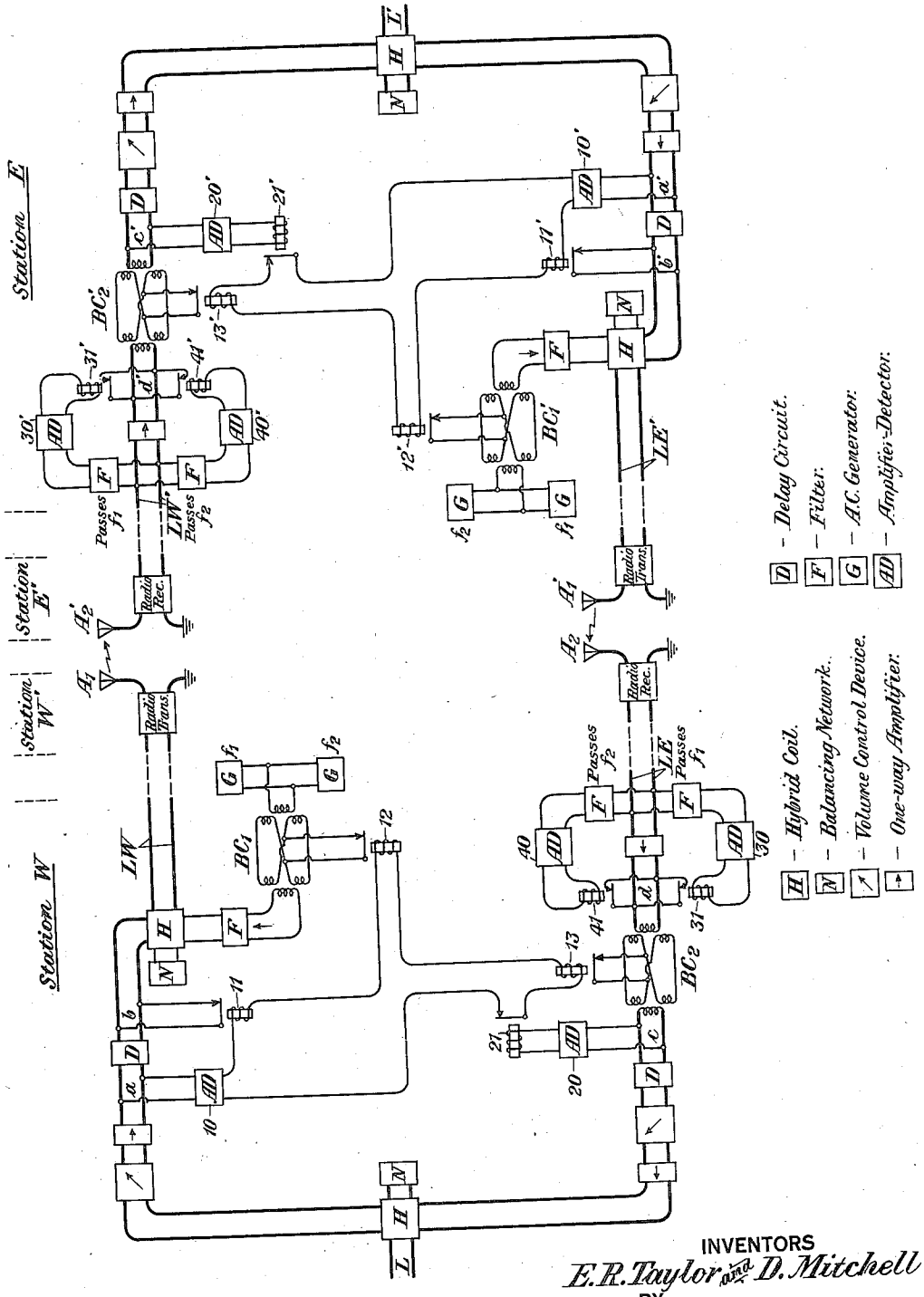
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TWO-WAY TELEPHONE SYSTEM

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TWO-WAY TELEPHONE SYSTEM

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This invention relates to systems for the transmission of energy between distant stations for the production of some desired over-all effect. More particularly, the invention relates to two-way telephone systems having wave-responsive devices for controlling transmission, such as "singing suppressors" and "echo suppressors".

In a long telephone system it is often desirable, in order to prevent "singing", to have one or both of the one-way paths normally disabled at one or more points. It follows that means must be provided whereby the voice waves will cause the removal of any such disability normally found on the path other which these waves are to be transmitted.

The system, however, may include what will be hereinafter termed a "mutable" link—that is, a link capable of or liable to change (from internal or external cause) which may give rise to interfering energy, or, more specifically, a link specially subject to noise, fading (in the case of radio transmission) or change of impedance. In such a case, the wave-responsive devices on the receiving side of the mutable link, when made sufficiently sensitive to operate on weak speech energy, are liable to false operation by the interfering energy originating in the mutable link. This difficulty is removed if control currents are employed and the wave-responsive devices on the receiving side of the mutable link made to respond exclusively to the frequencies of the control currents. These control waves not only are easier to detect, in spite of interfering noise waves, than the speech waves, being confined to a narrow frequency band, but also have the advantage that they are applied suddenly with full amplitude, producing a prompt and positive operation of the transmission controlling relays.

The applicants' invention is particularly applicable to systems such as that suggested above. More particularly, it is applicable to the short-wave radio-telephone systems used for trans-oceanic communication.

In general, the applicants apply the control currents—preferably, two or more control currents of different frequencies in each direction—during the periods when no voice energy is being transmitted, cause the control frequency—or any one of a plurality of control frequencies—to maintain disabled the receiving channel which is adapted for transmission from the mutable link, and cause the voice waves on the transmitting side of the mutable link to disconnect the source—or sources—of control current and thus clear the normally disabled channel at the receiving end of the system.

The applicants' transmission control apparatus is preferably confined to the "terminal" stations, as distinguished from the intermediate radio stations, and is of such a nature that, should it be desirable to shift the operation of the system from the use of control currents to the control of transmission by voice waves without special currents, only minor and readily made alterations would be required.

These and other features and advantages of the applicants' methods of and means for transmission control will be understood when the following detailed description of one desirable embodiment of the invention is read with reference to the accompanying drawing, which shows diagrammatically, and in part schematically, the application to a long two-way telephone system including a radio link.

With reference to the details of the drawing, there is disclosed a two-way telephone system extending from station W at the left to the distant station E at the right. The system may be extended to the left from station W over the two-wire circuit L, which is connected through the usual hybrid coil and is balanced by the usual network. Likewise, the system may be extended to the right from station E over the two-wire circuit L', which is connected through a hybrid coil and balanced by a network. The system extending between station W and station E takes the form of a four-wire circuit. The intermediate portion of this four-wire circuit consists of a radio link extending from station W' at the left to station E' at the right. It will be understood that station W' may be at a great distance from station W and that station E' and E may be separated by a great distance.

The path adapted for transmission from left to right comprises the one-way wire section LW connecting stations W and W', the radio link between the transmitting antenna A_1 and the receiving antenna A_2', and the receiving wire section LW' extending from station E' to station E. The path adapted for transmission from right to left comprises the one-way wire section LE', the radio link between antennae A_1' and A_2, and the receiving wire section LE. It will be noted that the left to right channel is normally disabled at the point b at station W and at the point d' at station E. Likewise, the channel for transmission from right to left is normally disabled at the point b' at station E and at the point d at station W.

Associated with the wire section LW at station

W are two generators of alternating current, one generating a frequency f_1 and the other a frequency f_2. These generators are normally connected to the transmission path LW through a balanced repeating coil BC_1, a filter and a hybrid coil. Likewise, two generators are associated with the path LE' at station E through the balanced coil BC_1', a filter and a hybrid coil. The frequencies generated in these two generators are different from each other but may be the same frequencies which are generated and applied to the path LW at station W. The alternating currents so generated and applied to the transmission paths are the control currents.

Consideration being given particularly to transmission from station W to station E, the frequencies f_1 and f_2 are normally sent over the path LW to station W', are there applied to the radio transmitter and the transmitting antenna A_1, are picked up at the distant station E' in the antenna A_2', are applied to the radio receiver and are then sent over the path LW' to station E. There each control frequency passes through the appropriate filter and operates an amplifier-detector, f_1 operating amplifier-detector 30' and f_2 operating amplifier-detector 40'. Relays 31' and 41' are connected in the output circuits of amplifier-detectors 30' and 40', respectively. It will be understood that as long as the control frequencies are transmitted these relays 31' and 41' are maintained in operated condition and that the operation of either one of these relays serves to disable the path LW' at points d'. While it is not of the essence of the invention, it is advantageous to use two or more control currents of different frequencies, which are usually outside the voice range. Thus if selective fading eliminates one of the control frequencies in the radio link, it is likely that the other—or one of the others, if more than two control frequencies are used—will be transmitted with sufficient strength to maintain one of the relays operated to disable the transmission path at point d'. The generators of frequencies f_1 and f_2 and the amplifier-detectors 30' and 40' are understood to represent any suitable number of generators and corresponding amplifier-detectors.

In the system specifically disclosed the transmission of control currents from station E to station W is the same as the transmission in the opposite direction.

At station W the amplifier-detector 10, controlling certain relays to be discussed hereinbelow, is connected to the path LW at point a and is responsive to the voice waves. At the distant station E the amplifier-detector 20' is connected to the path LW' at point c' and, like amplifier-detector 10, responds to the voice waves. Likewise, amplifier-detectors 10' at station E and 20 at station W respond to voice waves traveling from right to left.

If voice waves from circuit L enter the transmission path LW, they pass through a volume control device and a one-way amplifier to the point a at the input of a delay circuit. At this point a portion of the voice energy is diverted to operate amplifier-detector 10. Relays 11, 12 and 13 are operated by this amplifier-detector. Relay 11 serves to remove the disability from the path LW at point b. The operation of relay 12 disables balanced coil BC_1 and prevents the further application of the control currents of frequencies f_1 and f_2. It should be noted at this point that the filter in the output of the coil BC_1 is designed to prevent the application to the transmission path of transients in the voice range set up by the operation of the relay 12. The operation of relay 13 disables the balanced coil BC_2 in the opposite receiving path LE, thus preventing transmission over that path. It should be noted that if relay 21 has operated before the operation of amplifier-detector 10, the relays 11, 12 and 13 will not operate. This feature will be discussed hereinbelow.

The transmission of the voice waves beyond the point a in path LW is held up slightly in the delay circuit, time thus being given for the clearing of the channel at point b by relay 11 and the removal of the control energy by the operation of relay 12. The speech currents now divide in the hybrid coil, half of the energy being dissipated in the balancing network and the other half being transmitted on to the radio transmitter at station W'. At the distant end of the radio link the voice waves are picked up in the radio receiver at station E' and are then sent on over path LW' to station E. By the time the voice energy reaches station E the interruption of the control energy will have caused the release of relays 31' and 41', and accordingly the disability will have been removed from the path LW' at the point d'. Voice waves now pass through the balanced coil BC_2' to the point c'. At this point the waves cause the operation of amplifier-detector 20' and relay 21', unless relay 13' has operated, as will be discussed hereinbelow. The operation of relay 21' breaks the output circuit of amplifier-detector 10' (associated with the opposite transmitting path LE') and the circuits of relays 11', 12' and 13'. This operation secures control of the system at station E and prevents breaking in by the subscriber connected to circuit L'. Furthermore, echoes of the voice waves traveling from left to right, which may enter the path LE' and operate the amplifier-detector 10', are prevented from interfering with the transmission over the path LW' and from causing false operation of the relays 11' and 12'. Beyond point c' the voice waves pass through the delay circuit, which has introduced the delay necessary for the operation of relay 21', the volume control device and the one-way amplifier to the circuit L'.

It should be noted in connection with transmission from station W to station E that during the transmission of the voice waves relay 13 is held operated. Accordingly, even if relays 31 and 41 should both release momentarily because of control frequency fading in the radio link, the balanced coil BC_2 is held disabled and voice waves in the path LE cannot reach the point c to operate amplifier-detector 20 and relay 21. In other words, if the voice waves in path LW reach the point a in time to take control of the left end of the system at station W through the operation of relays 11 and 13, later arriving energy in the opposite path LE cannot interrupt this control. If, however, the voice energy in path LE has reached point c without interruption, amplifier-detector 20 and relay 21 will operate, and the control of the system at station W is given to the subscriber connected to station E.

The operation of the system in connection with transmission from right to left is, in the system specifically disclosed, the same as that described in connection with transmission from left to right. Control frequencies f_1 and f_2 are applied during the silent periods to the path LE', the filter at the output of the coil BC_1' passing the control frequencies but excluding the transients in the voice range. These control frequencies reach the station W and hold relays 31 and 41 (or one

of them, at least) operated to disable the path LE at point *d*. When voice waves travel over the circuit L' and the path LE', amplifier-detector 10' is operated. Relay 11' removes the transmission path disability at point *b'*; relay 12' disables the coil BC_1' and thus prevents the further application of the control frequencies; and relay 13' disables the opposite transmission path LW' at the coil BC_2'. When the voice waves reach the station W, the path LE has been rendered operative by the release of relays 31 and 41, and the voice waves travel on to the point *c*, unless relay 13 has operated in the meantime. As described above, the operation of amplifier-detector 20 and relay 21 secures control by preventing interruption due to later arriving voice waves in the opposite path LW. The voice waves in path LE are now free to pass on to the connected circuit L.

It remains to point out several advantages of the applicants' arrangements for transmission control:

The receiving path at either of the stations W and E is normally held inoperative by the control currents; accordingly, noise energy coming from the radio link cannot pass over this receiving path to produce false operation of the transmission control devices. Thus the voice responsive control devices can be made very sensitive, so as to operate on the weakest speech. This sensitivity of the voice responsive apparatus connected to the receiving path serves to insure the prevention of false operation by echo currents returning over the opposite transmitting path, as has been described above. Accordingly, the receiving volume is practically independent of noise originating in the mutable (radio) link.

It has been stated above that the control currents are usually of frequencies outside the voice range. Since these control currents are transmitted from the radio transmitters only when no speech is being transmitted, no additional load capacity is required in these transmitters. As has been indicated above, the filters in the inputs of amplifier-detectors 30, 40, 30' and 40' pass only the control frequencies and thus prevent operation of these amplifier-detectors by energy other than the control energy. It has been shown above that while a single control frequency may be employed in each direction of transmission, it may be preferable to use two or more control frequencies, in order to furnish some degree of insurance against damaging fading in the radio link and the resultant undesirable transmission of radio noise.

While the invention has been disclosed specifically in one desirable embodiment, it is to be understood that the applicants' methods of and apparatus for transmission control may take other and widely different forms within the scope of the appended claims.

What is claimed is:

1. In a two-way system for the transmission of energy, two paths adapted for transmission in opposite directions, means near the transmitting terminal of one of said paths for applying control energy to said path, means near the receiving terminal of said path responsive substantially only to said control energy for maintaining said path in disabled condition, means near the transmitting terminal of said path responsive to the energy transmitted thereover to produce the desired over-all effect for preventing the application thereto of said control energy, and means near the transmitting terminal of said path responsive to said energy transmitted to produce the desired over-all effect for controlling the transmission over both the transmission paths, near said terminal, said last-mentioned means being independent of the application to the system or the withdrawal therefrom of control energy designed to pass over the receiving end of the opposite path.

2. In a two-way system for the transmission of energy, including a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the method of transmission control which consists in applying control energy to the first path near the transmitting end thereof, causing said control energy to maintain the first path in disabled condition near the receiving end thereof, causing the energy transmitted for the production of the desired over-all effect, as it travels over the transmitting end of the first path, to prevent the application of the control energy thereto, causing said energy transmitted for the production of the desired over-all effect, as it travels over said transmitting end, to control the transmission over said first and second paths at that end of the system, and preventing the interruption of the last-mentioned control by the application to the system or the withdrawal therefrom of control energy designed to pass over said second path.

3. In a two-way system for the transmission of energy, a first path adapted for transmission in one direction, a second path adapted for transmission in the opposite direction, means near the transmitting end of said first path for applying control energy thereto, means near the receiving end of said first path responsive substantially only to said control energy for maintaining said path in disabled condition, means near the transmitting end of said first path responsive to the energy transmitted to produce the desired over-all effect for preventing the application of said control energy, means similarly responsive near the transmitting end of said first path for controlling the transmission over said path and the opposite section of said second path, and means near the receiving end of said second path and responsive to energy therein of earlier arrival than energy in the first path for rendering the paths exempt from control by energy in the first path, the control of the transmitting end of said first path being independent of the application to the system or the withdrawal therefrom of control energy designed to pass over said second path.

4. In a two-way signal transmission system, including two paths adapted for transmission in opposite directions, the method of transmission control which consists in applying control energy to each path when said path is not being used for signal transmission, causing the control energy applied to a path to disable said path, causing the signal energy applied to the transmitting end of a path to interrupt the application of the control energy thereto and to control the transmission over the transmitting end thereof, and rendering a path immune to prevention or interruption of the signal control thereover by the application to the system or the withdrawal therefrom of control energy designed to pass over the opposite path.

5. In a two-way transmission system, including two paths adapted for transmission in opposite directions, the method of transmission control which consists in applying control energy to each path when said path is not being used for signal transmission, causing the control energy applied to a path to disable said path near its receiving end, causing the signal energy applied to the

transmitting end of a path to interrupt the application of the control energy thereto and to control the transmission over the transmitting end thereof and the receiving end of the opposite path, and rendering a path immune to prevention or interruption of the signal control over the transmitting end thereof by the application to the system or the withdrawal therefrom of control energy designed to pass over the opposite path.

6. In a two-way system for the transmission of energy, including a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the method of transmission control which consists in applying control energy to each path near the transmitting end thereof, causing said control energy to maintain the path to which it is applied in disabled condition near the receiving end thereof, causing the energy transmitted for the production of the desired over-all effect, as it travels over the transmitting end of one of said paths, to prevent the application of the control energy thereto, causing said energy transmitted for the production of the desired over-all effect, as it travels over said transmitting end, to control the transmission over said first and second paths at that end of the system, and rendering the transmission over said transmitting end of the first path immune to interruption by the application to the system or the withdrawal therefrom of control energy designed to pass over said second path.

7. In a two-way signal transmission system, including two paths adapted for transmission in opposite directions, means associated with each path for applying control energy thereto when such path is not being used for signal transmission, means associated with each path and responsive to said control energy for maintaining the path inoperative for signal transmission, means responsive to the application of signal energy to either path for interrupting the application of control energy thereto, and means associated with the transmitting end of one of said paths and responsive to signal energy therein for controlling the transmission thereover, said last mentioned means being independent of the application to the system or the withdrawal therefrom of control energy designed to pass over the opposite path.

8. In a two-way signal transmission system, including two paths adapted for transmission in opposite directions, means associated with each path for applying control energy thereto when such path is not being used for signal transmission, means associated with the receiving end of each path and responsive to said control energy for maintaining the path inoperative for signal transmission, means responsive to the application of signal energy to either path for interrupting the application of control energy thereto and means associated with the transmitting end of one of said paths and responsive to signal energy therein for controlling the transmission thereover and over the receiving end of the opposite path, said last mentioned means being independent of the application to the system or the withdrawal therefrom of control energy designed to pass over the opposite path.

9. In a two-way signal transmission system, including two paths adapted for transmission in opposite directions, means associated with each path for applying control energy thereto when such path is not being used for signal transmission, means associated with each of said control energy applying means for preventing the application of transients in the signal frequency range to the transmission path as a result of the operation of said control energy applying means, means associated with each path and responsive to said control energy for maintaining the path inoperative for signal transmission, means responsive to the application of signal energy to either path for interrupting the application of control energy thereto, and means associated with the transmitting end of one of said paths and responsive to signal energy therein for controlling the transmission thereover, said last-mentioned means being independent of the application to the system or the withdrawal therefrom of control energy designed to pass over the opposite path.

10. In a two-way signal transmission system, including two paths adapted for transmission in opposite directions, means associated with each path for applying control energy thereto when such path is not being used for signal transmission, means associated with each of said control energy applying means for preventing the application of transients in the signal frequency range to the transmission path as a result of the operation of said control energy applying means, means associated with the receiving end of each path and responsive to said control energy for maintaining the path inoperative for signal transmission, means responsive to the application of signal energy to either path for interrupting the application of control energy thereto, and means associated with the transmitting end of one of said paths and responsive to signal energy therein for controlling the transmission thereover and over the receiving end of the opposite path, said last-mentioned means being independent of the application to the system or the withdrawal therefrom of control energy designed to pass over said opposite path.

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