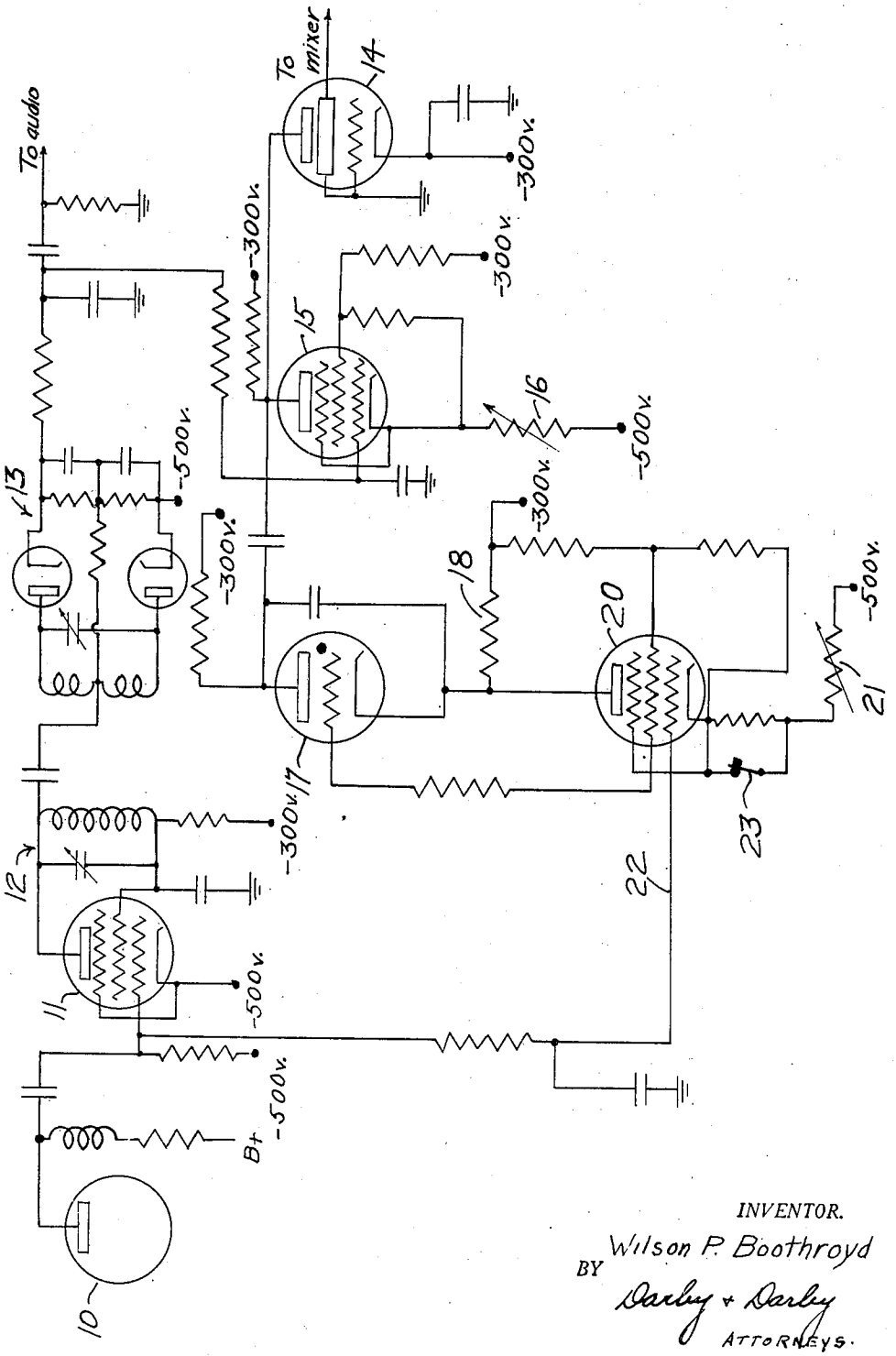
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AUTOMATIC TUNING ELECTRIC SYSTEM

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AUTOMATIC TUNING ELECTRIC SYSTEM

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The present invention relates to an automatic frequency control circuit and particularly to such a circuit for sweeping a band of frequencies and locking the converter to the first carrier received within the swept over band.

The receiver to which this circuit has been applied is designed for the reception of continuous wave frequency modulated signals, although quite obviously the circuit could be utilized in other types of receivers.

Prior circuit arrangements utilized for the same general purpose have been unsatisfactory in that they required extra electron tubes or lacked sensitivity or would not operate at low sweep rates without the use of large coupling components in the circuit.

As has been stated above the circuit is particularly useful in conjunction with a narrow band superheterodyne receiver used to receive signals from a plurality of transmitters within a specified frequency band. In order to avoid problems of frequency stability and the necessity of making absolute frequency measurements on several microwave transmitters and receivers so that the transmitters would always transmit signals within the narrow band of the receivers, means are provided for the completely automatic control of the local oscillator frequency of the receiver.

By means of this arrangement the local oscillator frequency is caused to sweep over the transmission band, to cut off the sweep upon the receipt of a carrier frequency and to lock the local oscillator to the proper frequency for reception of signals on that carrier.

It is an object of this invention to provide an automatic frequency control circuit which includes means for sweeping the local oscillator frequency over a relatively narrow transmission band.

It is another object of the invention to provide such a sweep circuit in which the sweeping action will be stopped upon reception of a carrier frequency within the assigned band.

It is a further object of the invention to lock the local oscillator to the incoming signal whereby the local oscillator frequency is the proper one for heterodyning the R.F. center frequency to the I.F. center frequency of the received transmission of the particular received signal.

Other objects and features of the invention will be apparent when the following description is considered in connection with the appended drawing in which the single figure of the drawings is a schematic diagram of a sweeping and locking circuit in accordance with my invention.

Referring now to the drawing, there is shown

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at 10 the last intermediate frequency tube of the intermediate frequency amplifier from which intermediate frequency signals are fed to the limiter tube 11. It is preferred that the intermediate frequency amplifier have sufficient gain to produce two volts of "noise" on the limiter grid, that is to say, two volts of negative grid bias in the absence of a carrier signal.

The intermediate frequency output of the limiter 11 is applied over the coupling circuit 12 to the discriminator 13 which discriminator is tuned to the intermediate frequency and also for noise balance, i. e., zero direct current discriminator output for no carrier wave input. The audio output of the discriminator is applied to an audio amplifier as is indicated in the drawing. The circuits so far described are commonly utilized and consequently need not be described in greater detail.

A local oscillator tube 14 is provided, the signal therefrom being applied in a normal manner to the mixer tube in which the incoming carrier frequency is heterodyned with the local oscillator frequency to produce the intermediate frequency signal for application to the first stage of intermediate frequency amplification. Tube 14 is a velocity modulated McNally tube such, for example, type 2K28. Such a tube, as is well known, can be frequency modulated by means of the tube repeller electrode, that is the tube can be modulated by variations in the voltage applied to the repeller.

For normal automatic frequency control on a carrier the direct current output of the discriminator 13 is connected to a direct curent amplifier 15, the plate circuit of which controls the local oscillator repeller and hence, the local oscillator frequency. Initially, the local oscillator repeller circuit is adjusted, by adjusting the cathode resistor 16 of the direct current amplifier 15, to give proper plate voltage from the amplifier with zero signal from the discriminator 13.

To provide a sweep voltage to sweep the local oscillator frequency over the assigned transmission and reception band a relaxation oscillator 17 is provided, this oscillator providing a generally saw-tooth wave having a frequency of the order of 30 cycles per second.

The relaxation oscillator 17 is a. c. coupled across the d. c. amplifier plate load and to the repeller electrode of the local oscillator 14. Thus when the sweep generator 17 oscillates the local oscillator frequency is caused to sweep the required band.

In order to provide plate voltage for the sweep oscillator tube 17 it is connected so as to shunt the plate resistor 18 of the cut off tube 20. The

cathode bias control 21 of the cut off tube 20 is adjusted so that, when the normal bias from the limiter, in the absence of carrier current, is present there is approximately 100 volts drop across its plate resistor 18. There is thus provided 100 volts for the plate circuit of the sweep generator 17, the bias of which is so adjusted as to cause it to oscillate at this voltage. Obviously, the values given may be altered and the above is merely a typical example of values which have been satisfactory.

The condition mentioned above is the normal rest condition of the circuit and provides for the sweeping of the receiver through a desired reception band.

When a carrier is found by the sweeping oscillator the signal in the limiter 12 increases above the noise and consequently the bias derived from the grid of the limiter tube 11 increases. This bias, applied over lead 22 to the grid of cut-off tube 20 causes a decrease in the plate current of the cut-off tube 20 thereby lowering the voltage across the sweep generator 17 and causing it to stop oscillating. Therefore, the sweep voltage is cut off whenever a carrier is present and the local oscillator is then locked on the incoming signal by the automatic frequency control circuit above described.

In addition to functioning as a cut-off tube to control the sweep generator, the tube 20 amplifies the change in limiter bias and thus provides a high degree of control over the sweep generator.

A switch 23 is provided in the cathode circuit of the cut-off tube 20 which switch is normally closed but may be opened in order to bias the cut off tube and thereby cause the sweep generator 17 to stop oscillating thereby removing the sweep from the local oscillator so that the local oscillator circuit may be adjusted.

Of course, audio modulation must be kept from the cut-off tube and from the amplifiers and this may be done by the utilization of suitable well known filters.

While I have described a preferred embodiment of my invention it is obvious that other embodiments and constructions may be adopted without departing from the spirit thereof and, consequently, I desire to be limited not by the foregoing description but solely by the scope of the appended claims.

What is claimed is:

1. In a superheterodyne receiver adapted to receive signals within a band of frequencies and having an oscillator for supplying heterodyne frequencies, means for automatically sweeping the tuning of the receiver over the frequency band comprising, in combination, a relaxation tube oscillator, means to bias said oscillator to sustain oscillations thereof when no signal is received, an electron tube, said tube supplying the bias to said relaxation oscillator, means to apply the output of said relaxation oscillator to the heterodyne oscillator and thereby to cause said heterodyne oscillator to sweep over the frequency band and thereby tune the receiver in a repeated sequence to each frequency within the band and means operable upon the reception of a signal within the band to control said electron tube and decrease its output thereby reducing the bias of said relaxation oscillator and causing it to cease to operate.

2. In a superheterodyne receiver adapted to receive signals within a band of radio frequencies, said receiver having a local oscillator and a frequency discriminator, the combination comprising means for varying the frequency of said local oscillator in response to a voltage, means for applying the output of said discriminator to said frequency varying means, a sweep voltage generator operable in response to an actuating voltage of at least a predetermined magnitude, control means for developing said actuating voltage, means for applying said actuating voltage to said generator, means for applying the output voltage of said generator to said frequency varying means to cause said local oscillator to sweep over a predetermined frequency band and thereby cyclically tune said receiver to frequencies within said radio frequency band, and means connected to said control means and responsive to a received signal for reducing the output voltage of said control means below said predetermined magnitude, whereby said sweep generator ceases operation and said frequency varying means, in response to the output voltage of said discriminator, controls the frequency of the local oscillator so as to properly receive and hold the received signal.

3. In a superheterodyne receiver adapted to receive signals within a band of radio frequencies, said receiver having a local oscillator, a frequency discriminator and a limiter, the combination comprising means for varying the frequency of said oscillator in response to a voltage, means for applying the output voltage of said discriminator to said frequency varying means, a sweep voltage generator operable in response to an actuating voltage of at least a predetermined magnitude, an electron tube having an input and an output circuit, said output circuit supplying said actuating voltage to said generator, means for applying the output voltage of said generator to said frequency varying means, and means coupling said limiter to said input circuit, said means normally supplying a bias voltage to the input circuit in accordance with the noise level in said ilmiter to develop in the output circuit of said tube said actuating voltage of at least a predetermined magnitude to cause said local oscillator to sweep over a predetermined frequency band and thereby cyclically tune said receiver to frequencies within said radio frequency band, said coupling means upon reception of a signal within said radio frequency band supplying an increased bias voltage such that the output of said electron tube falls below said predetermined magnitude, whereby said generator ceases operation and said frequency varying means, in response to the output voltage of said discriminator, controls the frequency of the local oscillator so as to properly receive and hold the received signal.

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