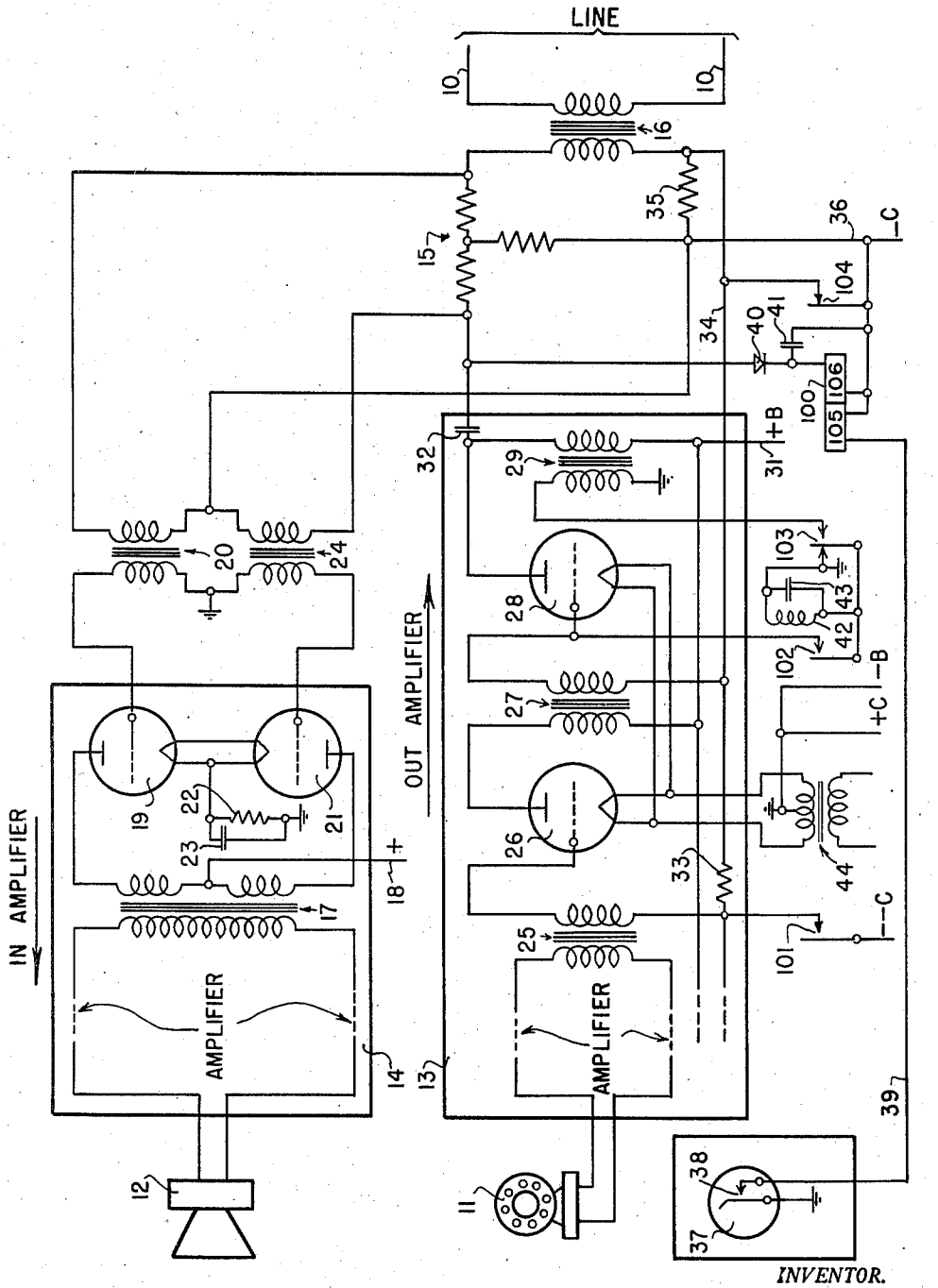
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TELEPHONE SUBSTATION CIRCUIT

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TELEPHONE SUBSTATION CIRCUIT

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The present invention relates generally to improvements in telephone substation circuits having incorporated therein coupled signal current channels for the transmission of incoming and outgoing signal currents and, more particularly, to improvements in such substation circuits for preventing interaction between the signal channels during the calling interval in which the substation is calling another substation.

In numerous installations the telephone substation circuit is provided with incoming and outgoing channel amplifiers to provide loudspeaking telephone communication service. In the usual telephone substation circuit a hybrid system or anti-sidetone impedance network is provided for preventing signal currents developed during the operation of the transmitter from being transmitted to the receiver and for similarly preventing signal currents incoming over the line extending to the substation from being transmitted to the transmitter for reproduction. In such an arrangement one of the factors which determines the efficiency of sidetone suppression is the impedance of the talking circuit established by way of two connected subscriber lines. Since this impedance is not the same for any two different established connections, the hybrid system of each substation is usually balanced to provide maximum sidetone suppression efficiency for average line conditions. In those substation circuits which are provided with amplifiers for incoming and outgoing signal currents, the conditions of unbalance introduced in the substation circuit by the impedances of the lines over which an established connection extends may become intolerable. This is particularly true in an exchange area where the subscriber lines are of widely different lengths. In order to obviate or minimize the interaction or singing which may result due to unbalance of the substation circuit occasioned by unfavorable line conditions, signal control switching means may be provided in the substation circuit for selectively blocking the channels when not in use. Such signal control switching means, however, are not effective during that interval in which the substation subscriber is calling another substation. Accordingly it becomes apparent that the hybrid system or anti-sidetone impedance network is not effective until connection has been completed with a called subscriber station. This unbalance existing in the substation circuit therefore will permit an interaction between the incoming and outgoing channel amplifiers which is commonly referred to as "howling." While "howling" occurs only during the calling interval and will cease as soon as the called substation answers, this condition may be particularly annoying even though it does not persist for any great length of time and it does not impair communication between substations after the called substation has responded to the call. Accordingly it would be desirable to provide some means for obviating the possibility of interaction between the incoming and outgoing channel amplifiers during the calling period.

It is an object of the present invention to provide improved telephone substation apparatus of the character described, wherein at least one of the channel amplifiers is disabled sufficiently to prevent such interaction occurring between the channel amplifiers as to bring about a condition commonly known as "howling."

It is another object of this invention to provide an improved telephone substation circuit with means for disabling at least one of the channel amplifiers upon initiation of a call from the substation, together with means responsive to the completion of a connection at a called substation for terminating the aforementioned disabling action.

It is a further object of this invention to provide an improved telephone substation apparatus of the character described with means for generating an alternating current which is to be applied to the telephone line during a calling interval, together with means responsive to the alternating current for disabling at least one of the channel amplifiers until a connection has been completed at a called substation.

Still another object of the present invention is to provide an improved telephone substation apparatus of the character described, wherein in response to the initiation of a call an alternating current is generated which is applied to the line and which is also effective to disable at least one of the channel amplifiers, and upon a change in the voltage of the alternating current or upon a change in the impedance of the line, the generation of the alternating current is terminated and the substation apparatus is returned to normal communication condition.

The present invention is applicable to telephone substation circuits of various types having incoming and outgoing channel amplifiers to provide loudspeaking telephone communication. Some substation circuits provide only loudspeaking telephone communication service and others provide a selection between the loudspeaking telephone and the conventional telephone. In some

substation circuits the amplifiers are completely disabled or blocked when not in use, whereas in other arrangements the channel amplifiers when not in use are disabled to a certain degree, whereby the gain of the disabled channel amplifier is reduced sufficiently to prevent any appreciable interaction between the transmitter and the receiver at the substation. Various control circuits are also used to enable and disable the channel amplifiers in accordance with the direction of the flow of signal transmission. The present invention is applicable to any of these substation circuit arrangements since all of them are subject to the condition of unbalance of the telephone line which would permit interaction between the incoming and outgoing signal channels to bring about a condition commonly called "howling" during the calling interval. The present invention is shown as being applied to an automatic dial telephone.

In accordance with the present invention means are provided responsive to the initiation of a call for rendering all or part of the channel amplifiers inactive during this interval and means are provided responsive to the completion of a connection at a called substation for again restoring the operation of the channel amplifiers. The channel amplifiers may be disabled by a simple arrangement for short-circuiting the transmitter or the loudspeaker or the input circuit of the incoming amplifier, but preferably at least the outgoing channel amplifier is disabled by applying thereto a bias sufficient to reduce the gain level thereof. Such an arrangement eliminates the possibility of electrical feed-backs through capacitive or other coupling between the leads connected to the switch contacts of relays and, furthermore, it avoids the necessity of controlling circuits having a relatively high potential as seen from an audio frequency standpoint. One method of obtaining means responsive to the initiation of a call is to provide off-normal contacts on the dial calling device, which operate a relay, when closed, to bring about the generation of an alternating current voltage which is applied to the telephone line. Means are provided for disabling the incoming channel amplifier in response to the application of this alternating current to the line. An impedance is connected in the line which is effective when the line is balanced, that is when a connection has been completed at a called substation, to feed back to the means for generating alternating current sufficient energy to stop further generation of alternating current. Upon cessation of the alternating current thus generated, the incoming channel amplifier is again returned to normal condition.

Further features of the invention pertain to the arrangement of the circuit elements, whereby the above and additional operating features are obtained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be understood readily by reference to the following description taken in connection with the accompanying drawing in which the figure illustrates a substation circuit having incorporated therein the features of the invention as briefly outlined above.

Referring now more particularly to the drawing, the substation circuit therein illustrated is connected to a telephone line 10 which may, for example, form a part of a conventional automatic or manual telephone system, the distant end thereof terminating in a line circuit, the character of which is determined by the character of the exchange. Briefly described, the substation circuit includes a transmitter or microphone 11 and receiving means in the form of a loudspeaker 12, each provided with suitable channel amplifiers 13 and 14, respectively, coupled to an anti-sidetone impedance network including a T-pad 15 connected to a transformer 16 coupled to the telephone line 10. While the impedance network 15 in the present disclosure is shown as comprising a T-pad, it of course will be appreciated that any other anti-sidetone impedance network including a hybrid coil and a balancing circuit may be provided for interconnecting the incoming and outgoing channel amplifiers with the telephone line.

For simplicity in disclosure and explanation, only so much of the incoming and outgoing channel amplifiers has been shown as is deemed necessary to understand the present invention. Accordingly, only the input stage of the incoming channel amplifier has been shown as being provided with an output transformer 17 connected between a conductor 18 which supplies suitable anode potential to the anodes of a pair of vacuum tubes 19 and 21. The grids of the vacuum tubes 19 and 21 may be self-biased by a grounded cathode resistor 22 which may be by-passed by a capacitor 23. The control electrodes or grids of the vacuum tubes 19 and 21 are connected to the secondary windings of input transformers 20 and 24, the primary windings of which are connected across the T-pad 15.

The outgoing channel amplifier also contains a plurality of stages of amplification, but only the last two stages are shown. These may be provided with an input transformer 25 connected to the control electrode of a vacuum tube 26. The vacuum tube 26 is coupled by a transformer 27 to a vacuum tube 28. The vacuum tube 28 is provided with a transformer 29 having one winding connected between the anode of the vacuum tube 28 and a suitable conductor 31 which is connected to the positive side of anode potential. The one winding of the transformer 29 thus connected in the anode circuit of the vacuum tube 28 serves as a choke or impedance so that the vacuum tube 28 is impedance-capacitance coupled by a suitable capacitor 32 to the line coupling transformer 16. The grid circuit of the vacuum tube 26 which is connected through one winding of the transformer 25 includes a resistor 33 connected in series with a conductor 34 which is connected through an impedance or resistor 35 to a conductor 36 which, in turn, is connected to a negative biasing potential. The grid circuit of the output tube 28 is connected through one winding of the transformer 27 directly to the conductor 34. The purpose of these connections will subsequently become apparent in connection with the description of the apparatus provided for preventing interaction between the incoming and outgoing channel amplifiers during the calling interval.

A dial calling device 37 is provided with off-normal contacts 38 connected between ground and a conductor 39 which, in turn, is connected to a relay 100 which is also connected to the negative bias conductor 36. As soon as the dial calling device 37 is actuated the contacts 38 are closed, thereby to energize the relay 100. The relay 100 is provided with two windings 105 and 106, the former winding being energized in response to the initial actuation of the dial 37.

The winding 106 is arranged for subsequent energization by a circuit including a contact or dry disk rectifier 40 connected to the output circuit of the vacuum tube 28. The relay coil 106 may be shunted by a suitable capacitor 41 to provide a slow release characteristic to hold over the half-cycle periods between the direct current pulses supplied by the contact rectifier. The relay 100 is provided with two make contacts 101 and 102, a break-make contact 103, and a break contact 104. The make contact 101 is connected between the juncture of the resistor 33 with the primary winding of the transformer 25 and a more negative potential obtained from the source of negative bias potential. The make contacts 102 are connected between the grid of the vacuum tube 28 and a circuit connected to ground which includes an inductance 42 and a capacitance 43. The armature contact of the make contacts 102 is also connected to the armature contact of the break-make contacts 103 which, in turn, is arranged to make with a circuit including the grounded winding of the transformer 29 connected in the anode circuit of the vacuum tube 28. The breaking of the contacts 104 removes a short-circuit from the impedance 35 so that it now is effectively connected between the outgoing channel amplifier and the telephone line. The vacuum tubes 26 and 28 are energized from a suitable source of potential which may include a center tapped transformer 44, the center tap of which is connected to the negative side of the anode potential and to the positive side of the negative biasing potential source.

When the dial calling device 37 is actuated, the off-normal contacts 38 are closed, thereby to energize the winding 105 of the relay 100. This operation connects the one winding of the transformer 29 to the tuned circuit comprising the inductance 42 and the capacitor 43, thereby to tune the anode circuit of the vacuum tube 28. The closing of the make contacts 102 connects the grid of the vacuum tube 28 across the tuned circuit comprising the inductance 42 and the capacitor 43, thereby producing sufficient feedback to cause the output stage of the outgoing amplifier to become an oscillator or a generator of alternating current. The output of this oscillator is impressed upon the telephone line 10 through the attenuator or T-pad 15 and the impedance matching transformer 16. The impedance or resistance 35 is in series with the primary winding of the transformer 16 and, hence, is effectively in series with the telephone line. This impedance 35 is also in series with the grid return circuit of the output stage of the outgoing channel amplifier. Since a short-circuit has been removed from the resistor or impedance 35 by the breaking of the contacts 104, there is provided a means for feeding back into the oscillator grid circuit certain of the alternating current energy which is in phase with the anode current and out of phase with the grid current, and which is also proportional to the line current. Since the dial 37 will, of course, be released, thereby again opening the contacts 38, it is necessary to provide some means for locking in the relay 100 and, hence, the vacuum tube 28 after starting a generation of alternating currents, supplies a portion of this alternating current to the dry disk rectifier 40 which therefore supplies rectified current to the winding 106 of the relay 100, thereby to lock it into operated position so long as the vacuum tube 28 continues to supply oscillations. It will be recalled that the resistor 33 is connected between the grid circuits of the vacuum tubes 26 and 28 so that now, upon the closing of the contacts 101, additional negative bias is supplied to the earlier stages of the outgoing channel amplifier, thereby to disable those stages. Therefore at least a portion of one of the channel amplifiers is disabled in response to initiation of a call by the subscriber at this substation. It may now be assumed that the called substation responds by actuation of a suitable switch corresponding to the receiver switch of a telephone set, or in other words, some response is made whereby connection is completed at a called substation, and thereby the impedance of the telephone line is changed. It of course is apparent that at the central office the automatic telephone equipment has selected a line connected to a called substation, but this connected line will offer comparatively high impedance due to its capacity until the called party answers, after which the overall line impedance will be reduced. Before the called substation responds the resistor 35 introduces little or no inverse feedback energy to the grid circuit of the vacuum tube 28, and hence this tube operates as an oscillator. When as a result of the completion of a connection to a called substation, by the response of a called party, the impedance of the line changes, there will be a resultant change in the voltage of the alternating current appearing across the line so that sufficient inverse feedback occurs to effectively stop further oscillation of the vacuum tube 28. When oscillation of the vacuum tube 28 is stopped the rectifier 40 no longer supplies current to the winding 106 of the relay 100, with the result that the contacts of the relay 100 are restored thereby removing from the earlier stages of the outgoing channel amplifier the increased negative bias and also restoring to the former condition the anode and grid circuits of the vacuum tube 28.

From the above description it becomes apparent that, in response to the initiation of a call, means are provided for generating an alternating current which is applied to the telephone line much in the manner of a form of test voltage, and that upon a change of certain conditions this test voltage will produce certain effects whereby an initial disabling action applied to at least a portion of one of the channel amplifiers is removed, thereby to restore the channel amplifiers to normal operative condition. The circuit arrangement thus provided is responsive to the change in the line impedance occurring when the called party answers so that alternating current or testing potential is no longer applied to the line. There is no further need for preventing interaction between the microphone and the loudspeaker, since the incoming and outgoing channel amplifiers are arranged to be sufficiently balanced to operate properly. In the cases where the operation of the incoming and outgoing channel amplifiers is further controlled by suitable control circuits, it of course becomes apparent that in those localities where the various substation lines vary greatly still other precautions are provided for minimizing or preventing any interaction between the transmitter and receiver at a substation during the normal communication period.

While one embodiment of the invention has been disclosed, it will be understood that various

modifications may be made therein which are within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone substation having an incoming channel amplifier and an outgoing channel amplifier interconnected by a balancing or anti-sidetone network, the combination comprising means for disabling said outgoing amplifier upon initiation of a call from said substation, and means responsive to the completion of a connection at a called substation for terminating the disabling action of said aforementioned means.

2. The combination of an automatic telephone substation having an incoming channel amplifier and an outgoing channel amplifier interconnected by a balancing or an anti-sidetone network, with means for preventing feedback between said amplifiers during a calling interval prior to the completion of a connection with a called substation, said means comprising means for disabling said outgoing amplifier at the time of initiation of a call from said substation, and means responsive to the completion of a connection at a called substation for terminating the disabling action of said aforementioned means.

3. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, the combination of an impulse transmitting device for setting up connections, means controlled by said device upon actuation thereof to set up a connection for disabling at least one of said amplifiers, and means responsive to a response by the subscriber at a called substation for terminating the disabling action of said first means.

4. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, the combination of an impulse transmitting device for setting up connections, means controlled by said device upon actuation thereof to set up a connection for disabling at least one of said amplifiers, and means responsive to the completion of a connection at a called substation for terminating the disabling action of said first means.

5. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, the combination of an impulse transmitting device for setting up connections having off-normal contacts, means controlled by said off-normal contacts of said device upon actuation of said device to set up a connection for disabling at least one of said amplifiers, and means responsive to the balancing of said telephone line by the completion of a connection at a called substation for terminating the disabling action of said first means.

6. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers, a telephone line, balancing means coupling said amplifiers to said line, means for generating an alternating current test voltage to be applied to said line during a calling interval, means responsive to said alternating current voltage for disabling said outgoing amplifier, and means responsive to the completion of a connection at a called substation for terminating the generation of said alternating current voltage and for enabling said disabled amplifier.

7. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers, a telephone line, balancing means coupling said amplifiers to said line, means for applying an alternating current to said line during a calling interval, means responsive to the application of said alternating current to said line for disabling said outgoing amplifier, and means responsive to a change in impedance of said line for removing said alternating current therefrom and for enabling said outgoing amplifier.

8. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers, a telephone line, balancing means coupling said amplifier to said line, means for causing a portion of said outgoing amplifier to generate an alternating current to be applied to said line during a calling interval, means responsive to said alternating current for disabling said outgoing amplifier, means responsive to a change in impedance of said line for terminating the generation of said alternating current and for enabling said outgoing amplifier.

9. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers, a telephone line, balancing means coupling said amplifiers to said line, an impulse transmitting device for setting up connections, means controlled by said device upon actuation thereof to set up a connection for generating an alternating current to be applied to said line during a calling interval, means responsive to said alternating current for disabling at least one of said amplifiers, means responsive to a change in the effective voltage of said alternating current appearing across said telephone line in response to completion of a circuit at a called substation to render ineffective said means for generating alternating current and said means disabling said amplifier.

10. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, a dial calling device provided with off-normal contacts, means controlled by said contacts for causing a portion of said outgoing channel amplifier to generate an alternating current to be applied to said line during a calling interval, means responsive to said alternating current for disabling at least one of said amplifiers, and impedance means for producing an inverse feedback from said line to said portion of said outgoing amplifier generating alternating current, said impedance means being so related to said line that when said line is balanced said inverse feedback will be effective to stop the generation of alternating current thereby to enable the disabled amplifier.

11. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, a dial calling device provided with off-normal contacts, means controlled by said off-normal contacts for disabling at least one of said amplifiers, means controlled by said contacts for causing a portion of said outgoing channel amplifier to generate alternating current to be applied to said line during a calling interval, means responsive to said alternating current for holding at least one of said amplifiers disabled during the calling interval, and impedance means for producing an inverse feedback from said line to said portion of said outgoing amplifier generating alternating current, said impedance means being so related to

said line that when said line is balanced said inverse feedback will be effective to stop the generation of alternating current thereby to enable the disabled amplifier.

12. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers interconnected with a telephone line, a dial calling device provided with off-normal contacts, relay means controlled by said off-normal contacts for disabling at least one of said amplifiers, means controlled by said relay for causing a portion of said outgoing channel amplifier to generate alternating current to be applied to said line during a calling interval, means responsive to said alternating current for maintaining at least one of said amplifiers disabled during the calling interval, and impedance means connected between said line and said outgoing channel amplifier for producing an inverse feedback to that portion of the outgoing amplifier generating alternating current, said impedance means being effective to stop the generation of alternating current when said line is balanced.

13. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers interconnected with a telephone line, a dial calling device provided with off-normal contacts, relay means having a plurality of windings one of which is controlled by said off-normal contacts, means controlled by said relay for disabling at least one of said amplifiers, means controlled by said relay for causing a portion of said outgoing channel amplifier to generate alternating current to be supplied to said telephone line, means including a rectifier responsive to said alternating current for energizing the other winding of said relay, and impedance means connected by said relay between said amplifier and said line for producing an inverse feedback to stop the generation of alternating current when said line is balanced by a response from a called substation.

14. In an automatic telephone substation, the combination comprising incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, a dial calling device provided with off-normal contacts, a relay having a plurality of windings one of which is controlled by said off-normal contacts, means controlled by said relay for disabling at least one of said amplifiers, circuit means arranged to be connected to a portion of said outgoing channel amplifier, said circuit means being controlled by said relay for causing said outgoing channel amplifier to generate alternating current to be applied to said telephone line during a calling interval, impedance means arranged to be connected by said relay between said telephone line and said outgoing channel amplifier, said impedance being so related to said line and said amplifier that when said line is balanced by a response from a called substation said inverse feedback will be effective to stop the generation of alternating current, and means including a rectifier responsive to said generated alternating current for energizing the other winding of said relay thereby to hold said relay in operated position as long as alternating current is generated by said amplifier.

15. In a telephone system, a line, a substation including an outgoing amplifier terminating said line, means at said substation for initiating a call over said line thereby to extend a connection to a called substation, means operated responsive to the initiation of said call for disabling said amplifier, and means controlled from the called station for restoring said disabling means thereby to enable said disabled amplifier for normal operation.

16. In a telephone system including automatic switching apparatus for establishing connections between calling and called stations, a calling station, an incoming channel at said station terminating in a loudspeaker, an outgoing channel at said station terminating in a microphone, an amplifier for each of said channels, dial spring off-normal contacts actuated when the subscriber at said station controls the switching apparatus to establish a connection with a called station, means controlled by said off-normal contacts for disabling said outgoing channel amplifier thereby to prevent acoustical feedback between said loudspeaker and said microphone during the period of time said connection is being established, and means at said calling station operated under control of the called station for rendering said disabling means ineffective thereby to complete the connection between said calling station and the called station.

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