

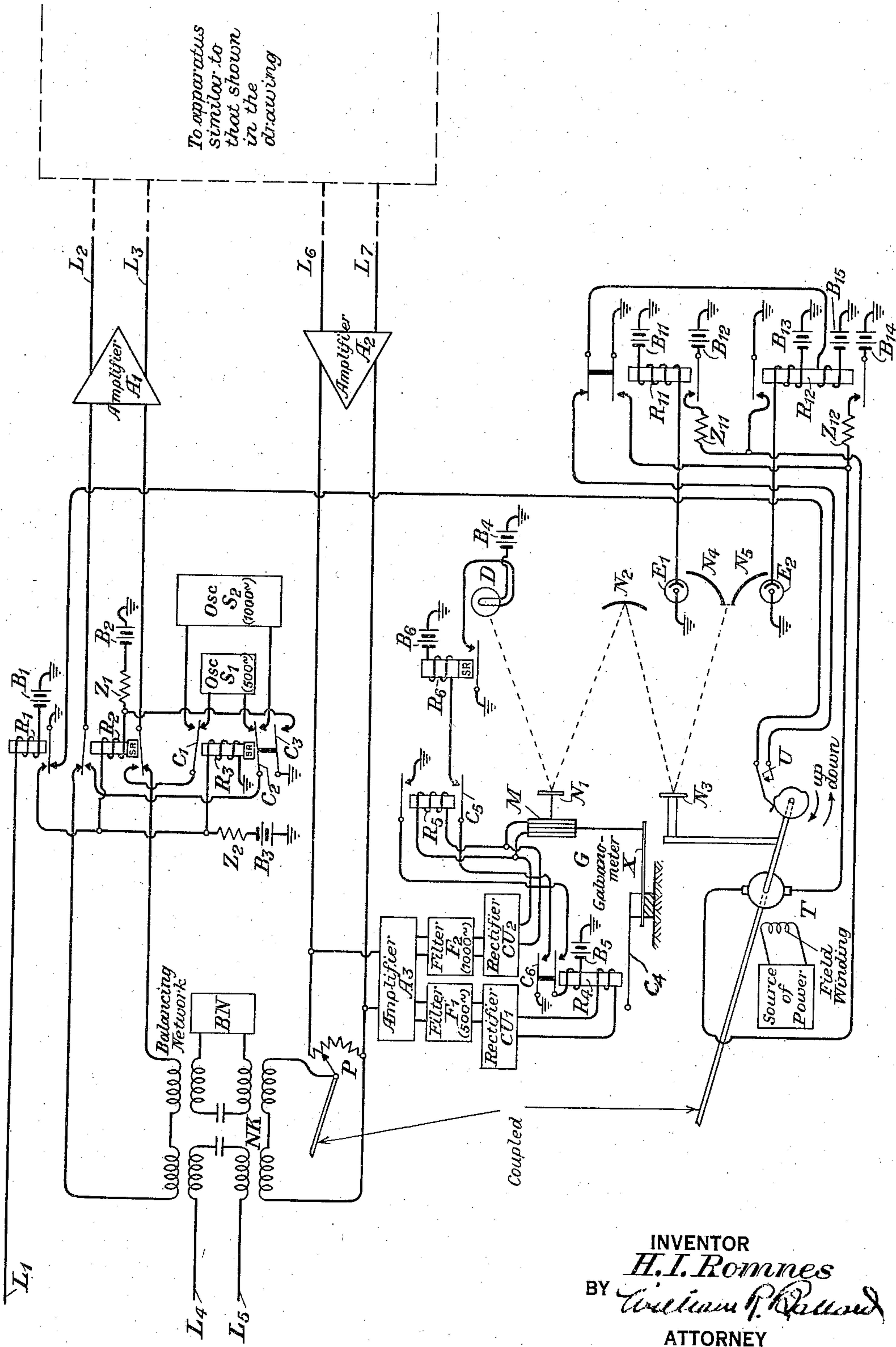
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GAIN ADJUSTING APPARATUS

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GAIN ADJUSTING APPARATUS

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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.

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 this invention, 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, 500 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 slowly.

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 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.

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, 500 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 predeter-

mined 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 by current supplied by battery B_3 through resistor Z_2 and the winding of relay R_3 . Thus all three re-

lays are in an operated state almost immediately after the operator closes the circuit of conductor L_1 . The operation of relay R_2 permits the 500 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 repeater A_1 and over 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 repeater 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 repeater A_1 and from the 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 repeater 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 repeater A_2 , the potentiometer P , and the hybrid coil network NK , as shown.

An amplifier A_3 is bridged across the output terminals of the repeater A_2 . The amplifier A_3 has two output branches, one of which includes a filter F_1 and a rectifier CU_1 connected in tandem. The other output branch includes a filter F_2 and a rectifier CU_2 . The filters F_1 and F_2 may be of any well known type capable of freely transmitting current or currents of predetermined frequencies such as 500 cycles and 1000 cycles, respectively, and of substantially suppressing currents of all other frequencies. The rectifiers CU_1 and CU_2 may be of any well known type, preferably of the copper oxide type.

The output of rectifier CU_1 is supplied to the lower winding of relay R_4 and operates this relay. The operation of relay R_4 unclamps the moving arm X of a galvanometer G , the moving arm X being then free to move in a direction perpendicular to the drawing between the block attached to armature C_4 and the lower stationary block. Rectified current obtained from rectifier CU_2 is supplied to the winding of relay R_5 . The operation of relay R_5 closes the circuit from ground through the make contact and upper armature of relay R_5 , and the upper winding of relay R_4 to battery B_5 and this current holds relay R_4 operated as long as such current is obtained and it maintains the arm X of galvanometer G unclamped. The rectifier CU_2 is also connected to the moving element or coil M of galvanometer G and causes the moving element M and the arm X carried thereby to take a position corresponding to the level of the energy obtained from the rectifier CU_2 . Upon release of relay R_4

the moving arm X of the galvanometer G is again clamped between the two blocks in its new position corresponding to the level of energy obtained from rectifier CU_2 .

Upon operation of relay R_5 , relay R_6 is operated, the circuit being established from ground through armature C_6 of relay R_4 , armature C_5 of relay R_5 , the winding of relay R_6 to battery B_6 . Relay R_6 operates to illuminate the lamp D . The light or beam produced by this illumination impinges upon a flat mirror N_1 which is mounted on the moving element M of the galvanometer G so as to be movable with the element M . These rays are then reflected by mirror N_1 , and then impinge upon a curved mirror N_2 . The latter mirror again reflects these rays upon a flat mirror N_3 . At the same time the mirror N_3 is controlled by a motor T to which it is mechanically coupled and, as will be seen hereinafter, the position of the mirror N_3 may be changed so that it may be brought to a position parallel to mirror N_1 . When mirrors N_1 and N_3 are parallel to each other, however, the rays reflected by mirror N_3 will strike the area intermediate the two curved mirrors N_4 and N_5 and will become effectively dissipated.

If, however, the rays reflected by mirror N_3 impinge upon mirror N_4 , they will be reflected thereby to illuminate the photoelectric cell E_1 , but the photoelectric cell E_2 will not be energized. On the other hand, if the reflected rays from mirror N_3 strike the curved mirror N_5 , they will be diverted to illuminate the photoelectric cell E_2 , but the cell E_1 will not be energized.

So it will be seen that the current (of 500 cycles) traversing filter F_1 and rectified by rectifier CU_1 operates relay R_4 to release the arm X of galvanometer G and that the current (of 1000 cycles) traversing filter F_2 and rectified by rectifier CU_2 maintains relay R_4 operated and arm X released. The position of arm X always corresponds to a predetermined position of mirror N_1 because the two are fixedly coupled together. The apparatus to be subsequently described will be employed to bring the other flat mirror N_3 into a position parallel to mirror N_1 . But if these two flat mirrors are parallel to each other, no change will be made in the position of mirror N_3 .

The photoelectric cells E_1 and E_2 are positioned at the foci of the parabolic mirrors N_4 and N_5 , respectively, in order that all rays reflected by these mirrors may impinge upon one or the other of these photoelectric cells. The two curved mirrors N_4 and N_5 may be spaced from each other, if so desired, so that rays normally reflected by mirror N_3 will be by-passed through this spacing. But when the reflected rays are not by-passed through the intervening space, they will be deflected to one or the other of the photoelectric cells and hence actuate the apparatus employed to move the mirror N_3 in one direction or the other.

Just as soon as the rectified current from rectifier CU_2 ceases to flow through the winding of relay R_5 , relay R_5 releases, releasing relay R_4 which instantly clamps arm X between the two blocks. The release of relays R_4 and R_5 also opens the circuit for relay R_6 , but this latter relay is made slow in releasing and therefore lamp D remains illuminated long enough to permit the subsequent adjustment of mirror N_3 to be completed. Relay R_6 then releases and lamp D is extinguished. If subsequent speech signals on the four-wire circuit should contain energy within the frequency range of filter F_1 causing relay R_4 to be operated to unclamp the galvanometer

G and permitting the galvanometer to swing to another position, no gain adjustment will be made since lamp D is not illuminated. It is assumed that the speech energy will rarely if ever contain the two frequencies used, for example, the 500 cycle and 1000 cycle components in the predetermined sequence.

The circuits controlled by the photoelectric cells E₁ and E₂ are employed to operate a motor T in one direction or another. The cell E₁ is in circuit with the winding of relay R₁₁, battery B₁₁ and ground. The operation of relay R₁₁ causes the battery B₁₂ to transmit current to the rotor of the motor T, this circuit including the lower armature and make contact of relay R₁₁, the resistor Z₁₁, the rotor of motor T, the inner upper armature and make contact of relay R₁₁ and ground.

The operation of the motor T controls the rotation of cam Y. The cam Y rotates in a clockwise direction when relay R₁₁ is operated. The clockwise rotation of this cam causes the closure of its contact U. This cam is directly coupled mechanically to the potentiometer P and causes the potentiometer arm to move up step-by-step to a higher gain level. One complete rotation of cam Y will be sufficient to move the arm of potentiometer P over its entire range.

The photoelectric cell E₂ is in circuit with the upper winding of relay R₁₂ and battery B₁₃. When relay R₁₂ becomes energized, the rotor of motor T will revolve in a counter-clockwise direction, the circuit for the rotor including battery B₁₄, the lower armature and make contact of relay R₁₂, resistor Z₁₂, the rotor of motor T, the upper make contact and armature of relay R₁₂ and ground. The subsequent rotation of cam Y in a counter-clockwise direction will cause the arm of potentiometer P to be lowered step-by-step until the motor T ceases to operate. This will ordinarily occur when the beam of light reflected by the mirror N₃ reaches the mid-position or intervening space between mirrors N₄ and N₅. When this happens neither photo cell E₁ or E₂ will be energized. But if the reflected light is in the nature of a very wide beam and reaches both of the cells E₁ and E₂, the reflected light will reach both of the cells E₁ and E₂ in equal amounts and both relays R₁₁ and R₁₂ will be operated and the motor T will then stop. In the latter case, the upper side of the rotor will be grounded through the upper armature and contact of relay R₁₂, and the lower side grounded to the upper inner armature and make contact of relay R₁₁.

When a call is completed, the circuit of conductor L₁ is opened upon removal of the plug (not shown) by the operator at the switchboard and therefore relay R₁ releases. The back contact of relay R₁ places ground on the contact U of cam Y. If at that time the net loss inserted by the potentiometer had been adjusted to supply more than a predetermined amount of gain to the circuit, the circuit might be subjected to "singing" tendency. This invention is intended to obviate such a condition. To avoid this condition, current is then supplied to the lower winding of relay R₁₂ and the motor T would be operated until the contact U of the cam Y opened. The circuit completed by the cam contact U includes battery B₁₅, the lower winding of relay R₁₂, the upper armature and back contact of relay R₁₁, the contact U of cam Y, the back contact and armature of relay R₁ and ground. The rotation of the motor T in a counter-clockwise direction

will lower the arm of potentiometer P to reduce the gain to a substantially lower value and thus it will be impossible for the circuit to "sing." The motor T will continue to operate until it reaches such a position as to open cam contact U.

Thus, after a call has been completed and the potentiometer P adjusted for the call to such a high level as to possibly bring on a "singing" condition thereafter, this undesirable condition then becomes eliminated. The relay R₁₂ operates to revolve the rotor in a counter-clockwise direction to reduce the gain of the potentiometer P. This is an important feature of this circuit arrangement.

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 immediately when the parties begin their conversation. The oscillators S₁ and S₂ transmit their currents in a predetermined order through the repeater A₁ over conductors L₂ and L₃ to other tonlar apparatus connected at the other end of the circuit.

When an 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 return over conductors L₆ and L₇ and through repeater A₂ and actuate the local control mechanism so as to change the setting of the local potentiometer P for good signal transmission. After the conversation has ceased and the circuit is idle, the position of the arm of the local potentiometer 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 S₁ and S₂ 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 need 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. 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. It is also essential that the two selected frequencies in their predetermined timed relationship be absent from the signal energy to avoid false operation of the various tonlars due to such signal energy.

If desired, the sources S₁ and S₂ may be employed to transmit currents of, for example, 2000 cycles and 1000 cycles, respectively. In that case, the filters F₁ and F₂ would be designed to transmit only those respective frequencies. Moreover, a guard channel of well known type may be added to the circuit. Such a guard channel is shown and described, for instance, in my copending application, Serial No. 219,276, filed July 14, 1938. Such a guard channel would be supplied with the ordinary signal energy received over conductors L₆ and L₇ and amplified by the repeater A₂ and the bridging amplifier A₃. The output of the amplifier A₃ would then be supplied to a low pass filter having a cut-off frequency at around 1200 cycles and the filtered energy would then be rectified by a separate rectifier of well known construction, the rectified energy then utilized to operate a relay which in turn would

operate to open the circuit of relay R₄. In other words, as soon as speech or other signal energy is actually received over conductors L₄ and L₅, the guard channel would receive such energy and instantly disable the control apparatus and circuit.

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. A gain control system for a four wire telephone 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, gain adjusting apparatus connected to the telephone circuit and operated in response to and during the reception of current from both of said sources in said predetermined order, and means to reduce the gain set up by said gain adjusting apparatus after the cessation of current from both of said sources to prevent singing.

2. Gain adjusting apparatus for a four wire signaling system comprising two sources of alternating current of different frequencies, means for transmitting both of the currents of said sources sequentially in a predetermined order, control apparatus operated only in response to two currents of different frequencies received by the apparatus in the same predetermined order from two additional sources of alternating current, a gain adjusting device operated by said control apparatus, and means to reduce the gain set up by said gain adjusting device to prevent singing, said latter gain reducing means being operated after the cessation of both of said currents.

3. Gain control apparatus for a four-wire signaling system comprising two sources of alternating current of different frequencies, means for transmitting current of both sources sequentially in a predetermined order over two of the wires of said circuit, control apparatus connected to the other two wires of said circuit and operated in response to two currents of different frequencies received over the latter two wires of said circuit from a distant point, said control apparatus being operated to indicate the level of only one of said received currents, a gain control device connected to said circuit, means coupling the control apparatus with the gain control device to change the gain of the latter device in accordance with the indication of said control apparatus, and means to reduce the gain of the gain control device to prevent singing after the cessation of said two received currents.

4. In a gain control system for a four-wire signaling circuit, the combination of two sources of alternating current of different frequencies, means for connecting said sources of alternating current sequentially to two of the wires of the four-wire circuit in a predetermined order, a gain control device connected to the other two wires of the four-wire circuit, control apparatus also connected to the latter two wires of the four-wire circuit and operated in response to two currents of different frequencies received by said control

apparatus in the same predetermined order from a distant point, said control apparatus including a movable element, means for changing the position of said movable element in accordance with the level of the second of the two currents received by the control apparatus, means for coupling the movable element to the gain control device to adjust the gain of said device, and means for readjusting the gain of said device to prevent singing after the two currents are no longer received.

5. In a four wire signaling system, the combination of a gain control element, a motor for adjusting the gain of said control element, means for controlling the operation of said motor and its direction of rotation, means responsive to two currents of predetermined frequencies flowing in a predetermined order to actuate the motor control means, and means for reactuating said motor control means to reduce the gain of said control element below the singing point after the cessation of said two currents.

6. In a four wire signaling system, the combination of a gain control element, means for changing the gain of said control element, means for producing currents of two predetermined frequencies in a predetermined order, means for operating said gain changing means in response to said two currents and for preventing the operation of said gain changing means in the absence of said two currents, and means for again operating said gain changing means to reduce the gain of said gain control element after said two currents have ceased to flow to prevent singing.

7. In a four wire signaling system, the combination of a gain control element, means for changing the gain of said control element, means for producing currents of two predetermined frequencies in a predetermined order, means responsive to said two currents for actuating said gain changing means, means for controlling the actuation of said gain changing means in accordance with the amplitude of the second of said currents, and means for again actuating said gain changing means after said two currents have ceased to flow to prevent singing.

8. In a four wire signaling system, the combination of a gain control element, means responsive only to two currents of predetermined frequencies in a predetermined order for operating said gain control element, means for controlling the gain of said element in accordance with the amplitude of but one of said currents, and means for reducing the gain of said element below the singing point, said latter gain reducing means being operated after said two currents have ceased to flow.

9. In a four wire signaling system, the combination of a gain control element, means responsive only to two currents of predetermined frequencies in a predetermined order for operating said gain control element, and means responsive to the cessation of said two currents for reducing the gain of said element below the singing point when said gain reaches a predetermined value.

10. In a four wire signaling system, the combination of a signal circuit, a gain control element therein, means responsive to two currents of predetermined frequencies flowing over the signal circuit in a predetermined order to control the gain of said gain control element, and means responsive to the absence of any current in said signal circuit for reducing the gain of said control element below the singing point.

11. The combination of a signal circuit having two paths, means for enabling said signal circuit, a gain control element connected to said signal circuit, means controlled by said enabling means for transmitting over one of the paths of said signal circuit two currents of predetermined frequencies in a predetermined order, means responsive to two currents of predetermined frequencies received in the same order over the other path of said signal circuit from a distant point for changing the gain of said control element in accordance with the amplitude of a selected one of the two received currents, and means for changing the gain of said control element after the cessation of said two received currents to prevent singing.

12. The combination of a signal circuit having two paths, means for enabling said signal circuit, a gain control element connected to said signal circuit, means controlled by said enabling means for transmitting over one of the paths of said signal circuit two currents of predetermined frequencies in a predetermined order for adjusting the gain of said gain control element, and means responsive to the attainment of a predetermined gain value by said gain control element when no current flows over the signal circuit to reduce the gain of said control element below said predetermined gain value.

13. In a four wire signaling system having a plurality of terminals, gain control apparatus connected to each terminal thereof, each gain control apparatus including two sources of current

of predetermined frequencies generated in a predetermined order, each gain control apparatus being operated in response to the two predetermined currents received from a distant terminal, means for adjusting the gain of each gain control apparatus in accordance with the level of energy of a selected one of the two received currents, and means for reducing the gain of each gain control apparatus to prevent singing after the two received currents have ceased to flow.

14. In a four wire signaling system, gain control apparatus, said gain control apparatus including transmitting apparatus and receiving apparatus, the transmitting apparatus including two sources of alternating currents of predetermined frequencies generated in a predetermined order, for transmission over the signaling system, the receiving apparatus including light controlled devices operated only in response to two alternating currents of predetermined frequencies received in the same predetermined order over the signaling system, said light controlled devices producing a beam of light, means for varying the light beam path in accordance with the level of energy of but one of the two received currents for adjusting the gain of said gain control apparatus by a corresponding amount, and means independent of said light controlled devices for readjusting the gain of said gain control apparatus below the singing level after the two currents are no longer received.

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