Oct. 27, 1936. W. L. CARLSON 2,058,411

RADIO RECEIVER

Filed Nov. 18, 1932

Fig. 1.

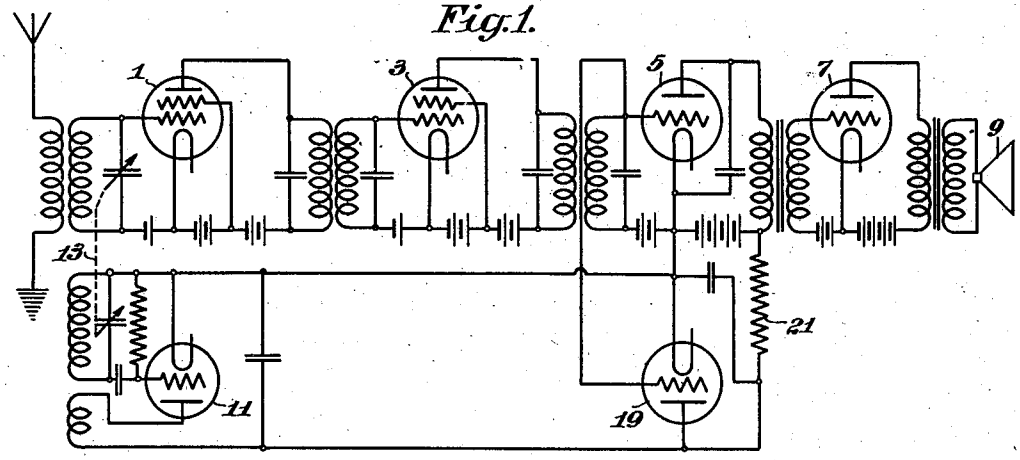


Fig. 2.

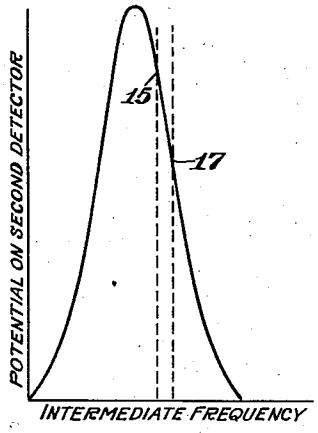


Fig. 3.

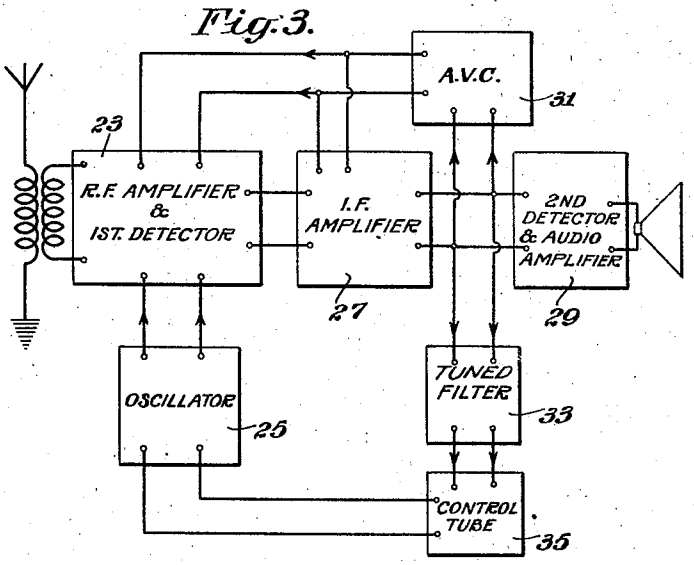
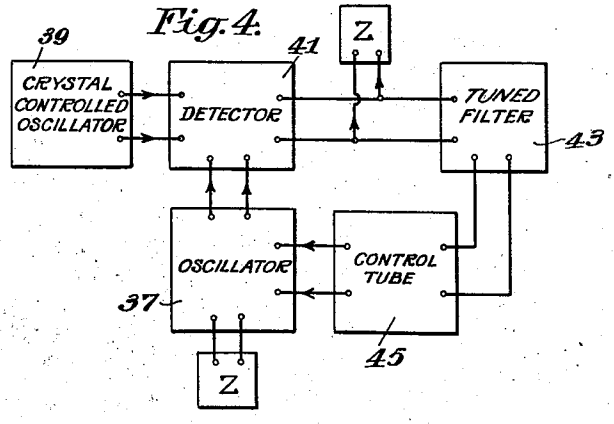


Fig. 4.



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RADIO RECEIVER

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Application November 18, 1932, Serial No. 643,134

2 Claims. (Cl. 250—20)

My invention relates to radio receivers and, more particularly, to receivers of the superheterodyne type especially adapted to the reception of signals at extremely high carrier-frequencies, as well as to oscillation generators.

Inasmuch as superheterodyne receivers, of usual types, utilize fixed tuning in the intermediate frequency amplifying stages, it is highly important that the intermediate frequency, produced through interaction between locally generated oscillations and the incoming carrier-wave, be maintained constant. Obviously, changes both in the frequency of the incoming carrier and the local oscillator are effective to alter the intermediate frequency and this condition is particularly detrimental when the local oscillator must cover a range of extremely high frequencies.

It is, accordingly, an object of my invention to provide a superheterodyne receiver especially adapted to the reception of radio signals at extremely high frequencies.

Another object of my invention is to provide an inexpensive oscillation generator wherein the tendency to drift is compensated.

In applying my invention to a radio receiver of the superheterodyne type, I intentionally so adjust the tuning of the local oscillator and that of the radio-frequency amplifier or first detector that the frequency of the beat-note produced from any incoming carrier wave is very slightly different from the frequency to which the intermediate stages are tuned. After suitable amplification in the intermediate stages, I impress the signal simultaneously upon a second detector and the input circuit of a control tube. The voltage developed across a resistor in the output circuit of the control tube is applied to the plate of the local oscillator and the connections are such that changes in the said voltage so alter the frequency of the oscillations supplied by the said oscillator that the intermediate frequency drift is compensated.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment, when read in connection with the accompanying drawing, in which

Fig. 1 is a diagrammatic view of a radio receiver including a preferred embodiment of my invention,

Fig. 2 is a curve exemplifying the manner in which my improved receiver operates, and

Figs. 3 and 4 are diagrammatic views illustrating alternative embodiments of my invention.

Referring to Fig. 1 of the drawing, a radio receiver including a preferred embodiment of my invention may be constituted by a first detector tube 1, an intermediate frequency amplifier tube 3, a second detector tube 5, an audio frequency amplifier tube 7, and an indicating device 9, such as a loud-speaker, or the like. Obviously, the first detector tube may be preceded by as many radio frequency amplifying stages as may be necessary to obtain the requisite selectivity and sensitivity. It is also self-evident that there may be as many intermediate frequency amplifying stages as desirable, and that the audio frequency amplifying stages may be constructed in any well known manner.

The receiver further includes a local oscillation generating tube 11, the output circuit of which may be coupled in any desirable manner to the first detector tube. In the drawing, this coupling is indicated as being of the inductive type, though the specific type of coupling is immaterial.

Also, I have illustrated my improved receiver as including a plurality of independent filament, bias, and plate potential sources. It will be obvious to those skilled in the art that a single source such as bleeder resistor across the output terminals of a rectifier might be substituted therefor. In that event, I find it preferable to utilize thermionic tubes of the equi-potential cathode type.

The devices thus far described constitute a receiver of the usual superheterodyne type and, as is well known to those skilled in the art, all of the adjustable tuning devices therein may be coupled together for simultaneous actuation, as indicated by the dotted line 13.

In the operation of a superheterodyne receiver, the radio frequency stages and the first detector stage are ordinarily tuned to resonance with a desired incoming signal and the frequency of the local oscillator is so adjusted that the beat frequency to which the intermediate stages are tuned, is produced from a desired incoming signal.

When receiving signals at extremely high frequencies, the slightest drift of the local oscillator away from the proper frequency causes serious interference with the reception of the desired sig-

nal. The change in the beat frequency may also be ascribed to the transmitting station but, since such stations are usually piezo-electric crystal controlled, there is much less likelihood of a change in the frequency of an incoming signal than in the frequency of the local oscillator.

According to my invention, however, I provide means whereby any change in the beat frequency, whether occasioned by reason of a change in the frequency of the received signal or by drift of the local oscillator, is compensated. Specifically, I provide automatic means, responsive to changes in the beat frequency, for altering the plate potential of the local oscillator to thus change its frequency in the proper direction, whereby the beat frequency is kept within fairly narrow limits.

For the purpose of obtaining automatic control, I intentionally so adjust the local oscillator that the beat frequency produced differs slightly from the frequency to which the intermediate amplifiers are tuned. For example, referring to Fig. 2, in which the curve shown is indicative of the amplitude of response of the intermediate frequency amplifier to a signal impressed thereon, the local oscillator, preferably, is so adjusted that its frequency is always higher than that of the desired signal, and the normal intermediate frequency impressed upon the amplifier is higher than the tuned frequency therefor and the amplitude of the output therefrom may be represented by a point 15 on the curve.

It is apparent, therefore, that if the beat frequency becomes lower than normal, through any cause, the voltage of the amplifier output increases and, if the beat frequency becomes higher, as represented by the point 17, the voltage decreases. The converse is true if a normal beat frequency lower than the tuned frequency of the amplifier is chosen.

Accordingly, as the beat frequency departs from the predetermined setting, the amplitude of the signal impressed upon the second detector 5 varies. In order that this phenomenon may be utilized, I provide a third detector or control tube 19, the grid of which is connected to the grid of the second detector tube 5, and the output circuit of which includes a resistor 21 over which plate potential is applied to the local oscillator 11. If, during the operation of my improved receiver, the intermediate frequency tends to become higher for any reason, the potential applied to the first detector and to the control tube input circuit drops, the current in the output resistor 21 of the control tube decreases to decrease the potential drop thereacross which, in turn, raises the potential to the oscillator plate and thereby reduces the oscillator frequency. Should the intermediate frequency or beat note tend to become lower, the converse action takes place, and a lower voltage is applied to the oscillator plate, which causes the frequency of the local oscillator to rise.

The same results might be obtained, but to a less satisfactory degree, by providing circuits, variably tunable to a frequency slightly different from that of the oscillator, and coupling the oscillator to the input of the control tube 19. This procedure has two distinct disadvantages, however, (1), the mechanical disadvantage in applying uni-control to the oscillator and the link circuits and, (2), the inherent difficulty of obtaining sharply resonant circuits at the higher frequencies, whereby good automatic control of the oscillator frequency may be had. By employing the beat note, however, which is much lower in frequency than the local oscillations, I am enabled to make use of the sharper selectivity obtainable in the intermediate frequency stages.

The successful operation of my improved radio receiver, as hereinbefore described, is predicated upon the reception of radio signals at a constant amplitude. As a matter of fact, such constancy of amplitude is never obtainable, the well-known phenomenon of "fading" causing the input to a receiver to vary between wide limits. Such being the case, although it is possible to construct a receiver without automatic volume control devices, I find that, for commercial purposes, it is much more satisfactory to apply my invention to receivers of the automatic volume control type. Also, for commercial reasons, it is, perhaps, better to maintain the beat frequency exactly the same as the frequency to which the main intermediate frequency amplifier is tuned.

Accordingly, referring to Fig. 3 of the drawing, a preferred commercial embodiment of my invention is constituted by a radio frequency amplifier and first detector portion 23, an oscillator 25, an intermediate frequency amplifier 27 tuned to the predetermined beat frequency, a second detector and audio frequency amplifier portion 29, and an automatic volume control system 31 which gets its input potentials from the output circuit of the intermediate frequency amplifier and which controls the gain either in the radio frequency portion of the system or in that of the intermediate stages preceding the stage from which the control is derived.

Inasmuch as there are now available a large number of automatic volume control systems, there is no necessity for complicating the drawing by the specific illustration thereof.

In order that the beat frequency may be kept constant, I also divert a portion of the output from the intermediate frequency amplifier through a tuned filter 33 and a control tube 35 which functions in the same manner as does the control tube 19 hereinbefore referred to, and utilize the control tube to cause a variation in the plate potential applied to the oscillator. The filter is so tuned as to most effectively pass a frequency slightly lower than the predetermined beat frequency and it functions to impress potentials at greater or less amplitude upon the control tube, with variation in the beat frequency, in exactly the same manner as does the tuned intermediate frequency amplifier described in connection with Fig. 1 of the drawing.

It is also quite feasible to utilize my invention to prevent an oscillator from drifting, provided a substantially constant second oscillation source is available. In other words, referring to Fig. 4, if the oscillation from an oscillator 37, which has a tendency to drift, and the output from a constant frequency oscillator 39, which may be of the crystal-controlled type, are simultaneously impressed upon a detector 41, the beat frequency output from the detector, either with or without amplification, may be passed through a filter 43, tuned to a lower frequency and, hereafter, impressed upon a control tube 45 to control the drifting oscillator 37, as hereinbefore described with respect to Figs. 1, 2, and 3. In such event, either the output from the drifting oscillator or the beat frequency may be utilized for any desired purpose. The utilization circuits have been illustrated in the drawing by rectangles designated "Z".

From the foregoing, it will be apparent that I have provided an improved oscillation generating system particularly adapted to the reception of signals at extremely high frequencies, whereby all tendency of the local oscillator to drift and any change in frequency of the received signal, within reasonable limits, are met and compensated. My invention, therefore, is particularly advantageous in connection with television receivers which, of necessity, must be designed to handle ultra-high frequencies of the order of 60 megacycles, or the like.

Although I have shown a specific embodiment of my invention, many modifications will be apparent to those skilled in the art to which it pertains. 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 of the superheterodyne type, a first detector, means for impressing a received signal-modulated carrier wave upon said detector, a tuned circuit having minimum attenuation for waves of a predetermined frequency, an electron tube generator tunable with said first named means, means for impressing the output of said generator upon said first detector to produce with said predetermined frequency, a beat frequency slightly different from that of said predetermined frequency, means for impressing said differing beat frequency upon said tuned circuit to cause said circuit to have a normal less than maximum response thereto at a point upon a steep portion of its frequency response characteristic, means connected to said tuned circuit for deriving therefrom a variable potential which is proportional to variations in the resultant intermediate frequency change from said point upon said response characteristic, and means for impressing said potential upon the anode of said electron tube generator to oppose an undesired change in said beat frequency.

2. In a radio receiver of the superheterodyne type, a first detector, means for impressing a received signal modulated carrier wave upon said detector, a tuned circuit having minimum attenuation for waves of a predetermined frequency, an electron tube generator tunable with said first named means, means for impressing the output of said generator upon said first detector to produce with said predetermined frequency, a beat frequency, slightly different from that of said predetermined frequency, means for impressing said differing beat frequency upon said tuned circuit to cause said circuit to have a normal less than maximum response thereto at a point upon a steep portion of its frequency response characteristic, means connected to said tuned circuit for deriving therefrom a variable potential which is proportional to variations in the resultant intermediate frequency change from said point upon said response characteristic, and means for impressing said potential upon said electron tube generator to control the frequency thereof, the polarity and direction of change of said potential being such as to cause the change in oscillator frequency to oppose an undesired change in said beat frequency.

WENDELL L. CARLSON.