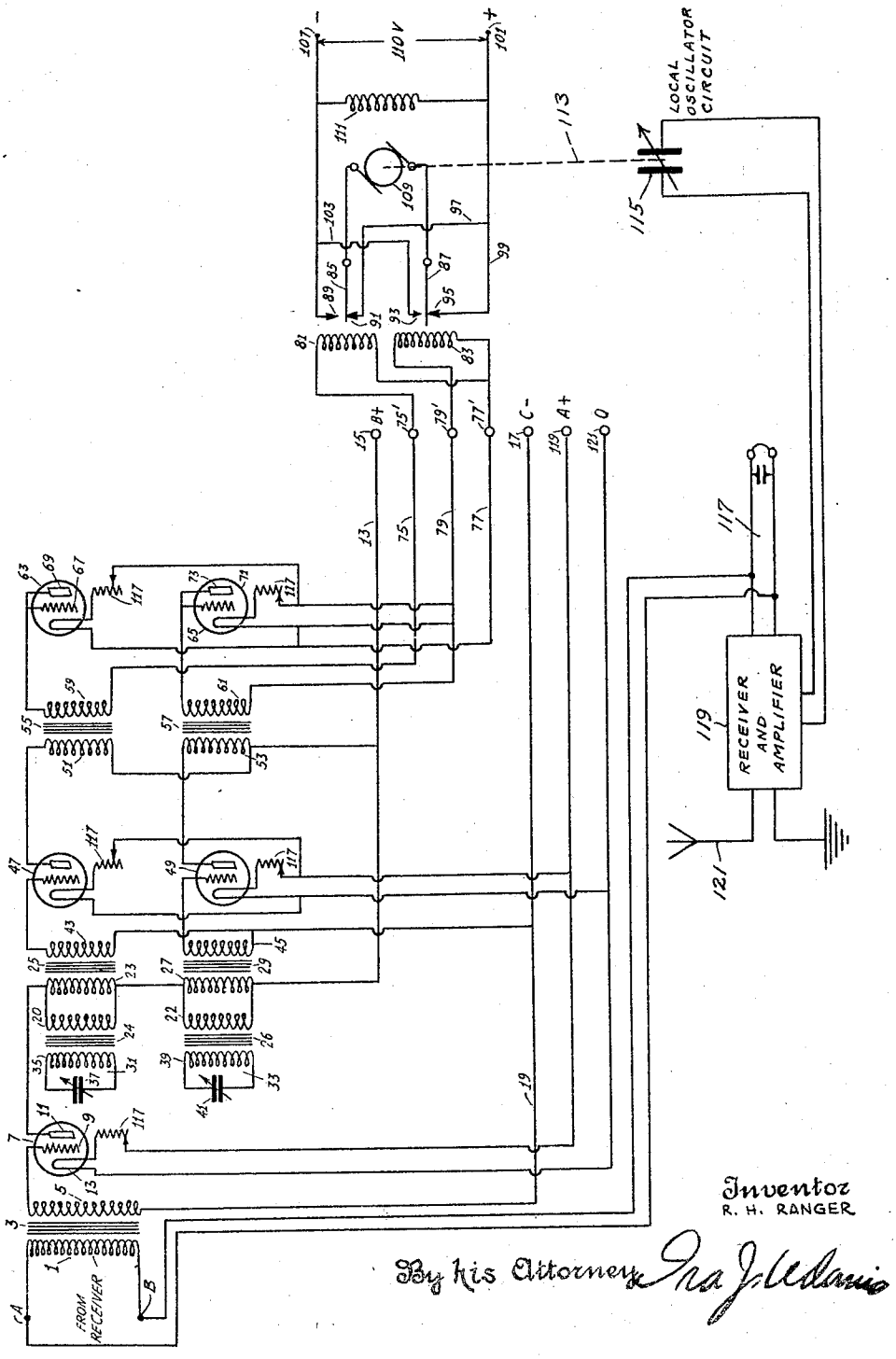
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TONE STABILIZING

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TONE STABILIZING

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This invention relates particularly to a method and apparatus for stabilizing the tone of signals received at a receiving point as transmitted from a distant station.

High power reception devices are continually being developed to take advantage of audio tuning. These devices require that the tone or frequency, whether it be audible or not, as received from a foreign or remote transmitting station, shall be absolutely constant in pitch or value. This, of course, can be accomplished best and most effectively at the transmitting end of the signaling system, but it is also possible to compensate for changes in the transmitting frequency at the receiving end of the system. The arrangement, as herein disclosed, is suited and adapted to compensate for changes in the transmitting frequency such as can not clearly be avoided at the transmitter and are occurring irrespective of how much care is taken to maintain absolutely constant frequency at the transmitting end of a system.

Briefly the invention consists in arranging a combination for keeping the frequency or tone at the receiver constant for shifts in incoming frequencies and provides a plurality of tuned circuits one of which is tuned above and the other of which is tuned below incoming signal frequency. Each of these tuned circuits actuates a differential relay which, working in combination with a motor, is arranged to shift or change the capacity, the inductance, or change both the capacity and inductance value in the circuit of a local oscillator at the receiver or to vary the potential upon the plate member of the local oscillator, so that the resulting frequencies or tones at the receiver will always remain at a constant value, within whatever predetermined limits may be desired, by using suitable settings of the tuned circuits.

The invention, therefore, has as its primary object that of maintaining substantially constant frequencies at a receiving point, or even maintaining constant frequency directly at the point from which the energy received is transmitted.

Other objects are to provide an arrangement for use in combination with a receiving system wherein the arrangement of circuits is relatively simple and the means for maintaining constant frequencies at the receiver is relatively simple.

Other objects of my invention are to provide circuits and apparatus for maintaining constant frequencies at a receiving point which utilize only well known vacuum tubes and differential relays in combination with the particularly type of circuits and a suitable driving means, for example, a motor, for controlling the frequency of a local oscillator circuit, for example, by any of the methods above set forth.

Still other objects of my invention are to provide, in a manner to be hereinafter described, a system for maintaining constant tone frequencies at a receiving point which is relatively simple in its construction and arrangement, efficient in its use, compact, conveniently installed, fool-proof, and conveniently operated.

Other objects will at once become apparent from a reading of the following specification and claims when read in connection with the accompanying drawing wherein I have illustrated by the single figure thereof one form of circuit arrangement which my invention may assume, although it is to be understood that various modifications may be made therein and that I may substitute for any of the elements shown other such elements as have become known in the art to which the invention relates as being full equivalents of those illustrated.

Now referring more particularly to the drawing, heterodyne signals are received from a receiver 119 associated with any desired type of antenna 121, or even over a wire line from a receiver, and are impressed upon the terminals A and B of the frequency control system from which they are directed through the primary winding 1 of a transformer member 3. The output energy in the secondary member 5 of the transformer 3, to which signals from the receiver are transferred, is then impressed across the grid and cathode members 9 and 13 respectively of the vacuum tube amplifier 7, and the output energy from this tube appearing in the

plate circuit including a plate member 11, the source of plate potential "B+" and the cathode member 13, as well as other elements to be hereinafter defined as being located in the plate circuit, is impressed upon the primary windings 23 and 27 of the transformers 25 and 29 respectively.

Connected in shunt with each of the primaries 23 and 27 of the transformers 25 and 29 respectively are transformers 24 and 26 having their primary windings 20 and 22 respectively shunting the primaries 23 and 27. The secondary members 35 and 39 of the transformers 24 and 26 respectively, together with the variable capacity elements 37 and 41 connected to the ends thereof, form tuned trap circuits 31 and 33 respectively. The secondary members of the transformers 24 and 26 preferably have a relatively large number of turns as compared with the number of turns in the primary windings of these transformers. If, for example, the trap circuit 31 is so tuned by means of the variable capacity element 37 as to be resonant to a frequency slightly above the incoming or received frequency this trap or rejector circuit 31 will form practically an infinite impedance with regard to this particular frequency and if, for example, the tuned trap or rejector circuit 33 is tuned by means of the variable capacity element 41 to a frequency slightly below the incoming or received signal frequency, this trap circuit will form practically an infinite impedance as regards the particular frequency to which it is tuned. The tuned trap circuit or frequency trap per se has been disclosed by my United States Patent No. 1,757,333, granted to me on May 6, 1930.

This tuning of the separate trap or rejector circuits may be accomplished in such a manner that the energy of the desired frequency which will be passed through the tuned trap circuit will still be sufficiently far up on the issuing curve to produce effective results.

The transformers 25 and 29 respectively are each provided with secondary windings 43 and 45 which connect with two individual branches of the frequency control system, each of which branches may be made selective for a specific audio tone, which is governed in accordance with the tuning of the separate trap circuits 31 and 33. The energy impressed upon the secondary member 33 of the transformer 25 is impressed in the usual manner across the grid cathode circuit of a vacuum tube amplifier 47 and the energy impressed in the secondary winding 45 of the transformer 29 is applied across the grid cathode circuit of the vacuum tube amplifier 49. The outputs of the vacuum tube amplifiers 47 and 49 are respectively impressed upon the primary windings 51 and 53 of the transformers 55 and 57 where the energy is transferred to and impressed upon the secondaries 59 and 61 from which it is applied to the rectifiers 63 and 65 respectively.

The rectifiers 63 and 65 may, if desired, be ordinary three-electrode vacuum tubes or may be the simple well known two-element rectifiers. As shown, I have chosen to illustrate an arrangement wherein it is possible to use the ordinary three element tube as a rectifier suitable to this system, and this is provided by connecting the grid and plate members 67 and 69 of the tube 63 together, and also with respect to the tube 65, by connecting the grid and plate elements 71 and 73 together.

The energy from each of these two separate rectifiers 63 and 65 which are each responsive to energy of a different frequency is then arranged to actuate sensitive telegraph relays 81 and 83 respectively. The relay 81, for example, is connected at terminals 75′ and 77′ connected respectively with the grid and plate members 67 and 69 of the tube 63 through the transformer secondary 59 and directly to the cathode member of the tube 63, and the relay 83 is connected at terminals 77′ and 79′ and through conductor 77 connects with the cathode member of the rectifier tube 65 and through conductor 79 and transformer secondary 61 connects with the grid and plate elements 71 and 73 of the rectifying tube 65.

Normally, with the received signal exactly between the two frequencies, for which the two branches including, respectively, the amplifier 47, and rectifier 63, and the amplifier 49, and rectifier 65, each of the relays 81 and 83, will be actuated on receipt of a signal. If, however, the tone of the signal is changed either by the frequency of the transmitter changing slightly or due to the fact that the local oscillator in the synchronous detector or heterodyne detector in the receiving station changes slightly, the tone will shift up or down. If the tone shifts up in frequency to the tone of the higher tone frequency system, which has been illustrated as including the amplifier 47 and the rectifier 63, this branch only will actuate its relay, namely, relay 81. A shift down in frequency would accomplish the opposite result, of course, namely, that the relay 83 would be actuated by the output energy of the rectifier 65 receiving energy from the amplifier 49 and in this case the higher tuned branch would not actuate the relay 81.

This differentiation in the signal pitch, irrespective of the frequency thereof, may now be utilized for the purpose of actuating a motor. A simple reversing connection is made from the two relays 81 and 83 to the armature of a motor 109, the field 111 of which is constantly energized by a D. C. source of power, for example, a 110 volt line connected at the terminals 107 and 101, re-

spectively, where, for the purposes of illustration, it is assumed that the positive terminal is 101 and the negative terminal is 107.

The tongues or armatures 85 and 87 of the relays 81 and 83 respectively are connected to two sides of the armature of the motor. The "make" contacts 91 and 95 of the two relays are connected together to one side of the power source through conductors 97 and 99, for example, and in the case herein assumed, these contacts are connected with the plus side of the power source. The "space" contacts 89 and 93 of these two relays are then likewise connected to the minus source of power, for example, through the conductors 105 and 103 respectively. Under these conditions, if the tongues or armatures of both relays 81 and 83 are in the same position, that is, resting upon the "space" or "make" contacts, no current flows into the armature of the motor and the motor stands still. This is the condition for a normal signal of a pitch just mid-way between the two tuned branches of the system. When the tongue or armature of one relay swings to the "making" contact, while the other remains on the "spacing" contact, the current will flow through the motor in one direction. If the reverse conditions is true, namely, that the other tongue or armature of the other relay moves while the relay in the first named branch stands still, current will be sent into the armature of the motor in a reversed direction and the motor will thus move in exactly the opposite direction to that first illustrated.

The motor 109 is arranged to be made effective for the purpose of controlling the frequency of the received signal by being connected through the connection 113, which may be a worm drive or any other suitable gear reduction system, to a capacity element 115, which is connected in parallel with or forms the condenser of the synchronous detector oscillator, which may be of the Hartley or Colpitts type oscillator. This capacity element is so connected that, for a single tone change in one direction, the motor will change the capacity value in such a manner as to bring the tone frequency down or, for a change in the other direction, the motor will move in such a direction as to bring the tone frequency up. It is thus seen that the whole arrangement consists of an equalizing or stabilizing device for the tone so that it keeps the tone frequency used in the output circuit 117 of the receiver and amplifier 119 constant within narrow limits.

As there is practically no inertia in the device "hunting" does not take place.

The arrangement is so connected and adapted that it is not necessary for one relay to actually stop making contact in order for the motor device to start correcting. If the signal strength is the least bit different in one relay than it in in the other, the tongue or armature of that relay will move slightly faster or slower than that of the other, and will move in exactly the proper manner to give small pulses of current in the armature of the motor which will move the capacity element in such a manner as to bring tone frequency back to the normal position midway between the two stabilizing frequencies.

For the purpose of maintaing proper grid bias on the grids of the amplifiers 7, 47, and 49 each of these grids is connected through a conductor 19 to a terminal 17 to which is connected a source "C−" of biasing potential. The cathode members of all the vacuum tubes in the system may, if desired, be connected in parallel to a common source of energy at the terminals 119 and 121, and for the purpose of controlling the potential on the various cathodes it is in some cases desirable to have a separate rheostat for each vacuum tube although this is not essential to operation. However, as illustrated, a separate rheostat 117 is provided for each of the individual vacuum tubes.

The invention has been particularly described as being applicable to receivers, but it is to be understood that it is not limited thereto and it may be arranged so that a constant frequency is maintained at the point where it is produced, such as at a transmitter, for example.

Certain modifications in the above system will at once suggest themselves to those skilled in the art to which the invention relates and I believe myself to be entitled to make any and all of these modifications and changes in so far as they fall fairly within the spirit and scope of the invention, as defined by the following claims, wherein:—

I claim:

1. A system for maintaining constant frequency from received signaling impulses which includes means for receiving signals and producing beat frequencies therefrom, a circuit tuned to a frequency above that of the normal beat frequency resulting from said received signals coupled to said receiving means, a circuit tuned to a frequency below that of the normal beat freqeuncy resulting from said received signals also coupled to said receiving means, and means responsive to the output energy of each of said circuits for controlling and maintaining constant beat frequency from the received signals in accordance with the differential output energy of each of said circuits.

2. A constant frequency receiving system including signal receiving means for receiving signals which vary slightly from a desired signaling frequency, a local oscillator associated with said receiving means for producing resulting beat frequencies from said received signals a circuit responsive to beat frequencies greater than those produced from a normal signaling frequency coupled with

said receiving means, a circuit responsive to beat frequencies less than those produced from a normal signaling frequency also coupled with said receiving means, means differentially responsive to the output of each of said circuits for varying the frequency of the said local oscillator in a direction such that a constant resulting beat frequency is continually maintained in the receiver from the received signaling impulses, and means for maintaining said changed oscillator frequency permanent for time periods equaling the time duration between varying received frequencies.

3. A system for maintaining constant frequencies in a receiver suitable for receiving signals of which the frequency of transmission varies to a slight degree which includes signal receiving means, a local oscillator associated with said signal receiving means for producing secondary frequencies when the locally generated frequency thereof is heterodyned with the said received signaling frequency, circuits tuned to frequencies above and below the secondary frequency coupled to the output of the said receiving means, and means differentially responsive to the output energy from each of said circuits for controlling the frequency of said local oscillator and varying the same in a direction to maintain permanently a constant resulting frequency in the receiver at all periods for all received signal frequencies.

4. A system for maintaining a constant frequency from received signals irrespective of variations in the frequency thereof which includes means for receiving signals, a local oscillator associated with said receiving means for producing beat notes of a predetermined frequency when said local oscillator frequency is heterodyned with said received signaling frequency, a circuit tuned to a frequency above the desired resulting frequency, a circuit tuned to a frequency below the desired resulting frequency, means for coupling each of said circuits with said signal receiving means, and means differentially responsive to the output of each of said tuned circuits for varying the frequency of the said local oscillator in a direction to continually maintain constant beat frequencies between the received and locally generated frequencies in the said receiving means.

5. A system for maintaining constant frequencies from received signals irrespective of periodic variation in the frequency thereof which includes means for receiving signals, a local oscillator associated with said receiving means for producing beat notes of a predetermined frequency when said local oscillator frequency is heterodyned with said received signaling frequency, a circuit responsive only to frequencies above the beat frequency, a circuit responsive only to frequencies below the beat frequency, means for coupling each of said circuits with said signal receiving means, a motor, a differential relay system differentially responsive to the output of each of controlling circuits for supplying driving current to said motor, and means operable from said motor for varying the natural frequency of said local oscillator in a direction to continually maintain constant beat note frequencies in the said receiving means.

6. A system for continually maintaining constant frequencies in a system for receiving signals from a source at which the transmission frequency continually varies to a slight degree which includes signal receiving means, a local oscillator associated with said receiving means, means for producing tone frequencies when the frequency of said local oscillator is heterodyned with said received signaling frequency, circuits responsive to energy of a frequency above and below that of the resulting tone frequency coupled to the output of said signal receiving means, means for varying the frequency of the said local oscillator, and a differentially operable motor responsive to the output of each of said last named circuits for operating said frequency varying means for said local oscillator to permanently change the frequency thereof in a direction to maintain constant tone frequencies at each change in the frequency of the received signals.

7. The method of maintaining constant frequencies in signal receiving systems irrespective of periodic variations in the frequency of the received signals which includes receiving signals, generating a local frequency, heterodyning the received signals with the locally generated frequency, producing by the said heterodyning beat frequencies of a value dependent upon the frequency of the received signals, producing independent responses in the system for beat frequencies above and below the desired beat frequency, periodically raising and lowering the frequency of the locally generated heterodyne frequency in accordance with a raising and lowering of the beat frequency from that desired as produced by the received signals for continually deriving the said predetermined frequency value from said signal reception, and permanently maintaining the last locally generated frequency constant between changes in the frequency of the received signals.

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