

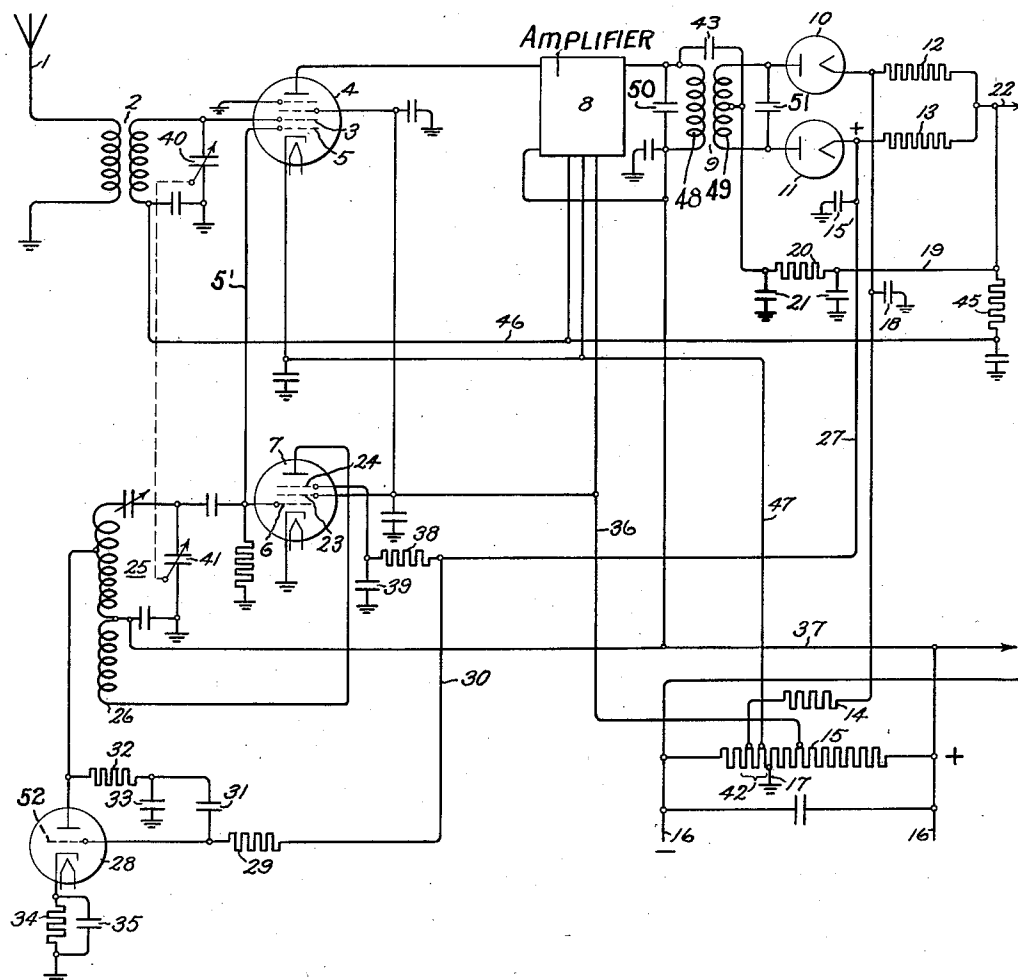
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SIGNAL SYSTEM

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SIGNAL SYSTEM

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My invention relates to signal systems and more particularly to oscillation generators utilized in such systems. It has for one of its objects to provide novel and improved means for controlling the amplitude of oscillations generated by such oscillation generators.

My invention relates more particularly to such oscillation generators utilized in superheterodyne radio receivers in which the frequency of oscillations produced thereby is regulated by the intermediate frequency produced by combining such oscillations with received signal currents. Such systems are commonly utilized to maintain the intermediate frequency constant irrespective of variations in the frequency of the received signal, or in the frequency of oscillations produced by the local oscillator. In such systems the frequency of the local oscillator is commonly regulated by means of an electron discharge device having its electrodes connected to simulate a reactance across the frequency determining circuit of the local oscillator and having a grid the bias on which is controlled by variations in frequency of the intermediate frequency currents. In this way, desired control of the value of simulated reactance and hence desired regulation of the frequency of oscillations produced is obtained.

One of the objects of my invention is to improve the operation of such systems with respect to the amplitude of oscillations produced.

A further object of my invention is to provide means automatically to counteract the effect of such systems upon the amplitude of oscillations produced.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which the single figure represents an embodiment of my invention.

Referring to the drawing, I have shown therein a radio receiver embodying my invention, this receiver comprising an antenna 1 which is connected through a transformer 2 to one grid 3 of an electron discharge device 4. This discharge device is connected to operate as a first detector, or superheterodyne converter, of the radio receiver. A second grid 5 of this discharge device is connected to the control grid 6 of the electron discharge device 7, which is connected to operate as an oscillation generator to produce local oscil-

lations to combine with the received oscillations in the superheterodyne converter, thereby to produce oscillations of the so-called intermediate frequency. These latter oscillations appear in the output circuit of the discharge device 4 and are, if desired, amplified in an intermediate frequency amplifier 8 and supplied through transformer 9 to a second detector comprising diodes 10 and 11. The anodes of the two discharge devices 10 and 11 are connected to opposite terminals of the secondary winding of transformer 9 and the cathodes thereof are connected together through resistances 12 and 13 for a purpose later to be described. The cathode of discharge device 10 is connected through resistance 14 to a point on bleeder resistance 15 which is negative with respect to ground. This bleeder resistance is connected across a source of unidirectional operating voltage 16 and is grounded at an intermediate point thereof as indicated at 17. This cathode is also grounded for alternating currents by condenser 18. The cathode of discharge device 11 is also grounded through condenser 15', which is a conventional by-pass condenser. To complete the circuit for rectifier currents produced by discharge devices 10 and 11 the point between resistances 12 and 13, which commonly are of substantially equal value, is connected through conductor 19 to the midpoint of the secondary winding of transformer 9, a suitable resistance capacity filter comprising resistance 20, and condensers 21 being incorporated in this connection.

The audio output from the receiver may be taken between ground and conductor 22, which is connected at the point between resistances 12 and 13 and upon which signal oscillations appear.

The local oscillator, comprising electron discharge device 7, may be of any suitable conventional type, and is shown as comprising an electron discharge device having a control grid 6, a screen grid 23, and a suppressor grid 24 arranged in the conventional manner and spaced at different distances from the cathode and anode, as indicated. The frequency determining circuit 25 of the oscillator is connected between the control grid and the cathode, and the inductance thereof is coupled to an inductance 26 which is connected between the anode and cathode of the discharge device 7, thereby to produce the necessary feed-back for the production of oscillations. The oscillations produced may be supplied to the input circuit of the receiver by any desired form of coupling, but in the arrangement shown they are supplied through conductor 51 from the 55

grid of discharge device 7 to a control grid 5 of the converter 4.

To control the frequency of oscillations produced by the discharge device 7, a further electron discharge device 28 is employed, this device having its anode and cathode connected between ground and a point on the inductance of the frequency determining circuit 25. The grid 52 of this discharge device is connected through resistance 29 and conductors 30 and 27 to the cathode of diode 11 whereby it is subjected to a bias or control potential with respect to ground dependent on the potentials on resistances 12 and 13. The grid of this discharge device is also connected through condenser 31 to an intermediate point on a path between the anode and cathode of discharge device 28, this path comprising resistance 32 and condenser 33.

The cathode of the discharge device 28 is biased positively with respect to ground by means of the usual cathode bias resistor 34 which is by-passed with respect to currents of radio frequency by condenser 35.

Operating potentials for the various discharge devices employed are supplied from the bleeder resistance 15 which may be connected across the output of any suitable rectifier. It will be seen that the screen grid potential for the converter 4, and oscillator 7, as well as similar potentials for the discharge devices, which may be employed in intermediate frequency amplifier 8, may be obtained from an intermediate point on resistance 15 through conductor 36. Anode potential for these discharge devices is obtained from the positive terminal of the resistance 15 through conductor 37.

The suppressor grid 24 of the discharge device 7, similarly with the control grid of discharge device 28, is connected to the control conductor 27 through resistance 33 and connected to ground through condenser 39. The latter elements comprise the usual resistance capacitance filter to prevent the supply of alternating currents from conductor 27 to the suppressor grid.

The operation of my device will now be explained in greater detail.

Signal oscillations received upon the antenna 1 are impressed by transformer 2 upon a tuned circuit comprising the secondary winding of this transformer and tuning condenser 40, which condenser is arranged for uni-control with a condenser 41 of the frequency determining circuit 25 of the oscillator. When the circuit comprising condenser 40 is tuned thereby to the frequency of oscillations to be received, the frequency determining circuit 25 is tuned to a corresponding frequency, usually greater than the frequency of the received signal by an amount equal to the intermediate frequency, which the amplifiers 8 are adapted to amplify. Usually this intermediate frequency is of about 455 kilocycles. Accordingly, the received signal oscillations which appear across condenser 40 and those produced by the local oscillator are supplied respectively to the two control grids 3 and 5 of the converter 4, thereby to produce currents of the intermediate frequency in the anode circuit of the discharge device 4. These currents are amplified by intermediate frequency amplifier 8 and are supplied through the transformer 9 to the diodes 10 and 11. The primary and secondary windings 48 and 49 of transformer 9 are tuned to this intermediate frequency by condensers 50 and 51 connected respectively thereacross. The upper terminal of the primary winding 48 is also connected through a condenser

43 to the midpoint on the secondary winding 49 of this transformer.

This transformer operates to supply to the diodes 10 and 11 equal electromotive force when the intermediate frequency is of the exact value to which the circuits of the transformer are tuned for operation. If this frequency varies in one direction then the transformer supplies a greater potential to one of the diodes 10 or 11 than it does to the other. If the frequency varies in the opposite direction then the greater potential is supplied to the opposite diode. These effects, as is now well understood, are produced by reason of the tuning of the primary and secondary windings at this intermediate frequency and by reason of the action of condenser 43. The result is that the unidirectional potential which appears on resistance 13 is equal to that on resistance 12 when the intermediate frequency is of the exact value, and since these potentials are oppositely polarized the control conductor 27 is negative with respect to ground by an amount determined by section 42 of the bleeder resistance 15. When the intermediate frequency varies in one direction or the other, the control conductor becomes either more or less negative, dependent upon the direction of the variation of the intermediate frequency from the normal value. This potential of conductor 27 is supplied through resistance 33 to the suppressor grid 24 of local oscillator 7 and also through resistance 29 to the control grid 52 of the electron discharge device 28.

The anode and cathode of discharge device 28, as previously stated, are connected across a portion of the frequency determining circuit 25 of the oscillator. This discharge device is connected to simulate a reactance across a portion of this frequency determining circuit, the magnitude of the reactance being varied by the potential on the control grid, thereby to control the frequency determined by the circuit 25. To effect this simulation of reactance by the discharge device 28, its anode is connected to ground through resistance 32 and condenser 33, and the point therebetween is connected through condenser 31 to the grid, as previously described. Since the circuit comprising resistance 32 and condenser 33 is capacitive, the potential across condenser 33 is of leading phase with respect to the potential on the anode of discharge device 28, and since this potential is supplied through condenser 31 to the grid of discharge device 28 the potential on that grid, therefore, is in leading phase with respect to the potential on the anode. The current between the anode and cathode is displaced in phase by 180 degrees from the grid potential of the discharge device and, therefore, lags the anode voltage. In other words, the discharge device acts in the nature of an inductance, and controls the effective reactance of the portion of the oscillating circuit 25 across which it is connected. Of course, for the same reason, were condenser 33 replaced by an inductance, the discharge device 28 would act in the nature of a capacitance. The magnitude of the current flowing through the discharge device 28, and hence the magnitude of this simulated reactance, may be varied by the potential of conductor 27. When this potential is less negative, the simulated reactance of discharge device 28 is reduced, and when it is more negative, the simulated reactance is increased with the result that the frequency of oscillations produced by the oscillator 7 is dependent upon the potential on conductor 27 and hence upon the frequency of the intermediate frequency currents. This change in

frequency of the local oscillator produced by variation of the potential on conductor 27, may be adjusted to compensate for such variations in the frequency of the local oscillator as are produced through changes in the characteristics of the discharge device 7 produced during the heating up period, for example, and for other causes. It may also compensate for changes in frequency of the received signal, or for any effect tending to disturb the intermediate frequency from its normal value. Thus, for example, if the oscillator frequency tends to increase the intermediate frequency increases and a potential is produced on conductor 27, which varies the impedance of the discharge device 28 to an extent sufficient to produce a compensating change in the frequency produced by the local oscillator. If the oscillator frequency tends to decrease, the opposite compensating action occurs. These effects serve to maintain a constant intermediate frequency over a certain range of movement of the tuning control for condensers 40 and 41 thereby to obviate the necessity for accurate adjustment of these condensers to the frequency to be received.

In the operation of this system, however, when the conductor 27 becomes less negative and the resistance of discharge device 28 is reduced and increased current from the oscillator flows through the discharge device 28, a considerable loading of the frequency determining circuit 25 is caused, this in turn having the effect of reducing the amplitude of oscillations produced by the oscillator 7. In some cases the effect of this amplitude variation is very detrimental to the operation of the receiver due to the reduced translation efficiency caused thereby in the converter 4. In cases where the operating voltage is subject to variation this effect may cause the oscillator to cease oscillating altogether.

This effect may be overcome, however, and the amplitude of the oscillations produced by the oscillator 7 may be rendered substantially constant, notwithstanding operation of the automatic frequency control circuit, by supplying the potential of the control conductor 27 also to the suppressor grid 24 of the oscillator through resistance 38. Thus when the conductor 27 becomes less negative, the suppressor grid 24 likewise becomes less negative with respect to the cathode and, therefore, increases or tends to increase the amplitude of oscillations produced by the oscillator. This effect may be made just sufficient to compensate for the opposite effect produced by the discharge device 28, thereby to maintain the amplitude of oscillations substantially constant.

It is highly desirable that the suppressor grid of device 7 never become positive with respect to the cathode of this discharge device. The potential on section 42 of bleeder resistance 15 is, therefore, made sufficiently great to maintain this suppressor grid 24 at the potential of the cathode, or negative with respect thereto at all times. This prevents the flow of grid current in suppressor grid 24 and objectionable results produced thereby.

The potential with respect to ground on section 42 of resistance 15 is also supplied through resistances 14, 12 and 45 and automatic volume control conductor 46 to the grid 3 of discharge device 4 and other discharge devices within the equipment represented by rectangle 8. This potential may in some cases be too great for bias purposes on these devices. In order to adjust the bias voltage on these devices properly, their

cathodes are connected through conductor 47 to a desired point on the bleeder resistance. A similar connection, not shown, may, if desired, be employed for control tube 28 in place of bias resistance 34 and condenser 35.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto, since different modifications both in the circuit arrangement and in the structure employed may be made without departing from the spirit and scope of my invention. I contemplate by the appended claims, therefore, to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, an electron discharge oscillator, having an anode, a cathode, and a plurality of grids interposed between said anode and cathode, a circuit between one of said grids and said cathode, a circuit between said anode and cathode, a coupling between said circuits whereby oscillations are generated by said oscillator, means to produce a unidirectional electromotive force having a magnitude dependent upon the frequency of said oscillations, means to control the frequency of said oscillations in response to said electromotive force, said last means operating to affect undesirably the intensity of said oscillations, and means to supply said unidirectional electromotive force to another grid of said oscillator to compensate for said undesirable intensity variations of said oscillations.

2. In combination, an electron discharge oscillator, having an anode, a cathode, and a plurality of grids interposed between said anode and cathode, a circuit between one of said grids and said cathode, a circuit between said anode and cathode, a coupling between said circuits whereby oscillations are generated by said oscillator, means tending to vary the intensity of said oscillations, means to supply a bias voltage to another grid of said electron discharge oscillator, and means responsive to the amplitude of oscillations generated by said oscillator to control the magnitude of said bias voltage thereby to reduce the variations in said amplitude produced by said first means.

3. The combination, in a superheterodyne signal receiver, a local oscillator, means to combine oscillations produced by said local oscillator with received signals to produce currents of intermediate frequency, means responsive to variations in said intermediate frequency to control the frequency of said local oscillator to maintain said intermediate frequency substantially constant, said last means operating to affect the amplitude of oscillations produced by said local oscillator, and means controlled by said intermediate frequency to oppose the effect of said last means on said amplitude of the generated oscillations.

4. In combination, an electron discharge oscillation generator having a plurality of electrodes and a frequency determining circuit, means responsive to the frequency of oscillations generated to control the effective reactance of said circuit thereby to regulate the frequency of said oscillations, said means undesirably affecting the amplitude of said oscillations, and additional means responsive to the frequency of the generated oscillations to affect the amplitude of said oscillations in opposite sense to the effect of said frequency regulating means.

5. The combination, in a superheterodyne signal receiver, of an electron discharge local oscillator, having a frequency determining circuit, means to combine the oscillations produced by said local oscillator with received signals to produce currents of intermediate frequency, means responsive to said intermediate frequency to control the effective reactance of said frequency determining circuit thereby to maintain said intermediate frequency substantially constant, said means adversely affecting the amplitude of oscillations produced by said oscillator, and additional means responsive to said intermediate frequency oppositely to affect the amplitude of said oscillations.
6. The combination, in a superheterodyne signal receiver, of an electron discharge local oscillator, having a frequency determining circuit, means to combine the oscillations produced by said local oscillator with received signals to produce currents of intermediate frequency, an electron discharge device having an anode and a cathode connected to different points on said frequency determining circuit, and having a grid, means to supply oscillations from said frequency determining circuit to said grid in such phase that said discharge device simulates an inductance connected between said points, means to supply a bias voltage to said grid having value depend-

ent upon said intermediate frequency thereby to control said simulated inductance to maintain said intermediate frequency constant, and means to control the amplitude of said oscillations, said last means comprising an additional grid in said electron discharge oscillator, and means to control the bias on said additional grid in accordance with said first mentioned bias.

7. The combination in a superheterodyne receiver, of an electron discharge device having an anode, a cathode, a control grid and a suppressor grid interposed between said control grid and anode, a frequency determining circuit connected with said anode and control grid thereby to generate oscillations, means to combine said oscillations with received signals to produce currents having an intermediate frequency, a second electron discharge device having a pair of electrodes connected across said frequency determining circuit thereby to control the frequency determined by said circuit, and having a control grid, means to produce a unidirectional potential dependent in magnitude upon said intermediate frequency, and to supply said unidirectional potential to said suppressor grid and to said last mentioned control grid whereby the potential on both of said grids is varied with variations in said intermediate frequency.

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