

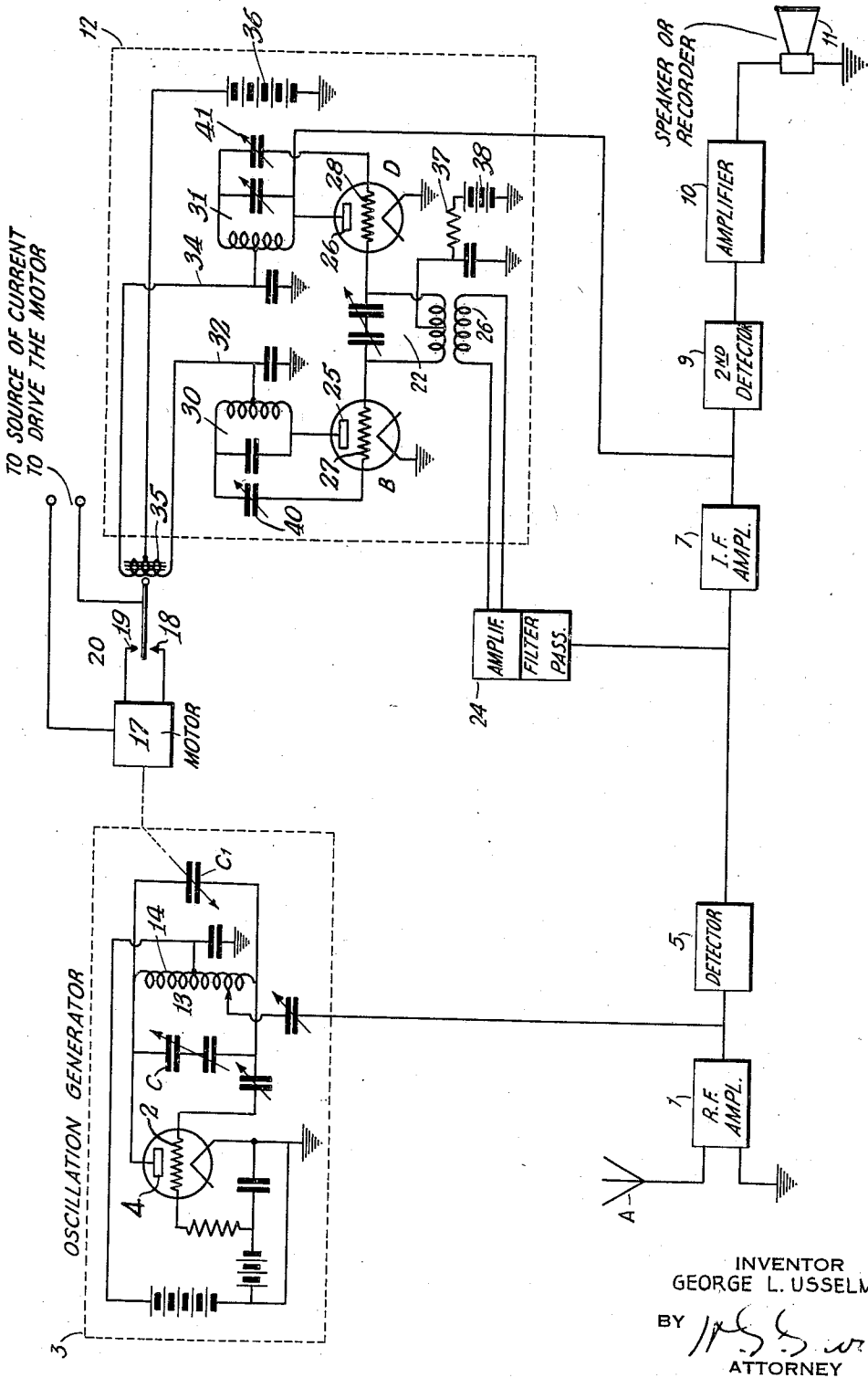
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RECEIVER

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RECEIVER

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The present invention relates to signalling systems and more in particular to a signalling system including transmitters and receivers which utilize a single side band for intercommunication.

As is known in signalling systems, the transmitted frequency on which the signal is impressed often times deviates from the desired frequency. Receivers also have frequency drift due to temperature or voltage changes or both. The receivers of the transmitted signals, being of the heterodyne or beat frequency type, are in general sharply tuned to the signal carrying carrier frequency sent out from the transmitter. Due to this deviation of the transmitted frequency received and tuning the receiver of the heterodyne type may not respond efficiently thereto. In some cases the transmitted signal may be entirely lost.

Attempts have been made heretofore in the prior art to provide means to synchronize the transmitter frequency and the frequency of the local oscillator at the receiver. Attempts have also been made to maintain the transmitted frequency exactly constant and the frequency of the local oscillator also exactly constant. Obviously, both of these schemes are difficult to follow successfully since at present it is practically impossible to hold two oscillators at sufficiently constant frequency to produce a beat note of constant frequency which may be passed through the intermediate frequency amplifier at the receiver.

By actual experiments I have come to the conclusion that it is necessary for the receiver to include means whereby the frequency to which it responds may be made to follow the transmitter frequency. In order to accomplish this in accordance with my present invention a frequency is radiated from the transmitter in addition to the signal carrying or side band frequency. This additional frequency may be a small amount of the effective transmitter carrier frequency. This additional frequency is used at the receiver in a novel manner to correct or control the frequency of an oscillator at the receiver. The oscillator at the receiver is tuned in a novel manner in accordance with my invention to generate a frequency which varies in the same direction as the received carrier so that when the received carrier and said generated frequency are beat together they produce an intermediate frequency which is constant in frequency irrespective of variations in the received carrier frequency. Of course the additional frequency sent over the transmitter must

be so related with the signal carrying frequency that they are relatively constant, that is, the frequency space between said frequencies must be constant except for the superimposed signal frequencies on the side band frequency. The additional frequency sent out from the transmitter for control purposes at the receiver may be the effective carrier frequency. If this frequency is assumed to be CF cycles, then the signal carrying carrier (side band) will be of a frequency CF plus the audible frequency representing the signal, which frequency will vary within an audible frequency band. In other words, the additional frequency is the transmitter output energy frequency when there is zero signal frequency.

An advantage of the present system is that, as will appear more in detail hereinafter, it is applicable to new installations and may also be readily applied to installations now in use without materially altering said installations.

The novel features of my invention have been pointed out with particularity in the claims attached hereto as required by law.

The nature of my invention and the method of operation of the same will be better understood by the following detailed description thereof and therefrom when read in connection with the drawing in which the single figure serves to illustrate the essential elements necessary at the receiver of the heterodyne type to practice my invention.

At the transmitter a carrier frequency may be derived from the first oscillator in the transmitter (or any other desirable stage therein) by slightly unbalancing the succeeding modulator so that a portion of the carrier is allowed to pass through the transmitter with the selected side band to be radiated along with the said selected side band or signal carrying carrier frequency (side band). Normally the carrier is all balanced out in the modulators which are of the suppressed carrier type which make effective only the side bands or is eliminated by filter circuits so that it does not appear in the radiated energy. In the present invention the desired amount of carrier is permitted to get through and be radiated. This small amount of carrier from the first oscillator or subsequent stages will have a certain definite frequency relation with respect to the signal carrying carrier and said relation will be maintained constantly since the small amount of carrier is derived from the first oscillator, the frequency of which determines

the frequency of the selected side band or signal carrying carrier.

The signal carrying carrier and the additional carrier are radiated from the transmitter and are received on the antenna system A of a radio receiver of the heterodyne type. This receiver may include, as indicated, a radio frequency amplifier included in unit 1, a local source of oscillations included in a unit 3, a first detector or demodulator included in a unit 5, and an intermediate frequency amplifier connected with said first detector and included in a unit 7. The intermediate frequency amplifier 7 may be followed by a second detector included in a unit 9. The second detector feeds the demodulated signals to a low frequency amplifier included in a unit 10. The low frequency signals may be translated in this unit or fed by way of the line shown to any utilization circuit. The utilization circuit may be a recorder or aural indicator 11. In the event the signals are of the continuous wave type for telephone operation, oscillations from an additional oscillation generator included in a unit 12 may be supplied to the input of the second detector included in unit 9, as shown, to beat therein with the continuous waves and render therefrom the voice signal. The devices included in the radio frequency amplifier 1, the detector in 5, the intermediate frequency amplifier in 7, the second detector in 9, and the low frequency amplifier in 10 are standard circuits in the present invention and need not be described in detail herein.

The transmitted signal is received on A, which is tuned to a frequency band broad enough to include the signal carrying carrier and the additional carrier transmitted for control purposes. Both of the carriers are amplified in the radio frequency amplifier 1, which is broad enough to amplify both carriers and combined in the unit 5, which includes the first detector, with oscillations from the oscillator in unit 3 to produce a beat note at intermediate frequency, which is amplified in 7 and further beat in 9 with oscillations from the oscillator in 12 and demodulated to render the signal.

The oscillator included in unit 3 is a substantially constant high frequency oscillator of the type in which oscillations are produced by coupling the anode 4 to the grid 2 by a tuned circuit 13, as shown. The frequency of the oscillations generated is determined by the capacities C and C' connected in parallel with the inductance 14 of the circuit. The capacity C' may be of the vernier type and may be driven by a motor 17 connected as shown. The motor 17 may be energized by way of the contacts 18 and 19 of a relay 20 in such a manner that when the movable contact 21 is in one closed position say on 18 the motor rotates in one direction. When the movable contact 21 is in the other closed position say on 19 the motor rotates in the other direction and when the contact is as shown in the neutral or intermediate position no energizing current is supplied to the motor and the motor and the vernier condenser connected therewith remain stationary.

The oscillation generator included in the unit 12 is of a unique type and is, as shown, in effect, two similar tube oscillators B and D, each having their anodes 25, 26 and grids 27, 28 respectively, coupled by circuits 30 and 31, respectively so that each tends to produce oscillations of a frequency determined by said circuits. The separate oscillators, however, have their grids 27

and 28 interconnected in push-pull relation, as shown, by an additional tuned frequency determining circuit 22. Biasing potentials for the grids 27 and 28 of tubes B and D are supplied from a source 38 connected by way of a resistance 37 to the electrical center of the inductance in the tuned circuit. This resistance 37 is also of assistance in stabilizing the oscillations produced in this unit. The anode electrodes 25 and 26 of the oscillators B and D are connected, as shown, in push-pull relation by way of direct current energizing circuits 32 and 34 which include the balanced winding 35 in the relay 20. Both of these direct current circuits include a source of potential 36. The inductance and capacity in the alternating current anode circuits of each of the oscillators and the common tuned grid circuit determine the frequency of said oscillator. Each plate circuit of these oscillators is normally slightly detuned with respect to the other so that normally the tendency of the oscillators B and D is for one to oscillate on one side of the normal frequency, as determined by the tuned inductance 22 interconnecting their grids, and the other to oscillate at a frequency on the other side of the normal frequency of the combined oscillators, as determined by said tuned frequency determining circuit 22. However, oscillators B and D must both oscillate at the same frequency because their grid electrodes are, as shown, connected together by way of the same tuned frequency determining circuit 22. The oscillations of the oscillators B and D are out of phase by 180° because, as shown, the grids of said oscillators are connected in push-pull. There is enough excitation brought back from the plate circuit of each oscillator by way of the variable capacities 40 and 41 to the grid circuit of each oscillator to maintain sustained oscillations in said oscillators.

The output of the first detector included in the unit 5 is connected, as shown, to a filter and an amplifier included in the unit 24. The oscillations at the intermediate frequency pass through the filter in this unit, are amplified, and are impressed by inductive coupling by way of an inductance 26 on the inductance in the tuned circuit 22. As will be seen, a slight shift in phase of the frequency of the oscillations passed in the filter and amplified in unit 24, assuming said oscillations are of a frequency substantially equal to the mean frequency of the oscillations developed by the oscillators acting together in unit 12, will increase the excitation on the grid of B or D and decrease the excitation on the other grid. This will increase the efficiency of the first oscillator and decrease the efficiency of the second oscillator. Increasing the efficiency of one of the oscillators decreases the amount of current flowing in the direct current plate circuit thereof. This increase in efficiency of one oscillator, and consequently decrease of plate current therein, occurs simultaneously with the decrease in efficiency of the other oscillator and the increase of the plate current therein. This decreases the current in half of the balanced winding in relay 20 and increases the current in the other half so that the movable armature 21 of said relay is actuated in one direction or the other to complete a circuit through the motor to energize said motor and drive the vernier condenser C₁ in the proper direction to produce in 3 oscillations of shifted frequency which, when combined or beat with the incoming additional carrier, will produce an intermediate frequency,

the frequency of which falls in step or in phase with that of oscillator 12 and which is also the middle of the frequency band passed by the intermediate frequency amplifier. The original shift of the intermediate frequency applied by 24 to 26 may result from a shift in the transmitter frequency or in the frequency of the oscillator in 3 or both.

Although applicant does not wish to limit his invention to any specific frequencies, it is thought that the operation thereof will be more readily understood if specific or definite frequencies are used to set forth said operation.

Assume that a signal carrying frequency and an additional carrier having a certain frequency relation from the commercial signals is being transmitted simultaneously without interference between said carriers. Assume that the transmitter frequency corresponding to this additional carrier frequency is 17,300,000 cycles and that the useful signals lie between 50 and 6,000 cycles so that the signal carrying carrier occupies a space from 17,300,050 to 17,306,000 cycles. The frequency band received at the antenna A connected with the receiver will be 17,300,000 to 17,306,000 cycles. This frequency band is amplified in the radio frequency amplifier included in unit 4 and beat in the detector included in unit 5 with oscillations from the oscillator included in unit 3. The frequency of these oscillations in 3 may be 17,200,000 cycles or very close thereto. These two frequencies are beat in the detector in unit 5 and a beat note varying between 100,000 and 106,000 cycles is produced, of which the 100,000 beat note represents the additional carrier. Part of the energy is diverted from the output of the detector in unit 5 and fed to the pass filter in unit 24. This filter permits a beat frequency of 100,000 cycles plus or minus 50 cycles to pass through the amplifier in 24 and be impressed on the inductance 26 coupled to the frequency determining circuit 22. The combined oscillators in unit 12 operate at, say, 100,000 cycles or very closely thereto. The oscillations produced in the oscillator in 12 are fed from said oscillator to the input of the second detector in 9 to beat with the frequency band applied to the intermediate frequency amplifier in unit 7 from the output of the first detector. This band varies between 100,000 and 106,000 cycles and when beat with the oscillations from 12 produces a beat note varying at signal frequency between 50 and 6,000 cycles, and the receiver output has the same frequency and relative amplitude as the original signal.

Now assume that the transmitter frequency or receiver frequency changes slightly, that is, the frequency of the transmitted carrier or the frequency of the oscillations produced in the oscillator in unit 3 drifts in either direction from the desired frequency. This drift in either of these frequencies causes the beat note appearing in the output of the detector in unit 5 to change slightly, that is, said beat note of the example given for purposes of illustration will vary slightly above or below 100,000 cycles. This variation in the beat note is applied by way of the band pass filter and amplifier in unit 24 to the inductance 26 coupled to the frequency determining circuit connected with the grids of B and D. Since the frequency of the combined oscillators B and D is fixed by the frequency determining circuits, there will be a phase difference between the current in the inductance 26 and that in

the inductance in the tuned circuit 22. This phase difference will be in one direction or the other so that it will add energy to the oscillations in one of said oscillators and oppose in the other. This will cause a change in excitation and efficiency in each side of the combined oscillator and result in an unbalancing of the same and a change in the amount of current flowing in the direct current anode circuits of each. The unbalance in the anode current acts through the winding of relay 20 to move the movable contact in a direction such as to complete a circuit through the motor windings in the desired direction to rotate the motor in the direction necessary to shift the frequency of the oscillations developed in the oscillation generator in 3 in the desired direction to correct the frequency resulting from the beating of the incoming signal and the oscillations from the first oscillator. This changes the beat frequency output of the detector in unit 5. By proper connections to the relay 20 the reaction of unbalanced plate current in oscillators B and D can be made to change the frequency of the oscillator in unit 3 so that the carrier output of the detector in unit 5 will again come in step and have the same frequency and phase as the oscillations in the tuned circuit 22, that is, in the combined oscillators B and D. This is again the correct phase relation between the oscillators in 12 and in 3 for proper operation of the receiver.

Obviously, if the frequency of the oscillators in 3 and 12 are maintained in harmonic relation with each other the action of the frequency correction circuits will be made more rapid.

Although in describing the operation of this device it has been assumed that the frequency of the incoming carrier or of the oscillator in unit 3 is subject to variations, it will be obvious that the present control system will function in a similar manner, to correct the frequency of the oscillator in unit 3, to compensate for any shift in frequency of the combined oscillators B and D in unit 12.

Having thus described my invention and the operation thereof, what I claim is:

1. The method of automatically tuning a receiver to a signal carrying carrier and a reference carrier transmitted therewith which bears a definite frequency relation to the signal carrying carrier which includes the steps of, receiving said carriers, beating said carriers with local oscillations to produce beat notes, one of which carries the signal modulated oscillations which may be translated, and controlling the frequency of said local oscillations in accordance with the frequency of the other beat note.

2. The method of automatically tuning a receiver to a signal carrying carrier and a reference carrier transmitted therewith which bears a definite frequency relation to the signal carrying carrier which includes the steps of, receiving said carriers, beating said carriers with local oscillations to produce beat notes, one of which carries the signal modulated oscillations, separating said beat notes and translating said signal carrying beat note, and producing changes in the frequency of the local oscillations characteristic of changes in the frequency of the other beat note.

3. The method of automatically tuning a receiver to a signal carrying carrier and a pilot or reference carrier which bears a definite frequency relation to the signal carrying carrier which includes the steps of, producing two oscillations

of substantially equal amplitude, receiving said carriers, beating said signal carrying carrier with local oscillations to produce signals, impressing energy representative of said pilot carrier on said two produced oscillations to produce relative changes in the amplitudes thereof characteristic of deviations of the frequency of said carrier from the desired carrier frequency, and utilizing said amplitude deviations to control the frequency of the local oscillations beat with said signal carrying carrier.

4. The method of automatically tuning a receiver to a signal carrying carrier which includes the steps of, producing two oscillations of substantially equal amplitude, beating said signal carrying carrier with local oscillations to produce signals, impressing energy representative of said carrier on said two produced oscillations to produce relative changes in the amplitudes thereof characteristic of deviations of the frequency of said carrier from the desired carrier frequency, and producing changes of the frequency of said local oscillations characteristic of said amplitude changes.

5. The method of automatically tuning a receiver of the beat note type, including an intermediate frequency filter circuit, to a signal carrying carrier to maintain the frequency of the energy passed through said filter at the center of the frequency band of said filter irrespective of variations in the carrier frequency or in the local oscillator frequency which includes the steps of, producing two oscillations of substantially equal amplitude but of different frequencies, beating said carrier to an intermediate frequency to be passed by said filter, differentially impressing energy representative of the energy passed through said filter on said two produced oscillations to produce relative changes in the amplitudes of the produced oscillations characteristic of deviations of said energy in said filter from the mean resonance frequency of said filter, and producing changes in the frequency of said intermediate frequency energy characteristic of the relative changes in the amplitudes of the produced oscillations to compensate for variations in the carrier frequency or in the local oscillator frequency.

6. The method of automatically tuning a receiver to a signal carrying carrier and a pilot or a reference carrier which bears a definite relation to the signal carrying carrier which includes the steps of, receiving said carriers, producing local oscillations, beating said local oscillations with said carriers to produce a beat note resulting from said pilot carrier and said local oscillations and a beat note resulting from said signal carrying oscillations and said local oscillations, translating said last named beat note to render the signal, producing a pair of local oscillations of constant amplitude and of a frequency substantially equal to the frequency of said first named beat note, impressing said first named beat note on said pair of oscillations differentially to produce variations in the energy of said oscillations, and controlling the frequency of said first named produced oscillations in accordance with said variations in energy.

7. The method of automatically tuning a receiver to a signal carrying carrier and a pilot or a reference carrier which bears a definite relation to the signal carrying carrier which includes the steps of, receiving said carriers, producing local oscillations, beating said local oscillations with said carriers to produce a beat note resulting from said pilot carrier and said local oscillations

and a beat note resulting from said signal carrying oscillations and said local oscillations, translating said last named beat note to render the signal, producing a pair of local oscillations of constant amplitude and of a frequency substantially equal to a subharmonic of the frequency of said first named beat note, impressing said first named beat note on said pair of oscillations differentially to produce relative variations in the energy of said oscillations, producing movements characteristic of said relative variations in the energy of said oscillations, and controlling the frequency of said first named produced oscillations in accordance with said movements.

8. A signal receiving means comprising signal responsive means, signal demodulating means provided with an output circuit, a local oscillation generator coupled between said signal responsive means and said signal demodulating means said generator including a tuning element, a pair of local oscillators each provided with an output electrode and having a frequency determining circuit in common coupled to the output circuit of said demodulator, and a relay operatively interposed between the output electrodes of said pair of oscillators and the tuning element in said first named oscillator.

9. A signal receiving means comprising signal responsive means, signal demodulating means provided with an output circuit, a local oscillation generator, including a frequency determining element, coupled between said signal responsive means and said signal demodulating means, a pair of local oscillators each provided with an output electrode and having a frequency determining circuit in common coupled to the output circuit of said demodulator, a magnetic relay having a winding connected between the output electrodes of said pair of oscillators, and a connection between the frequency determining element in said first named oscillator and the armature of said relay.

10. A signal receiving means comprising signal responsive means, signal demodulating means provided with an output circuit, a local oscillation generator, including a frequency determining element, coupled between said signal responsive means and said signal demodulating means; a filter circuit tuned to an intermediate frequency, a pair of local oscillators each provided with an output electrode and having a frequency determining circuit in common coupled to the output circuit of said demodulator by way of said filter circuit, a magnetic relay having its winding connected between the output electrodes of said pair of oscillators and its armature mechanically coupled to the frequency determining element in said first named oscillator.

11. Signal receiving means comprising, signal responsive means, detecting means coupled therewith, a local oscillator comprising a frequency determining means coupled between said signal responsive means and said signal demodulating means, control means connected with said frequency determining means, a pair of thermionic tubes having coupled input and output circuits, a frequency determining circuit connecting the control electrodes of said tubes in push-pull relation, a direct current output circuit including a relay having a winding connecting the output electrodes of said tubes in push-pull relation, an operative connection between said relay and said control means, and a filter circuit interposed between the output of said demodulator and said fre-

quency determining circuit connecting the control grids of said tubes in push-pull.

12. A frequency control device, to be used with signal receiving means of the heterodyne type including, a demodulator, a local oscillator having a frequency determining circuit and an intermediate frequency amplifier comprising, a pair of thermionic tubes having coupled alternating current input and output circuits, one of said circuits being tuned to a frequency lying on one side of the mean frequency of said intermediate frequency amplifier, the other of said circuits being tuned to a frequency lying on the other side of the mean frequency of said intermediate frequency amplifier, a tuned circuit connecting the control electrodes of said tubes in push-pull relation, said circuit being tuned to the frequency of said intermediate frequency amplifier, a direct current output circuit connecting the output electrodes of said tubes in push-pull relation, an energy responsive device connected between said output circuit and the frequency determining circuit in said local oscillator to control the frequency of the oscillations produced thereby, and a circuit interposed between the output of said intermediate frequency amplifier and said frequency determining circuit connecting the control grids of said tubes in push-pull.

13. Signal receiving means including signal collecting means, signal demodulating means, a thermionic oscillator having oscillation circuits and a frequency determining element in one of said circuits, circuits for connecting said demodulating means to said oscillator and to said signal collecting means, an intermediate frequency amplifier coupled to said demodulating means, a pair of local oscillators having a frequency determining circuit in common coupled to the output circuit of said signal demodulating means, a relay connected between the outputs of said last named oscillators and the frequency determining element in the circuit of said first named oscillator, a second demodulator, a coupling between the input of said second demodulator and said intermediate frequency amplifier and between the input of said second demodulator and one of said pair of oscillators, and signal indicating means connected with the output of said second demodulator.

14. A frequency control device to be used with signal receiving means of the heterodyne type including signal collecting means, signal demodulating means, a thermionic oscillator having oscillation circuits and a frequency determining element in one of said circuits, circuits for connecting said demodulating means to said oscillator and to said signal collecting means, and an intermediate frequency amplifier coupled to said demodulating means, comprising, a pair of local oscillators having a frequency determining circuit in common coupled to the output circuit of said signal demodulating means, circuits connected with the output of said pair of oscillators, a relay connected with the output circuits of said last named pair of oscillators and the frequency determining element in the circuit of said first named oscillator, a second demodulator, a coupling between the input of said second demodulator and said intermediate frequency amplifier and between the input of said second demodulator and said pair of oscillators, and signal indicating means connected with the output of said second demodulator.

15. Signal receiving means comprising, signal responsive means, rectifying means coupled there-

with, a local oscillator comprising, a thermionic tube having input electrodes and output electrodes connected in oscillation circuits including a frequency determining element, a circuit connecting said rectifying means to said signal responsive means and to said oscillator, an intermediate frequency amplifier coupled with the output of said rectifier, a pair of thermionic tubes, each having their input and output electrodes coupled in oscillation circuits, said circuits tending to produce oscillations slightly above and slightly below the beat frequency resulting from the combination of oscillations from said first named oscillator and signal waves in said detector, a frequency determining circuit connecting the control electrodes of said pair of tubes in push-pull relation, a direct current output circuit including a relay winding connecting the anodes of said tubes in push-pull relation, a connection including a driving motor between said relay winding and the frequency determining element in the circuit of said first named oscillator, a circuit including a filter connected between the output of said rectifying means and said frequency determining circuit connected between the control electrodes of said pair of tubes, an intermediate frequency amplifier coupled to the output of said rectifying means, a second rectifying means coupled to said intermediate frequency amplifier and to one of the oscillation circuits connected with said last named pair of oscillators, a beat frequency amplifier connected with said second named rectifying means, and indicating means connected with said beat frequency amplifier.

16. The method of automatically tuning a receiver to a signal carrying carrier which includes the steps of, producing two oscillations, beating said signal carrying carrier with local oscillations, impressing energy representative of said carrier on said two produced oscillations to produce relative changes therein characteristic of deviations of the frequency of said carrier from the desired carrier frequency, and changing the frequency of said local oscillations in a manner characteristic of the relative changes produced in said two produced oscillations.

17. The method of automatically tuning a receiver to a signal carrying carrier which includes the steps of, producing two oscillations by means of electrical power, beating said signal carrying carrier with local oscillations, impressing energy representative of said signal carrying carrier on said two produced oscillations to produce relative changes in the amount of power utilized to produce said oscillations characteristic of deviations of the frequency of said carrier from the desired carrier frequency, and controlling the frequency of the oscillations beat with said signal carrying carrier in accordance with said relative changes in the amount of power utilized to produce said two oscillations.

18. The method of automatically tuning a receiver to a signal carrying carrier which includes the steps of, producing two oscillations which are normally entrained, beating said signal carrying carrier with local oscillations, impressing energy representative of said carrier on said two produced oscillations to disentrain said oscillations when said carrier frequency changes in a manner characteristic of deviations of the frequency of said carrier from the desired carrier frequency, and producing changes of the frequency of said local oscillations characteristic of the manner in which said two oscillations are disentrained.

19. In a radio receiver of the superheterodyne type employing a local oscillator consisting of a single tube provided with main and auxiliary frequency determining elements, the main element
5 comprising a resonant circuit which includes a variable reactance, and said auxiliary frequency determining element comprising a capacitive reactance electrically connected across said resonant circuit, a first detector network having an
10 output circuit resonated to a predetermined intermediate frequency, a secondary tuned circuit which is resonated to said intermediate frequency, a pair of electron discharge devices having a common direct current output circuit, said devices
15 having a common signal input circuit resonant to said intermediate frequency and electrically connected with said secondary circuit, the magnitude and direction of flow of the direct current in said output circuit being dependent upon the
20 amount and the sign of the difference between the frequency of said secondary circuit and the frequency of the signal energy applied thereto, and means coupled to said direct current output circuit, responsive to said direct current in said
25 output circuit, for automatically adjusting the magnitude of said auxiliary frequency determining reactance element.

20. In a superheterodyne receiver, a first detector network having a modulated signal carrier

input circuit and an output circuit tuned to a predetermined operating intermediate frequency, a local oscillator network consisting of a single tube provided with a main frequency determining element and an auxiliary frequency adjusting
5 device, the main frequency determining element comprising a resonant circuit which includes an adjustable reactance, and said auxiliary adjusting device comprising a capacitive reactance electrically connected across the resonant circuit, an
10 arrangement for automatically regulating the effect of said adjusting device on the frequency of said oscillator network as the signal energy output of said first detector departs in frequency from
15 said intermediate frequency, said arrangement comprising a pair of space discharge devices having a common signal input circuit and a common direct current output circuit, said common input
20 circuit being resonated to said operating frequency, said devices being additionally constructed and arranged to produce in said direct current output circuit a direct current whose magnitude and sense of flow is dependent upon the
25 amount and sign of the said frequency departure, and means coupled to said direct current output circuit and responsive to said direct current for controlling the magnitude of the reactance of said auxiliary adjusting device.

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