R. A. HEISING.

CONTROL MEANS FOR VACUUM TUBE CIRCUITS.

APPLICATION FILED SEPT. 21, 1915.

1,343,562. Patented June 15, 1920.

Fig. 1.

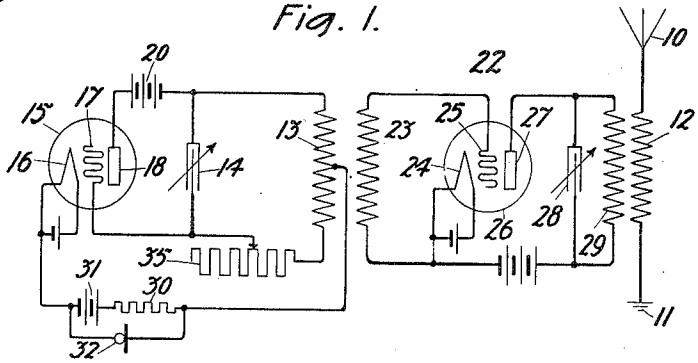


Fig. 2.

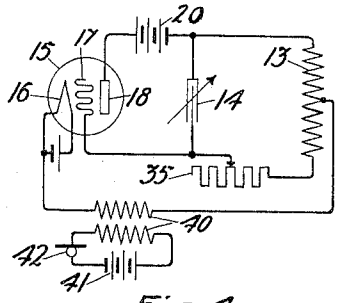


Fig. 3

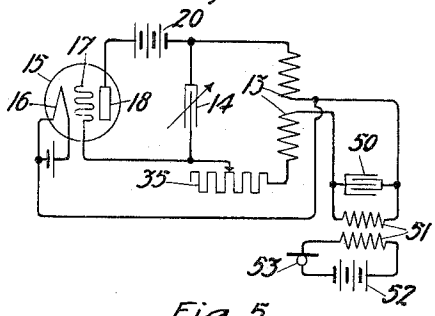


Fig. 4.

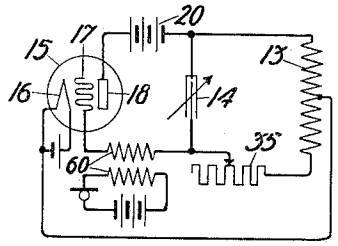


Fig. 5.

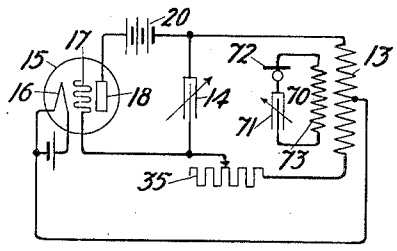
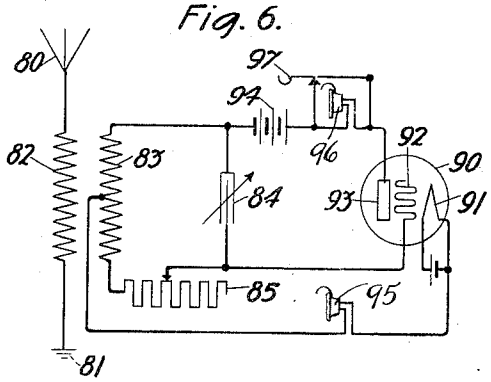


Fig. 6.



Witnesses:

O. E. Pacunnen

Ph. R. Rossi

Inventor:

Raymond A. Heising

by J. G. Roberts

Att'y.

UNITED STATES PATENT OFFICE.

RAYMOND A. HEISING, OF EAST ORANGE, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, INCORPORATED, A CORPORATION OF NEW YORK.

CONTROL MEANS FOR VACUUM-TUBE CIRCUITS.

1,343,562. Specification of Letters Patent. Patented June 15, 1920.

Application filed September 21, 1915. Serial No. 51,761.

To all whom it may concern:

Be it known that I, RAYMOND A. HEISING, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Control Means for Vacuum-Tube circuits, of which the following is a full, clear, concise, and exact description.

This invention relates to the generation of high frequency oscillations to be used in connection with the transmission or reception of signals, and in particular relates to the production of high frequency oscillations of desired characteristics by means of circuits including vacuum tubes of the audion type.

In circuits using such vacuum tubes for generating high frequency oscillations, brought out by bringing the circuit into the so-called singing condition, it is customary to have a coupling or feed-back connection from the output to the input circuit of the vacuum tube. The frequency is generally determined by using a resonant or tuned circuit connected with the vacuum tube.

Under different circumstances, according to the use to which this system is to be placed, it may be desirable to change the characteristics of the system by bringing it to the oscillatory, slightly oscillatory, near oscillatory or non-oscillatory condition.

This invention affords a ready means for doing this and consists in placing in the tuned circuit an adjustable resistance so that the circuit may be readily brought into one or another of the conditions desired.

The invention will be better understood by reference to the following specification and accompanying drawings in which Figure 1 shows a system adapted for radiating high frequency oscillations for signaling purposes; Figs. 2 to 5 show various modifications of such a transmitting circuit; and Fig. 6 shows the application of the invention to a receiving station.

Like reference characters refer to the same parts.

In Fig. 1, an elevated conductor 10 or other suitable radiating system is connected to earth at 11 through the inductance 12. A tuned circuit comprising the inductance 13 and the condenser 14 may be connected to the inductance 12 through amplifier 22. Conductors leading from the one side of the condenser 14 and from an intermediate point in the inductance 13, lead to the input of a thermionic amplifier 15, the input electrodes comprising the usual heated element 16 and grid 17. The output electrodes, 16 and 18, of said amplifier or vacuum tube are connected to the middle of the inductance 13 and the other side of the condenser 14. The usual battery 20 is placed in the output circuit.

The frequency of the oscillations in the output circuit is determined primarily by the period of the tuned circuit 13, 14 and the connection from this tuned circuit to the input circuit of the vacuum tube causes the oscillations to be maintained. For signaling purposes it is desirable to have some means of modifying the amplitude of the oscillations. This is accomplished by means of the resistance 30 and battery 31 connected in series with the element 16. In parallel to the resistance and battery is connected the microphone transmitter 32. Signals may then be transmitted by speaking against the microphone 32, thereby causing the impression of low frequency oscillations, in accordance with speech variations, upon the input circuit of the vacuum tube. These low frequency oscillations will then bring about a corresponding modification or modulation of the power in the output circuit. According to this invention, there is inserted in the tuned circuit a non-inductive adjustable resistance 35. By means of this variable resistance it is possible to bring the circuit into an oscillatory, slightly oscillatory, near oscillatory or non-oscillatory condition. In cases of transmission, however, it is usually desirable to adjust the resistance to such a point that the system will be in the oscillatory condition. The oscillations then set up may be radiated directly into the antenna. In general the quality of signals transmitted by the modulated waves will be better when the system is slightly oscillatory than when it is highly oscillatory.

In view of the small amount of power in the output circuit of the amplifier 15, it will in general be desirable and necessary to have the inductance 13 connected to an amplifying circuit which may then be connected to the radiating antenna.

Such an arrangement is shown in Fig. 1

in which 22 is the amplifying circuit inserted between 12 and 13. This amplifying circuit comprises the inductance 23 connected inductively to 13. The inductance 23 is connected to the input terminals 24 and 25 of the thermionic amplifier 26. The output electrodes 24 and 27 feed into the circuit consisting of the condenser 28 and inductance 29, tuned to signaling frequency. This circuit is inductively connected to the antenna as shown.

In Fig. 2 a modified method for impressing the low frequency signaling oscillations upon the input circuit is shown. In this case the resistance 30 and battery 31 is replaced by the secondary of a transformer 40, the primary of which is included in a circuit containing the battery 41 and microphone 42. In this circuit also the high frequency oscillations fed back from the tuned circuit 13, 14 are impressed upon the input circuit of the amplifier. It is then amplified and sent into the plate circuit resulting in a continuous oscillation of power at a frequency determined by the network. The amplitude of these oscillations is altered, however, by the low frequency oscillations impressed upon the circuit by means of the transformer 40.

In both of the circuits described above, the voltage impressed upon the circuit by the telephone circuit changes the potential of the plate as well as the grid with respect to the filament. The effect upon the grid and plate will be additive, but the same amount of energy when applied to the plate circuit will cause less effect than when applied to the grid circuit. Since the amount of low frequency energy supplied by the microphone circuit is limited, it may be desirable in some cases to operatively associate the microphone circuit with the grid circuit only so that the total modulating effect may occur through action upon the grid rather than by action upon both grid and plate. The desirability of so doing will depend upon a number of factors such as the amplifying power of the tube and the constants of the tube, associated circuits and microphone or variable impedance device. An arrangement for doing this is shown in Fig. 3. In this case the inductance 13 is split in the middle and a large condenser 50, which has practically zero impedance for the high frequency currents, is in circuit. Since such a condenser will not be of zero impedance for voice frequency currents, the transmitter 53 with its associated battery 52 and transformer 51 may be connected in parallel to the condenser 50, as shown in the figure. The telephonic frequencies are thus impressed across the condenser by the transformer, and the potential variations are introduced on the grid circuit without being introduced also on the plate circuit.

In Fig. 4 the telephonic potential variations are impressed on the grid by a transformer 60 between the condenser 14 and the grid 17.

In the modification shown in Fig. 5 the variation of the oscillations is caused by varying the effective resistance in the oscillator circuit. In this case the resistance of the transmitter is introduced into the oscillator circuit by a tuned circuit 70 coupled thereto. The circuit 70 includes the condenser 71, microphone 72 and the inductance 73. The whole circuit may be tuned to the signaling frequency, and is coupled to the inductance 13. Changes in the resistance of the circuit containing the microphone transmitter will produce corresponding changes in the amplitude of the oscillations taking place in this system as a whole.

In all of the above described modifications the frequency of the system is adjusted by means of the condenser 14 and the amplitude of oscillation can be adjusted by the resistance 35.

Fig. 6 shows the application of this invention to a receiving system. In this figure, 80 shows an elevated conductor connected to earth at 81 through the inductance 82. Coupled to this inductance 82 is a resonant circuit including the inductance 83, condenser 84 and adjustable resistance 85. Conductors lead from the one side of the condenser 84 and from a point in the inductance 83 to the input terminals 92 and 91 of the amplifier 90. The output circuit of the amplifier has the plate electrode 93 connected through the battery 94 to the other side of the condenser 84 and the filament 91 to a point in inductance 83. A telephone receiver 95 is placed in series with the filament 91. This receiver may, however, be placed as shown at 96, the switch 97 serving to short-circuit this receiver when receiver 95 is being used. However, two receivers may be employed, one in the position 95 and the other in the position 96, in which case either one may be employed for the reception of signals, or both may be used simultaneously. This circuit arrangement provides a means for heterodyne or beat receiving without the use of an additional generator to furnish the superposed, beat producing oscillations. It also provides means for amplifying and sustaining the signals, and is so arranged that these two methods of operation may be obtained in the same circuit. The action for heterodyne receiving is as follows: The resistance 85 is adjusted so that the circuit containing it and the variable capacity is oscillatory at a frequency near that of the signals to be received. Then, when the received signals at high frequency combine with the oscillations of the frequency set up in the local oscillatory circuit, the interference of

these two inaudible oscillations produces beats which are audible in the telephone exactly as in the usual heterodyne receiving system, using a separate source for the local frequency.

In the heterodyne method it has been found preferable to have the circuit adjusted to the slightly oscillatory condition so that the received signals may be amplified to a great extent. In case the system is to be used as a self-amplifying one, it is desirable that the system be so adjusted that the circuit of the condenser is near oscillatory. As pointed out, this is accomplished by varying the resistance 85 until the circuit is nearly in the singing condition, in which condition a disturbance entering the system starts oscillations which are nearly undamped and die out more slowly, resulting in an amplified signal which is more easily received. In either method of operation, the tuning can be done entirely with the variable condenser, and the adjustment to bring this system into the required state may be made with the resistance alone. In this latter case the state of the system is indicated by the reading of an ammeter placed to record the space current. The condition of free oscillation or singing is shown by a sudden increase in the magnitude of the space current.

What is claimed is:

1. A generator of high-frequency oscillations comprising a vacuum tube of the audion type, a single tuned circuit conductively connected to said tube and primarily determining the frequency of the oscillations generated, a feed-back connection from the output to the input circuit of said tube, and means included in said tuned circuit for bringing the system into the slightly oscillatory or the non-oscillatory condition.

2. A generator of high-frequency oscillations comprising a vacuum tube of the audion type, a tuned circuit connected to the output circuit of said tube, a feed-back connection from the output to the input circuit of said tube, and an adjustable resistance connected to said tuned circuit adapted to bring the system into the slightly oscillatory or near oscillatory condition.

3. In a receiving system, a receiving conductor, a tuned circuit coupled thereto, a thermionic amplifier having an anode, a cathode and an impedance varying element, said amplifier being connected to said tuned circuit for the generation of oscillations therein, a telephone receiver connected to said amplifier, and means included in said tuned circuit operative to cause large changes in the oscillatory condition of the system without thereby causing a material change in the natural frequency of the system.

4. In a receiving system, a receiving conductor, a tuned circuit associated therewith, a thermionic amplifier of the audion type connected to said tuned circuit, a telephone receiver connected to said amplifier, and an adjustable resistance connected to the circuit and adapted to bring the system into the slightly oscillatory or near oscillatory condition for the purpose set forth.

5. In a receiving system, a receiving conductor, a tuned circuit associated therewith, a thermionic amplifier of the audion type having its input and output circuits connected to said tuned circuit, and an adjustable resistance in said tuned circuit adapted to bring the system into the slightly oscillatory condition whereby the system is caused to generate oscillations of a frequency slightly different from the signaling frequency to form beats with said received signal waves.

6. A generator of high frequency oscillations comprising a vacuum tube of the audion type, a tuned circuit conductively connected to the output circuit of said tube, a feed-back connection from the output to the input circuit of said tube, and an adjustable resistance connected to said tuned circuit to bring the system into the slightly oscillatory, near oscillatory or non-oscillatory condition.

7. In a signal receiving system, an electric discharge device, means including circuit arrangements connected thereto whereby said device may act as a generator of continuous oscillations, and a variable non-inductive resistance connected to a part of said circuit arrangements for adjusting said device to the critical point, a receiving conductor, and means to transfer energy from said conductor to said circuit arrangements.

8. A system for generating oscillations comprising a discharge device having a cathode, an anode and an impedance varying element, an oscillation circuit containing a capacity, leads from said anode and impedance varying element to the opposite sides of said capacity respectively, and a variable non-inductive resistance in said circuit whereby the system may be adjusted to the critical point.

9. A system for generating oscillations comprising an inductance and a discharge device having an anode, a cathode and an impedance varying element, a lead from said cathode to a point in said inductance, a lead from said anode to said inductance, a lead from said impedance varying element to said inductance, an electric capacity in effective shunt to at least a portion of said inductance including at least a portion of that part of said inductance which lies between the leads from said cathode and said anode, and a variable means for varying the amplitude of oscillations generated without materially affecting the frequency.

10. Means for receiving electrical signals comprising a receiving conductor, a thermionic discharge device having a feed-back from the output to the input circuit thereof, a tuned oscillation circuit, means for connecting said circuit to the electrodes of said device whereby said device may generate oscillations at a definite single frequency, said device being adjusted to the point just below which oscillations start, and means for transferring energy from said receiving conductor to said oscillatory circuit to cause oscillations therein.

11. Means for receiving electrical signals comprising a receiving conductor, an electric discharge device, a tuned frequency determining oscillation circuit means for connecting said circuit to the electrodes of said device whereby said device may generate oscillations at the approximate frequency to which said circuit is tuned, means for adjusting said device to the point just below which oscillations start, said means being such that variations thereof do not materially vary the oscillation frequency of said tuned circuit, and means for transferring energy from said conductor to said oscillatory circuit to cause oscillations therein.

12. Signal receiving means comprising in combination a receiving conductor, an electrical discharge device, means associated with said device for impressing on the input circuit a voltage corresponding to alternating current flowing in the output circuit, a tuned oscillation circuit, means for connecting said circuit to the electrodes of said device for controlling the same whereby oscillations may be generated at a single definite frequency, means for adjusting said device to the critical point without materially changing the oscillation frequency of said tuned circuit, and means for transferring energy from said conductor to said oscillation circuit.

13. The method of receiving signal waves by receiving circuit means comprising an amplifying device, a feed-back from the output to the input circuit of said device, and a tuned frequency determining circuit, which comprises establishing a natural period of said circuit means equal to the period of the waves to be received, setting said circuit means immediately adjacent the point at which it acts as a sustained generator of oscillations, and applying the energy of waves to be received to said means.

14. A signal wave receiving system comprising a receiving conductor, a thermionic discharge device connected thereto, an oscillation circuit tuned to the frequency of the incoming waves, a feed-back circuit, said feed-back and oscillation circuit being arranged to selectively feed back wave energy of the incoming wave frequency, means for adjusting said system to a point immediately below the critical point at which sustained oscillations are generated, and a connection between said conductor and said device.

15. A receiving system comprising a space discharge device, and means whereby said device functions as an oscillation generator, said means including an input circuit, an output circuit and a tuned circuit, and means including a variable resistance in said tuned circuit for bringing the system to a slightly oscillatory condition.

16. A system comprising a space discharge device and means whereby said device functions as an oscillation generator, said means including an input circuit, an output circuit, and a tuned circuit, and means including a variable resistance in said tuned circuit for bringing the system to a slightly oscillatory condition.

17. A receiving system comprising a space discharge device, circuit arrangements operatively associated with said device including an input circuit, an output circuit, a feed-back connection and a tuned circuit, and means including a variable resistance in said tuned circuit for bringing the system to a point just below the oscillatory condition.

18. A system comprising a space discharge device, circuit arrangements operatively associated with said device including an input circuit, an output circuit, a feed-back connection and a tuned circuit, and means including a variable resistance in said tuned circuit for bringing the system to a point just below the oscillatory condition.

In witness whereof, I hereunto subscribe my name this fifteenth day of September, A. D., 1915.

RAYMOND A. HEISING.