

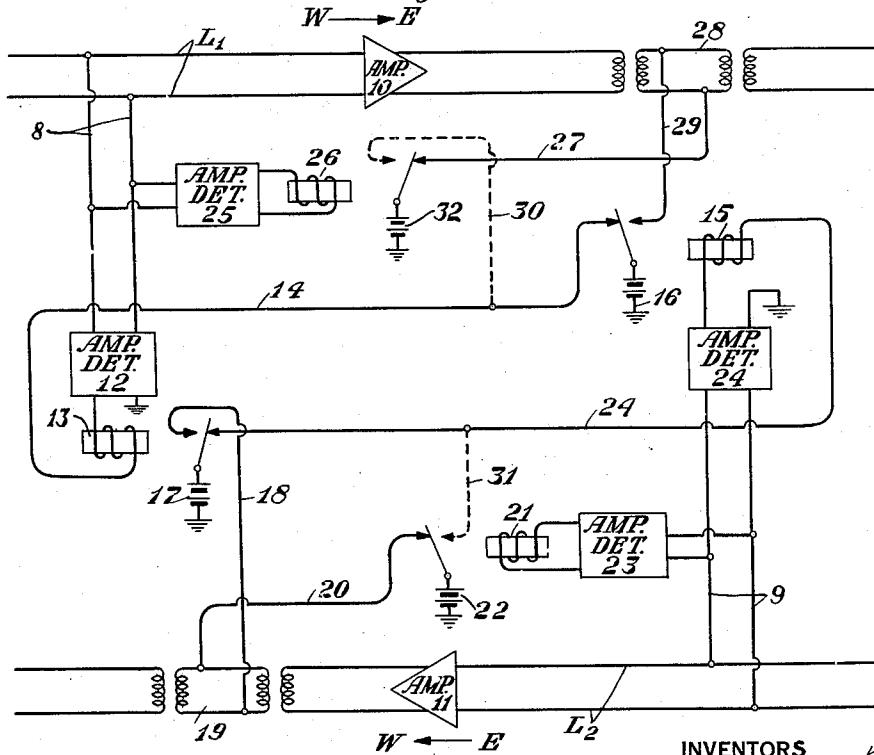
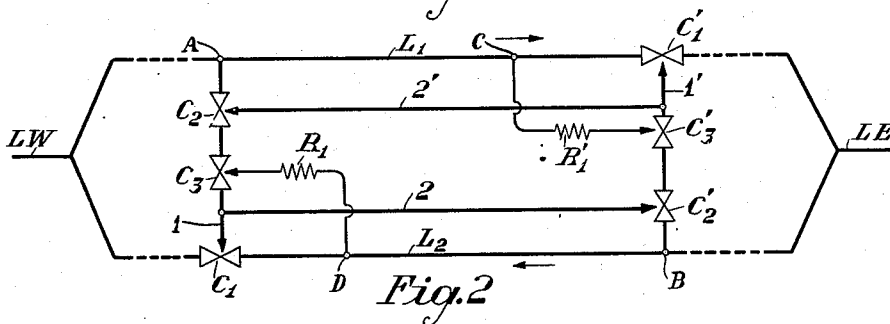
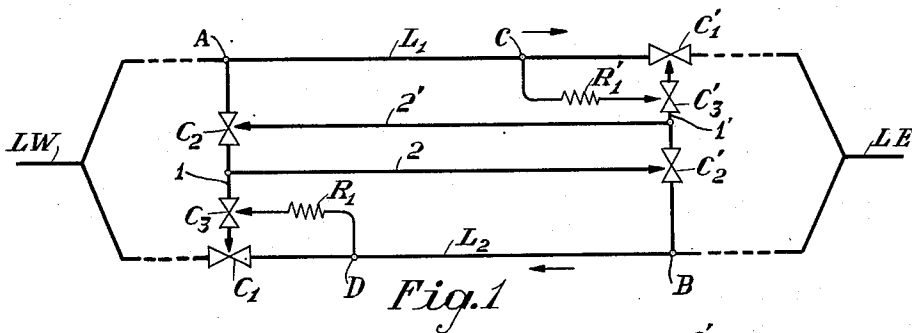
Dec. 29, 1942.

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2,306,689

VOICE-OPERATED SWITCHING CIRCUIT FOR TWO-WAY TELEPHONY

Filed Dec. 5, 1941



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UNITED STATES PATENT OFFICE

2,306,689

VOICE-OPERATED SWITCHING CIRCUIT
FOR TWO-WAY TELEPHONY

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Application December 5, 1941, Serial No. 421,704

12 Claims. (Cl. 179—170)

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

Such signal-controlled switching circuits, commonly called echo suppressors, usually employ two switching branches respectively connected to each of the two oppositely-directed one-way signal transmission paths at a terminal or intermediate point of the two-way system, each including an amplifier and detector for amplifying and detecting the applied signal waves, and electromagnetic relays or other switching devices operated by the detected signals to suitably control the transmitting efficiency of the signal transmission paths and to disable the other switching branch, so as to provide the desired directional control with suppression of echoes and singing.

An object of the invention is to improve the operation of such switching circuits particularly from the standpoint of facilitating "break-ins" by a listening subscriber when a talking subscriber has obtained control of the system. A more specific object is to improve such circuits so as to enable a party to break in on a talking party without waiting for the latter to pause and regardless of how loudly the latter party is talking.

These objects are attained in accordance with the invention by the addition of relatively insensitive auxiliary controls properly located with respect to the echo suppressor controls, operating on an amplitude basis to provide break-in whenever a party wishing to break-in produces signals whose amplitude is greater than a given amount.

The various objects and features of the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawing in which:

Figs. 1 and 2 illustrate diagrammatically different embodiments of the invention; and

Fig. 3 shows schematically detailed circuit arrangements which may be employed in these embodiments.

The diagrams of Figs. 1 and 2 are not actual circuit diagrams, but rather single-line layouts, each line indicating a two-wire transmission path. A normal make in each two-wire path is indicated by contacting arrowheads and an arrow directed at a make point indicates that the path will be disabled at that point by operation of a control device in the circuit from which the arrow points.

Fig. 1 shows one modification of the invention applied to a four-wire telephone circuit including a one-way transmission path L_1 normally conditioned to transmit in the direction from west to

east between the two-way line LW and the two-way line LE, and a one-way transmission path L_2 normally conditioned to transmit in the direction from east to west between the two-way line LE and the two-way line LW. The transmission paths L_1 and L_2 may be coupled at the terminals of the four-wire circuit in conjugate relation with each other and in energy transmitting relation with the two-way lines LW and LE by the usual hybrid coils with associated balancing networks (not shown).

Connected across the west-to-east path L_1 at a point A is the input of a voice-controlled echo suppressor, to be referred to hereinafter as the west echo suppressor, comprising a main control branch 1 and an auxiliary control branch 2. Connected across the east-to-west path L_2 at a point B is the input of a similar voice-controlled echo suppressor, to be referred to hereinafter as the east echo suppressor, comprising a main control branch 1' and an auxiliary control branch 2'. The main control branch 1 of the west echo suppressor when operated by applied voice currents disables the transmission path L_2 at a point C_1 beyond the point B of connection of the east echo suppressor to that path, and the auxiliary control branch 2 of the west echo suppressor when operated by applied voice currents disables the east echo suppressor at a point C_2 in its input so as to disable both the main control branch 1' and the auxiliary control branch 2' of that echo suppressor. Similarly, the main control branch 1' of the east echo suppressor when operated by applied voice currents disables the path L_1 at the point C_1 beyond the point A of connection of the west echo suppressor to that path, and the auxiliary control branch 2' of the east echo suppressor when operated by applied voice currents disables the west echo suppressor at a point C_2 at its input thereby disabling both the main control branch 1 and the auxiliary control branch 2 of the latter echo suppressor.

Connected across the path L_1 at any point C in front of the disabling point C_1 is the input of a third voice-controlled control circuit R_1 , to be referred to hereinafter as the west break-in control, which, as indicated by the showing of a resistance therein, is relatively insensitive compared to the west echo suppressor circuit. The west break-in control when operated by voice currents of sufficient amplitude received from the path L_1 , will disable the main control branch 1' of the east echo suppressor at a point C_3 but will not affect the auxiliary control branch 2' of that echo suppressor. Similarly, connected across the path L_2 at any point D in front of the disabling point C_1 is the input of a fourth voice-controlled control circuit R_2 , to be referred to hereinafter as the east break-in control, which, as indicated by a showing of a resistance therein,

is relatively insensitive compared to the east echo suppressor. The east break-in control when operated by voice currents of sufficient amplitude received from the path L_2 will disable the main control branch 1 of the west echo suppressor at a point C_3 , but will not affect the auxiliary control branch 2 of the latter echo suppressor.

In the subsequent description, it will be convenient to speak of a "loud talker," meaning one who can operate a break-in control, and a "weak talker," meaning one who cannot. Since we are to deal with circuits from the terminals of which portions of signals are returned as echoes, it is assumed that a loud talker, in order to break-in, must operate a control at least insensitive enough so that it will not operate on the echo of the other talker's speech energy.

Let it be assumed that a west telephone subscriber associated with the line LW starts to speak and at that time the east subscriber associated with the line LE is silent. The speech waves of the west subscriber received over the line LW will pass over the one-way transmission path L_1 and the line LE to the east subscriber. A portion of these speech waves will be diverted at the point A in path L_1 into branches 1 and 2 of the west echo suppressor and will cause the operation of the former branch to disable the one-way transmission path L_2 at the point C_1 and the operation of the latter branch to disable the east echo suppressor at the point C'_2 in its input thereby disabling both the branches 1' and 2' of the latter echo suppressor. Another portion of the west subscriber's speech waves will be later diverted from the transmission path L_1 at the point C into the west break-in control circuit R'_1 . If the west subscriber is a weak talker (as previously defined) these diverted currents will be of insufficient amplitude to cause the operation of this relatively insensitive control so that the branch 1' of the east echo suppressor will be maintained in its enabled condition at the point C'_3 .

Now, let it be assumed that while the west subscriber is still talking the east subscriber associated with the line LE starts to talk. The latter's speech waves will pass from LE into the transmission path L_2 and will pass over that path in the direction from east to west towards the west subscriber. The portion of east's speech waves diverted from the transmission path L_2 into the east echo suppressor connected at the point B in that path will be ineffective to cause operation of that suppressor because the latter has been previously disabled in its input at the point C'_2 by the speech waves of the west subscriber under control of the auxiliary branch 2 of the west echo suppressor. Another portion of east's speech currents will be diverted from the path L_2 at a point D into the break-in control R_1 . If east is a weak talker (as previously defined) his speech currents will not cause operation of that relatively insensitive control, and the main suppressor branch 1 of the west echo suppressor circuit controlled from the path L_1 will be maintained operated by west's speech to disable the path L_2 at the point C_1 so that east's speech waves will not be able to get through to the west subscriber. Also, any echoes of west's speech waves reflected at the east terminal of the four-wire circuit into the transmission path L_2 will be suppressed at the disabled point C_1 of that path held disabled by the west echo suppressor.

Now if east desires to break in on west, the

former will raise his voice so that at least portions of his speech signals will exceed a given amplitude determined by the sensitivity of the break-in control. East's higher amplitude speech waves will be transmitted over path L_2 and will cause operation of the east break-in control R_1 to disable the main suppressor branch 1 of the west echo suppressor at the point C_1 . The consequent release of that control branch will render the path L_2 again operative at the point C_1 so that east's speech will get through to line LW and will be heard by the west subscriber associated with that line. If the west subscriber keeps on talking, the auxiliary control branch 2 of his echo suppressor will remain operated to hold the east echo suppressor disabled at the point C'_2 so that both subscribers will hear each other. However, as the main control branches of both echo suppressors are disabled, there will be no echo suppression and both parties will hear echoes. This condition will continue until the loud talker (east) lowers his voice sufficiently or the weak talker (west) stops talking. Now, if while east is talking loudly west also raises his voice the required amount, the latter's speech currents will cause operation of the west break-in control device R'_1 to further disable the main control branch 1' echo suppressor at the point C'_3 . This will not result in any change in the operation of the circuit as the east echo suppressor is already completely disabled at the point C'_2 , and both loud talkers will be heard by each other and both will hear echoes during the period of double talking.

Similarly, if the east subscriber starts to talk first he will obtain control of the switching circuits by operating the main control branch 1' of the east echo suppressor to disable the transmission path L_1 at the point C'_1 and by operating his auxiliary echo suppressor branch 2' to disable the west echo suppressor at the point C_2 in its input. The disabling of path L_2 will prevent west's speech from getting through to east, and will also suppress the echoes of east's speech waves. Then west can break in on east by talking loudly enough to operate the west break-in control R'_1 to disable the main control branch 1' only of the east echo suppressor at the point C'_3 . Because of the continued operation of the auxiliary control branch 2' of the east echo suppressor to disable the west echo suppressor at the point C_2 while east continues to talk, west cannot operate his own echo suppressor. Thus both west and east will be heard by each other and each will hear echoes until one subscriber or the other ceases talking or lowers his voice sufficiently.

To make the above-described type of break-in effective, it is necessary that the various echo suppressor and break-in controls have their relative sensitivities properly proportioned. The break-in controls R_1 and R'_1 should be made sufficiently insensitive so as not to be operated by the maximum amount of echo which it is possible to obtain.

The modification of the invention shown in Fig. 2 differs from that of Fig. 1 merely in the relative location of the point of disablement of each echo suppressor when the associated break-in control operates. In the system of Fig. 1 the disabling point C'_3 in the east echo suppressor, controlled by the west break-in control R'_1 is located only in the main control branch 1', and the disabling point C_3 in the west echo suppressor, controlled by the east break-in control R_1 is lo-

cated only in the main control branch 1, so that only the echo suppressing function of each echo suppressor is disabled by operation of the associated break-in control. This arrangement permits double talking echoes with one loud and one weak talker or with two loud talkers.

On the other hand, in the system of Fig. 2 the disabling point C₃ or C'₃ in the west or east echo suppressor, respectively, controlled by operation of the east or west break-in control R₁ or R'₁, is located in common to both control branches 1, 2 or 1', 2' of the echo suppressor so that operation of a break-in control disables both the echo suppressing and echo suppressor circuit disabling functions of the associated echo suppressor. Thus one talker of any degree of loudness or the one of two weak talkers who first starts to talk, by operating his own echo suppressor to disable the echo path and to disable the echo suppressor controlled from that path, will obtain directional control of the system with a normal amount of echo suppression. But when a loud talker attempts to interrupt a weak talker, the former by operating his break-in control to disable both control branches of the latter's echo suppressor, and then by operating his own now-operative echo suppressor to disable his echo path and further disable the weak talker's echo suppressor, will gain directional control of the system. Along with the interrupting speech the weak talker will hear as echo his own speech energy which had been stored in the circuit beyond his echo suppressor when the strong talker's break-in control operated, but the loud talker will hear no echo. Thus breaking is obtained with minimum echo. Now, if both talkers raise their voices to the required degree of loudness to operate their respective break-in controls, both echo suppressors will be effectively removed from the system and both parties will hear each other and will also hear echoes which will persist until one talker or the other drops his speech volume so that his own break-in control releases.

Fig. 3 shows in more detail circuit arrangements which may be employed in the system of Fig. 1 or Fig. 2. In the figure the west-to-east two-wire transmission path L₁ and the east-to-west two-wire transmission path L₂ correspond to the similarly designated paths of the four-wire circuit of Fig. 1 or 2. The transmission path L₁ includes the one-way amplifying device 10 and the transmission path L₂ includes the oppositely-directed one-way amplifier 11. The path L₁ also includes a short section of two-wire line 28 coupled by tandem transformers in that path in the output of amplifier 10, and the path L₂ includes a short section of two-wire line 19 coupled by tandem transformers in that path in the output of amplifier 11.

Connected across the transmission path L₁ at a point in front of the amplifier 10 is the common input circuit 8 for the west echo suppressor and the west break-in control, feeding in parallel into the input of the two amplifier-detectors 12 and 25 for those respective controls. The operating winding of the electromagnetic switching relay 13 and the battery 16 operating as the space current source for the detector which may be of the electron discharge tube type, are connected in series across the output of the amplifier-detector 12 of the west echo suppressor through the normally closed armature and back contact of electromagnetic switching relay 15. The operating winding of electromagnetic switching relay 26 is con-

nected across the output of amplifier-detector 25 for the west break-in control. Similarly, connected across the transmission path L₂ in front of the amplifier 11 is the common input circuit 9 for the east echo suppressor and the east break-in control feeding in parallel into the input of the amplifier-detectors 24 and 23 for those respective controls. The operating winding of electromagnetic switching relay 15 and the battery 17 operating as the detector space current source are connected in series across the output of amplifier-detector 24 for the east echo suppressor through the normally closed armature and back contact of switching relay 13. The operating winding of electromagnetic switching relay 21 is connected across the output of the amplifier-detector 25 for the east break-in control. One side of line section 19 in transmission path L₂ is connected through conductor 20 and the normally closed back contact and armature of switching relay 21 to the positive terminal of a battery 22 of the same voltage as battery 17, the negative terminal of the former battery being grounded. The other side of line section 19 in transmission path L₂ is connected through a conductor 18 to the open front contact of switching relay 13. Similarly, one side of line section 28 in the path is connected through conductor 27 and the normally closed back contact and armature of switching relay 26 to the positive terminal of the battery 32 of the same voltage as battery 16, the negative side of the former battery being grounded. The other side of line section 28 is connected through conductor 29 to the normally open front contact of switching relay 15.

The operation of the switching arrangement of Fig. 3 just described corresponding to the echo suppressor and break-in control circuits diagrammatically illustrated in Fig. 1 will now be described.

It will be assumed that with the switching circuits of Fig. 3 in the condition indicated, a telephone subscriber associated with the west terminal (not shown) of the four-wire telephone circuit starts to speak and that his speech waves are transmitted in the direction from west to east over the one-way transmission path L₁. A portion of west's speech waves will be diverted at a point in transmission path L₁ in front of amplifier 10 into the circuit 8 and will be divided between the input of the west echo suppressor amplifier-detector 12 and the input of the break-in control circuit amplifier-detector 25. The portion impressed on amplifier-detector 12 will be amplified and detected thereby and the detected currents applied as energizing current to the operating winding of switching relay 13. The consequent operation of relay 13 will shift its armature from the back contact to the front contact thereby disabling the energizing circuit for the switching relay 15 connected to the output of amplifier-detector 24 in the east echo suppressor, and connecting the positive terminal of grounded battery 17 through the armature and front contact of relay 13 and conductor 18 to the lower line wire of line section 19. The completion of the latter connection, the upper line wire of line section being connected through conductor 20 and the closed back contact and armature of relay 21 to the positive terminal of the grounded equivalent battery 22, will, in effect, short-circuit line section 19 so as to disable the transmission path L₂ in the output of amplifier 11, thus preventing echoes of west's speech currents reflected from the east terminal of the four-wire

circuit into the transmission path L_2 from being transmitted over that path to the west talker. The breaking of the energizing circuit for switching relay 15 in the manner described will prevent subsequent operation of the east echo suppressor amplifier-detector 24 by speech waves of the east telephone subscriber subsequently received over the transmission path L_2 from causing operation of the switching relay 15, which, if operated, would result in the short-circuiting of line section 28 in the transmission path L_1 the disabling of that path and to disable the switching relay 13 of the west echo suppressor. The disabling of the path L_2 in the manner described will also prevent the transmission to the west subscriber of any subsequently received speech waves of normal amplitude from the east subscriber.

The circuit comprising amplifier-detector 25 and associated switching relay 26 corresponding to the west break-in control R'_1 of the system of Fig. 1 or 2 is designed to have a relatively lower sensitivity than the amplifier-detector circuit 12 and switching relay 13 of the west echo suppressor so that the former relay will be operated only a relatively small part of the time by applied speech waves of the normal amplitude which will operate the latter, but will be operated readily by applied speech waves of higher amplitude such as would be produced by the west subscriber raising his voice to a given degree of loudness greater than normal. The circuit comprising amplifier-detector 23 and associated switching relay 21 corresponding to the east break-in control R_1 in the system of Fig. 1 or 2, is likewise designed to have a relatively lower sensitivity than the amplifier-detector 24 and associated relay 15 of the east echo suppressor, so that the former relay will be operated infrequently by applied speech waves of the normal amplitude which would operate the latter relay but will be operated readily by speech waves applied from the transmission path L_2 of a given higher amplitude such as would be obtained by the east subscriber raising his voice to a degree of loudness a given amount above normal.

Now, with the west subscriber having obtained control of the switching circuit in the manner which has been described, let it be assumed that the east subscriber desires to break in. To do this, east merely raises his voice to the required degree of loudness. A portion of his speech waves transmitted over the transmission path L_2 and diverted into circuit 9 will then be of sufficient amplitude to cause operation of the break-in amplifier-detector 23 to operatively energize switching relay 21. The consequent operation of relay 21 will shift the relay armature from the back contact to the front contact. The breaking of the back contact of the relay will disconnect battery 22 from one side of line section 19 in transmission path L_2 thereby effectively removing the short circuit across that line section and making the transmission path L_2 operative to transmit east's speech waves amplified by amplifier 11 over that path and line LW to the west subscriber. By the disabling of the short-circuiting connection across line section 19 the echo suppression function of the west echo suppressor is effectively disabled. East, however, cannot operate his own echo suppressor while west continues to talk because the energizing circuit for the switching relay 15 of the former echo suppressor is maintained broken by the continued operation of switching relay 13 is

response to west's speech currents to hold the back contact of that relay open. Thus both west and east will hear each other and will also hear echoes until east lowers his voice or west stops talking.

If while east is talking loudly and has broken in in the manner described, west also begins to speak with sufficient loudness so as to operate the west break-in control comprising amplifier-detector 25 and associated relay 26, the shifting of the armature of the latter relay from its back contact will disconnect battery 32 from one side of line section 28 in transmission path L_1 . This will have no effect on the operation of the system for with relay 15 disabled a short circuit cannot be established across line section 28 to disable the path L_1 . It is apparent, therefore, that with both talkers speaking loudly both echo suppressors are disabled and both talkers hear each other and echoes. The operation of the system when the east talker is the first to speak and the west talker wishes to break in is similar to that described above for the opposite condition.

The modification of the system of Fig. 3 to include the connections shown by the dotted lines 30 and 31 will result in a system such as illustrated diagrammatically in Fig. 2, in which the operation of a break-in control by one talker disables both the echo suppressing function and the echo suppressor disabling function of the echo suppressor controlled by the other talker. Thus in Fig. 3 the operation of the west break-in switching relay 26 in response to the loud speech of the west subscriber received from the transmission path L_1 , when the latter is trying to break in, in addition to disabling the echo suppression branch of the east echo suppressor by breaking the back contact of relay 26 to disconnect the lower wire of line section 28 from battery 32 and ground, also through the closing of the armature and the front contact of that relay connects the output of amplifier-detector 12 across the winding of switching relay 13 and battery 32 now operating as a space current source, through the front relay contacts and conductors 30 and 14. As the latter connection does not include the switching contacts of switching relay 15 of the east echo suppressor, the operation of the latter relay in response to east's speech waves while break-in relay 26 is operated cannot result in the disabling of the west echo suppressor. Similarly, the operation of east's break-in relay 21 in response to the loud speech of the east subscriber received from the path L_2 to close the front contacts of that relay completes a connection between the output of the amplifier-detector 24 of the east echo suppressor across the winding of switching relay 15 and battery 22 now operating as the detector space current source, through the latter contacts, conductors 31 and 24, which does not include the switching contacts of switching relay 13 of the west echo suppressor. This effectively prevents west from disabling the east echo suppressor while the east break-in switching relay 21 remains operated.

While the arrangements of the invention have been shown as embodying certain specific forms which are deemed desirable, various modifications of these forms 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 a two-way telephone system including oppositely directed one-way transmission paths

for respectively transmitting the voice signals of the subscribers at the two terminals of the system, voice-controller echo suppressors respectively connected to each of said paths, operating to give directional control of the system to the subscriber who first starts to talk and to disable the path for transmitting the other subscriber's signals, and means to enable said other subscriber to transmit his signals to the first subscriber while the latter continues to talk and regardless of the degree of loudness of the latter's speech, by merely raising his voice so that portions of his speech signals exceed a given value, comprising an auxiliary voice-controlled switching circuit relatively insensitive as compared with the echo suppressors, respectively connected to each of said paths in front of the disabling point therein, which when operated disables the echo suppressor controlled from the other of said paths.

2. The system of claim 1 in which said given value of portions of said other subscriber's speech signals is determined by the echo of the first subscriber's speech signals.

3. In a two-way telephone transmission system including oppositely-directed one-way transmission paths for transmitting voice signals in opposite directions over the system, one switching circuit connected to each path responsive to voice signal transmission therein, in the absence of prior voice signal transmission in the other path, to disable the other path, and a second switching circuit connected to each path in front of the disabling point therein, responsive to voice signal transmission in that path only of amplitudes above a given amount, to disable said one switching circuit controlled from the other path.

4. In a two-way telephone transmission system including oppositely-directed one-way transmission paths for transmitting the voice signals for opposite directions over the system, one switching circuit connected to each path responsive to voice signal transmission therein, in the absence of prior voice signal transmission in the other one-way path, to disable said other path, and to disable the other switching circuit connected to the latter path, a second switching circuit connected to each path in front of the disabling point therein, responsive to voice signal transmission in that path, only of amplitudes higher than a given amount, to disable said one switching circuit controlled from the other path.

5. In a two-way telephone transmission system including two one-way transmission paths for respectively transmitting the voice signals for opposite directions over the system, an echo suppressor circuit connected to each path, operatively responsive to voice signal transmission in that path, in the absence of prior voice signal transmission in the other one-way path, each echo suppressor circuit comprising two control branches one operating to disable the other one-way path and the other control branch operating to disable the other echo suppressor circuit, a break-in control circuit connected to each path in front of the disabling point therein, responsive only to voice signal transmission in that path of an amplitude above a given amount to disable at least one control branch of the echo suppressor circuit controlled from the other one-way path.

6. The system of claim 5, in which the sensitivity of the break-in control circuit connected to each path is made such that it will be un-

operated by the maximum echo of the signals transmitted over said other one-way path.

7. The system of claim 5, in which the break-in control circuit connected to each one-way path operates to disable both control branches of the echo suppressor circuit controlled from the other one-way path.

8. The system of claim 5 in which the break-in control circuit connected to each one-way path operates only to disable the control branch of the echo suppressor circuit controlled from the other one-way path, the function of which is to disable the first one-way path.

9. In combination in a two-way telephone system including two oppositely directed one-way transmission paths for respectively transmitting the voice signals of the subscribers at opposite ends of the system, one voice-operated switching device connected to each path, responsive to voice signal transmission over that path to disable the other path and the switching device connected thereto so as to give directional control of the system to the subscriber who first starts to talk and means to enable break-ins by a subscriber when the subscriber at the other terminal is talking and has obtained directional control of the system, comprising a relatively insensitive control device connected to each path in front of the disabling point therein, operating only in response to applied voice signals of an amplitude higher than a given amount the minimum value of which is determined by the maximum echo of signals transmitted over the other path, to immediately disable the switching device controlled from the other one-way path.

10. In combination in a two-way telephone system including oppositely directed one-way transmission paths for respectively transmitting over the system the voice signals of subscribers at opposite terminals thereof, an echo suppressor circuit connected to each path responsive to the voice signals from one subscriber transmitted thereover, in the absence of prior voice signals from the other subscriber in the other one-way path, to disable said other one-way path and to disable the other echo suppressor circuit, so as to obtain directional control of the system, and means to facilitate break-ins by one subscriber when the other subscriber is talking and has obtained directional control of the system comprising an auxiliary control device connected to each path in front of the disabling point therein operating only in response to voice signal transmission in that path of an amplitude higher than a given amplitude to disable at least one of the functions of the echo suppressor circuit controlled from the other one-way path.

11. The system of claim 10, in which said auxiliary control device connected to each path when operated effectively removes the disablement in that path caused by operation of the echo suppressor circuit controlled from the other one-way path, while allowing the latter echo suppressor circuit to maintain the echo suppressor circuit controlled from the first one-way path disabled.

12. The system of claim 10 in which the auxiliary control device connected to each path, when operated, disables both functions of the echo suppressor circuit controlled from the other one-way path.

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