

Nov. 10, 1936.

L. G. ABRAHAM

2,060,008

TWO-WAY SIGNALING SYSTEM

Filed Aug. 18, 1934

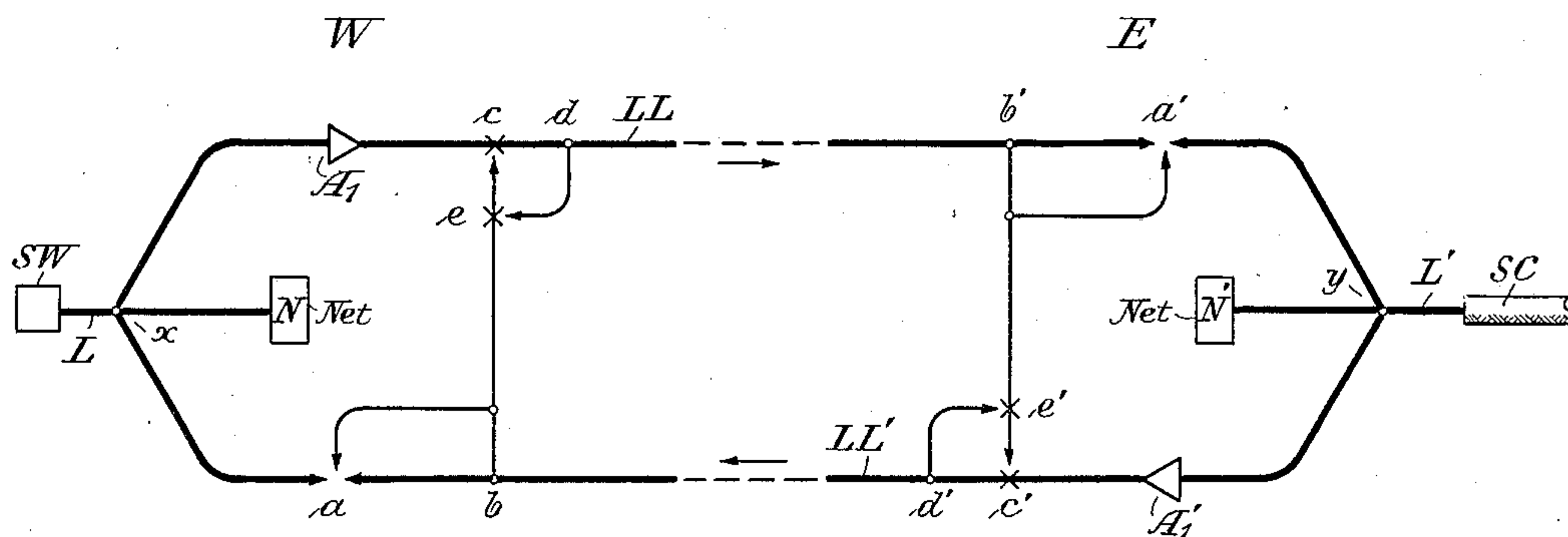


Fig. 1

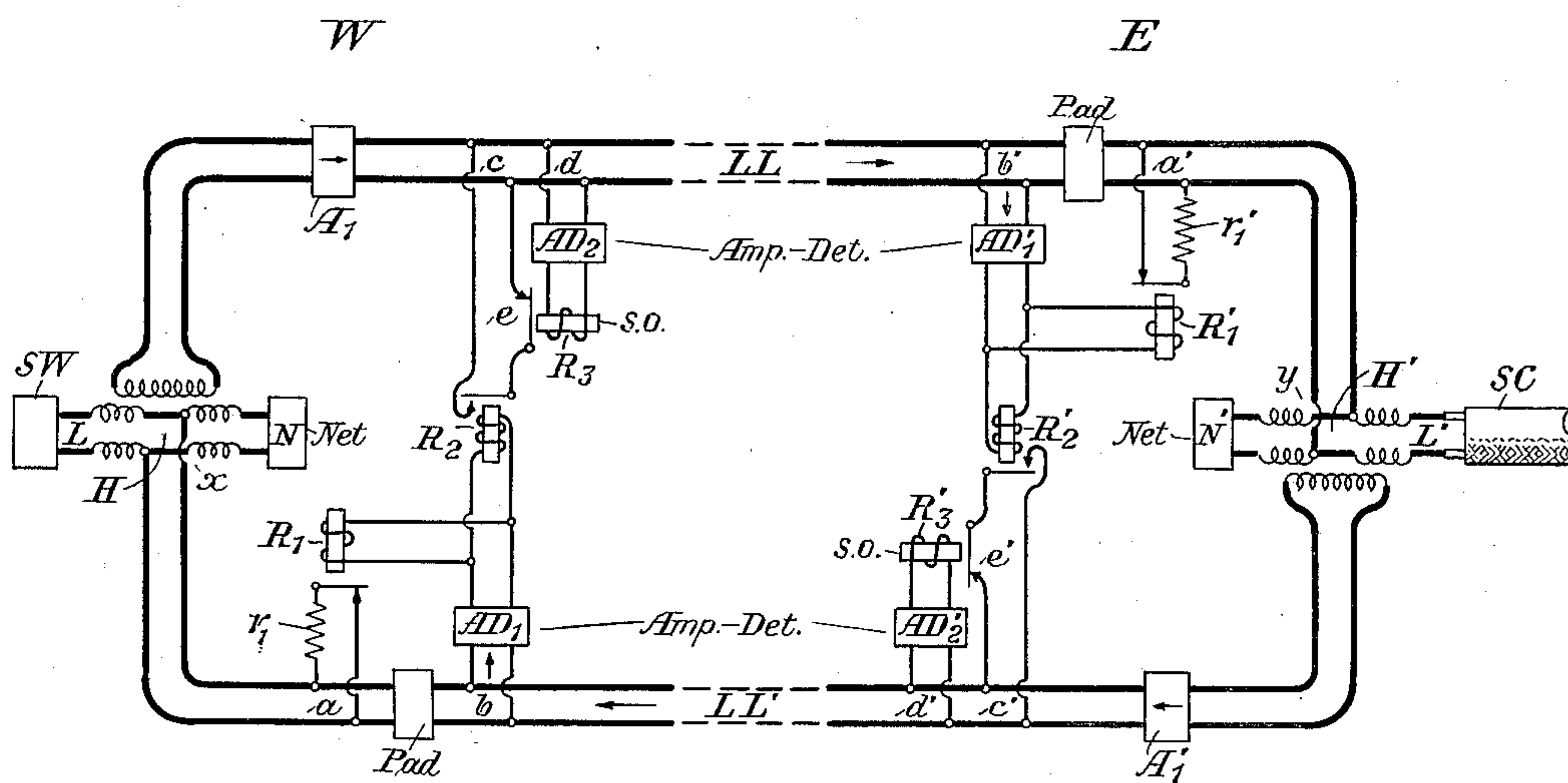


Fig. 2

INVENTOR
L. G. Abraham
BY *g e y o r e*
ATTORNEY

UNITED STATES PATENT OFFICE

2,060,008

TWO-WAY SIGNALING SYSTEM

Leonard Gladstone Abraham, Madison, N. J.,
assignor to American Telephone and Telegraph
Company, a corporation of New York

Application August 18, 1934, Serial No. 740,518

20 Claims. (Cl. 178—44)

This invention relates to two-way transmission systems, and more particularly to two-way telephone systems including a long four-wire section having separate paths for transmission in opposite directions.

In a four-wire circuit such as that contemplated, there arise certain problems. Each end of the circuit may be connected to an extending circuit, which is usually a two-wire line. It is the usual practice to connect an end of the four-wire circuit and the extending two-wire line together through a hybrid coil or the equivalent and to provide an artificial network designed to "balance" the impedance of the two-wire line. This "balance" is, at the best, an approximation, and the inevitable lack of perfect balance between the impedance of the two-wire line and the artificial network results in the reflection of energy, which is normally transmitted in one direction over one side of the four-wire circuit, back over the oppositely directed path. As a result of this reflection, there arise, as is well understood in the art, various transmission problems, including those of "singing" and "echoes". For the purpose of preventing singing and the objectionable transmission of echoes, it is the practice to utilize certain transmission control apparatus usually responsive to energy such as that representing the voice in the case of a telephone system. The use of such apparatus, however, leads to further problems such as those of unduly difficult "breaking" and mutual lockout.

The present invention contemplates, as indicated hereinabove, a four-wire circuit which may be of great length and transmission control apparatus located at or near the terminals of the four-wire circuit.

One object of the invention is the satisfactory suppression of singing. Another object of the invention is the satisfactory suppression of echoes, including "crosstalk echoes", which may arise due to crosstalk in the extending circuit or circuits or due to unbalances occurring in a section of the four-wire circuit intermediate to the terminals equipped with the transmission control apparatus. It is a further object of the invention to accomplish the objects stated hereinabove without the introduction of the chance of mutual lockout or unduly extended time required for the breaking-in by one subscriber after the subscriber talking in the opposite direction has given up control of the circuit.

In general, the invention resides in novel methods of and means for controlling the terminals of the four-wire circuit, which methods and means

will be described in adequate detail and claimed hereinafter.

The invention is applicable to many different types of two-way circuits. For instance, it is applicable to a four-wire circuit which is extended at one end by a land two-wire line and at the other end by a submarine cable circuit. Again, the four-wire circuit to the terminals of which the transmission control apparatus is directly applied may include sections intermediate to which are hybrid coils or the equivalents, no intermediate transmission control apparatus being applied. Also it will be clear to those skilled in the art that the oppositely directed paths of the four-wire circuit may include a radio link or radio links. Furthermore, it is to be understood that, while in many cases the circuit with the applied transmission control apparatus will be symmetrical, the symmetry may be departed from, with apparatus applied to one terminal of the circuit in a manner somewhat different from that in which the apparatus is applied to the other terminal.

The following description of the invention is to be read with reference to the accompanying drawing, in which—

Figure 1 is a schematic disclosure illustrating the applicant's methods in one form and indicating the essentials of the arrangement of transmission control apparatus, and

Fig. 2 shows diagrammatically, and in part schematically, one desirable embodiment of the invention.

Like characters of reference in the two figures of the drawing designate corresponding elements or points.

With reference to the details of Fig. 1, there is shown schematically a four-wire circuit extending between a point W at the left and a point E at the right. This circuit is extended at its left end by a two-wire line L, which furnishes the connection to the station of the west subscriber, for instance, labeled SW. At the right end, the four-wire circuit is extended by a two-wire line L', which may form the circuit of a submarine cable SC. It will be understood that the connections between the four-wire circuit and the lines L and L' may be made in any suitable manner known in the art, but the scheme of Fig. 1 indicates a connection such as a hybrid coil connection involving the artificial networks N and N' designed to furnish an approximate balance with the lines L and L', respectively.

The four-wire circuit extending between points W and E comprises the two-wire path LL adapted

for transmission from west to east and the two wire path LL' adapted for transmission from east to west. The inclusion of suitable amplifying elements is indicated at A₁ and A'₁. It will be noted that the lines representing the two-wire paths LL and LL' and the extending circuits are shown in heavy line, while the connections of the transmission control apparatus are shown in light line. It will be noted, further, that the lines representing the oppositely directed two-wire paths of the four-wire circuit are broken over the intermediate portion lying between the two sets of transmission control apparatus, and it will be understood that the four-wire circuit may be very long and may have in its intermediate section hybrid coils or other arrangements which may produce unbalances. As indicated hereinabove, a circuit is contemplated which has no transmission control apparatus applied to it between the points W and E. Furthermore, it is to be understood that, for the best results, the transmission control apparatus indicated at W or E is placed at or very near the terminal of the four-wire circuit. It should be noted in connection with the disclosure of Fig. 1 that the principal transmission, such as the transmission of voice energy, takes place over the heavy line paths, while at certain points a portion of such energy is diverted to operate certain control devices such as relays. The arrowheads represent relays or equivalent devices and the crosses indicate relay controlled contacts or the equivalents. It will be understood, however, by those skilled in the art that the use of well-known devices other than relays can be resorted to within the spirit of the invention.

The essential features of the applicant's transmission control arrangement will be best understood, in connection with Fig. 1, from the following discussion of the operation of the circuits.

With reference to transmission from west to east and transmission from east to west, it will be noted that the one-way paths LL and LL' are normally disabled (or involve appreciable loss) at points a' and a, respectively. Thus, without the intervention of transmission control apparatus in response to voice energy, the incoming path at each end of the four-wire circuit is normally disabled (or the transmission thereover is subject to a considerable loss). This arrangement serves to prevent singing. When, however, waves of sufficient amplitude—for instance, those representing speech—come in at either end of the circuit, a portion of this energy is diverted at point b' (or point b) to remove the disability or loss at point a' (or point a) and thus permit the incoming voice energy or the like to reach the end of the four-wire circuit and travel on over the extending circuit L' (or L).

With reference, first, to transmission from W to E, the energy representing speech or the like travels over the two-way circuit L and divides at the point x. The useful portion of the energy travels over the one-way path LL and through the one-way amplifier A₁. If transmission in the opposite direction over path LL' has not produced the operation of transmission control apparatus affecting the point c, the west-east energy will reach the point d. At this point, a portion of the energy is diverted to operate apparatus at point e which prevents the disabling of the path LL at point c in response to later-arriving energy in the opposite path LL'. At the E end of the four-wire circuit, the west-east energy reaches the point b' and a portion of the energy is di-

verted. The diverted energy will, under any condition, provided only that it is of sufficient magnitude, remove the disability or loss normally placed on the path LL at point a', and accordingly the principal energy travels on to the point y. At that point, there is the usual division of energy. The useful portion passes on over the two-way circuit L' and into the submarine cable SC or any other circuit connected as an eastward extension of the four-wire circuit. It will be noted that the energy diverted at point b', in addition to removing the disability or loss at point a', may disable the oppositely directed path LL' at point c'. The condition attached to such operation is that energy traveling from east to west shall not already have reached the point d' and produced the disabling operation at the point e'. If such disabling operation has occurred and the effect remains, the energy diverted at point b' will have no effect on the outgoing section of path LL'; otherwise that section of the path LL' will be disabled, with the result that echoes passing through the amplifier A'₁ will not travel beyond the point c'.

It will be understood that with the symmetrical arrangement of transmission control apparatus schematically indicated in Fig. 1, the case of transmission from east to west matches that just described in connection with transmission from west to east. If the subscriber connected to the west end of the four-wire circuit has produced the disabling operation at point c', the east-west speech or the equivalent cannot, for the time being, pass beyond the point c'. If, on the other hand, the path LL' is operative at point c', a portion of the energy reaching point d' is diverted to disable at point e' the apparatus which might otherwise produce the disabling operation at point c' in response to transmission from west to east over path LL. With continued reference to voice waves or the like traveling from east to west and successfully passing the E terminal of the four-wire circuit, a portion of the energy reaching the west end of the four-wire circuit is diverted at point b; the diverted energy clears the normally disabled incoming section of path LL' at point a and also disables the opposite path LL at point c unless the disabling operation at e has taken place in response to earlier arriving energy traveling from W to E over path LL.

It will be understood from the discussion contained hereinabove that once voice energy, or the like, of magnitude sufficient to operate the transmission control apparatus has passed the near end of the four-wire circuit, it will, under any condition, reach the far end of the circuit and travel on over the extending two-wire circuit. It should be noted that, with the arrangement schematically disclosed in Fig. 1, suitable provision is made for the suppression of interfering energy traveling in either of the paths LL and LL' as a result of crosstalk or other interfering conditions due to unbalance, since such energy will normally be of magnitude insufficient to produce the false operation of the transmission control apparatus. Furthermore, since the transmission control apparatus is confined to the terminal sections of the four-wire circuit, the time required for one talker to break in after the other talker has stopped talking is reduced toward the minimum.

It remains to consider Fig. 2 of the drawing, in which there is made a more nearly complete disclosure of the transmission control apparatus by the use of diagram as well as scheme. It is

believed that the nature and connections of the transmission control apparatus will be best understood from the following description of the operation of the system.

5 It will be noted that in the path LL' at its west end, as specifically disclosed, an appreciable loss is normally inserted at the point *a* by the normally closed contact of relay R₁, which completes a shunt including a resistance *r*₁; correspondingly, the opposite path LL is normally affected at its east end at the point *a'* by the normally closed contact of relay R'₁, which completes a shunt including resistance *r'*₁. Let it be assumed that the subscriber at SW is talking and that the subscriber connected to the line L' at the opposite end of the system is silent. The voice waves reaching the four-wire circuit over line L divide in the hybrid coil H and the useful portion of the energy passes through the amplifier A₁ in the one-way path LL to point *c*. Since the circuit is unaffected at this point by any operation due to the speech of the talker at the east end of the system, the energy reaches point *d*, where a portion is diverted to operate the amplifier-detector AD₂ and the relay R₃, which is preferably slow operating. Associated with the point *c* is a potential shunt circuit which may be completed in response to voice energy originating at the east end of the system (now assumed to be absent). When relay R₃ operates, the shunt circuit is opened at point *e* and, as long as the relay remains operated, the path LL cannot be disabled at point *c*, even though energy in path LL' subsequently reaches the point *b* in that path. The energy representing the speech of the subscriber at SW, having successfully passed the west end of the path LL, travels on to the east end and reaches point *b'*. At this point, a portion of the energy is diverted to operate the amplifier-detector AD'₁ and relays R'₁ and R'₂. Between points *b'* and *a'*, there may be inserted a suitable pad, and this pad may involve an appreciable delay. The operation of relay R'₁ removes the loss at point *a'* and the principal energy passes on to the east end of the four-wire circuit, where it divides in the hybrid coil H', the useful portion passing on over the two-way circuit L'. The operation of relay R'₂ closes a contact which completes the shunt circuit across the path LL' at point *c'* provided the contact of relay R'₃ at point *e'* remains closed. If, however, the talker connected to the east end of the system begins to talk before speech energy in the opposite direction has reached point *b'*, the east-west transmission, uninterrupted at point *c'*, will produce the operation of amplifier-detector AD'₂ and the operation of relay R'₃, preferably slow operating. In response to the operation of the relay R'₃, the shunt, which may be applied at point *c'*, is broken at point *e'* and, as long as the relay remains operated, voice energy originating at the east end of the system can pass the point *c'*.

65 Energy originating at the east end of the system, which has successfully passed the E end of the four-wire circuit, will reach the west end of the circuit and pass on over the two-way circuit L. This travel is assured because of the operation of amplifier-detector AD₁ and relay R₁, resulting in the removal of the loss at point *a*. It will be noted that the operation of amplifier-detector AD₁ produces not only the operation of relay R₁ but also the operation of relay R₂. If the talker at SW holds control of the west end of path LL and relay R₃ is operated, the west end

of the path LL remains in operative condition, since the potential shunt circuit is broken at point *e*. If, however, the relay R₃ is not operated, the operation of relay R₂ will result in the completion of the shunt circuit and the west-east path LL will be disabled at point *c*. Between points *b* and *a* in path LL', there may be inserted a suitable pad, corresponding to that mentioned hereinabove in connection with path LL.

While the invention has been disclosed somewhat specifically for the purpose of illustration, it will be understood that its scope is not limited thereby but is determined by the appended claims, and the reader is reminded that there may be a departure from the symmetrical arrangement of the transmission control apparatus disclosed in the drawing without a departure from the spirit of the invention. For instance, in the system shown, including a four-wire circuit extended at W by a land line and at E by a submarine cable, the transmission control apparatus at W may be substantially as disclosed while the transmission control apparatus at E may be of a different type. In other words, the invention resides not only in the use of the transmission control apparatus with the duplication specifically shown but also in the use of the apparatus at one terminal or in combination with different apparatus at the distant terminal.

What is claimed is:

1. In a two-way system for the transmission of energy, comprising two separated stations connected by two paths adapted for transmission in opposite directions, the method of transmission control which consists in normally introducing an appreciable loss in one of said paths near the receiving end thereof, causing the energy approaching the receiving end of said path to remove said loss therefrom independently of the presence or absence of energy in the opposite path, and causing said first-mentioned energy to disable the transmitting section of the opposite path provided said opposite path is not carrying energy of earlier arrival.

2. In a two-way system for the transmission of energy, comprising two separated stations connected by two paths adapted for transmission in opposite directions, the method of transmission control which consists in normally introducing an appreciable loss in each path near its receiving end, causing the energy approaching the receiving end of either path to remove said loss therefrom independently of the presence or absence of energy in the opposite path, and causing the energy approaching the receiving end of either path to disable the transmitting section of the opposite path provided said opposite path is not carrying energy of earlier arrival.

3. In a two-way system for the transmission of energy, comprising two separated stations connected by two paths adapted for transmission in opposite directions, the method of transmission control which consists in introducing an appreciable loss in each path near its receiving end, causing the energy approaching the receiving end of either path to remove said loss therefrom independently of the presence or absence of energy in the opposite path, and causing the energy approaching the receiving end of one of said paths to disable the transmitting section of the opposite path provided said opposite path is not carrying energy of earlier arrival.

4. In a two-way telephone circuit including paths adapted for transmission in opposite directions, the method of transmission control

which consists in normally introducing an appreciable loss in one of said paths near the receiving end thereof, causing the voice waves which approach the receiving end of said path to remove said loss therefrom independently of the presence or absence of voice waves in the opposite path, and causing said first-mentioned voice waves to disable the transmitting end of the opposite path provided said opposite path is not carrying voice waves of earlier arrival.

5. In a two-way telephone circuit including paths adapted for transmission in opposite directions, the method of transmission control which consists in normally introducing an appreciable loss in each of said paths near the receiving end thereof, causing the voice waves approaching the receiving end of either path to remove said loss therefrom independently of the presence or absence of voice waves in the opposite path, and causing the voice waves approaching the receiving end of either path to disable the transmitting end of the opposite path provided said opposite path is not carrying voice waves of earlier arrival.

6. In a two-way telephone circuit including paths adapted for transmission in opposite directions, the method of transmission control which consists in normally introducing an appreciable loss in each of said paths near its receiving end, causing the voice waves approaching the receiving end of either path to remove said loss therefrom independently of the presence or absence of voice waves in the opposite path, and causing the voice waves approaching the receiving end of one of said paths to disable the transmitting end of the opposite path provided said opposite path is not carrying voice waves of earlier arrival.

7. In a two-way system for the transmission of signal energy, comprising two separate stations connected by two paths adapted for transmission in opposite directions, the method of transmission control which consists in normally introducing an appreciable loss in one of said paths near its receiving end, causing signal waves traveling over the transmitting end of said path to pass on to the receiving end thereof only if such waves pass said transmitting end before the arrival of signal waves at the receiving end of the opposite path, and causing all signal waves which pass the transmitting end section and approach the receiving end of said first-mentioned path to remove said loss therefrom.

8. In a two-way system for the transmission of signal energy, comprising two separated stations connected by two paths adapted for transmission in opposite directions, the method of transmission control which consists in normally introducing an appreciable loss in each of said paths near its receiving end, causing the signal waves traveling over the transmitting end of either path to pass on toward the receiving end thereof only if such waves pass said transmitting end before the arrival of signal waves at the receiving end of the opposite path, and causing all signal waves which pass the transmitting end section and approach the receiving end of either path to remove the loss normally introduced therein.

9. In a two-way system for the transmission of energy, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, means associated with the receiving section of one of said paths

for normally introducing an appreciable loss therein, means whereby energy approaching said receiving section will remove said loss therefrom independently of the presence or absence of energy in the opposite path, and means whereby said first-mentioned energy will disable the transmitting section of the opposite path provided said transmitting section is not carrying energy of earlier arrival.

10. In a two-way system for the transmission of energy, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, means associated with the receiving section of each of said paths for normally introducing an appreciable loss therein, means associated with the receiving section of each of said paths whereby energy approaching said section will remove said loss therefrom independently of the presence or absence of energy in the opposite path, and means whereby energy reaching the receiving section of either path will disable the transmitting section of the opposite path provided said transmitting section is not carrying energy of earlier arrival.

11. In a two-way system for the transmission of energy, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, means associated with the receiving section of each of said paths for normally introducing an appreciable loss therein, means whereby energy reaching the receiving section of either of said paths will remove said loss therefrom independently of the presence or absence of energy in the opposite path, and means whereby energy reaching the receiving section of one of said paths will disable the transmitting section of the opposite path provided said transmitting section is not carrying energy of earlier arrival.

12. In a two-way telephone system, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, and transmission control apparatus near one end of the system comprising means for normally introducing an appreciable loss in the receiving section of the incoming path, means responsive to voice waves coming in over said receiving section for removing said loss therefrom independently of the presence or absence of voice waves in the oppositely-directed path, and means responsive to said incoming voice waves for disabling the transmitting section of the oppositely directed path provided said transmitting section is not carrying voice waves of earlier arrival.

13. In a two-way telephone system, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, and transmission control apparatus at each station comprising means for normally introducing an appreciable loss in the receiving section of the incoming path, means responsive to voice waves coming in over said receiving section for removing said loss independently of the presence or absence of voice waves in the opposite path, and means responsive to said incoming voice waves for disabling the transmitting section of the opposite path provided said transmitting section is not carrying oppositely directed voice waves of earlier arrival.

14. In a two-way telephone system, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, means near the receiving end of each of said paths for normally introducing an appreciable

able loss therein, means responsive to voice waves reaching the receiving section of either path for removing said loss therefrom independently of the presence or absence of voice waves in the opposite path, and means responsive to voice waves reaching the receiving section of one of said paths for disabling the transmitting section of the opposite path provided said transmitting section is not carrying voice waves of earlier arrival.

15. In a two-way telephone system, a four-wire circuit having paths adapted for transmission in opposite directions; transmission control apparatus near one end of said four-wire circuit comprising means for normally introducing an appreciable loss in the incoming path, means responsive to incoming voice waves for removing said loss from the incoming path independently of the presence or absence of voice waves in the opposite path, and means responsive to the incoming voice waves for disabling the transmitting section of the opposite path provided said section is not carrying voice waves of earlier arrival; a two-way line connected in extension of said four-wire circuit at one end thereof, and a submarine cable circuit connected in extension of said four-wire circuit at the other end thereof.

16. In a two-way telephone system, a four-wire circuit having paths adapted for transmission in opposite directions; apparatus near each end of said four-wire circuit comprising means for normally introducing an appreciable loss in the incoming path, means responsive to incoming voice waves for removing said loss from the incoming path independently of the presence or absence of voice waves in the opposite path, and means responsive to the incoming voice waves for disabling the transmitting section of the opposite path provided said transmitting section is not carrying voice waves of earlier arrival; a two-way line connected in extension of said four-wire circuit at one end thereof, and a submarine cable circuit connected in extension of said four-wire circuit at the other end thereof.

17. In a two-way telephone system, a four-wire circuit having paths adapted for transmission in opposite directions, means near each end of said four-wire circuit for normally introducing an appreciable loss in the incoming path, means near each end of said four-wire circuit for removing said loss from the incoming path in response to voice waves coming in over said path independently of the presence or absence of voice waves in the opposite path, means responsive to the incoming voice waves at one end of the four-wire circuit for disabling the outgoing section of the

opposite path provided said outgoing section is not carrying voice waves of earlier arrival, a two-way line connected in extension of said four-wire circuit at one end thereof and a submarine cable circuit connected in extension of said four-wire circuit at the other end thereof.

18. In a two-way telephone system, a four-wire circuit having two paths adapted for transmission in opposite directions, a two-wire circuit connected in extension of said four-wire circuit at each end thereof, means whereby voice waves applied to one end of the four-wire circuit will pass on to the opposite end of said circuit only in the absence of the earlier arrival at the first end of voice waves traveling in the opposite direction, means whereby voice waves which pass either end section of the four-wire circuit will under all conditions reach the opposite end of said circuit, and means whereby crosstalk echoes will be prevented from traveling the full length of the four-wire circuit.

19. In a two-way transmission system, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, means associated with the receiving section of each of said paths for normally introducing an appreciable loss in said section, means whereby energy reaching the receiving section of either of said paths will remove said loss therefrom independently of the presence or absence of energy in the opposite path, means responsive to energy reaching the receiving section of one of said paths for closing a circuit designed to disable the transmitting section of the opposite path, and means responsive to earlier arriving energy in said transmitting section for opening said circuit.

20. In a two-way telephone system, two separated stations, two paths connecting said stations and adapted for transmission in opposite directions, means associated with the receiving section of each of said paths for normally introducing an appreciable loss in said section, means responsive to voice waves reaching the receiving section of either of said paths for removing the loss normally introduced therein independently of the presence or absence of voice waves in the opposite path, means responsive to voice waves reaching the receiving section of either of said paths for closing a circuit designed to disable the transmitting section of the opposite path, and means responsive to earlier arriving voice waves in said transmitting section for opening said circuit.

LEONARD GLADSTONE ABRAHAM.