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TWO-WAY TELEPHONE SYSTEM

Filed June 13, 1931

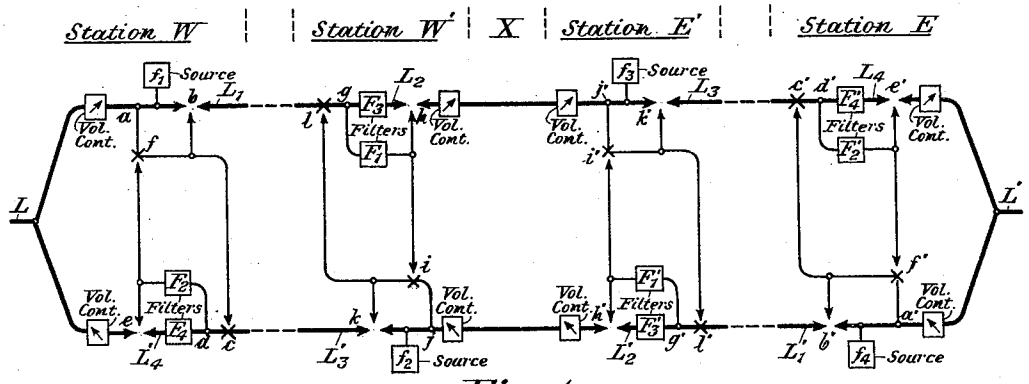

Fig. 1

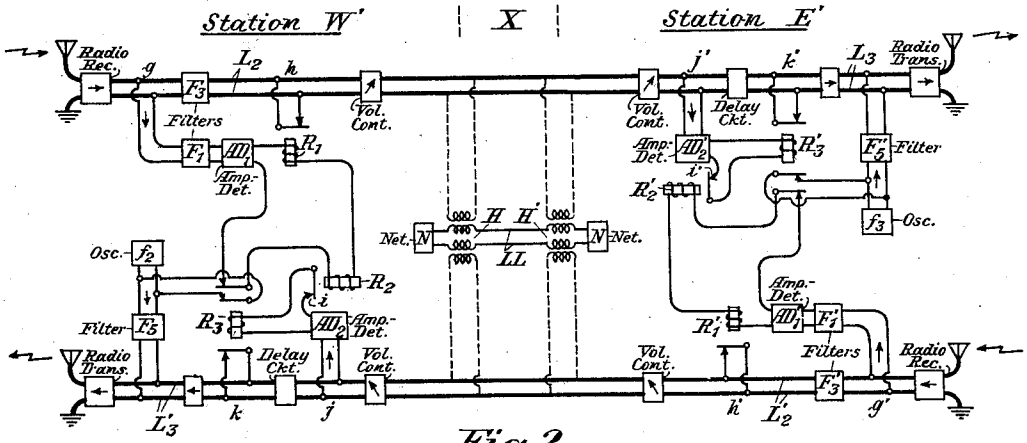

Fig. 2

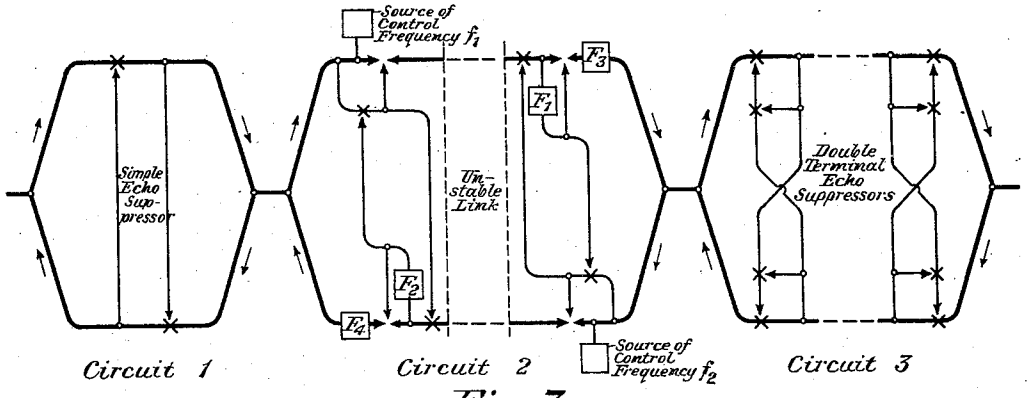

Fig. 3

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UNITED STATES PATENT OFFICE

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TWO-WAY TELEPHONE SYSTEM

Application filed June 13, 1931. Serial No. 544,194.

This invention relates to two-way 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 one or more comparatively unstable links and equipped with wave responsive devices such as "singing" suppressors for controlling the transmission over the voice channels. With greater particularity, the invention relates to methods of transmission control which permit the use in tandem of two or more telephone circuits of which at least one is noisy or unstable.

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 over which these waves are to be transmitted.

It may be that two long four-wire circuits, for instance, are so located that it is convenient to connect them in tandem for extended transmission. One of these circuits, 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. If transmission is effected from the mutable circuit to the other circuit, wave responsive devices in the latter circuit may be falsely operated by the noise or other interfering energy originating in the mutable circuit. If the mutable link is a radio link, static or fading effects are likely to be present, and in the case of a wire circuit changes of temperature, for instance, may produce the objectionable mutability.

If two circuits are to be connected in tandem as suggested above, a possible remedy is the removal of the transmission control devices at the circuit terminals which are connected together. This possible remedy, however, is open to several objections. In the case of radio circuits there is often considerable transmission from a transmitter to the local receiver, and in order to prevent the undesirable effects of this radio coupling, local transmission control devices are necessary. Again, the switching of privacy devices from one side of a four-wire circuit to the other requires local wave responsive apparatus. Furthermore, on long land circuits the presence of devices for suppressing echoes is often necessary. Accordingly, the problem of satisfactorily controlling transmission when two circuits are connected in tandem remains to be solved.

The principal object of the applicants' invention is the provision of transmission control methods and the arrangement of apparatus to render satisfactory the transmission over two or more four-wire circuits of the type indicated above when the circuits are operated in tandem.

In general, the applicants accomplish their object by using control energy which is applied at the transmitting end of the mutable circuit in response to voice waves and is made to operate the singing suppressor apparatus at the receiving end of the circuit. The control wave, in addition to being confined to a narrow frequency band and thus easy to detect in spite of interfering noise, is applied suddenly with full amplitude and thus has the further advantage over speech waves of producing a prompt and positive operation of the transmission controlling relays.

It will be understood that while it is desirable to make certain somewhat specific disclosures of the application of the invention, the applicants' methods are applicable to a great variety of long transmission systems. For instance, the mutable link may be a radio link or a submarine cable. Again, the connected circuits may be composed of various transmission media and may be equipped with various types of wave responsive devices for transmission control.

It is proposed to describe the invention in connection with a limited number of long two-way telephone systems, and accordingly the following description should be read with reference to the accompanying drawing. Figure 1 of the drawing shows schematically

two four-wire circuits connected in tandem and indicates the application of the applicants' transmission control. Fig. 2 shows diagrammatically and in part schematically, a part of a system such as that disclosed schematically in Fig. 1 and shows in somewhat greater detail the arrangement of the transmission control apparatus. Fig. 3 of the drawing shows schematically the application of the invention to a long two-way system comprising three four-wire circuits of which the middle circuit is mutable. Like reference characters in the several figures of the drawing designate corresponding parts, particularly in the case of Figs. 1 and 2.

With reference first to Fig. 1, the scheme indicates two four-wire circuits, one extending from station W to station W′ and the other extending from station E′ to station E. The first circuit may be extended to the left through a connecting circuit L, and the second four-wire circuit may be extended to the right through circuit L′. It will be understood that the heavy lines each represent a two-wire transmission path and that the connections between the four-wire circuits and the circuits L and L′, which are two-wire circuits, may be effected in any suitable manner. It is to be understood further that stations W′ and E′ may be very close together or may be the same station. The point to be understood is that these two four-wire circuits are to be connected in tandem at some point X which may lie between stations W′ and E′ or may be the common point of the two stations.

It is believed that the conventional disclosure employed in connection with the scheme of Fig. 1 and the nature of the apparatus schematically indicated will be clearly understood from the following description and discussion.

In the case of transmission from the two-wire circuit L at the left to the two-wire circuit L′ at the right, the transmission is effected over the one-way path L_1—L_2 extending from station W to station W′ and the one-way path L_3—L_4 extending from station E′ to station E. The path L_1—L_2 is normally disabled at points *b* and *h*, and the indicated intervening link is understood to be mutable, by reason, for instance, of being a radio link. Likewise the path L_3—L_4 is normally disabled at points *k*′ and *e*′, and again it is understood that the intermediate link indicated by the broken lines is a mutable link such as a radio link.

According to the applicants' invention, when voice waves travel from the line L over the path L_1, they pass through a volume control device to the point *a*. At this point a portion of the transmitted energy is diverted to operate wave responsive apparatus such as an amplifier-detector having connected in its output relays which control contacts associated with the transmission paths. Through the operation of such means the energy diverted at point *a* renders the path L_1 operative at the normally disabled point *b* and applies to the path L_1 control energy from the source indicated, which energy may take the form of alternating current waves of frequency f_1. In addition, the energy diverted at point *a* disables the opposite one-way transmission path L_4′ at point *c*. It will be understood from the discussion contained hereinbelow that in response to energy passing in the opposite direction a certain operation may be effected at the point *f* which will prevent the above described effects of the energy diverted at point *a*.

This control energy now travels over the path L_1, the voice waves being preferably somewhat delayed in a manner well understood in the art. When the control energy reaches station W′ a portion is diverted at point *g* to operate apparatus similar to that suggested at station W to render the path L_2 operative at the point of normal disability *h*. In addition the control energy breaks an auxiliary circuit at point *i*, thereby preventing the effects which would otherwise be produced by energy traveling in the opposite path L_3′ and diverted at point *j*. It will be understood that the particular transmission control system discussed is based on the following arrangement: If the waves in path L_2 pass the point *l* before the waves in the opposite path L_3′ reach the point *j*, transmission from left to right in path L_2 is assured, whereas, if the energy in path L_3′ arrives first, the path L_2 is disabled at point *l* and the transmission control apparatus associated with that path is temporarily disabled.

The filter F_1 passes only the control energy from the source f_1, while the filter F_2 passes only the voice waves. Thus the transmission control operation at point *h* is effected only in response to the control energy, and the control waves, having performed their function at station W′, are excluded from the transmission path L_2.

It will be noted that the two four-wire circuits are connected directly in tandem at point X; that is, the paths L_2 and L_3 adapted for transmission in the same direction are connected together, and the paths L_2′ and L_3′ adapted for transmission in the opposite direction are connected directly together. It is to be understood that this direct four-wire connection is not essential to the application of the invention. The connection may be made on a two-wire basis. It will be understood further, however, that it is the application of the invention which permits the direct four-wire connection and that if the connection is made on a two-wire basis the two-wire balance becomes unimportant.

The voice waves traveling from circuit L to circuit L′ next pass through the volume control devices at point X, and at that section of the system designated as station E′ a portion of the voice energy is diverted at point *j′* to perform a function which is the same as that discussed in connection with station W. If no disability has been applied at point *i′*, the path L_3 is rendered operative at the point of normal disability *k′*, control waves of frequency f_3 are applied from the source indicated and an auxiliary disabling operation is performed at point *l′* on path L_1'. The control energy passes over the intermediate link, which may be mutable, this control energy somewhat preceding the voice energy, and passes the point *c′* at station E. If no disability has been applied at that point in response to voice waves in the opposite path L_1' at point *a′*, a portion of the control energy is diverted, passes through filter F_2', renders the path L_4 operative at point *e′* and disables an auxiliary circuit at *f′* to prevent transmission control operations in response to later arriving voice waves at point *a′* in path L_1'. The control energy is eliminated from the transmission path, and the voice waves pass through filter F_4' and the volume control device to the connected circuit L′.

The operation of the system in the opposite direction for the transmission of voice waves from circuit L′ at the right to circuit L at the left is quite similar to that operation just described, and the apparatus associated with the paths L_1', L_2', L_3' and L_4' correspond to the apparatus associated with the left to right channel and are correspondingly designated by reference characters. At station E in response to voice waves from circuit L′ a control frequency f_4 is applied to the path L_1' and is transmitted to the path L_2' at station E′, where it effects transmission control as described above. Likewise at station W′ a control frequency f_2 is applied to the path L_3', is transmitted over the path L_4' at station W and there performs the transmission controlling function.

From the above description and discussion it will be understood that in connection with transmission from left to right false operation of the transmission control apparatus at station E′ and E by noise energy originating in the mutable link between stations W and W′ is prevented since the singing suppressor of station W′ is operated only when voice waves travel over the path L_1 at station W and apply the control energy. Likewise it will be understood that the transmission control apparatus associated with the right to left transmission path at stations W′ and W cannot be operated by noise energy originating between stations E and E′ since the control at point *h′* is the function of the control frequency f_4 applied at station E only in response to the voice waves. It should be noted further in connection with transmission from left to right, for instance, that noise originating in the mutable link between stations E′ and E cannot be transmitted on to circuit L′, except when speech is also present, since the transmission at point *e′* is under the control of the control energy applied at station E′. Likewise noise originating in the mutable link between stations W and W′ cannot pass on to the circuit L over the path L_4' in the absence of the operation at point *e*, which is performed only by the control frequency f_2 applied in response to voice waves traveling from right to left. In short, the applicants' invention prevents the passage of noise energy from a mutable circuit to a connected circuit except when voice waves are traveling over the circuit; accordingly, only the desired operation of transmission control apparatus is permitted.

In Fig. 2 it is assumed that the unstable link to the left of station W′ and the unstable link to the right of station E′ are radio links. Thus, the transmission path L_2 is that which normally leads from a radio receiver to some terminal point at X, and the path L_3 is one which normally leads from a terminal point to the radio transmitter from which waves are sent out to the right over a radio link. The connection of the two circuits at point X is shown in full line as a four-wire connection. It will be noted, however, that there are disclosed a connecting two-wire line LL, hybrid coils H and H′ and balancing networks N and N′, and the broken line connections indicate that the two four-wire circuits may be connected together over this apparatus. In this case it will be understood that the balances between the line LL and the networks N and N′ are relatively unimportant. Furthermore, under certain conditions, the hybrid coils and balancing networks may be omitted.

The transmission control apparatus schematically indicated in Fig. 1 at stations W′ and E′ is diagrammatically disclosed in Fig. 2 and will now be discussed with some additional detail.

The control energy picked up by the antenna at station W′ passes through the radio receiver and over the line L_2 to point *g*. A portion of this energy is diverted and passes through the filter F_1, which excludes substantially different frequencies. The amplifier-detector AD_1 operates in response to the control energy, and relays R_1 and R_2 connected in the output circuit of the amplifier-detector are operated. Relay R_1 removes the disability from the path L_2 at point *h*, and relay R_2 breaks the output circuit of the amplifier-detector AD_2 associated at point *j* with the opposite path L_3'. It will be understood that if energy flowing in the opposite direction arrives before the energy in path L_2, the amplifier-detector AD_2 operates re-

lay R_3 and the amplifier-detector AD_1 is disabled. In such a case the energy diverted at point g in path L_2 will have no effect and the transmission control at station W' is taken by the waves in the opposite path L_3'. It being assumed, however, that the control energy in path L_2 has rendered that path operative at point h, the voice waves are permitted to pass on through the volume control device to the point X. As stated above, in connection with Fig. 1, however, transmission of the control energy is prevented by filter F_3, which passes only the voice frequencies. At station E' a portion of the voice energy is diverted at point j' to operate the amplifier-detector AD_2'. The relay R_3' now operates unless control has been taken by voice waves in the opposite direction, and the path L_3 is rendered operative at the point of normal disability k'. The operation of relay R_3' also permits the control current of frequency f_3 from the oscillator to pass through the filter F_5' and through the radio transmitter for transmission from station E'. The delay circuit shown between point j' and k' serves to delay the voice waves and permit the control energy to precede the voice energy. The filter F_5' serves to eliminate transients set up by the application to the transmission path of the oscillator.

The transmission from right to left in the circuits of Fig. 2 is similar to the transmission from left to right just described. A portion of the control energy received at station E' is diverted at point g', passes through the filter F_1' and operates amplifier-detector AD_1', unless control has been taken by waves passing in the opposite direction. Relays R_1' and R_2' will operate. Relay R_1' renders the path L_2' operative at point h', and relay R_2' opens a contact at point i' to disable the output of the amplifier-detector AD_2' including the relay R_3'. The voice waves pass through filter F_3', which excludes the control current.

At station W' the voice waves in path L_3' reach the point j, where a portion of the energy is diverted to operate amplifier-detector AD_2. If the output circuit of this amplifier-detector has not been disabled at point i in response to energy in the opposite path L_2, relay R_3 operates. This relay operation clears the path L_3' at point k, disables the output circuit of amplifier-detector AD_1 and applies the control frequency f_2 from the oscillator to the path L_3'. The filter F_5 serves to eliminate transients.

The detailed description given above in connection with Fig. 2 of the drawing will serve to clarify the arrangement and operation of the circuit of Fig. 1 and to make clear the application of the applicants' invention to two long four-wire circuits connected in tandem.

In Fig. 3 there is disclosed a long two-way system including three four-wire circuits 1, 2 and 3, connected in tandem. Circuit 1, which may be understood to be a comparatively stable circuit, is equipped with simple echo suppressor apparatus. Circuit 3, likewise stable, is equipped at each end with double terminal echo suppressor apparatus.

Circuit 2 is understood to include a mutable link, which may be a radio link or any link rendered mutable in one of the ways suggested hereinabove.

In connection with transmission from left to right, the applicants cause the voice waves at the transmitting end of circuit 2 to send a control current of frequency f_1 to the right end of circuit 2. This control energy passes through filter F_1 and functions as described above. Filter F_3 passes the voice energy but excludes the control energy. This arrangement serves to prevent operation of the echo suppressors of circuit 3 except in response to the voice waves. In other words, noise energy or the like from the mutable link of circuit 2 cannot reach circuit 3 to cause false operation of the echo suppressors when no voice energy is being transmitted.

In connection with transmission from right to left, voice energy reaching circuit 2 sends out the control frequency f_2 from the transmitting end to the receiving end of the circuit, where this control energy passes through filter F_2 and performs its transmission controlling function. The filter F_4 passes the voice waves but excludes the control current. Accordingly, the echo suppressor of circuit 1 is rendered exempt from false operation from noise energy or the like arising in circuit 2.

While the applicants' methods of and arrangements for transmission control have been disclosed in connection with a limited number of transmission systems, it will be understood that the invention is applicable to many other transmission systems involving different transmission media and different types of wave responsive auxiliary apparatus for controlling transmission over component sections of either one way channel, within the scope of the appended claims.

What is claimed is:

1. In a system for the transmission of energy, including a mutable transmission path and other transmission paths connected in tandem therewith, the method of controlling transmission over the system which consists in causing the energy transmitted thereover for the production of the desired overall effect to apply control energy to the transmitting end of the mutable path, causing the control energy to control the transmission over the receiving end of said path, and excluding the control energy so applied from

the system beyond the point where it performs the above-stated function.

2. In a system for the transmission of energy, comprising a first transmission path, a second transmission path adapted to be connected in tandem therewith, means near the receiving end of the first path responsive to energy therein for controlling the transmission thereover and means associated with the second path and responsive to energy therein for controlling the transmission thereover, the method of preventing false operation of the controlling means associated with the second path by interfering energy originating in the first path which consists in causing the energy transmitted for the production of the desired over-all effect to apply control energy to the transmitting end of the first path, causing the controlling means near the receiving end of the first path to respond only to said control energy, and excluding the control energy from the system before it is transmitted on to the second path.

3. In a system for the transmission of energy, a transmission link which is mutable, other transmission links adapted to be connected in tandem therewith, means at the transmitting end of said mutable link responsive to the energy transmitted to produce the desired over-all effect for applying control energy thereto, means at the receiving end of said mutable link responsive substantially only to the control energy for controlling the transmission thereover, and means at said receiving end for excluding the control energy from the transmission channel.

4. In a system for the transmission of energy, including a mutable transmission link and a second transmission link positioned so as to be available for transmission from said mutable link but including transmission control means which will not normally operate satisfactorily when said second link is connected to said mutable link, the method of rendering the transmission satisfactory when said links are connected in tandem which consists in causing the energy transmitted for the production of the desired over-all effect to apply control energy to the transmitting end of said mutable link, and causing the control energy to control exclusively the transmission over the receiving end of said mutable link.

5. In a system for the transmission of energy, including a mutable transmission link and a second transmission link positioned so as to be available for transmission from said mutable link but including transmission control means which will not normally operate satisfactorily when said second link is connected to said mutable link, the method of rendering the transmission satisfactory when said links are connected in tandem which consists in causing the energy transmitted for the production of the desired over-all effect to apply control energy to the transmitting end of said mutable link, causing the control energy to control the transmission over the receiving end of said mutable link, and excluding the control energy from the system before it is transmitted on to said second link.

6. In a two-way system for the transmission of energy, including two four-wire circuits connected in tandem and providing two extended one-way paths adapted for transmission in opposite directions, and means near each end of each four-wire circuit responsive to energy in the local section of one of the one-way paths for controlling the transmission thereover, the method of transmission control of the tandem circuit which consists in causing the energy transmitted for the production of the desired over-all effect, as it travels over the transmitting path at either end of either four-wire circuit, to apply control energy thereto, and causing the transmission controlling means at the distant end of that four-wire circuit to respond substantially only to said control energy.

7. In a two-way system for the transmission of energy, including two four-wire circuits connected in tandem and providing two extended one-way paths adapted for transmission in opposite directions, and means near each end of each four-wire circuit responsive to energy in the local section of one of the one-way paths for controlling the transmission thereover, the method of transmission control of the tandem circuit which consists in causing the energy transmitted for the production of the desired over-all effect, as it travels over the transmitting path at either end of either four-wire circuit, to apply control energy thereto, causing the transmission controlling means at the distant end of that four-wire circuit to respond substantially only to said control energy, and eliminating the control energy at said distant end of the four-wire circuit.

8. In a two-way system for the transmission of electrical waves, comprising two two-way circuits each having separate paths adapted for transmission in opposite directions and each having wave responsive apparatus for controlling the transmission over the transmission paths, the method of transmitting electrical waves over said circuits without subjecting the wave responsive apparatus of one circuit to false operation by noise waves originating in the other circuit, which consists in causing the one-way paths of both circuits to be normally disabled near their respective terminals, causing the waves transmitted for the production of the desired over-all effect, as they travel over the transmitting end of each of the paths of said circuits, to remove the disability from said end and to send

out control waves, causing said control waves to remove the disability from the receiving end of said path and to maintain the operative condition thereof during the arrival of the waves transmitted for the production of the desired over-all effect, and connecting directly together the paths of the two circuits adapted for transmission in the same direction.

9. In a two-way system for the transmission of electrical waves, comprising two two-way circuits each having separate paths adapted for transmission in opposite directions and each having wave responsive apparatus for controlling the transmission over the transmission paths, the method of transmitting electrical waves over said circuits without subjecting the wave responsive apparatus of one circuit to false operation by noise waves originating in the other circuit, which consists in causing the one-way paths of both circuits to be normally disabled near their respective terminals, causing the waves transmitted for the production of the desired over-all effect, as they travel over the transmitting end of each of the paths of said circuits, to remove the disability from said end and to send out control waves, causing said control waves to remove the disability from the receiving end of said path, excluding the control waves from further transmission, and connecting directly together the paths of the two circuits adapted for transmission in the same direction.

10. In a two-way system for the transmission of electrical waves, comprising two two-way circuits each having separate paths adapted for transmission in opposite directions and each having wave responsive apparatus for controlling the transmission over the transmission paths, the method of operating said circuits in tandem which consists in causing each one-way path to be normally disabled near each of its terminals, causing the waves transmitted for the production of the desired over-all effect, as they travel over the transmitting end of each of said paths, to remove the disability from said end and to send out control waves, causing said control waves to remove the disability from the receiving end of said path and to maintain the operative condition thereof during the arrival of the waves transmitted for the production of the desired over-all effect, and providing for the direct transmission between a path of the one two-way circuit and the path of the other two-way circuit adapted for transmission in the same direction of the waves transmitted for the production of the desired over-all effect.

11. In a two-way system for the transmission of electrical waves, comprising two two-way circuits each having separate paths adapted for transmission in opposite directions and each having wave responsive apparatus for controlling the transmission over the transmission paths, the method of operating said circuits in tandem which consists in causing each one-way path to be normally disabled near each of its terminals, causing the waves transmitted for the production of the desired over-all effect, as they travel over the transmitting end of each of said paths, to remove the disability from said end and to send out control waves, causing said control waves to remove the disability from the receiving end of said path, excluding the control waves from further transmission, and providing for the direct transmission between a path of the one two-way circuit and the path of the other two-way circuit adapted for transmission in the same direction of the waves transmitted for the production of the desired over-all effect.

In testimony whereof, we have signed our names to this specification this 12th day of June 1931.

SUMNER B. WRIGHT.
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