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TRANSMISSION CONTROL

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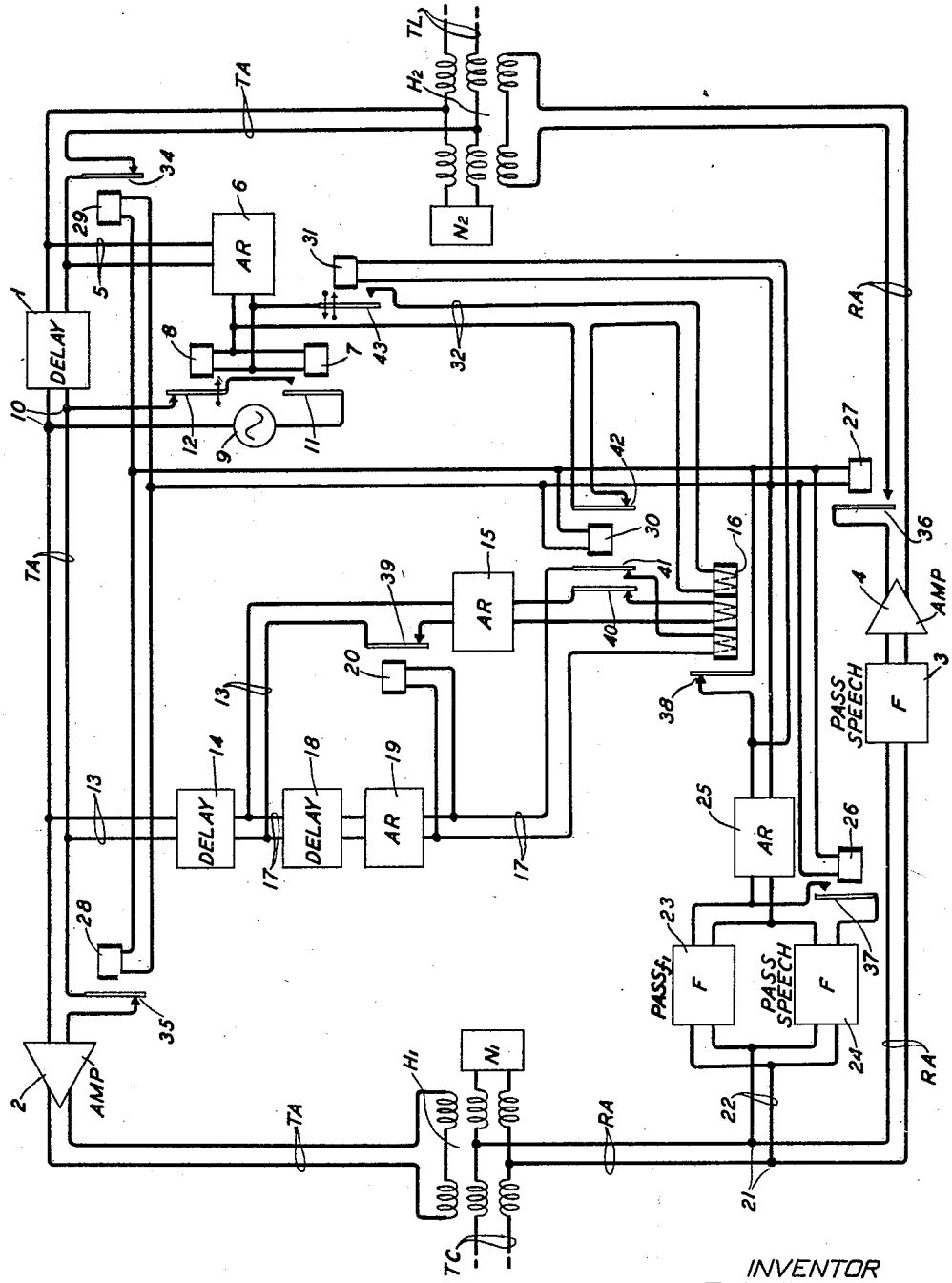

INVENTOR
B. G. BJORNSON
BY H. A. Burgess
ATTORNEY

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BJORN G. BJORNSON, OF NEW YORK, N. Y., ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TRANSMISSION CONTROL

Application filed July 9, 1930. Serial No. 466,721.

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

An 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 specially applicable to a system over which two-way transmission of signaling energy is required within the same frequency range, and including as a link therein a two-way cable of high attenuation and high transmission time-constant, such as a 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 suppress echoes. This is usually accomplished by making the circuit-control apparatus at each terminal responsive to transmission in one direction to render the circuit 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 the cable in a system such as has just been described greatly increases the chance that two subscribers at the 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 transmision 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 invention relates to an improved circuit of that type, the improvement residing in means for facilitating break-ins by a listening party after one party has obtained control. Specifically stated, the invention comprises means responsive to the signals of the first talker and operative a definite time after he has obtained complete control of the system, for making certain circuit changes at the teminals which will bias the system from the standpoint of break-ins in favor of the listener and maintain that bias for a definite time after the first talker ceases to talk. While the circuits are so biased, the listener can, on perceiving a pause by the first talker, immediately break-in, gain control of the system for his own speech currents and shut the first talker out.

The invention is especially adapted for, although not limited to, two-way signaling systems which employ the so-called "courier" method of transmission control for preventing transmission lock-outs, such as described in the copending applications of R. C. Mathes, Serial Nos. 370,034 and 370,035, both filed June 11, 1929 and in my copending applications, Serial Nos. 419,668 filed January 9, 1930 and 425,092 filed February 1, 1930.

The exact nature and advantages of the invention will be clear from the following detailed description thereof when read in connection with the accompanying drawing the single figure of which shows a circuit diagram of one terminal station for a submarine cable telephone system embodying the invention.

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, etc.

Since the terminal station 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 courier wave generators and the filters used therein, necessitated by the fact that the values of the frequencies of the courier waves transmitted from the two terminals are different, it has

been deemed sufficient to illustrate only one terminal of the cable system.

The single figure of the drawing illustrates the east terminal circuit for a two-way telephone cable system utilizing a courier system of transmission control of the general type disclosed in Fig. 2 of the copending patent application of R. C. Mathes, Serial No. 370,034, mentioned above, which terminal circuit is applicable to cable systems in which the two-way cable between terminals is comparatively short or of such low attenuation that it is feasible to select the courier control currents in the presence of simultaneously outgoing speech energy.

The terminal station of the drawing comprises connected between a two-way speech wave transmission circuit TL which may be a telephone line, and a two-way cable TC of high attenuation and high transmission-time constant, such as a deep sea telephone submarine cable, a one-way transmitting amplifying path TA and a one-way receiving amplifying path RA. The output of the transmitting path TA and the input of the receiving path RA are connected to the east end of the cable TC by means of a three winding transformer or hybrid coil H_1 which cooperates with the balancing network N_1 in well known manner to insure substantial conjugacy between the paths TA and RA. For a similar purpose the input of the transmitting path TA and the output of the receiving path RA are connected to the circuit TL through the hybrid coil H_2 having an associated balancing network N_2.

Connected between the hybrid coils H_2 and H_1 in the one-way transmitting path TA is a delay circuit 1 and a one-way transmitting amplifier 2, and connected between the hybrid coils H_1 and H_2 in the receiving path RA is a band pass filter 3 and a one-way receiving amplifier 4. Connected across the path TA between the hybrid coil H_2 and the input of delay circuit 1 is a control circuit 5 comprising a wave-controlled, relay-controlling device 6, and the windings of relays 7 and 8 connected in parallel to the output of the device 6. The relay 8 is slow operating as compared to the relay 7.

A source 9 of alternating current of frequencies f_2 outside the signal frequency range, which in the case being described is the speech frequency range, is adapted to be momentarily connected across the transmitting path TA at the points 10 between the output of the delay circuit 1 and the input of the transmitting amplifier 2, by means of switches 11 and 12, respectively controlled by operation of relays 7 and 8. Connected across the transmitting path TA between the points 10 therein and the input of the transmitting amplifier 2 is a second control circuit 13 comprising a delay circuit 14, a wave-controlled, relay-controlling device 15 and one winding of a three-winding relay 16 connected to the output of the device 15. Connected across the control circuit 13 in the output of the delay circuit 14 therein is a third control circuit 17 comprising the delay circuit 18, the wave-controlled, relay-controlling device 19, the winding of a relay 20 and a second winding of the relay 16 connected in parallel to the output of the device 19.

Connected across the receiving-amplifying path RA between the hybrid coil H_1 and input of the filter 3 is a fourth control circuit 22 comprising filters 23 and 24 in parallel branches thereof, a wave-controlled, relay-controlling device 25 connected to the output of filter 23 and adapted to be connected to the output of filter 24 in a manner which will be explained, and the windings of relays 26 to 31 connected in parallel to the output of the device 25. Relay 31 is designed so that it will operate at a given instant of time later than relays 26 to 30, and so that it will remain operated longer than the latter relays, in response to the operation of the device 25.

The output of the device 6 in control circuit 5 is adapted to be connected through a circuit 32 to the third winding of the relay 16. Relay 16 is constructed so that energization of any one of its three windings will cause the relay to operate.

In the input of the transmitting path TA between the point of connection thereto of control circuit 5 and the hybrid coil H_2 is a normally closed switch 34 adapted to be opened by operation of relay 29 to disable the input of the path TA, and in the transmitting path TA between the point of connection of the control circuit 13 thereto and the input of the amplifier 2, is a normally closed switch 35 adapted to be opened by operation of relay 28 to disable the output of the path TA. In the receiving path RA between the output of the amplifier 4 therein and the hybrid coil H_2 is a normally open switch 36 adapted to be closed by operation of relay 27 to make the path RA operative.

In the output of filter 24 in the lower parallel branch of control circuit 22 is a normally open switch 37 adapted to be closed by operation of relay 26 to connect the output of filter 24 to the input of the device 25. In control circuit 22 between the point of connection of relay 31 thereto and the relays 26 to 30 is a normally closed switch 38 adapted to be opened by operation of relay 16 to disable the input of relays 26 to 30.

In the portion of control circuit 13 connected between the output of delay circuit 14 and the input of control device 15 is a normally closed switch 39 adapted to be opened by operation of relay 20 to disable the input of control device 15. In control circuit 13 between the output of the device 15 and the relay 16 is a normally closed switch 40

adapted to be opened by operation of relay 30 to disable the input of one winding of relay 16. In the output of control circuit 17 is a normally closed switch 41 adapted to be opened also by operation of relay 30 to disable the input of another winding of relay 16. In the circuit 32 is a normally closed switch 42 adapted to be opened also by operation of relay 30 to disable the input to the third winding of relay 16. In the circuit 32 connecting the output of the device 6 in control circuit 5 to relay 16 is a normally open switch 43 adapted to be closed by operation of the relay 31 to enable the third winding of relay 16 to be energized through operation of control device 6.

The wave-controlled, relay-controlling devices, 6, 15, 19 and 25, and the corresponding devices at the west 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 delay circuits 1, 14 and 18 may be networks of any type suitable for producing a delay in the transmission therethrough of alternating current waves impressed on their inputs; for example, they may be low pass electrical filters such as disclosed in the U. S. patents to Campbell, 1,227,113 and 1,227,114 issued May 22, 1917, acoustic filters, or networks for similar purposes such as disclosed in Arnold Patent 1,565,302 issued December 15, 1925. The delay circuit 1 and the corresponding delay circuit at the west terminal station, in the embodiment of the invention which is now being described, are designed to produce a very small time delay t in the transmission of speech waves therethrough, this delay being just sufficiently long enough to enable the completion of the operation of the circuit control relays by a preceding courier impulse to condition the speech transmission paths for transmission of the following speech waves. The delay circuit 14 and the corresponding delay circuit at the west terminal station are designed to produce a time delay of T—t in the transmission of alternating current waves therethrough, T being substantially equal to the overall transmission time of the cable TC between the east and the west terminal station. The delay circuit 18 and the corresponding delay circuit at the west terminal station are designed to produce a time delay of T in the transmission of alternating current waves therethrough.

The filters 3, 23 and 24 and the corresponding filters at the west terminal station may be of the band pass type disclosed in the U. S. patents to Campbell mentioned above. The filters 3 and 24 and the corresponding filters at the west terminal station are designed to transmit frequencies within the speech frequency range. Filter 23 at the east terminal station is designed to pass the courier frequencies f_1 generated by the courier generator at the west terminal station corresponding to generator 9 at the east terminal station and to suppress the frequencies f_2 corresponding to those generated by the generator 9 at the east terminal station, f_1 and f_2 being different frequencies outside the speech frequency range. The filter at the west terminal station corresponding to the filter 23 at the east terminal station is designed to pass waves of frequencies corresponding to the courier frequencies f_2 generated by the courier generator 9 at the east terminal station and to suppress the frequencies f_1 corresponding to the courier frequencies generated by the courier generator at the west terminal station. The one-way amplifiers 2 and 4, the courier generator 9 and the relays 7, 8, 16, 20 and 26 to 31 at the east terminal station and the corresponding apparatus at the west terminal station may be of any of the types well known in the art.

The operation of the system as a whole will now be described referring to the east terminal station only. When no speech waves are being transmitted over the system in either direction the switches at both terminal stations are in the condition indicated at the east terminal station in the drawing. The transmitting amplifying paths at both terminal stations are then operative and the receiving path at both terminals inoperative.

It will be assumed that speech waves from a subscriber associated with the telephone circuit TL to be transmitted over the cable TC in the direction from east to west are being received at the east terminal station over the telephone circuit TL, and at that time no speech waves from the subscriber associated with the telephone circuit at the west terminal station corresponding to the circuit TL at the east station to be transmitted over the cable TC from west to east are being received at the west terminal station. The speech waves received over the circuit TL are impressed by the hybrid coil H_2 on the transmitting path TA at the east terminal station and will be divided therein between the input of the delay circuit 1 and the input of the control device 6 in control circuit 5. The portion diverted into control circuit 5 will operate the control device 6 therein causing the windings of relays 7 and 8 to be energized. The relay 7 will operate quickly to close the switch 11 to connect the source 9 of courier waves of frequencies f_2 across the transmitting path TA at the points 10 in the output of delay circuit 1, and the comparatively slow operating relay 8 will operate a given instant later to open the switch 12 so as to disconnect the generator 9 from the transmitting path TA. The momentary connection of the generator 9 to the transmitting path TA will

cause a short train of waves of frequencies f_2, which will be referred to hereinafter as the courier f_2, to be transmitted over the transmitting path TA. This train of waves may be made as short as is desired or is necessary by the relative design of relays 7 and 8. Relays 7 and 8 are also so designed that they will remain operated as long as speech waves from the circuit TL are being impressed on the input of control device 6, and so that they will release only after a complete pause in the continuous transmission of the impressed speech currents, for example, at the end of the sentence, and not for the usual short pauses between words or syllables.

A portion of the courier f_2 will be amplified by the transmitting amplifier 2 and the amplified waves impressed by the hybrid coil H_1 upon the cable TC over which it will be transmitted to the west terminal station to establish initial control of the circuit control apparatus thereat in a manner which will be described later.

Another portion of the courier f_2 is diverted from the transmitting amplifying path TA into the control circuit 13 and will be delayed in transmission therethrough by the delay circuit 14 for a time T—t where, as indicated before, T is the overall transmission time of the cable TC between the terminal stations and t is equivalent to the delay produced in the transmission of the speech currents by the delay circuit 1 in transmitting path TA. In the output of the delay circuit 14 the courier f_2 will be divided between the control circuits 13 and 17. The portion transmitted through the control circuit 13 will operate the control device 15 therein which in turn will energize one winding of relay 16. Relay 16 will then operate to open the normally closed switch 38 in the receiving control circuit 22 thereby rendering that circuit inoperative to cause false operation of relays 26 to 30 due to later operation of control device 25 by incoming waves received from the west terminal station. The first talker, that is, the subscriber connected to the telephone line TL, has now obtained absolute control of the east terminal station.

The portion of the courier f_2 transmitted into the control circuit 17 will be delayed in transmission therethrough for an additional time interval T and then will operate control device 19 to apply energizing current to the winding of relay 20, and to one winding of relay 16 over the circuit 17. Relay 20 will operate to open the normally closed switch 39 in the input of control circuit 13, thereby disabling control device 15. Relay 16 is then under the control of control device 19 over the circuit 17 instead of under the control of control device 15 in control circuit 13. This rearrangement of the controlling circuits at the east station in the manner which will be explained below will enable a listening subscriber at the west terminal station to break in on the talking subscriber and to seize absolute control of the talking circuits of the system for his own (the listener's) speech currents.

The courier f_2 because of its momentary duration only produces initial operation of the relays in its path in the manner explained above. These relays are thereafter maintained in their initially operated condition by the speech currents transmitted over the same paths as courier f_2 but with a time delay of t produced by the delay circuit 1, in the transmission path TA. The main portion of the speech currents will be transmitted from the output of the delay circuit 1 in the transmitting path TA to the input of the transmitting amplifier 2 therein, and will be amplified by that amplifier and impressed on the cable TC by the hybrid coil H_1. The impressed speech waves will then be transmitted over the cable TC following the previously transmitted courier f_2 by the time interval t.

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

Because of the time delay of T—t introduced by the delay circuit 14 in control circuit 13 of the east terminal station in the transmission of the portion of the talker's courier f_2 diverted therein, the other portion of the talker's courier f_2 arrives at the west terminal station over the cable TC (which has an overall transmission time of T) at about the time the portion of the courier f_2 diverted into control circuit 13 at the east station has operated the control device 15 to cause the relay 16 to disable the output of the circuit 22 by opening switch 38 therein.

The portion of the courier f_2 received over the cable TC will be impressed by the hybrid coil H_1' upon the receiving-amplifying path RA′ at the west station. The impressed courier f_2 will be diverted into the control circuit 22′ and then will be passed by the band-pass filter 23′ in the upper branch thereof and cause the initial operation of control device 25′. The operation of control device 25′ will energize the windings of the relays 26′ to 31′. Relay 26′ will operate to close the switch 37′ in the output of filter 24′, enabling a portion of the speech waves following the

courier f_2 with a time delay of t to be transmitted through filter 24′ to the input of the control device 25′ and maintain that device in the operated condition initiated by the preceding courier f_2. The main portion of the speech waves will be transmitted through band-pass filter 3′ in the main receiving path RA′ and will be amplified by the amplifier 4′ therein.

Relay 27′ will operate to close the normally open switch 36′ in the output of the receiving path RA′, thus rendering that path operative to transmit the amplified east to west speech waves from the output of amplifier 4′ to the hybrid coil H_2 which will impress them on the circuit TL.

Relays 28′ and 29′ will operate substantially simultaneously with relays 26′ and 27′ to open the normally closed switch 35′ and 34′, respectively, in the transmitting-amplifying path TA′, thus rendering that path inoperative from that time to transmit any west-to-east speech waves which may be received over the circuit TL′ to the cable TC or to the input of control device 6′. Relay 30′ will operate substantially simultaneously with relays 26′ to 29′ to open the normally closed switch 40′ in control circuit 13′, the normally closed switch 41′ in control circuit 17′ and the normally closed switch 42′ in circuit 32′, thus preventing the relay 16′ from being thereafter rendered operative by energy which may be stored in the circuits 13′, 17′ and 32′ at the time switch 34′ opens, to cause false operation of the switch 38′ to block the receiving control circuit 22′. Both the east and west terminal stations are now under complete control of the first talker.

A given instant after relays 26′ to 30′ have operated, the comparatively slow-operating, slow-releasing relay 31′ will be operated by control device 25′ to close the normally open switch 43′ in the circuit 32′, thus making the latter circuit operative to allow the operation of control device 6′ by the listener's speech currents to operate relay 15′ whenever the switch 42′ in circuit 32′ is closed.

From the above description it is seen that at a time after the courier f_2 has been sent out from the east terminal station substantially equal to the overall transmission time T of the cable TC between the stations, the circuits have been arranged so that the first talker (the east subscriber) has obtained complete control of the transmitting and receiving circuits and the associated control of both stations. With the circuits in this condition the listening subscriber associated with the west terminal station normally cannot, by starting to talk, during a pause in the talker's speech, seize control of the system for the transmission of his own speech currents unless this pause continues for a time interval at least equal to the overall transmission time T of the cable, for it will take that interval of time for the listener to transmit his courier f_1 to the east terminal station. The automatic rearrangement of the control circuits at the transmitting terminal a given interval of time after complete control of the system has been obtained by the first talker will bias the system so that the listener may obtain, if he desires, exclusive control of the system at a slight pause by the talker in the manner explained below.

At a time substantially equal to the time T after the subscriber has obtained complete control of the system, the circuits at the east terminal are rearranged by operation of the control device 19 by a portion of the talker's courier f_2 which has been delayed in transmission through control circuits 17 for the time T by delay circuits 18. The operation of device 19 energizes the relay 20 to open the switch 39 in the input of control device 15 in control circuit 13, disabling that device, and energizes the blocking relay 16 over the circuit 17. The talker's speech waves following the courier f_2 through the control circuit 17 with a time delay of t maintains the device 19 in the operated condition initiated by the courer f_2.

Meanwhile, at the west terminal station the talker's courier f_2 has, through the operation of control device 25′ in receiving control circuit 22′, operated the relay 31′ to close the normally open switch 43′ in circuit 32′. As stated above, the relay 31′ is arranged to operate a given time after the operation of the other control relays 26′ to 30′ and to remain operated for a short time after the latter release. This delay in operation and hang-over may be obtained by the mechanical design of relay 31′ to make it slow-operating and slow-releasing, as indicated in the drawing, or the required delay in operation may be obtained by the use of a delay circuit of proper design between the winding of relay 31′ and the output of the control device 25′. The relay 31 at the east terminal station may be similarly arranged to operate later than the relays 26 to 30 thereat and to remain operated longer than the latter relays.

Now suppose that at any time after this rearrangement of the east terminal circuits, that is, subsequent to a time interval T after complete control of both terminals has been obtained by the east talker, the east talker pauses long enough to allow release of the relays 28′ and 29′ at the west station, thereby making the transmitting circuit TA′ thereat operative during the pause. If the listener starts talking during this pause, he can get immediate control of the west station controls as the slow-release relay 31′ is still operated by the east talker's speech to hold the switch 43′ in circuit 32′ closed. The west subscriber's speech currents diverted into the control circuit 5′ will operate the control de-

vice 6′, which in turn will cause the operation of relay 16′ through circuit 32′ to block the receiving control circuit 22′ by opening the switch 38′. The operation of the control circuit 6′ will also control the operation of relays 7′ and 8′ to send a courier impulse of frequency f_1 from generator 9′ out over the transmitting path TA′ to the cable TC. A portion of the courier f_1 and the following speech waves diverted into control path 13′ control device 15′ and later control device 19′ to maintain the relay 16′ operated after the slow release relay 31′ has released to disable the circuit 32′.

The portion of the listener's courier f_1 transmitted over the cable TC to the east terminal station will arrive there when the switch 38 in the control circuit 22 thereat is closed due to the release of relay 16 during the same pause in the east subscriber's speech that allowed the control relays at the west terminal to release.

The switch 38 being closed when the courier f_1 operates control device 25, the latter device will cause operation of relays 26 to 31 to seize control of the east terminal for the west subscriber in a manner similar to that described in connection with the courier f_2 at the west terminal station.

The talking subscriber associated with the west terminal, that is, the former listener, has now obtained control of both terminal stations and will normally be able to exclusively control the stations for transmission of his own speech currents to the east subscriber, until a time T later when the circuit at the west terminal will be rearranged automatically in a manner similar to that which has been described in connection with the east terminal station, to bias the system as regards subsequent transmission control in favor of the subscriber associated with the east terminal who is now the listener.

All of the control relays in the system which has just been described, should be designed to have such hangovers in their operation as to insure their release only after the dissipation of any speech which the subscriber who does not control the system may have transmitted.

It is apparent from the above description that the circuits at the east and west terminals of the system are such as to enable a subscriber associated with either terminal, a given time after the first talker associated with another terminal has obtained complete control of the talking circuits of the system, to interrupt the speaker at the least pause in the latter's continuous transmission of speech, for example, a pause between words. This will enable considerable speeding up of a two-way conversation between subscribers over a long cable system.

Although in the particular embodiment of the invention described mechanical relays have been shown for conditioning the transmission paths for 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 control 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 an article by C. A. Beers 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 in 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.

What is claimed is:

1. A system for transmitting signals in opposite directions between stations, comprising means normally preventing transmission of signals between said stations in either direction, means responsive to the initiation of signals at one of said stations for rendering the system operative to transmit said signals to another station while preventing transmission of later initiated signals from said other station to said one station, and means also responsive to the signals initiated at said one station for altering the circuit connections thereat to bias the system as regards subsequent directional control of transmission in favor of later initiated signals at said other station.

2. A system for transmitting signals in opposite directions between stations, comprising means normally preventing signal transmission in either direction between stations, means responsive to the initiation of signals at one of said stations for rendering the system operative to transmit said signals to another station, while preventing transmission of later initiated signals from said other station to said one station, and means also responsive to the signals initiated at said one station, and operative at a predetermined time after their initiation, to bias said system as regards subsequent directional control of transmission in favor of later initiated signals at said other station.

3. A system for transmitting signals in opposite directions between stations, comprising means normally preventing signal transmission between said stations in either direction, circuit-control apparatus at each station, means at each station responsive to the

initiation of signals thereat to control the circuit control apparatus at said stations to render the system operative to transmit said signals to another station and to prevent transmission of later initiated signals from said other station to the first station, and means also responsive to the initiation of said signals at said first station, and at a time thereafter substantially equal to twice the overall transmission time of the system between stations, to alter the connections to said circuit-control apparatus at said first station to bias said system as regards subsequent directional control of transmission in favor of later initiated signals at said other station.

4. A system for transmitting telephone currents in opposite directions between subscribers at different stations comprising means responsive to the initiation of telephonic currents by the subscriber at one station who first starts talking to condition the system to transmit said telephonic currents thereover to a second subscriber at another station, and to prevent transmission of later initiated telephonic currents thereover from said other subscriber to said first subscriber and means also responsive to the telephonic currents of said first subscriber for biasing the circuits at said one station as regards obtaining subsequent directional control of the system in favor of the second subscriber at said other station.

5. The system of claim 4 and in which said biasing means is responsive to the telephonic currents of said first subscriber at a predetermined time after their initiation.

6. The system of claim 4 and in which said biasing means is responsive to the telephonic currents of said first subscriber at a time after the initiation of said currents substantially equal to twice the overall transmission time of the system between said one and said other station.

7. A two-way system for transmitting signals between subscribers connected to different stations comprising means at said stations normally preventing transmission between the subscribers in either direction, means responsive to the initiation of signals by the subscriber at one station to condition the system to transmit said signals to a second subscriber at another station while preventing transmission of signals later initiated by said second subscriber to the subscriber connected to said one station until a predetermined time after a pause in the first mentioned subscriber's signals, and means also responsive to said first subscriber's signals and operative a definite time after the initiation thereof, for biasing the system so as to enable said second subscriber to break said first mentioned subscriber's control of the system and to seize control thereof for the transmission of his own signals, at a pause in the transmission of signals by the first subscriber less than said predetermined time.

8. In a two-way telephone system comprising two stations connected by a two-way transmission medium, circuit control means at each station, and means responsive to the speech currents of the subscriber at one station who first starts to talk for controlling said circuit control means to condition the system for the transmission of said speech currents to a second subscriber at the other station, and to prevent said second subscriber from obtaining control of the system until a pause of given length in the first subscriber's transmission, means responsive to the first subscriber's telephonic currents and operative a definite time after the first subscriber has obtained complete control of the system for altering the circuit connections of the system so as to enable the second subscriber to immediately seize control of the system for the transmission of his own telephonic currents to the first subscriber at a pause in the transmission of the first subscriber's telephonic currents of a length less than said given length.

9. The system of claim 8 and in which the last mentioned means comprises means at said other station for enabling said second subscriber to immediately seize control of the circuit control means at said other station and to send out control waves over said medium to the circuit control means at said one station, at a slight pause in the continuous transmission of telephonic currents by said first subscriber.

10. The system of claim 8 and in which the last mentioned means comprises means at said other station for enabling said second subscriber to seize control of the circuit control means at said other station and to send out control waves over said medium to the circuit control means at said one station, at a slight pause in the continuous transmission of telephonic currents by said first subscriber, and means at said one station responsive to the first subscriber's telephone currents for changing the connections to the circuit control means at said one station at a time after said first subscriber has obtained complete control of said system substantially equal to the overall transmission time of said medium between said stations, so that said control waves may seize control of said circuit control means thereafter at a slight pause in the continuous transmission of said first subscriber's speech currents.

11. A terminal circuit for a two-way signal transmission line comprising a transmitting path and a receiving path connected to said line, a source of signals to be transmitted over said line connected to said transmitting path, circuit control means in said receiving path, means responsive to signals from said source transmitted over said transmitting path for controlling said circuit control

means and other means also responsive to the signals transmitted over said transmitting path but operative a predetermined time after the first mentioned means for assuming control of said circuit control means in place of said first mentioned means.

12. A terminal circuit for a two-way signal transmission line comprising a transmitting path connected to said line and supplied from a source of signals, a receiving path connected to said line, circuit control means in said receiving path, means responsive to the signals from said source transmitted over said transmitting path for controlling said circuit control means, and other means also responsive to the signals transmitted over said transmitting path but operative a predetermined time after the first mentioned controlling means, for disabling said first mentioned means and assuming control of said circuit control means.

13. In combination with a two-way signal transmission circuit, a terminal station comprising a transmitting path and a receiving path connected to said two-way circuit, a source of signals connected to said transmitting path, means responsive to signals transmitted from said source to said transmitting path for normally disabling said receiving path a predetermined appreciable time after the initiation of said signals in said transmitting path, control means normally inoperative but adapted when operative to be responsive to signals from said source to disable said receiving path substantially at the time of initiation of the controlling signals in said transmitting path, and means responsive to waves received in said receiving path from said two-way circuit for rendering said control means operative.

In witness whereof, I hereunto subscribe my name this 7th day of July, 1930.

BJORN G. BJORNSON.