

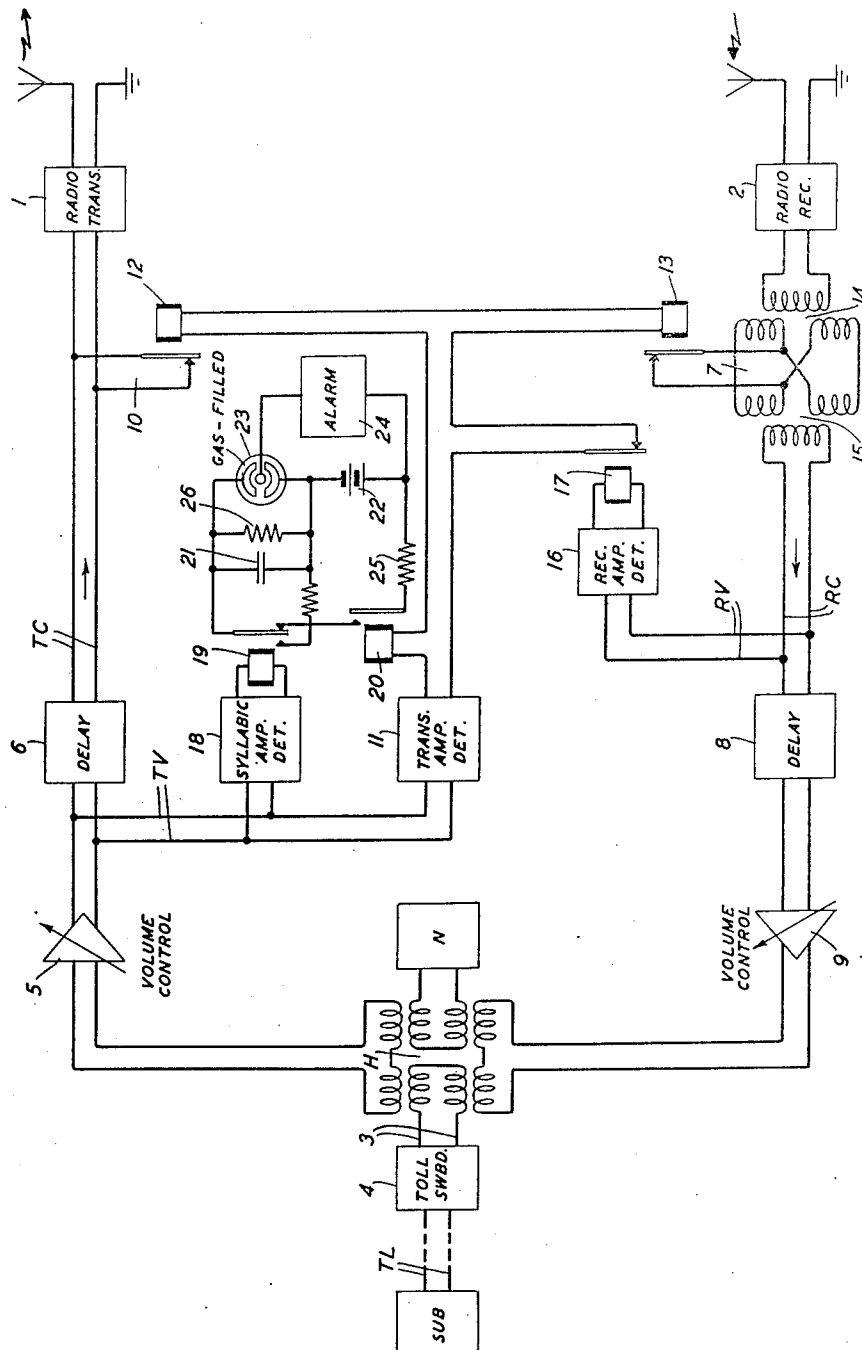
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INDICATING CIRCUIT

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INDICATING CIRCUIT

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The invention relates to indicating circuits and particularly to circuits for indicating the operation of signal-controlled switching devices in telephone systems under service conditions.

5 The invention will be specifically described as applied to voice-operated echo suppressors and anti-singing (vodas) devices in two-way telephone systems, such as a two-way radio telephone system, but is adapted as well for use in
10 connection with other types of voice-operated switching devices. As is well known, such systems are subject to variable noise, such as room or line noise, or static, having a frequency spectrum similar to that of speech signals but which
15 is of a steady nature compared to speech signals. This noise is often of such amplitude as to tend to produce false operation of the voice-operated switching device at the sensitivity required for its proper operation on speech signals.

20 In the case of a radio telephone system, for example, under some conditions of operation, the noise received by the transmitting circuit at a terminal from the associated two-way telephone line may be sufficient to cause false operation of
25 the transmitting vodas, and such operation, when severe, may actually lock up the transmitting vodas for an extended period of time thus blocking the receiving circuit at the terminal and preventing the signals received from the distant
30 terminal from reaching the telephone subscriber associated with the local terminal during that time interval. Also the receiving vodas of a radio telephone terminal, particularly in a short wave system, may be falsely operated and in some
35 cases actually locked up by static received from the radio link, thus mutilating or preventing the transmission of signals from the terminal.

It is an object of the present invention to indicate promptly and positively the occurrence and extent of false operation of a voice-operated
40 switching device by noise.

Another object is to give an indication of abnormal false operation by noise of a voice-operated switching device both in the presence of
45 or absence of speech signals.

A related object is to indicate promptly and positively to an attendant at a station of a two-way telephone system, the locking up of one or more voice-operated switching devices therein
50 by noise, in order to enable the necessary steps to be promptly taken to remove this objectionable operating condition.

Another object is to provide automatically an indication of an abnormally low volume output
55 of a volume control device in a signaling system.

These objects are attained in accordance with the invention by a circuit arrangement which effectively balances, on the basis of operated times, the operation of a voice-operated switching device subject to false operation by noise, against that of a syllabic device responsive to the voice signals but substantially unresponsive to noise, in such manner that if there are infrequent or no operations of the syllabic device indicating the absence of applied speech signals, while there are operations of the switching device indicating the presence of objectionable noise, an alarm will be given.

In one embodiment, this circuit arrangement includes a condenser which is charged at a certain rate by operation of the voice-operated switching device in response to voice signals or noise in an associated transmission path, and is discharged at a more rapid rate by operation of a syllabic device connected to the transmission path, the latter device operating in response to the syllabic variations in speech signals but being substantially unresponsive to the comparatively steady noise, and an alarm device responsive to the building up of a charge on the condenser a predetermined amount greater than that which would occur if speech signals alone were present on the transmission path.

Other objects and features of the invention will be brought out in the following detailed description thereof when read in connection with the accompanying drawing, the single figure of which shows schematically one terminal of a radio telephone system embodying the invention.

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 and associated balancing network N in substantially conjugate relation with each other and in energy transmitting relation with the two-wire line section 3 which is connected by the toll switchboard 4 with the two-way telephone line TL.

The transmitting circuit TC comprises, in order, connected between the hybrid coil H and the radio transmitter 1, the volume control device 5 and the delay circuit 6, and the receiving circuit

RC comprises, in order, connected between the radio receiver 2 and the hybrid coil H, the variable loss pad 7, the delay circuit 8 and the volume control device 9. The transmitting circuit TC is normally blocked 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 variable loss pad 7.

Connected across the circuit TC, between the volume control device 5 and the delay circuit 6, is the input of a transmitting vodas circuit TV comprising a wave-operated switching device 11, which may be a voltage-operated amplifier-detector circuit such as is well known in the art, and a plurality of mechanical relays including relays 12 and 13, connected to the output of the control device 11, so as to be simultaneously energized in response to operation of the latter device by outgoing speech signals in the transmitting circuit TC provided their energizing circuit has not been previously disabled by the receiving vodas circuit in response to prior signals in the receiving circuit RC received from the distant radio terminal in a manner to be described below. Relay 12 when energized operates to open its normally closed contacts to break the short-circuiting connection 10 across the circuit TC so as to render that circuit operative, and relay 13 when energized operates to open its normally closed switch contacts to put the loss pad 7 in the receiving circuit RC in a high loss condition so as effectively to disable that circuit preventing singing and suppressing echoes.

The variable 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 variable 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, comprising two transformers 14 and 15 connected in tandem in the circuit RC, the two halves of the secondary winding of transformer 14 and the two halves of the primary winding of transformer 15 being cross-connected through the normally closed contacts of relay 13 so as to provide what amounts to two series-aiding circuits permitting transmission through the pad with little or no loss. The operation of relay 13 to open its contacts breaks this cross-connection so that the same windings are connected in opposing relation effectively blocking transmission through the pad.

Connected across the receiving circuit RC between the variable loss pad 7 and the delay circuit 8 is the input of a receiving vodas circuit RV comprising the wave-operated control device 16, which may be a voltage-operated amplifier-detector circuit like the transmitting device 11, and the receiving vodas relay 17 connected to the output of the device 16 and operating in response to operation thereof to open its normally-closed contacts to disable the transmitting vodas circuit TV in its output by breaking the energizing circuit for the windings of the transmitting vodas relays including relays 12 and 13.

The volume control device 5 in the circuit TC may be a vogad (volume-operated gain-adjusting device) the primary function of which is to deliver a constant signal volume to the radio transmitter, and the secondary function of which is to effectively vary the sensitivity of the transmitting vodas TV to compensate for the varying signal input to that device with strong and weak

talkers. Such vogad circuits are disclosed, for example, in Hogg et al. Patent 1,853,974, Mitchell et al. Patent 2,019,577 and Wright et al. Patent 2,043,403. The volume control device 9 in the receiving circuit RC may be a similar vogad device operating to produce a constant output volume irrespective of variations in the range of volumes delivered to its input.

The transmission devices and the vodas switching circuits in the radio telephone control terminal shown in the drawing and described above are such as are commonly used in radio control terminals. The remaining portion of the circuit illustrated in the drawing constitutes one embodiment of the indicating circuit of the invention.

As illustrated, this indicating circuit includes as its main elements a syllabic control device 18 having its input connected across the transmitting circuit TC between the volume control device 5 and the delay circuit 6 and preferably at the same point as the input of the transmitting vodas TV; a syllabic relay 19 operating in response to operation of the syllabic device 18; an additional transmitting vodas relay 20 having its winding connected in series with the transmitting vodas relays 12 and 13 across the output of the transmitting control device 11 in the circuit TV, so as to be operated simultaneously with the latter two relays in response to operation of the control device 11; a condenser 21 arranged to be charged from the battery 22 during the operation of the vodas relay 20 and to be discharged at a more rapid rate during the operation of the syllabic relay 19; and an alarm circuit including a gas-filled discharge device 23 and an alarm device 24 which may be a relay controlling the energization of alarm lamps or an audible alarm device, adapted to be operated in response to a predetermined charge condition of the condenser 21.

The syllabic control device 18 may be any device adapted to operate in response to signals applied to its input having the syllabic characteristic of speech signals and to be substantially unresponsive to comparatively steady noise waves, due to room and circuit noise, ordinarily occurring in the transmitting circuit of a radio telephone system. Such a device may consist of an amplifier-detector circuit tuned to a frequency within the speech frequency range, for example, 1000 cycles, followed by a filter or tuned circuit adapted to selectively transmit the syllabic frequencies of speech, for example, a low-pass filter having a cut-off at about 22 cycles per second. The circuit would also have a high impedance input so that it will insert little loss in the transmission circuit across which it is bridged. Suitable circuits of this type are disclosed, for example, in Nyquist Patent 1,749,841, Mathes Patent 1,892,284, my Patent 1,859,019, Fisher Patent 2,026,305 and Dickieson Patent 2,132,205.

The principle of operation of the indicating circuit of the invention may be explained as follows:

It is known that an amplifier-detector circuit operating only on syllabic frequencies is much less sensitive to line and room noise than one operating in the mid-range of voice frequencies. Unfortunately, the slow operation of such an amplifier-detector prevents full advantages of this characteristic from being taken in the vodas circuit where quick operation is essential. Consequently, cases often occur in practice where the noise is such as to operate the vodas and oc-

casionaly to keep it operated so continuously that the distant talker is locked out. Under these same conditions, a syllabic amplifier-detector, sensitive enough to operate on some parts of
 5 nearly every speech syllable, would rarely, if ever, operate on noise. These characteristic differences between the operation of a syllabic amplifier-detector and the voltage-operated amplifier-detector used in the ordinary vodas circuit, is made
 10 use of in the indicating circuit of the invention which is jointly controlled by the two devices in such manner as to indicate whether noise alone, speech signals alone, or both speech signals and loud noise are present on the associated
 15 transmission circuit.

The design of this indicating circuit is based on the principle that for speech signals, the ratio

Percentage of time vodas is operated
 20 $K(\text{Percentage of time syllabic device is operated})$

where K is a constant, is greater than it is for noise.

The circuit is designed so that when this ratio, averaged over a period of time, is greater than a
 25 predetermined value, an indication or alarm will be given. The specific manner in which this is accomplished will be brought out in the following detailed description of the operation of the system of the invention.

30 Let it be assumed first that the radio terminal is in the idle condition with no speech signals being transmitted or received, but that there is some noise present in the transmitting circuit TC. This noise will be diverted into the transmitting vodas
 35 circuit TV and will be impressed on the inputs of the syllabic device 18 and of the transmitting vodas control device 11. Unless this noise is of a very unusual type, it will not cause the operation of the syllabic device 18 to energize the syllabic
 40 relay 19, and that relay will remain in its normal unoperated condition with its armature on the back relay contact. If this noise is sufficiently strong, it will cause operation of the voltage-operated control device 11 to cause operation of the
 45 vodas relays 12, 13 and 20 in its output while the noise level is maintained above the operating level of the device 11. This false operation of the relays 12 and 13 during this interval will respectively open the short-circuiting connection 10
 50 across the circuit TC to render that circuit operative, and to adjust the loss pad 7 in the receiving circuit RC to the high loss condition disabling the latter circuit.

The operation of the vodas relay 20 by the noise
 55 will complete a charging circuit for condenser 21 from battery 22 through the charging resistance 25, the closed contacts of the relay 20 and the back contacts of the syllabic relay 19. This charging will continue as long as the vodas device
 60 11 is maintained operated by the noise and the syllabic relay 19 is maintained released. If this condition continues for a time interval sufficiently long so that the charge on the condenser 21 is brought up to a predetermined value for which
 65 the circuit is designed to give an alarm, indicating objectionable noise operation of the vodas circuit, the voltage applied by the condenser across resistance 26 to the cathode of the gas-filled tube 23 will exceed the ionization potential
 70 of the tube (in the particular tube used this occurred for a charge on the condenser of about 65 volts), and the gas tube 23 will break down between the two cathodes permitting a discharge to be established from the cathodes to the plate
 75 of the tube. Current from battery 22 will then

flow through the tube 23 and the alarm device 24 to energize the latter causing an alarm to be given. If the vodas relay 19 is completely locked up by the noise, the alarm will operate within a
 5 time interval determined by the constants of the charging circuit. In an experimental circuit in accordance with the invention, the alarm usually operated in 3.5 to 4 seconds after the vodas relay
 10 first operated. If the vodas relay is not locked up solidly by the noise, the continued operations will cumulate and operate the alarm provided the relay operations are not too infrequent.

Once started, the alarm will continue to be given until the tube 23 is returned to the de-ionized condition by any of the methods for ac-
 15 complishing this known in the prior art, for example, by breaking the anode circuit of the tube, when the condenser 21 will discharge through the resistance 26.

When speech signals received from the tele-
 20 phone line TL are present in the transmitting circuit TC and there is little or no noise on that circuit, the control device 11 in the transmitting vodas circuit TV will be operated by the speech
 25 in the same way as described above for operation on noise, to energize the vodas relays including relay 20, provided the receiving vodas circuit RV has not been previously operated by prior received signals in the circuit RC to dis-
 30 able the energizing circuit for these relays. The operation of the relay 20 will cause the charging circuit from battery 22 to be closed and charge condenser 21 in the manner previously described. At the same time, the speech signals applied to
 35 the syllabic device 18 will control it so as to cause frequent operation of the syllabic relay 19. When the armature of relay 19 reaches the front contact in response to energization of the relay wind-
 40 ing, the condenser 21 will be discharged at a rapid rate through the resistance 26 and the front contact and armature of the relay 19. If the speech signals applied to the syllabic device 18 are of the proper volume, the frequent operations
 45 of the syllabic relay 19 will nullify the effect of the operation of the vodas relay 20 under control of the voltage-operated control device 11 by continually reducing the charge which has been placed on the condenser 21. Therefore, the operation of the vodas relay 20 cannot result in the
 50 charging of the condenser 21 to the high value necessary to operate the alarm circuit.

When noise and speech signals are both present on the transmitting circuit TC, the applied noise will have no effect on the operation of the syllabic relay 19 because the syllabic control de-
 55 vice 18 is not ordinarily responsive to noise. The noise, however, together with the accompanying speech signals, will control the voltage-operated device 11 in the transmitting vodas circuit to maintain the vodas relays including relay 20 op-
 60 erated. The operation of relay 20 will cause the condenser 21 to be charged in the manner previously described, but while the speech signals continue, unless the applied noise energy is of extremely high amplitude level, this will not ordi-
 65 narily result in producing a sufficient charge on condenser 21 to operate the alarm circuit. This is due to the fact that the syllabic relay 19 which also will be operating under control of the applied speech signals will cause the condenser 21 to be
 70 discharged at a more rapid rate in the manner previously described. The alarm, however, will operate if there is a pause between the words or syllables of the applied speech signals sufficiently
 75 long, say 3 or 4 seconds, to let the condenser

charge to be brought up to the alarm operating value by the operation of the vodas relay 20 in response to the applied noise. When this happens, the alarm will be operated in the manner previously described.

If the steady noise energy applied to the vodas control device 11 from the circuit TC is extremely high, the charge on the condenser 21 under control of the vodas relay 20 will be brought up to the required value which will cause operation of the alarm circuit even though speech energy is also present on the transmitting circuit TC. This will be the case because the intermittent operation of the syllabic relay 19 in response to the speech energy will not result in a sufficient discharge of condenser 21 to keep its charge below the alarm operating value because of the increased charge produced in the condenser under control of the extremely high noise. The continuous operation of the alarm in this case will indicate a condition of serious trouble.

Tests of an experimental indicating circuit as shown in the drawing in connection with a transoceanic radio control terminal employing a vogad in the transmitting circuit for controlling the effective sensitivity of the transmitting vodas circuit, as well as the signal volume applied to the radio transmitter, indicated that when the sensitivity at reference volume fell below 2.5 decibels there was a sharp decrease in the number of operations of the syllabic detector on speech. This leads to the conclusion that when the volume decreases (which amounts to decreasing the sensitivity at reference volume), the syllabic relay operations will decrease and an alarm will result. This alarm would be an indication that the output volume of the vogad is low.

Although the indicating circuit of the invention has been described as applied only to the transmitting vodas of a relay circuit, it is apparent that it may be used in the same way as described to indicate false operation or lock-up of the receiving vodas circuit RV by static received by the receiving circuit RC from the radio link where that static is of a steady nature without crashes. When used in connection with the receiving vodas circuit the syllabic device 18 would be connected across the circuit RC at a point between the variable loss device 7 and the delay circuit 8 and preferably at the same point as the input of the receiving vodas RV; and the vodas relay 20 of the indicating circuit would be connected to the output of the receiving vodas control device 16 in such manner as to be operated simultaneously with the receiving vodas relay 17 by operation of the control device 16. It is also apparent that the indicating circuit of the invention shown in the drawing by slight changes in wiring and the addition of the proper switches may be readily used either as a transmitting vodas alarm or a receiving vodas alarm in the same system.

Other modifications of the circuit illustrated

and described within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. In a circuit for indicating undue noise operation of a signal-controlled switching device supplied from a source of signals subject to noise, a second switching device operative by signals but substantially unresponsive to noise, also supplied from said source, means for effectively balancing, on the basis of operated times, the operation of the first switching device against that of said second switching device, and alarm means operative when the ratio of the total operated time of said first switching device to that of the second switching device over a given interval of time is greater than a predetermined value.

2. In combination with a line transmitting voice signal waves and subject to disturbing noise waves, and a wave-operated switching device connected to said line and operatively responsive to applied waves within the voice frequency range, means to automatically indicate excessive false operation of said switching device by applied noise waves comprising a control device also connected to said line, operatively responsive to applied voice signal waves but substantially unresponsive to applied noise waves, and alarm means jointly controlled by the operations of said switching device and said control device, said alarm means being operative to give an alarm for the condition where the relative amounts of controlling energy applied to the two devices are such that the ratio of the percentage of time said switching device is operated to the percentage of time said control device is operated, averaged over a given period of time, is greater than a predetermined value.

3. In combination with a line for transmitting voice signal waves and subject to disturbing noise waves, and a wave-operated switching device connected to said line and operatively responsive to the waves received therefrom within the voice frequency range, a second switching device connected to said line, operatively responsive to the applied voice signal waves and substantially unresponsive to the applied noise waves, a capacitor adapted to be charged at a certain rate in response to operation of the first switching device and to be discharged at a more rapid rate in response to operation of said second switching device and alarm means responsive to the building up of a charge on said capacitor above a certain predetermined value.

4. The combination of claim 3, in which said second switching device comprises a syllabic amplifier-detector circuit.

5. The combination of claim 3, in which said predetermined value of the charge on said capacitor is a value which is rarely exceeded when voice signal waves alone are present on said line.

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