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CALLING AND WARNING APPARATUS
FOR COMMUNICATION SYSTEMS

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2 Sheets-Sheet 1

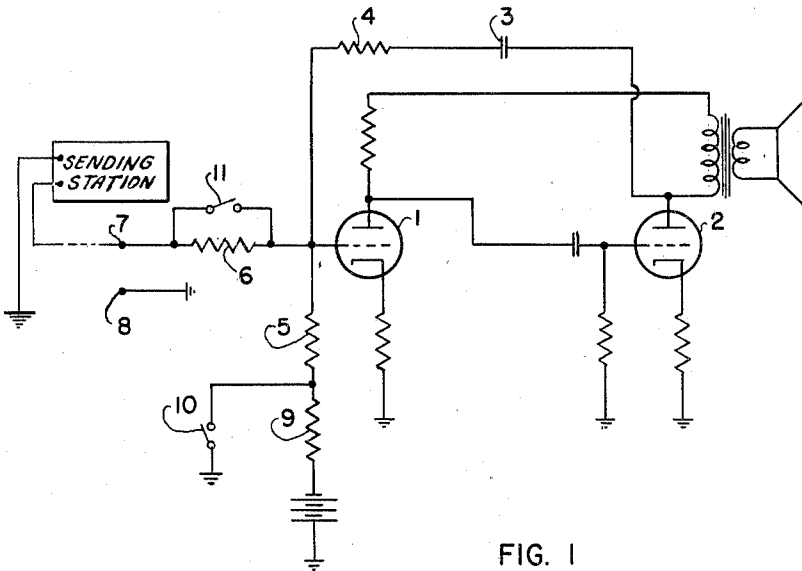


FIG. 1

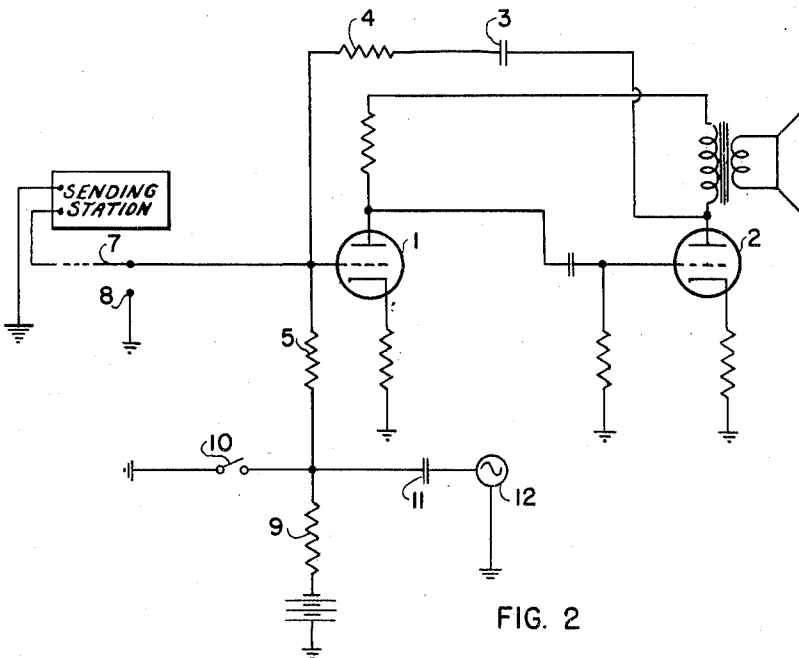


FIG. 2

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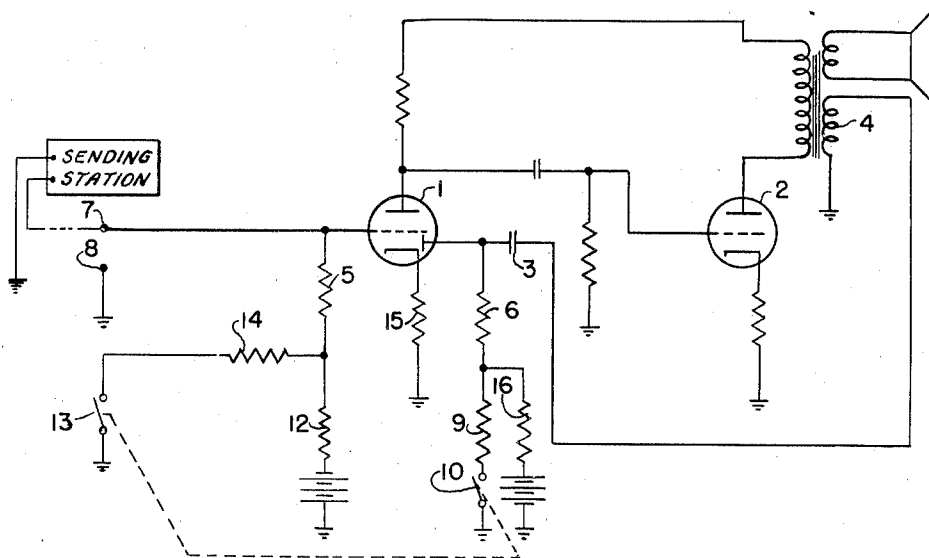


FIG. 3

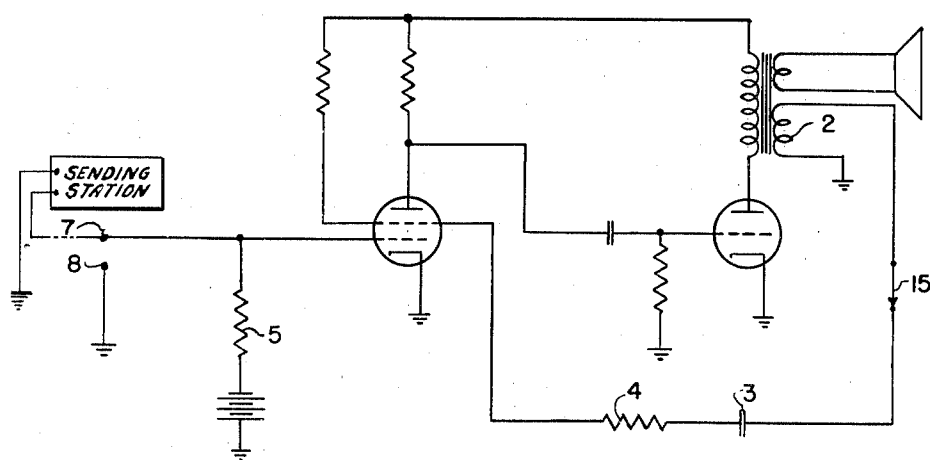


FIG. 4

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CALLING AND WARNING APPARATUS FOR
COMMUNICATION SYSTEMSHerbert Selinger, Sydney, New South Wales, Aus-
tralia, assignor to Hartford National Bank &
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In Australia January 19, 1945

13 Claims. (Cl. 179-84)

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This invention relates to apparatus for producing calling and warning signals for communication systems in which thermionic vacuum tube amplifiers are used at the subscriber stations, and particularly to those systems using a "talk-listen" switch for the purpose of converting the amplifier from a sending condition to a receiving condition and vice versa.

In such systems it is desirable to incorporate means whereby an audible tone may be produced by the receiving equipment when a station is called and means whereby an audible warning is given when the connection between two stations is broken. The need for an audible warning that the connection is broken is particularly important in communication systems in which the subscriber has to perform some action on the completion of a conversation to restore the equipment to a condition that is suitable for the reception of another call.

It is the primary object of the invention to provide means whereby calling and warning tones as above mentioned may be produced.

According to one embodiment of the invention, the warning and calling tones are produced by the generation of audio frequency oscillations in the receiving amplifier when a calling signal is received or if the circuit connection with the calling station is interrupted. According to other embodiments of the invention, either the warning tone or the calling tone is generated by self-oscillation of the receiving amplifier whilst the other tone is generated by other suitable means.

In performing the invention I contemplate using either one or both of two types of circuits for the production of oscillations in the receiving amplifier.

In one type of circuit, positive feedback is applied from the output circuit of the amplifier to the input circuit of the amplifier via a high impedance. The amplifier will generate audio oscillations if the attenuation caused by the said impedance is less than the gain of the amplifier but will not generate oscillations if either the gain of the amplifier is made less than the attenuation or if the attenuation is made greater than the gain. If the impedance across the input circuit of the amplifier is of relatively high value oscillations may be produced but if the impedance across the said input circuit is made small in value, e. g. by the connection of a line, the attenuation of the feedback voltage may be so great that the generation of oscillations is prevented. Alternatively, if the input impedance is high, giving little attenuation to the feedback voltage

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and the first tube of the amplifier has a large negative bias applied to its control grid, the gain of the amplifier may be insufficient to generate oscillations.

In the other type of circuit, the positive feedback voltage is applied to a preceding tube-element via a high impedance in series with a rectifier such as a diode tube which may be suitably back biased. In this circuit, oscillations will not be generated unless the back bias voltage of the rectifier is removed or unless a voltage from some other source is applied across the rectifier and renders it conductive.

In the second type of circuit it is convenient to make use of a tube known commercially as the 6G8 in which a diode tube and an amplifying tube are incorporated in the same envelope, obtaining their electron currents from the same cathode. With such a tube, the positive feedback voltage may be applied to the cathode element via the anode of the diode, and the diode may be rendered conductive by applying a suitable positive voltage to its anode via an impedance to enable the circuit to generate oscillations.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings which show the circuit diagrams of certain applications of the foregoing circuits for the production of oscillations to achieve the object of the invention.

In the drawing:

Fig. 1 is a schematic diagram of one preferred embodiment of the invention,

Fig. 2 is a schematic diagram of a second preferred embodiment,

Fig. 3 is a schematic diagram of a third preferred embodiment, and

Fig. 4 is a schematic diagram of a fourth preferred embodiment.

In Figure 1 of the drawings the numeral 1 indicates the first tube and the numeral 2 the second tube of a resistance coupled amplifier. A positive feedback network comprising the resistor 4 and the capacitor 3 provides an alternating current circuit between the grid of the tube 1 and the anode of the tube 2. A negative bias voltage is applied to the grid of the tube 1 by means of the resistive network comprising the resistors 5 and 9, this bias voltage being sufficiently large to cut off the anode cathode current through the tube 1.

The grid of the tube 1 is also connected to the input terminal 7 via the resistor 6 which may be shortcircuited by the switch 11. In the circuit arrangement shown the other input terminal

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8 is connected to earth. A switch 10, linked to the switch 11, is also provided and is connected between the junction point of the resistors 5 and 9 and earth.

This circuit arrangement functions in the following manner:

When the switches 11 and 10 are open and the direct current resistance between the terminals 7 and 8 is of a relatively high value, the tube 1 will be in a cut-off condition and the amplifier will be silent.

If a component having a relatively low direct current resistance is connected across the terminals 7 and 8 such as, for example, the output winding of a remote transformer, the bias voltage applied to the grid of the tube 1 will be reduced. If the resistors 6, 5 and 9 are suitably proportioned and if the negative bias voltage is of a suitable value, the reduction in the effective bias voltage will make the tube 1 operative and the amplifier will oscillate as a result of the feedback produced by the feedback network 3, 4. The oscillations so produced can be used as a calling signal to indicate that a circuit has been connected across the terminals 7 and 8.

If the switches 11 and 10 are then closed the bias voltage applied to the grid of the tube 1 will be further reduced but the feedback voltage will be attenuated owing to the reduction in the value of the alternating current impedance across the terminals 7 and 8. The resistor 4 and the alternating current impedance across the terminals 7 and 8 may be so proportioned that under these conditions the positive feedback voltage is insufficient to cause oscillation and the amplifier will function normally.

When the remote circuit is disconnected from the terminals 7 and 8, the positive feedback voltage will increase and the amplifier will again oscillate, thus giving a warning that the remote circuit has been disconnected.

If the switches 10 and 11 are then opened oscillations will cease and the amplifier will be restored to its initial state in readiness for a further call.

The circuit shown in Figure 2 is a modification of that of Figure 1, the arrangement being one which provides for a calling tone and a warning tone, thereby permitting the use of two different tones for calling the warning purposes. This circuit differs from that of Figure 1 in that the resistor 6 and the switch 11 are omitted and the junction point of resistors 5 and 9 constituting a resistive network is connected through a blocking capacitor 11 to an auxiliary source of oscillations 12.

With this circuit the connection of a remote circuit of low alternating current impedance across the terminals 7 and 8 renders the tube 1 operative but does not permit self oscillation as the positive feedback voltage is attenuated owing to the impedance of the remote circuit. On the other hand, the auxiliary oscillations from the source 12 are applied to the grid of the tube 1 and so provide a calling signal. By closing the switch 10 the calling tone is eliminated and the amplifier may be used in a normal manner. The removal of the remote circuit from across the terminals 7 and 8 increases the feedback voltage and causes the amplifier to oscillate thereby to produce a warning signal. By opening the switch 10 the warning signal is cut out and the original conditions are restored.

With this arrangement, the tone of the calling signal is determined by the frequency of the

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auxiliary oscillator while the tone of the warning signal is dependent upon the characteristics of the amplifier.

Figure 3 depicts another embodiment of the invention in which use is made of a type 6G8 tube. In this arrangement the numeral 1 represents the 6G8 tube and the numeral 2 the second tube of the amplifier. The output transformer of the amplifier has a secondary winding 4 which is connected to the diode anode 11, of the tube 1 by the blocking condenser 3. The diode anode is connected to a source of positive voltage by the resistors 6 and 16. A resistor 9 is connected from the junction point of resistors 6 and 16 to earth via a switch 10.

The input terminals are indicated by the numerals 7 and 8, the latter terminal being connected to earth and the terminal 7 being connected to the grid of the tube 1. The grid of the tube 1 is also connected to a suitable source of negative voltage via the resistive network comprising the resistors 5 and 12, a resistor 14 in series with a switch 13 being connected between the junction point of resistors 5 and 12 and earth. The switch 13 is linked to the switch 10.

When open circuit conditions exist between the terminals 7 and 8 the bias voltage applied to the grid of the tube 1 is sufficient to render the tube inoperative.

When a remote circuit is connected across the terminals 7 and 8, the tube 1 becomes operative as a result of the reduction in the grid bias voltage. With the switch 10 in its open position, positive feedback is applied from the winding 4 via the blocking condenser 3 and the diode anode 11, and if the diode anode is positive with respect to the cathode, the amplifier will oscillate and produce a calling signal.

If the switch 10 is closed the positive voltage applied to the diode anode 11 will be reduced and, if the components have suitable values, the amplifier will function in normal manner.

If the remote circuit connected across the terminals 7 and 8 is removed, the current through the tube 1 will decrease because the negative bias will increase to a value determined by resistors 12 and 14. Consequently, the voltage at the cathode of the tube 1, which is maintained positive with respect to earth by the cathode resistor 15, will decrease to a value which can be less than the voltage at the diode anode 11 if the components have suitable values. The diode will thus become conductive and cause the circuit to oscillate thereby producing a warning signal. By opening the switches 10 and 13 the circuit is restored to its initial condition.

The circuit in Figure 4 is that of an embodiment of the invention in which a calling signal is produced. In this circuit positive feedback is applied to the screen of the first tube of the amplifier from the secondary winding 2 of the output transformer via the switch 15, the resistor 4, and the capacitor 3. A bias voltage sufficient to bias the first tube beyond cut-off is applied to the grid of the tube via the resistor 5. When a remote circuit is connected across the terminals 7 and 8 the bias voltage is removed from the first tube and the amplifier will oscillate thereby to produce a calling signal. When the signal is answered, the switch 15 is opened, thus breaking the positive feedback circuit and permitting the amplifier to function normally.

If desired, time delay filters may be employed in the circuits above described in order to prevent the generation of calling or warning signals

as a result of momentary actions such as when a switch is opened or closed.

In the circuit diagrams illustrated, those components well known in the art but not forming portion of the invention have been omitted for the sake of clarity.

Direct current voltages are shown as though produced by batteries but they may be produced by resistor networks in any suitable manner.

It is not intended to limit the invention to circuit arrangements in which control voltages are applied to the control grid electrodes as it will be obvious to those skilled in the design of amplifiers that similar effects may be obtained by means of voltages applied to other electrodes.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. Calling and warning apparatus for a communication system including a vacuum tube amplifier at a receiving station and a sending station arranged for connection to the input circuit of said amplifier, comprising means for rendering the amplifier inoperative until a connection is made with the sending station, and for rendering the amplifier operative by the connection made at the sending station; tone-producing means at said receiving station; means whereby audio frequency oscillations may be generated, means for introducing said oscillations into said amplifier so that a calling tone may be given by said tone-producing means when a call from said sending station is received, and means whereby the generation of the oscillations may be discontinued so as to permit the amplifier to function in a normal manner.

2. Apparatus according to claim 1, wherein said amplifier includes a vacuum tube having a cathode, a grid and an anode, and the means for rendering the amplifier inoperative comprises a resistive network connected to apply a voltage to said grid so that the anode cathode current through the tube is substantially zero.

3. Apparatus according to claim 1, wherein said amplifier includes a vacuum tube having a cathode, a grid and an anode, and the means for rendering the amplifier inoperative comprises a resistive network connected to apply a voltage to said grid so that the anode cathode current through the tube is substantially zero, said resistive network being connected in parallel with the input terminals of the amplifier so that, when a connection is made with the sending station, the constants of the network are altered to vary the voltage applied to said grid to an extent permitting the anode cathode current through the tube to increase to render the amplifier operative.

4. Apparatus according to claim 1, wherein the means whereby the audio frequency oscillations may be generated includes a feed back network connected to inject a feed back voltage into the amplifier thereby to cause the amplifier to generate the oscillations.

5. Calling and warning apparatus for a communication system including a vacuum tube amplifier at a receiving station, said amplifier being provided with a vacuum tube having a cathode, a grid and an anode, and a sending station arranged for connection to the input circuit of said amplifier, comprising means for rendering the amplifier inoperative until a connection is made with the sending station, and for rendering the amplifier operative by the connection made at the sending station; tone-producing means at said receiving station; a feedback network con-

nected to inject a feedback voltage into the amplifier thereby to cause the amplifier to generate low frequency oscillations so that a calling tone may be given when a connection is made with said sending station, said means comprising a resistive network connected to apply a voltage to said grid so that the anode cathode current through the tube is substantially zero, the resistive network being connected in parallel with the input terminals of the amplifier so that, when a connection is made with a sending station the constants of the network are altered to vary the voltage applied to said grid to an extent permitting the anode cathode current through the tube to increase to render the amplifier operative, and switch means whereby the constants of the circuits in parallel with the input terminals may be changed thereby to attenuate the feedback voltage so that the generation of the oscillations may be discontinued to permit the amplifier to function in a normal manner.

6. Apparatus according to claim 5, wherein the constants of the resistive network having values at which, when the connection with the sending station is broken, the generation of the oscillations recommences so that a warning tone may be given.

7. Apparatus according to claim 1 and including an auxiliary source to generate the low frequency oscillations, in combination with switch means whereby the oscillations may be eliminated.

8. Apparatus according to claim 1, and including an auxiliary source to generate the low frequency oscillations, in combination with switch means whereby the oscillations may be eliminated, and a feedback network connected to inject a feedback voltage into the amplifier thereby to cause the amplifier to generate low frequency oscillations so as to give a warning tone when the connection with the sending station is broken.

9. Calling and warning apparatus for a communication system including a vacuum tube amplifier at a receiving station, and a sending station arranged for connection to the input circuit of said amplifier, comprising means for rendering the amplifier inoperative until a connection is made with the sending station, and for rendering the amplifier operative by the connection made at the sending station; tone-producing means at said receiving station; a feedback network connected to inject a feedback voltage into the amplifier via a rectifier of the diode type thereby to cause the amplifier to generate audio frequency oscillations so that a calling tone may be given when a call is received, and means whereby the generation of the oscillations may be discontinued so as to permit the amplifier to function in a normal manner.

10. Apparatus according to claim 9, wherein the feedback network is combined with switch means whereby the voltage applied to the diode anode may be reduced so that the generation of the oscillations may be discontinued.

11. Calling and warning apparatus for a communication system including a vacuum tube amplifier, comprising means for rendering the amplifier inoperative until a connection is made with a sending station, and for rendering the amplifier operative by the connection made at the sending station; tone-producing means at said receiving station; a feedback network which is connected to inject a feedback voltage into the amplifier via a rectifier of the diode type thereby to cause the amplifier to generate audio fre-

quency oscillations so that a calling tone may be given when a call is received, said means comprising a resistive network which is connected to apply a voltage to at least one of the electrodes of a vacuum tube in the amplifier so that the anode cathode current through the tube is substantially zero, the constants of the resistive network having values at which when the connection with the sending station is broken, the generation of oscillations recommences so that a warning tone may be given.

12. Calling and warning apparatus for a communication system including a vacuum tube amplifier at a receiving station, and a sending station arranged for connection to the input circuit of said amplifier, comprising means for rendering the amplifier inoperative until a connection is made with the sending station and for rendering the amplifier operative by the connection made at the sending station, tone producing means at said receiving station, and for rendering the amplifier operative by the connection made at the sending station; tone-producing means at said receiving station; and a feedback network coupled between the output and input circuits of said amplifier to inject a feedback voltage into the amplifier thereby to cause the amplifier to generate audio frequency oscillations exciting said calling tone means when a call is received, said feedback network including switch means whereby the path for the feedback voltage may be broken so that the generation of the oscillations may be discontinued to permit the amplifier to function in a normal manner.

13. Calling and warning apparatus for a com-

munication system, comprising a vacuum tube amplifier at a receiving station; means for rendering the amplifier inoperative until a connection is made at a calling station arranged for coupling to the input circuit of said amplifier to complete the circuit therebetween; means operative in response to such connection for locally generating at the receiving station an audio-frequency tone to indicate a connection has been made to the receiving station; means at the receiving station for then terminating such connection-indicating tone and for rendering the amplifier operative for normal functioning; and means including said connection-tone-terminating means and responsive to disconnection of the calling station for establishing a warning tone on said tone-producing means to indicate such disconnection and to maintain said warning tone until a predetermined operation of the tone-terminating means is performed.

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