

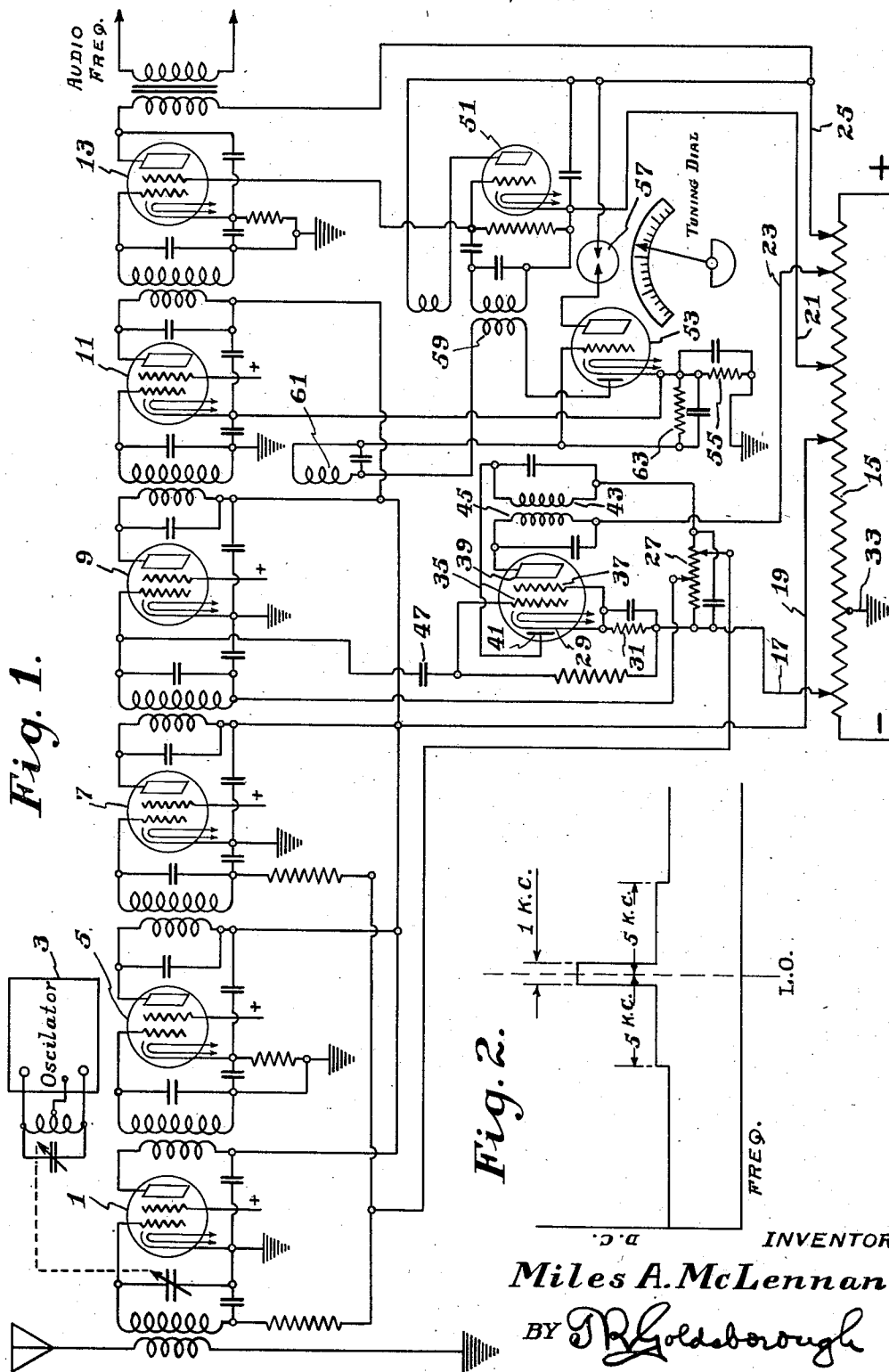
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RADIO RECEIVER

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RADIO RECEIVER

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My invention relates to radio receivers and more particularly to receivers of the superheterodyne type provided with automatic volume-control devices.

During the reception of radio signals undesirable distortion is often noticed. One cause of such distortion is the phenomenon known as selective fading occasioned by interference, at the point of reception, between the so-called ground wave and the sky-wave reflected from the heaveside layer. Such interference may reduce the amplitude of the carrier with respect to the side bands and the received signal is then analogous to that radiated by a transmitter which is over modulated.

It is, accordingly, an object of my invention to provide a radio receiver that shall automatically compensate the effects of selective fading.

Another object of my invention is to provide a radio receiver that shall automatically minimize distortion during the reception of over-modulated carrier waves.

Radio receivers having automatic volume-control devices ordinarily have two objectionable features, namely, the difficulty of exactly tuning in a desired signal unless a tuning meter or the like is provided and, further, the increase in sensitivity during intervals when the tuning is being changed from the frequency of one signal to that of another. Such increase in sensitivity gives rise to back-ground noise which is extremely unpleasant.

Another object of my invention, therefore, is to provide a radio-receiver of the automatic volume-control type that shall be semi-automatic in tuning; that is to say, a receiver that requires manual adjustment to only approximately the proper frequency after which further adjustment is accomplished automatically.

A still further object of my invention is to provide, in a radio receiver of the type described, automatic means for back-ground noise suppression during the operation of tuning.

In a preferred embodiment of my invention, I achieve the foregoing objects and other objects ancillary thereto by providing a local oscillator, adapted to operate at an intermediate frequency, for compensating over-modulation in an incoming signal, together with means whereby energy derived from the oscillator is utilized in conjunction with the incoming signal for the purpose of blocking one or more stages of the receiver until such time as a desired signal is actually tuned in. Furthermore, still in accordance with my invention, I so dispose the various elements of the re-

ceiver that, as the tuning of the radio-frequency stages thereof is adjusted to approximately a desired frequency, the oscillator "locks in" with the intermediate frequency and stays locked in over a small range at each side of the mean frequency to which the intermediate frequency amplifier portion of the apparatus is tuned.

The novel features which 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;

Figure 1 is a diagrammatic view of a portion of a radio receiver embodying my invention, and

Fig. 2 is a diagram to which reference will be made in explaining the operation of the receiver illustrated in Fig. 1.

Referring to Fig. 1 of the drawing, an illustrative receiver constructed according to my invention may most easily be explained by considering it as divided into three distinct though mutually cooperative portions, namely, a substantially conventional multi-stage superheterodyne receiver, an automatic volume control device and a group of devices functioning to provide both background suppression and additional energy to compensate for carrier fading or over-modulation. Specifically, the receiver portion may comprise one or more radio-frequency amplifying stages, exemplified in the drawing by the thermionic device 1, a local oscillator 3, a first detector 5, a plurality of intermediate frequency amplifiers 7, 9, and 11, a second detector 13 and an audio frequency amplifier (not shown).

As is customary in modern radio receivers, all plate and bias potentials may be derived from a single source of rectified alternating current. This source is exemplified, in the drawing, by a bleeder resistor 15, to points on which a plurality of leads 17, 19, 21, 23, and 25 extend from the various thermionic devices in the receiver.

To avoid the necessity of providing anti-oscillation devices in connection with the amplifier tubes, and to obtain satisfactory gain therein, such tubes are preferably of the equipotential-cathode screen-grid type. Connections from the screen grids to the bleeder resistor have not been shown nor have connections for supplying potential to the cathode heaters, since their existence in an actual receiver is obvious to those skilled in the art.

For the purpose of obtaining automatic volume control, the control grid of the radio frequency amplifier 1, the grid of the first intermediate frequency amplifier 7 and that of the second intermediate frequency amplifier 9 are returned to points in the receiver that become more negative with respect to their cathodes with increase in signal amplitude. These points are found on a resistor 27 included in the diode output circuit of a thermionic AVC of the diode-pentode type commercially known as radiotron 2B7, the cathode 29 of which is connected through a resistor 31 and the lead 17 to the bleeder resistor 15 at a point more negative than the ground connection 33 thereto. Since the cathodes of the controlled tubes 1, 7 and 9 are directly connected to ground, that portion of the bleeder resistor between its ground connection 33 and the connection 17 thereto of the AVC tube cathode provides a fixed bias on the said controlled tubes in the absence of additional potential across the diode output resistor 27.

In addition to the cathode, the AVC tube includes a control grid 35, a suppressor grid 37, an anode 39 and a diode plate 41. The diode plate of the tube is connected back to the cathode thereof through a circuit 43, tuned to the intermediate frequency, and the diode resistor 27 which has a value of approximately one megohm, and the anode 39 is connected to the bleeder resistor through a tuned circuit 45, coupled to the first mentioned tuned circuit 43, and the lead 23.

The incoming signal is applied to the AVC tube from the input circuit of the second IF tube over a connection, including a stopping condenser 47, extending between the control grids of the several tubes. In the absence of incoming signal potential across the input circuit of the AVC tube, corresponding to the condition of the receiver while tuning from one station to the next, the bias on the grids of the first RF tube and the first and second IF tubes is determined solely by the potential drop along the bleeder resistor 15 between the ground connection 33 and the connection thereto of the AVC tube cathode.

As soon, however, as an incoming signal is impressed upon the input circuit of the AVC tube, it is amplified therein, appears in the output circuit 45 connected to the anode thereof and is fed back to the diode plate through the coupled circuit 43. The signal, accordingly, is rectified in the diode portion of the tube and an average unidirectional potential corresponding to the amplitude of the intermediate frequency is developed across the output resistor 27. With such an arrangement, the unidirectional current flowing in the resistor, during reception of a signal, is always proportional to the amplitude of the carrier and the end of the resistor connected to the diode plate becomes increasingly negative as the carrier amplitude increases, thus reducing the gain in the RF amplifier and the first and second IF amplifiers. The net result is that the gain in the system is reduced as signal amplitude increases and vice versa, thus causing substantially constant signal potentials to be impressed upon the input circuit of the third IF tube.

A radio receiver such as I have thus far described has no means for suppressing background noise during the tuning operation, when sensitivity is maximum, and the automatic volume control feature renders it very difficult to exactly tune "by ear". Heretofore, tuning meters, disposed in the anode circuits of certain of the amplifiers, have been utilized to simplify

the tuning operation but it has been my observation that meters have very little practical utility.

Therefore, in accordance with my invention, I provide a further group of instrumentalities that conjointly function to give back-ground noise suppression, semi-automatic tuning and deficient carrier-wave, or overmodulation, compensation.

Specifically, the said instrumentalities include an oscillator 51, tuned to the intermediate frequency, and a thermionic tube 53, hereinafter designated the suppressor tube, which is preferably of the equipotential-cathode diode-triode type commercially known as radiotron 55. It is to be clearly understood, however, that my invention is not limited to the specific tube chosen for purposes of illustration.

The suppressor tube is provided with a bias resistor 55, the cathode end of which is connected to the cathode of the third IF tube 11 and the other end of which is connected to ground. Since the grid of the tube 11 is also connected to ground, the said self bias resistor therefore is included in the input circuit of the said tube.

Under normal conditions, when no signal is being received, a fairly heavy current flows through the self bias resistor 55 and through a glow tube 57 connected between the anode of the suppressor tube and the lead 25 which extends to a point on the bleeder resistor at a positive potential with respect to ground. The self bias resistor, preferably, has a value of approximately 500 ohms and the potential developed across it is sufficient to bias the third IF tube 11 to "cutoff" during the tuning operation, thus giving noise suppression.

For the purpose of removing the bias as soon as a signal is tuned in, it is necessary to provide signal-responsive means for controlling the bias on the grid of the suppressor tube. For this purpose, I connect the diode plate in the suppressor tube to the cathode thereof through a circuit including a coil 59 coupled to the output circuit of the IF oscillator 51, a sharply tuned circuit 61 which is coupled to the input circuit of the third IF amplifier 11, and a resistor 63 having value of approximately one megohm. By reason of the coupling between the diode circuit and the IF oscillator, a certain amount of rectified current flows in the resistor 63 and also a certain amount flows therein, as a signal is being tuned in, by reason of the coupling between the diode circuit and the input circuit of the third IF amplifier tube. As a matter of fact, however, there is very little change in the current flowing in the resistor and, consequently, very little change in the potential developed across it until the intermediate frequency and the IF oscillator frequency are in phase. Therefore, since the grid of the suppressor tube, as will be seen from the drawing, is connected to the negative terminal of the resistor 63, there will be but very slight change in its potential until the receiver is so tuned that the intermediate frequency delivered from the IF amplifier 9 differs from the normal frequency of the oscillator 51 by not more than approximately $\frac{1}{2}$ KC. This condition is exemplified by Figure 2 of the drawing which shows direct current in the resistor 63 plotted against frequency.

As the intermediate frequency, during the tuning operation, closely approaches that of the oscillations normally generated by the local IF oscillator, two things occur; namely, the suppressor tube is abruptly biased off, thus removing the bias of the third IF tube, and the IF oscillator is "locked in" with the IF frequency being impressed upon the diode plate in the suppressor

tube. Through proper choice of the constants of the several circuits, depending upon the tubes used, this "locking in" can be caused to take place at not more than 500 cycles away from the mean intermediate frequency and the oscillator will stay "locked in" over a range of substantially one kilocycle.

It will be noted from an inspection of the drawing that I have chosen to illustrate the second detector 13 as a thermionic tube of the coplanar grid type, one grid being coupled to the output circuit of the third intermediate frequency amplifier and the other grid being connected directly to the grid of the IF oscillator. By reason of this latter connection, the IF oscillator supplies to the second detector sufficient intermediate frequency potential to offset the effect of selective fading, over modulation at the transmitter and the distortion produced in the detector by an over modulated signal.

This introduction of the intermediate frequency would cause very annoying interference effects at each side of the tuned-in point were it not for the fact that as soon as the third intermediate frequency amplifier 11 "opens up" the IF oscillator "locks in" with the then effective intermediate frequency. These simultaneous actions prevent any beat notes from being generated through interaction between oscillations from the IF oscillator and the intermediate frequency appearing in the output circuit of the second IF amplifier 9.

From a consideration of the foregoing, it will be apparent that I have provided an improved background noise suppressing circuit whereby it is impossible to mis-tune the receiver. A receiver constructed according to my invention permits a station to be audibly tuned in over only a very restricted range of the tuning dial, which range may, through proper choice of constants of the system, be fixed at any desired value from 10 to 500 cycles on each side of the mean intermediate frequency. Such an arrangement prevents distortion resulting from the mis-alignment of tuning controls, which is a common occurrence with present day receivers of types including automatic volume control devices.

My improved receiver also gives an apparent increase in selectivity over receivers in use prior to my invention and provides a still further reduction in between-station noise usually heard on such receivers, especially those having automatic volume control devices.

Furthermore, by reason of the introduction of the intermediate frequency into the second detector, my improved receiver exhibits a very remarkable reduction of distortion caused by carrier cancellation or selective fading, which distortion at times totally destroys the intelligibility of received speech and introduces effects into music which are very objectionable.

In addition, the glow lamp included in the anode circuit of the suppressor tube begins to blink on and off as the correct tuning point is approached and finally is extinguished completely at the instant the station is exactly tuned in. As shown in the drawing, the glow lamp may be utilized to illuminate the usual tuning dial if desired.

Many other advantages of my invention will be apparent to those skilled in the art to which it pertains, as well as many obvious modifications thereof. The specific circuit described has been chosen merely for purposes of illustration and my invention 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 multi-stage radio receiver, means for converting an incoming signal to an intermediate frequency signal, means for biasing one of the stages to substantially the cut-off potential, an oscillator, and means conjointly responsive to potentials representing said intermediate frequency signal and to potentials derived from said oscillator for rendering the biasing means inoperative.

2. In a multi-stage radio receiver, means for converting an incoming signal to an intermediate frequency signal, means for biasing one of the stages to substantially the cut-off potential during the operation of tuning, an oscillator, a rectifier, connections for impressing amplified oscillations representative of said intermediate frequency signal and potentials from said oscillator on the rectifier, and connections whereby the unidirectional current from the rectifier is utilized for the purpose of rendering the biasing means inoperative.

3. In a tunable radio receiver of the superheterodyne type, means for converting an incoming modulated carrier to an intermediate frequency signal, means including an oscillator tuned to said intermediate frequency for compensating selective fading of said incoming modulated carrier and means for effectively restraining the action of the compensating means as the receiver is tuned towards an incoming signal until the receiver is tuned to a frequency differing from the frequency of said signal by a relatively small number of cycles.

4. In a tunable radio receiver of the multi-stage type, means for converting an incoming signal to an intermediate frequency signal, an oscillator, a rectifier, connections for impressing said intermediate frequency signals upon said rectifier, connections for impressing potentials from said oscillator upon said rectifier, means for biasing one of the stages to the cut-off potential during the absence of an incoming signal, and means, responsive to the output of said rectifier for rendering the biasing means inoperative.

5. The invention set forth in claim 4, characterized in that the biasing means is constituted by a multi-electrode thermionic tube provided with a self-bias resistor and further characterized in that the resistor is connected in the input circuit of the stage to which the bias is applied.

6. The invention set forth in claim 1, characterized in that the biasing means is constituted by a thermionic device provided with an output circuit including a resistor and having a control electrode, and further characterized in that the means conjointly responsive to potentials representing said intermediate frequency signal and to potentials derived from the oscillator is constituted by a rectifier having an output circuit including a resistor the negative end of which is connected to the control electrode.

7. The invention set forth in claim 1 characterized in that another one of the stages includes a detector and further characterized in that a connection extends between the oscillator and the said detector.

8. The invention set forth in claim 1 characterized in that the biasing means is constituted by a thermionic tube having an output circuit and further characterized in that a current-responsive device is included in the said output circuit.

9. In a radio receiver, tuning means, manually controllable means for adjusting the tuning means to syntony with a desired incoming radio signal, means for silencing the receiver during the tuning operation until approximate syntony with the desired signal is attained, and signal-responsive means including an oscillator for abruptly rendering the silencing means inoperative when approximate syntony is attained and for maintaining the frequency of said oscillator unchanged and said silencing means inoperative during a further adjustment of the tuning means over a limited range, whereby the action of automatic tuning is simulated.
10. In a superheterodyne radio receiver, tuning means including a frequency converting oscillator, manually controllable means for adjusting the tuning means to syntony with a desired incoming radio signal, means for silencing the receiver during the tuning operation until approximate syntony with the desired signal is attained, a local oscillator and means conjointly responsive to the intermediate frequency signal and to potentials derived from said local oscillator for abruptly rendering the silencing means inoperative when approximate syntony is attained and for maintaining the said silencing means inoperative during a further adjustment of the tuning means over a limited range, whereby the action of automatic tuning is simulated.
11. The invention set forth in claim 10, characterized in that the silencing means includes a space-current device, and still further characterized

in that the means for abruptly rendering the silencing means inoperative is constituted by a rectifier on which are impressed potentials representing the intermediate frequency and potentials derived from the local oscillator and from which is derived an unidirectional potential, which, through suitable connections, is utilized to control the flow of current in the space current device.

12. The invention set forth in claim 10, characterized in that the circuit constants of the local oscillator are such as to tune it normally to the intermediate frequency, and additionally characterized in that the said oscillator is coupled to one of the intermediate frequency amplifying stages, the coefficient of coupling being sufficient to cause the said local oscillator to lock in with the intermediate frequency and to remain locked in therewith over a limited range of adjustment of the tuning means.

13. The invention set forth in claim 10, characterized in that means are provided for impressing upon the second detector potentials derived from the local oscillator.

14. The invention according to claim 10, characterized in that the second detector has a control grid upon which the intermediate frequency signal is impressed and a second grid, and further characterized in that means are provided for impressing upon said second grid potentials derived from said local oscillator.

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DISCLAIMER

2,035,176.—*Miles A. McLennan*, Riverton, N. J. RADIO RECEIVER. Patent dated March 24, 1936. Disclaimer filed December 15, 1937, by the assignee, *Radio Corporation of America*.

Hereby enters this disclaimer to claims 3 and 10 in said specification.
[*Official Gazette January 4, 1938.*]