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TRANSMISSION CONTROL CIRCUITS

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This invention relates to two-way signaling systems and particularly to means for controlling transmission in such systems.

The object of the invention is to improve the operation of a signal transmission system including therein circuit-control means operated under control of the signals transmitted over the system.

The invention is especially applicable to a system in which two-way transmission of signaling energy is required and including as a link therein a two-way cable of high attenuation and long transmission time, such as a long, deep sea submarine telephone cable. Signal-controlled, circuit-control apparatus are usually associated with the transmitting and receiving circuits at each terminal of the cable in such a system to insure that the system is operative to transmit in only one direction at a time, so as effectively to prevent singing and to suppress echoes. This is usually accomplished by making the circuit-control apparatus at each terminal responsive to transmission in one direction to render the circuits thereat operative to transmit in that direction and effectively to disable the circuits for transmission in the opposite direction.

The relatively long time (as compared to radio circuits, for example) required for transmitting signals over a cable in such a system, greatly increases the chance that two subscribers at opposite ends of the system may both start talking within a time interval equal to the overall transmission time of the cable, resulting in each subscriber seizing control of the circuit-control apparatus at his own terminal and locking out the transmission of the other subscriber.

Circuits have heretofore been designed to avoid the above mentioned difficulty by giving complete control of the circuit-control apparatus at both ends of the system to that subscriber who first starts talking. This is accomplished in certain of these circuits by providing means at each terminal under control of the speech currents initiated thereat for transmitting over the system along with, or in advance of, the speech waves, one or more control waves to operate the circuit-control apparatus in their path. The control wave first sent out determines which terminal or talker gets control of the system.

In one aspect the invention relates to a circuit of the above mentioned type in which break-ins by a listening party after one party has obtained control are facilitated. This is accomplished by the provision of an auxiliary control circuit at each terminal responsive to the initiation of

speech waves thereat for disabling the receiving control circuit at that terminal substantially at the same time as the arrival of the control waves at the other terminal, and for reestablishing said control circuit substantially simultaneously with the cessation of said speech waves, thus enabling a listener to seize control of the talking circuits of the system at a pause by the talker for a time considerably less than the overall transmission time of the cable.

Another feature is that of utilizing for controlling circuit-control apparatus at each terminal of the system a beat frequency produced by combining two control frequencies or other means requiring for operation both or all control frequencies transmitted from the other terminal under control of the speech waves initiated thereat. The control frequencies are different for each terminal, and are preferably chosen so that they are normally not to be found simultaneously in speech, in their harmonics or difference tones. This method of control lessens the chance of false operation of the circuit-control apparatus.

The exact nature of the invention and its advantages will be clear from the following detailed description thereof when read in connection with the accompanying drawing, Fig. 1 of which shows diagrammatically a portion of one terminal of a submarine telephone cable system embodying the invention, and Fig. 2 shows an alternative modification of a portion of the circuit of Fig. 1.

For convenience the invention will be described as applied to a system for the two-way transmission of speech waves, but it is to be understood that the principles of the invention apply equally well to systems for the two-way transmission of signal waves in general of frequencies within or outside the speech frequency range, such as waves representing speech, entertainment programs comprising music as well as speech, telegraph waves, etc.

Since the terminal stations at each end of the cable in the system to be described may be substantially identical in construction except for changes in the design of the control wave generators and the filters used therein, necessitated by the fact that the values of the frequencies of the control waves transmitted from the two terminals are different, it has been deemed sufficient to illustrate only one terminal of the cable system.

Fig. 1 of the drawing illustrates the west terminal circuit for a two-way telephone cable sys-

tem. This west cable terminal circuit comprises a transmitting-amplifying path TA having its output connected directly to the west end of the submarine telephone cable TC, and a receiving-amplifying path RA having its input connected directly to the west end of the submarine telephone cable TC. The input of the transmitting path TA and the output of the receiving path RA may be connected by means of a three-winding transformer or hybrid coil, or other suitable means in energy transmitting relation with a circuit associated with a west subscriber, (not shown), such as a toll telephone circuit, and in substantially conjugate relation with each other.

The transmitting-amplifying path TA comprises reading in order from west to east, the one-way amplifying device 1 and the one-way amplifying device 2. The receiving-amplifying path RA comprises reading in order from east to west, the one-way amplifying device 3 and the filter 4.

Connected across the transmitting path TA in the input of the one-way amplifying device 1 is the input of a control circuit 5 comprising the wave-controlled, relay-controlling device 6 and the windings of the mechanical relays 7 to 19 connected in parallel across the output of the device 6. The source 11 of alternating current control waves of frequencies f_1 and the source 12 of alternating current control waves of frequencies f_2 are normally connected across the path TA between amplifying devices 1 and 2 therein through the band-pass filter 13.

Connected across the input of the receiving path RA between the input of the receiving-amplifying device 3 and the west end of the cable TC is the receiving control circuit 14 comprising the selective network 15, the amplifier-detector 16, the band-pass filter 17, the wave-controlled, relay-controlling device 18, and the windings of the mechanical relays 19 and 20 connected in parallel across the output of the device 18. Connected across the receiving path RA between the output of the amplifying device 3 and the filter 4 therein is the input of a second receiving control circuit 21 comprising the wave-controlled, relay-controlling device 22, and the windings of the mechanical relays 19 and 20 connected in parallel across the output of the device 22.

In the output of the transmitting path TA between the output of the amplifying device 2 therein and the west end of the cable TC are the normally open switch contacts 23 adapted to be closed by operation of relay 8 to connect the output of the transmitting-amplifying device 2 to the cable TC. Also in the transmitting path TA in front of the point of connection of the control circuit 5 thereto are the normally closed switch contacts 24 adapted to be opened by operation of relay 19 to prevent transmission of speech waves to the input of the control circuit 5.

In the input of the receiving path RA between the point of connection of the receiving control circuit 14 thereto and the input of the amplifying device 3 are the normally closed switch contacts 25 adapted to be opened by operation of relay 7 to disconnect the receiving-amplifying device 3 from the cable TC.

In the circuit connecting the band-pass filter 13 to the transmitting path TA are the normally closed switch contacts 25 adapted to be opened by operation of relay 9 to disconnect the control wave sources 11 and 12 and the filter 13 from

the transmitting path TA. In the control circuit 5 between the output of the control device 6 and the winding of relay 10 are the normally closed switch contacts 26 adapted to be opened by operation of relay 20 to disable the input to relay 10. In the receiving control circuit 14 between the selective network 15 and the amplifier-detector 16 are the normally closed switch contacts 27 adapted to be opened by operation of relay 10.

The wave-controlled, relay-controlling devices 6, 18 and 22, and the corresponding devices at the east cable terminal station, may be vacuum tube, amplifier-rectifier devices of the type well known in the art, or any other devices which will respond to alternating current waves impressed on their inputs to control the operation of circuit-control devices, such as mechanical relays in their outputs. The amplifier-detector 16 may be of the vacuum tube type well known in the art.

The selective network 15 and the corresponding network at the east station may be a tuned circuit or a band-pass filter. The former is designed to select the control wave frequencies f_3 and f_4 transmitted from the east station and the latter to select the control wave frequencies f_1 and f_2 transmitted from the west station.

The filters 4, 13 and 17 at the west cable terminal station and the corresponding filters at the east cable terminal station may be of the band-pass type disclosed in United States patents to Campbell, Nos. 1,227,113 and 1,227,114 issued May 22, 1917. The filter 17 is designed to select the beat frequency $f_4 - f_3$, or any other beat frequency produced by combination of f_3 and f_4 where f_3 and f_4 are the control wave frequencies generated by the control wave sources at the east cable terminal station corresponding to the sources 11 and 12 at the west cable terminal station, and to suppress other frequencies. The filter at the east station corresponding to filter 17 is designed to select the beat frequency $f_2 - f_1$, or other combination, where f_1 and f_2 are the control wave frequencies transmitted from the west station. The band-pass filter 4 in the receiving path RA at the west cable terminal station is designed to suppress the control wave frequencies f_3 and f_4 transmitted from the east cable terminal station while transmitting other frequencies in the speech band. The filter at the east cable terminal station corresponding to filter 4 at the west station, is designed to suppress the control wave frequencies f_1 and f_2 transmitted from the west station while passing other frequencies within the speech frequency band. The filter 13 in the circuit connecting the control wave sources 11 and 12 to the path TA is designed to transmit the control wave frequencies f_1 and f_2 while suppressing other frequencies. The corresponding filter at the east terminal station is designed to pass the control wave frequencies f_3 and f_4 while suppressing other frequencies.

The control wave frequencies f_1 and f_2 generated by the sources 11 and 12, respectively, at the west cable terminal station, and the control wave frequencies f_3 and f_4 generated by the corresponding sources at the east station, are so chosen that they are not normally to be found simultaneously in speech, in their harmonics or difference tones. Thus, both control wave frequencies at each terminal may be below the lowest transmitted speech frequency and separated by greater than syllabic frequency and less than fundamental speech frequencies, or both may be in the speech band if properly chosen. One may be low in the band

and the other high, not harmonically related, for, according to analyses of normal speech both low and high frequencies do not occur therein simultaneously. The chance of false operation of the receiving control circuits by speech will thus be reduced although noise considerations might well influence choice of frequencies. Control wave frequencies f_1 and f_2 transmitted from the west station should be different frequencies from the control wave frequencies f_3 and f_4 transmitted from the east cable terminal station.

Fig. 2 shows a modified circuit arrangement which may be used in place of the portion of the receiving control circuit 14 shown within the dot-dash box. It comprises two portions connected in parallel to the output of the selective network 15. One parallel portion comprises the filter 29 designed to pass the control wave frequency f_3 transmitted from the east cable terminal and to suppress the control wave frequency f_4 transmitted from that terminal, the wave-controlled, relay-controlling device 30 (similar to the device 18) and the winding of mechanical relay 31 connected to the output of the control device 30 and arranged to be energized by the operation thereof. The other parallel portion comprises the filter 32 designed to pass the control wave frequency f_4 and to suppress the control wave frequency f_3 the wave-controlled relay-controlling device 33 and the winding of the mechanical relay 34 connected to the output of the device 33 and arranged to be energized by operation thereof. Relays 31 and 34 operate in response to the energization of their windings respectively to close the normally open switch contacts 35 and 36 in an energizing circuit for the windings of relays 19 and 20. When the switch contacts 35 and 36 are both closed, the windings of relays 19 and 20 will be energized.

The operation of the system as a whole will now be described, referring to the west cable terminal station only. When no speech waves are being transmitted over the system in either direction the switch contacts at both stations are in the conditions indicated at the west station shown in the drawing. With the switch contacts in the position shown the transmitting-amplifying path at each terminal is disabled in its output while the receiving-amplifying path at each terminal is operative.

It will be assumed that the west subscriber associated with the west cable terminal station shown in the drawing starts to speak before the east subscriber associated with the east cable terminal station not shown. The west subscriber's speech waves in the transmitting path TA are divided between the input of the amplifying device 1 therein and the input of the control circuit 5 connected thereto. The portion of the speech waves impressed upon the amplifying device 1 are amplified thereby and transmitted to the amplifying device 2 in the transmitting path TA which amplifies them still more. The portion of the west subscriber's speech waves diverted into the control circuit 5 will operate the control device 6 therein causing the windings of relays 7 to 10 in the output thereof to be energized.

Relay 7 is designed so that it will operate in response to the energization of its winding simultaneously with or slightly before the operation of relay 8, and to release simultaneously with or slightly after relay 8 releases. The operation of relay 7 opens the switch contacts 37 in the input of the receiving path RA so as to disconnect the receiving-amplifying device 3 from the cable TC. Relay 8 operates to close the normally open switch

contacts 23 in the output of transmitting path TA making that path operative to transmit from the output of the amplifying device 3 into the cable TC. The control waves of frequencies f_1 and f_2 selected by the filter 13 from the output of sources 11 and 12, respectively, after amplification in the amplifying device 2 are then transmitted out over the cable TC along with the amplified speech waves in the output of the device 2.

Relay 9 is designed by any of the well known means to be slow operating, so as to operate a small interval of time, t_1 , after the operation of relay 8, to open switch contacts 25 to disconnect the control wave sources 11 and 12 from the transmitting path TA. The time t_1 should be equal to, or greater than the overall transmission time through the receiving control circuit 14. Relay 9 may be dispensed with in an alternative type of circuit, in which case the control wave frequencies will be continuously transmitted over the system as long as the speech waves are being transmitted thereover. As this alternative method might result in some interference with the speech waves, the former method is probably preferable.

The inclusion of some means for delaying the transmission of speech waves to the cable TC with respect to the transmission of the control waves thereto, such as an electrical delay circuit of well known design located in the transmitting path TA before the point of connection of the sources 11 and 12 thereto, as indicated by the dotted box 28 in the drawing, would make the system of the invention a "courier" system.

Relay 10 by any suitable means is designed to operate in response to the operation of control device 6 by the speech waves from the path TA, slightly more than T seconds after relay 8 has operated to render the transmitting path TA operative, where T is substantially equal to the overall transmission time of the cable TC between the west and east cable terminal stations. The relay 10 is also designed to have such small hangover as to release almost immediately with cessation of the supply of speech waves to the control device 6, or any desired hangover depending on the desired operation. Relay 10, then, will open the normally closed switch contacts 27 in the receiving control circuit 14 substantially at the same time as the control waves f_1 and f_2 which have been previously transmitted over the cable TC, reach and seize control of the switching apparatus at the east cable terminal in the manner which will be described below.

The manner in which control of the transmitting and receiving path and the associated control circuits at the east cable terminal station is obtained for the first talker associated with the west station will now be described and will be clear by reference to the similar apparatus at the west station shown in the drawing. That the apparatus to be referred to is that of the east station will be indicated by designating the apparatus thereat with the same character which designate the corresponding apparatus at the west station, but followed by a prime (') mark.

If the subscriber associated with the east terminal station has not yet started to talk at the time of arrival of the two control waves of frequencies f_1 and f_2 and the accompanying west subscriber's speech waves at the east cable terminal station, the transmitting path TA' thereat will be in its normal disabled condition, and the receiving path RA' and the receiving control circuit 14' will be in their normally operative posi-

tion. Then, the received waves will divide between the receiving path RA' and the input of the receiving control circuit 14'.

The portion of the combined speech and control waves diverted into the receiving path RA' will be amplified by the amplifying device 3' therein and the amplified waves will be divided between the input of the filter 4' in the path RA' and the input of the control circuit 21'. The filter 4' will suppress the frequencies f_1 and f_2 in the impressed waves and transmit the remaining frequencies in the speech waves to the circuit associated with the east subscriber. The portion of the amplified speech and control waves from the output of the amplifying device 3' diverted in the control circuit 21' will operate the control device 22' therein causing the windings of the relays 19' and 20' in the output thereof to be energized. The device 22' will be maintained in the operated condition by the impressed speech waves when transmission of the control waves to the device 22' ceases due to the operation of relay 9 at the west terminal station. Relay 19' will operate to open the normally closed switch contacts 24' in the input of the path TA' thereby preventing any later initiated speech currents from the east subscriber getting into the control circuit 5' and causing false operation of the circuit. Relay 20' simultaneously operates to open the normally closed contacts 26' in the circuit connecting the output of the control device 6' to the winding of relay 10' thus preventing false operation thereafter of relay 10' by any speech waves of the east subscriber which might be stored in the transmitting path TA' or in the control circuit 5' at the time relay 19' operates to disable the input of the path TA'.

The west subscriber has now obtained complete control of the talking circuits at both the west and east terminal stations and the east subscriber will not be able to break-in to transmit his own speech waves over the cable until there is a pause in the continuous transmission of the west subscriber's speech current long enough to allow release of the relay 19' at the east cable terminal station, for example, a pause at the end of a sentence.

Meanwhile, the portion of the control wave frequencies f_1 and f_2 and the corresponding frequencies in the west subscriber's speech waves will be transmitted by the selective network 15' in the receiving control circuit 14', as the network 15' is designed to select the frequencies f_1 and f_2 . The frequencies f_1 and f_2 passed by the network 15' will be combined in the amplifier-detector 16'. Of the combination products of the frequencies f_1 and f_2 in the output of the amplifier-detector 16', the difference frequency $f_2 - f_1$ or some other combination frequency will be selected by the band-pass filter 17' and impressed on the control device 18' which will operate to supply energizing current to the windings of relays 19' and 20' which relays, as above pointed out, have been previously operated by control device 22' and maintained operated thereby in response to the speech waves received over the cable TC.

It is apparent then that for the case where the two subscribers at the opposite ends of the system do not start talking within a time interval equal to the overall transmission time of the cable TC between the terminal stations, with the circuit as described, exclusive control of the system is given to the first talker and the second talker by merely starting to talk cannot seize control of the circuit away from the first talker.

However, after the first talker gets control over both terminals in the manner described above, if the second talker persists in trying to interrupt the first talker, he will succeed in gaining control of the system when the first talker pauses for only a short interval of time much less than the time of transmission over the cable, as will be explained below.

It will be assumed that the first talker, the west-subscriber, has obtained control of both terminals in the manner described above, and then, that the first subscriber pauses for a time interval equal to or greater than the transmission time through the control circuit 14 at the west cable terminal station or the corresponding control circuit 14' at the east cable terminal station, the overall transmission time over each of those circuits to simplify the explanation of the operation of the system being assumed to be equal. At the beginning of this pause, the control device 6 at the west terminal station will release causing the relays 7 to 10 in its output to release also. As stated above, although relay 10 at the west terminal station is designed to operate with a time lag of T seconds, it is designed also to release a very short time after the cessation of speech waves to the control device 6. The circuits at the west cable terminal station, therefore, momentarily return to their normal condition as indicated in the drawing with the transmitting path TA disconnected from the cable, the receiving control circuit 14 operative and the receiving path RA connected to the cable. During this pause the control devices 18' and 22' at the east cable terminal station will also release due to cessation of supply of input currents thereto, allowing the windings of relays 19' and 20' connected to their outputs to be deenergized. The release of relay 19' closes the switch contacts 24' in the input of the transmitting path TA' and the release of relay 20' causes the switch contacts 26' in the input of relay 10' also to return to their normally closed condition. The east subscriber now, if he so desires, can get his speech waves through to the input of the control device 6' in control circuit 5' at the east cable terminal station. The resultant operation of control device 6' will energize the windings of relays 7' to 10' in its output. Relay 7' immediately operates to open switch contacts 37' disconnecting the receiving-amplifier 3' from the cable TC. Relay 8' simultaneously operates to close switch contacts 23' connecting the transmitting-amplifier 2 to the cable TC and allowing the amplified control waves of frequencies f_3 and f_4 generated by the control wave sources 11' and 12' at the east terminal station after amplification by the amplifying device 2' to be transmitted out over the cable TC along with the amplified east subscriber's speech waves. Approximately t_1 seconds after the control waves f_3 and f_4 have been transmitted out over the cable TC, where, as stated above, the time interval t_1 is equal to or greater than the overall transmission time of the control circuit 14' at the east terminal station, relay 9' operates to disconnect the sources of control waves f_3 and f_4 from the transmitting path TA'. Substantially T seconds after the control waves of frequencies f_3 and f_4 have been transmitted out over the cable TC, relay 10' operates to open the normally closed switch contacts 27' in the receiving control circuit 14'. The east subscriber has now seized complete control of the circuit at his own terminal away from the west subscriber.

Suppose at the time of the arrival of the east subscriber's control waves f_3 and f_4 and speech waves at the west cable terminal station over the cable TC, the west subscriber may have started to talk again and by again operating his control device 6 causes relays 7 and 8 to respectively break his receiving path RA by opening the contacts 37 therein, and render operative his transmitting path TA by closing normally open contacts 23 therein, so as to transmit his control waves f_1 and f_2 along with his speech waves to the cable TC. However, this will not prevent the east subscriber's currents from seizing control of the circuits at the west cable terminal station. Because of the delay of T seconds in the operation of the relay 10 in response to the west subscriber's speech currents after the west subscriber's control waves have been transmitted to the cable due to the design of that relay, the switch contacts 27 in the receiving control circuit 14 at the west cable terminal station are still in the closed condition and the east subscriber can get his control waves f_3 and f_4 through to the amplifier-detector 16.

The control waves of frequencies f_3 and f_4 transmitted from the east cable terminal station will be selected by the selective network 15 in the control circuit 14 and, the switch contacts 27 in the output thereof being closed, will be transmitted to and combined in the amplifier-detector 16. Of the combination products in the output of the amplifier-detector 16, the beat frequency $f_4 - f_3$ is selected by the band-pass filter 17 and impressed on the input of the control device 18 causing its operation to energize the windings of relays 19 and 20.

If the alternative circuit of Fig. 2 is used in the place of the portion of the control circuit 14 within the dot-dash box, the frequencies f_3 and f_4 will be separated by the filters 29 and 32 and utilized to operate control devices 30 and 32 to respectively energize relays 31 and 34. The resultant operation of relays 31 and 34 will close switch contacts 35 and 36 in the energizing circuit for relays 19 and 20 causing the operation of the latter relays.

Relay 19 will operate immediately to disable the input of the transmitting path TA by opening the switch contacts 24 therein and the relay 20 will simultaneously operate to disable the input of the control relay 10. The control device 6 in control circuit 5 on cessation of the supply of the west subscriber's speech currents thereto due to the operation of relay 19 will release, causing the windings of relays 7 to 9 in its output to be deenergized. The output of the transmitting path TA will therefore be again disabled by the opening of its contacts 23, and the receiving path again rendered operative by the closing of its switch contacts 37.

The speech waves received over the cable TC from the east cable terminal, except for the portion reaching the point in path RA where the switch contacts 37 are located before these contacts have closed, may therefore be transmitted over the receiving-amplifying path RA to the input amplifying device 3. These waves will be amplified by the amplifying device 3 and transmitted to the band-pass filter 4 in that path and to the input of the control device 22 in the control circuit 21. The portion of the speech waves impressed on the control device 22 will cause its operation to maintain relays 20 and 19 energized. The band-pass filter 4 will transmit

the subscriber's speech currents except for the frequencies f_3 and f_4 to the west subscriber.

From the above description of the operation of the system it will be apparent that transmission lockouts when two subscribers at opposite ends of the system start talking about the same time are limited to the time required for currents to pass through the receiving control circuit 14, 14' at each terminal. The time of hangover of the relay 10 or 10', for disabling the receiving control circuit, if the same at both terminals, determines how often each talker will be subject to interruption. By changing the hangover of these relays so that they are different, the circuit may be biased as regards interruption toward one talker or the other.

There will be some mutilation of speech in breaking a lockout with the circuit described since selectivity requirements for filters will not allow fast interruption through outgoing speech. The inclusion of delay of the proper amount to speech in the transmitting circuit at each terminal, between the input of the transmitting control circuit and the point in the transmitting circuit at which the sources of control waves are connected thereto, making the transmission control a "courier" system, may reduce this mutilation of speech appreciably, but will increase the time of transmission through the circuit.

All of the control relays in the system which has just been described may be designed by any of the well known methods to have such hangovers in their operation as to prevent loss of part of the speech due to premature opening or closing of the switch contacts controlled by the relays.

Although in the particular embodiment of the invention described, mechanical relays have been shown for conditioning the transmission paths by operating movable switches to close or open circuit these paths, the invention is not limited to the particular conditioning means shown. For example, within the scope of the invention the transmission paths may be effectively disabled or made operative by the insertion or removal of short-circuits or loss networks in the paths controlled by wave-controlled apparatus. Stationary devices having no movable elements may be employed in place of the mechanical relays shown, for example, vacuum tube relays, such as disclosed in Crisson Patent 1,647,212, issued November 1, 1927, or in article by C. A. Beer and G. T. Evans in the Institute of P. O. Electrical Engineers (London), vol. 20, pages 65 to 72 inclusive, published in 1920.

It is to be understood that the invention is not limited to the exact details of the circuits and the terminal stations illustrated and described as numerous modifications thereof may be made by persons skilled in the art without departing from the spirit and scope of the invention. For example, although in the system described only two control currents are transmitted from each terminal station, a greater number of control currents may be used each of different frequencies requiring slight changes in the design of the apparatus used at each terminal, so as to decrease the probability of false operation.

What is claimed is:

1. A signal transmission system comprising a signal transmission path supplied from a source of signals of a plurality of frequencies, wave-controlled, circuit-control apparatus at a control point along said path and adapted when operated to properly condition said path for transmitting

- said signals, means for transmitting over said path along with said signals, and under the control thereof, a plurality of control waves of different frequencies not normally found simultaneously in said signals, means for selecting the control waves at said control point, means for combining the selected control waves, and means for selecting and utilizing a combination wave for controlling said circuit-control apparatus.
2. A two-way signal transmission system comprising a two-way signal transmission path connecting stations each comprising wave-controlled, circuit-control apparatus for directionally controlling signal transmission in the system, means at each station under control of the signals there initiated for transmitting over said path to another station, and along with said signals, a plurality of control waves of different frequencies and different for each station, the frequencies of the respective control waves at each station being chosen such that they are not normally found simultaneously in the signals transmitted between said stations, in their harmonics or difference frequencies, a control circuit at each station connected to said path, said control circuit comprising means for receiving and separating from the received signals the control waves from the other station, means for combining the separated control waves to form beat waves, and means for selecting and utilizing one of said beat waves to operate the circuit-control apparatus at the station, and means at each station also responsive to the signals there initiated for disabling the control circuit at the same station at substantially the same time as the control waves therefrom reach the other station.
3. A two-way signal transmission system comprising a two-way signal transmission path connecting stations each comprising a signal transmitter, a signal receiver and wave-controlled, circuit-control apparatus which when operated disables said transmitter while allowing transmission from said path to said receiver, means at each station under control of the signals initiated in the transmitter thereat when operative for transmitting over said path to another station, and in advance of said signals, a plurality of control waves of frequencies different from each other and different for each station, the frequencies of the control waves transmitted from each station being chosen such that they are not normally found simultaneously in the signals transmitted between said stations, a normally operative control circuit at each station connected to said path and comprising means for selecting the control waves received over said two-way path from the other station, means for combining the selected control waves to form beat waves and means for selecting and utilizing one of said beat waves to operate the circuit-control apparatus at the station, and means at each station responsive to the signals initiated in the transmitter thereat for disabling the control circuit at the same station substantially at the time the control waves transmitted therefrom in advance of said signals operate the circuit-control apparatus at the other station.
4. A two-way signal transmission system comprising a two-way signal transmission path of limited transmission frequency range connecting stations each comprising a signal transmitter, a signal receiver and wave-controlled circuit-control means which when operated disables said transmitter while allowing transmission from said path to said signal receiver, means at each station under control of the signals initiated in the transmitter thereat when operative for transmitting over said path to another station, and in advance of said signals, a plurality of short trains of control waves each of different frequencies and different for each station, the frequencies of the respective trains of control waves transmitted from each station being chosen such as would not normally be found simultaneously in the signals transmitted between the stations, in their harmonics or difference frequencies, a normally operative control circuit at each station connected to said path and comprising means for selecting the control waves received from said path, means for combining the selected waves to form beat waves, and means for utilizing one of the beat waves to operate initially said circuit-control apparatus at said other station, and means for utilizing the signals received at said other station over said path for maintaining the circuit-control apparatus in the operated condition initiated by the preceding control waves during signal transmission between said stations.
5. A signal transmission system comprising a signal transmission path supplied from a source of telephonic waves, wave-controlled, circuit-control apparatus at a control point along said path and adapted when operated to properly condition said path for the transmission of said signals, means for transmitting over said path and along with said signals control waves of high frequency and control waves of low frequency, said high and low frequencies being within the frequency range of said telephonic waves and not harmonically related, means at said control point for separating waves of said high and low frequencies from the other received waves, means for combining the separated high and low frequency waves, and means for selecting and utilizing one of the combination waves for controlling said circuit-control apparatus in proper manner.
6. A terminal circuit for a two-way signal transmission medium of appreciable overall transmission time between terminals, comprising a transmitting circuit and a receiving circuit connected to said medium, means responsive to the initiation of signals in said transmitting circuit, and operative at a time thereafter substantially equal to said overall transmission time of said medium, for disabling said receiving circuit, and means responsive to the cessation of said signals in said transmitting circuit and at a time thereafter small in comparison with said overall transmission time of said medium for rendering said receiving circuit again operative.
7. A terminal circuit for a two-way signal transmission medium of appreciable overall transmission time between terminals, comprising a normally disabled transmitting circuit and a receiving circuit connected to said medium, means responsive to the initiation of signals in said transmitting circuit for rendering it operative to transmit said signals to said medium, means also responsive to the initiation of said signals in said transmitting circuit and operative at a time after said transmitting circuit has been rendered operative substantially equal to said over-all transmission time of said medium for disabling said receiving circuit, and means responsive substantially immediately to the cessation of said signals in said transmitting circuit for again rendering operative said receiving circuit.
8. A two-way telephone system comprising a two-way transmission medium connecting sta-

tions, each station comprising a control circuit, means at each station responsive to the initiation of speech waves by a subscriber associated therewith for causing, in addition to said speech waves, control waves to be transmitted over said medium to the other station, means also responsive to said speech waves for effectively disabling the control circuit at the same station substantially at the same time as the arrival of the control waves at the other station, and for rendering the control circuit operative again substantially instantaneously with the cessation of said speech waves at the transmitting station, the control circuit at each station when operative being selectively responsive to the control waves received over said medium to disable the means at said station for transmitting speech waves and control waves to said medium, and said control-circuit disabling means, while permitting the speech waves transmitted over said medium from the subscriber associated with the other station to be received by the subscriber at the first station.

9. A two-way signal wave transmission system comprising a two-way signal transmission medium connecting stations, means normally preventing transmission of waves between said stations over said medium, a source of control energy at each station comprising frequencies different for each station and differing at each instant from the signal frequencies, means at each station responsive to the initiation of signals thereat for causing transmission of said signals together with the control energy from the source at the same station over said medium to the other station, a normally operative control circuit at each station, means at each station also responsive to the signals initiated thereat and operative at a time after the transmission of the control energy to said medium substantially equal to the overall transmission time of said medium between said stations, to disable the control circuit at the same station, and adapted to release to render said control circuit again operative substantially simultaneously with cessation of the controlling signals, and means in said control circuit selectively responsive when said circuit is operative, to the control energy received over said medium from said other station to prevent transmission of waves to said medium at the first station, and to disable the control-circuit disabling means.

10. A two-way signal transmission system comprising a two-way signal transmission medium connecting two stations, each comprising a normally disabled transmitting circuit, a normally operative receiving circuit, a source of signals and a source of continuous control energy of frequencies different for each station and outside the signal frequency range, connected to said transmitting circuit, means responsive to signals from said source of signals for rendering said transmitting circuit operative to transmit said signals and control energy to said medium for transmission thereover to said other station, a control circuit connected to said medium, means also responsive to the signals in said transmitting circuit for effectively disabling said control circuit at substantially the same time as

the arrival of the control energy at the other station, and for rendering said control circuit operative again substantially instantaneously with the cessation of said signals in said transmitting circuit, and means in said control circuit and selectively responsive when that circuit is operative, to control energy received over said medium from said other station, to disable said transmitting circuit and said control-circuit disabling means.

11. A terminal circuit for a two-way transmission medium comprising a normally disabled transmitting circuit, a normally operative receiving circuit, a source of signals and a source of continuous control energy of frequencies outside the signal frequency range, connected to said transmitting circuit, control means responsive to signals supplied from said source of signals for rendering said transmitting circuit operative to transmit said signals and said control energy to said medium for transmission thereover, and for disabling said receiving circuit, a control circuit operatively connected to said medium, means also responsive to the signals supplied to said transmitting circuit, for effectively disabling said control circuit at a time after the transmission of said control energy to said medium substantially equal to the overall transmission time of said medium between terminals and for rendering said control circuit operative again substantially instantaneously with cessation of said signals in said transmitting circuit, means in said control circuit and selectively responsive when that circuit is operative, to control energy received over said medium to disable said transmitting circuit and said control circuit disabling means, and a second control circuit connected to said receiving circuit and responsive when that circuit is operative, to waves received over said medium to disable or maintain disabled said transmitting circuit and said control means.

12. A two-way telephone system comprising a two-way signal transmission medium connecting stations, each station comprising a control circuit, means at each station responsive to the initiation of speech waves by a subscriber associated therewith for causing, in addition to said speech waves, control waves to be transmitted over said medium to said other station, means also responsive to said speech waves for effectively disabling the control circuit at the same time as the arrival of the control waves at the other station, and for rendering the control circuit operative again a given small time interval after the cessation of said speech waves, said time interval being different for the two stations so as to bias the system as regards gaining control in favor of one or the other subscriber, the control circuit at each station when operative being selectively responsive to the control waves received over said medium to disable the means at that station for transmitting speech waves and control waves to said medium or to the control-circuit disabling means while permitting the speech waves received over said medium from the subscriber associated with the other station to be received by the subscriber at the first station.

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