May 31, 1938. J. SCHALKWIJK 2,119,357

OSCILLATION GENERATOR

Filed July 27, 1935

Fig. 1.

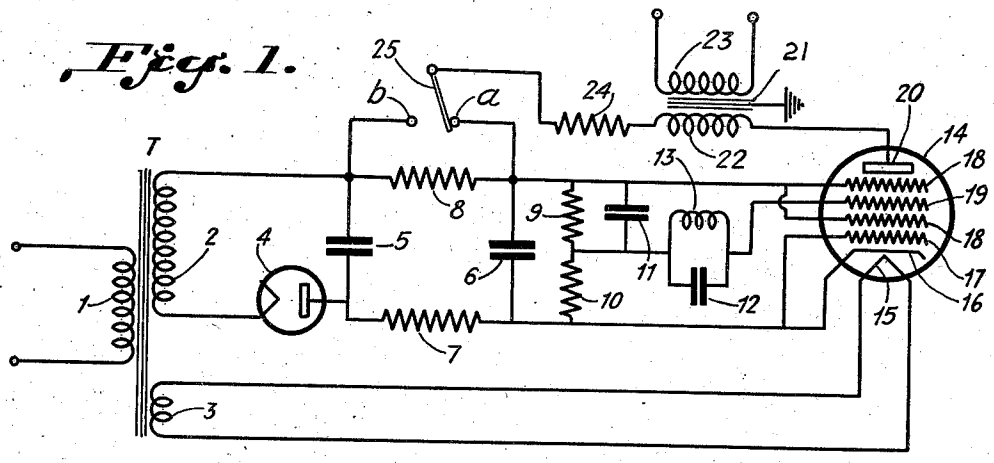


Fig. 3.

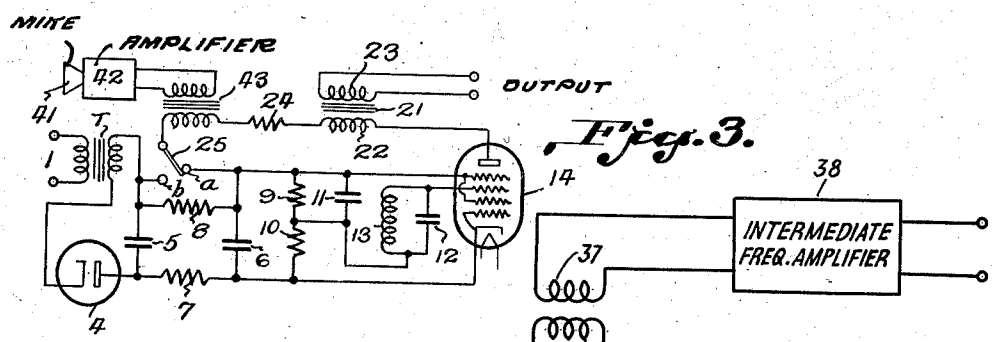
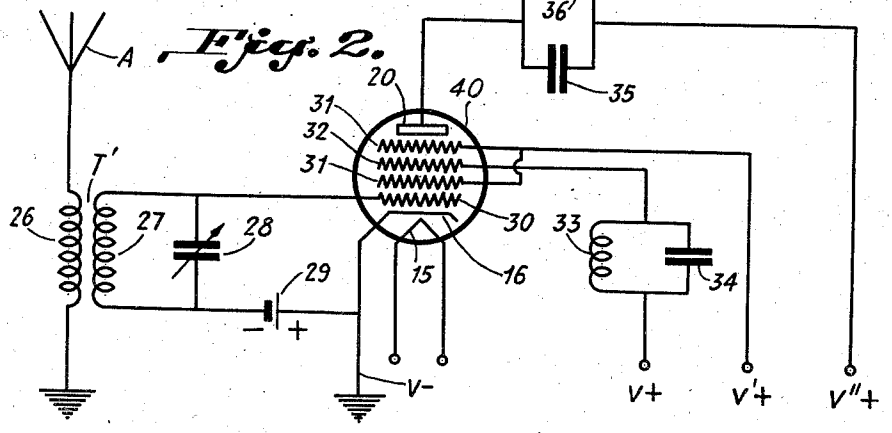


Fig. 2.



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OSCILLATION GENERATOR

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In Germany July 20, 1934

2 Claims. (Cl. 179—171)

This invention relates to oscillators and more particularly to circuits employing multigrid electron discharge tubes for producing high frequency oscillations.

It is well known that oscillator tubes may be so constructed as to exhibit a so-called "dynatron-effect", that is to say an effect which may be attributable to secondary emission. If, for example, the grid of a triode is made more positive than the anode, and if the anode consists of a material capable of secondary emission, then secondary electrons will be supplied by the anode when primary electrons impinge thereon. The number of secondary electrons quite frequently exceeds that of the primary electrons. The secondary electrons pass to the grid electrode since the latter has the higher potential and, therefore, they fly toward the primary electrons. In this manner an anode current characteristic appears which reveals a descending slope of its curve such as may be utilized for the setting up of oscillations.

The "dynatron effect" which may be observed in a triode, as above described, gives rise to the term "anode dynatron" as applied to such a triode since it is the anode that furnishes the secondary electrons. There is also what is known as a "grid dynatron" in which the anode has a positive bias and the grid likewise a positive, but lower bias. If it is assumed that a sufficiently high potential is impressed upon the grid with respect to the cathode and the grid is of a material capable of secondary emission the grid supplies secondary electrons which are absorbed by the plate and the grid current characteristic reveals a portion of its curve with a descending slope.

Both the "anode dynatron" and the "grid dynatron" can be used for setting up oscillations, if in the circuit of the electrode capable of secondary emission a resonance condition is provided. For this purpose one generally employs a tank circuit consisting of parallel disposed capacitive inductive elements and tuned to the frequency to be produced.

The "dynatron" arrangement has the advantage over the ordinary feed-back circuit in that it is simple in structure and does not produce skip-and-disruption phenomena, and furthermore an oscillator so constructed is comparatively free from harmonics and parasitic oscillations. One drawback which has not heretofore been satisfactorily overcome in the use of the "dynatron" arrangement relates to a certain instability of the secondary emission effect, but it is among the objects of this invention to overcome such a disadvantage by providing a multigrid tube, the structure of which will be hereinafter described in more detail.

My invention finds particular utility in transmitter circuits, and also in a self-oscillating mixer stage in connection with superheterodyne receivers.

According to the invention the electrode capable of secondary emission is enclosed between two electrodes maintained at a higher potential, these electrodes being suitably formed as screen grids. The utilization circuit is preferably connected with still another electrode.

The features of my invention which are considered to be novel have been set forth in the appended claims. The details of construction, however, as well as the mode of operation will be described in the following portion of the specification and may be best understood upon reference to the accompanying drawing in which

Figure 1 shows diagrammatically one embodiment of an oscillator circuit employing a multigrid tube;

Fig. 2 shows a somewhat different embodiment which also employs a multigrid tube; and

Fig. 3 illustrates a fragmentary portion of the diagram of Fig. 1 modified so as to provide for speech modulation.

Referring to Fig. 1 which represents certain elements of a transmitter circuit, it may be seen that I have provided means particularly suited to the generation of low power oscillations wherein the frequency is maintained constant within remarkably close tolerances.

The energy for operating this circuit may be derived from a transformer T having a primary 1 connected to any suitable source of alternating current. The secondary winding 2 feeds energy through a rectifier 4 and thence to a filter circuit comprising the two capacitors 5 and 6 which are connected across opposite terminals respectively of the resistors 7 and 8. The direct current potential so obtained may then be impressed upon the cathode 16 and the double grid 18 of the oscillator tube 14, thus providing a suitable positive potential upon the double grid 18 with respect to the cathode. The cathode 16 may be heated in the usual manner by a filament 15 which derives its heating current from the secondary winding 3 on the transformer T.

If desired, for the purpose of impressing a greater load upon the tube 14, chokes may be substituted in place of the resistors 7 and 8. A closed circuit for the filter is provided by the

voltage divider consisting of resistors 9 and 10. An intermediate voltage may be derived from a tap connected between the resistors 9 and 10 and led through a tank circuit comprising the inductance 13 in parallel with which is a capacitor 12, and thence it may be impressed upon the grid 19. This grid 19 is enclosed by the two grids 18 and emits secondary electrons. Suitable operating voltages are obtained if, for example, the grid 19 is maintained at between 70 and 80 volts while the grids 18 are maintained at around 150 volts.

The aforementioned capacitor 12 in parallel with the inductance 13 constitutes a frequency determining circuit in connection with the grid 19.

Connected with the cathode 16 is a grid 17 which is positioned immediately surrounding the cathode and within the other grids. If desired, the grid 17 may be made slightly more positive than the potential of the cathode or it may even be made more negative.

The oscillations set up in the tube 14 may be utilized by taking them off from the plate circuit which includes the anode 20, the primary winding 22 of a transformer, a resistor 24 and a return circuit to the cathode by way of a switch 25 having contacts *a* and *b* for alternative connection with different portions of the aforementioned filter.

The utilization circuit itself is shown connected with the secondary winding 23 which is inductively related to the primary winding 22, there being interposed therebetween a suitable electrostatic shield 21 which is grounded so as to eliminate the possibility of feed-back from the work circuit into the oscillator tube of undesirable capacity effects.

It has been found to be of particularly great advantage that the work circuit is connected to an electrode different from the electrodes of the oscillatory circuit per se, since it provides complete freedom of the oscillator circuit from work circuit reaction. The independence of the oscillator circuit from the work circuit is further insured by making the grids 18 of screen formation.

The circuit arrangement of Fig. 1 lends itself to a variety of different modulating systems. When the switch 25 is in contact with the segment *a*, then the anode 20 will be supplied with filtered direct current and the oscillations will be unmodulated. If, however, the switch 25 is thrown into contact with the segment *b*, then the anode will receive unfiltered direct current and the oscillations will be modulated with the line frequency. In a receiver, particularly one which employs push-pull or multiphase detection, the second and higher harmonics of the fundamental frequency will be obtained. If another modulating frequency as, for example, speech is to be transmitted from the microphone 41 and amplifier 42, then a transformer 43 may be inserted in the anode circuit by means of which a modulating voltage may be superposed on the steady potential applied to the anode 20, in which case the switch 25 is obviously to be placed in contact with the segment *a*.

A further very interesting modification of my invention may be had if the oscillator circuit is adapted to produce secondary emission from the anode 20. In this case the direct current potential applied to the anode should be considerably lower than that applied to the grids 18. It will be found then that the plate current characteristic has a descending slope. Now, if in the plate circuit, an oscillatory circuit tuned to the modulation frequency is inserted, then this circuit will be excited in its natural oscillation and the high frequency oscillations will be modulated due to the "dynatron effect" of the grid 19.

Referring now to Fig. 2, the adaptation of my invention to a self-oscillating mixer stage will now be described.

Only such portions of the receiving circuit as are necessary to an understanding of the invention have been shown in the circuit diagram of Fig. 2. They comprise an antenna A feeding energy to the primary winding 26 of a transformer T', and thence through its secondary winding 27 to an input circuit for the tube 40, this input circuit being connected between the cathode 16 and the control grid 30. The input circuit may be tuned by inserting a tuning condenser 28 in parallel with the secondary winding 27. A suitable negative bias may be impressed upon the control grid 30 by means of the bias battery 29. Between the control grid 30 and the anode 20 are located a double walled screen grid 31 which surrounds, both interiorly and exteriorly, a grid 32. Suitable operating potentials may be impressed upon the various electrodes of the tube 40 as shown by the terminals V+, V'+ and V''+ respectively in relation to the potential of the cathode 16 which is V—.

In the circuit of the grid 32 there is placed a frequency determining tank circuit comprising the inductance 33 and the capacitor 34. It is in this circuit that the "dynatron" characteristic appears. The resonance circuit 33—34 is tuned to the superheterodyne frequency. The oscillations of the energy collected on the antenna are then combined with the oscillations, the frequency of which is determined by the tank circuit 33—34, and either a sum frequency or a difference frequency may be derived in the output circuit which includes the anode 20 and a tank circuit comprising the capacitor 35 and inductance 36. This tank circuit may be tuned to the desired intermediate frequency. Furthermore, the inductive winding 36 may be coupled to a secondary winding 37 through which the output energy may be taken off and utilized, say, in an intermediate frequency amplifier 38 feeding to any desired utilization device.

Due to the arrangement shown in Fig. 2 in which successively higher voltages are impressed upon the grids 31 and the anode 20 in respect to the grid 32, it may be seen that secondary emission takes place from the grid 32. There is, however, a very decided advantage to be had from the arrangement of the several grids 30, 31 and 32 as shown, in that the mixing of the oscillations to be heterodyned is greatly facilitated.

I claim:

1. In an oscillation generator, an electron discharge tube having a cathode, an anode, and a multiplicity of grid electrodes of screen-like formation, one of said grid electrodes being adjacent the cathode, the second and fourth grid electrodes being conductively interconnected, and a third grid electrode being positioned intermediate the second and fourth grid electrodes, a resonant circuit connected to said third grid electrode, an output circuit connected to said anode, means including polarized circuits between said cathode, said grid electrodes and said anode for so applying direct current potentials to said electron discharge tube that oscillations are caused to be set up therein and secondary emission is derived from said third grid electrode, and means for superposing upon said output circuit energy of a

modulating frequency, said energy being prevented by the fourth grid electrode from influencing the frequency of the oscillations generated.

2. In an oscillation generator, an electron discharge tube having a falling current-voltage characteristic and having therein a cathode, an anode, and a multiplicity of grid electrodes, one of said grid electrodes having a frequency determining oscillatory circuit connected thereto and being placed between two others of said grid electrodes, means for maintaining the two electrodes last mentioned at a higher positive potential than is impressed upon the first mentioned grid electrode relative to the potential of the cathode, means for enabling the grid electrode of lower positive potential to emit secondary electrons, an output circuit connected betwen the anode and cathode, means for modulating said output circuit, and means for retaining said cathode, anode and grids in suitable spaced relations to one another whereby the modulating effects are prevented from reacting upon said oscillatory circuit.

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