

May 8, 1934.

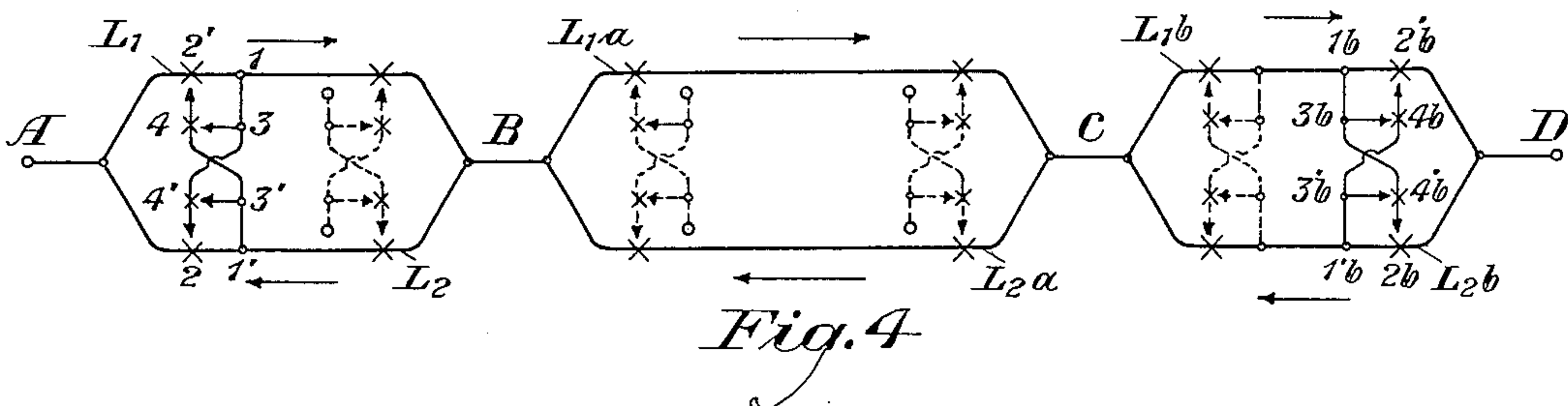
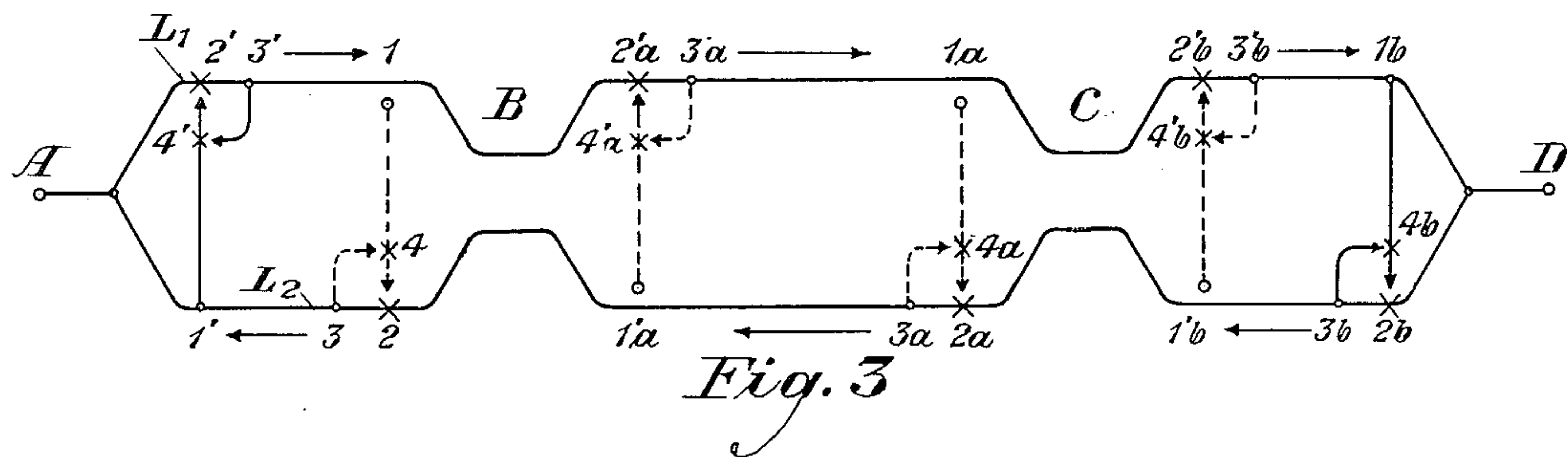
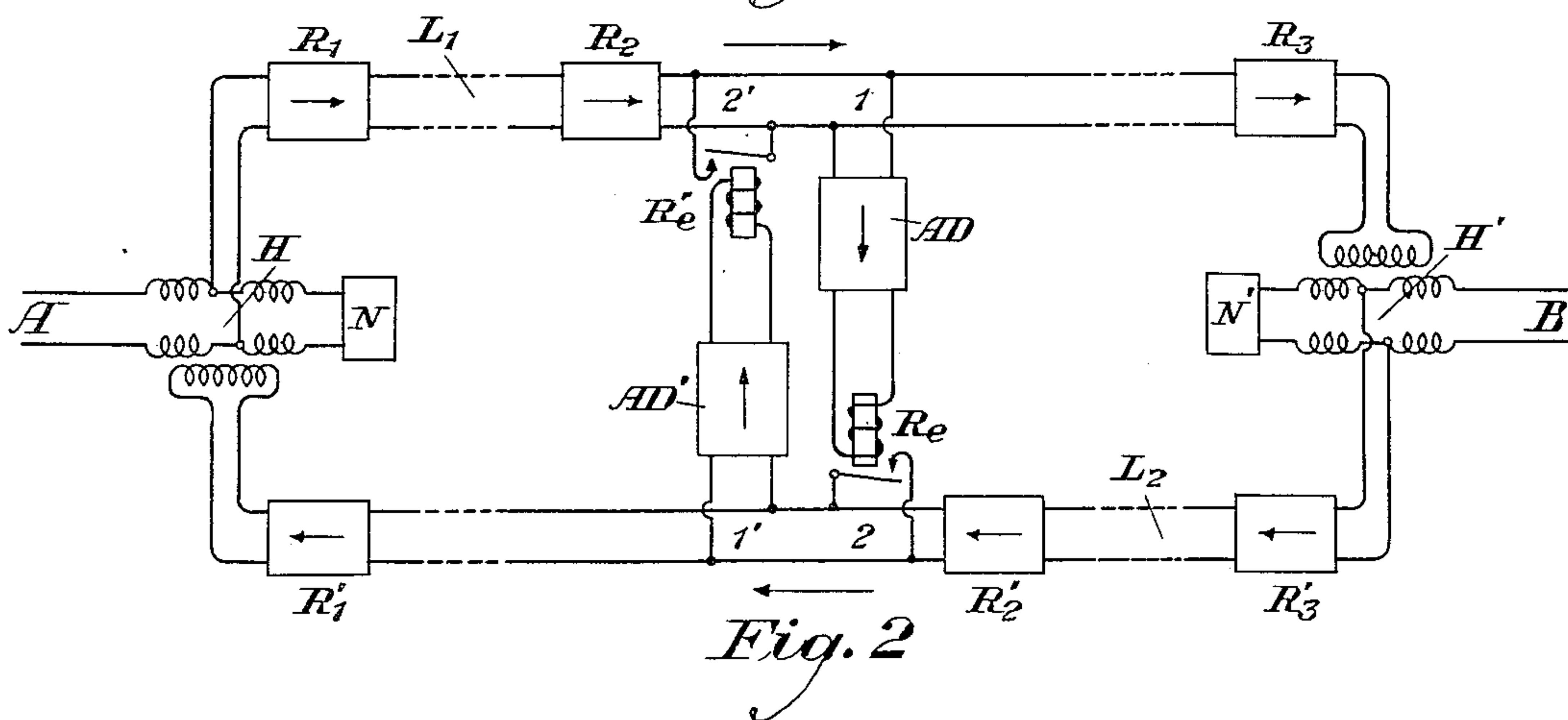
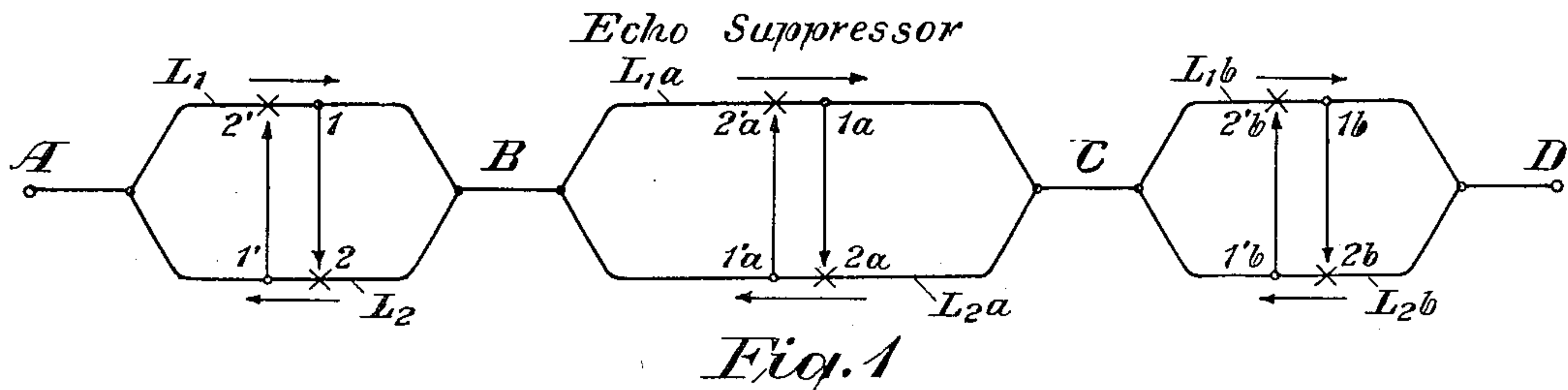
S. B. WRIGHT ET AL

1,957,571

ECHO SUPPRESSOR

Filed Jan. 14, 1933

2 Sheets-Sheet 1



INVENTORS
S. B. Wright, D. Mitchell
 BY *L. G. Abraham*
 ATTORNEY

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ECHO SUPPRESSOR

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2 Sheets-Sheet 2

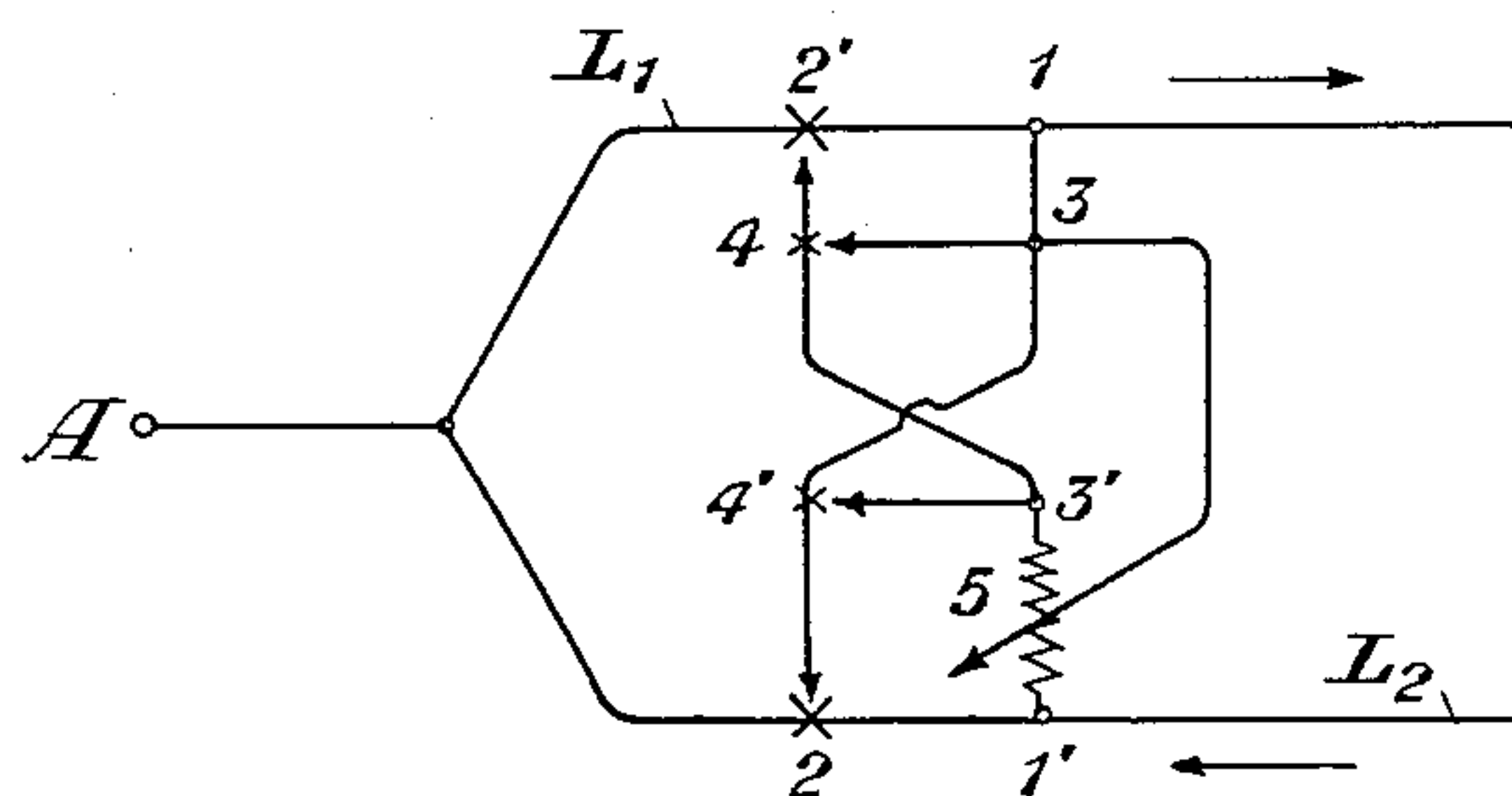


Fig. 5

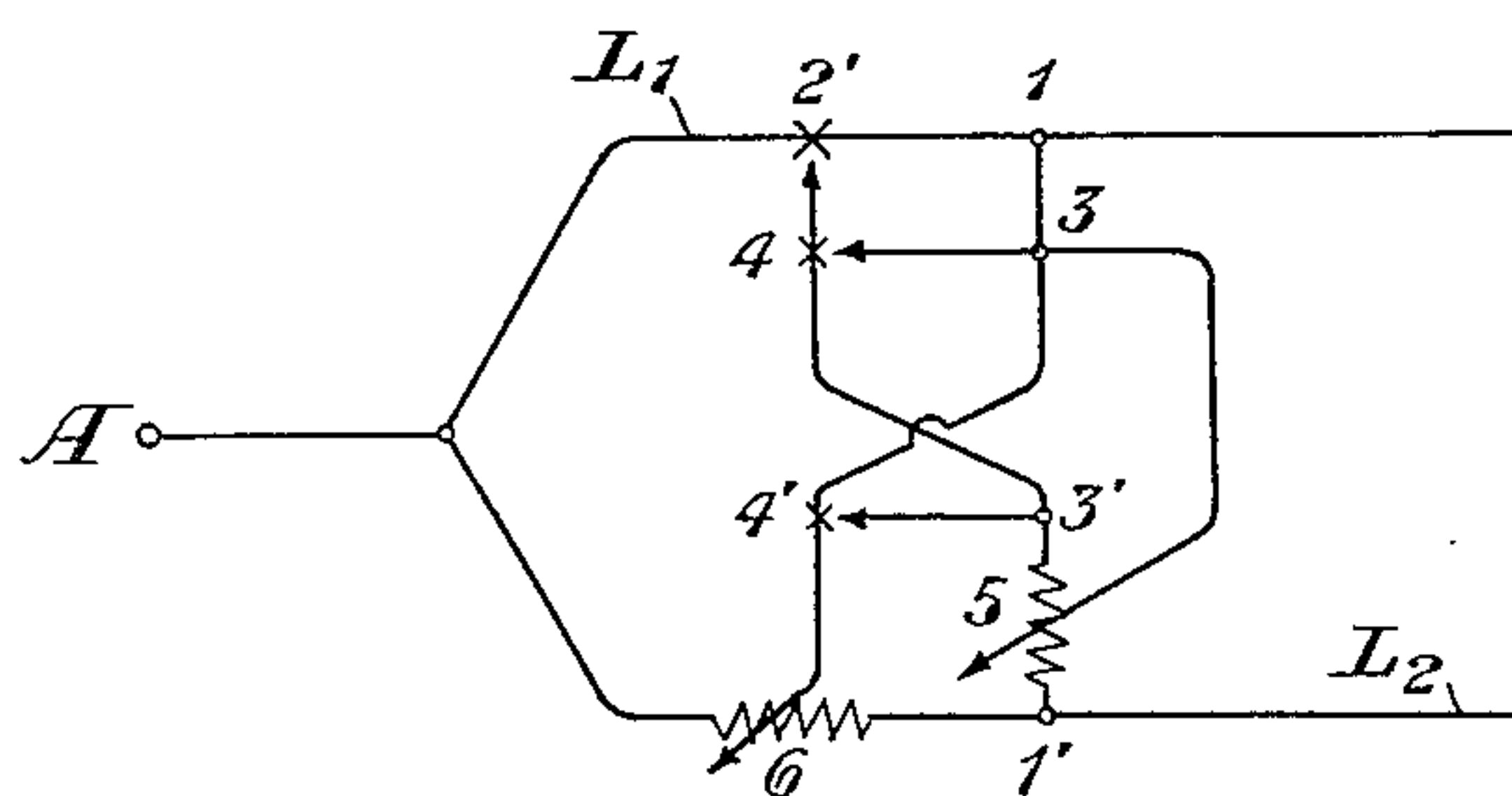


Fig. 6

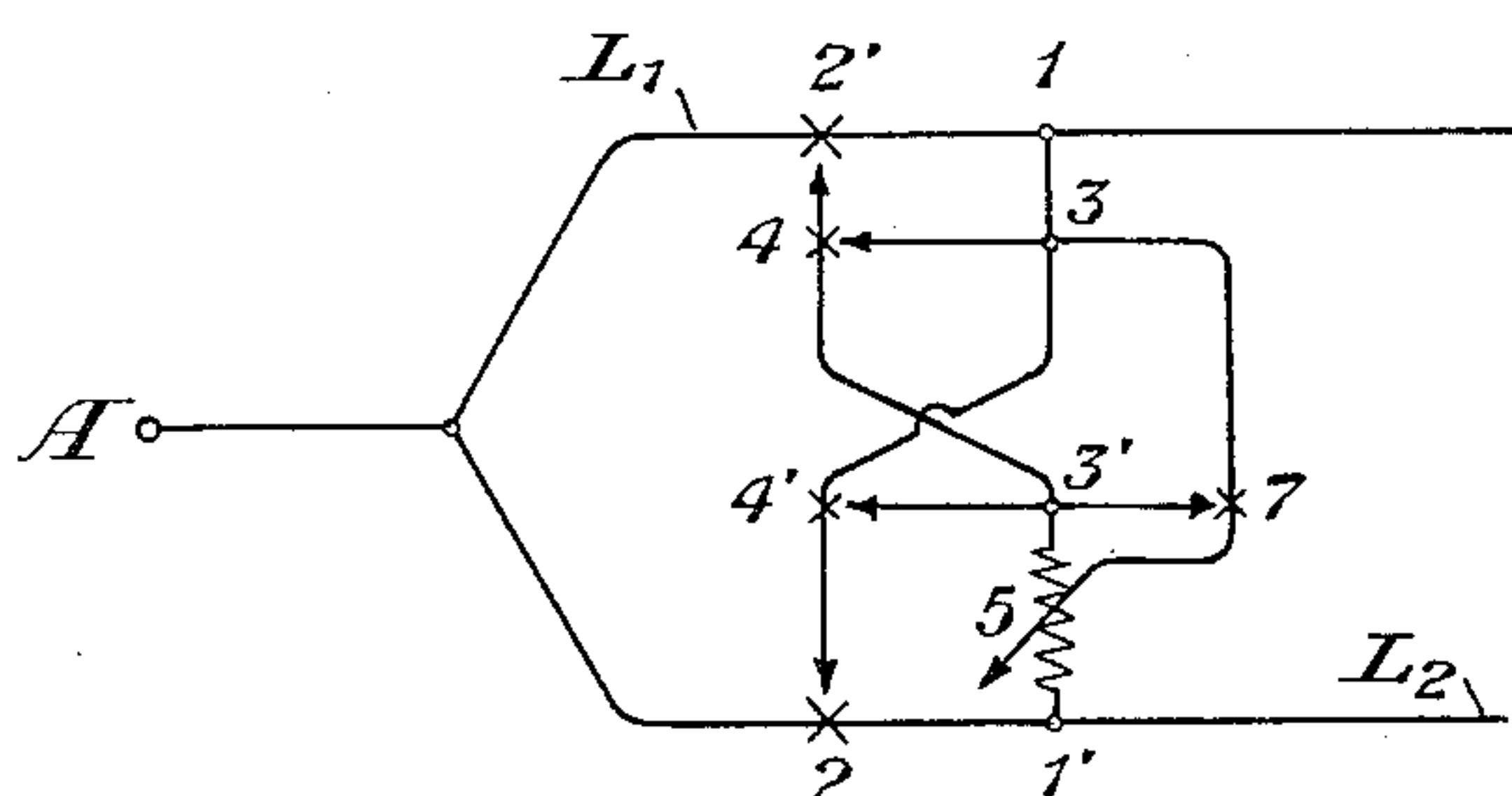


Fig. 7

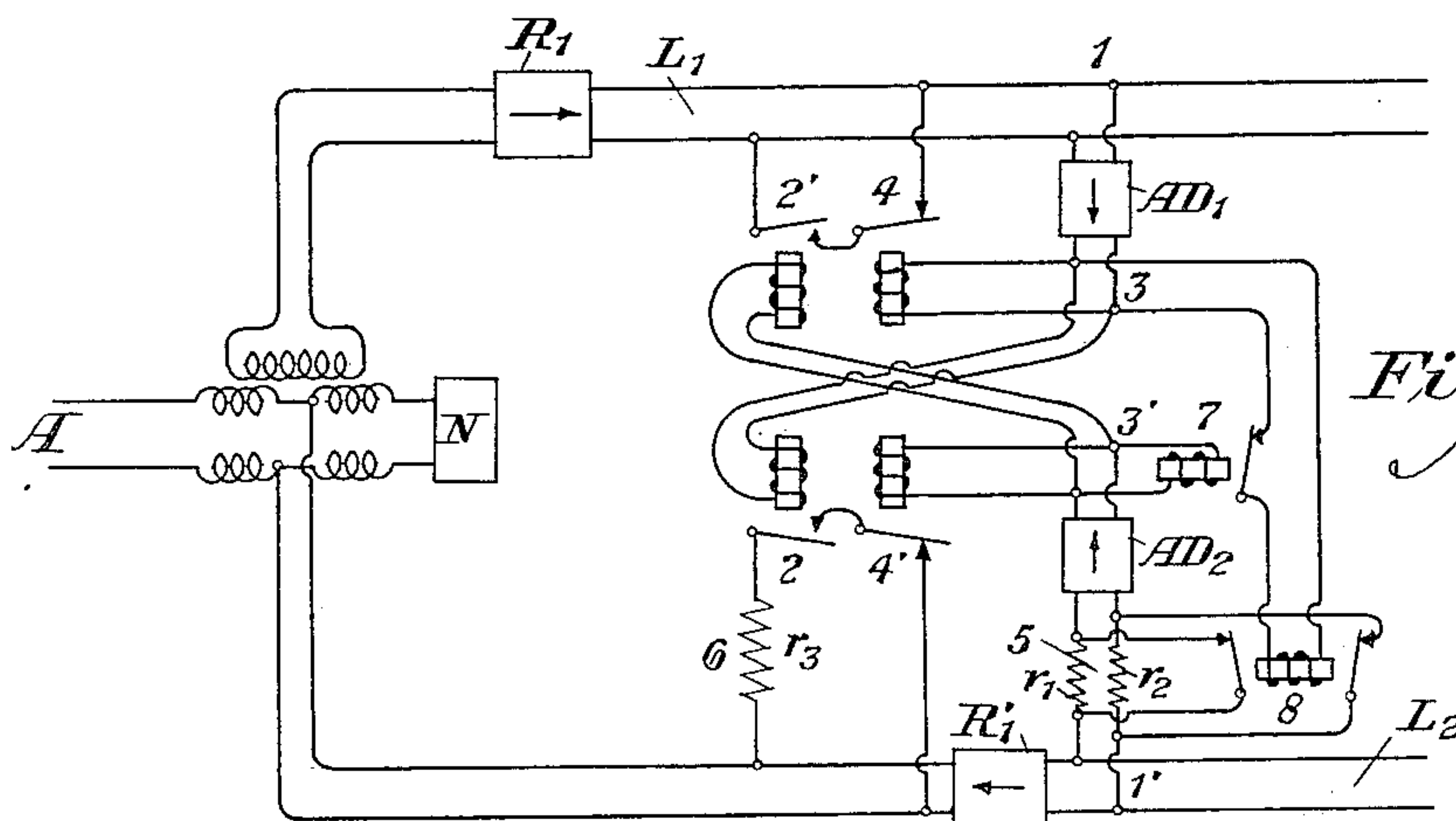


Fig. 8

INVENTORS
S.B. Wright, D. Mitchell and
 BY *L.G. Abraham*
 ATTORNEY

UNITED STATES PATENT OFFICE

1,957,571

ECHO SUPPRESSOR

Sumner B. Wright, South Orange, Doren Mitchell, Martinsville, and Leonard G. Abraham, Madison, N. J., assignors to American Telephone and Telegraph Company, a corporation of New York

Application January 14, 1933, Serial No. 651,812

8 Claims. (Cl. 179—170)

This invention relates to telephone transmission systems and particularly to systems and particularly to systems involving long four-wire circuits equipped with echo suppressors.

In the operation of long-distance telephone systems it is frequently necessary to build up long circuits by connecting two or more four-wire circuits in tandem. The connection between two four-wire circuits may be effected by a four-wire junction in which the terminal apparatus at the adjacent ends of the two four-wire circuits is removed and each conductor of one circuit connected to a corresponding conductor of the other, thus, in effect, establishing a single four-wire circuit of great length, or the two two-wire terminals of the long four-wire circuits may be joined by two conductors. These methods of connection are well known to those familiar with the telephone art. In some cases it may be required to connect in tandem two four-wire circuits which do not terminate at the same office, the connection being effected by means of an intermediate two-wire link.

If the four-wire circuits are both equipped with echo suppressors there arises the possibility that lockout may occur. Lockout occurs when the talkers at the two ends of the circuit begin to speak at approximately the same time so that each takes control of the echo suppressor nearest to his own end and prevents the passage of waves from the other end. Under such conditions each person talks without knowing that the other does not hear him, which results in confusion and loss of time.

"Terminal type" echo suppressing devices arranged to avoid this difficulty have been disclosed by L. G. Abraham in his Patent No. 1,826,196 issued October 6, 1931 and in his application Serial No. 512,441 filed January 30, 1931, and by G. Crisson in his application Serial No. 512,442 filed January 30, 1931, which have been assigned to the assignee of this application.

The operation of the arrangements disclosed in the applications, mentioned above, is subject to limitations due to the fact that certain relays should respond to the arrival of speech waves over the circuit but must not respond to waves due to echoes arising in intermediate parts of the circuit. It is the object of this invention to provide means whereby these limitations may be removed or made less burdensome. These limitations and the means for overcoming them will be more easily understood from the following description when read in connection with the accompanying drawings.

Figures 1 and 3 of the drawings are single-line functional diagrams illustrating the present state of the art and showing how the performance of known types of echo suppressors is limited. Fig. 2 is a more detailed diagram used to explain the single-line diagrams. Fig. 4 is a single-line diagram illustrating the use of a proposed type of echo suppressor. Figs. 5, 6 and 7 are single-line diagrams showing various aspects of the present invention. Fig. 8 is a detailed diagram used in connection with Figs. 5, 6 and 7.

In the single-line diagrams the heavy lines represent transmission paths such as the separate sides of a four-wire circuit or as a two-wire connecting link. The light arrows parallel to the transmission paths indicate the direction of transmission. The remaining arrow-headed lines indicate control paths such that when waves arrive at a point in a transmission path marked by the tail of a control path arrow a mechanism is operated which produces a controlling effect such as a short-circuit or a change of transmission loss at a point in some other transmission or control path indicated by the head of the arrow. This head points to a symbol indicating the effect to be produced and the point at which it is to occur.

In Fig. 1 is shown a commonly used arrangement in which two or more four-wire circuits are connected in tandem. Three four-wire circuits extending from station A to station B, from B to C and from C to D, respectively, are joined by means of two-wire connections to form a circuit extending from A to D. Each four-wire circuit is equipped with a "central type" echo suppressor, that is, an echo suppressor designed to be applied to the circuit at a point intermediate between and at some distance from the ends of the circuit. For an extended description of such devices reference is made to an article by A. B. Clark and R. C. Mathes entitled "Echo Suppressors for Long Telephone Circuits" which was published in the Journal of the American Institute of Electrical Engineers Vol. XLIV, pp. 618-626, for June 1925. In order, however, to make the meaning of the diagram of Fig. 1 more clear, one of the four-wire circuits, for example, the one extending from A to B, is shown in greater detail in Fig. 2.

The upper heavy line L_1 of Fig. 1 indicates the one-way path of the circuit of Fig. 2 extending from A to B and equipped with one-way amplifiers or repeaters R_1 , R_2 , etc. at suitable intervals. These amplifiers are connected so that they amplify waves passing from A to B as indicated by

the arrows. Similarly the line L_2 of Fig. 1 indicates the two-wire circuit adapted to transmit signal waves from B to A. L_1 and L_2 constitute the two sides of the four-wire circuit. At A and B the ends of L_1 and L_2 are connected to the two-wire extensions through the hybrid coils H and H', respectively, in a well-known manner. The extensions are balanced more or less perfectly by the networks N and N' to reduce the transfer of energy from L_2 to L_1 at A and from L_1 to L_2 at B. The echo suppressor is located at an intermediate station between A and B. The echo suppressor consists of amplifier-detectors AD and AD' which control relay devices R_e and $R_{e'}$, respectively. These amplifier-detectors and relays may be of any suitable type.

When a voice wave traveling from A to B over the side L_1 reaches the point 1 a small portion of its energy is diverted to actuate the amplifier-detector AD which operates the relay R_e thus short-circuiting or otherwise disabling the line L_2 at the point 2. This is indicated by the control arrow 1—2 on Fig. 1. The two arrow-heads, touching each other, in line L_2 at which the arrow-head of the control path 1—2 points indicate that the line L_2 is disabled at this point as a result of the passage of waves at the point 1 in the line L_1 . The disabling of the line L_2 prevents the return to station A of echoes of waves in the line L_1 which occur since the network at station B does not perfectly balance the two-wire line. In addition to suppressing echoes in the line L_2 the relay R_e of Fig. 2 also prevents the operation of amplifier-detector AD' so that these echoes cannot cause unwanted operation of the relay $R_{e'}$. The relay R_e thus combines the functions of an echo suppressor in the line L_2 and a disabler of the amplifier-detector AD'. Similarly the passage of waves from B to A over the line L_2 disables the line L_1 at 2' and so prevents the passage of echoes from A to B and also disables the amplifier-detector AD.

The four-wire circuits extending from B to C and from C to D are like that from A to B in all essential particulars so that no further description of them is deemed necessary.

If the subscriber at station A speaks, his voice waves travel from A to D, over lines L_1 , L_{1a} and L_{1b} disabling lines L_2 , L_{2a} and L_{2b} at 2, 2a and 2b, respectively, thus suppressing all echoes. The suppressor relays are made slow to release, sufficient "hangover" being provided so that echoes returning from point B, for example, to point 2 after the voice waves have passed point 1 will be suppressed.

Similarly if the subscriber at D speaks, the lines L_1 , L_{1a} and L_{1b} are disabled at 2', 2'a and 2'b.

Because of the distances separating the suppressors shown in Fig. 1 an appreciable time will elapse between the arrival of voice waves from the subscriber at A at the point 1, which gives control of the suppressor between A and B to this subscriber, and the arrival of the waves at 1b, which gives him control of the whole circuit. If the subscriber at D speaks at nearly the same instant as the subscriber at A it is possible for the waves from D to operate the suppressor in the line from C to D while the waves from A operate the suppressor in the line from A to B so that neither subscriber can hear the other and each continues to talk. This condition, which is called "lockout", continues till one subscriber pauses long enough to release the suppressor nearest to him and so permit the

voice of the other subscriber to come through. Lockout may be the cause of much confusion and loss of time. The frequency with which lockouts occur and the disturbing effect of each lockout increase rapidly as the time of transmission between the echo suppressors nearest to the subscribers increases.

In order to avoid lockout it has been proposed to use the arrangement shown in Fig. 3. The echo suppressors used here are of the "terminal type" disclosed in the patent to L. G. Abraham cited above. In this arrangement the echo suppressor apparatus is divided and placed near the two ends of the four-wire circuit. Consider first the four-wire circuit extending from station A to station B. At station A is provided a suppressor which is operated by waves reaching the point 1' over the line L_2 to disable line L_1 at the point 2' and a disabler which responds to waves at the point 3' in line L_1 to disable the suppressor but which does not interfere with the passage of waves from line L_2 toward A. A similar arrangement is provided at station B as indicated by the dotted control paths 1—2 and 3—4. The other four-wire circuits are similarly equipped with suppressor apparatus at each end. The four-wire circuits are joined at the intermediate offices by four-wire connections. When this is done the echo suppressing apparatus at the intermediate offices is removed or made inoperative, which is indicated in Fig. 3 by the use of dotted lines. This is done to avoid the possibility of lockout occurring by the subscriber at A gaining control of all the apparatus on the circuit from A to B while subscriber at D gains control of the apparatus on the circuit from C to D. In effect the result is to provide a continuous four-wire circuit from A to D with echo suppressing apparatus only at the ends. Lockout cannot occur in this system because the voice waves from the subscriber at one end cannot disable the return path until these waves have traveled to the other end and taken control of the whole system. If both subscribers speak at nearly the same time each disables the suppressor at his own end of the circuit which permits the voice waves to pass freely in both directions. This system, however, will not suppress echoes arising at intermediate points in the circuit. For example, if conditions exist at station B such that when the subscriber at A speaks part of the energy of his voice waves is transferred from line L_1 to L_2 this energy will return to A where it will be heard as an echo. If it is strong enough this echo will tend to operate the suppressor at A and so break up the transmission from A toward B. Powerful echoes may arise when it is necessary to use hybrid coils at intermediate points because of the difficulty of securing a high degree of balance between the network and the line or apparatus connected to the two-wire terminal. Such conditions arise when provision has not been made for using four-wire connections or when an intermediate length of two-wire circuit must be used.

Suppression of intermediate echoes may be accomplished by the use of a "double terminal echo suppressor" of the type disclosed by Crisson in his application cited above.

Fig. 4 shows three four-wire circuits each equipped at each end with this type of suppressor, and connected in tandem by two-wire connections. The echo suppressing apparatus at the intermediate stations is put out of opera-

tion so that lockout cannot occur at the intermediate points.

Assuming first that no speech is being transmitted in either direction, all the apparatus will be in the normal or unoperated state. If now the subscriber at A speaks, his voice waves pass over the lines L_1 , L_{1a} and L_{1b} to the listener at D. At 1 these waves act upon the suppressor to operate the relays at 2 and 4, thus disabling line L_2 and the relay 2'. At 1b they cause the operation of 2b and 4b thus disabling the line L_{2b} and the relay 2'b. The operation of the relay 2b prevents the return of echoes from the terminal at D, but other echoes which do not pass the relay 2b will be returned from the switching points B and C due to the imperfect balance of the hybrid coils. Echoes may also be returned from other intermediate points where there is coupling of some sort between the two lines. The relay 2, having disabled line L_2 , keeps these intermediate echoes from the subscriber at A and the relay 4 keeps them from operating relay 2' and so prevents interruption of the outgoing waves. Similarly, if the subscriber at D speaks, the apparatus being initially in the normal state, his voice waves operate relays 2'b, 4'b, 2' and 4', suppressing echoes from the terminal at A and intermediate points and disabling relays 2b and 2.

If the subscriber at A speaks, operating relays 2 and 4 but before his voice waves reach the apparatus at D the subscriber at D begins to talk, operating relays 2'b and 4'b, a condition will be established in which voice waves are travelling in both directions at the same time. When the waves from D reach the point 1' in line L_2 the relay 4' will operate, disabling relay 2 which at once returns to normal, and permits these waves to reach the terminal at A. Relay 2' being disabled cannot interfere with the transmission of speech over line L_1 . Similarly when the waves from A reach the point 1b in line L_{1b} they operate the relay 4b, disabling relay 2'b and so permitting the waves to reach the terminal at D but they cannot operate relay 2b. By this action the transmission of waves in both directions at the same time is permitted and lockout is avoided. For this system to function satisfactorily it is obvious that the relay 4' at station A must always operate in response to waves from station D and that relay 2' must also operate unless it is disabled through the operation of relay 4. On the other hand, relays 4' and 2' must not be operated by noise or by echoes from intermediate points. Similar requirements also apply to the corresponding relays at D. Under certain conditions as, for example, when the intermediate connections are of the two-wire type the echoes tending to operate falsely the relays 4' and 2' may be much more powerful than the steady noise on the circuit. The relays 4' and 2' must be made so insensitive, that they will not operate on the loudest echo. This may mean that they will respond only to the more powerful voice waves from station D or may even fail to respond at all. This condition defeats wholly or in part the ability of the system to prevent lockouts.

The present invention provides means for overcoming wholly or in part these limitations upon the operation of the double terminal echo suppressor. Figs. 5, 6 and 7 illustrate certain forms that the invention may assume. These figures show the arrangements to be used at one end of the circuit. The apparatus at the other end is exactly like that shown so that separate

description is not thought to be necessary. Referring to Fig. 5 the zigzag line 5 is a symbol representing a device which causes a transmission loss between the points 1' and 3'. This device may be of any suitable type, one of which will be described later. It is of such a nature that normally the loss between the points 1' and 3' is zero or relatively low, but when speech waves traverse the line L_1 , the loss increases to a suitable value.

The relays 4' and 2' and the device 5 are so adjusted that they will not be operated by the noise normally present in this line. They will thus respond promptly to any voice waves which are substantially above the normal noise in magnitude. Most voice waves in a telephone circuit are stronger than the noise.

When the subscriber at A speaks, his voice waves tend to increase the loss of the device 5. If the voice is so weak that there is no danger that the echoes will operate the relays 4' and 2' the device 5 does not respond, but as the strength of the voice, and consequently, of the echoes increases a loss is introduced which is sufficient to prevent the operation of the relays by the echoes. The mechanism which controls this loss must have sufficient hangover, that is, time required to release, so that the echoes from the most distant points will have died out before the loss returns to its normal value. In order that the distant subscriber may make himself heard at A it is, of course, now necessary for him to talk loud enough to operate the relay 4' in spite of the increased loss. This arrangement thus avoids the danger of false operation and at the same time interferes to the least possible degree with the ability of the distant subscriber to break through and make himself heard if he desires to interrupt the subscriber at A. When the subscriber at A is not talking there is no appreciable interference with the distant subscriber and when A is talking the interference exists only for the time and to the degree required to avoid the false operation by echoes.

Fig. 6 shows a modified form of the invention in which a second variable loss 6 is substituted for the suppressor relay 2 of Fig. 4. The device 6 normally introduces no loss or a relatively small loss but when the subscriber at A begins to talk the loss introduced by the device 6 increases to such an extent that the echoes from the intermediate points of the circuit cease to be annoying to the subscriber. By this arrangement voice waves from the distant station are somewhat weakened but are not suppressed completely if they arrive while the subscriber at A is talking. In this way the distant subscriber has a chance to make himself heard even though his voice is not sufficiently powerful to operate the disabler relay 4' through the loss 5.

Fig. 7 shows a further modification of the invention. This arrangement is the same as that shown in Fig. 5 except that an additional relay 7 had been added, the function of which is to disable the control of the device 5. As in the case of Fig. 5 when the subscriber at A speaks the relays 2 and 4 respond and if the speech is strong enough the device 5 operates to insert a loss and prevent false operation of the relays 2', 4' and 7 by echoes. The device 5 must have sufficient hangover to protect these relays from the echoes from the most distant points, which may involve a delay of several tenths of a second. On shorter connections this long hangover might cause some difficulty when the distant subscriber begins to talk. The relay 7, however, acts as soon as the

voice waves from the distant subscriber attain sufficient volume to operate it, and immediately restores the device 5 to its normal condition. Once the relay 7 has operated these waves have the same degree of control over the relay 4' that they would have if the subscriber at A had not been talking, which increases the ability of the distant subscriber to make himself heard if he desires to interrupt the subscriber at A.

10 The invention resides in the use of the loss producing devices 5 and 6 of Figs. 5, 6 and 7 and the relay 7 in Fig. 7 in the manner disclosed and does not depend in any degree upon the particular type of apparatus used to produce the loss of the type of relay used. There are many suitable devices well known in the art. Fig. 8 shows, in some detail, one arrangement which may be used in practicing the invention. The reference characters used on this figure correspond to those used on the other figures. The loss producing device 5 of Figs. 5, 6 and 7 consists of the resistances r_1 and r_2 in series with the input terminals of the amplifier-detector AD₂ which controls the suppressor relay 2' and the disabler relay 4' whose functions will be understood from the preceding description. The loss producing device 6 of Fig. 6 consists of resistance r_3 , which acts as a shunt on line L₂ when relay 2 is operated and relay 4' is non-operated. The resistances r_1 and r_2 are normally short-circuited by the back contacts of the relay 8. The operating winding of the relay 8 is connected through the back contact of the relay 7 to the output of the amplifier-detector AD₁. When the subscriber at the terminal A speaks, his voice waves act upon the amplifier-detector AD₁ the output current of which operates the relays 2 and 4. If the waves are strong enough to produce echoes which can operate the relays 2' and 4' associated with the amplifier-detector AD₂ the relay 8 will operate, removing the short circuits from the resistances r_1 and r_2 and so introducing enough loss between the point 1 on the line L₂ and the amplifier-detector AD₂ to prevent its response to the echoes. If voice waves arrive over the line L₂ in sufficient strength to cause the operation of the relay 7 the operating circuit of relay 8 will be opened at the back contact of relay 7, and relay 8 will release, short-circuiting the resistances r_1 and r_2 and restoring the input circuit of the amplifier-detector AD₂ to its normal condition.

The resistance r_3 of Fig. 8 may be used if it is desired to cause a transmission loss in the line L₂ as described in connection with Fig. 6 instead of completely disabling it. When the subscriber at A speaks, his voice waves operate the amplifier-detector AD₁ which in turn operates the relays 2 and 4. The relay 2 closes a shunt path, including the resistance r_3 , across the line L₂ which causes the desired loss. If r_3 is made zero this shunt path becomes a short-circuit and completely disables the line L₂. Similarly part of the output current of amplifier-detector AD₁ might be used to control the grid voltage of one or more tubes in an amplifier in the receiving branch of the circuit at 6.

The scope of this invention is defined in the following claims.

What is claimed is:

70 1. In a two-way telephone circuit including paths adapted for transmission in opposite directions, apparatus relatively near each end of the circuit comprising means responsive to voice waves in the incoming path for disabling the outgoing path, means responsive to voice waves

in the outgoing path for disabling the incoming path, means responsive to voice waves in the outgoing path for preventing the disabling of said path by later arriving voice waves in the incoming path and means responsive to voice waves in the incoming path for preventing the disabling of said path and for restoring the same to operative condition if it be already disabled, the method of transmission control which consists in causing waves in the transmitting path of greater than a predetermined magnitude to prevent the operation of said last mentioned means by echoes from intermediate points in the circuit and at the same time allowing said means to be operated by incoming speech waves provided they are of sufficient magnitude.

2. In a two-way telephone circuit including paths adapted for transmission in opposite directions, apparatus relatively near each end of the circuit comprising means responsive to voice waves in the incoming path for disabling the outgoing path, means responsive to voice waves in the outgoing path for disabling the incoming path, means responsive to voice waves in the outgoing path for preventing the disabling of said path by later arriving voice waves in the incoming path and means responsive to voice waves in the incoming path for preventing the disabling of said path and for restoring the same to operative condition if it be already disabled, the method of transmission control which consists in effectively preventing the operation of said last mentioned means by echoes of the transmitted speech returning from intermediate points of the circuit by causing transmitted speech waves of greater than a predetermined magnitude to insert suitable amounts of loss in the input circuit of said last mentioned means and keeping said loss in said circuit for a sufficient time to prevent operation of said means by echo from the most distant intermediate echo path.

3. In a two-way telephone circuit including paths adapted for transmission in opposite directions, apparatus relatively near each end of the circuit comprising means responsive to voice waves in the incoming path for disabling the outgoing path, means responsive to voice waves in the outgoing path for disabling the incoming path, means responsive to voice waves in the outgoing path for preventing the disabling of said path by later arriving voice waves in the incoming path and means responsive to voice waves in the incoming path for preventing the disabling of said path and for restoring the same to operative condition if it be already disabled, the method of transmission control which consists in effectively preventing the operation of said last mentioned means by echoes of the transmitted speech returning from intermediate points of the circuit by causing transmitted speech waves of greater than predetermined magnitude to insert suitable amounts of loss in the input circuit of said last mentioned means and keeping said loss in said circuit for a sufficient time to prevent operation of said means by echo from the most distant intermediate echo path, and causing said loss to be removed immediately by any incoming speech waves of sufficient magnitude to operate said last mentioned means.

4. In a two-way telephone circuit including paths adapted for transmission in opposite directions, apparatus at or relatively near each end of the circuit comprising receiving echo sup-

pressor means responsive to voice waves in the receiving path for disabling the transmitting path, transmitting echo suppressor means responsive to voice waves in the transmitting path for disabling the receiving path, receiving dis-
 5 abler means responsive to voice waves in the receiving path for disabling the transmitting echo suppressor, transmitting disabler means respon-
 10 sive to voice waves in the transmitting path for disabling the receiving echo suppressor provided the latter is not already operated, and means
 15 responsive to waves of greater than a predetermined magnitude in the transmitting path adapted to adjust the sensitivity of said receiving disabler means.

5. In a two-way telephone circuit including paths adapted for transmission in opposite di-
 20 rections, apparatus at or relatively near each end of the circuit comprising receiving echo sup-
 25 pressor means responsive to voice waves in the receiving path for disabling the transmitting path, transmitting echo suppressor means re-
 30 sponsive to voice waves in the transmitting path for disabling the receiving path, receiving dis-
 35 abler means responsive to voice waves in the receiving path for disabling the transmitting echo suppressor, transmitting disabler means respon-
 40 sive to voice waves in the transmitting path for disabling the receiving echo suppressor provided the latter is not already operated, means re-
 sponsive to voice waves of greater than a prede-
 45 termined magnitude in the transmitting path adapted to effectively reduce the sensitivity of said receiving echo suppressor and receiving dis-
 50 abler means to the extent that they will not re-
 55 spond to echoes in the receiving line of voice waves in the transmitting line, and means re-
 sponsive to voice waves in the receiving line of substantially greater magnitude than the echoes
 60 to immediately restore the sensitivity of said re-
 ceiving echo suppressor and receiving disabler to its original value.

6. In a two-way telephone circuit including paths adapted for transmission in opposite direc-
 45 tions, apparatus at or relatively near each end of the circuit comprising receiving echo suppressor means responsive to voice waves in the receiving path for disabling the transmitting path, trans-
 50 mitting echo suppressor means responsive to voice waves in the transmitting path to insert sufficient loss in the receiving path to cause any echoes that
 55 are heard to be unobjectionable, receiving dis-
 abler means responsive to voice waves in the re-
 ceiving path for disabling the transmitting echo
 60 suppressor, and transmitting disabler means re-
 sponsive to voice waves in the transmitting path for disabling the receiving echo suppressor pro-
 65 vided that the latter is not already operated.

7. In a two-way telephone circuit including

paths adapted for transmission in opposite direc-
 tions, apparatus at or relatively near each end of
 the circuit comprising receiving echo suppressor
 means responsive to voice waves in the receiving
 80 path for disabling the transmitting path, trans-
 mitting echo suppressor means responsive to
 voice waves in the transmitting path to insert
 sufficient loss in the receiving path to cause any
 echoes that are heard to be unobjectionable, re-
 85 ceiving disabler means responsive to voice waves
 in the receiving path for disabling the transmit-
 ting echo suppressor, transmitting disabler means
 responsive to voice waves in the transmitting path
 for disabling the receiving echo suppressor pro-
 90 vided the latter is not already operated, in combi-
 nation with means responsive to voice waves of
 greater than a predetermined magnitude in the
 transmitting path adapted to effectively reduce
 the sensitivity of said receiving echo suppressor
 and receiving disabler means to the extent that
 95 they will not respond to echoes in the receiving
 line of voice waves in the transmitting line and
 means responsive to voice waves in the receiving
 line of greater magnitude than the echoes to ef-
 100 fectively disable said last named means.

8. In a two-way telephone circuit including paths adapted for transmission in opposite direc-
 tions, apparatus at or relatively near each end of
 the circuit comprising receiving echo suppressor
 means responsive to voice waves in the receiving
 105 path for disabling the transmitting path, trans-
 mitting echo suppressor means responsive to voice
 waves in the transmitting path to insert suffi-
 cient loss in the receiving path to cause any
 echoes that are heard to be unobjectionable, re-
 110 ceiving disabler means responsive to voice waves
 in the receiving path for disabling the transmit-
 ting echo suppressor, transmitting disabler means
 responsive to voice waves in the transmitting path
 for disabling the receiving echo suppressor pro-
 115 vided that the latter is not operated, in combina-
 tion with means responsive to voice waves of
 greater than a predetermined magnitude in the
 transmitting path adapted to effectively reduce
 the sensitivity of said receiving echo suppressor
 120 and receiving disabler means to the extent that
 they will not respond to echoes in the receiving
 line or voice waves in the transmitting line,
 means responsive to voice waves in the receiving
 line of greater magnitude than the echoes to ef-
 125 fectively disable said last named means, a two-
 way line connected in extension of said four-
 wire circuit at one end thereof and a mutable cir-
 130 cuit connected in extension of said four-wire cir-
 cuit at the other end thereof.

SUMNER B. WRIGHT.
 DOREN MITCHELL.
 LEONARD G. ABRAHAM.

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