

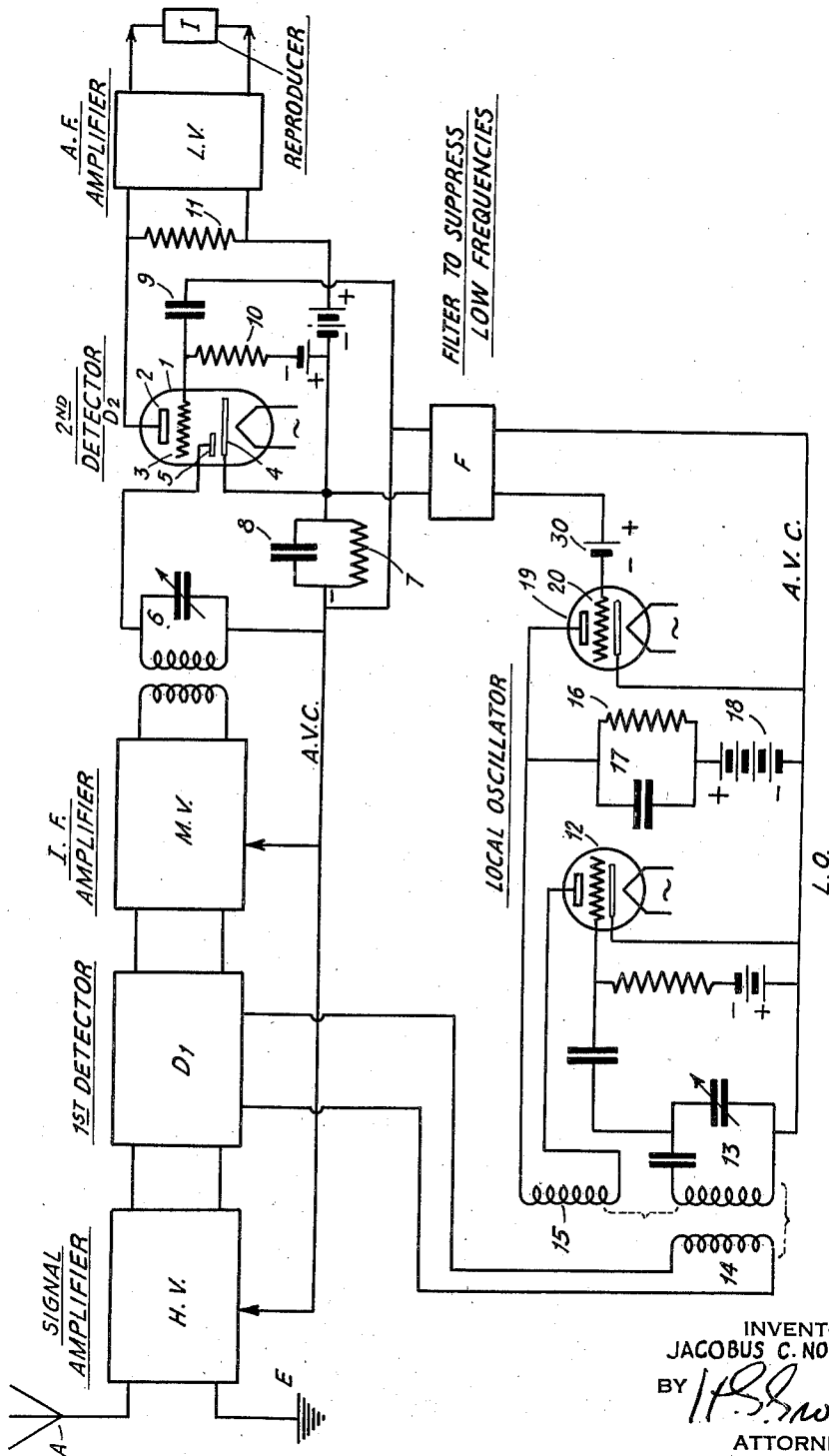
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# SUPERHETERODYNE AUTOMATIC GAIN CONTROL SYSTEM

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## UNITED STATES PATENT OFFICE

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SUPERHETERODYNE AUTOMATIC GAIN  
CONTROL SYSTEM

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## 4 Claims. (Cl. 250—20)

This invention relates to the regulation of the sound strength in receiving sets, in which the well known superheterodyne principle is used.

With this receiving method modulated high frequency oscillations, whether or not amplified by a high frequency amplifier, are caused to interfere with the electric oscillations produced by a local generator, and subsequently supplied to a first detector by which the beat oscillations are rectified. In this case oscillations of the sum-frequency and also oscillations of the difference-frequency of the received and the locally produced oscillations are present in the output circuit of the first detector. In superheterodyne receiving sets the oscillations of the difference-frequency are usually employed. This so-called medium frequency which has taken over the modulation of the received high frequency oscillations, is successively amplified and rectified by a second detector. The low frequency oscillations occurring therewith are made perceptible, if desired, after having been subjected to low frequency amplification, by some reproducing device, for instance, a loud speaker. Now, it is known that the amplitude of the medium frequency oscillations depends on the product of the amplitude of the received high frequency oscillations and the amplitude of the oscillations produced by the local oscillator. Due to "fading" phenomena the amplitude of the received high frequency carrier wave is subject to variations so that the amplitude of the medium frequency oscillations, and also the strength of the low frequency signals made perceptible after the second rectification will vary accordingly.

The present invention has for its purpose to provide means by which variations in the amplitude of the medium frequency oscillations due to variations of the received carrier wave amplitude are entirely or almost entirely avoided, so that medium frequency oscillations of always substantially constant amplitude are obtained, due to which the low frequency signal strength remains substantially constant independently of "fading" phenomena.

According to the invention this purpose is attained by controlling the amplitude of the oscillations generated by the local oscillator in accordance with the amplitude of the received oscillations in such a manner that the product of the amplitudes of the local and of the received oscillations is substantially constant.

In order that the product of the amplitudes of the local and the received oscillations always remains constant, a variation of the carrier wave

amplitude must be incidental to an inversely proportional variation of the amplitude of the local oscillations, which consequently means that if, for instance, the amplitude of the received high frequency oscillations impressed on the first detector, decreases to half the initial value, the amplitude of the local oscillations must increase two fold.

Such a control of the amplitude of the local oscillations can be ensured in different manners. It is possible, for instance, to rectify the received high frequency oscillations after having been amplified, for which purpose either the high frequency amplifier connected before the detector, or a separate high frequency amplifier, may be used. Thus, a direct current is produced whose value depends on the carrier wave amplitude and by means of the voltage drop caused by this direct current through a resistance, the bias of one or more of the electrodes, for instance, of one of the grids or of the anode of the tube of the local generator can be controlled.

Another possibility of ensuring the desired control is to regulate by means of the voltage drop caused through a resistance by the direct current set up by rectification of the medium frequency oscillations in the second detector, the bias of one or more of the electrodes of the tube of the local generator. In this case it is possible, of course, to use a separate rectifier instead of the second detector.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, will best be understood by reference to the following description taken in connection with the drawing, in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

One embodiment of the invention will be more clearly set out by reference to the accompanying drawing in which a superheterodyne set is diagrammatically represented.

The input terminals of a high frequency amplifier H. V., the circuit arrangement of which may be supposed to be known, are connected to an antenna A and to earth E. The amplified received high frequency oscillations are impressed on the input circuit of a first detector D<sub>1</sub> to which are also supplied in a suitable manner the oscillations generated by a known local oscillator L. O., so that a medium frequency is produced which after having been amplified in a medium fre-

quency amplifier M. V. is rectified by a second detector D<sub>2</sub>. Successively the low frequency signals can be amplified by a low frequency amplifier L. V. and rendered perceptible by a suitable reproducing device I.

As appears from the drawing the second detector D<sub>2</sub> may be constituted by a thermionic tube 1, of the multi-duty type, comprising an anode 2, a controlling grid 3, an indirectly heated cathode 4 and in addition a small anode 5 outside the electron stream to the grid 3 and anode 2. The amplified medium frequency oscillations are supplied between the anode 5 and the cathode 4, for instance, by means of a tuned circuit 6. Since these electrodes form a diode-rectifier, the resistance 7 will be traversed by a rectified current comprising both low frequency components and a direct current component. In order to allow the passage of the high frequency alternating currents a condenser 8 is connected in parallel with the resistance 7. The low frequency alternating tensions through the resistance 7 control the controlling grid 3 of the tube 1 before which a condenser 9 together with a leakage resistance 10 is provided. Now the low frequency anode current variations brought about by this control means cause voltage variations across a resistance 11 inserted in the anode circuit of the tube 1, by which variations the low frequency amplifier is controlled.

The arrangement of the local oscillator represented in the drawing comprises a triode 12 which is coupled back and which has a tuned grid circuit 13 to which a coil 14 is coupled whereby the generated oscillations are impressed on the first detector D<sub>1</sub>. In order to achieve the desired variation of the amplitude of the local oscillations a resistance 16 is inserted in the anode circuit of the tube 12 in series with the reaction coil 15 which resistance is shunted by a condenser 17 having a small impedance to high frequency currents. This resistance 16 is at the same time in series with a source of anode voltage 18 in the anode circuit of a tube 19 whose grid 20 is controlled by the direct voltage drop through the resistance 7 with the interposition of a filter F suppressing the low frequency currents.

The working of the arrangement is as follows: With a definite strength of the incoming signal a direct voltage drop having a corresponding value occurs through resistance 7. Accordingly, an anode current flows in the tube 19, which current causes a certain voltage drop through the resistance 16. This voltage drop together with the voltage of the source of voltage 18 determines the anode voltage of the oscillator tube 12 and this anode voltage is adjusted in such a manner that with a normal signal strength the alternating tensions supplied by the local oscillator to the first detector have a definite desired value. If, for instance, the amplitude of the incoming carrier wave decreases then the voltage drop through the resistance 7 will also decrease. Due to this the grid 20 of the tube 19 acquires a more negative voltage relatively to the cathode, so that the current through the resistance 16 will decrease; thus the anode voltage of the oscillator tube 12 will increase. Assuming the amplitude of the oscillations generated by the oscillator to be in a linear relation with the anode direct voltage, which may be ensured by giving the oscillator a proper size, then an increase of the anode voltage of the tube 12 will cause an increase of the am-

plitude of the local oscillations, and consequently also an increase of the voltages supplied to the first detector.

If the increase of the last mentioned voltages is almost inversely proportional to the decrease of the amplitude of the received oscillations at the first detector due to the decrease of the signal strength, then the amplitude of the medium frequency oscillations will remain substantially constant, since as is well known the medium frequency amplitude depends on the product of the amplitudes of local and received oscillations. In a quite analogous manner can be shown that if the strength of the incoming signals increases, the amplitude of the local oscillations will decrease so that also in this case the amplitude of the medium frequency oscillations remains substantially constant. Thus, with a constant modulation degree of the received transmitter the low frequency signals supplied to the low frequency amplifier are automatically kept on a constant level so that annoying phenomena due to fading are no longer perceptible.

The sound volume control according to the invention may be used simultaneously with known sound strength regulations. This may be advantageous, for instance, if a control between very wide limits is desired. With the circuit arrangement represented in the drawing this may be ensured without any further means by causing the direct voltage drop to act through the resistance 7 on the controlling grids of the high and/or medium frequency amplifying tubes.

If it is desired that the automatic sound strength control becomes operative only when the received signal strength exceeds a definite value, this may be ensured in a simple manner with the arrangement represented in the drawing by giving the grid 20 of the tube 19 a negative bias from a source as 30 having such a value that anode current can flow in the tube 19 only if the signal strength exceeds a definite value.

Regulation of the amplitude of the local oscillations occurs in the arrangement shown in the drawing by varying the anode voltage of the oscillator tube. It will be appreciated, however, that this purpose can also be attained in various other manners, for instance, by varying the bias of the controlling grid, or when using a tube having a plurality of grids, by varying the bias of one of the remaining grids.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What is claimed is:—

1. In a signal receiver, a frequency changer network adapted to have signals impressed thereon, a local oscillator coupled to the said network and impressing current thereon of a frequency differing from the signals by a desired beat frequency, a detector adapted to have the beat current impressed thereon, and means, responsive to the variations in the direct current component of the detected beat current, for varying the amplitude of the oscillator current in a direction such that the amplitude of the beat current is substantially constant, said last means including an electron discharge tube having its input electrodes arranged to have the said component impressed therebetween, and an impedance common

to the space current paths of said tube and the local oscillator.

2. In a superheterodyne receiver of the type including in cascade a signal amplifier, a first detector, an intermediate frequency amplifier, a second detector and an audio frequency amplifier, a local oscillator coupled to the first detector, means for automatically regulating the amplitude of the local oscillations impressed on the first detector in a sense inverse to amplitude variations of signal waves received by the receiver, said means comprising an electron discharge tube having an impedance in its space current path, said impedance being included in the oscillator space current path, and connections between the input electrodes of said tube and the second detector for impressing on the input electrodes the direct current component of detected intermediate frequency current.

3. In a superheterodyne receiver of the type including in cascade a signal amplifier, a first detector, an intermediate frequency amplifier, a second detector and an audio frequency amplifier, a local oscillator coupled to the first detector, means for automatically regulating the amplitude of the local oscillations impressed on the first detector in a sense inverse to amplitude variations of signal waves received by the re-

ceiver, said means comprising an electron discharge tube having an impedance in its space current path, said impedance being included in the oscillator space current path, and connections between the input electrodes of said tube and the second detector for impressing on the input electrodes the direct current component of detected intermediate frequency current, and additional connections from the second detector to the signal and intermediate frequency amplifiers for impressing thereon the said component thereby to vary the gain of the said last amplifiers.

4. In a signal receiver of the superheterodyne type, a first detector network, a local oscillator network electrically associated with the detector to produce energy of a predetermined intermediate frequency in the detector output circuit, said oscillator network including an electron discharge device having at least a cathode, control grid and anode, means, responsive to variations in received signal amplitude, for adjusting the oscillator anode potential in a sense to maintain the said intermediate energy at a substantially constant amplitude, and additional means for delaying the adjusting action of said means until the received signal amplitude exceeds a desired value.

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