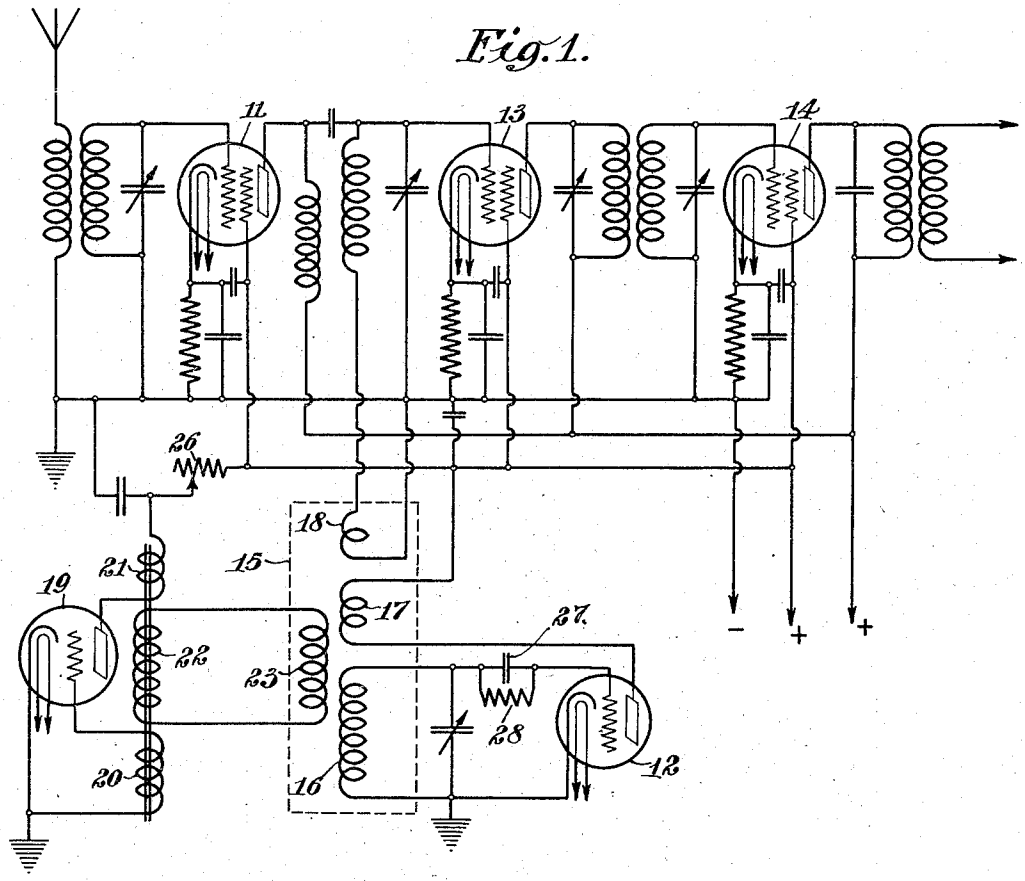
Jan. 7, 1936. A. H. TURNER 2,026,759

SUPERHETERODYNE RECEIVER

Filed March 31, 1934

Fig. 1.



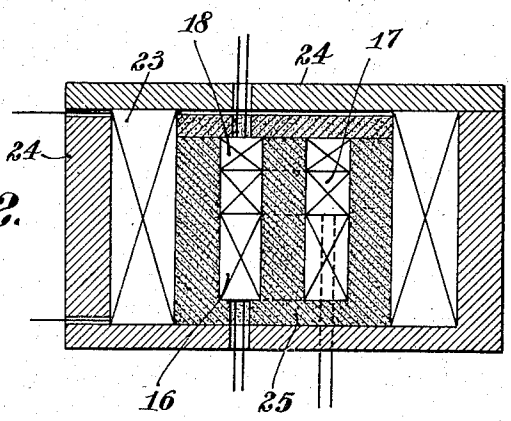


Fig. 2.

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SUPERHETERODYNE RECEIVER

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9 Claims. (Cl. 250—20)

This invention relates to radio receivers and more particularly to means for and a method of eliminating the effect of undesirable frequency modulation and distortion of signals when received on a very selective superheterodyne.

In general, the higher the carrier frequency, the more difficult and costly it becomes to maintain frequency stability of the transmitter. There are instances in short-wave and ultra short-wave transmission where crystal control of the transmitter frequency is undesirable for reasons of cost or weight, as in airplane and portable transmitters. In the simplest transmitter consisting of a modulated oscillator, frequency modulation is unavoidable and is greater the higher the carrier frequency. When received on the usual selective superheterodyne receiver intended for sound reception, speech from such a transmitter is nearly or quite unintelligible because the intermediate frequency swings so far beyond the reception band-width.

Accordingly, it is among the objects of my invention to provide a device in which the incoming carrier waves are not only heterodyned by a local oscillator, but the frequency of the local oscillator is periodically varied at a super-audible frequency to as great an extent as the possible range of frequencies occurring in the transmitter.

Another object of my invention is to provide a device as aforesaid in which the resulting intermediate frequency current will vary continuously in frequency and amplitude at a super-audible frequency.

In carrying out my invention I find that the conversion efficiency, although not as great as when the oscillator frequency remains constant, is, nevertheless, quite satisfactory due to the increase in the amplification which is obtained by using a sharply tuned intermediate frequency amplifier instead of one that is broadly tuned. The intermediate frequency amplifier does not accept all of the output of the first detector, but this loss is partially or completely made up by the greater ratio of amplification. The use of a sharply tuned intermediate frequency amplifier has an additional advantage in that it is possible to take full advantage of a frequency stabilized transmitter, if the receiver oscillator be returned to its normal unmodulated condition.

My invention in its more detailed aspects may best be understood from the following description when read in connection with the accompanying drawing in which

Figure 1 shows a circuit diagram of a portion of a superheterodyne receiver in which apparatus is shown for accomplishing the objects of my invention; and

Fig. 2 is a cross-sectional view of a special form of transformer which I prefer to use in obtaining periodic variation in the frequency of the local oscillator.

Referring now to Fig. 1, I show in a more or less conventional manner an ordinary radio frequency amplifier stage, a first detector, an intermediate frequency amplifier, and a local oscillator with output from which the incoming carrier wave is heterodyned. The incoming radio frequency wave is preferably amplified by the screen grid tube 11 and is heterodyned with the oscillations of a local generator 12. The screen grid tube 13 represents a first detector while another screen grid tube 14 represents the first stage of intermediate frequency amplification.

The various coils of my special transformer, as shown in Fig. 2, are represented in the diagram of Fig. 1 by comprehending the same within the broken line rectangle 15. In this transformer I provide three windings 16, 17, and 18, which are preferably embedded in a core 25 of finely comminuted iron the particles of which are separated from one another by a non-metallic material such as bakelite. As is well known in the art, there are numerous compositions of iron with insulating material such as would be suited to this purpose. The chief characteristics of such core material are that its permeability may be caused to have a value of approximately 10, and it does not introduce appreciable loss even at very high radio frequencies. It is, therefore, well suited to the conditions under which my system is intended to operate.

Referring again to Fig. 1, it will be seen that the tube 12 produces oscillations due to the intercoupling of the grid coil 16 and the plate coil 17. A third coil 18 is inductively related to the coils 16 and 17, a core 25 common to all three coils being provided. As previously stated, the core 25 is composed of finely comminuted iron and a binder. The coil 18 constitutes a pick-up device for transferring some of the oscillator energy to the grid circuit of the first detector tube 13 where it heterodynes with the incoming carrier wave.

In order that the frequency of my local oscillator may be swung gradually over a range at least as great as the possible variation in frequency of the incoming carrier wave, I prefer to use an auxiliary oscillator comprising an electron tube 19 having an external grid circuit which includes the coil 20 and an external plate circuit

which includes the coil 21. The coils 20, 21 and an output circuit coil 22 are mutually intercoupled by means of a conventional laminated iron transformer core. The frequency of the oscillator 19 is preferably made super-audible, although at a much lower frequency than that of the incoming carrier wave.

The oscillatory energy induced in the coil 22 is transferred to the coil 23 which surrounds the structure including the powdered iron core 25, and its transformer coils 16, 17 and 18. Energization of the coil 23 induces magnetism in a field occupied by the core 25 and by the laminated iron shell 24. The degree of saturation may be controlled by controlling the amplitude of the oscillations. One device which enables this adjustment to be made manually comprises an adjustable potentiometer 26 in the anode circuit of the oscillator 19.

The auxiliary oscillator 19 serves to "wobble" or vary the frequency of the local oscillator 12 by varying the flux density in the core 25 and hence the effective inductance of the coils 16 and 17. Furthermore, the range of frequencies within which the oscillator 12 may be "wobbled" may be easily controlled according to the extent of the frequency excursions of the transmitter, this object being gained by manual adjustment of the potentiometer 26, which in turn controls the amplitude of oscillations derived from the oscillator 19.

As a modification of my invention, I find it possible to dispense with the auxiliary oscillator 19 and to produce frequency modulation of the local oscillator 12 by causing the latter to become self-quenching. One way to accomplish this is to choose a greater capacitance for the grid condenser 27. Another way is to increase the resistance of the grid leak 28. Either way, or the adoption of both ways is with the object of obtaining a time constant for the grid leak-condenser combination such that the tube 12 will generate oscillations intermittently. The interruption frequency should, of course, be super-audible. According to this modification of my invention less desirable results are obtainable than according to the preceding disclosure. The reason for this is that no satisfactory method has as yet been found for avoiding extreme amplitude-modulation of the locally generated oscillations along with their frequency modulation. Notwithstanding this disadvantage, however, it is possible in certain circumstances to obtain satisfactory reception of voice signals and with a freedom from distortion that is quite remarkable, considering the difficulties usually encountered when frequency control of the transmitted carrier wave is not all that it should be.

In the operation of my improved radio receiver it will be understood, therefore, that it is possible to overcome the difficulties heretofore encountered. Distortion of the received signals is avoided in spite of poor frequency control at the transmitter. The continuously varying frequency of my local oscillator is such that a response may be had during some portion of every frequency excursion thereof. The sharpness of tuning of the intermediate frequency amplifier is such that the signals will be rejected when not properly heterodyned. I have found that my improved radio receiver and the improved method of operating it are such that very satisfactory results may be obtained even when receiving signals from a transmitter comprising a voice modulated oscillator operating at 100 megacycles.

Although I have disclosed herein certain specific means and two methods for accomplishing the objects of my invention, these are given merely by way of example and are not to be construed as limitations to the scope of my invention. Other modifications will suggest themselves to those skilled in the art. My invention, therefore, is not to be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a radio receiver, means including an oscillator for heterodyning an incoming amplitude modulated carrier wave, means including a second oscillator for cyclically varying the frequency of the first oscillator to provide a relatively wide frequency band heterodyned wave, and a sharply tuned intermediate frequency amplifier adapted to selectively accept a portion of the heterodyned wave which is in a substantially undistorted narrow frequency band including the amplitude modulation.

2. In a radio receiver, a network containing a generator of local oscillations and means for heterodyning said local oscillations with an incoming amplitude modulated carrier wave, means including a magnetic core structure of finely comminuted iron embedded in insulating material for inductively relating different portions of said network, means including a second oscillator having a utilization circuit which includes a coil surrounding said last named means and core structure for cyclically varying the flux density of said core structure thereby to vary the frequency of the first mentioned generator and the width of the heterodyned wave band, between predetermined wide limits, and an intermediate frequency amplifier tuned to accept a portion of the last named band between said limits.

3. A device in accordance with claim 2 comprising means for manually adjusting the band width of the frequency excursions made by the first mentioned oscillator.

4. In a radio receiver, a network comprising radio frequency stages, intermediate frequency stages and a heterodyne oscillator having a plurality of inductively related coils embedded in a core of high magnetic permeability, means including a second oscillator for periodically varying the flux density of said core and for wobbling the frequency of the heterodyne oscillator, and means for sharply tuning said intermediate frequency stages whereby they are caused to accept a portion only of the heterodyned wave thereby to discriminate in favor of undistorted signals and against signals which are distorted by undue frequency modulation accompanying amplitude modulation of a received carrier wave.

5. The method of reducing the distortion of intermediate frequency signals in a receiver the intermediate amplifier stages of which are relatively sharply tuned, which includes generating local oscillations at a super-audible frequency, causing said oscillations to vary the flux density of a magnetic field, superimposing within said field oscillations which are locally generated and oscillations of a received carrier wave, and causing the variations in flux density of said magnetic field to frequency modulate the locally generated oscillations over a band substantially commensurate with the frequency excursions of said received carrier wave, whereby a relatively wide band of intermediate frequency signals may be derived only a portion of which band is inter-

mittently acceptable to said intermediate amplifier stages.

6. Radio receiving apparatus adapted for substantial elimination of distortion effects comprising radio-frequency, first detector, and intermediate frequency stages, means including a heterodyne oscillator the output energy from which may be combined with that of a received carrier wave to produce a difference frequency, a transformer having a plurality of windings embedded in a substantially closed structure composed of iron dust and a binder, two of said windings being in circuit with said heterodyne oscillator and another of said windings being in the input circuit for said first detector stage, means including a supersonic frequency oscillator for varying the flux density in said iron dust, thereby to frequency-modulate the energy of said heterodyne oscillator, manually adjustable means for controlling the frequency band width of the heterodyne oscillator, and means for sharply tuning said intermediate frequency stages so that only substantially undistorted amplitude modulations of a predetermined relatively narrow band of intermediate frequency signals are accepted.

7. In a superheterodyne receiver for an amplitude modulated carrier wave, the combination with a signal detector of a tunable local oscillator, means for cyclically varying the frequency of said local oscillator about a predetermined mean frequency adjustment to provide wide frequency excursions proportional to variations in the frequency of a received carrier wave and a relatively wide band of intermediate frequency signals, and an intermediate frequency amplifier tuned to accept a relatively narrow amplitude modulated and undistorted portion of said intermediate frequency band.

8. The combination with a superheterodyne receiver for amplitude modulated carrier wave signals comprising a tunable local oscillator, a first detector and an intermediate frequency amplifier, of means for preventing variations in the frequency of a received carrier wave from causing signal distortion, said means comprising inductive coupling elements for said oscillator and detector, a common core member for said elements, a coupling winding associated with said core, a second oscillator having an output circuit connected with said winding to cyclically vary the permeability of the core member and the frequency of the first named oscillator about a predetermined mean frequency to provide a relatively wide band intermediate frequency signal, and at least one tuned circuit in said intermediate frequency amplifier for accepting only a minor portion of said wide band intermediate frequency signal.

9. In a superheterodyne radio receiving system for amplitude modulated carrier wave signals, the combination of a first detector, an oscillator tunable within a predetermined frequency range and including inductive windings, a coupling winding for said detector associated with said last named windings, a common core for said windings, means for cyclically varying the permeability of said core at a superaudible frequency comprising a second oscillator having a coupling winding associated with said core, means for adjusting said last named oscillator to vary the permeability of said core and the frequency of the first named oscillator about a mean frequency in a band of frequencies proportional to the variation in frequency of a received carrier wave, and a tuned intermediate frequency amplifier connected with said detector sharply responsive to intermediate frequency signals in a relatively narrow band with respect to the band of intermediate frequencies produced by interaction of said first named oscillator and a received carrier wave, thereby to amplify a selected amplitude modulated portion of the intermediate frequency signals.

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