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OSCILLATION GENERATOR

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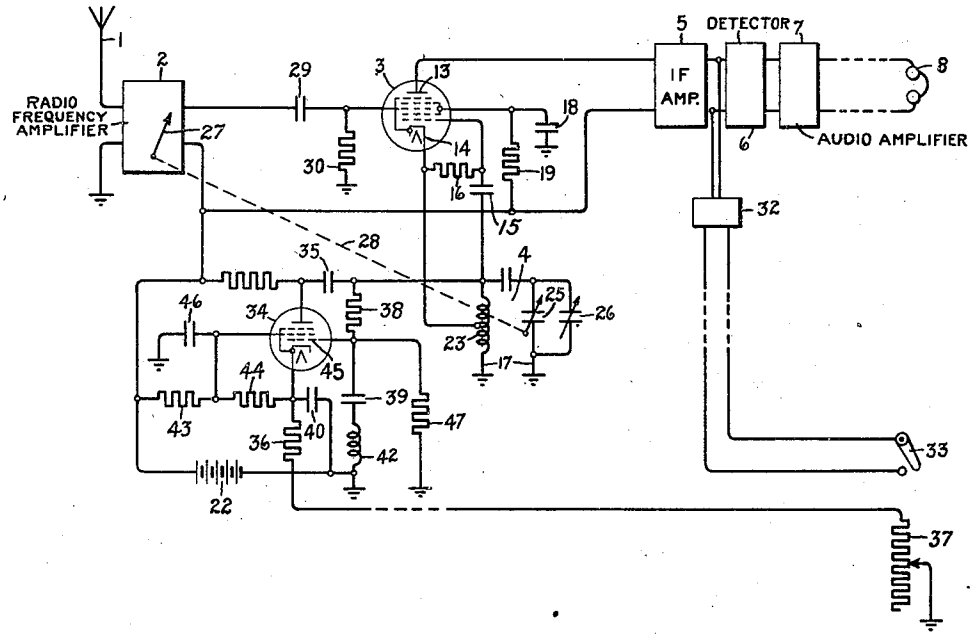

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OSCILLATION GENERATOR

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5 Claims. (Cl. 250—36)

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My invention relates to oscillation generators and particularly to frequency control means therefor.

While not limited thereto, my invention is useful in the local oscillators of radio receivers of the superheterodyne type. Frequently in such receivers the local oscillator is variable in unison with the tuning of the input circuit over a wide range of frequencies to tune the receiver for response to stations operating at those frequencies. In addition, in certain receivers it is desirable to provide means to effect a fine adjustment of the frequency at any point in this wide range.

One expedient sometimes employed to effect variation of the frequency of an oscillator, in response to variations in a primary variable, such as a variable electromotive force, is that of the so-called reactance tube, that is, an electron discharge device connected to the oscillator to simulate a reactance variable with variations in the primary variable to vary correspondingly the frequency of the oscillator.

One of the objects of my present invention is to provide improved means employing such a reactance tube to effect such fine adjustment of the frequency determined by the oscillator.

Another object of my invention is to provide means whereby the primary variable controlling the reactance tube is equally effective to vary the frequency of the oscillator at all parts of the range of frequencies at which the oscillator operates.

A further object of my invention is to provide in connection with a primary variable for fine adjustment of the oscillator means whereby the range of frequencies over which the oscillator frequency may be varied by variation of the primary variable is substantially the same at both high and low frequencies in the band of frequencies over which the oscillator operates.

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 having an antenna 1, a radio frequency amplifier 2, which may be tunable over a wide range of frequencies, a converter 3, to which oscillations amplified by amplifier 2 are

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supplied and which comprises a local oscillator having a local frequency determining circuit 4, an intermediate frequency amplifier 5, a detector 6, an audio amplifier 7, and a suitable signal reproducing device, such as a pair of headphones or loudspeaker 8.

The converter 3 is one of the usual pentagrid converter types comprising an electron discharge device having an anode 13 and a cathode 14 and five grid electrodes interposed therebetween. The first of these electrodes, that is, the one adjacent the cathode, is utilized as the control electrode of the local oscillator, being connected through the usual grid condenser 15 to one terminal of the oscillatory circuit 4 and through grid leak 16 to the cathode. The opposite terminal of the oscillatory circuit is grounded as indicated at 17 to which ground the second and fourth control electrodes of the discharge device are connected through condenser 18. Operating voltage is applied between ground and these latter electrodes through a resistance 19 from a suitable source 22. The cathode 14 of the discharge device is connected to an intermediate point on the inductance 23 of the oscillatory circuit and thus oscillates above ground as does the first control electrode. Due to the interaction between this cathode 14 and the first two control electrodes with the oscillatory circuit 4, oscillations are excited in the circuit 4 of a frequency determined by the inductance thereof and such other constants as may be present in the circuit, these other constants of course including a tuning condenser 25, trimmer condenser 26 and other reactances certain of which will be presently referred to. The tuning condenser 25 is arranged for unicontrol with similar tuning elements in the amplifier 2, which are conventionally indicated by the arrow 27. This arrow is joined to an arrow through condenser 25, by the dotted line 28, indicating the mechanical connection between the movable electrodes and these elements. By variation of these movable elements the frequency to which the radio receiver responds may be varied over a wide range, as from 2 to 4 megacycles.

The ouput from the amplifier 2 is supplied through the coupling condenser 29 to a control electrode of device 3, this control electrode being the third electrode from the cathode, and being connected to ground through the usual grid leak 30. The electrode adjacent the anode 13 is connected to the cathode and operates as the usual suppressor grid.

Of course oscillations of the so-called intermediate frequency, which may be a frequency

of 1225 kilocycles, are produced in the output circuit and are amplified by the amplifier 5, detected by the detector 6 to reproduce audio frequency voltages, which are amplified by the amplifier 7, and converted to audible signals by the reproducing device 8.

Where the receiver is to be used for continuous wave telegraphic reception, it is desirable to beat with the oscillations of the intermediate frequency, further oscillations differing therefrom by an audible amount, as for example 1,000 cycles. Such further oscillations are produced by an oscillator conventionally indicated at 32, which is coupled to the output of the intermediate frequency amplifier 5 so that oscillations produced thereby are combined with the intermediate frequency oscillations in the detector 6 to produce the 1,000-cycle beat note which is amplified by the audio amplifier and is heard from the reproducing device 8. This oscillator 32 may be controlled by a switch 33 which, if desired, may be arranged at a remote point and which, when open, disables the oscillator 32, thereby adapting the receiver for telephonic reception. When switch 33 is closed the oscillator 32 operates and the receiver is adapted for continuous wave telegraphic reception.

During either of these two types of reception it is desirable that a fine adjustment means be provided for variation of the frequency of the local oscillator. During telephonic reception this is desirable in order to effect accurate tuning to the station to be received, and during telegraphic reception it is desirable to effect precise adjustment of the tone to be reproduced by the sound reproducing device 8.

In accord with my invention this fine adjustment of the local oscillator frequency is effected by a so-called reactance tube 34. This electron discharge device has an anode connected through condenser 35 to a suitable point on the oscillatory circuit, and a cathode connected through a resistance 36, and a further variable resistance 37 to ground. This further resistance may be located at the remote point and may be the primary variable previously referred to, which is varied for fine adjustment of the frequency of the local oscillator.

Connected between the anode of the discharge device 34 and ground is a phasing network comprising resistance 38, capacitance 39 and an inductance 42, the control electrode of the discharge device being connected to this network at a point between resistance 38 and the capacitance 39. This electrode 45 is also connected to ground through a resistance 47 for unidirectional currents. The various impedances of this network are so proportioned that oscillations from the local oscillator circuit 4 are supplied between the control electrode and cathode of the discharge device in such phase that the current flowing between the anode and cathode of the discharge device lags in phase the oscillations between the anode and cathode thereof. Thus the path through discharge device 34 and by-pass condenser 40 simulates an inductance in shunt with the oscillatory circuit 4. This inductance, of course, is effectively a part of the oscillatory circuit 4 and affects the frequency at which the local oscillator oscillates. The magnitude of this effect is dependent upon the magnitude of the current flowing in device 34 and hence upon the bias applied between its control electrode and cathode. Resistances 36 and 37 are connected in a direct current path across source 22, this

path comprising resistances 43 and 44 in addition to the resistances 36 and 37. Thus by variation of the resistance 37 the unidirectional potential between the cathode of device 34 and ground may be varied, thereby varying the impedance of this reactance device and hence varying the effective inductance in shunt with the oscillatory circuit 4. It will be observed that since the control electrode 45 of device 34 is connected through resistance 47 to ground, it is normally at negative potential with respect to the cathode, which is positive with respect to ground.

The screen grid of device 34 is supplied with operating potential from a point between resistances 43 and 44 and is by-passed to ground at the frequency of the local oscillator by condenser 46. The suppressor grid is connected directly to the cathode as usual.

With the circuit as thus described it will be observed that by variation of the resistance 37 the impedance of device 34 may be varied and hence the simulated inductance is varied, thereby varying over a certain range the frequency determined by the local oscillator circuit 4. This is true irrespective of the adjustment of the tuning condensers indicated at 25 and 27.

It is desirable in the operation of the system that equal increments of adjustment of the resistance 37 effect equal variations in the local oscillator frequency irrespective of the station or frequency to which the receiver responds; that is, irrespective of the portion of the band of frequencies in which it is, at the particular instant, operating. For this reason the inductance 42 is inserted in the circuit in series with the capacitance 39 proportioned to resonate therewith at a frequency higher than any frequency at which the local oscillator operates. Thus when the local oscillator is adjusted for operation in the high frequency portion of the band, the series impedance of capacitance 39 and inductance 42 is relatively low and the voltage between the control electrode 45 and cathode of device 34 is small with the result that variation of resistance 37 throughout its range effects a certain variation in frequency of the local oscillator. In the lower frequency portion of the band the series impedance of this condenser 39 and inductance 42 is higher, thereby increasing the voltage between the control electrode 45 and the cathode so that a substantially equal change in frequency of the oscillator may be effected by variation of the resistance 37 through its range. In this way equal increments of change in resistance 37 may be caused to produce equal increments of change in the frequency of the local oscillator irrespective of the frequency at which the oscillator may be adjusted by its tuning condenser to operate.

In one equipment employing my invention, for example, variation of resistance 37 was caused to vary the frequency of the local oscillator over a range of 6 kilocycles when the local oscillator was adjusted at either 2 megacycles or 4 megacycles, these being frequencies widely spaced in the band of frequencies over which it was designed to operate. Were the inductance 42 removed, the shift in frequency produced by variation of resistance 37 was about 6 kilocycles when the oscillator operated in the neighborhood of 2 megacycles and about double that when it operated in the neighborhood of 4 megacycles.

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 various modifications both in the circuit arrangement and in the instrumentalities employed may be made, and I contemplate by the appended claims 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 oscillator having a frequency determining oscillatory circuit, an electron discharge device connected in shunt with a portion of said circuit whereby oscillations in said circuit are impressed between the anode and cathode thereof, a control electrode between said anode and cathode, means to supply oscillations from said circuit between said control electrode and cathode in phase to cause the impedance between said anode and cathode to simulate a reactance affecting the frequency determined by said circuit, means to vary the resonant frequency of said circuit over a wide range, a pair of connections between said discharge device and a remote point, means utilizing said connections variably to control said discharge device over said conductor to vary said frequency over a narrow range from any frequency determined by said last means, and means to maintain said narrow range substantially constant at all frequencies in said wide range, said means comprising a circuit between said control electrode and cathode resonant to a frequency outside said range to vary the voltage between said grid and cathode over said range.

2. In combination, an oscillator having a frequency determining oscillatory circuit, an electron discharge device having an anode, a cathode and control electrode, a path across said circuit including the anode-cathode space of said discharge device, means to supply oscillations from said circuit to said control electrode phased to cause said path to simulate a reactance affecting the frequency determined by said circuit, means to vary the frequency of said circuit over a wide range, means to vary the impedance of said path to vary said frequency between narrow limits at any point in said range, said means comprising a fixed resistance between said anode and cathode and a variable resistance located at a remote point from which said impedance variation is to be effected, said variable resistance being connected between said cathode and ground to vary the cathode operating potential with respect to ground, and means to vary the voltage at the frequency of said oscillator supplied to said control electrode to maintain said limits substantially equally spaced apart in frequency at both high and low frequencies in said range.

3. In combination, an oscillator having a frequency determining oscillatory circuit, an electron discharge device having an anode, a cathode and control electrode, a path across said circuit including the anode-cathode space of said discharge device, a control electrode, means to supply oscillations from said circuit to said control electrode phased to cause said path to simulate a reactance affecting the frequency determined by said circuit, means to vary the frequency of said circuit over a wide range, means to vary the impedance of said path to vary said frequency between narrow limits at any point in said range, and an impedance between said control electrode and cathode, said impedance being resonant at a frequency higher than the highest frequency in said range and being variable with frequency to an extent sufficient to vary the voltage thereon over said range to such an extent that said limits are substantially equally spaced in frequency at both high and low frequencies in said range.

4. In combination, an oscillator having a frequency determining oscillatory circuit, an electron discharge device having an anode, a cathode and control electrode, a path across said circuit including the anode-cathode space of said discharge device, means to supply oscillations from said circuit to said control electrode phased to cause said path to simulate a reactance affecting the frequency determined by said circuit, means to vary the frequency of said circuit over a wide range, means to vary the impedance of said path to vary said frequency between narrow limits at any point in said range, and a network connected between said control electrode and cathode having gradually reducing impedance as the frequency determined by said circuit increases, said impedance being resonant at a frequency higher than the highest frequency in said range and said reduction in impedance being at such a rate that said limits are substantially equally spaced apart in frequency at both high and low frequencies in said range.

5. In combination, an oscillator having a frequency determining oscillatory circuit, an electron discharge device having an anode, a cathode and control electrode, a path across said circuit including the anode-cathode space of said discharge device, means to supply oscillations from said circuit to said control electrode phased to cause said path to simulate a reactance affecting the frequency determined by said circuit, means to vary the frequency of said circuit over a wide range, means to vary the impedance of said path to vary said frequency between narrow limits at any point in said range, and a circuit between said control electrode and cathode exhibiting series resonance at a frequency higher than the highest frequency in said range.

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