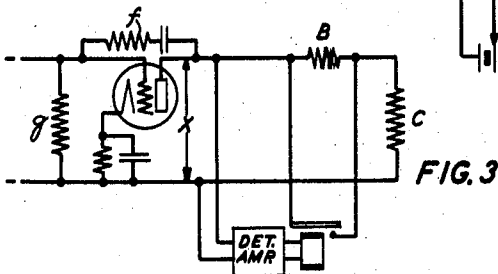
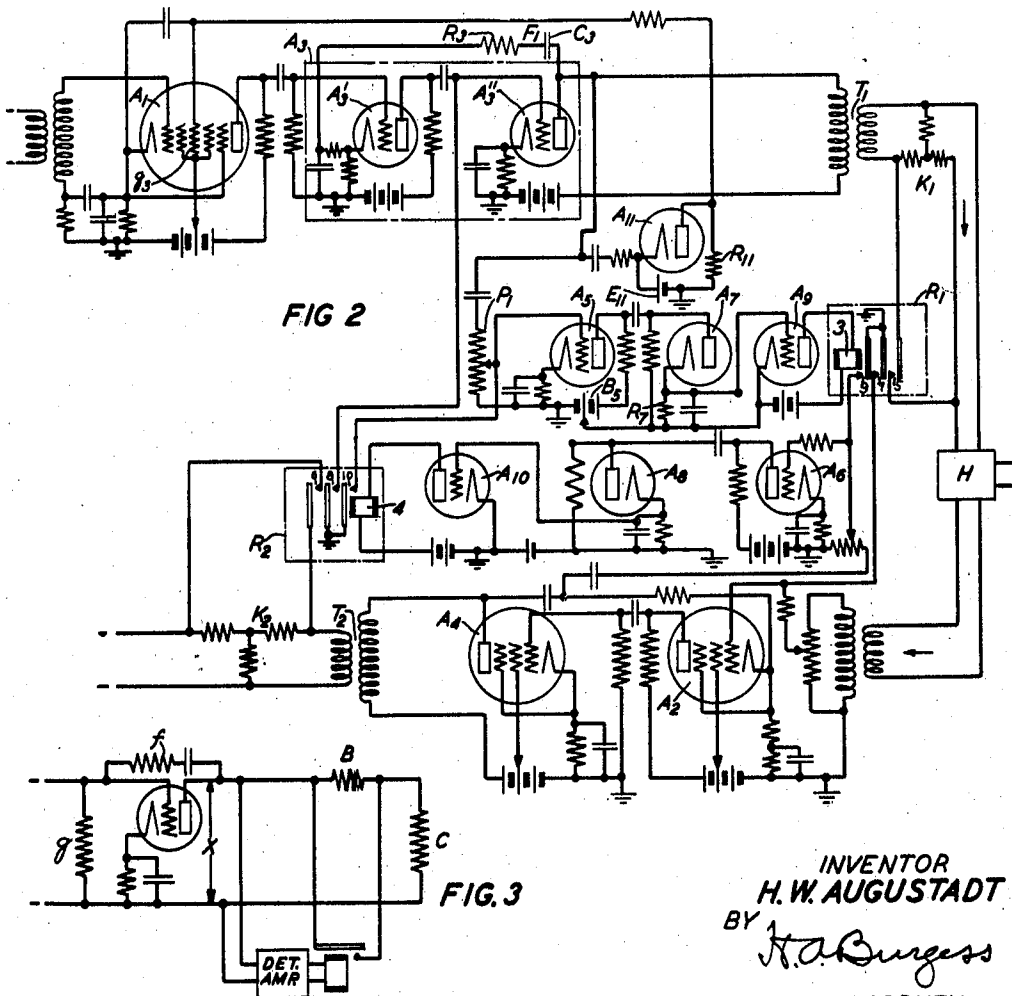
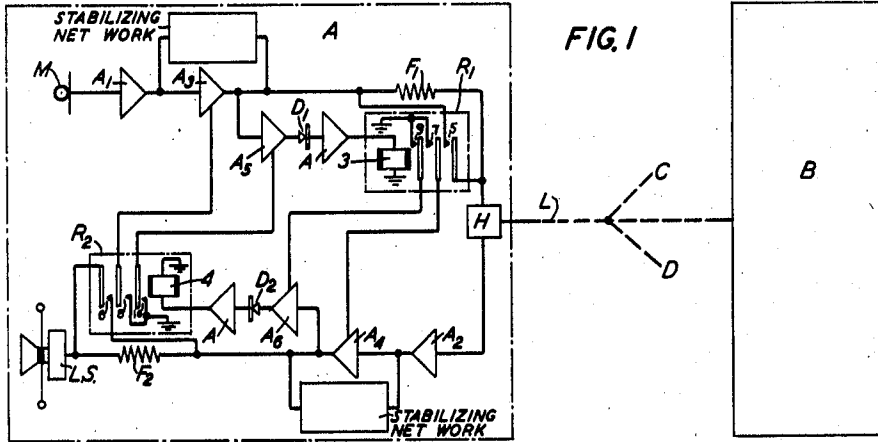


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TWO-WAY COMMUNICATION SYSTEM

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TWO-WAY COMMUNICATION SYSTEM

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This invention relates to two-way communication systems and more particularly to communication terminal circuits. Still more specifically, it relates to feedback stabilization for a combined signal and control amplifier in voice operated systems with applications to two-way communication.

While the invention has applicability in a wide variety of communication circuits, it will be described more specifically in connection with a telephone conference circuit.

In two-way communication terminals, especially if used in conference circuits where the connection between a plurality of terminals is more or less permanent, it is desirable that when no normal signal is taking place the system shall be as quiet as possible, being substantially immune from room noise and other background disturbances. Even during periods of signaling, such as speech signaling, it is desirable that in the pauses of the usual speech the circuits shall be brought to a highly quiescent condition. It is desirable also that at no time shall the power level of the signal rise to such values as to overload any part of the signaling equipment. Furthermore, it is necessary, if the terminal is a two-way circuit, that the high gain which is characteristic of amplifiers in such circuits shall not lead to singing.

In my invention there is present in a signal path a vacuum tube amplifier, the output load of which comprises a communication line or some signal responsive device. In order to maintain the system in a quiet condition during intervals of no signal, there is inserted in the signal path a loss device or attenuator which in my invention may be a series resistance or a shunt resistance, or a combination of the two. When signal is initiated in this path the loss is removed, this being accomplished by a control circuit, the input of which is itself connected in parallel to the main load. Also connected across the output of the amplifier and in parallel to the main load is a circuit which limits the power delivered by the amplifier to the main load. Thus there are two control circuits in parallel with the load.

However, the cutting out of the loss referred to above substantially alters the impedance into which the amplifier works, causing a drop in output voltage which may be of sufficient magnitude to seriously affect the operation of the control circuits. A part of my invention resides in stabilizing the amplifier circuit in such manner that the output voltage is nearly independent of the variations in load impedance. This stabilization

is accomplished by means of a negative feedback circuit to be described in greater detail. In addition, if the system is a two-way terminal having a transmit side and a receive side, the control circuits on the one side, when subjected to signal, operate to disable the circuits on the other side.

The invention will be more fully understood by reference to the following specification and accompanying drawing in which:

Fig. 1 is a simplified schematic circuit showing my invention:

Fig. 2 is a more detailed circuit diagram; and

Fig. 3 is explanatory of the principles underlying a part of my invention.

Referring more particularly to Fig. 2, there is shown at A_1 an initial amplifier, preferably of the variable μ type. While a variety of such tubes is available, the one which I have illustrated in this figure is that commonly identified as the 6L7 tube. The output of A_1 is impressed on an amplifier A_2 which is here shown as a two-stage amplifier comprising the amplifiers A_2' and A_2'' . In the output of the latter stage there is shown a transformer T_1 feeding into a line, the line including a loss device K_1 here shown as a series resistance and a shunt resistance. The loss K_1 is of such a magnitude that signal initiated in this path will be so attenuated as to be of relatively small magnitude on arrival at another terminal. For the satisfactory transmission of signal, therefore, it is necessary to reduce the effective value of this loss and I accomplish this by shorting out the whole or a part of this loss, in this case the series portion of the resistance being shorted out by a relay. To this end there is connected across the output circuit of A_2'' , in parallel to the line load a circuit comprising a potentiometer P_1 which in turn applies potential to the input circuit of the amplifier A_3 . The alternating current output of this last amplifier is rectified with any suitable form of rectifier, such as the tube A_7 , giving a direct current drop across resistance R_7 . This drop may then be applied directly to the winding 3 of a relay R_1 or preferably, as shown, may be impressed on the input circuit of an amplifier A_6 operating virtually as a direct current amplifier which, in turn, gives power to the relay winding 3. The relay upon excitation closes the contacts 5 shorting out portion of the loss K_1 .

It will be appreciated that the removal of an appreciable portion of the loss K_1 materially affects the impedance of the main load circuit, thus causing a drop in the output voltage of the

amplifier A_3'' and this drop may be sufficient to cause a release of the control circuit operating on energization of coil 3, thus giving rise to a chattering of the relay with accompanying undesirable effects.

A second control circuit is connected across the output of the amplifier A_3'' , this circuit containing a rectifier such as the diode A_{11} . The voltage drop thus set up from the output of diode A_{11} across resistance R_{11} is applied to the grid g_3 of the variable mu tube A_1 , the bias being such as to reduce the gain when the signal volume becomes excessive. The operation of this volume limiting device is also subject to variations when the load impedance changes.

To stabilize the action of the circuit as a whole I provide a negative feedback over a portion of the circuit, such as across a part or across the whole of the amplifier A_3 , the feedback in this circuit being shown as a network consisting of the blocking condenser C_3 and resistance R_3 . The effect of this stabilizer is that of making the output voltage of A_3'' practically independent of the variations in load impedance, thus removing the difficulties referred to.

The action of this stabilizing circuit will be better understood by analysis with reference to Fig. 3, which shows a simplified circuit diagram of a portion of the circuit under consideration, and in connection with which an analysis on the basis of a numerical example will be given. It is to be understood, however, that the invention is in no way restricted by the values used.

For the purposes of the analysis let R be the equivalent plate circuit generator impedance. Also for illustrative purposes assume the following impedance effects,

$$\begin{array}{lll} B=9R & C=R & \mu=100 \\ g=4R & f=20R & \end{array}$$

these being reasonable values for the circuits and tubes which may be used. For convenience also one may use the following notations:

V_1 =voltage at X required to operate the relay.

V_2 =voltage at X after relay operates when $f=\infty$.

V_3 =voltage at X after relay operates when $f=20R$.

E_0 =equivalent plate circuit generator to produce voltage V_1 when $f=\infty$.

E =equivalent plate circuit generator to produce voltage V_1 when $f=20R$.

The analysis of feedback circuits then leads to the following:

For Case $f=\infty$

$$V_1 = \frac{E_0(B+C)}{R+B+C} = .909E_0$$

$$V_2 = \frac{E_0C}{R+C} = .5E_0$$

For Case $f=20R$

$$V_1 = \frac{E(B+C)}{R(f+g) + B+C} = .995E$$

$$V_3 = \frac{EC}{R(f+g) + B+C} = .945E$$

Voltage V_1 to operate relay is the same in both cases, hence the percentage voltage change is

$$\frac{V_1 - V_2}{V_1} 100\% = 45\% \quad \frac{V_1 - V_3}{V_1} 100\% = 4.8\%$$

From this it is seen that without the stabilizing circuit there would be a 45% change in the output voltage of the amplifier A_3'' whereas with the stabilizing network this variation is reduced to 4.8% for the particular values used in this illustrative case.

In Fig. 3 one tube only is shown whereas in Fig. 2 the feedback is over the two amplifiers A_3' and A_3'' . Whether the one or the other connection is made will be determined by the sensitivity required for suitable stabilization. In either case consideration must be given to the proper phasing of the feedback connection. Thus in Fig. 3 the particular feedback network should be connected directly to the grid of the one amplifier whereas in Fig. 2 the feedback over two stages should be made to the cathode for proper phasing. Also, while in both of these figures a very simple form of negative feedback is shown, it is to be understood that other more complicated networks may be desirable in certain cases.

If the terminal is to be arranged for two-way communication as shown in Fig. 2, a similar circuit is provided for the receive side. Thus incoming signal is impressed on the input circuit of the tube A_2 which in turn is shown as connected to a second stage A_4 . To the output of this stage there is connected the transformer T_2 feeding into the line through a loss device K_2 similar to K_1 . A control circuit is also provided analogous to the control circuit of the transmit side already described. Operating on the relay R_2 this controls the contact 6 to short out a portion of the loss K_2 when signal comes through the receive path.

In order that there shall be no singing around the circuits of the terminal it is desirable that when signal is going out over the transmit side, the receive side shall be disabled. To this end two additional sets of contacts 7 and 9 subject to the relay winding 3 are provided and when the relay is operated the contacts 7 close to connect the control grid of A_2 to ground and the contacts 9 close to connect the grid of tube A_3 to ground, thus disabling both of these circuits. Similarly, if signal is passing over the receive side then the operation of its control circuit closes two additional sets of contacts 8 and 10 of relay R_2 which respectively connect the grid of the tube A_3'' and the grid of the tube A_5 to ground, thus disabling the transmit side.

In the operation of the rectifiers, it is desirable that they shall not respond to undesired disturbances of relatively small magnitude. This can be accomplished by suitable biasing of these rectifiers. Thus in the rectifier A_7 instead of connecting one terminal of the resistance R_7 to ground it is shown as connected to a point above ground on the battery B_5 of A_5 , the biasing being such that no current flows through the rectifier unless the impressed voltage is in excess of this bias. This or similar provision is in general provided on all the rectifiers. Thus in the case of the limiting voltage to be impressed on the grid g_3 of amplifier A_1 it may be desirable that no limiting action shall occur until the signal power level at the output of A_3'' exceeds a certain value. To this end a biasing battery E_{11} may be inserted in the circuit of the tube A_{11} , the polarity being such as to prevent rectification until the impressed voltage exceeds a certain predetermined level.

In Fig. 2 the transmit and the receive sides are shown as connected together to a two-wire circuit through a hybrid coil H but it is to be under-

stood, of course, that one may leave the system as a four-wire circuit. Also, while the invention has been described primarily in terms of a terminal circuit, it would serve equally well as a repeater station at any intermediate point on the transmission line.

The schematic drawing of Fig. 1 is a simplified diagram of a two-way telephone system which include a terminal A having circuits such as illustrated in Fig. 2, shown in single line schematic form, and a plurality of other similar terminals B, C and D which may be associated with each other and terminal A over the two-way line L.

While in the specification the change in impedance has been described as that due to the insertion or removal of a loss device as a function of time, it will be recognized that the impedance variation may come about in other ways. For example, the impedance of a certain element in the load circuit might be a function of frequency and my circuit arrangement would still be effective for such impedance changes.

What is claimed is:

1. In combination, an amplifier, a plurality of load circuits connected in parallel to the output of said amplifier, at least one of said load circuits having a variable impedance, and means to prevent any substantial change in the voltage input to one of said load circuits due to the varying impedance of another load circuit comprising means for negatively feeding back the alternating voltage across the output of said amplifier to the input thereof so as to maintain the amplifier output voltage substantially constant with variation in the impedance of said other load circuit.

2. In a signal transmission system, a signal transmission circuit, an amplifier in said circuit, a load circuit associated with the output of said amplifier, a control circuit having its input associated with the output of said amplifier in shunt with said load circuit and responsive to impressed signals to function as a control in said system, and means for substantially preventing variation in the input to said control circuit due to variations in the impedance of said load circuit, comprising means for negatively feeding back voltage from the output of said amplifier to the input thereof so as to maintain the output voltage of said amplifier substantially independent of variations in the impedance of said load circuit.

3. In a signal transmission system, a signal transmission circuit, an amplifier in said circuit, a load circuit containing a loss device connected to the output of said amplifier, a control circuit having its input connected to the output of said

amplifier in shunt with said load circuit and responsive to impressed signals to remove the loss from said load circuit and means for substantially preventing variation in the input to said control circuit due to variations in the impedance of said load circuit with removal of the loss therefrom comprising means for negatively feeding back voltage across the output of the amplifier to the input thereof so as to maintain the output voltage of said amplifier substantially constant with variation in the impedance of said load circuit.

4. The combination of claim 2 characterized by the fact that there are two such transmission circuits with an associated control circuit, one serving as the transmit side and the other as the receive side of a two-way communication system.

5. The combination of claim 3 characterized by the fact that there are two such transmission circuits with associated control and load circuits, one serving as the transmit side and the other as the receive side of a two-way communication system, and further characterized by the fact that each control circuit when performing its function of removing the loss on its one side also disables the amplifier and the control circuit on the other side.

6. In a signal transmission system, a signal transmission circuit, an amplifier in said circuit, a load circuit containing a loss device connected to the output of said amplifier, a plurality of control circuits connected to the output of said amplifier in shunt to said load circuit and responsive to impressed signals to remove the loss from the load circuit and to limit the amplitude of the signal impressed on the input of said amplifier, means for substantially preventing variation in the input of said control circuits due to variations in the impedance of said load circuit with removal of said loss therefrom comprising means for negatively feeding back the voltage across the output of said amplifier to the input thereof so as to maintain the output voltage of said amplifier substantially constant with variation in impedance of said load circuit.

7. In a telephone communication system, a plurality of two-way communication terminals adapted to be associated with each other for intercommunication, each terminal comprising a transmit side and a receive side, each side being characterized by the combination of claim 6 and further characterized by the fact that when one of the control circuits on the one side is functioning to remove loss from its side it disables the line amplifier and control circuits on the other side.

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