

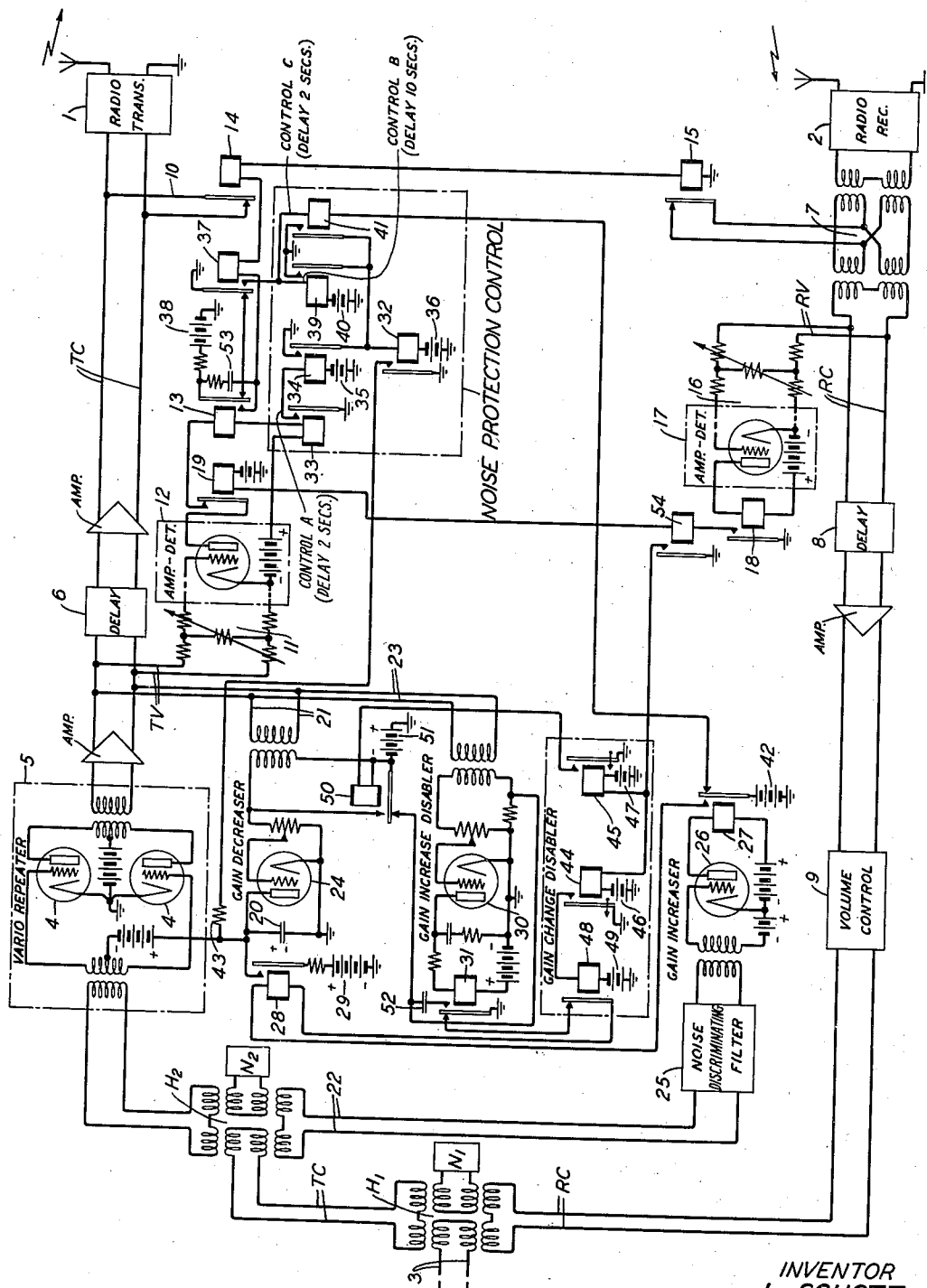
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SIGNAL CONTROLLED SWITCHING CIRCUITS IN TELEPHONE SYSTEMS

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SIGNAL CONTROLLED SWITCHING CIR-  
CUITS IN TELEPHONE SYSTEMSLionel Schott, Orange, N. J., assignor to Bell  
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The invention relates to signal wave transmission systems and particularly to signal control switching circuits employed for controlling transmission in telephone systems.

5 The invention will be specifically described as applied to the voice-operated switching circuits, commonly called Vodas (voice-operated device anti-singing) circuits, employed for preventing singing and suppressing echoes in two-way tele-  
10 phone systems, but is adapted as well for use with other types of voice-operated switching circuits. As is well known, such systems are subject to variable interfering waves of different types as regards duration and frequency of occurrence, such as room or line noise and static,  
15 having a frequency spectrum similar to that of the voice signals but which are of a steady nature compared to such signals. This noise is often of such amplitude as to tend to produce false  
20 operation of the voice-operated switching circuits at the sensitivity required for their proper operation on voice signals.

The Vodas switching circuits at the terminals of a radio terminal system are intended to be  
25 operated properly only by the speech waves which pass through the terminal. To that end, the sensitivities of these circuits must be so adjusted as to make their proper actions possible. The receiving Vodas circuits are usually adjusted as sensitive as possible for the amount of noise or  
30 static present in the receiving signal path, whereas the transmitting Vodas circuits have their sensitivities adjusted in relation to the level of the speech current in the transmitting signal path.  
35 In the case of the former circuit, the sensitivity may, but not necessarily so, remain fixed for appreciable periods of time with predictable adjustments, whereas in the case of the latter circuit the sensitivity may vary widely for suc-  
40 cessive talkers over about a 40-decibel range.

Particularly, when an automatic device like the Vogad (volume-operated gain adjusting device) is used in the transmitting path to provide,  
45 in addition to its usual function of delivering substantially constant signal volume to the radio transmitter, that of adjusting the sensitivity of the transmitting Vodas circuit to compensate for the varying signal input with strong and weak  
50 talkers, difficulties may be encountered from abnormal noise operations of the transmitting Vodas circuit, which may impose severe penalties on circuit performance.

It is an object of this invention to eliminate to a large extent the noise operation difficulties of  
55 voice-operated switching circuits in such systems,

observed as detrimental under service conditions.

A more specific object is to protect the switching relays of a relay type, voice-operated switching circuit employed for preventing singing and suppressing echoes in a two-way telephone system, against excessive false operation by noise of the different types encountered in such a system.

These objects are attained in accordance with the invention by a circuit arrangement comprising a plurality of control circuits controlled from different parts of the voice-operated switching circuit, or from that circuit and the Vogad in combination, having such delays in operation as to be respectively responsive to abnormal false operation of the voice-operated switching circuit by noise of one of the different types, to adjust the sensitivity of the switching circuit sufficiently to cause its release.

The invention will be better understood from the following detailed description thereof when read in conjunction with the accompanying drawing, the single figure of which shows schematically, and in part diagrammatically, one terminal of a radio telephone system embodying one form of the invention.

First, the different types of noise difficulties which experience has indicated are most likely to be encountered under service conditions at the terminal of a radio telephone system will be described briefly. These include:

(1) Room noise, the most troublesome cases of which are generally caused by the traffic operator leaving her talking set connected to the terminal during idle circuit periods. This noise, generally below the normal talking level, may occasionally become high enough to operate the gain increaser of the Vogad and cause the gain in that device to rise, in turn causing the noise at the transmitting Vodas input to become high enough to operate the transmitting switching relays. In many cases, this noise has caused solid operation of the relays which thus blocks off completely any received transmission until the transmitting relays are released.

(2) Intermittent noises, which may or may not affect the Vogad but whose frequency of occurrence is such as to effectively bridge the normal releases of the transmitting Vodas relays, particularly the final relay in the chain operating to disable the receiving voice transmission path, which is the slowest to release, causing excessive operation times for these relays.

(3) Steady noise of a type such as would hold

the transmitting master relay operated for an excessive period.

The Vodas and the Vogad operate on these types of noise in a characteristic manner generally quite distinguishable from the manner in which they operate on pure speech current. The circuits of the invention to be described in connection with the drawing make use of the characteristic differences in operation to effect automatic release from the noise troubles when they occur.

The drawing shows schematically one terminal of a two-way radio telephone system comprising a four-wire circuit connecting a telephone line to a radio transmitter and a radio receiver which may be of any well-known type or construction. The four-wire circuit comprises a transmitting circuit TC leading to the radio transmitter 1 and a receiving circuit RC leading from the radio receiver 2. The input of the transmitting circuit TC and the output of the receiving circuit RC are connected in well-known manner by the hybrid coil  $H_1$  and associated balancing network  $N_1$  in substantially conjugate relation with each other and in energy transmitting relation with the two-wire line section 3 which may be connected with a two-way telephone line.

The transmitting circuit TC includes, in order, connected between the hybrid coil  $H_1$  and the radio transmitter 1, a vario-repeater 5 which, with the associated control circuits to be described later, constitutes an automatic volume control device known as a Vogad, a delay circuit 6 and one or more amplifiers. The receiving circuit RC includes, in order, connected between the radio receiver 2 and the hybrid coil  $H_1$  the variable loss pad 7, a delay circuit and a volume control device 9. The transmitting circuit TC is normally disabled at a point between the radio transmitter 1 and the delay circuit 6 by a short-circuiting connection 10, whereas the receiving circuit RC is normally operative due to a normal low loss condition of the suppressor loss pad 7.

Connected across the circuit TC at a point between the vario-repeater 5 of the Vogad and the delay circuit 6, is the input of the transmitting Vodas circuit TV comprising an adjustable resistance loss pad 11 for obtaining desired initial adjustment of the sensitivity of the transmitting Vodas, a wave-operated switching device 12 which may be a voltage-operated amplifier-detector circuit such as is well known in the art, and a plurality of mechanical switching relays including the master Vodas relay 13, connected to the output of the control device 12, so as to be simultaneously operatively energized in response to operation of the latter device by outgoing speech signals in the transmitting circuit TC, providing their energizing circuit has not been previously disabled by the receiving Vodas circuit RV in response to prior signals in the receiving circuit RC received from the distant radio terminal in the manner described below. The master Vodas relay 13, when operated, closes an energizing circuit for relay 37 and the switching relays 14 and 15 so that these relays are operated. Relay 14, when operated, opens its normally closed contacts to break the short-circuiting connection 10 across the circuit TC so as to render that circuit operative to transmit the speech signals which meanwhile have been delayed in delay circuit 6. Relay 15 when operated opens its normally closed contacts to put the loss

pad 7 in the receiving circuit RC in a high loss condition, so as effectively to disable that circuit to prevent singing and suppress echoes.

Relays 14, 37 and 15 have progressively lower bias winding effects for the purpose of their respective slow release actions which are otherwise controlled by the charging of condenser 53. After relay 13 releases, relay 14 releases in about .12 second, relay 37 in .15 second and relay 15 in .17 second. Relay 37 releases and quickly stops the charging of condenser 53, thus insuring that the slower release of relay 15 is soon thereafter effected.

The suppressor loss pad 7 may be of any type adapted to be changed from a low loss condition to a high loss condition by operation of a relay. The particular loss pad illustrated operating in this manner is similar to the one disclosed and claimed in the Silent Patent 1,749,851 issued March 11, 1930.

The receiving Vodas circuit RV, the input of which is connected across the receiving circuit RC at a point between the loss pad 7 and the delay circuit 8, comprises the adjustable resistance loss pad 16 for obtaining a desired initial sensitivity adjustment of the receiving Vodas circuit, the wave-operated control device 17 which may be a voltage-operated amplifier-detector circuit like the transmitting device 12, and a chain of switching relays including a master relay 18 which is operated in response to operation of the control device 17 by applied voice waves, and a relay 19 operatively energized by operation of the master relay 18 and operating to break the energizing circuit for the relays including the master Vodas relay 13, controlled from the output of the transmitting control device 12 in the transmitting Vodas circuit TV.

The Vogad in the transmitting circuit TC may be of any of the well-known types. The particular Vogad illustrated is essentially the same as disclosed in Mitchell et al. Patent 2,019,577 issued November 5, 1935. It includes the vario-repeater 5 comprising two three-electrode amplifying vacuum tubes 4 connected in push-pull in the transmitting circuit TC, having a gain regulating condenser 20 common to the control grid-cathode circuits of the two amplifying tubes, and associated control circuits comprising the "gain decrease" circuit 21, the "gain increaser" circuit 22 and the "gain increase disabler" circuit 23.

The gain decrease circuit 21 includes the three-electrode vacuum tube detector 24 having its input connected across the transmitting circuit TC beyond the output of vario-repeater 5, and its output connected across the gain-regulating condenser 20. This circuit is arranged to operate in response to an increase in the level of the waves in the output of vario-repeater 5 above a certain desired value to reduce the charge on the condenser 20, so as to cause the gain of the vario-repeater 5 to be decreased in proportion to the increase in the output level thereof over the desired value.

The gain increaser circuit 22, the input of which is coupled to the transmitting circuit TC at a point in front of vario-repeater 5 by the hybrid coil  $H_2$  and associated balancing network  $N_2$ , includes the noise discriminating filter 25 in its input, the three-electrode vacuum tube detector 26 having its input connected to the output of filter 25, relay 27 connected to the output of detector 26, so as to be operatively energized by operation of the latter, and the gain increase relay 28 adapted to be operatively energized by

operation of relay 27, relay 28 operating to connect the positive pole of the grounded battery 29 to gain-regulating condenser 20 so as to increase its positive charge and thus raise the gain of vario-repeater 5. The gain increaser circuit 22 is arranged to operate in response to an increase in the level of the voice waves in the transmitting circuit TC in front of vario-repeater 5, above a certain minimum value to increase the gain of vario-repeater 5 proportionately.

The gain increase disabler circuit 23, the input of which is connected across the transmitting circuit TC at the same point as the input of the gain decrease circuit 21, includes a three-electrode vacuum tube detector 30 and the gain increase disabler relay 31 operatively responsive to operation of detector 30 to disable the gain increaser circuit 22 by opening the energizing circuit for the gain increase relay 28. The gain increase disabler circuit 23 is arranged to operate in response to the waves in the transmitting circuit TC beyond the output of vario-repeater 5 when their level reaches the desired value so as to prevent further increase of the gain of vario-repeater 5 under control of the gain increaser circuit 22.

In addition, the Vogad includes circuits for preventing change in the gain of the vario-repeater 5 in the transmitting circuit TC by the associated gain control circuit when the receiving Vodas circuit RV has been operated in response to received signals or noise in the receiving circuit RC. These circuits include a relay 54 in circuit with the relay 19 operating simultaneously therewith in response to operation of the receiving Vodas master relay 18, and the relays 44 and 45 arranged to be supplied with energizing current from batteries 46 and 47, respectively, when relay 54 is operated. Relay 44 is designed to be quick-operating and slow-releasing so that it will be operated quickly in response to operation of the receiving Vodas master relay 18 either by speech signals or noise waves, and will remain operated during the usual pauses in speech transmission. Relay 45, on the other hand, is designed to be slow-operating but quick-releasing, so that it will not respond to operation of the receiving Vodas master relay 18 by momentary speech or noise impulses but will respond to operation of relay 18 in response to continuously received speech waves.

Relay 44, when operated, causes relay 48 to be operatively energized by current from battery 49. The consequent operation of relay 48 will open the energizing circuit for the gain increase relay 28 of gain increaser 22 preventing its operation to increase the gain of vario-repeater 5 while the receiving Vodas circuit RV is locked up regardless of whether this is caused by received speech signals or noise.

Relay 45, when operated, causes a relay 50 to be operatively energized by current from battery 51 to short-circuit the input of the gain decrease circuit 25, disabling that circuit and removing battery 51 from the grid of the gain increase disabler tube 30 thereby holding the gain increase disabler circuit 23 operated and effectively preventing any increase in the Vogad gain during the period in which the receiving Vodas circuit RV is operated by received speech waves.

The volume control device 9 in the receiving circuit RC may be a manually adjusted arrangement, or is preferably an automatic adjusting arrangement such as disclosed in British Patent

No. 381,831, which functions at all times by inserting sufficient loss to maintain a safe margin wherein received energy in circuit RC which is so weak as to fail to operate control RV will also, at least, just fail to cause false operation of control TV when parts of this energy reach circuit TC as echo energy.

The transmission devices and circuits in the radio telephone control terminal as shown in the drawing, as described above, are such as are commonly used in radio control terminals. The remaining portions of the circuit illustrated in the drawing constitute one embodiment of the noise protection circuit of the invention. As illustrated, this noise protection circuit includes three delayed operating relay control circuits A, B and C, shown within the dot-dash box labeled "Noise protection control," controlled respectively from the transmitting Vodas master relay circuit including relay 13, the transmitting Vodas relay 37 which operates in a manner closely related to the operations of the switching relay circuit including relays 14 and 15, and in combination from relay 37 and the gain increaser circuit 22 of the Vogad in the transmitting circuit TC, each of which delayed operating relay circuits controls the operation of the quick-operate quick-release action relay 32, which, in turn, controls the transmitting Vogad gain.

The relay circuit A includes a master relay 33 in circuit with the master relay 13 of the transmitting Vodas circuit TV and operating simultaneously therewith, and a relay 34 adapted to be operatively energized from battery 35 when relay 33 is operated. The operation of relay 34 causes operating current to be supplied to the winding of the action relay 32 from battery 36. By suitable design of relay 34 to make it slow to operate in the required degree, the relay control circuit A is made to cause operation of the action relay 32 in response to continuous operation of master relay 33, and therefore of the Vodas master relay 13, by the output current of the transmitting amplifier-detector 12 for a time interval of about 2 seconds after the transmitting Vodas master relay 13 operates.

The relay control circuit B includes relay 37, which is in circuit with and a part of the transmitting Vodas switching system with relays 14 and 15 and operates simultaneously with the latter relays when operating current is supplied from battery 38 in response to operation of the master Vodas switching relay 13, and the relay 39 arranged to be supplied with operating current from the battery 40 when relay 37 operates. Operation of the relay 39 also causes energizing current to be supplied to the winding of the action relay 32 from battery 36. By proper design of the relay 39 to make it slow-operating to the required degree, the control circuit B is made to cause operation of the action relay 32 in response to continuous operation of relay 37 for a time interval of about 10 seconds.

The relay control circuit C includes relay 37 and relay 41 which is supplied with energizing current from battery 42 through the back contacts of the gain increase relay 27 (when that relay is unoperated) and the front contacts of relay 37 when the latter relay operates under control of the transmitting Vodas master relay 13. The operation of relay 41 also causes energizing current to be supplied to the winding of action relay 32 from battery 36. By proper design of the relay 41 to make it slow-operating to the required degree, the control circuit C is made to cause op-

eration of the action relay 32 in response to continuous operation of relay 37 for a time interval of about 2 seconds provided the Vogad gain increaser relay 27 has not operated.

5 The relays 34, 39 and 41 are designed to be quick-releasing so that the quick-releasing action relay 32 will return quickly to the unoperated condition when the transmitting Vodas switching relays release.

10 The operation of the control circuit C will be prevented if the gain increaser circuit 22 has been previously operated by applied voice waves from the transmitting circuit TC, to open the back contacts of the gain increase relay 27, thereby breaking the connection of battery 42 to the winding of relay 41.

Operation of the action relay 32 in response to operation of any one of the control circuits A, B or C will cause the relay contacts to be closed to connect the discharge resistance 43 in shunt with the gain-regulating condenser 20 of the Vogad. Then, the condenser will be discharged through that resistance to reduce the gain of the vario-repeater 5 in an amount dependent on the time during which the action relay 32 remains operated, that is, until the amplitude level of the waves in the output of the vario-repeater 5 impressed on the transmitting Vodas circuit TV is sufficiently reduced to cause the release of the master relays 13 and 33. Preferably, the time constant of the circuit (discharge resistance 43) controlled by the action relay 32 should be made such that the gain of the Vogad is reduced several decibels more than is sufficient to release the Vodas relays in order to avoid any appreciable effects like hunting.

35 The manner in which the circuits of the invention as described above operate to provide protection against the various types of noise difficulties occurring in the operation of a radio terminal may be explained as follows:

40 Considering the room noise problem, it will be assumed, as is generally the case, that the transmitting Vogad gain is at some moderately low value as adjusted properly by the last speech currents transmitted. With the transmitter of the talking party left "open" during a lull in conversation, it will be assumed that a burst of room noise then occurs in sufficient magnitude to operate the Vogad gain increaser 22 momentarily, whereupon the Vogad gain may increase some amount. From this, or from successive but generally infrequent bursts of room noise, the gain of the Vogad may become high enough to cause virtual lock-up of the transmitting Vodas relays 13, 37, 14 and 15 on the lower background of room noise. When that occurs and persists for as long as 2 seconds, the slow-operate (2 seconds) relay control circuit C will operate to cause operation of the action relay 32, provided the gain increase relay 27 has not in the meantime been operated to disable that circuit.

60 The gain increaser in any Vogad should have a sensitivity so that it will operate at least on the strong peaks of any speech for which the Vogad is intended to adjust, and these peaks should occur at least once every second during continuous flow of speech current. It is practically unavoidable that the gain increaser will operate occasionally, but certainly not so regularly on random bursts of noise. On speech then, the control relay circuit C is effectively disabled by the gain increase relay 27, whereas on the usual types of room noise this relay circuit is seldom operated again within 2 seconds so

that the control C is permitted to operate the action relay 32 and reduce the Vogad gain as it should. Thus, the undesirable room noise operation can be effectively and automatically detected and compensated for, in most cases within 2 seconds of its occurrence.

Certain other types of noise, however, may not be effective in operating control circuit C. It has been observed that in ordinary conversation, the speech flows are so broken or grouped that the Vodas relays 37, 14 and 15 are practically never operated continuously for as long as 10 seconds. Thus, any type of noise, intermittent or steady, which, in so far as the Vodas relays 37, 14 and 15 are concerned, tends to bridge the gaps between the speech flows in an outgoing continuous train of speech, will operate control circuit B and thus operate the action relay 32 within a time interval of 10 seconds after the Vodas switching relays 37, 14 and 15 become operated. In the absence of speech currents in the transmitting circuit TC, the relay control circuit B would be effective, of course, on any intermittent noise whose gaps between the successive operating peaks did not exceed .15 second in a continuous 10-second period, the time of .15 second being the slow-release time of the transmitting Vodas relay 37, required in connection with the particular transatlantic radio telephone terminal to which the circuits of the invention were applied.

It has been further observed that in normal operation, the transmitted speech currents will not hold the transmitting Vodas master relay 13 operated solidly for a continuous period as long as 2 seconds. Thus, any steady noise tending to hold the master relay 13 operated continuously for 2 seconds would operate relay control circuit A and thus the action relay 32. This type of noise would also, of course, operate relay control circuit B if it persisted for 10 seconds, but when it is so definitely and quickly detected it is desirable to make any necessary correction in the sensitivity of the transmitting Vodas circuit as soon as possible. This type of noise would also be detected in 2 seconds by control circuit C if the noise at the input of the Vogad was low enough in magnitude so as to fail to operate the gain increaser 22.

When any of these three noise protector circuits A, B or C causes operation of the action relay 32, a connection through its contacts connects the discharge resistance 42 across the gain-regulating condenser C, which operates to reduce the charge on the gain-controlling condenser 20 in the Vogad so as to make the necessary reduction in the Vogad gain. When the gain is reduced sufficiently, the Vodas relays 13, 37, 14 and 15 will release, in turn causing release of the action relay 32 and stopping further unnecessary reduction of the Vogad gain. The time action of this gain decreasing arrangement can be adjusted by the choice of the value of the resistance 42 in the leakage path of the gain control condenser 20, so that in relation to the slow-release time of relay 37 (and the action relay 32), the gain reduction will be desirably carried several decibels beyond the "just release" point and thus provide a necessary margin of safety. This time action can be arranged, of course, so that following an action of the noise protection circuits, the Vogad is immediately available to make any desired gain change.

To obtain optimum protection against noise difficulties, it has been found experimentally that

all three of the controls A, B and C are necessary. It was found that the control circuit C is particularly effective in detecting and compensating for the difficulties arising from room noise operation. Control circuits A and B appear to be less important only because noises of the types necessary to cause their operation occur rather infrequently.

It is to be understood that the values for the delayed operating times of the control circuits A, B and C specified above are given by way of example only, and that these operating times may differ radically from the values given, depending on the constants of the particular Vodas circuits with which these circuits are employed.

The action relay 32, of course, may be arranged to operate on a variable gain amplifier or Vogad located in the transmitting Vodas circuit TV to produce the required change in sensitivity to cause its release from abnormal operation on the different types of noise, instead of on the Vogad used in the transmitting circuit TC, in a manner similar to that described for the latter device. Also, similar results can be obtained by causing the operation of the action relay to switch fixed losses of the proper values into the transmitting circuit TC or the transmitting Vogad circuit TV. This may be accomplished, for example, by providing resistance pads of the proper values in these circuits, which are normally short-circuited, and having the action relay 32, when operated, remove the short circuits.

Other modifications of the circuits illustrated and described which are within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. In combination with a circuit transmitting signal waves and subject to interfering noise waves of different types, and an associated wave-operated switching device operating differently on said signal waves and said noise waves, means for minimizing false operation of said switching device by the applied noise waves, comprising a plurality of control circuits unresponsive to operation of said device by the signal waves but respectively responsive to characteristic abnormal operation of said device by applied noise waves of a different one of said types, to adjust the sensitivity of said device to prevent further false operation by the applied noise waves.

2. In combination with a wave-operated switching device supplied from a source of signal waves intermittent in character and subject to comparatively steady interfering noise waves of different types, means for minimizing false operation of said device by said noise waves comprising a plurality of control circuits respectively responsive to continuous operation of said device for different abnormally long time intervals, each characteristic of operation by one of said different types of noise, and each longer than would occur in response to applied signal waves alone, and means responsive to operation of any one of said control circuits to adjust the sensitivity of said device to prevent its further false operation by the applied noise waves.

3. In combination, a line transmitting voice signal waves and subject to comparatively steady interfering noise waves of different types as regards duration and frequency of occurrence, a voice-operated switching device connected to said line, a plurality of control circuits respectively

operatively responsive to continuous operation of said device for an abnormally long time interval longer than would occur in response to voice signal waves alone, caused by a different one of said different types of noise, and means responsive to operation of any one of said control circuits to reduce the sensitivity of said device sufficiently to prevent further false operation by the applied noise waves.

4. In combination, a circuit transmitting voice signal waves and subject to comparatively steady noise waves of different types as regards duration and frequency of occurrence, a wave-operated switching device connected to said circuit, and means to minimize false operation of said switching device by said noise waves comprising a plurality of control circuits having different delays in operation, each operatively responsive to continuous operation of said switching device for a different interval of time longer than would occur in response to applied voice signal waves alone, respectively characteristic of operation by noise waves of a different one of said types, and means responsive to operation of any one of said control circuits to reduce the sensitivity of said switching device sufficiently to cause its release.

5. In a two-way telephone system comprising oppositely directed one-way transmission paths for the telephone signals transmitted in opposite directions, which are subject to comparatively steady interfering noise waves of different types as regards duration and frequency of occurrence, and a voice-operated switching circuit connected to one path, operating to control transmission in said paths so as to prevent singing and suppress echoes, means to minimize false operation of said device by said noise waves comprising a plurality of control circuits respectively operatively responsive to continuous operation of portions of said switching circuit for different intervals of time longer than would occur in response to applied telephonic signals alone, respectively characteristic to operation by a different one of said types of noise waves, and means responsive to operation of any one of said control circuits to reduce the sensitivity of said device sufficiently to cause its release.

6. The system of claim 5 in which said voice-operated switching device comprises an amplifier-detector connected to one of said one-way paths, a master relay circuit controlled by operation of said amplifier-detector and a switching relay circuit responsive to operation of said master relay circuit to properly control transmission in said paths, and said control circuits comprise relay chains having different delays in operation respectively determined by said different types of noise waves, the operations of which are respectively controlled from said master relay circuit and said switching relay circuit.

7. In a two-way telephone system comprising oppositely directed one-way paths for the telephonic signals transmitted in opposite directions, which are subject to comparatively steady interfering noise waves of different types as regards duration and frequency of occurrence, a voice-operated switching circuit consisting of an amplifier-detector connected to one of said paths so as to be supplied with the telephonic signals and noise waves therefrom, a master relay circuit responsive to operation of said amplifier-detector, and a switching relay circuit responsive to operation of said master relay circuit to disable the other of said paths and render said one path operative to transmit signals, and a Vogad in-

cluding a gain increaser portion, in said one path for automatically regulating the sensitivity of said switching circuit in accordance with the level of the telephonic signals in said one path, and means for minimizing false operation of said switching circuit by the applied noise waves comprising a plurality of control circuits having respective delays in operation determined by the characteristics of the different types of noise waves, one of these control circuits being controlled from said master relay circuit and two others from said switching relay circuit, and means controlled by operation of said gain increaser of said Vogad for preventing operation of one of said two other control circuits.

8. The system of claim 7, in which the delay time of said control circuit controlled from said master relay circuit is of the order of 2 seconds, the delay time of said one of said two other control circuits controlled from said switching relay circuit is of the order of 2 seconds, and the delay time of the second of said two other control circuits is of the order of 10 seconds.

9. The system of claim 7, in which the delay in operation of said one control circuit controlled from said master relay circuit is determined by

the duration of comparatively steady noise such as would hold said master relay operated for an excessive period, the delay in operation of one of said two other control circuits is determined by the duration of the usual room noise, and the delay in operation of the other of said two other control circuits controlled from said switching relay circuit is determined by the duration of intermittent noise whose frequency of occurrence is such as to effectively bridge the normal releases of the relays in said switching relay circuit.

10. In combination with a voice-operating system comprising a plurality of wave-responsive devices which separately or in combination respond differently as regards duration of continuous operating intervals to a given train of voice waves, means to indicate continuous operation of the respective devices for predetermined time intervals longer than predetermined longest sustained operating intervals in response to normal voice waves, respectively characteristic of operation by different types of noise waves, and means responsive to said indicating means to adjust said system to make it unobjectionably responsive to noise waves.

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