last mentioned electrode when a predetermined negative potential is applied to said second control electrode and an anode outside of the electrode having perforated portions and solid portions.

3. An electron discharge device having a cathode and a control electrode, and a screen electrode surrounding said cathode and control electrode, said control electrode and screen electrode being adapted to have potentials applied there-
5 to for focusing the electrons from said cathode into a beam, a second control electrode in the path of said beam, and a second screen electrode outside of said second control electrode perme-
10 able to electrons only thru that portion adjacent said second control electrode, an anode in registry with the permeable portion of said second screen electrode, said second control electrode deflecting electrons in said beam to the imper-
15 meable portions of said second screen electrode when a predetermined potential is applied to said second control electrode.

4. An electron discharge device having a cathode for emitting electrons, a control electrode for
20 focusing the electrons from said cathode into a beam, a screen electrode surrounding said control electrode, a second control electrode in the path of said beam, an auxiliary electrode having imperforate and foraminous portions, and an
25 anode in the path of said beam, said electrodes and anode being successively positioned, said second control electrode being positioned only between the screen electrode and the foraminous
30 portions of said auxiliary electrode for deflecting electrons in said beam to the imperforate portion of said auxiliary electrode when a predetermined potential is applied thereto.

5. An electron discharge device having a cath-
35 ode for emitting electrons, a control electrode for

focusing said electrons into a beam, a screen electrode surrounding said cathode and control electrode, a second control electrode in the path of the electron beam, an auxiliary electrode outside of said second control electrode and having per-
5 forate and imperforate portions, said second control electrode being positioned only in front of the perforate portions of the auxiliary electrode, an anode positioned outside of said auxiliary electrode for receiving electrons passing thru the
10 perforate portions of said auxiliary electrode, said second control electrode deflecting the electrons from said cathode towards the imperforate portion of said auxiliary electrode when a pre-
15 determined voltage is applied to said second control electrode.

6. An electron discharge device having a cathode for emitting electrons and surrounded by a first control electrode and a screen electrode, a
20 second control electrode positioned outside said screen electrode and comprising spaced conductors electrically connected, an auxiliary electrode surrounding said second control electrode and being perforated only opposite the conductors of
25 said second control electrode, and being imperforate at all other places, and an anode surrounding said auxiliary electrode, said electrodes and said anode being successively positioned, the
30 electrons from the cathode being deflected on to the imperforate portions of said auxiliary electrode when a predetermined voltage is applied to said second control electrode.

GÜNTHER JOBST.
HORST ROTHE.