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H. I. ROMNES

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GAIN ADJUSTING APPARATUS

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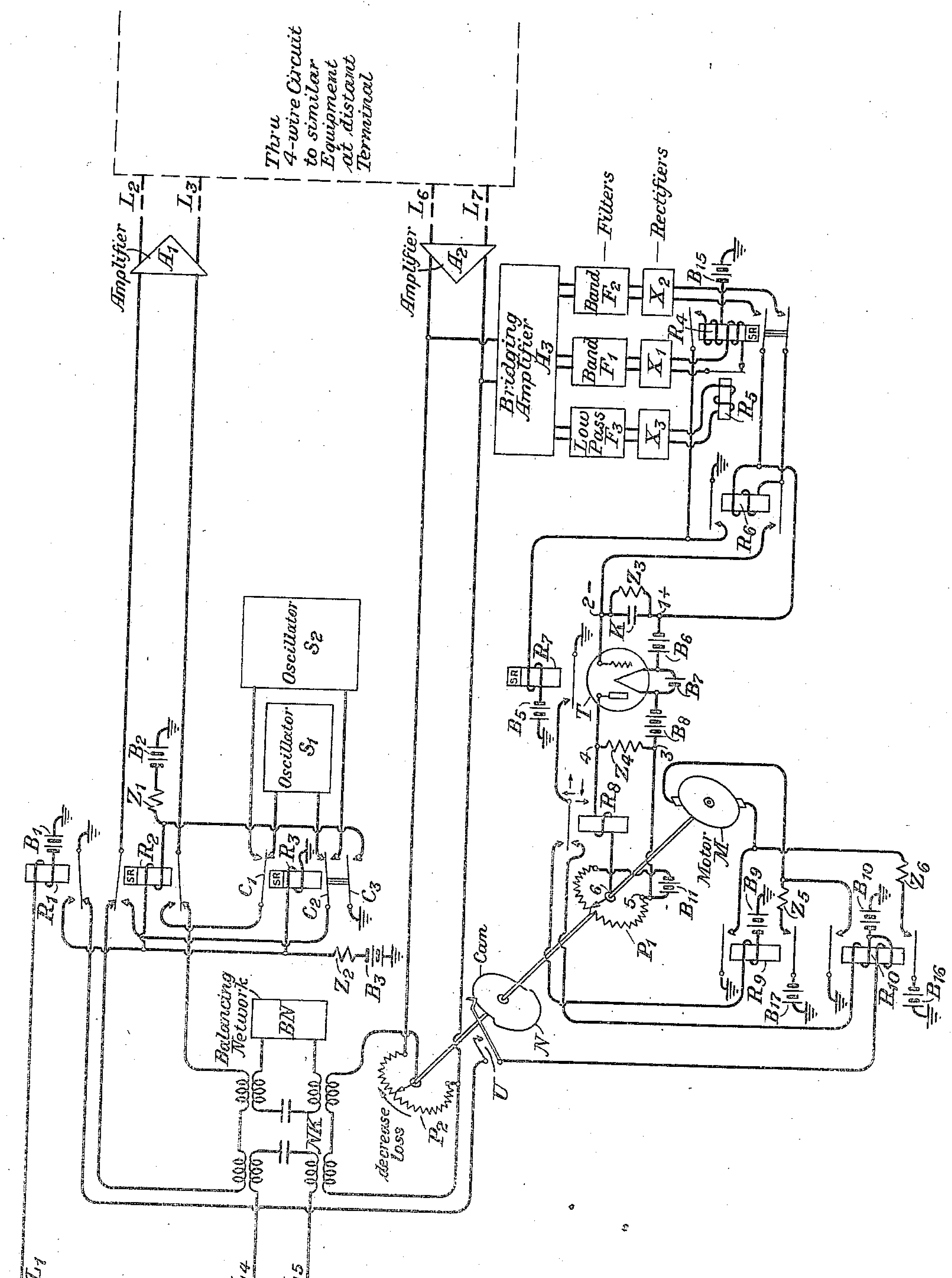

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GAIN ADJUSTING APPARATUS

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5 Claims. (Cl. 178—44)

This invention relates to signaling systems. More particularly, this invention relates to loss adjusting apparatus suitable for signaling systems. The invention has still more particular relation to tone operated net loss adjusting receivers, otherwise known as tonlars.

This application is a continuation in part of my copending application, Serial No. 215,903, filed June 25, 1938, entitled Gain adjusting apparatus.

Tonlar apparatus is employed for transmitting a test current just prior to each regular message or call and at the distant end of the circuit to compare the amount of test current there received with the amount of current desired at that point. If these currents differ appreciably, an adjustment or line-up in the net loss of the circuit will be made automatically by the apparatus. No readjustment of the circuit loss will be required until a time immediately prior to the transmission of the next regular call or message. The tonlar apparatus is thus a supplement of the pilot wire regulators, pilot channel regulators and battery regulators previously used for adjustments in signaling circuits.

In accordance with the invention to be subsequently described, two test currents are employed in a tonlar apparatus. Immediately upon picking up the circuit, a short spurt of current of one frequency of, for example, 2200 cycles will be transmitted to the distant end of the circuit primarily for connecting the receiving gain adjusting controls to the circuit. Following this, a short spurt of current of a different frequency of, for example, 1000 cycles, will be transmitted to the distant end where some indication of the magnitude of this current will be obtained. This indication will be obtained very quickly so as not to interrupt speech or other transmission over the circuit for more than a very brief interval of time. The net loss of the circuit will be adjusted to correspond to this indication, the loss adjustments being made relatively rapidly.

An object of this invention is to provide a gain adjusting apparatus which will make changes in gain in a signal circuit rapidly before signals corresponding to the subscribers' conversations are actually transmitted over the circuit and will utilize two different alternating currents of predetermined frequencies to actuate the gain changing apparatus.

Another object of this invention is to prevent gain changes to be made by the apparatus unless both alternating currents above-mentioned are transmitted in a predetermined order. In other words, the object is to prevent false operation of the gain adjusting apparatus in response to extraneous currents or by the signals actually transmitted over the circuit.

Another object of the invention is to employ a condensive element for receiving a charge from one of the two currents above mentioned, the magnitude of the charge being proportional to the amplitude of the particular current employed and to utilize the charge on the condensive element for producing changes in gain of the apparatus to be controlled.

Still another object is to prevent large increases in gain to be maintained during idle periods when the circuit is not utilized for signal transmission, such large gain increases ordinarily subjecting the circuit to the possibility of "singing."

This invention as well as its further objects and features will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing which illustrates one form of tonlar apparatus positioned at one point of a four-wire signaling circuit at one other point of which a similar form of tonlar apparatus will be connected.

The drawing illustrates the tonlar apparatus of this invention connected at a terminal of a four-wire circuit used for two-way signal transmission over comparatively long distances. The remainder of the four-wire circuit is not shown because it is not deemed necessary to an understanding of the invention. It will be understood, however, that a similar tonlar apparatus will be connected at the opposite terminal of the four-wire circuit.

Referring now to the drawing, the conductor L_1 extends to a switchboard (not shown), this conductor being connected in series with the winding of a relay R_1, a battery B_1 and ground. The circuit of relay R_1 is completed by the switchboard operator when the four-wire circuit is to be used to transmit signals such as speech, etc. The make contact of relay R_1 is connected in a local circuit which includes the winding of a slow-release relay R_2, a resistor Z_1, a battery B_2 and ground. The two make contacts of relay R_2 are connected to the armatures C_1 and C_2 of a slow release relay R_3, the corresponding make contacts of which are connected to a source of alternating current designated S_1 having a frequency of, for example, 2200 cycles, as shown in the drawing. The back contacts of armatures C_1 and C_2 of relay R_3 are connected to a similar source of alternating current labeled S_2, the latter source having a frequency of, for example, 1000 cycles. The make contact of relay R_1 also short-circuits the winding of relay R_3, both terminals of the winding of relay R_3 being connected to ground when the make contact of relay R_1 is closed. The operation of relay R_1 also causes the winding of relay R_2 to become short-circuited when relay R_3 releases, one terminal of the winding of relay R_2 being grounded through the armature and back contact of relay R_1, its other terminal being grounded by armatures C_3 of relay R_3.

Thus, when a call is to be made, the operator will merely close the circuit of conductor L_1 and a series of events will then occur in a predetermined order. First, the relay R_1 will be operated and then relay R_2 in turn will be operated. Relay R_3 has previously been operated normally before relay R_1 was operated, the operation of relay R_3 being accomplished by current supplied by battery B_3 through resistor Z_2 and the winding of relay R_3. Thus all three relays will be in an operated state almost immediately after the operator closes the circuit of conductor L_1.

The operation of relay R_2 permits the 2200 cycle current of source S_1 to flow over the armatures C_1 and C_2 of relay R_3 and over the armatures of relay R_2 through the amplifier A_1 and over the conductors L_2 and L_3 to similar tonlar apparatus located at the other end of the circuit. Then after a predetermined time interval, determined by the release period of relay R_3, the relay R_3 will release and hence disconnect the source S_1 from the circuit and at the same time connect the source S_2 to the circuit to permit the 1000 cycle current to flow through the amplifier A_1 to the other tonlar apparatus connected to the circuit. Upon the lapse of a brief period of time thereafter determined by the time constant of relay R_2, the relay R_2 will release and hence disconnect source S_2 from the amplifier A_1 and from other tonlar apparatus to be operated by the current obtained from the sources S_1 and S_2 shown in the drawing.

The conductors L_2 and L_3 extend to a distant switchboard (not shown). The conductors L_2 and L_3 are also connected to the local circuit conductors L_4 and L_5 through the amplifier A_1 and the armatures and back contacts of relay R_2 and through a hybrid coil network NK which is terminated by a balancing network BN, as is believed to be well known in the art. The lower two conductors L_6 and L_7 of the four-wire circuit are connected to the local circuit conductors L_4 and L_5 through the amplifier A_2, the potentiometer P_2 and the hybrid coil network NK, as shown.

An amplifier A_3 is bridged across the output terminals of the amplifier A_2. The amplifier A_3 has three output circuits. One of these branches includes a band pass filter F_1 and a rectifier X_1 connected in tandem. Another of these output branches includes a band pass filter F_2 and a rectifier X_2 similarly arranged in tandem. The third output branch includes a tandem connected low pass filter F_3 and the rectifier X_3. It will be clear that the filters F_1 and F_2 may be of any well-known type capable of freely transmitting currents of predetermined frequencies such as 2200 and 1000 cycles, respectively, and of substantially suppressing currents of all other frequencies. The filter F_3 is capable of freely transmitting currents of all frequencies below, for example, 1200 cycles, and of substantially suppressing all higher frequencies. The three rectifiers X_1, X_2 and X_3 may be of any well-known type, preferably of the copper oxide type.

The bridging amplifier A_3 and the three-branch output circuits just described comprise part of the receiving apparatus of the tonular device illustrated in the drawing. Sources S_1 and S_2 and relays R_2 and R_3 comprise part of the transmitting apparatus of the tonlar equipment. The tonlar device at the distant terminal (not shown), of course, includes similar transmitting and receiving apparatus operating in exactly the same manner. The bridging amplifier A_3 of the tonlar apparatus illustrated has, of course, an input circuit of high impedance in order to avoid introducing any appreciable loss to the circuit of conductors L_6 and L_7.

Current of frequency of, for example, 2200 cycles received from the output of amplifier A_2, amplified by amplifier A_3, passed by band filter F_1 and rectified by the rectifier X_1 will operate the relay R_4, the rectified current flowing through the lower winding of relay R_4 and the armature and back contact of relay R_5. The operation of relay R_4 connects the rectifier X_2 to the winding of relay R_6 through the two lower armatures and make contacts of relay R_4.

When this happens, relay R_6 will be operated only if rectified current is supplied by rectifier X_2 to the winding of relay R_6 and this can occur only if current of the second frequency, namely, 1000 cycles is transmitted through amplifier A_3 and filter F_2. Thus the relay R_6 will be operated only if currents of the two predetermined frequencies, for example, 2200 cycles and 1000 cycles, are transmitted through the respective filters F_1 and F_2 in a predetermined order. The operation of relay R_6 will cause current to flow through the upper winding of relay R_4 to hold relay R_4 operated as long as relay R_6 remains operated, the holding circuit comprising ground, the upper armature and make contact of relay R_6, the upper armature and make contact of relay R_4, the upper winding of relay R_4 and battery B_{15}.

The operation of relay R_6 also bridges the condenser K across the output circuit of the rectifier X_2, this bridging circuit including the lower armature and make contact of relay R_6 and the two lower armatures of relay R_4 and their respective make contacts. Part of the current received from the rectifier X_2 will charge the condenser K to a value which is determined by the magnitude of the current having the frequency transmitted through filter F_2. It is the charge on the condenser K which will be employed to change the gain of potentiometers P_1 and P_2 as will be subsequently described in greater detail.

The condenser K is shunted by a resistor Z_3 which is of a rather large magnitude so that any charge on the condenser produced by current flow from the rectifier X_2 will not be appreciably reduced for a predetermined period of time such as, for example, about ten seconds. Thus when spurts of current of 2200 and 1000 cycles cease to flow through filters F_1 and F_2, respectively, the relays R_4 and R_6 will release but the charge on the condenser K will remain substantially unreduced for an appreciable time. The relay R_6 also controls the relay R_7 which is of the slow release type, the relay R_7 being operated when the relay R_6 operates. The circuit for relay R_7 includes the battery B_5, the winding of relay R_7, the upper armature and make contact of relay R_6 and ground. The relay R_7 may be one which will release, for example, about ten seconds after relay R_6 releases.

The condenser K is connected in the grid circuit of a vacuum tube T, the grid circuit including the battery B_6 and the condenser K and resistor Z_3 in parallel relationship as illustrated. The battery B_6 provides the grid bias for this tube and when the condenser K is discharged the tube is operated at the upper part of its static characteristic during which time a large plate current may flow in the plate circuit of the tube. The battery B_7 provides the filament current for the tube and the battery B_8 the plate current. The plate circuit of the tube T includes the battery B_8 and the resistor Z_4.

When the condenser K becomes charged by current derived from the rectifier X_2, the voltage across the condenser increases the negative bias of the tube T and decreases the flow of current from the battery B_8 through the circuit of resistor Z_4 and the plate-filament electrodes of the tube T. Inasmuch as the charge on condenser K depends upon the net loss of the four wire signaling circuit, the value of the plate current and the voltage across resistor Z_4 both depend upon the net loss of signaling circuit.

The winding of the relay R_8 which is of the unbiased or neutral type is connected between the upper terminal 4 of resistor Z_4 and the sliding contact 6 of potentiometer P_1. The battery B_{11} is connected across the outer terminals of the potentiometer P_1. Movable arm 6 of potentiometer P_1 may be adjusted so that the voltage across terminals 5 and 6 of potentiometer P_1 will be substantially equal to the voltage across terminals 3 and 4 of resistor Z_4. When so adjusted, practically no current will flow through the winding of relay R_8 and the armature of the latter relay will be separated or spaced from both of its contacts. Thus the voltage across terminals 5 and 6 of potentiometer P_1 may be made equal to any voltage between terminals 3 and 4 of resistor Z_4 and in that case no voltage will exist between points 4 and 6 and the relay R_8 will therefore be unoperated and in its neutral position.

When the condenser K is charged by current received from rectifier X_2 the voltage between terminals 3 and 4 of resistor Z_4 will assume a value corresponding to this charge and a current will then flow through the winding of relay R_8 in one direction or the other depending upon the magnitude of the voltage across resistor Z_4. If the voltage of point 4 is higher than that of point 6, the relay R_8 will operate to close its lower contact. This will cause the operation of the motor M to raise the potential of point 6 as will be subsequently described. On the other hand, if voltage point 4 is lower than that of point 6 the relay R_8 will operate to close its upper contact and this will cause the motor M to operate so as to reduce the voltage of point 6 as will be subsequently described.

When the lower contact of the relay R_8 becomes closed as will be the case when there is a higher voltage at point 4 than at point 6, the relay R_{10} will operate, the circuit of relay R_{10} including the battery B_{10}, the upper winding of relay R_{10}, the lower contact and armature of relay R_8 and the armature and make contact of relay R_7 and ground. The operation of relay R_{10} will connect the motor M to the battery B_{16}, the circuit to the motor M including the battery B_{16}, the lower armature and make contact of relay R_{10}, the resistor Z_6, the rotor of the motor M and the upper armature and make contact of relay R_{10}. The motor will run in a clockwise direction and thereby adjust the position of the sliding contact 6 of the potentiometer P_1 so as to make the voltage between points 5 and 6 of potentiometer P_1 equal to the voltage between terminals 3 and 4 of the resistor Z_4. When these voltages are made equal no current will flow through the winding of relay R_8 and its armature will assume a neutral position. When the armature of relay R_8 is separated or spaced from both of its contacts, the relay R_{10} will release and thereby stop the motor M.

If the amplitude of the current supplied by the rectifier X_2 is such as to cause the upper terminal 4 of the resistor Z_4 to be at a lower potential than point 6 of the potentiometer, current will flow through the winding of relay R_8 in such a direction as to cause its armature to close its upper contact. The relay R_9 will then operate, the circuit of the latter relay including the battery B_9, the winding of relay R_9, the upper contact and armature of relay R_8, the armature and make contact of relay R_7 and ground. The operation of relay R_9 will in turn operate the motor M in a counter-clockwise direction, the circuit of the motor M now including the battery B_{17}, the lower armature and make contact of relay R_9, the resistor Z_5, the motor M, the upper armature and make contact of relay R_9 and ground. The rotation of the motor M in a counter-clockwise direction will, of course, change the position of the sliding contact 6 of the potentiometer P_1 and thereby reduce the voltage between terminals 5 and 6 of potentiometer P_1. And, when the voltage between terminals 5 and 6 is made equal to the terminals of 3 and 4 of resistor Z_4, the flow of current through the winding of relay R_8 will cease, the armature of the latter relay will assume its neutral position and the motor M will stop running.

Thus, after spurts of currents of appropriate frequencies have traversed filters F_1 and F_2 in a predetermined order, the condenser K will become charged by current obtained from the rectifier X_2. A voltage will then be established across the terminals 3 and 4 of resistor Z_4 which is above or below some predetermined value and if above a predetermined value the motor M will be rotated in one direction to raise the potential of point 6 of potentiometer P_1 while if the voltage of point 4 is below said predetermined value, the motor M will be rotated in the opposite direction to reduce the voltage at point 6 of potentiometer P_1. It will be clear also that the relay R_7 will remain operated through the interval required to sufficiently rotate the motor M in one direction or the other.

The motor M is mechanically coupled to both potentiometers P_1 and P_2, the potentiometer P_2 being included in the receiving side of the four-wire signaling circuit shown in the drawing. Hence, in adjusting the voltage across points 5 and 6 of potentiometer P_1 to balance the voltage across resistor Z_4, the motor M also adjusts the potentiometer P_2 to correspondingly change the gain of the receiving branch of the four-wire signaling circuit. The direction and amount of the adjustment of the gain of potentiometer P_2 are such as to make the net loss of the four-wire signaling circuit approximately equal to some predetermined value.

Shortly after the motor M has made the necessary changes in the positions of the movable arms of the potentiometers P_1 and P_2, the relay R_7 will release. Then, also, the condenser K will discharge gradually through resistor Z_3. However, the remaining charge on the condenser K will have no effect to cause the motor to further adjust the potentiometers and the condenser charge will in due course drop to a virtual nullity.

After the various adjustments have been made, as explained hereinabove, speech or other signaling currents received over the conductors L_6 and L_7 and amplified by amplifier A_2 will be further amplified by the amplifier A_3 and will reach the low pass filter F_3. The filter F_3 will transmit currents of all frequencies below, for example, 1200 cycles, which includes a substantial part of the speech or signaling range. The energy thus passed by filter F_3 will be rectified by rectifier X_3 and will operate relay R_5, the winding of which is connected to the output circuit of rectifier X_3. The operation of relay R_5 will open the circuit of the lower winding of the relay R_4 and thereby prevent the operation of relay R_4 by components of the speech or signaling currents which may perchance traverse the filter F_1. The release of relay R_4 will prevent any flow of current to the condenser K from rectifier X_2 and the relay R_4 will remain unoperated as long as relay R_5 is operated even though perchance currents of appropriate frequencies are transmitted through both filters F_1 and F_2. Thus, after the speech or signaling energy is received by the system, the relay R_4 will be unoperated and remain unoperated even though at the same time the speech or signaling currents contain components which may traverse filters F_1 and F_2.

The cam N is also coupled to the motor M as illustrated in the drawing. This cam controls contacts U which when closed will be applied to reduce the gain of the potentiometer P_2 as will now be described.

When a call is completed, the circuit of conductor L_1 will be opened upon removal of the plug (not shown) by the operator at the switchboard and therefore relay R_1 will release. The back contact of relay R_1 places ground on the fixed contact associated with the cam N. If at that time the net loss inserted by potentiometer P_2 had been previously adjusted to apply more than a predetermined amount of gain to the circuit, the circuit might be subjected to a "singing" tendency. To obviate such an undesirable condition, current is then supplied to the lower winding of the relay R_{10} to operate the motor M in the counter-clockwise direction to open the contacts U of the cam N. The circuit of the relay R_{10} which now controls the motor N includes the battery B_{10}, the lower winding of relay R_{10}, the contacts U, the back contact and armature of relay R_1 and ground. The operation of relay R_{10} will cause current to flow from battery B_{16} through the motor M as already explained. Thus, the gain setting of potentiometer P_2 will be reduced to a substantially lower value, rendering the circuit impossible to "sing." The motor M will continue to rotate until the contacts U are opened and the relay R_{10} will then release.

As will be apparent from the foregoing description, the tonlar apparatus is intended to quickly line up the circuit to permit good signal transmission thereover just immediately prior to the time when the parties begin their conversation. The oscillators S_1 and S_2, forming part of the transmitting portion of the tonlar apparatus, send their currents in a predetermined order through the amplifier A_1 over conductors L_2 and L_3 to other tonlar apparatus connected at the other end of the circuit.

When a distant operator plugs into the jack associated with the circuit, that tonlar will immediately transmit two corresponding currents in the same predetermined order. These currents will be received over conductors L_6 and L_7 and through amplifier A_2 and actuate the local mechanism so as to change the setting of the local potentiometer P_2 for good signal transmission. After the conversation has ceased and the circuit is idle, the position of the arm of the local potentiometer P_2 will be stepped down if there is more than a predetermined gain in the circuit. This will prevent any "singing" tendency as already explained.

The drawing illustrates two sources S_1 and S_2 for producing two currents of predetermined frequencies. Either or both of the frequencies of these currents need not be lower but may be higher than are ordinarily involved in the signal transmission, all of which is within the scope of this invention. Moreover, they may or may not be harmonically related to each other. But in any case, a single apparatus capable of producing the two currents may be employed to generate both currents if so desired. It is essential that both currents be carefully maintained so as to be highly constant both in frequency and amplitude and practically invariable due to temperature and other conditions.

The values assigned to the frequencies transmitted in the above-described circuit are given merely for purposes of illustration and may be changed to other values within the scope of this invention.

While the invention has been shown and described in connection with a four-wire signal circuit, it will be clear that the invention may be applied equally well to a two-wire signal circuit or to a radio system.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Gain adjusting apparatus for a four wire signaling system comprising a condensive element, a potentiometer, means responsive to two alternating currents of predetermined frequencies received in a predetermined order to charge said condensive element in accordance with the level of one of said currents, means responsive to the charge on said condensive element to adjust the position of the movable arm of said potentiometer by an amount corresponding to said charge, and means for readjusting the position of the arm of the potentiometer to prevent singing, said readjustment being made after said two alternating currents have ceased to flow.

2. Gain control apparatus for a four wire signaling system comprising two sources of alternating currents of predetermined frequencies, a condenser, means responsive to said two currents in a predetermined order to charge the condenser by an amount corresponding to the amplitude of the second of said currents, a potentiometer, means to raise the arm of the potentiometer when the condenser charge exceeds a predetermined value and to lower the arm of the potentionmeter when the condenser charge recedes from said predetermined value, and means to lower the arm of the potentiometer to prevent singing after said two currents have ceased to flow.

3. A gain control system for a four wire tele-

phone circuit comprising two sources of alternating current of different frequencies, means for connecting both of said sources to the telephone circuit in a predetermined order, and gain adjusting apparatus connected to the telephone circuit and operated only in response to and only during the reception of current from both of said sources in said predetermined order, said gain adjusting apparatus including a condensive element upon which a charge is impressed corresponding to the amplitude of a selected one of said alternating currents, a rotatable device coupled to said condensive element and operated in one direction when the charge on said condensive element exceeds a predetermined value and in the opposite direction when said charge is less than said predetermined value, and means to readjust the gain of said gain adjusting apparatus to prevent singing over the telephone circuit after the two received currents have ceased to flow.

4. Gain adjusting apparatus for a four wire signaling system comprising two sources of alternating current, means for transmitting both of the currents of said sources sequentially in a predetermined order, a condenser, means responsive to both of said currents in said predetermined order to charge said condenser by an amount corresponding to the amplitude of the second of said currents, a gain adjusting device operated in response to the charge on said condenser, and means for re-operating said gain adjusting device to prevent singing, said re-operation being performed after both of the currents have ceased.

5. In a four wire signaling system, the combination of a gain control element, a condenser, means responsive only to two currents of predetermined frequencies flowing in a predetermined order for charging said condenser, means for controlling the magnitude of the condenser charge in accordance with the level of but one of said currents, means for varying the gain of said control element in accordance with the magnitude of said condenser charge, and means for again varying the gain of the said control element to prevent singing, said latter variation again being made after the two currents of predetermined frequencies have ceased to flow.

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