

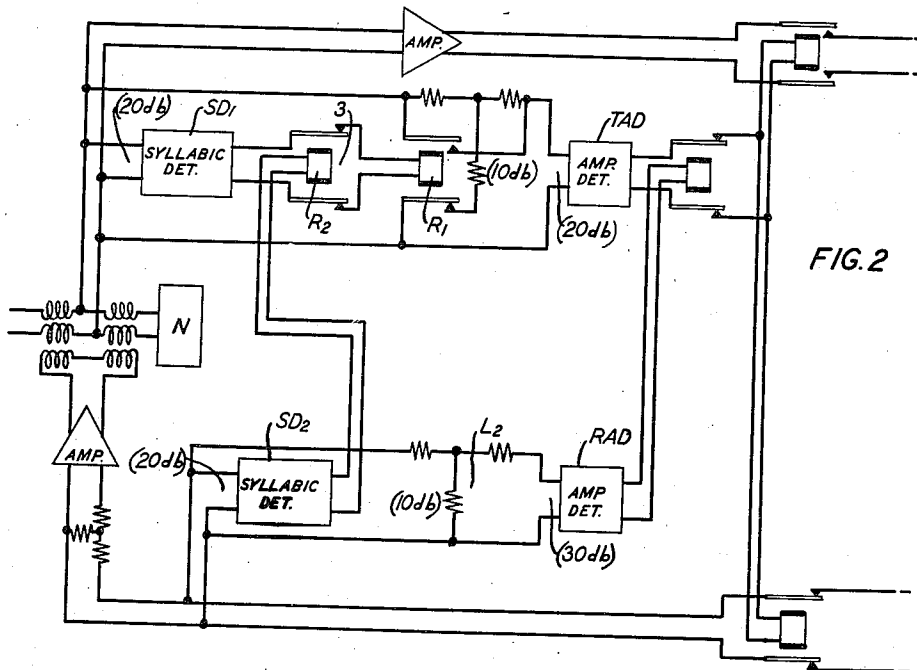
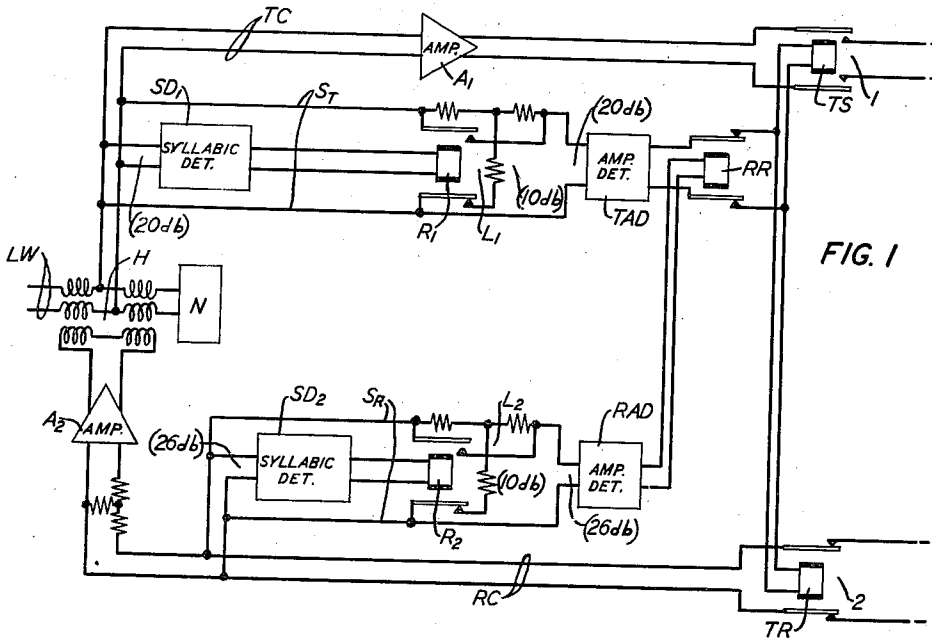
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CONTROL OF TWO-WAY TELEPHONE SYSTEMS

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CONTROL OF TWO-WAY TELEPHONE SYSTEMS

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The invention relates to two-way telephone systems and particularly to the voice-operated switching circuits used with such systems to directionally control transmission while suppressing echoes and preventing singing.

The invention is particularly applicable to voice-operated switching circuits used for that purpose, so called vodas circuits, located at a terminal of a two-way radio or wire telephone system, consisting of two amplifier-detector switching portions respectively connected to the voice transmitting and receiving paths at the terminal, and respectively responsive to outgoing telephone signals to condition the terminal for transmitting only, for example, by disabling the receiving voice path and the associated switching circuit and enabling the normally disabled voice transmitting path, and to incoming telephone signals to condition the terminal for receiving only, for example, by disabling the switching circuit controlled from the voice transmitting path.

Such telephone systems are subject to interfering noise waves of varying amplitude, such as line noise and static, tending to adversely affect the operation of the voice-operated switching circuits. To prevent false operation of the voice-operated switching circuits by noise waves of large amplitude would require that their sensitivities be reduced to such an extent as to prevent their proper operation on telephone signals of low amplitude. In prior art circuits, this has been obviated by the use, in connection with the transmitting switching circuit, of circuits which discriminate between applied speech waves and noise on the basis of differences in energy distribution with time. An example of such a circuit is the so-called "syllabic" detector circuit which operates on the syllabic variations in speech but is unresponsive to the comparatively continuous or steady noise energy.

One type of voice-operated switching circuit employing such a syllabic detector is disclosed in H. J. Fisher Patent 2,026,305, issued December 31, 1935, or in my copending patent application Serial No. 297,832, filed October 4, 1939, issued as Patent No. 2,224,569, December 10, 1940. It employs similar voltage-operated detectors in the transmitting and receiving branches of the switching circuit, the sensitivity setting of the transmitting detector being determined by the sensitivity of the receiving switching detector which is set as high as possible consistent with preventing too frequent operation of the receiving switching branch by incoming noise or static in the voice receiving path: a loss pad of suitable value, say, 10 decibels, is normally inserted in front of the detector in the transmitting switching branch to reduce the sensitivity of that branch sufficiently so that it will be unoperated

in response to the usual amount of applied line noise when no telephone signals are being transmitted over the voice transmitting path: and an auxiliary sensitive syllabic detector connected to the voice transmitting path is used to effectively remove the loss pad from the transmitting switching branch in response to outgoing telephone signals in the voice transmitting path, so that the latter switching branch will be operated quickly by the applied telephone signals to provide the proper switching operation.

With the voice paths designed to provide zero net loss between the transmitting and receiving switching circuits and the transmitting and receiving switching detectors set at the same local sensitivities at equal volume points in the two circuits, the condition of zero echo margin exists in such a system when the syllabic detector has removed the 10-decibel loss pad and a 10-decibel positive echo margin exists before the pad is removed. Echo margin is expressed in decibels, and may be defined as the difference between the volume delivered by the output of the voice receiving path of the terminal to the associated two-way circuit under a given set of operating conditions and the maximum volume which could be delivered by reducing the voice receiving path loss without producing echo operation of the transmitting switching branch.

It has been found by tests of such a switching circuit that there are many speech impulses which will cause the receiving switching circuit to disable the transmitting switching circuit before the syllabic detector can remove the loss pad. However, since there are syllables which will cause operation of that detector to remove the pad very quickly, and also because of inherent hang-over in the syllabic device which may cause the pad to stay out over most of a talk spurt, it has been found necessary to consider that the pad is out when computing echo margin.

An object of the invention is to improve the operation of circuits of the above-described general type.

A more specific object is to enable the signal output of the receiving voice path in such a system to be increased without increasing the chance of false operation of the transmitting switching branch by signal echoes and noise.

These objects are attained in accordance with the invention by a circuit arrangement operating to maintain a positive echo margin for any operating condition of the voice-operated switching circuits, which allows the receiving signal volume to be increased by the amount of that margin.

In one embodiment this is accomplished by employing, in addition to a sensitive syllabic detector circuit controlled from the voice transmitting path, operating to remove a small sensi-

tivity-reducing loss pad from the input of the transmitting voltage switching detector in response to outgoing telephone signals, employed in the prior art circuits described above, a second sensitive syllabic detector circuit of like characteristics controlled from the voice receiving path, operating in response to received telephone signals, when the transmitting switching detector is unoperated, to remove an equivalent sensitivity-reducing loss pad from in front of the voltage detector in the receiving switching branch, or to disable the first (transmitting) syllabic detector circuit so as to prevent any increase in sensitivity of the transmitting switching control detector. The sensitivities of the several detectors are chosen to fit the noise conditions encountered, and the relative sensitivity of transmitting and receiving voltage detectors, as seen from the receiving side, are maintained by adjusting the loss in the receiving path to provide positive echo margin.

The objects and the various features of the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawing, Figs. 1 and 2 of which show schematically one terminal of a two-way telephone system equipped with vodas switching circuits embodying different modifications of the invention.

The two-way telephone terminal of Fig. 1 comprises a voice signal transmitting circuit TC including the one-way amplifier A₁, for repeating telephone signals received from the west two-way circuit LW in the direction from west to east, and a voice signal receiving circuit RC including the one-way amplifier A₂, for repeating telephone signals received from a distant east station (not shown) into the two-way circuit LW. The input of the transmitting circuit TC and the output of the receiving circuit RC may be connected in conjugate relation with each other and in transmitting relation with the two-way circuit LW by the usual hybrid network H and associated balancing network N as shown, or by any other suitable means.

The two-way circuit LW may be assumed to extend to the left eventually to a subscriber's telephone set, and the circuits TC and RC to extend to the right to a two-way radio or wire transmission channel. For example, the circuit TC may extend to a radio telephone transmitter and the circuit RC to a radio telephone receiver, or both circuits may extend to a long distance telephone terminal such as an ocean cable telephone terminal.

The transmitting circuit TC is normally disabled at the point 1 due to the normally open condition of the contacts of the transmitting switching relay TS at that point and the receiving circuit RC is normally operative due to the normally closed condition of the contacts of the transmitting switching relay TR at the point 2.

The voice-operated switching circuits embodying the invention include a transmitting switching branch S_T having its input connected across the input of the transmitting circuit TC at a point in front of the disabling point 1, and a receiving switching branch S_R having its input connected across the circuit RC at a point to the left of the disabling point 2. The transmitting switching branch S_T includes the transmitting amplifier-detector TAD and the transmitting switching relays TS and TR, which, for the sake of simplicity, have been shown as controlled directly from the output of that amplifier-de-

tector, although in a practical circuit they would be preferably arranged to be operatively energized by operation of one or more master relays directly controlled from the output of the amplifier detector TAD, for example, as shown in the aforementioned Fisher patent, or copending application, the master relay and the switching relays being provided with the required transmitting hang-over to prevent premature release when the controlling speech currents cease, in any suitable manner.

The receiving switch branch S_R includes the receiving amplifier-detector RAD and the receiving switching relay RR controlled from the output of the amplifier-detector RAD, the contacts of the relay RR maintaining the output of the amplifier-detector TAD in the transmitting switching branch S_T operative when the relay RR is unoperated and disabling the output of the transmitting amplifier-detector TAD when that relay is operated by amplifier-detector RAD in response to received telephone signals from the voice receiving path RC. The receiving switching relay RR also would be provided with the required hang-over in operation to prevent its premature release when the controlling voice circuits cease, in any suitable manner.

A resistance loss pad L₁ is normally inserted in the input of the transmitting switching amplifier-detector TAD and an equivalent loss pad L₂ is normally inserted in the input of the receiving switching amplifier-detector RAD. The values of the two loss pads are made such as to reduce the sensitivity of the associated amplifier-detectors just sufficiently to prevent false operation of the switching relays in their outputs in response to the normal amount of line noise or static applied to the transmitting switching branch S_T and receiving switching branch S_R, respectively. With the particular sensitivities selected for the transmitting and receiving switching amplifier-detectors TAD and RAD as a result of tests, it was found that an optimum value for each loss pad was about 10 decibels.

A sensitive syllabic detector SD₁, which may be of the type disclosed in the aforementioned Fisher patent or in my copending patent application, responsive to the syllabic variations in speech but substantially unresponsive to the comparatively steady line noise or static, connected across the voice transmitting path TC, preferably at the same time as the transmitting switching branch S_T, operates in response to outgoing telephone signals in that path to cause the operation of a relay R₁ to effectively remove the loss pad L₁ from in front of the amplifier-detector TAD, for example, by short-circuiting its series-resistance arms and open-circuiting its shunt resistance arm, as indicated, to increase the sensitivity of that amplifier-detector by an amount equal to the loss value, 10 decibels, of the removed pad. A similar sensitive syllabic detector SD₂ connected across the voice receiving path RC, preferably at the same point as the receiving switching branch S_R, operates in response to incoming telephone signals in the path RC, when that path is operative, to control relay R₂ to remove the loss pad L₂ of equivalent value (10 decibels) in similar manner from the input of the receiving switching amplifier-detector RAD, to increase the sensitivity of the receiving switching branch S_R by an equal amount (10 decibels).

The sensitivity of the transmitting switching branch S_T depends on the amount of signal clip-

ping in the voice transmitting circuit considered as tolerable, whereas the selected sensitivity of the receiving switching branch S_R depends on the amount of static or noise received over the voice receiving path RC. For a particular amount of static applied, the sensitivity of the receiving switching branch S_R is adjusted so that static operations which disable the transmitting switching branch S_T and thus the outgoing voice transmitting path TC by the release of the transmitting switching relay TS, will cause a tolerable amount of clipping of outgoing speech. As found by test, a suitable sensitivity setting to accomplish this may be 20 decibels for the transmitting switching amplifier-detector TAD, and a higher sensitivity, for example, 26 decibels, is chosen for the receiving amplifier-detector RAD, as indicated by the legends in front of the boxes representing these amplifier detectors in Fig. 1. The sensitivity setting of the transmitting syllabic detector SD_1 would be 20 decibels and that of the receiving syllabic detector SD_2 would be 26 decibels for this condition, as indicated by the legends in front of them. It will be seen that the net sensitivity of the receiving amplifier-detector RAD changes from 16 to 26 decibels as the loss pad L_2 goes in or out of its input under control of the associated syllabic detector circuit when received voice signals are absent or present, respectively, in the input of the latter circuit whereas the sensitivity of the transmitting amplifier-detector TAD changes from 10 to 20 decibels as the loss pad L_1 goes in or out of its input under control of the associated syllabic detector circuit depending on whether outgoing telephone signals are absent or present in the input of the latter circuit. If the two syllabic devices are alike ("twins") the loss pads will switch in synchronism in the presence of receiving speech, the 16-decibel sensitivity of the receiving amplifier-detector RAD going with the 10-decibel sensitivity of the transmitting amplifier-detector TAD, and the 26-decibel sensitivity of the former going with the 20-decibel sensitivity of the latter, providing a 6-decibel positive echo margin in each case, thus allowing the gain of the receiving voice path RC to be increased by a similar amount to give greater received signal volume.

In the circuit of Fig. 1 employing the twin syllabic amplifier-detectors, the sensitivity of the receiving voltage amplifier-detector RAD changes from 16 to 26 decibels when the loss pad L_2 is removed. During the period in which its sensitivity is 26 decibels, for example, in a period of hang-over of the syllabic detectors SD_2 , there is a possibility that weaker static might be able to cause operation of RAD to disable the transmitting switching branch S_T . This would be prevented in the modified circuit of Fig. 2, which differs from that of Fig. 1 essentially only in the following particular: the 10-decibel loss pad L_2 is permanently connected in the input of the receiving switching amplifier-detector RAD, and the receiving syllabic circuit comprising syllabic detector SD_2 and relay R_2 , when operated, instead of removing that pad, disables the transmitting syllabic detector SD_1 at the point 3 in its output, without affecting the sensitivity of the receiving switching amplifier-detector RAD. The sensitivity of the receiving amplifier-detector RAD, as an example, could be set to 30 decibels, as indicated, instead of 26 decibels as in the circuit of Fig. 1, which with the loss pad L_2 in, gives a net sensitivity of 20 decibels, and the sensitivity of the transmitting amplifier-detector TAD

remains at 20 decibels, which, with the 10-decibel loss pad L_1 in, gives a net sensitivity of 10 decibels. Then, if the sensitivity of the receiving syllabic detector SD_2 is raised to 30 decibels from 26 decibels, which can be done with this arrangement, there will always be a positive echo margin of 10 decibels which can be used for increasing the output volume of the voice-receiving path RC by that amount. With the scheme of Fig. 1, it is necessary to go to the 16—26 decibel sensitivity combination to get the same operation of the receiving side on the same static that would require 20-decibel sensitivity for the ordinary voltage detector. In the scheme of Fig. 2, the receiving detector operates as an ordinary voltage detector, as far as disabling the transmitting voltage detector is concerned and, therefore, we can go back to the 20-decibel sensitivity condition.

Various modifications of the circuits which have been illustrated and described which are 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 oppositely directed, one-way transmission paths for repeating telephone signal waves in opposite directions, both subject to interfering noise waves, a wave-operated switching circuit connected to each of said paths for respectively conditioning the terminal for transmitting only or for receiving only, means normally reducing the sensitivity of each of the two wave-operated switching circuits sufficiently to prevent false operation by noise waves in the absence of signal transmission in the connected transmission path, a control device substantially unresponsive to noise waves but responsive to telephone signals of substantially all amplitudes, connected to the transmitting signal transmission path, operating on outgoing telephone signals therein, to increase the sensitivity of the switching circuit connected to said transmitting path, so as to enable quick operation of that circuit by the outgoing telephone signals when the receiving switching circuit is unoperated, and a second control device substantially unresponsive to noise waves but responsive to telephone signals of substantially all amplitudes, operating in synchronism with the first control device in response to incoming telephone waves in the receiving path, when the transmitting switching circuit is unoperated, to effectively control the relative sensitivities of the two switching circuits so as to provide a desired positive margin against false operation of said transmitting switching circuit by signal echoes, enabling a greater signal output for said receiving path to be obtained.

2. The combination of claim 1 in which said second control device operates to properly control the relative sensitivities of the two switching circuits by effectively reducing the sensitivity of the transmitting switching circuit with respect to that of the receiving switching circuit.

3. The combination of claim 1 in which said second control device operates to properly control the relative sensitivities of the two switching circuits by increasing the sensitivity of the receiving switching circuit to the necessary degree.

4. The combination of claim 1 in which said second control device operates to control the sensitivity of the transmitting switching circuit by desensitizing the first control device so as to

prevent its operation by signal echoes or outgoing telephone signals to increase the sensitivity of said transmitting switching circuit.

5. The combination of claim 1 in which the two control devices are equivalent sensitive, syllabic detector circuits.

6. The combination of claim 1 in which the means normally reducing the sensitivity of the two switching circuits to prevent false operation by interfering noise waves comprises a loss pad of value in the order of 10 decibels in each switching circuit.

7. The combination of claim 1 in which each of said switching circuits includes a wave detector with a 10-decibel loss in its input, the sensitivity of the detector in the transmitting switching circuit being selected so that with the loss in its input it has a net sensitivity of about 10 decibels and with the loss out a sensitivity of about 20 decibels, the sensitivity of the detector in the receiving switching circuit being selected so that with the loss in its input it has a net sensitivity a desired amount greater than the net sensitivity of said detector in said transmitting switching circuit for that condition and with the loss out a sensitivity 10 decibels greater, the operation of the first control device causing the effective removal of the loss in the transmitting switching circuit and the operation of the second control device removing the loss in the receiving switching circuit, so that in any condition of operation of the switching circuits there is a positive echo margin of the same amount.

8. The combination of claim 1 in which each of said switching circuits includes a wave detector with a normal loss in its input of about 10 decibels, the sensitivity of the detector in the transmitting switching circuit being selected so that with the normal loss in its input it has a net sensitivity of about 10 decibels and with the loss out a sensitivity of about 20 decibels, the sensitivity of the detector in the receiving switching circuit being selected so that with the normal loss in its input it has a net sensitivity of 20 decibels, the first control device, when operated, causing the effective removal of the normal loss from the transmitting switching circuit, and the operation of the second control device causing the first control device to be disabled, preventing its operation to remove the loss from said transmitting switching circuit, so that in all conditions of operation of the switching circuits there is net positive echo margin of about 10 decibels.

9. A control circuit for a two-way telephone system including at a terminal thereof a voice transmitting path and a voice receiving path both subject to interfering noise waves, comprising one wave-operated switching device connected to said transmitting path and responsive to outgoing signals therein, in the absence of prior received telephone signals in said receiving path, to condition the terminal for transmitting only, a second wave-operated switching device connected to said receiving path and responsive to incoming telephone signals therein, in the absence of prior outgoing signals in said transmitting path, to condition the terminal for receiving only, the sensitivities of the two switching devices being normally set at the highest values consistent with preventing clipping or false operation of either by noise waves of normal am-

plitude in the connected voice path in the absence of signal transmission in that path and with the relative sensitivities as seen from said receiving path maintained by proper adjustment of the loss in said receiving path to provide a given positive echo margin, and a control device, substantially unresponsive to said interfering noise waves but operatively responsive to telephone signals of substantially all amplitudes, connected to each voice path, the control device connected to the voice transmitting path operating in response to outgoing telephone signals to increase the sensitivity of said one switching device by a given amount to cause, when said second switching device is unoperated, quick operation of said one switching device by the applied telephone signals, and the control device connected to said voice receiving path, when said one switching device is unoperated, operating in synchronism with the first control device in response to incoming telephone signals in said voice receiving path, to effectively maintain the sensitivities of said one switching device and said second switching device in the same relationship as existing normally with neither voice path transmitting signals, to maintain said given positive echo margin.

10. The control circuit of claim 9 in which the control device connected to said voice receiving path operates to maintain the sensitivity of said one and said second switching device in said same ratio by increasing the sensitivity of said second switching device by the same given amount as the sensitivity of said one switching device is increased by operation of the first control device.

11. The control circuit of claim 9 in which said control device connected to said voice receiving path operates to maintain the sensitivities of said one and said second switching device in said same ratio by disabling the first control device.

12. The control circuit of claim 9 in which said one switching device conditions the terminal for transmitting only, by removing a normal disability from said voice transmitting path and disabling said voice receiving path, and said second switching device conditions the terminal for receiving only by disabling said one switching device.

13. The control circuit of claim 9 in which said one switching device and said second switching device each includes a wave detector and a normal loss of the order of 10 decibels in its input, said control device connected to said voice transmitting path operating to increase the sensitivity of said one switching device by removing said normal loss from the input thereof, the sensitivity of the detector in said second switching device being normally set so that the net sensitivity of said second switching device with said loss therein is such as to prevent operation of said second switching device by incoming noise of said normal amplitude in said voice receiving path in the absence of signal transmission therein, and the sensitivity of the detector in said one switching device being normally set so the net sensitivity thereof with the normal loss therein is lower than the sensitivity of the detector in said second switching device by the desired positive echo margin.

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