

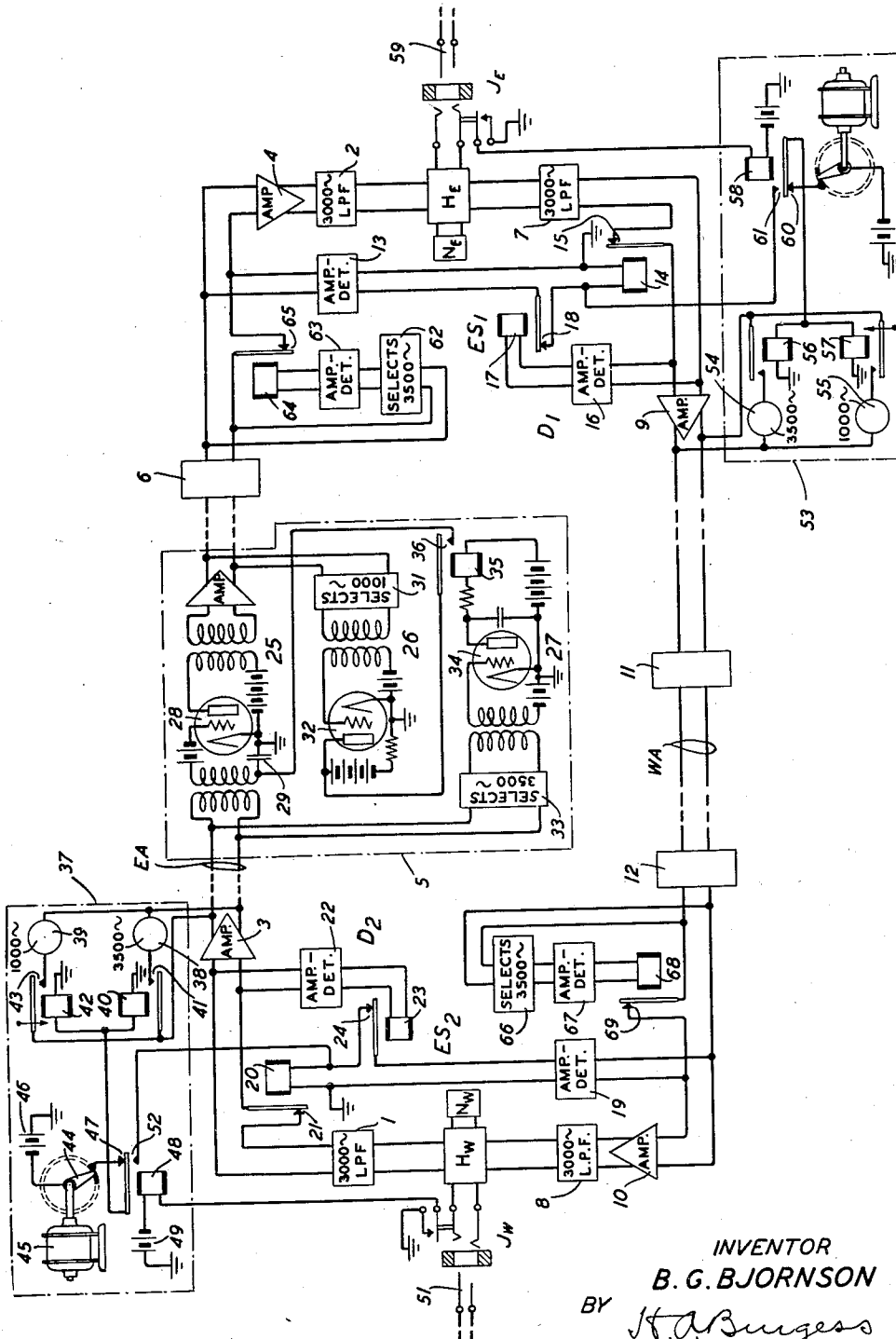
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TRANSMISSION CONTROL IN TWO-WAY SIGNALING SYSTEMS

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TRANSMISSION CONTROL IN TWO-WAY  
SIGNALING SYSTEMSBjorn G. Bjornson, Wyoming, N. J., assignor to  
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The invention relates to signaling systems and particularly to the regulation of transmission in two-way signaling systems.

Signal-controlled switching devices are often used at the terminals of a long two-way signaling system, for example, a long two-way telephone cable system, to directionally control transmission therein and to suppress echoes and prevent singing. These devices, most common of which are echo suppressors, usually operate to disable the one-way transmission path for one direction when signal transmission is taking place over the transmission path for the opposite direction.

In such systems, it is also customary to insert repeaters at regular intervals along the transmission paths, each to provide sufficient amplification of the transmitted signals to compensate for the attenuation of a preceding portion of the transmission path or section of line. It is well known in the prior art to provide for the automatic adjustment of the gain of the repeaters in such systems at intervals to compensate for irregular transmission variations, such as variations due to fluctuations in the batteries for the repeaters, etc. In certain circuits of the prior art this is accomplished by transmitting a tone, that is, a pilot wave of a single frequency, over the transmission path and utilizing it to control apparatus to adjust the gain of the repeaters in accordance with the tone intensity so as to bring the transmission equivalent of the transmission path to the desired value. The transmitted tone is preferably within the signal frequency range as a tone outside the signal frequency band may have intensity variations different from those of the transmitted signals. In the circuits of the prior art utilizing a tone within the signal frequency range in order to prevent interference with the signals, the adjustment of the transmission equivalent of the transmission paths is limited to periods between conversations requiring the application of the tone by manual means.

An object of the invention is to improve the operation of tone-controlled systems for adjusting the transmission equivalent of the transmission paths in a two-way signaling system.

Another and a more specific object is to adjust the transmission equivalent of one side of a four-wire signaling circuit while signal transmission is taking place over the other side by means of a tone having a frequency either within or outside the signal frequency range, under control of the transmitted signals.

These objects are attained in accordance with the invention by providing circuits controlled by

operation of echo suppressor circuits in response to signal transmission in one direction over the system to apply tone to the idle signal transmission path for the opposite direction, to properly control the gain of the repeater in that path.

In one embodiment of the invention, a terminal suppressor associated with one side of a four-wire toll telephone circuit operates in response to speech transmission thereover to disable the input of the opposite (idle) side of the circuit, and to impress on the input of that side of the circuit two tone waves of different frequencies. One of these tone waves transmitted in advance of the other, and preferably outside the frequency range of the transmitted speech, operates to condition the gain control apparatus on the idle side of the circuit for adjustment by the following pilot tone wave which is preferably within the frequency range of transmitted speech and to disable the idle side of the four-wire circuit at its receiving end to prevent the tone within the transmitted speech range being heard by the speaker.

The exact nature and advantages of 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 a four-wire toll telephone circuit equipped with transmission control circuits in accordance with the invention.

The four-wire telephone circuit comprises the two oppositely directed one-way paths EA and WA. The path EA contains in its input and output respectively, the low pass filters 1 and 2 preferably having a 3000 cycle cut-off and includes between these filters one-way amplifying devices 3 and 4 for repeating telephonic currents in the direction from west to east, and automatic gain regulating devices 5 and 6. The path WA contains in its input and output, respectively, the low pass filters 7 and 8 each preferably having a 3000 cycle cut-off and between these filters one-way amplifying devices 9 and 10 for repeating telephonic currents in the direction from east to west, and automatic gain regulating devices 11 and 12.

In well-known manner, the oppositely directed one-way transmission paths EA and WA are connected in substantially conjugate relation with each other and in energy transmitting relation with the terminal jacks  $J_E$  and  $J_W$  by hybrid coil transformers  $H_E$  and  $H_W$  and associated balancing networks  $N_E$  and  $N_W$ .

Located near the east terminal of the four-

wire circuit is the terminal echo suppressor ES<sub>1</sub>, and associated disabler D<sub>1</sub>. The echo suppressor ES<sub>1</sub> operates on signals transmitted from west to east over the path EA to effectively break the continuity of the path WA and thereby prevent any of the signal energy from returning as an echo to the west terminal. It consists of an amplifier-detector 13 the input of which is bridged across the path EA ahead of the input to the one-way amplifying device 4, and a relay 14 responsive to operation of the amplifier-detector 13 by signals transmitted over path EA to open the normally closed contacts 15 in the input of the path WA.

The disabler D<sub>1</sub> operates on signals transmitted from east to west over path WA to prevent operation of the echo suppressor relay 14 and thus insure continuity of the path WA during transmission of signals from east to west. It consists of an amplifier-detector 16 the input of which is bridged across the path WA ahead of the input to the one-way amplifying device 9 and a relay 17 responsive to operation of the device 16 by signals transmitted over WA to open the normally closed contacts 18 effectively disconnecting the echo suppressor relay 14 from the amplifier-detector 13.

Located near the west terminal of the four-wire circuit is the terminal echo suppressor ES<sub>2</sub> and associated disabler D<sub>2</sub>. The echo suppressor ES<sub>2</sub> operates on signals transmitted from east to west over the path WA to effectively break the continuity of the path EA and thereby prevent any of the signal energy from returning as an echo to the east terminal. It consists of an amplifier-detector 19 the input of which is bridged across the path WA ahead of the input to the one-way amplifying device 10, and a relay 20 responsive to operation of the amplifier-detector 19 by signals transmitted over path WA to open the normally closed contacts 21 in the input of the path EA.

The disabler D<sub>2</sub> operates on signals transmitted from west to east over path EA to prevent operation of the echo suppressor relay 20 and thus insure continuity of the path EA during transmission of signals from west to east. It consists of an amplifier-detector 22 the input of which is bridged across path EA ahead of the input to the one-way amplifying device 3, and a relay 23 which opens the normally closed contacts 24 thereby effectively disconnecting the echo suppressor relay 20 from the amplifier-detector 19.

The automatic gain adjusting device 5 is an adaptation of a prior art vacuum tube, tone-operated net loss adjuster, referred to hereinafter as a tonlar. It contains an amplifying portion 25, a gain regulating portion 26 and an enabling portion 27. The amplifying portion 25 includes a three-electrode vacuum tube amplifying device 28 in the path EA and having a biasing condenser 29 in its grid-filament circuit. The gain regulating portion 26 consists of a selective circuit 31 connected to the path EA in the output of amplifier 25, and adapted to select from the path EA the gain-adjusting tone which preferably comprises a narrow band of frequencies or a single frequency, say 1000 cycles, within the normal range of the voice signals transmitted over the path EA, a vacuum tube rectifier 32 for rectifying the selected frequencies, and the condenser 29 adapted to be charged by the rectified waves in the manner described below. The enabling portion 27 consists of a selective circuit 33 connected to the path EA in the input of amplifier 25, and

adapted to select from the path EA the conditioning tone which preferably comprises a narrow band of frequencies or a single frequency, say 3500 cycles, outside the normal range of the voice signals transmitted over the path EA, a vacuum tube rectifier 34 for rectifying the selected frequencies and a relay 35 responsive to the rectified waves to close the normally open contacts 36 thereby connecting the output of the rectifier 32 in the gain regulating portion 26 across the biasing condenser 29 in the amplifying portion 25.

Automatic gain adjusting devices 6, 11 and 12 are identical with the tonlar 5.

Bridged across the path EA in the output of the one-way amplifying device 3 near the west terminal of the four-wire circuit is the output of the two-tone sending device 37. It consists of a source 38 of tone of the frequency assigned to the conditioning tone which is selected by selective circuit 33, that is, 3500 cycles, a source of tone 39 of the frequency assigned to the gain adjusting tone which is selected by selective circuit 31, that is, 1000 cycles, a fast operate relay 40 which when energized closes contacts 41 connecting the tone source 38 to the path EA, a slow operate relay 42 which when energized closes the contacts 43 connecting the tone source 39 to the path EA, a rotary intermittent switch 44, a motor 45, battery 46 and switch contacts 47. The rotary intermittent switch 44 is continuously driven by a motor 45 and normally operates periodically to send energizing direct current from the battery 46 through the normally closed contacts 47 to the windings of the relays 40 and 42 causing periodically the operation of those relays to send first a spurt of the 3500 cycle tone from the source 38 and then a spurt of the 1000 cycle tone from the source 39 over the path EA. A relay 48 is arranged to be operated in response to current from the battery 49 when the line plugs 51 attached to a west subscriber's telephone circuit are inserted in the west terminal jack J<sub>w</sub>, to open the normally closed contacts 47 to prevent operation of the tone-sending relays 42 and 40 in response to rotary switch 44. The operation of relay 48 simultaneously closes the normally open switch contacts 52, thereby connecting the relays 40 and 42 across the output circuit of the amplifier detector 19 of the echo suppressor ES<sub>2</sub> in parallel with the relay 20.

Bridged across the path WA in the output of the one-way amplifying device 9 near the east terminal of the four-wire circuit is the output of a second two-tone sending device 53, similar to the device 37, which operates in a manner similar to that described for the device 37 normally, that is, when the jack J<sub>e</sub> is clear, to send periodically over the line WA a spurt of the conditioning tone of 3500 cycle frequency from the source 54 followed an instant later by a spurt of the gain-adjusting tone of 1000 cycle frequency from the source 55 in response to operation of the fast operate relay 56 and slow operate relay 57, respectively, under control of another continuously driven rotary switch. The relay 58 is responsive to the insertion of line plugs 59 attached to an east subscriber's telephone circuit into the east terminal jack J<sub>e</sub>, to open switch contacts 60 to break the energizing circuit for relays 56 and 57 from the rotary switch, and to close switch contacts 61 adapting the tone-control relays 56 and 57 for operation under control of the amplifier-detector 13 in the echo suppressor ES<sub>1</sub>.

Bridged across the path EA ahead of the input to the echo suppressor ES<sub>1</sub>, at the east terminal,

is a circuit comprising a selective network 62 adapted to select a portion of the transmitted 3500 cycle tone from that path, an amplifier-detector 63 for rectifying the selected tone and a relay 64 responsive to the rectified tone to open the normally closed contacts 65 in the path EA also at a point in front of the input to ES<sub>1</sub>, thus preventing false operation of ES<sub>1</sub> during the period when tone is transmitted.

Similarly, bridged across the path WA ahead of the input to the echo suppressor ES<sub>2</sub> at the west terminal is a circuit comprising the selective network 66 adapted to select from that path a portion of the transmitted 3500 cycle tone, an amplifier-detector 67 for rectifying the selected tone and a relay 68 responsive to the rectified tone to open the normally closed contacts 69 in the path WA also in front of the input to ES<sub>2</sub>, thus preventing false operation of ES<sub>2</sub> during the period when tone is transmitted.

The operation of the system will now be described.

It is assumed that initially the four-wire circuit is in the idle condition, that is, the terminal jacks J<sub>w</sub> and J<sub>E</sub> are clear so that no speech signals are being transmitted over path EA or the path WA.

The two tones periodically transmitted over the path EA by the tone sender 37 in the manner described above operate to adjust the transmission equivalents of the respective paths in the following manner.

A portion of the 3500 cycle current transmitted first is picked off from the path EA by the selective circuit 33 in the enabling portion 22 of the vacuum tube tonlar 5, is rectified by the vacuum tube rectifier 34, and causes the operation of the relay 35 to close contacts 36 to condition the gain-regulating portion 26 of the tonlar for operation by the following 1000 cycle tone. A portion of the following 1000 cycle tone is selected by the selective circuit 31 in the gain-regulating portion 26 of the tonlar, is rectified by the vacuum tube rectifier 32, and charges the biasing condenser 29 in the grid circuit of the vacuum tube amplifier 39 in accordance with the amplitude level of the 1000 cycle tone. This changes the gain of the amplifier 25 so that it compensates for variations in attenuation of the preceding portion of the path EA from the normal value.

Other portions of the transmitted tones picked off from the path EA control in similar manner the tonlar device 6 near the east terminal of the path EA to regulate the gain in the path at that point to compensate for variations in attenuation in the path EA between tonlar 5 and tonlar 6.

A portion of the transmitted 3500 cycle tone in the output of tonlar 6 is picked off by selective circuit 62, is amplified and rectified by the amplifier-detector 63 and causes the operation of the relay 64 to open the contacts 65 thus breaking the path EA ahead of the input to the echo suppressor ES<sub>1</sub>.

The apparatus controlling the sending of the two tones over the path EA during the idle condition of the four-wire circuit is adjusted so that the transmission of the tones persists until the tonlars 5 and 6 in the path EA have had time to complete the gain adjustment and then is interrupted for an interval of time after which the whole process is repeated.

The gain in the path WA is periodically adjusted by tonlars 11 and 12 in similar manner under control of the tones transmitted over that path from sources 54 and 55.

Now if two subscribers' loops are to be connected together through the four-wire circuit, the terminal plugs 51 and 59 thereof will be inserted in jacks J<sub>w</sub> and J<sub>E</sub>, respectively, causing the control of the tone sending relays 40 and 42 at the west terminal to be transferred from the rotary switch 44 to the amplifier-detector 19 in echo suppressor ES<sub>2</sub>, and the control of tone sending relays 56 and 57 from the rotary switch at the east terminal to the amplifier-detector 13 in echo suppressor ES<sub>1</sub> in the manner described previously.

With the circuits so connected, in the absence of speech transmission between the two subscribers, the control tones will not be transmitted either over path EA or path WA because of the unoperated condition of amplifier-detector 19 in ES<sub>2</sub> controlling the tone sending relays 40 and 42 and of amplifier-detector 13 in ES<sub>1</sub> controlling tone sending relays 56 and 57.

When the east subscriber begins to talk, his speech signal currents are impressed by the hybrid coil H<sub>E</sub> on path WA and the frequencies thereof below 3000 cycles are transmitted by low pass filter 7 and traverse the line WA from east to west. Part of the transmitted signal energy is diverted into disabler D<sub>1</sub> at the east terminal and causes the operation of the amplifier-detector 16 and thus relay 17 to disable the echo suppressor ES<sub>1</sub> in its output. This prevents subsequent operation of relay 14 to block the path WA, and of relays 56 to 57 to apply tones from the sources 54 and 55 to path WA under control of the amplifier-detector 13 in ES<sub>1</sub>.

The undiverted portion of the speech signal currents from the east subscriber passes through the tonlars 11 and 12 without affecting their gain adjustments, being blocked from the enabling circuits thereof by the previously described 3500 cycle selective circuits therein. Also, the transmitted speech signal energy is prevented from falsely operating the relay 68 to block the input of the echo suppressor ES<sub>2</sub> at the west terminal by the 3500 cycle selective circuit 66.

When the speech signal currents reach the input to the echo suppressor ES<sub>2</sub>, a portion of the energy is diverted and causes the operation of amplifier-detector 19 to energize the winding of relays 20, 40 and 42.

Relay 20 operates to break the path EA by opening the normally closed contacts 21 therein, thus preventing echoes of the signal currents of the east subscriber from returning to his receiver via the path EA. Fast operate relay 40 and slow operate relay 42 operate in the manner previously described to send 3500 cycle tone followed by 1000 cycle tone over the path EA to control the tonlars 5 and 6 in the manner previously described to suitably adjust the transmission equivalent of the path EA. The transmitted 3500 cycle tone at the east terminal also controls amplifier-detector 63 and thus relay 64 to disable the output of path EA at contacts 65, so that the 3500 and 1000 cycle tones subsequently reaching the disabling point in that path will not be heard by the east subscriber. Any portion of the 3500 cycle tone which may pass the switch contacts 65 before they are opened by operation of relay 64, is prevented from reaching the east subscriber by the 3000 cycle low pass filter 2 in the output of the path EA. As long as signals from the east subscriber keep the echo suppressor ES<sub>2</sub> operated, the two tone sources 38 and 39 will remain connected to the line EA.

When the east subscriber stops talking, the re-

lay 17 of the disabler D<sub>1</sub> releases to return echo suppressor ES<sub>1</sub> at the east terminal to its normal condition. The relays 20, 40 and 42 connected to the output of the amplifier-detector 19 in the echo suppressor ES<sub>2</sub> at the west terminal then release unblocking the path EA and preventing further application of the two tones from the sources 38 and 39 to the path EA. Relay 64 at the east terminal also releases due to the removal of the 3500 cycle tone from the path EA returning switch contacts 65 in the path EA to the closed condition and making that path again operative to transmit signals from the west subscriber to the east subscriber's receiver.

When a call is completed and the line plugs 51 and 59 are removed from the jacks J<sub>W</sub> and J<sub>E</sub>, respectively, the relays 48 and 58 release thereby breaking contacts 52 and 61 and making contacts 47 and 60 so that the gain of the two paths EA and WA may be periodically adjusted by tones transmitted thereover under control of the motor operated rotary switches.

In the circuits of the invention as described the enabling circuits of the tonlars are controlled by the conditioning tone picked off from the transmission paths in the input of the tonlars. It is apparent that proper operation may be attained also if the inputs of the enabling circuits are connected to the transmission path in the outputs of the tonlars.

The circuits of the invention have been illustrated and described in connection with circuits utilizing tone operated net loss adjusters (tonlars) of the vacuum tube type but are applicable equally well to circuits employing tonlars of any other type, such as, for instance, the mechanical tonlar described in U. S. Patent 1,918,822 issued July 18, 1933 to N. C. Norman.

The circuits of the invention have been illustrated and described in connection with circuits employing disablers in connection with the echo suppressors so as to facilitate break-ins but are applicable as well to circuits not employing disabler circuits as the latter circuits play no essential part in the operation of the circuits of the invention.

In the preferred form of the invention, the conditioning tone has a frequency outside the signal frequency range, for example 3500 cycles, and the gain adjusting tone a frequency inside the signal frequency range, for example 1000 cycles. Obviously any other frequencies could be used for either the conditioning tone or the gain adjusting tone. If the selective circuits and filters are suitably chosen, both tone frequencies could lie outside or inside the signal transmission band.

It is also within the scope of the invention to employ means other than the motor and rotary switch mechanism to connect periodically the two-tone sources to the one-way transmission paths.

Other modifications which may be made in the circuit illustrated and described within the scope and spirit of the invention will be apparent to persons skilled in the art. The invention is to be limited only within the scope of the appended claims.

What is claimed is:

1. In combination, two signal transmission circuits, means at a given point in one of said circuits responsive to waves of a given frequency to adjust the transmission equivalent of said one circuit in accordance with the amplitude of the applied waves, means connected to the other of

said circuits and responsive to signal transmission therein in the absence of signal transmission in said one circuit to impress on the input of said one circuit control waves of said given frequency, and means for selecting the transmitted control waves at said given point and applying them to control said transmission equivalent adjusting means.

2. In combination, two signal transmission circuits including signal repeating means, wave controlled means at a repeating point in one of said circuits for adjusting the gain of the repeating means thereat in accordance with the amplitude of the applied waves, switching means connected to the other of said circuits and responsive to signal transmission therein in the absence of signal transmission in said one circuit to cause control waves to be transmitted over said one circuit to said repeating point, and means for selecting the transmitted control waves at the repeating point and for applying the selected waves to control said gain adjusting means thereat.

3. In combination with a two-way signal transmission system comprising two one-way paths each including a repeater, for transmitting signals in opposite directions between two two-way circuits, switching means connected to each path and responsive to signal transmission therein in the absence of prior initiated signal transmission in the other path for disabling said other path, wave controlled means at the repeating point in each path for adjusting the gain of the repeater thereat in accordance with the amplitude of the applied waves, and means responsive to the operation of the switching means connected to one of said paths for causing control waves to be transmitted over the other path to operate the gain adjusting means for the repeater in said other path.

4. A two-way signal transmission system comprising two one-way paths for transmitting signals in opposite directions between two two-way circuits, a signal repeater in each of said paths, wave controlled means at the repeating point in each path for adjusting the gain of the signal repeater thereat in accordance with the amplitude of applied waves, switching means connected to each path and responsive to signal transmission therein in the absence of prior initiated signal transmission in the other path effectively to disconnect the input of said other path from the associated two-way circuit and to impress control waves of a definite amplitude on the input of said other path for transmission thereof, means for selecting the transmitted control waves at the repeating point and for applying the selected waves to control said wave controlled gain adjusting means, and means for preventing the control waves transmitted over said other path from reaching the two-way circuit connected to the output thereof.

5. In combination, two one-way paths for transmitting signals in opposite directions between two two-way circuits, a signal repeater in each of said paths, normally disabled means at the repeating point in each path responsive when operative to applied waves to adjust the gain of the repeater thereat in accordance with the amplitude of said waves, switching means connected to each path and responsive to signal transmission therein in the absence of prior initiated signal transmission in the other path to disconnect effectively the input of said other path from the first path and from the associated

two-way circuit and to cause two control waves of different frequency to be transmitted over said other path one in advance of the other, means for selecting one of said control waves at the repeating point in said other path and for utilizing it to condition the gain adjusting means thereat for operation, means for selecting the following other control wave at said repeating point and for applying it to control the gain adjusting means thereat, means selectively responsive to said one control wave to disable said other path in its output, and filtering means in the input and output of each path for suppressing waves of the frequency of said one control wave while transmitting other signal frequencies.

6. The combination of claim 5 and in which the frequency of said other control wave is within the frequency range of the transmitted signals.

7. The combination of claim 5 and in which the frequency of said one control wave is outside the normal frequency range of said signals.

8. The combination of claim 5 and in which the frequency of said one control wave is within the normal frequency range of said signals.

9. In combination, two one-way paths for transmitting signals in opposite directions between two two-way circuits, a signal repeater in each of said paths, normally disabled means at the repeating point in each path responsive when operative to applied waves to adjust the gain of the repeater thereat in accordance with the amplitude of said waves, switching means connected to each path and responsive to signal transmission therein in the absence of prior initiated signal transmission in the other path, to disconnect effectively the input of said other path from the first path and from the associated two-way circuit and to cause two control waves of different frequency to be transmitted over said other path one in advance of the other, means for selecting one control wave at the repeating point in said other path and for utilizing it to condition the gain adjusting means thereat for operation, means for selecting the following other control wave at said repeating point and applying it to control the gain adjusting means thereat, means selectively responsive to said one control wave to disable said other path in its output, filtering means in the input and output of each path for suppressing waves of the frequency of said one control wave while transmitting other signal frequencies, and means operative only in the absence of signal transmission over either path for periodically transmitting over each of said paths said one control wave followed by said other control wave, respectively, to condition for operation and to operate the gain adjusting means in the path to adjust the gain of the repeater therein in accordance with changes in amplitude of said other control wave in transmission over the path.

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