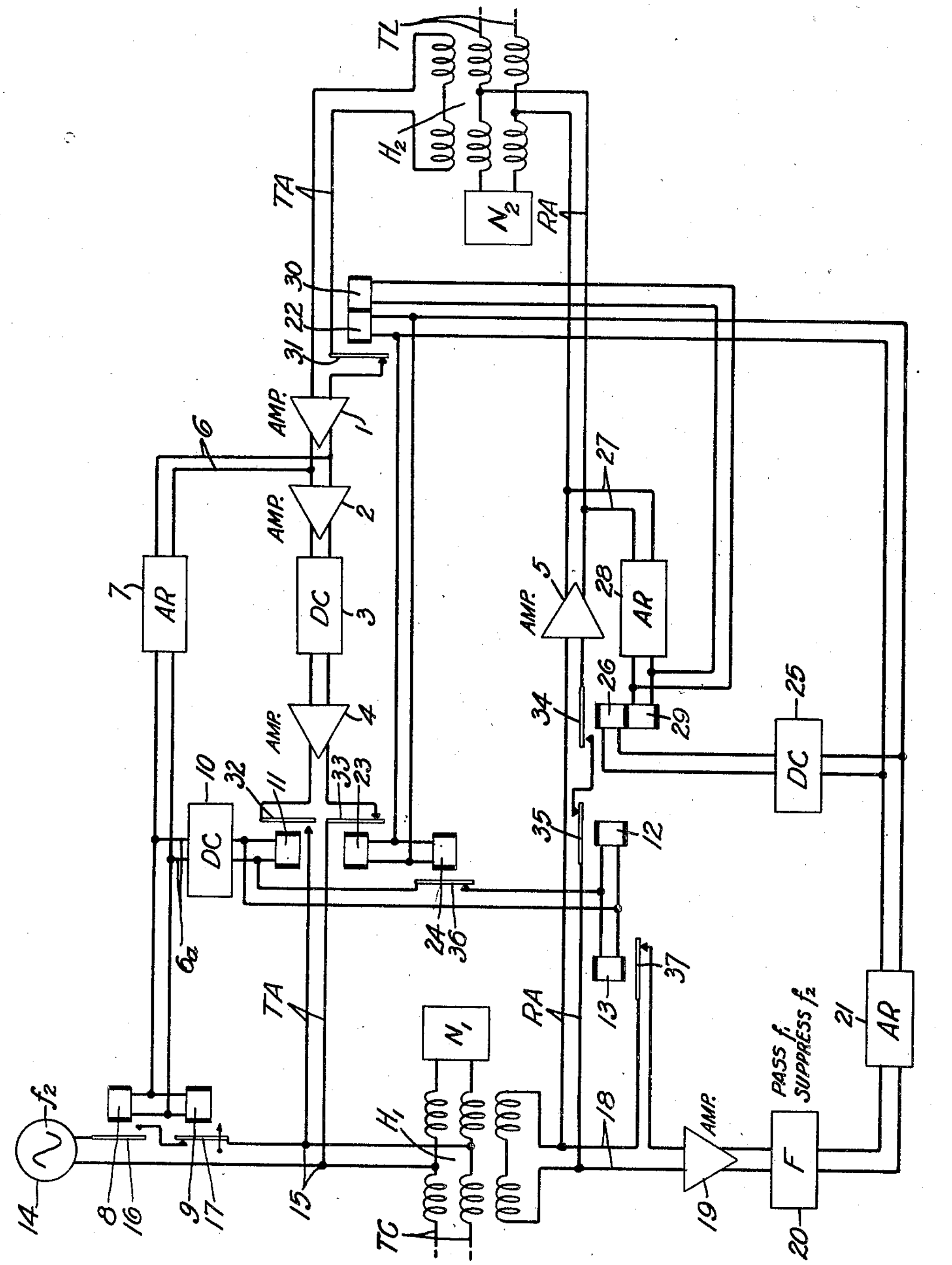
May 22, 1934. R. C. MATHES 1,959,438

SIGNAL TRANSMISSION CONTROL

Filed Jan. 1, 1930



INVENTOR
R. C. MATHES
BY H. A. Burgess
ATTORNEY

Patented May 22, 1934

1,959,438

UNITED STATES PATENT OFFICE

1,959,438

SIGNAL TRANSMISSION CONTROL

Robert C. Mathes, Wyoming, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application January 1, 1930, Serial No. 417,844

10 Claims. (Cl. 179—170)

This invention relates to electric wave transmission systems and particularly to two-way electric communication systems.

The invention is directed to directional control of transmission in a signal transmission system utilizing control energy transmitted over the system in response to the signals and in advance thereof to control the operation of switching circuits at one or more points in the system.

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 especially applicable to a system over which two-way transmission of signaling energy is required and including as a link therein a section of two-way cable of high attenuation and of long transmission time, such as a deep sea submarine telephone cable. Signal-controlled switching devices are usually associated with the oppositely directed amplifying paths 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 to effectively suppress echoes, singing or both. This is usually accomplished by making the switching apparatus at each terminal responsive to transmission in one direction to render the circuits operative in that direction and to effectively disable the circuits for transmission in the opposite direction.

My copending applications, Serial Nos. 370,034 and 370,035, both filed June 11, 1929, now respectively Patents 1,829,805 and 1,829,806 issued November 3, 1931, disclose certain signal-controlled switching circuits which are suitable for use in a system of the above described type. In the circuits of those applications, the so-called "courier" method of switching is employed. In accordance with that method the speech waves to be transmitted over the cable at each terminal are made to control the sending out of a spurt of control energy of a frequency which differs for each terminal, designated as the courier, over the transmission circuits ahead of the speech waves to establish initial control of the switching circuits at various points in the system, which control is maintained by the speech waves when they arrive at the switching points. The terminal which first starts its courier on the way obtains exclusive control of the transmitting and receiving circuits of the system. In all the circuits of the above mentioned applications suitable discrimination between the speech and carrier currents is obtained partly by the fact that the courier frequencies are placed outside the speech frequency range of the cable.

The present invention is directed to courier switching circuits of the general type described in the above mentioned applications, but differs therefrom mainly in that provisions are made whereby the frequencies of the couriers which are used for establishing initial control of the system for one terminal or the other, may be placed within the frequency range of the signals to be transmitted over the cable.

The circuits of the invention are preferably of the "full neutral" type in which the transmitting and receiving circuits at the terminal stations are normally disabled. Means are provided at each terminal station for preventing false operation of the receiving control which is normally connected to the cable, by waves of frequencies within the signal frequency range corresponding to the courier frequencies generated at that terminal station, while allowing the receiving control to be operated by the courier transmitted from the other terminal station and to be maintained operated by the following signal. One feature of these circuits is that the receiving circuit is made operative in response to the incoming courier but only after any energy due to the reverse courier, which might be in the process of being applied to the cable when the first courier arrived, and the energy of the incoming courier have been dissipated in the input of the receiving circuit, thus preventing the couriers from being heard by the listener. Another feature is that the control for the incoming courier is disconnected from the cable just before the transmitting circuit is made operative so that the transmitted signal will not falsely operate the incoming courier control.

The east cable terminal station illustrated in the drawing connects a two-way signal transmission circuit TL, such as a land telephone line, to a two-way cable TC of high attenuation and high overall signal transmission time, such as a submarine telephone cable. The terminal station comprises a transmitting circuit TA for repeating waves received from the circuit TL into the cable TC, and a receiving circuit RA for repeating waves received from the cable TC into the circuit TL. The output of the transmitting circuit TA and the input of the receiving circuit RA are coupled to each other and to the cable TC through a three-winding transformer or hybrid coil H_1, which cooperates with the balancing network N_1 and the cable TC to insure substantial conjugacy between the circuits TA and RA. Similarly, the input of the transmitting circuit TA and the output of the receiving circuit RA are connected to each other and to the circuit TL by a similar coupling means comprising the three-winding transformer or hybrid coil H_2 and the balancing network N_2. Connected in the transmitting circuit TA between the hybrid coil H_2 and the hybrid coil H_1 is the one-way amplifier 1, the one-way amplifier 2, the delay circuit 3, and the one-way amplifier 4. Connected in the receiving circuit RA between the hybrid coil H_1 and the hybrid coil H_2 is the one-way receiving amplifier 5.

Connected to the transmitting circuit TA in the output of the amplifier 1 is a control path 6 comprising the current controlled, relay-controlling device 7 and the windings of a fast operating relay 8 and a slow operating relay 9 connected in parallel to the output of the device 7. Connected to the output of control device 7 in control path 6 is an auxiliary control path 6*a* comprising the delay circuit 10 and the windings of relays 11, 12 and 13 connected in parallel to the output circuit of delay circuit 10.

A source 14 of alternating current of a single frequency or a band of frequencies f_2, which may be within the frequency range of the signals to be transmitted over the system, is adapted to be momentarily connected across the transmitting path TA at the points 15 by means of switches 16 and 17 controlled by the operation of relays 8 and 9, respectively.

Connected to the receiving circuit RA between the hybrid coil H_1 and the input of the receiving amplifier 5 is a control path 18 comprising a one-way amplifier 19, a filter 20, the current controlled, relay-controlling device 21, and the windings of relays 22, 23 and 24 connected in parallel to the output of the control device 21.

Connected across the output of the control device 21 in control path 18 is the input of a delay circuit 25, to the output of which is connected the windings of the relay 26.

Connected to the receiving circuit RA between the output of amplifier 5 and the hybrid coil H_2 is a control path 27 comprising the current controlled, relay-controlling device 28 and the windings of relays 29 and 30, connected in parallel to the output of device 28.

In the transmitting circuit TA between the point of connection of control path 6 thereto and the hybrid coil H_2 is a normally closed switch 31 adapted to be opened by operation of relay 22 and to be maintained open by the operation of relay 30. Connected in transmitting circuit TA between the output of amplifier 4 and hybrid coil H_1 is the normally open switch 32 adapted to be closed by operation of relay 11 and the normally closed switch 33 adapted to be opened by operation of relay 23.

Connected in receiving circuit RA between the input of amplifier 5 and hybrid coil H_1 is a normally open switch 34 adapted to be closed by operation of relay 26 and to maintained closed by operation of relay 29. Connected in the input of receiving circuit RA between the input of amplifier 5 and hybrid coil H_1 is a normally closed switch 35 adapted to be opened by operation of relay 12. Connected in control path 6*a* between the output of delay circuit 10 and the windings of relays 12 and 13 is a normally closed switch 36 adapted to be opened by operation of relay 24. Connected in the input of control path 18 is a normally closed switch 37 adapted to be opened by operation of relay 13.

It is seen that the cable terminal which has just been described is of the form which is known in the art as "neutral", that is, the circuits thereof are normally disabled for transmission in either direction between the circuit TL and the cable TC and are made operative to transmit in the proper direction by switching means controlled by the currents received from the line or cable.

The terminal circuit at the west end of the cable TC is assumed to be substantially identical with that at the east terminal just described and to operate in a similar manner.

The one-way amplifiers 1, 2, 4, 5 and 19 may be of any of the types well known in the art. The amplifier 1 is adjusted so as to amplify the signal waves incoming from the circuit TL to a level sufficient to enable operation of the control device 7 in control circuit 6 thereby. Amplifier 19 is adjusted so as to amplify the signal waves incoming from the cable TC to a level sufficient to enable operation of control device 21 in control path 18 thereby. The amplifiers 1, 2 and 4 are adjusted so as to produce jointly sufficient amplification in the east to west signal waves received from the circuit TL as to compensate for, at least in part, the attenuation which will be produced in these waves in transmission over the cable TC to the west cable terminal station. Similarly, amplifier 5 is adjusted to amplify the waves received over the cable TC sufficiently to compensate for, at least in part, the attenuation which has been produced therein in transmission over the cable TC.

The control devices 7, 21 and 28 may be vacuum tube amplifier-rectifier circuits of the type well known in the art, or any devices which will respond to alternating currents impressed on their inputs to control the operation of a relay or relays in the output thereof.

The delay circuit 3 may be of any type for producing a delay of the required amount, which will be specified below in alternating currents transmitted therethrough, as for example, a low pass filter such as disclosed in the U. S. patents to Campbell Nos. 1,227,113 and 1,227,114, issued May 22, 1917, or a network such as disclosed for a similar purpose in Arnold Patent 1,565,302, issued December 5, 1925. The delay circuits 10 and 25 may be any suitable circuit arrangement which will delay the operation of relays 11, 12 and 13 or relay 26, by the rectified current in the output of device 7 or device 21, respectively. For example, means similar to that disclosed in the patent to H. S. Black No. 1,709,554 issued April 16, 1929 for controlling the energization of relays may be used.

The mechanical relays 8, 9, 11 to 13, 22 to 24, 26, 29 and 30, the generator 14, and the corresponding apparatus at the west cable terminal station (not shown) may be of any of the types well known in the art.

The filter 20 may be of the band pass type disclosed in the U. S. patent to Campbell mentioned above. The filter 20 is designed to suppress a band of frequencies f_2, equivalent to those generated by the generator 14 at the east cable terminal station and to transmit a band of frequencies f_1 corresponding to those frequencies generated by the generator at the west cable terminal station corresponding to the generator 14 at the east cable terminal station. The frequencies f_2 generated at the east cable station and the frequencies f_1 generated at the west cable terminal station must have different values but may be frequencies within or without the signal frequency range.

Since the terminal stations at both ends of the cable TC may be substantially identical in construction, except for the amplification factors of the various amplifiers used, the frequency ranges of the filters and the values of the courier frequencies generated thereat, it has been deemed sufficient to illustrate the terminal station at one end of the cable, the east end, only, and in the following description the method of operation of the system will be clear from reference to the single station shown in the drawing. Also, as the system operates in a similar manner when the direction of signal transmission is from east to west, as when it is from west to east, the operation of the system for the former case need only be described.

When no waves are being received over the cable TC in the direction from west to east, or when the waves being received thereover are of insufficient level even when amplified by the amplifier 19 to operate control device 21 and thus the relays 22 to 24 and 26, the switches 31, 33 and 36 will be in the closed condition and switch 34 in the open condition indicated in the drawing. Similarly, when no waves are being received over the circuit TL in the direction from east to west, or the waves being received thereover are of insufficient level, even when amplified by the amplifier 1, to cause operation of control device 7 and thus operation of relays 8, 9 and 11 to 13, the switches 17, 35 and 37 will be in the closed condition and the switches 16 and 32 in the open condition indicated in the drawing. For this condition of the circuits, the generator 14 of the courier frequencies f_2 is disconnected from the cable TC.

To simplify the description of the operation of the system it will be assumed that telephone currents to be transmitted from east to west are received at the east cable terminal station (that shown in the drawing) over the circuit TL and that at that time no telephone currents have as yet been generated or received at the west cable terminal station (not shown) for transmission from west to east.

The received telephonic currents will be impressed by hybrid coil H_2 on the input of the transmitting circuit TA and amplified by the amplifier 1 therein. The amplified waves in the output of amplifier 1 will be divided between the input of amplifier 2 and the input of control path 6. The portion diverted into control path 6 will operate control device 7, thus causing the windings of relays 8 and 9 to be immediately energized and T seconds later, where T is equal to the overall transmission time of the cable TC between the east and west terminal stations, will cause the windings of relays 11, 12 and 13 to be energized over the auxiliary control path 6*a*. The delay in the energization of the windings of relays 11 to 13 is due to the delay in the transmission thereto of currents from the output of device 7 produced by the delay circuit 10 in their path.

The fast operating relay 8 will operate to close the switch 16 so as to connect the generator 14 of the courier frequencies f_2 across the output of transmitting circuit TA. Slow-operating relay 9 will operate an instant later to open the switch 17 to disconnect the generator 14 from the output of transmitting circuit TA. The effect of this momentary connection of the generator 14 to the transmitting circuit TA will be to cause a momentary impulse or spurt of current of frequencies f_2, which will be referred to hereafter as the courier f_2, to be transmitted directly over the circuit to the cable TC. The transmitted impulse may be made as short as is desired or as is necessary by the design of relays 8 and 9. The relays 8 and 9 are also so designed that they will remain operated as long as telephonic waves from the circuit TL are being impressed on the input of control device 7, and so that they will release only after a complete pause in the conversation, and not for the usual pauses between words or syllables.

The courier f_2 will be impressed by hybrid coil H_1 upon the cable TC and transmitted thereover to the west cable terminal station, where it will establish initial control of the switching circuits thereat in a manner which will be described later.

Substantially T seconds after the courier f_2 has been sent out over the cable TC, relays 11 to 13 will operate. Relay 11 will operate to close the normally open switch 32 in the output of the transmitting circuit TA, making that circuit operative to transmit waves from the output of amplifier 4 to the cable TC. Relay 12 will operate to open the normally closed switch 35 in the input of the receiving circuit RA, making that circuit inoperative to transmit waves from the cable TC to the input of the receiving amplifier 5. Relay 13 will operate to open the normally closed switch 37 in the input of control path 18, making that path inoperative to transmit waves from the cable TC or unbalance energy through hybrid coil H_1 from the transmitting circuit TA to the control device 21. Relays 12 and 13 should be adjusted so that they will operate simultaneously with or slightly before relay 11 so that the control path 18 for the incoming courier f_1 is disabled just before the transmitting circuit TA is made operative to transmit to the cable TC. This prevents any unbalance energy of the speech frequencies in the range of the incoming courier band from falsely operating the control device 21.

Instead of the delay circuit 10 any other suitable means for producing the delay in operation of relays 11, 12 and 13 with respect to the operation of relays 8 and 9 may be used. For example, the relays may be mechanically designed to have the required slowness in their operation to give the desired difference in operating times.

The main portion of the telephonic waves in the output of amplifier 1 in transmitting circuit TA will be amplified by the amplifier 2 and passed through the delay circuit 3 which is designed to delay their transmission for T+t seconds, t being a small increment of time in the order of a few hundredths of a second. This additional increment of time is to insure that the switch 32 in the output of amplifier 4 has been closed by relay 11 by the time the speech waves arrive at that point in the transmitting circuit TA. The waves in the output of delay circuit 3 are amplified by the amplifier 4 and transmitted from the output thereof directly to the hybrid coil H_1. The amplified waves are impressed by the hybrid coil H_1 on the cable TC and are then transmitted thereover to the west terminal station substantially T+t seconds behind the preceding courier f_2.

In the manner which has just been described complete control of the transmitting and receiving circuits at the east terminal station has been obtained for the east to west telephonic waves.

The manner in which complete control of the transmitting and receiving circuits at the west terminal station (not shown) is obtained by the east to west telephonic waves, provided they are set up at the east terminal before any telephonic waves are set up at the west terminal for transmission from west to east, will be clear from the following description by referring to the receiving circuits at the east terminal station. That the apparatus referred to is that located at the west terminal station will be indicated by designating the apparatus thereat corresponding to that at the east terminal station with the same characers as the latter but followed by a prime (′) mark.

The courier f_2 which is transmitted over the cable TC in advance of the speech waves by an interval of time T+t seconds on arrival at the west terminal is impressed on the input of the receiving circuit RA′ thereat by the hybrid coil H_1'. The switch 34′ in the input of amplifier 5′ being normally open, the courier f_2 will be diverted into control path 18′ in which it will be amplified by amplifier 19′ and passed by filter 20′, which is designed to transmit frequencies within the range of the courier f_2 and to suppress frequencies within the range of the courier f_1. The passed courier f_2 will operate control device 21′ causing the windings of the relays in the output thereof to be energized. The windings of relays 22′, 23′ and 24′ will be energized immediately and the windings of relay 26′ will be energized T seconds later due to the retarding action of the delay circuit 25′ which is designed to give a delay of T seconds. This delay in operation of relay 26′ may be produced by other means than the delay circuit 25′, for example, by mechanically constructing relay 26′ to make it slow operating.

Relay 22′ will operate to open the switch 31′ in transmitting circuit TA′, thus preventing any telephonic waves arriving later over the circuit TL′ from being transmitted over the transmitting circuit TA′ or into control path 6′. Relay 23′ will simultaneously operate to disable the output of transmitting circuit TA′ by opening switch 33′ therein, thus preventing any west to east wave energy which may be in the portion of circuit TA′ between switch 31 and switch 33 at the time switch 31 is opened from being transmitted to the cable TC, if relay 11′ happens to be still in the operated condition due to energy which may happen to be stored in the control circuit path 6′ at that time. Relay 24′ will simultaneously operate to disable the input of relays 12′ and 13′ by opening the switch 36′ in control path 6a′, thus preventing false operation of these relays to disable the input to control device 21′ and the input to receiving circuit RA′ by any energy which might be stored in control paths 6′ or 6a′.

T seconds after the operation of relays 22′, 23′ and 24′, relay 26′ will operate to initially close the switch 34′ in the input to amplifier 5′, thus making the receiving circuit RA′ operative in time to transmit the incoming telephonic waves, which will arrive at the west terminal station T+t seconds behind the courier f_2, to the input of the receiving amplifier 5′. The delayed switching action of relay 26′ is provided to enable any energy due to the reverse courier f_1 which may be in the process of being applied to the cable TC at the time the incoming courier f_2 arrived to be dissipated before the receiving circuit RA′ is made operative.

The east to west speech waves arriving at the west terminal station and transmitted by the hybrid coil H_1' thereat are divided between the input of the receiving circuit RA′ and the control path 18′. The portion diverted into control path 18′ within the transmission range of filter 20′ after amplification by the amplifier 19′ will be transmitted by the filter 20′ and impressed on the input of the control device 21′ maintaining that device in the operated condition initiated by the preceding courier.

The main portion of the east to west telephonic waves, the switch 34′ being in the closed condition at the time of their arrival due to the previous operation of relay 26′ by courier f_2 will be impressed on the input circuit of amplifier 5′ and amplified thereby. The main portion of the amplified waves in the output of amplifier 5′ will be transmitted directly to hybrid coil H_2' and impressed thereby upon the circuit TL′. A portion of the amplified telephonic waves in the output of amplifier 5′ will be diverted into control path 27′ and operate control device 28′ therein, causing the windings of relays 29′ and 30′ to be energized. Relay 29′ will operate to maintain the switch 34′ in the input of receiving circuit RA′ in the closed condition as long as speech waves are being impressed on the input of device 28′. A relay 30′ will simultaneously operate to maintain switch 31′, which has been initially operated by relay 22′ in response to the courier f_2, in the open condition as long as telephonic waves are being impressed on the input of control device 28′.

Although not shown in the drawing, it might be advisable to utilize another relay controlled by the device 28′ to open and maintain open a switch in the input of control path 18′ as long as telephonic waves are being received over the cable TC.

The one-way amplifier 2′ in the transmitting circuit TA′ is provided mainly to prevent false operation of the control device 7′ in control path 6′ by reflection of the telephonic waves which may be stored in the delay circuit 3′ at the time switch 31′ is opened in response to the courier frequency f_2. This amplifier may be dispensed with if another relay controlled by the operation of control device 21′ is utilized to disable the transmitting circuit TA′ at some point between the point of connection of control path 6′ thereto and the input of delay circuit 3′, for example, by opening a switch in the input of delay circuit 3′.

If west to east telephonic waves are set up at the west cable terminal after east to west telephonic waves are set up at the east terminal, but before the courier f_2 has seized control of the west terminal, the courier f_1 on arrival at the east terminal will not get into the control path 18 thereat to cause false operation of control device 21 because of the open condition of switch 37 due to the previous operation of relay 13 by the previously setup east to west telephonic waves.

To prevent clipping of part of the speech waves or singing or echo difficulties caused by premature closing or opening of the various switches in the transmitting and receiving circuits at each cable terminal when the supply of speech waves to the input of the controlling devices ceases or falls off, it may be desirable to utilize some means for introducing a hangover in the time of operation of the relays. This may be accomplished, for example, by mechanical design of the relays to make them sufficiently slow-releasing, or by associating with them electrical hangover circuits such as disclosed in the copending application of J. Herman, Serial No. 144,848, filed October 28, 1922. The transmitting and receiving hangover times should, of course, be relatively adjusted to avoid trouble from transmission lockouts.

The transmitting and receiving circuits at the two cable terminals in the manner pointed out are now under complete control of the east to west speech waves.

Because of the open condition of the switch 31′ in the input of the transmitting circuit TA′ at the west terminal, speech waves from the incoming circuit TL′ cannot get through to disturb this control until there is a complete pause in the steady transmission of east to west speech waves, such as would occur at the end of a sentence or actual cessation of speech transmission at that terminal. When this occurs the circuits of both terminals will return to their normal condition and may be then seized by the first speaker to send a courier on the way.

Because of the delay produced in the transmission of the telephonic waves by the delay circuits 3 and 3′ in the transmitting circuits and east and west terminals, respectively, it is apparent that the telephonic waves from each terminal and the courier from the other terminal are never being transmitted over the cable TC at the same time. It is apparent also from the above description of the operation of the system that the design of the filter in the receiving control circuit and the time delays in the operation of the control relays provided by the delay circuits in their input, at each terminal enable the courier frequencies to be placed within the frequency range of the signals transmitted over the cable, thus effectively increasing the available signal transmission range of the cable.

It is to be understood that the invention is not limited to the details of the particular circuits illustrated and described as numerous modifications therein may be made by persons skilled in the art without departing from the spirit and scope of the invention. For example, although in the circuits illustrated and described, mechanical relays are employed for conditioning the transmission paths by operating movable switches at various points to close or open gaps in the paths, it is within the scope of the invention effectively to disable the transmission paths by short circuits or loss networks inserted at various points therein and controlled by current controlled relays. 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 an article by C. A. Beers and G. T. Evans, in the Journal of the Institute of Electrical Engineers (London), Vol. 20 pp. 65–72 incl. published in April 1920 or in the U. S. patent to G. Grisson, No. 1,647,221, issued November 1, 1927 or the U. S. patent to Beatty, No. 1,470,954 issued October 16, 1923.

Because of the high gain which may be used in the cable terminal circuits described and illustrated, it may be desirable to have the transmitting and receiving circuits normally disabled or adapted to be disabled in more places than those shown.

The invention is not to be construed as limited to the specific disclosure, but its scope is defined in the appended claims.

What is claimed is:

1. A terminal station for a two-way signal transmission path having a limited transmission frequency range comprising a transmitting circuit, a receiving circuit, means coupling said transmitting circuit and said receiving circuit to said path, means responsive to the initiation of signals in said transmitting circuit for transmitting to said path through said coupling means, and in advance of said signals, a control wave of frequencies within the frequency range of said signals, means normally disabling said receiving circuit from receiving waves from said path, a control circuit connected to said path through said coupling means and responsive to waves received over said path to render said receiving circuit operative to receive waves from said path, and means for preventing false operation of said control circuit by waves of frequencies corresponding to those of said waves received over said medium, transmitted from said transmitting circuit through said coupling means.

2. The terminal station of claim 1 and in which said means for preventing false operation of said control circuit includes filtering means designed to suppress from said control circuit waves of frequencies corresponding to those of said transmitted control wave.

3. A two-way signal transmission system comprising a two-way signal transmission line connecting terminal stations each comprising a transmitting circuit, a receiving circuit and means coupling said transmitting circuit and said receiving circuit in substantally conjugate relation with each other and in energy transmitting relation with said line, wave-controlled circuit-control means, which when operated disables the transmitting circuit and renders the receiving circuit operative at that station, means normally disabling said receiving circuit for receiving waves from said line, means responsive to the initiation of signals in said transmitting circuit for transmitting to said line for transmission to the other station, and in advance of said signals, a short train of control waves of frequencies different for each terminal and within the frequency range of said signals, a receiving control circuit connected to said line through said coupling means and responsive to the waves received from said other station over said line to operate said circuit-control means, and means for preventing false operation of said circuit-control means by unbalance energy transmitted to said receiving control circuit through said coupling means from said transmitting circuit.

4. The system of claim 3 and in which said means for preventing false operation of the circuit-control means at each terminal station comprises means in said receiving control circuit for suppressing therefrom waves of frequencies corresponding to those of the control waves generated at that terminal.

5. The system of claim 3 and in which said means for preventing false operation of the circuit-control means at each terminal station comprises filtering means in the receiving control circuit thereat for effectively suppressing therefrom waves of frequencies corresponding to those of the control waves generated at that station, and means responsive to the initiation of signals in said transmitting circuit, and operative at a time thereafter substantially equal to the overall transmission time of said line between the terminal stations, for disabling said control circuit.

6. A two-way signal transmission system comprising a two-way signal transmission line connecting terminal stations each having a transmitting path, a normally inoperative receiving path, coupling means connecting said transmitting path and said receiving path to said line, a receiving control circuit connected to said line through said

coupling means and responsive to waves received over said line from the other station for disabling said transmitting path and rendering said receiving path operative, means responsive to signals initiated in said transmitting path for sending over said line to said other station, and in advance of said signals, control waves of frequencies different for each terminal station and within the frequency range of said signals, means also responsive to the signals in said transmitting path for disabling said receiving control circuit and further disabling said receiving path, and means for preventing false operation of said receiving control circuit by waves of frequencies corresponding to the frequencies of the control waves sent out from that station, transmitted through said coupling means from said transmitting path.

7. The system of claim 6 and in which said means for preventing false operation of said receiving control circuit comprises a filter in the input thereof effectively suppressing frequencies corresponding to said control wave frequencies.

8. A terminal station for a two-way signal transmission line having a transmission time of T seconds, comprising a source of signals, normally disabled transmitting and receiving circuits, a control path for control waves received over said line, means responsive to signals from said source for immediately sending out over said line a short train of control waves, means responsive to said signals to make operative the transmitting circuit to transmit to said line substantially T seconds after said train of control waves has been sent out, means to delay transmission of said signals in said transmitting circuit until that circuit has been rendered opertive, means responsive to said signals for disabling said control path and further disabling said receiving circuit substantially T seconds after said train of control waves has been sent out, means in said control path and when said control path is operative to control waves therein received over said line in advance of signals for immediately disabling said means responsive to signals for sending out said train of control waves, and for further disabling said transmitting circuit, and for preventing operation of the means for disabling said control path and for further disabling said receiving circuit, means responsive to the received control waves and operative substantially T seconds after their arrival over said line for rendering operative said receiving circuit, and means responsive to signals received over said line for maintaining said receiving path operative, and for maintaining said transmitting path, said control path disabling means and said means for sending out a train of control waves disabled.

9. A system for the two-way transmission of telephonic currents comprising a two-way line having a transmission time of T seconds connecting two stations each including transmitting and receiving paths for said currents, said paths being normally disabled, current-controlled switching means at each station for controlling the transmitting efficiency of said paths, and means for insuring exclusive control of said paths for both stations to the one of said stations at which telephonic transmission is first initiated, the last mentioned means comprising means at each station for utilizing a portion of the telephonic currents there generated for sending out over said line to said other station an impulse of current within the frequency range of said telephonic currents, means for utilizing said current impulse to operate the switching means at the other station so as to make the transmitting path thereat inoperative, and T seconds later to make the receiving path at said other station operative to receive transmission from the first station, means also responsive to said telephonic currents and operative substantially T seconds after said impulse has been sent out from the first station to make the transmitting path thereat operative to transmit and the receiving path and switching means thereat inoperative to receive transmission from the other station, means at each station for delaying transmission of the generated telephonic currents in the transmitting path thereat until said path has been rendered operative, and means for utilizing the delayed telephonic currents when they arrive at said other station for maintaining the switching means thereat in the operated condition initiated by the preceding impulse of current.

10. A two-way signal transmission system comprising a two-way signal transmission line having an overall transmission time of T seconds and connecting terminal stations each having a transmitting path, a normally inoperative receiving path, means coupling said transmitting path and receiving path to said line, a receiving control circuit connected to said line through said coupling means and responsive when operative to waves received over the line from the other station to disable said transmitting path and to render said receiving path operative, means in said receiving control circuit for delaying the rendering of said receiving path operative in response to the received waves until substantially T seconds after said waves are received by said receiving circuit, means responsive to signals initiated in said transmitting circuit when operative for sending over said line to said other station, control waves of frequencies different for each terminal station and within the frequency range of said signals, means in said transmitting path for delaying the transmission of said signals to said line until substantially T seconds after said control waves have been transmitted thereto, and means also responsive to the signals in said transmitting path when operative for disabling said receiving control circuit and further disabling said receiving path substantially at the same time as said signals are transmitted to said line, and means for preventing false operation of said receiving control circuit by waves of frequencies corresponding to those of the control waves sent out from said stations transmitted from said transmitting path through said coupling means.

ROBERT C. MATHES.