

Sept. 8, 1942.

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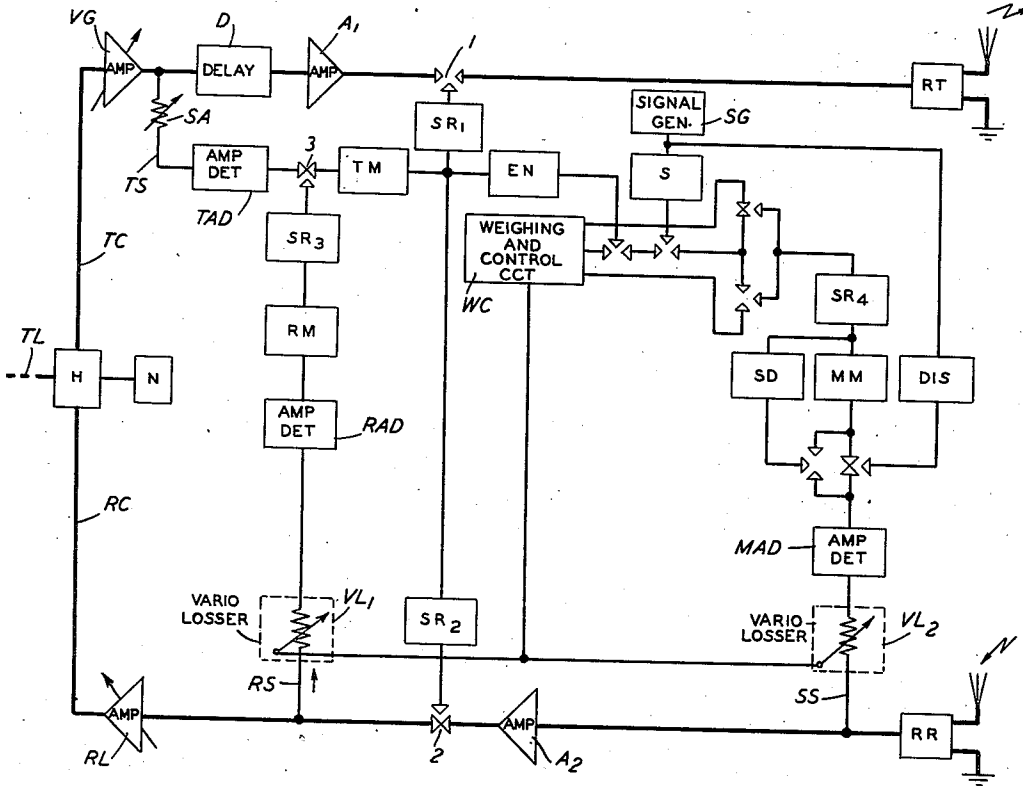
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TWO-WAY SIGNAL TRANSMISSION SYSTEM

Filed June 10, 1941

3 Sheets-Sheet 1

FIG. 1



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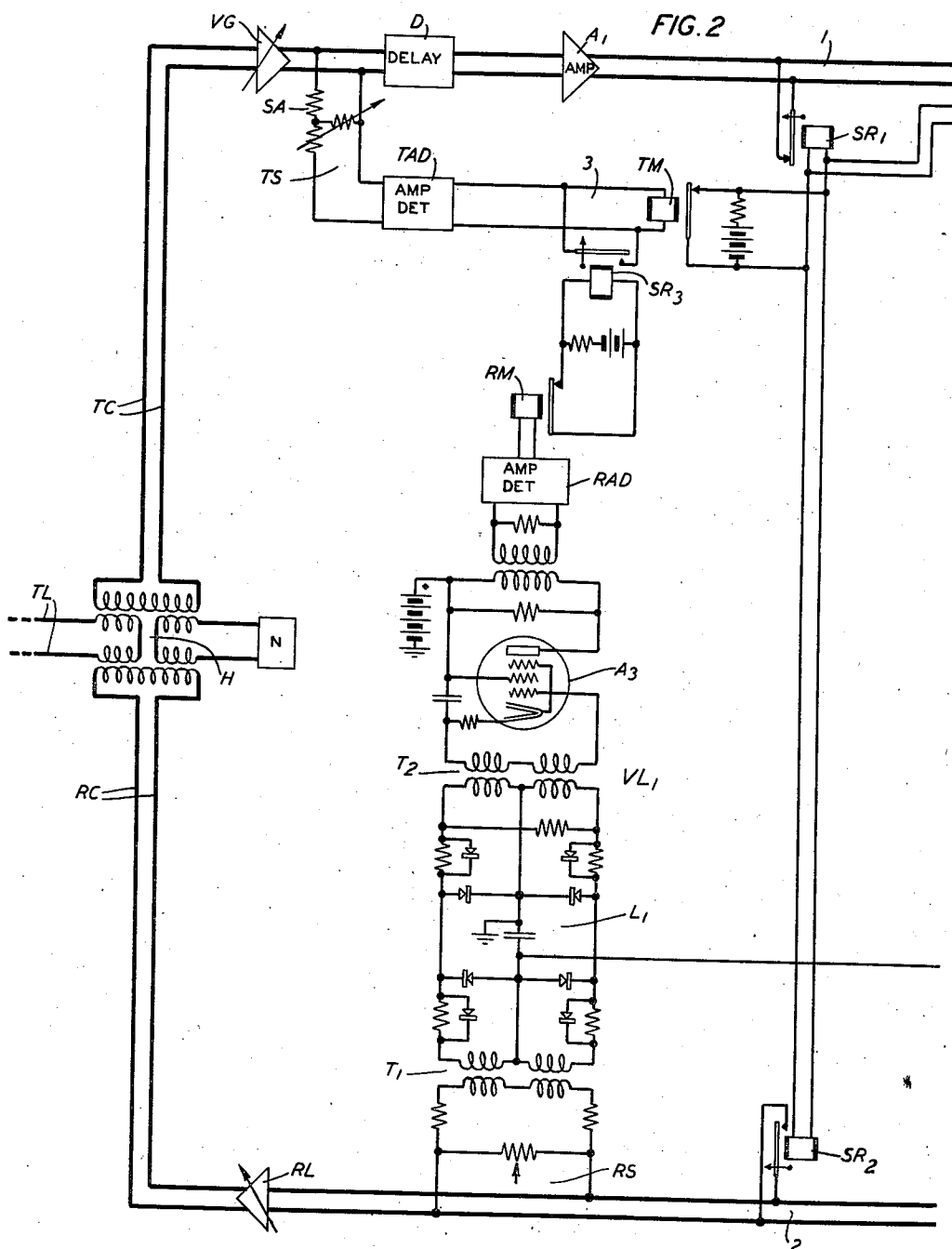
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3 Sheets-Sheet 2



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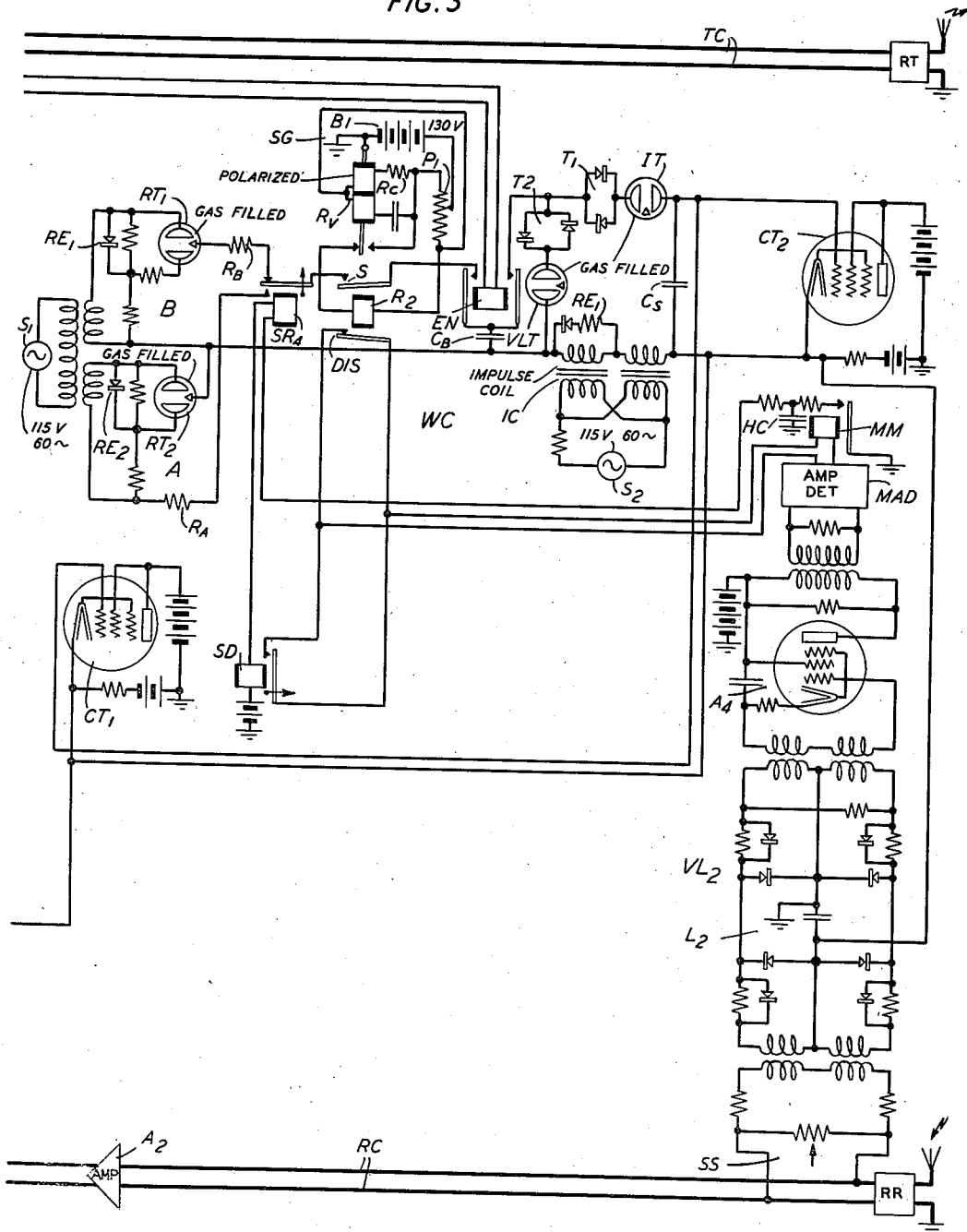
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FIG. 3



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TWO-WAY SIGNAL TRANSMISSION SYSTEM

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The invention relates to the signal-controlled switching devices employed for directionally controlling signal transmission in a two-way signal transmission system, and particularly to circuits for testing and adjusting the operation of such devices under service conditions.

The invention is particularly applicable to the voice-operated switching circuits, so-called vodas (voice-operated device antisinging) circuits employed at the terminals of a two-way radio or wire telephone system for directionally controlling telephone communication thereover while preventing singing and suppressing echoes. Such circuits usually comprise at each terminal of the system, a transmitting voice-operated switching branch responsive to outgoing telephone signals in the outgoing signal path to condition that path for transmitting the signals and to disable the incoming signal path, and a receiving voice-operated switching branch responsive to incoming telephone signals in the incoming signal path to disable the transmitting voice-operated switching branch at the terminal.

As is well known, such systems are subject to variable line noise or variable static and selective fading conditions in the intermediate two-way wire or radio link, tending to cause false operation of the receiving voice-operated switching circuits at the sensitivity required for their proper operation on speech signals, and such conditions may at times be so severe as to greatly interfere with signal communication over the system.

It is an object of the invention to automatically test the operation of such voice-operated directional control switching circuits.

A more specific object is to measure the interference effect on outgoing speech signals in a voice-operated terminal for a two-way telephone system, caused by false operation of the voice-operated switching devices by noise or static, and to adjust the sensitivity of these voice-operated devices in accordance with the measurements.

These objects are accomplished in accordance with the invention by circuits which measure during outgoing speech signals a certain attribute of received noise or static, and automatically adjust the sensitivity of the receiving vodas switching branch accordingly. In one embodiment, these circuits include an amplifier-detector relay circuit controlled by the received static interlocked with a relay circuit controlled by a source of auxiliary signals simulating speech signals, and a weighing and control circuit operative only during periods of outgoing signal trans-

mission to measure the ratio of the operated time of the first relay circuit to that of the latter relay circuit as a measure of signal clipping, and to control the adjustment of the sensitivity of the receiving branch of the vodas switching circuit as well as that of the static-controlled circuit, to the optimum value to reduce the clipping.

The various objects and features of the invention will be understood from the following detailed description when read in conjunction with the accompanying drawings, Fig. 1 of which is a single line functional schematic of one terminal of a two-way radio telephone system equipped with measuring and control circuits in accordance with the invention, and Figs 2 and 3 of which in combination show schematically these measuring and control circuits in more detail.

In the diagram of Fig. 1, the heavier single lines represent the main two-wire signal transmission paths and the lighter single lines two-wire circuits of the associated switching and control circuits. The transmission apparatus in the main transmission paths and associated circuits are represented by boxes suitably labeled or simplified representations of their functions. Contacting arrowheads in a transmission path indicate that the path is normally enabled at that point, and separated arrowheads in a transmission path indicate that the path is normally disabled at the point. An arrow directed from a box towards a normal make point in a path indicates that the path will be disabled at that point by operation of the apparatus represented by the box. An arrow directed from a box towards a break point in a transmission path indicates that the path will be enabled at that point by operation of the device presented by the box. A box containing a simplified representation of a resistance with an arrow crossing through it represents a variable loss device the value of which is adapted to be varied under control of the apparatus from which the arrow points.

The two-way radio telephone terminal of Fig. 1 comprises a one-way signal transmitting circuit TC including the vario-amplifier VG, which may be a vogad (volume-operated gain adjusting device) of the type well known in the art, the delay circuit D and the one-way amplifier A₁, leading to the radio transmitter RT, and a one-way signal receiving circuit RC including the one-way amplifier A₂ and the variable loss device RL, leading from the radio receiver RR. The input of the transmitting circuit TC and the output of the receiving circuit RC are coupled by the usual hybrid coil H and associated balancing

network N in conjugate relation with each other and in energy transmitting relation with the two-way line section TL which may be connected directly or through a switchboard (not shown) to a two-way line leading to a telephone subscriber's station.

The radio telephone terminal in Fig. 1 is shown equipped with a vodas switching circuit of well-known type for giving directional control of the terminal to either the outgoing signals in the transmitting circuit TC, of the local talker, or to the incoming signals in the receiving circuit RC, of the talker associated with the distant terminal, depending on which are prior, while preventing singing and suppressing echoes. The transmitting circuit TC is normally disabled at a point 1 to the right of the delay circuit D, and the receiving circuit RC is normally operative. The vodas switching circuit includes a transmitting branch TS having its input connected across the transmitting circuit TC at a point to the left of delay circuit D, and a receiving branch RS having its input connected across the receiving circuit RC at a point to the left of the disabling point 2. The transmitting branch TS includes an input sensitivity-adjusting variable loss pad SA followed by the transmitting amplifier-detector TAD a master relay TM which is operatively energized by the output currents of the latter when it is operated by the outgoing signals of the local talker applied to its input from the circuit TC, and the slow-releasing switching relays SR₁ and SR₂ operating in response to operation of the master relay TM to respectively enable the transmitting circuit TS at the point 1 to allow transmission of the outgoing telephone signals to the radio transmitter RT, and to disable the receiving circuit RC at the point 2 to prevent subsequent transmission of incoming telephone signals to the line TL or to the input of the receiving branch RS of the vodas switching circuit. The receiving branch RS of the vodas switching circuit includes the input sensitivity-adjusting vario-losser VL₁ followed by the receiving amplifier-detector RAD, the receiving master relay RM operatively energized by the output currents of the latter when incoming signals in the circuit RC are applied to its input, and the slow-releasing switching relay SR₃ operating in response to operation of the master relay RM to disable the transmitting switching branch TS at the point 3 between the output of the amplifier-detector TAD and the transmitting master relay TM to prevent operation of the latter relay by any subsequent outgoing signals or echoes applied to the input of the branch TS.

It is apparent that if the receiving switching relay SR₃ is held operated in response to incoming static in the receiving circuit RC when outgoing signals of the local talker are impressed on the transmitting circuit TC and are applied to the transmitting amplifier-detector TAD, that the consequent disabling of the transmitting switching branch TS will allow the first words, at least, of the local talker's outgoing speech currents to be clipped, or possibly lost. As the basis for the design of the static measuring circuits of the invention to be described, a "noise criterion" was established as a measure of the transmission impairment caused by such clipping of outgoing speech. The "noise criterion" taken is that the percentage clipped time is a satisfactory measure of clipping, regardless of the type of clipping. This infers that for a given percentage of clipped time the average annoyance effect on the listener

will be the same whether the mutilations occur frequently with short duration, or less frequently with longer duration. With static noise operation the type of clipping can vary over a wide range, and under certain conditions of fading the circuit may be commercial although occasionally several words are lost.

According to the above criterion, the product of a number of clips per minute and the average duration of the clips should be kept constant. The influence of the durations of the static impulses is, therefore, apparent and is illustrated by the following simple example. Let it be assumed that all potential noise operations are of equal duration t , occurring at the rate s . Then for a given set of outgoing speech signals, the number of clips per minute is proportional to the probability of finding the circuit blocked by noise, which is (ts) , that is, equivalent to the fraction of time the receiving switching relay SR₃ is held operated by noise in the absence of speech in the receiving circuit RC. If a syllable is clipped, the part lost is equally likely to be of any length from zero to t . Therefore, the average duration of the clips is $t/2$. The clipped time T_c is then

$$T_c = K(ts) \frac{t}{2}$$

where the value of K depends upon the distribution of the outgoing signals, and the vodas operation. K also increases with the hangover time on the transmitting switching relay SR₂. With static type of noise interference, the durations of the potential noise operations will vary over a wide range. But under commercial operating conditions, it can be expected that $t/2$ can be taken as equivalent to the means potential noise operation.

The procedure that is adopted in accordance with the invention to determine the transmission impairment of the outgoing signals caused by received static and to correct for this condition, is to measure during periods of outgoing speech indicated by the operation of the transmitting vodas branch TS, a certain attribute of the static and to adjust the sensitivity of the receiving vodas switching branch RS according to these measurements.

The circuits for accomplishing this result include a switching circuit SS similar to the vodas receiving switching branch RS, operating on static during outgoing speech periods, connected across the receiving circuit RC at some point between the disabling point 2 and the radio receiver RR. The circuit SS comprises an input sensitivity-adjusting vario-losser VL₂, the measuring amplifier-detector MAD, a master relay MM controlled from the output of the letter and the slow-releasing relays SR₄ and SD operating in response to operation of the relay MM. They also include a signal generator SG for continuously supplying signal pulses simulating speech signals to operate the signal relay S which tests whether or not the switching relay is operated, and to operate the disabler relay DIS to disable the circuit SS at a point between the output of measuring amplifier-detector MAD and the master relay MM; a "weighing and control" circuit WC controlled by the relays SR₄ and S in the manner to be described, which measures what fraction of the signal time is clipped or lost due to static, and controls the adjustments of the vario-lossers VL₁ and VL₂ in the input of the receiving vodas branch RS and the static-controlled switching circuit SS, respectively, in an attempt to keep the percentage of lost signal time within given

limits; and a slow-releasing enabler relay EN operating in response to the operation of the transmitting vodas master relay TM to put the circuit WC in operation during periods of outgoing speech signals. The operation of relay SR₄ puts a break in the upper branch and closes a normal break in the lower branch of the weighing and control circuit WC.

The relay SD operates in response to operation of the master relay MM to close a short circuit around the contacts of the disabler relay DIS to prevent subsequent operation of the latter relay from disabling the relay MM.

The measuring and control circuits of Fig. 1 operate as follows:

If the signal relay S and the static-controlled relay SR₄ are both released, the first of these relays to operate controls, and during its holding period, prevents any action by the other relay. Let it be assumed that the relay EN is held operated due to the operation of the transmitting master relay TM in the transmitting vodas branch TS by outgoing speech signals, and that the signal generator SG is sending out pulses about 0.18 second long four times a second, simulating average speech signals. These signal pulses cause the operation of the signal relay S and the disabler relay DIS. If at the moment the signal is applied the switching relays SR₄ and SD are released, the operation of disabler relay DIS will break the energizing circuit for the master relay MM so as to prevent static from mutilating the signal pulses. In other words, the auxiliary signals will obtain control of the circuit SS and the upper branch of the weighing and control circuit WC is put in action. If the relays SR₄ and SD are operated at the moment the auxiliary signals of signal generator SG are applied, the relay DIS is ineffective because of the short circuit around its contacts, and the lower input branch of the weighing circuit WC is effective as long as the switching relay SR₄ and the relay S are simultaneously operated. The values of the elements in the condenser-resistance circuit (not shown) associated with relays SR and SD would be selected to give the required amount of hang-over in operation of these relays.

The period of closure of the upper branch of the weighing and control circuit WC corresponds to (signal time)—(clipped time) and that of the lower branch to the clipped time. When the ratio

Clipped time

(Signal time)—(Clipped time)

averaged over a given time interval, exceeds a given value, the circuit WC operates to increase the loss in the vario-lossers VL₁ and VL₂ to reduce the sensitivity of the receiving vodas branch RS and the static-operated switching branch SS a proportional amount, and when the ratio falls below a given value the loss in the vario-lossers will be decreased and thus the sensitivities of RS and SS will be increased in the proper amount. Since the average clipped time is a small fraction of the total signal time, the action of the circuit can be described as an adjustment of the static amplitudes at the input to the amplifier-detectors in circuits RS and SS so as to keep the percentage clipped time, averaged over some time interval, within certain narrow limits.

The schematic circuits of Figs. 2 and 3 when laid side by side with Fig. 2 at the left show in detail the two-wire circuits and apparatus illustrated in the block single line functional sche-

matic of Fig. 1, corresponding elements in the two figures bearing the same identification characters.

As shown in Fig. 2, the vario-losser VL₁ in the receiving vodas branch RS includes the amplifying vacuum tube A₃ connected in front of the receiving amplifier-detector RAD; the preceding well-known type of copper-oxide varistor network L₁ comprising the input and output transformers T₁ and T₂, and connected between them a plurality of series copper-oxide rectifiers shunted by resistors and a plurality of shunt copper-oxide rectifiers; and a pentode control tube CT₁ having its plate cathode circuit connected across network L₁ so that the amount of plate current flowing through the series and shunt impedances of the latter controls the loss value of the network and thus the effective gain of tube A₃ and the sensitivity of the circuit RS. The similar vario-losser VL₂ in the circuit SS comprises the amplifying vacuum tube A₄ connected in front of the amplifier-rectifier MAD, the preceding copper-oxide varistor network L₂, similar to L₁, and the pentode control tube CT₂ the plate current of which flows through the network L₂ to control its loss value, and thus the effective gain of tube A₄ and the sensitivity of the static-operated switching circuit SS.

The amount of plate current flowing in the plate-cathode circuits of tubes CT₁ and CT₂ determining the amount of loss in the vario-lossers VL₁ and VL₂, respectively, is in turn determined by the voltage on the capacitor C_s in the weighing and control circuit WC, the capacitor C_s being connected in common to the control grid-cathodes circuits of the two sensitivity control tubes CT₁ and CT₂.

As shown in Fig. 3, the weighing and control circuit WC consists of several parts of which the capacitor C_B with its associated rectified voltage supply, cold cathode gas tubes RT₁ and RT₂ and associated alternating current source S₁ (60 cycles, 115 volts) can be considered the weighing part; and the cold cathode, gas-filled voltage limiter tube VLT, the cold-cathode gas-filled isolator tube IT, the saturable core impulse coil IC and associated alternating current input source S₂ (60 cycles, 115 volts), the capacitor C_s and the hot cathode, space discharge control tubes CT₁ and CT₂, as the control part. In the control part, the voltage limiting tube VLT functions to limit the maximum rate of gain change produced by the control tubes CT₁ and CT₂ in the vario-lossers VL₁ and VL₂ in the receiving vodas branch RS and the static-operated switching circuit SS, respectively. It also prevents excessively high voltages from being established on the capacitors C_s and C_B in the limiting condition of very low static or very high static, which would require a long time to reverse. The limiting action in this circuit depends on the impedance in series with the tube VLT provided by the two "Thyrte" elements T₁ and T₂, which were selected on an empirical basis to give about the same limiting voltages in both directions, and not excessive variations from tube to tube, caused by the critical nature of the tube characteristic and low current values.

The isolating tube IT serves to provide high leakage impedance for the C_s condenser, during the non-charging periods. The breakdown voltage of this tube and the priming voltage supplied by the impulse coil IC are the main factors in determining the critical voltages V_a and V_b of opposite polarity on the condenser C_B at which

the gain changing actions of the lower and upper branches A and B, respectively, of the weighing and control circuit WC are initiated. The relative values of V_a and V_b can be varied by making the secondary voltage of the impulse coil IC asymmetrical by shunting one of the secondary windings by a copper-oxide resistance RE₁. The function of the impulse coil IC and the associated input alternating source S₂ (60 cycles, 115 volts) is to provide a voltage primer to lower the critical voltages V_a and V_b at which the gain change action starts. An impulse coil was utilized in place of an ordinary alternating current transformer to allow the use of lower capacity values in C_s and a lower charging resistance. The impulse coil shortens the duration of the priming impulse.

The function of the other principal elements in the weighing and control circuits WC may be summarized as follows: (1) The ratio of the charging resistance R_a to the charging resistance R_b determines the percentage of clipped time of the standard signal under normal operating conditions. Reducing this ratio decreases the sensitivity. (2) The value of the condenser C_b determines the time required for action to begin when the static level changes. The time, starting with C_b on zero and no static, required for initiating the gain increase, will be referred to as the "go" period of the system. Increasing the capacity of C_b will reduce the frequency and magnitudes of the gain changes, but will affect the average sensitivity very little. Thus an increase in C_b capacity tends to stabilize the system from the standpoint of gain changes. (3) Varying the capacity C_s changes the rate of gain increase and decrease in the same proportion. (4) The ratio between the rates of gain decrease and increase can be varied by varying the relative priming voltages. Reducing the ratio tends to reduce the sensitivity. (5) The copper-oxide rectifiers RE₁ and RE₂ across the input resistances in the control gap circuits of rectifier tubes RT₁ and RT₂ confine the discharge in the control gaps to the periods when the anode voltage is positive and thereby prevent discharge in the main gaps of the tubes for negative anode voltages.

The signal generator SG as shown, consists of a vibratory relay R_v driven by the 130-volt battery B₁ and associated resistances and condensers, which drives relay R₂ with disabling (DIS) and signal (S) contacts performing the function of the two relays so labeled in Fig. 1. To explain the operation of the signal generator circuit, let it be assumed that the armature of relay R_v has just moved to the lefthand contact. The high condenser current through the lower winding will tend to hold the armature on that contact, but the current through the upper winding will tend to pull it over to the righthand contact, and will do so when the condenser current is falling to a different definite value. When the armature is on the righthand contact, the reverse action takes place. This particular type of vibratory circuit was selected because its period can be changed by varying the value of resistance R_c without affecting the percentage operated time, and the percentage operated time can be changed by the sliding contact on the potentiometer P₁, without changing the period.

The operation of the system of Figs. 2 and 3 will now be described.

During periods of non-operation of the transmitting vodas TS, the capacitors C_b and C_s will

have the charge (neglecting leakage) existing at the moment the relay EN releases. The signal pulses supplied by the signal generator SG operate the relay R₂ four times a second closing the S contacts and opening the DIS contacts for 0.18 second each time. For simplifying the description, synchronization of associated operations may be assumed and the error will be small because as a whole the system is slow operating.

Now, assume that the relay EN is operated in response to the operation of the transmitting vodas TS by outgoing speech signals, and that at that time the DIS contacts of the relay R₂ are open. If the relay SD is released at the moment, the consequent opening of the output circuit of the measuring amplifier-detector MAD will prevent operation of the master relay MM during the signal period. The signal pulses therefore will be unclipped, and the capacitor C_b will be charged from S₁ through rectifier RT₁ and charging resistance R_a in the branch B during the whole signal period, tending to make the upper side of C_b negative. A series of unclipped signals will increase the voltage on C_b in the direction indicated above until the isolator tube IT breaks down, with transfer of part of the charge on C_b to C_s, thereby making the voltage of the latter more negative, with a consequent increase in the negative bias on the control grids of control tubes CT₁ and CT₂ and decrease in the plate current of these tubes. This in turn changes the direct current flowing through the series varistors of the varistor networks L₁ and L₂ in VL₁ and VL₂, respectively so as to reduce their alternating current impedance and the direct current flowing through the shunt varistors of these networks so as to increase their alternating current impedance. The net result is an increase in the static level at the input of the measuring amplifier-detector MAD because of the decrease in the loss of the vario-losser VL₂ (increase of effective gain of A₂) and an increase in the static level at the input of the receiving amplifier-detector RAD of the receiving vodas RS because of the decrease in loss of the vario-losser VL₁ (increase of effective gain of A₃). A further series of unclipped signals will increase the voltage of C_b and thereby speed up the transfer of charge from C_b to C_s and consequently the rate of sensitivity increase. The maximum voltage on C_b is limited to about 70 volts by the voltage limiter tube VLT. The operating voltage range during gain increase is therefore from about 30 to 70 volts.

The increase in the static level as the gain of vario-losser VL₂ increases, will finally cause the operation of the master relay MM. Now, if when the signals arrive, the DIS contacts of relay R₂ are already shorted by the contacts of operated relay SD, the armature of relay SR₄ will be on the lower contact, and the capacitor C_b will be charged in the reverse direction from source S₁ through rectifier tube RT₂ and charging resistance R_a in branch A as long as the relay SR₄ and the S contacts of relay R₂ are simultaneously operated. If the relay SR₄ releases during the signal period, the capacitor C_b will be charged in the other direction for the rest of the signal period. Under normal conditions it can be assumed that when the sensitivity is being increased the first clippings will be small. The process will then be as follows: The initial tiny clips will retard the rate of gain increase. When the clips increase they will reduce the voltage on C_b below the critical value, thereby stopping the gain increase action. The voltage on C_b may now

fluctuate about the zero value for considerable periods without exceeding the critical values V_a and V_b . It would be desirable to select the constants of the circuit to adjust the time actions so that for the average type of static this condition is satisfied for long periods.

To prevent failure of the circuits illustrated and described above to operate properly in the remote chance of a rapid increase in static during a period of received speech to such a value that the receiving switching relay SR_3 is held continuously operated to lock the transmitting vodas and prevent operation of the enabler relay EN to start the operation of the static measuring and adjusting circuit, it may be desirable to employ an idle period enabler (not shown) which will automatically start the measuring and adjusting operation if the transmitting vodas branch TS has not operated for a given length of time determined by the length of the longest talk spurt to be expected which is in the order of two minutes, to permit the proper adjustment of the receiving vodas branch sensitivity when the terminal is idle between calls. A suitable idle period enabler which could be used for this purpose is that illustrated in Fig. 2 of my copending patent application Serial No. 362,476, filed October 23, 1940, which issued as Patent No. 2,272,998 on Feb. 10, 1942.

In the circuits illustrated and described, the sensitivity is not adjusted during periods of received speech but only when static alone is being received. If the measuring amplifier-detector MAD and associated currents are designed to discriminate between static and received speech in any suitable manner so as to provide operation of the relay MM on static only, the circuit would be adapted for operation also while speech signals are being received.

Other modifications of the circuits illustrated and described within the spirit and scope of the invention will be apparent to persons skilled in the art.

What is claimed is:

1. In combination with a two-way telephone system including at a terminal thereof a normally disabled outgoing signal transmission path, an incoming signal transmission path subject to received noise waves, and directional control means comprising a transmitting wave-operated switching branch responsive to outgoing telephone signals in said outgoing path to enable that path and a receiving wave-operated switching branch responsive to incoming telephone signals in said incoming path to disable said transmitting branch, means to determine the effect of said received noise waves on outgoing signal transmission comprising a source of auxiliary signals simulating telephone signals, one relay means operatively responsive to the signals from said source, a second relay means operatively responsive to the received noise waves in said incoming path, said one relay means operating to disable said second relay means except when the latter is in the operated condition, and a measuring circuit controlled by said transmitting switching branch, said one and said other relay means for indicating the ratio of the operated time of said second relay means to the operated time of said one relay means during outgoing signal transmission intervals as a measure of the clipping of the outgoing telephone signals caused by false operation of said receiving switching branch during those intervals.

2. In combination with a terminal for a two-way telephone system including a signal transmitting path, a signal receiving path subject to received noise waves, and voice-operated switching means including a transmitting portion responsive to outgoing telephone signals in said transmitting path, in the absence of prior incoming telephone signals in said receiving path, to condition the terminal for transmitting only, and a receiving portion responsive to incoming telephone signals, in the absence of prior outgoing signals in said transmitting path, to condition the terminal for receiving only, and means to determine the effect of false operation of said receiving switching portion by the received noise waves on outgoing signal transmission comprising relay means operatively responsive to the received noise waves in said receiving path, a source of auxiliary signals simulating telephone signals, a second relay means operated by said auxiliary signals, the operation of said second relay means causing the disabling of the first relay means except when the latter is in the operated condition, and a measuring circuit controlled by the two relay means and effective only during periods of outgoing signal transmission, to indicate the percentage operated time of said first relay means with respect to the total operated time of said second relay means during a given outgoing signal interval as a measure of the percentage clipped time of said outgoing signals.

3. In combination with a terminal of a two-way radio telephone system including a normally disabled signal transmitting path, a normally operative signal receiving path and voice-operated switching means comprising a transmitting switching branch responsive to outgoing telephone signals in said transmitting path to enable that path and to disable said receiving path, and a receiving switching branch responsive to incoming telephone signals in said receiving path, when it is operative, to disable said transmitting switching branch, means to reduce the effects of incoming static in said receiving path on outgoing signal transmission comprising a static-operated switching circuit connected to said receiving path in front of the disabling point therein, relay means operatively responsive to operation of said static-operated circuit, a source of auxiliary signals simulating telephone signals, a second relay means operatively responsive to the auxiliary signals from said source, means responsive to operation of said second relay means to disable said static-operated switching circuit, means responsive to operation of the first relay means to prevent the disabling of said static-operated switching circuit in response to subsequent operation of said second relay means, a measuring circuit adapted to be rendered operative by operation of said transmitting switching branch to measure the relative times of operation of the first relay means and said second relay means during a given outgoing signaling interval as a measure of the clipped time of outgoing telephone signals during that interval, and means controlled by said measuring circuit for adjusting the sensitivity of said receiving switching branch and that of said static-operated switching circuit in accordance with the measurements to the optimum values.

4. The combination of claim 1, in which said measuring circuit is rendered operative each time said transmitting switching branch is operated by outgoing telephone signals and said measuring circuit includes a capacitor, means to cause

said capacitor to be charged at a certain rate in one direction in response to each operation of said one relay means during an outgoing signal interval if said second relay means is unoperated at the time, and to be charged in the reverse direction at the same rate when during an outgoing signal interval said second relay means operates and said one relay means becomes simultaneously operated, and means for indicating the charged condition of said capacitor.

5. The combination of claim 3, in which said measuring circuit includes a capacitor and means responsive to each operation of said second relay means during an outgoing signal interval if said first relay means is unoperated at the time to cause said capacitor to be charged at a certain rate in one direction, and if said first relay means is operated at the time to cause said capacitor to be charged at the same rate in the reverse direction, and said sensitivity adjusting means comprises a vario-losser in the input of said receiving switching branch, another vario-losser in the input of said static-operated circuit, and means responsive to an average charge on said capacitor in excess of a given value to increase the loss in the two vario-lossers and responsive to a charge on said capacitor less than another lower given value to decrease the losses in the

two vario-lossers, so as to maintain the percentage clipped time of the outgoing signals, averaged over some predetermined time interval, within tolerable limits.

6. The combination of claim 3, in which said measuring circuit is rendered operative by operation of a third relay means in response to operation of said transmitting switching branch, said measuring circuit comprises a capacitor adapted to be charged at a certain rate in one direction when said second relay means and said third relay means are simultaneously operated, and to be charged in the reverse direction when all three relay means are simultaneously operated, and said sensitivity adjusting means comprising a vario-losser in the input of said transmitting switching branch, a second vario-losser in the input of said static-operated circuit, and means responsive to a charge on said capacitor greater than a predetermined value to cause the losses of the two vario-lossers to be increased, and responsive to a charge on said capacitor less than a predetermined lower value to cause the losses of the two vario-lossers to be decreased, so as to maintain the sensitivity of said receiving switching branch at the optimum value for the amount of received static at all times.

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