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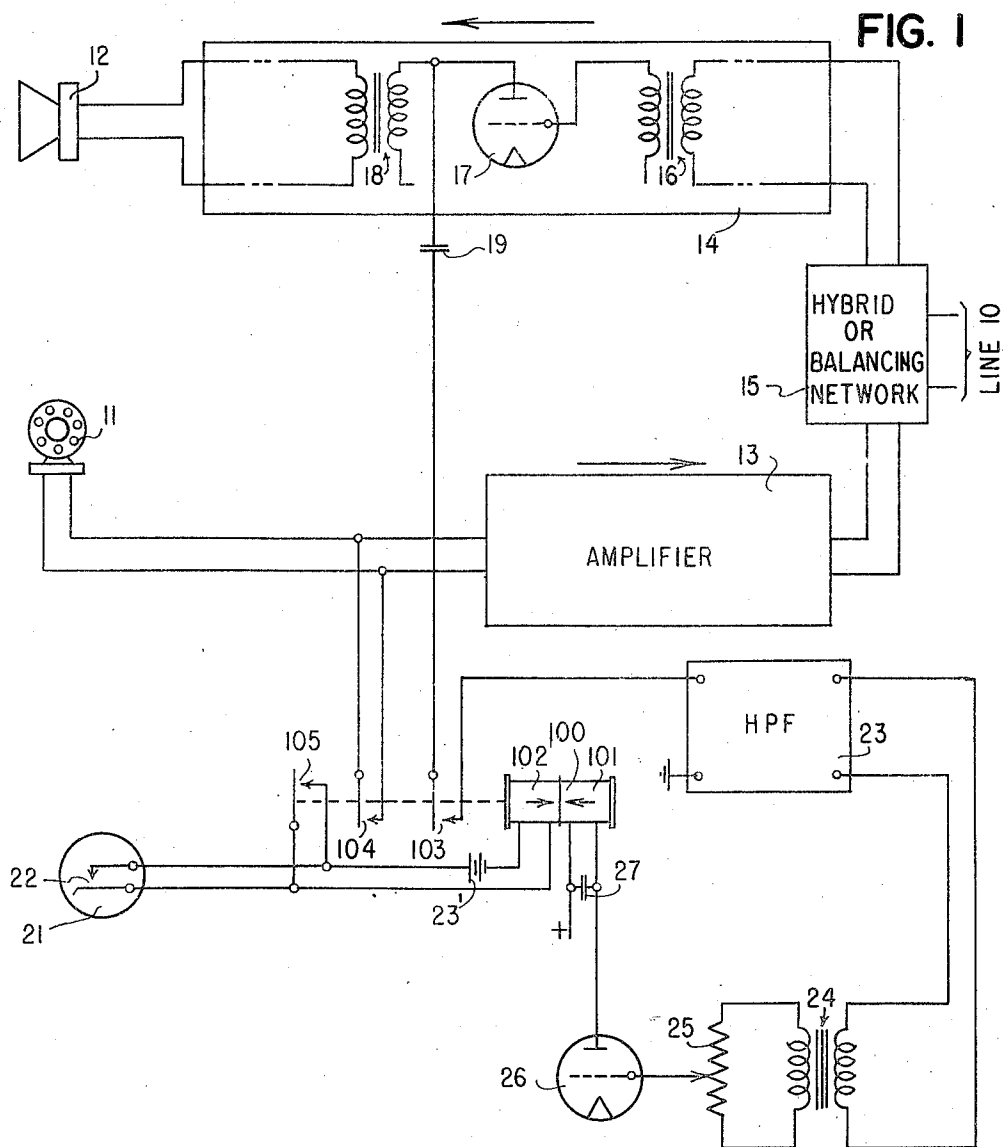
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2,369,144

TELEPHONE SUBSTATION CIRCUIT

Filed May 10, 1943

3 Sheets-Sheet 1



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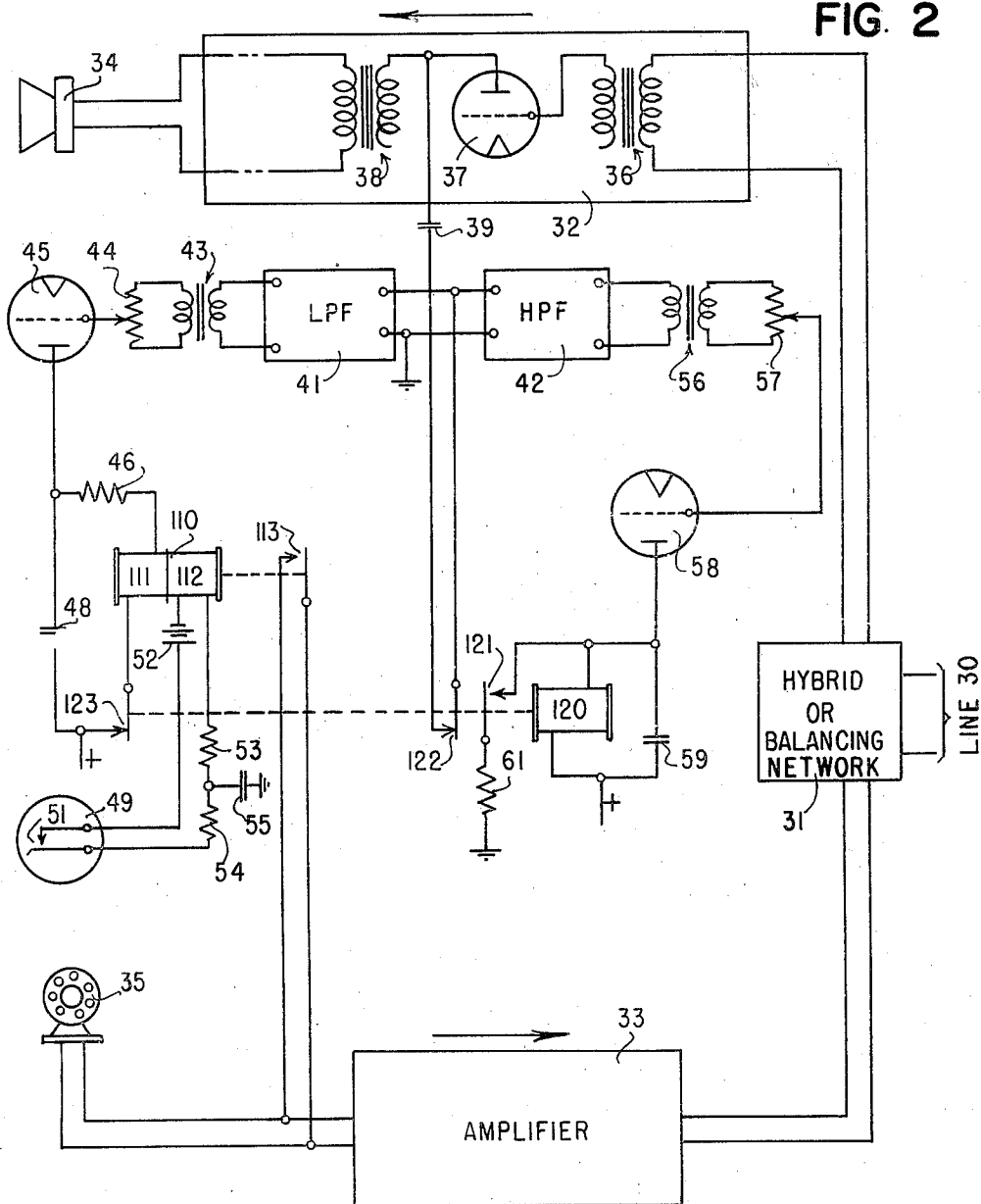
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3 Sheets-Sheet 2

FIG. 2



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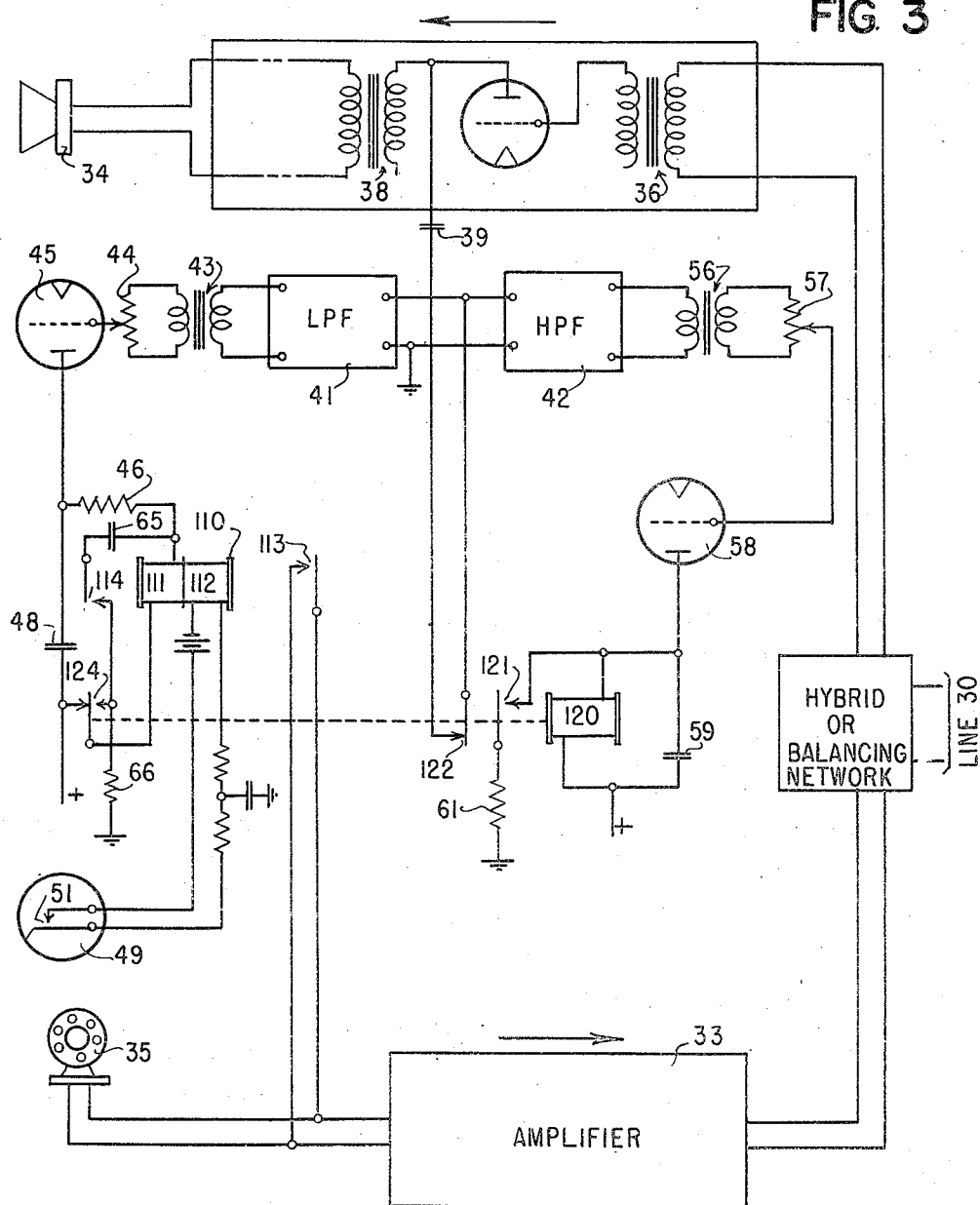
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3 Sheets-Sheet 3

FIG 3



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TELEPHONE SUBSTATION CIRCUIT

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17 Claims. (Cl. 179—81)

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 under the control of the dial tone, ring-back tone, or a dial calling device to disable at least one of the channel amplifiers during the calling interval.

Still another object of the present invention is to provide an improved telephone substation apparatus of the character described with means under the control of the dial tone, ring-back tone, or a dial calling device for disabling at least one of the amplifiers during the calling interval, together with means responsive to the upper range of voice frequency currents received from the called substation to restore the channel amplifier to normal operating condition.

A still further object of the present invention is to provide an improved telephone substation apparatus of the character described wherein one of the channel amplifiers is coupled to a control circuit for disabling at least one of the channel amplifiers during the calling interval, and in response to voice signals received from the called substation, the channel amplifiers are restored to normal operating condition and the control circuit is disconnected from its associated channel amplifier for the entire communication period.

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. In each case 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 with a called substation for again restoring the operation of the channel amplifiers. At least one of the channel amplifiers may be disabled by applying thereto a bias sufficient to reduce the gain level thereof or by a simple arrangement such as short-circuiting the transmitter, the loudspeaker, or the input circuit of the outgoing channel amplifier. While certain advantages may be obtained by the application of one or the other of the alternatives referred to, it is believed that these are not necessary for a complete understanding of the present invention and, hence, these various methods have merely been indicated by showing an arrangement for short-circuiting the transmitter. One method of obtaining disabling responsive to the initiation of a call is by the use of off-normal contacts on the dial calling device which, upon initial actuation of the dial, operate to lock in a relay which disables at least one of the channel amplifiers until the called substation responds. High-pass filter means are coupled to the incoming channel amplifier so that in response to an answer from a called substation the disabling means may be rendered ineffective and normal operation of the channel amplifiers may thereby be restored.

Another method of obtaining a disabling of at least one of the channel amplifiers during the calling period is to provide a control circuit which is responsive to the dial tone to disable at least one of the channel amplifiers. Since the dial tone is interrupted during dialing, a dial device is provided with off-normal contacts to insure the maintenance of the disabling action and after dialing has been completed the apparatus which responded to the dial tone will now be responsive to the ring-back tone to continue to disable at least one of the channel amplifiers until other means operating in response to the higher voice frequencies received from the called substation become effective to disconnect the control circuit

and to render ineffective the disabling apparatus. In order to insure a relatively rapid restoration of the channel amplifiers to normal operating condition, still further circuit arrangements may be provided such as an arrangement whereby a capacitor or other energy storage device is initially charged during the initial application of a disabling action which is brought about by the operation of the relay. In response to the answer from the called substation the charged capacitor is discharged through the relay, thereby to cause the relay to be restored rapidly and positively to its normal or unlocked position.

Further features of the invention pertain to various arrangements 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 drawings in which Figure 1 illustrates a substation circuit having incorporated therein certain of the features of the invention as briefly outlined above; Fig. 2 illustrates a substation circuit arranged in a different manner than Fig. 1 and wherein the initial disabling action is brought about in response to the dial tone; and Fig. 3 shows a substation circuit similar to that shown in Fig. 2 which is provided with the additional feature of an arrangement for insuring a rapid restoration of the initial disabling relay to its normal or unlocked position.

Referring more particularly to Fig. 1, there is illustrated a substation circuit connected to a telephone line 10 which may form part of a conventional automatic telephone system, the distant end thereof terminating at the telephone exchange. Briefly described, the circuit includes a transmitter or microphone 11 and a loudspeaker 12, each provided with suitable channel amplifiers 13 and 14 coupled to a hybrid network or other balancing circuit arrangement 15. Each of the channel amplifiers 13 and 14 may be provided with a plurality of stages of amplification in accordance with the requirements to be met at a particular substation. One of the intermediate stages of the incoming channel amplifier 14 which is coupled to a control circuit has been shown as having an input transformer 16, a vacuum tube 17, and an output transformer 18. The control circuit is coupled to the intermediate stage of amplification of the incoming channel amplifier by the capacitor 19 which is connected to the make contacts 103 of a relay 100 which is provided with two opposing coils 101 and 102. The relay 100 is furthermore provided with two additional make contacts 104 and 105, the former contacts being arranged to provide a short-circuit across the microphone 11, thereby to represent one form of circuit arrangement for disabling the outgoing channel amplifier 13. The substation is provided with a dial calling device 21 having off-normal contacts 22 which will be closed upon the initial actuation of the dial device 21. The off-normal contacts 22 are connected in parallel with make contacts 105 of relay 100 and in series with a source of voltage 23' and one winding 102 of the relay 100. The contacts 103 of the relay 100 are arranged to connect the high-pass filter 23 between ground and the anode circuit of the vacuum tube 17. The high-pass filter is so constructed and arranged as to transmit only the upper range of voice fre-

quencies so that the control circuit will be responsive to the answer of a called substation. The high-pass filter 23 is coupled by a transformer 24 and a voltage divider to the control electrode of a vacuum tube 26. The vacuum tube 26 has an anode connected through the winding 101 of the relay 100 which may be suitably by-passed by a capacitor 27. The other terminal of the relay winding 101 is connected to the positive terminal of a suitable source of potential for the vacuum tube 26. The capacitor 27 which is connected across the winding 101 of the relay 100 is provided to lower the plate load impedance of the vacuum tube 26 sufficiently in order to obtain the maximum possible change in anode current with a given applied voice voltage to the control electrode.

When a substation subscriber desires to communicate with another substation, the channel amplifiers 13 and 14 are conditioned for operation by a suitable switch, not shown, which connects a source of power to the required power supply. Thereupon the subscriber initiates the outgoing call by actuating the dial calling device 21, thus closing the off-normal contacts 22 upon initial actuation of the dial. The contacts 22 being closed complete a circuit from the battery 23' through the winding 102 of the relay 100, which thereupon closes all of the make contacts 103, 104 and 105. The latter make contact 105 is in parallel with the off-normal contacts 22 of the dial 21 so that the relay is locked into operation. The relay, having operated, has disabled at least one of the channel amplifiers, as by closing of the contacts 104 the input to the channel amplifier 13 has been short-circuited. The control circuit is now also connected to the intermediate stage in the incoming channel amplifier 14 by the closing of the contacts 103 which connect a capacitor 19 to the high-pass filter 23. Since at least one of the channel amplifiers of the associated circuits has been disabled, there is no possibility of interaction between the microphone and the loudspeaker which might bring about a condition of "howling" during the calling operation.

The vacuum tube 26 is preferably arranged so that it is biased at or near the plate current cutoff and, hence, the anode current will increase with an increase in applied voice current voltage. When the called substation responds a portion of the incoming voice frequency energy appearing in the incoming channel amplifier 14 will be transmitted through the high-pass filter 23 to the input of the vacuum tube 26, thus causing increased anode current to flow. The relay winding 101 is arranged to oppose the relay winding 102 and the resulting increase in anode current of the vacuum tube 26 is sufficient to release the relay, thereby to restore the disabled channel amplifier to normal talking condition and also to disconnect the control circuit from the substation circuit. The high-pass filter 23 is provided so that the control circuit will not be responsive to ring-back tone but will respond only to an answer from the called substation. At the end of the communication period the circuit just described will again be subject to the condition of howl since no means are provided for further disabling any of the channel amplifiers or preventing the interaction therebetween, but this howl now may have a useful purpose since it will remind the substation operator that the equipment should be restored to its initial condition.

Reference may now be had to Fig. 2 wherein

there is shown a telephone line 30 being connected by a hybrid network or other balancing network 31 with incoming and outgoing channel amplifiers 32 and 33 connected respectively to a loudspeaker 34 and a microphone 35. Each of the channel amplifiers is provided with a plurality of stages of amplification, and of these only an intermediate stage has been shown for the incoming channel amplifier 32. This stage may include an input transformer 36, a vacuum tube 37, and an output transformer 38.

The control circuit is arranged to prevent interaction between the incoming and outgoing channel amplifiers during the calling period, and this control circuit is coupled to the incoming channel amplifier by a suitable capacitor 39 which is connected through the break contact 122 of a relay 120 to the common conductor between a low-pass filter 41 and a high-pass filter 42, which in turn are each grounded. The low-pass filter 41 is designed to transmit only the lower voice frequencies, in which range are found the dial tone and the ring-back tone. The low-pass filter 41 is connected to a suitable coupling circuit including a transformer 43 and a voltage divider 44 to the input or control electrode of a vacuum tube 45. The anode of the vacuum tube 45 is connected through a current limiting resistor 46 and one winding 111 of a relay 110 and the break contacts 123 of relay 120 to the positive terminal of a suitable source of anode voltage. The resistor 46 and the relay winding 111 are suitably by-passed by a capacitor 48 which lowers the impedance of the plate circuit sufficiently that the vacuum tube 45 may be properly responsive to the voice frequency currents which will be impressed upon the control electrode. The vacuum tube 45 is preferably biased at or near the plate current cutoff so that its plate current increases in response to applied low frequency alternating current voltage, thereby to operate the relay 110. The relay 110 is provided with make contacts 113 arranged to disable the outgoing channel, by placing a short-circuit across the microphone 35 or the input tube of the outgoing channel amplifier 33. The relay 110, therefore, is arranged to become operative in response to the dial tone as soon as the incoming and outgoing channel amplifiers 32 and 33 are conditioned for operation, preparatory to the initiation of a telephone call. The substation is provided with a dial calling device 49 which is provided with a pair of off-normal contacts 51 connected in series with a source of potential 52, one winding 112 of relay 110, and a pair of resistors 53 and 54. The common juncture of the resistors 53 and 54 is connected to a grounded capacitor 55. The capacitor 55 is provided so that the circuit including the relay winding 112 and the resistors 53 and 54 will have a time constant sufficient to hold over operation of the relay 110 into the period when ring-back tone is impressed through the low-pass filter 41 upon the control tube 45, whereupon the other winding 111 of the relay 110 will again become effective to hold the relay 110 in operated position.

The high-pass filter 42 is connected through a coupling circuit including a transformer 56 and a voltage divider 57 to the control electrode of a vacuum tube 58 which has an anode connected to the winding of the relay 120 which, in turn, is connected to a suitable source of anode voltage. The winding of the relay 120 is by-passed by a capacitor 59 which lowers the impedance of the plate circuit sufficiently so that the maximum possible change in anode current will occur with

a given applied voice voltage. The relay 120 is provided with make contact 121 and break contacts 122 and 123. The make contact 121 is connected between the anode of the vacuum tube 58 and a grounded resistor 61. The break contacts 122 are connected between the coupling capacitor 39 and the filters 41 and 42 so that when the relay 120 is energized the control circuit is disconnected from the communication circuit. The break contact 123 is connected between the source of anode voltage and the winding 111 of relay 110 so as to deenergize the relay 110 upon the receipt of an answer from a called station, thereby to remove the disabling action of this relay from the communication circuit.

Whenever it is desired to initiate a call a suitable switch, not shown, is actuated to supply the necessary energy to condition the incoming and outgoing channel amplifiers for operation. As soon as the channel amplifiers are conditioned for operation the dial tone appearing across the line 30 will be impressed through the coupling capacitor 39 to the circuit between the low-pass and high-pass filters 41 and 42. The high-pass filter 42 cannot pass either the dial tone or the ring-back tone signals, but these currents are transmitted by the low-pass filter 41. Therefore, upon initial energization of the channel amplifiers the low-pass filter 41 will transmit dial tone to the input of the vacuum tube 45 which, in turn, responds by an increase in anode current so as to bring about actuation of the relay 110. The relay 110, having been actuated, disables at least one of the channel amplifiers by the closing of the short-circuit contacts 113 connected across the microphone 35. The substation subscriber thereupon actuates the dial calling device 49, thus closing the off-normal contacts 51, whereupon the winding 112 is energized to continue to hold up the relay 110 which is no longer energized by the anode current of the vacuum tube 45, since initial actuation of the dial 49 has interrupted the dial tone. The circuit through the relay winding 112 of the relay 110 has a time constant provided by the capacitor 55 and the resistors 53 and 54 such that the relay 110 remains energized through the dialing operation and into the period in which ring-back tone will be transmitted over the line 30 to the incoming channel amplifier 32. The ring-back tone is then transmitted through the coupling capacitor 39 and the low-pass filter 41 to the vacuum tube 45 so that increased anode current again flows, thereby to energize the relay winding 111 of the relay 110. Thus during the initial calling operation at least one of the channel amplifiers or the circuits associated therewith is disabled so as to prevent interaction between the incoming and outgoing communication channels.

When the called substation subscriber answers the upper range of voice frequencies will be transmitted by the high-pass filter 42 to the control grid of the vacuum tube 58, thereby to cause increased anode current flow to actuate the relay 120. The relay 120 opens the contacts 123, thereby deenergizing the relay 110 so as to restore this relay to normal condition, thereby removing the disabling action brought by the energization of this relay. The entire control circuit is disconnected from the communication channels by the opening of the break contacts 122 of the relay 120. The relay 120 locks itself into operated position by closing of the contacts 121 so that the anode potential source transmits current through the winding of the relay 120, the closed contacts

121 and the current limiting resistor 61. The control circuit therefore is locked out of circuit from the incoming and outgoing communication channels during the ensuing telephone conversation. At the termination of the telephone conversation the incoming and outgoing communication channels will be subject to interaction and "howling" so that the substation operator will throw the switch to deenergize the power supply which supplies the energy to the incoming and outgoing channel amplifiers. Thus the power is removed from the relay 120 which thereupon is released, thus restoring the control circuit to its original condition.

Since telephone subscribers are accustomed to communicate over a system which is simultaneously two-way, thus permitting him to answer promptly or even interrupt, a subscriber will expect to start conversation immediately upon hearing the called party's acknowledgment of his call. This requires rapid and positive operation of the relay 110. In order that this operation be both rapid and positive there is shown a circuit arrangement in Fig. 3 which in other respects is similar to the disclosure of Fig. 2 and, hence, identical parts have been given corresponding reference characters. The relay 110 in Fig. 3, in addition to the make contact 113, is provided with make contact 114. The relay 120 is provided with make contact 121, break contact 122 and break-make contact 124. The low-pass filter 41 which energizes the vacuum tube 45 supplies energy thereto so that anode current flows through the circuit including a resistor 46 and one winding 111 of the relay 110 which is connected through the break contacts 124 of the relay 120 to the positive side of the anode potential for the vacuum tube 45. When the relay 110 is operated the disabling contacts 113 are closed and, in addition, contacts 114 are closed so as to connect a capacitor 65 through a current limiting resistor 66 to ground. The capacitor 65 is therefore connected in a circuit which receives energy from the source of anode potential for the vacuum tube 45, thereby to charge this capacitor to a predetermined potential. During the initial calling period the relay 110 is initially energized in response to the dial tone, and subsequently energized by the off-normal contacts 51 of the dial device 49, and after the dialing operation again by the ring-back tone through the winding 111. The capacitor 65 therefore is being charged during the initial calling period.

When the answer is received from the called substation the upper range of voice frequencies is transmitted through the high-pass filter 42 to the control tube 58 to bring about actuation of the relay 120 which locks itself into position by the closing of the contacts 121. The relay 120 disconnects the control circuit from the communication channels by opening the contacts 122. At the same time the break-make contacts 124 are actuated so that the capacitor 65 is removed from a charging circuit and connected directly across the winding 111 of the relay 110 which just previously was energized by anode current from the vacuum tube 45. The capacitor 65, however, has been charged to an opposite potential so that now current rapidly passes through the winding 111 in the opposite direction, thereby causing rapid deenergization and demagnetization of the relay 110, so that this relay rapidly releases thus opening its contacts 113. Thereby the disabling action of the relay 110 is removed in a time interval sufficiently short so that com-

munication from the calling substation may be started immediately in response to an answer received from the called substation. The remaining operation of the control circuit being identical to the circuit described in connection with Fig. 2, will require no further explanation.

While numerous embodiments of the invention have 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 an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, the combination comprising means including a relay for disabling at least one of said amplifiers during a calling interval, means including a high-pass filter and a vacuum tube arranged to be responsive to voice currents received from the called substation, and circuit means interconnecting said tube and said disabling relay for releasing said relay thereby to restore said amplifiers to normal condition.

2. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to an intermediate stage of the incoming channel amplifier, means associated with said control circuit for disabling at least one of said amplifiers during a calling interval, and means actuated by said control circuit for disconnecting said control circuit in response to an answer from a called substation for the duration of communication between two substations.

3. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to an intermediate stage of the incoming channel amplifier, said control circuit including a relay actuated at the beginning of a calling interval for disabling at least one of said amplifiers during the calling interval, a high-pass filter and a vacuum tube arranged to be responsive to voice currents received from the called substation, a circuit means interconnecting said vacuum tube and said disabling relay for releasing said relay in response to an answer from a called substation thereby to restore said amplifier to normal and for disconnecting said control circuit for the duration of communication between two substations.

4. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination of a dial calling device, means controlled by said device upon actuation of said dial for disabling at least one of said amplifiers, and means responsive to the voice currents received from 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, the combination of a dial calling device having off-normal contacts, means controlled by said off-normal contacts of said device upon actuation of said dial for disabling at least one of said amplifiers, and means operated responsive to voice frequencies received from a called substation subscriber for terminating the disabling action of said first means.

6. In an automatic telephone substation hav-

ing incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, the combination of a dial calling device having auxiliary off-normal contacts, means including a relay controlled by said off-normal contacts of said calling device upon actuation thereof for disabling at least one of said amplifiers, and means operated responsive to voice frequencies received from a called substation for terminating the disabling action of said first means by releasing said relay.

7. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising means responsive to the dial tone for disabling at least one of said amplifiers, means for holding said amplifier disabled during the calling interval, and means responsive to the upper range of voice frequencies received from the called substation for rendering ineffective said disabling means.

8. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising means responsive to the dial tone for disabling at least one of said amplifiers, means including off-normal dial contacts for subsequently holding said amplifier in disabled condition, means responsive to ring-back tone for continuing to hold said amplifier in disabled condition, and means responsive to the upper range of voice frequencies received from the called substation for rendering ineffective said disabling means.

9. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line by a balancing network, the combination comprising means responsive to the dial tone for disabling at least one of said amplifiers, means including off-normal dial contacts for subsequently holding said amplifier in disabled condition, means responsive to ring-back tone for continuing to hold said amplifier in disabled condition, and means including a high-pass filter and a rectifier arranged to be responsive to the upper range of voice currents received from the called substation for rendering ineffective said disabling means.

10. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination with a control circuit coupled to an intermediate stage of the incoming channel amplifier, said control system including means responsive to the dial tone for disabling at least one of said amplifiers, means including off-normal dial contacts for subsequently holding said amplifier disabled, means responsive to ring-back tone for continuing to hold said amplifier in disabled condition, a high-pass filter and a vacuum tube arranged to be responsive to the upper range of voice currents received from the called substation, and means controlled by said high-pass filter and vacuum tube for rendering ineffective said disabling means and for disconnecting said control circuit for the duration of communication between two substations.

11. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough including low-pass filter means arranged to disable at least one of said amplifiers in response to a dial tone,

a dial calling device provided with off-normal contacts, means controlled by said contacts for subsequently holding said amplifier disabled during the dialing period, means associated with said low-pass filter means for holding said amplifier disabled in response to ring-back tone, and high-pass filter means arranged in response to the upper range of voice frequencies received from a called substation to disconnect said control circuit from said amplifier thereby to restore said amplifiers to normal condition.

12. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough, said control circuit including a relay arranged to disable at least one of said amplifiers, low-pass filter means arranged to be responsive to dial tone to energize said relay, means for maintaining said relay energized during a calling interval, and high-pass filter means arranged in response to the upper range of voice frequencies received from a called substation to disconnect said control circuit from said amplifier thereby to restore said amplifiers to normal condition.

13. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough including a relay arranged to disable at least one of said amplifiers, low-pass filter means arranged to be responsive to a dial tone to energize said relay, a dial calling device provided with off-normal contacts, means interconnecting said relay and said contacts for subsequently holding said amplifier disabled during the dialing period, said means associated with said low-pass filter means operating to hold said amplifier disabled in response to ring-back tone, and high-pass filter means arranged in response to the upper range of voice frequencies received from a called substation to disconnect said control circuit from said amplifier thereby to restore said amplifiers to normal condition.

14. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough, including a plural winding relay arranged to disable at least one of said amplifiers, low-pass filter means arranged to be responsive to dial tone to energize one winding of said relay, a dial calling device provided with off-normal contacts, a second winding of said relay being controlled by said contacts for subsequently holding said amplifier disabled during the dialing period, said first relay winding associated with said low-pass filter means being operative to hold said relay in energized position in response to ring-back tone, and high-pass filter means arranged in response to the upper range of voice frequencies received from a called substation to deenergize said relay and to disconnect said control circuit from said amplifier thereby to restore said amplifiers to normal condition.

15. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough, including a relay arranged to disable at least one of said amplifiers, low-pass filter means arranged to be responsive to dial tone to energize said relay, a dial calling device provided with off-normal contacts, means controlled by said contacts for subsequently holding said amplifier disabled during the dialing period, said low-pass filter means being operative to hold said relay in energized position in response to ring-back tone, a second relay connected to be energized from high-pass filter means in response to the upper range of voice frequencies received from a called substation, means controlled by said latter relay for disconnecting said control circuit from said amplifier, and means controlled by said latter relay for rapidly releasing said first relay.

16. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough including a relay arranged to disable at least one of said amplifiers, low-pass filter means arranged to be responsive to dial tone to energize said relay, means for holding said relay in energized condition throughout a calling interval, a second relay connected to be energized from high-pass filter means in response to the upper range of voice frequencies received from a called substation, means controlled by said latter relay for disconnecting said control circuit from said amplifier, a capacitor arranged to be charged by operation of said first relay, and means controlled by said second relay for discharging said charged capacitor through said first relay to insure rapid release thereof.

17. In an automatic telephone substation having incoming and outgoing channel amplifiers interconnected with a telephone line, the combination comprising a control circuit coupled to said incoming amplifier to be responsive to signal currents passing therethrough, including a relay arranged to disable at least one of said amplifiers, low-pass filter means arranged to be responsive to dial tone to energize said relay, a dial calling device provided with off-normal contacts, means controlled by said contacts for subsequently holding said amplifier disabled during the dialing period, said low-pass filter means being operative to hold said relay in energized position in response to ring-back tone, a second relay connected to be energized from high-pass filter means in response to the upper range of voice frequencies received from a called substation, means controlled by said latter relay for disconnecting said control circuit from said amplifier, a capacitor arranged to be charged by operation of said first relay, and means controlled by said latter relay for discharging said charged capacitor through said first relay to insure rapid release thereof.

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