

May 20, 1930.

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1,759,623

SIGNALING SYSTEM

Filed Jan. 21, 1928

2 Sheets-Sheet 1

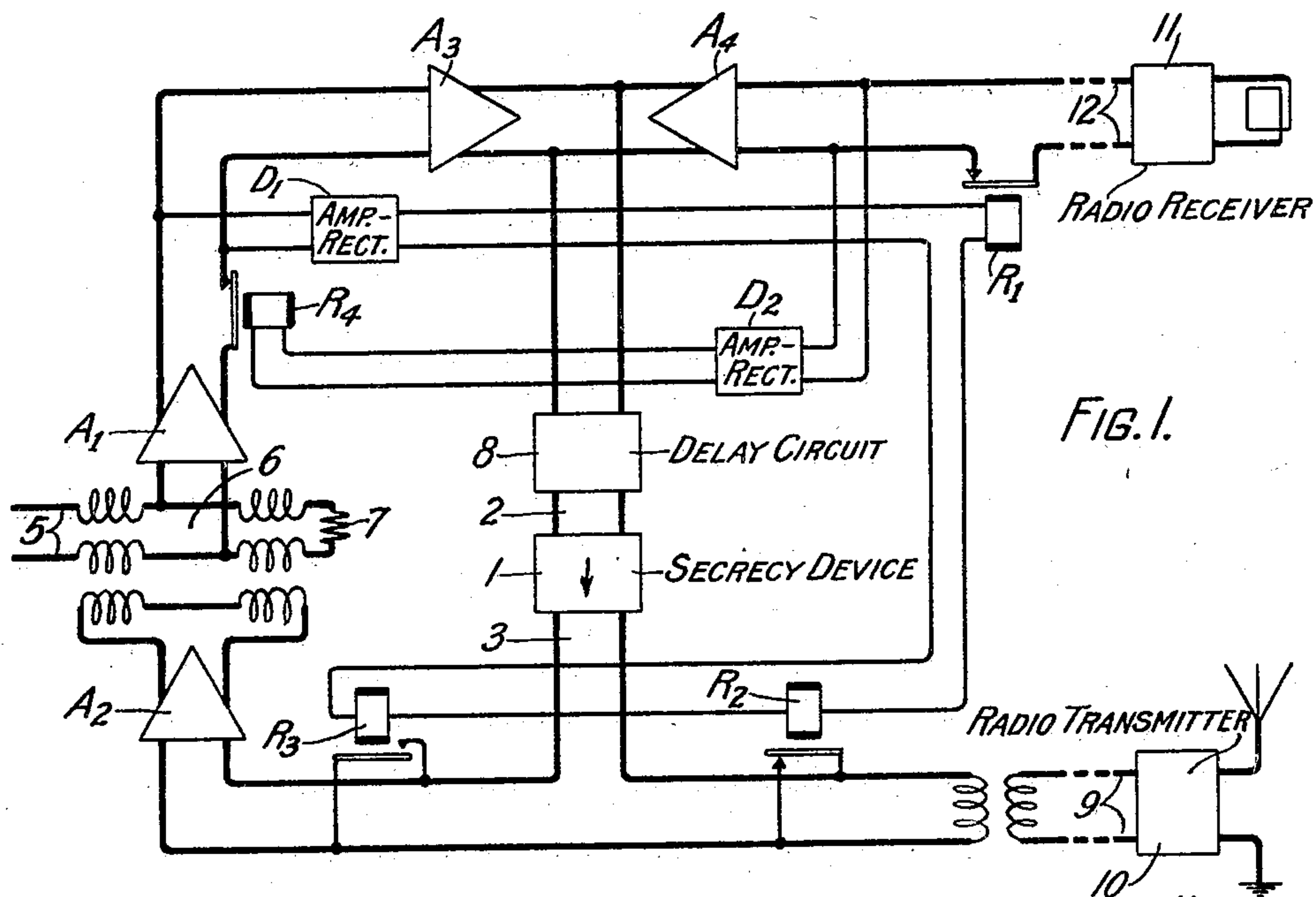


FIG. 1.

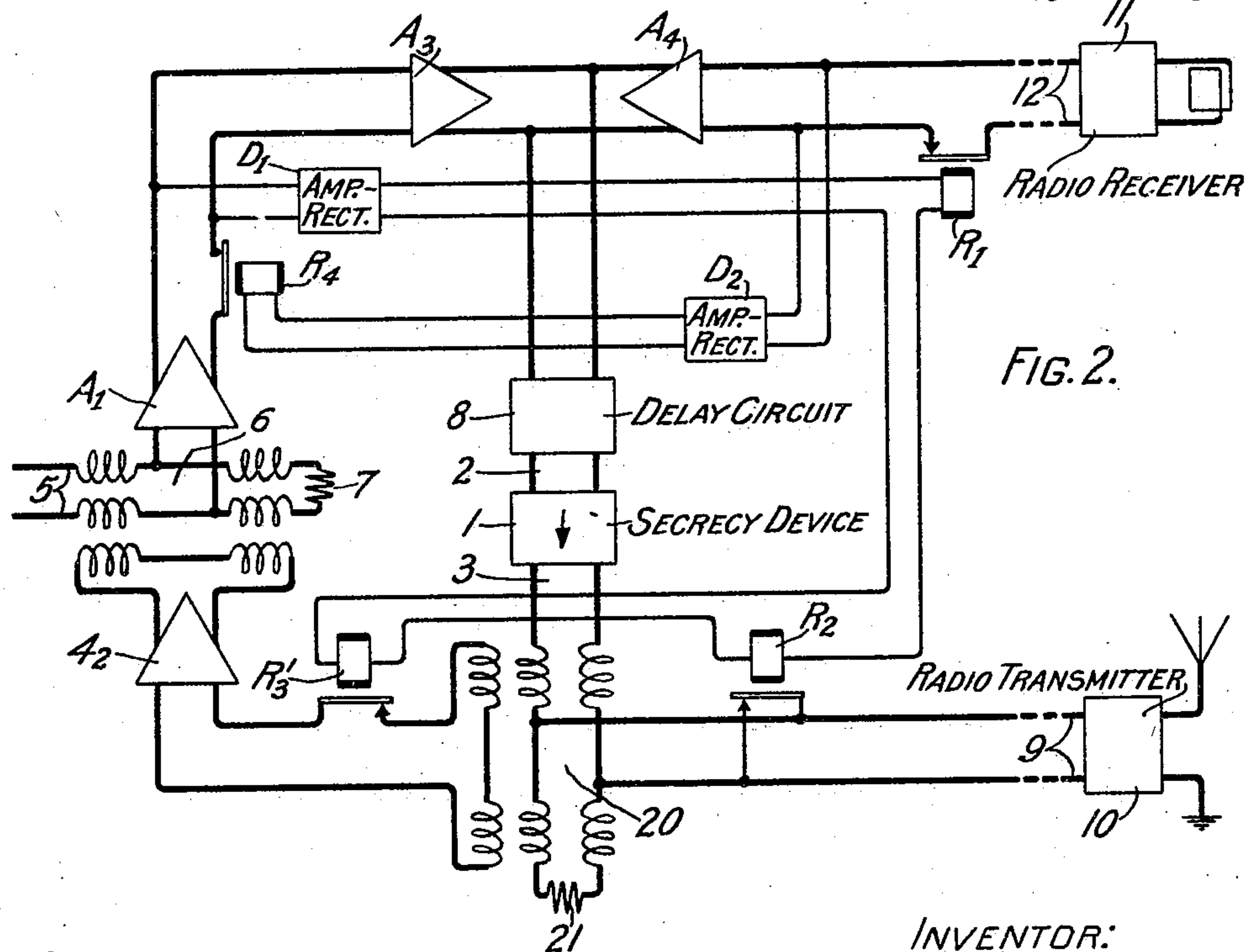


FIG. 2.

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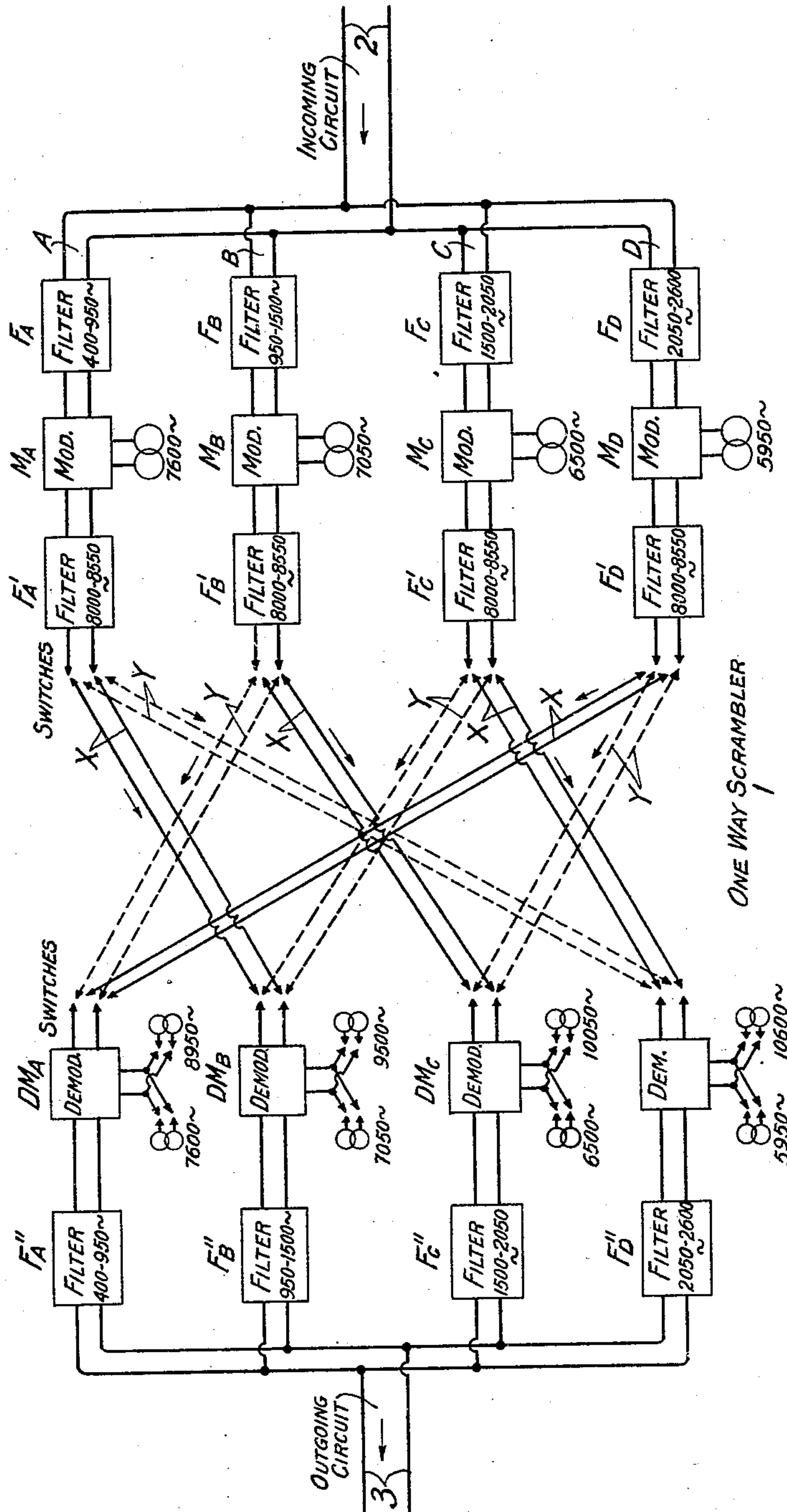


FIG. 3.

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SIGNALING SYSTEM

Application filed January 21, 1928. Serial No. 248,377.

This invention relates to wave transmission, and especially to two-way signaling systems, as for example radio telephone systems. As to certain features, this application is a continuation in part of applicant's prior application Serial No. 667,437, filed October 9, 1923, Patent No. 1,695,813, granted December 18, 1928.

Considering for instance a system such as the transatlantic telephone system now in commercial operation, which is well known and is described in a paper by S. B. Wright and H. C. Silent, pages 736 to 749 of the Bell System Technical Journal, vol. 6, No. 4, published by the American Telephone and Telegraph Company, New York, October, 1927, it is desirable that echoes and singing in the system be prevented, as for example in some such manner as that disclosed in the paper just mentioned, which describes voice-operated relays that, together with suitable delay circuits, prevent simultaneous transmission in opposite directions in the system. It is also desirable that privacy or secrecy in communication be insured, as for instance in some such manner as that disclosed in H. Fletcher Patent 1,573,924, February 23, 1926, which describes relatively changing the frequencies of signal components of different frequencies during their transmission.

An object of the present invention is economy of apparatus for preventing disturbances, such as echoes or side tone or singing, in wave transmission systems, as for example in two-way signaling systems such as those mentioned above.

It is also an object of the invention to economize apparatus for insuring privacy or secrecy in communication in two-way systems such for example as those mentioned above.

A further object is to insure such secrecy with apparatus economy without necessity for transmitting in opposite directions in the means for insuring secrecy. The preferred means for insuring secrecy (as well as the means for insuring secrecy in the system of the Fletcher patent mentioned above) involves transmitting the signals oppositely directed in the system through a unilateral vacuum tube modulating path. Therefore, avoiding necessity for transmitting in opposite directions in the means for insuring secrecy, avoids necessity for either: (1) duplicating the means for insuring secrecy of transmission in one direction in the system, in order to insure secrecy of transmission in the opposite direction also; or (2) employing apparatus (for example a bridge transformer and impedance balanced circuits as disclosed in the Fletcher patent mentioned above) to prevent local circulation of signal energy at the modulating means. Combinations of the first of the above mentioned objects of the invention with the second or the third, respectively, form additional objects. In one specific aspect the invention is a radio telephone system of the general type described in the paper mentioned above, but with a modified means for suppressing echoes and singing, and with means for insuring secrecy in communication. The system is of the four-wire type, including at one end of the radio link a section of four-wire circuit terminated at one end in a bridge transformer or hybrid coil connection to a two-way two-wire circuit for connection to a subscriber's telephone transmitter and receiver. At the other end of the section of four-wire circuit, one side of the section terminates in a radio transmitter and the other side in a radio receiver. At the other end of the radio link the system includes a section of four-wire circuit and a terminating two-wire circuit therefor, which may be similar to the ones just mentioned, so that only the apparatus at one end of the radio link needs further description. For suppressing echoes and singing this apparatus includes a system of voice operated relays such that a single delay circuit suffices to control the operation of the relays for both directions of transmission through the apparatus. The apparatus includes a one-way path, comprising the delay circuit and a unilateral secrecy device for scrambling signals to be transmitted over the sending side of the section of four-wire circuit to the radio transmitter and unscrambling signals received from the radio receiver via the receiving side of the section of four-wire circuit.

cuit. The unilateral path is normally connected for transmission purposes in the receiving side of the section of four-wire circuit. Signals from the two-way two-wire terminating circuit operate the voice relay system to transfer the unilateral path from the receiving side of the section of four-wire circuit to the sending side for transmission purposes. Thus the unilateral path, including the delay circuit and the unilateral secrecy device, is common to the two sides of the section of four-wire circuit, so that a single unilateral secrecy device, as well as a single delay circuit, serves for both directions of transmission over the section of four-wire circuit.

Other objects and features of the invention will be apparent from the following description and claims.

Fig. 1 of the drawings is a circuit diagram of one embodiment of the invention; Fig. 2 is a similar showing of a modified form of the invention; and Fig. 3 shows schematically a form of secrecy device or signal scrambler and unscrambler suitable for use in the systems of Figs. 1 and 2.

The form of secrecy device which is preferred for use in the system of this invention is shown only schematically in Fig. 3. It is disclosed in detail, and claimed, in Patent 1,725,032, issued August 20, 1929, on an application of C. L. Weis, Jr., Serial No. 203,703, filed July 6, 1927. The device is a unilateral or one-way device 1 for scrambling message currents passed through it into unintelligible form and for unscrambling, or rendering intelligible, message currents which are passed through it after having been scrambled by a complementary secrecy device at a distant point.

The device 1 includes a combination of band filters, modulators, demodulators and switches. The intelligible message currents would be transmitted over circuit 2 to the device. The message frequency band would first be sub-divided into four sub-bands A, B, C and D by the band filters F_A , F_B , F_C and F_D . These bands, for purposes of illustration, have been chosen as 400 to 950 cycles, 950 to 1500 cycles, 1500 to 2050 cycles, and 2050 to 2600 cycles. Band A will then be beaten at modulator M_A with a frequency of 7600 cycles and passed through a filter F'_A which will pass the upper side band of 8000-8550 cycles. In like manner, bands B, C and D will be beaten by the frequencies 7050 cycles, 6500 cycles and 5950 cycles, respectively, and passed through the filters F'_B , F'_C and F'_D , respectively, which in turn will transmit the upper side band, which in each case will be 8000-8550 cycles. The sub-bands A, B, C and D will then be transmitted through switching arrangements and the circuits X to certain of the demodulators DM_A , DM_B , DM_C and DM_D . For purposes of illustration, the sub-band A has been shown connected to

DM_B , the band B connected to demodulator DM_C , the band C connected to demodulator DM_D and the band D connected to demodulator DM_A . However, various other combinations may be effected for purposes of secrecy through other switching arrangements not shown. At the demodulator DM_B the sub-band A may be beaten either with the frequency of 7050 cycles or 9500 cycles, depending upon whether it is desired to invert the band or not. Switching arrangements are shown schematically for connecting either of these frequencies to the demodulator. For purposes of illustration, let it be assumed that the sub-band A is beaten at demodulator DM_B with the frequency 7050 cycles. This will result in a lower side band of 950 to 1500 cycles. In other words, it will be seen that the sub-band A by this treatment will be shifted in the frequency scale so as to occupy the position previously occupied by the sub-band B. In a similar manner, the sub-band B will be shifted in the frequency scale to occupy the position formerly occupied by sub-band C. Sub-band C will likewise be shifted to the D position, and sub-band D will be shifted downwardly in the scale to occupy the A position. In other words, the incoming intelligible frequency band having components arranged in the order of A, B, C and D, will be transformed into unintelligibility by having its components re-arranged in the order D, A, B and C. This unintelligible message band will be transmitted to circuit 3 and thence, as described hereinafter, to a distant signaling station, and will there be transmitted to a secrecy device, (not shown), which will be similar in construction to the scrambler device 1, with the exception that it will be arranged by the switches therein to operate in a manner complementary to the scrambler 1. In other words, the unintelligible message band with its components arranged in the order D, A, B and C, will be transmitted over a circuit corresponding to 2 and will be subdivided by filters similar to the filters F_A , F_B , F_C and F_D into four sub-bands. It has been pointed out that the original sub-band A was shifted to occupy the position in the frequency scale originally occupied by the B sub-band, namely 950 to 1500 cycles. Accordingly, the original sub-band A will now be selected by the filter F_B , beaten at the modulator M_B by 7050 cycles, transmitted through the filter F'_B and will thence be transmitted over the circuit Y shown in dotted lines, to the demodulator DM_A . Here it will be beaten by a frequency of 7600 cycles and the lower side band selected by the filter F''_A . It will be seen that this will result in restoring the A sub-band to its original position in the frequency scale, namely 400 to 950 cycles. In a similar manner, by arranging the circuit Y in a manner complementary to the circuits X, it will be seen that the B, C and

D bands will all be restored to their original positions in the frequency scale. This will transform the incoming message into intelligible form.

5 The system of Fig. 1 is a signal transmitting and receiving system designed for radio communication with a distant system, (not shown), which may be considered to be substantially like the system of Fig. 1 except
10 that the two transmitting and receiving systems have complementary secrecy devices as indicated above.

The two transmitting and receiving systems and the intervening radio transmission medium are similar to a four-wire land telephone circuit in which speech waves transmitted between two two-way, two-wire circuits geographically remote from each other travel over different paths in the two directions, for the greater portion of the distance. However, as is well recognized and as is pointed out in the paper mentioned above, the operation of the system including the radio link presents problems not presented by the
25 case of a transmission system not involving such a link. In this specification and in the claims, the application of the expression "four-wire circuit" is limited to a circuit in which two-way transmission is carried on
30 with the transmission in one direction passing over a path that, for the greater portion of the distance between two points geographically remote from each other, is different from the path for transmission in the
35 other direction.

In Fig. 1, a two-way, two-wire circuit 5, for connection at one end to a telephone transmitting and receiving set (not shown), has its other end connected to a bridge transformer or hybrid coil 6, to which is connected an impedance 7 for balancing the impedance of circuit 5. The bridge transformer connects with a four-wire circuit comprising an outgoing or transmitting branch and an
45 incoming or receiving branch. The outgoing branch extends from the bridge transformer through an amplifier A_1 , an amplifier A_3 , a delay path 8, the circuit 2, the secrecy device 1, the circuit 3, and a line 9
50 to a radio transmitter 10. The receiving branch extends from a radio receiver 11 through a line 12, an amplifier A_4 , the delay path 8, the circuit 2, the secrecy device 1, the circuit 3, and an amplifier A_2 , to the bridge transformer 6. The amplifiers may be, for example, of the well known vacuum tube type. The delay path is preferably the delay circuit disclosed and claimed in U. S. patent to H. Nyquist, 1,607,687, November
60 23, 1926, but may be a transmission delay path of any suitable type. For example, it may be a delay path of an acoustical or a mechanical type. Such types are disclosed and claimed in Patent 1,696,315, issued December 25, 1928, on a division of my appli-

cation Serial No. 747,164, filed November 1, 1924.

The transmission circuits 5, 9 and 12, and the radio transmitter 10 and the radio receiver 11, may be, for example, substantially like the transmission circuits and the radio transmitter and the radio receiver at the west end of the present (commercial) transatlantic telephone system described in the paper mentioned above, the lines 9 and 12 being repeated lines of considerable length, the radio transmitter and the radio receiver being geographically remote from each other, and the radio sending and the radio receiving being carried on in the same radio frequency band.

The system of Fig. 1 normally is set for speech energy to come from the receiving station 11 to the input of the amplifier A_4 and an amplifier-rectifier or detector D_2 . The operation of D_2 cuts off by means of a relay R_4 the transmitting part of the circuit before any unbalanced speech energy can get around to the input of the amplifier A_3 , or an amplifier-rectifier D_1 . The output of amplifier A_1 passes through the delay circuit 8 and is unscrambled by the secrecy device 1 before being sent out to the circuit 5 by means of amplifier A_2 . When speech comes from the circuit 5 it is transmitted by the amplifier A_1 from the bridge points of the hybrid coil 6 to the amplifier-rectifier D_1 and the amplifier A_3 . The amplifier-rectifier D_1 operates three relays, R_1 , R_2 and R_3 . R_1 cuts off the receiving circuit and so prevents any local round-trip singing. R_2 opens a path for the speech energy to get to the transmitting station and R_3 prevents the local circulation of energy back through the amplifier A_2 . In the meantime speech is passed through the delay circuit and has been scrambled by the secrecy device before passing on to the transmitting station. The amplifiers A_1 and A_2 serve to prevent any reaction upon the impedance which this terminal circuit presents to the circuit 5 due to any of the switching operations.

The secrecy devices and their functions can be omitted from the system, if desired.

Either the secrecy device 1 or the delay circuit 8, or the two in tandem, may have a transmission equivalent greater than zero, the loss in these elements being compensated for by the amplifiers.

The amplifier-rectifiers or detectors D_1 and D_2 are representative of any means for operating on the signal currents to obtain a wave which can efficiently operate the relays R_1 , R_2 , R_3 and R_4 , or actuate equivalent control means. Each amplifier-rectifier preferably comprises a combination of amplifier and rectifier elements of the vacuum tube type. Examples of suitable amplifier-rectifiers are those disclosed in U. S. patent to E. D. Johnson, 1,526,550, February 17,

1925, and in my application Serial No. 667,437, filed October 9, 1923.

The system of Fig. 2 is like that of Fig. 1 except that Fig. 2 includes a bridge transformer 20 and balancing network 21 and employs, instead of the relay R_s of Fig. 1, a relay R'_s which performs its function in a shorter time by simply opening the relay contact. Any possible reaction of the switching operation due to the relay R'_s upon the energy outgoing to the radio transmitter is avoided by the use of the bridge transformer or hybrid coil 20 and the network 21.

What is claimed is:

1. A signaling system of the four-wire type comprising two one-way line sections, one for incoming transmission and one for outgoing transmission, a one-way device having its input associated with both of said one-way line sections and having its output associated with both of said one-way line sections, and voice operated devices connected to each of said one-way line sections for selectively establishing a connection through said one-way device over either of said one-way line sections.

2. A signaling system of the four-wire type comprising two one-way line sections, one for incoming transmission and one for outgoing transmission, relay means connected to said one-way line sections and operated by signaling currents transmitted thereover, a one-way device, and switching means controlled by said relay means whereby transmission may be established through said one-way device over either of said one-way line sections to the exclusion of the other.

3. A signaling system of the four-wire type comprising two one-way line sections for transmission in opposite directions, voice operated relay means connected to one of said line sections, a one-way device, and means controlled by said relays for operatively connecting said one-way device for transmission purposes into either of said one-way line sections.

4. A signaling system of the four-wire type comprising two line sections for transmission in different directions, respectively, means in each section capable of transmitting in but one direction and consequently preventing two-way transmission therethrough, voice operated relay means connected to one of said line sections, a one-way device, and switching means controlled by said relays for operatively connecting said one-way device for transmission purposes into one of said line sections and for disabling the other of said line sections for transmission purposes.

5. A signaling system comprising two line sections for transmission in different directions, respectively, means in each section capable of transmitting in but one direction and consequently preventing two-way transmission therethrough, voice operated relay means connected to one of said line sections, a one-

way device, and means controlled by said relays for operatively connecting said one-way device for transmission purposes into either of said line sections.

6. A signaling system of the four-wire type comprising two one-way line sections, one for incoming transmission and one for outgoing transmission, a delay path having its input associated with both of said one-way line sections and having its output associated with both of said one-way line sections, and means responsive to changes in signaling waves in the system for establishing a connection for transmission purposes through said delay path over either of said one-way line sections.

7. A two-way signaling system comprising a one-way secrecy device and signal controlled means for connecting said device to serve for both directions of transmission.

8. A signaling system comprising a unilateral frequency band translating means, and signal controlled means for connecting said first means to transmit in opposite directions in the system.

9. A signaling system of the four-wire type comprising two line sections for transmission in different directions, respectively, a device in each section capable of transmitting in but one direction and consequently preventing two-way transmission therethrough, a signal transmitting path, and means responsive to changes in signaling waves for selectively establishing a signal transmitting connection through said path in either of said line sections.

10. A signaling system of the four-wire type comprising a two-wire two-way circuit and two one-way line sections, one for transmission incoming from the two-wire circuit and one for transmission outgoing to the two-wire circuit, means connecting one end of each of said one-way line sections to said two-wire circuit, a radio transmitter and a radio receiver connected respectively to the other ends of said one-way line sections, a signal modifying path, and means responsive to changes in signaling waves for selectively establishing in either of said one-way line sections a signal transmitting connection through said path.

11. In combination, a line, a circuit for transmitting waves to said line, a circuit for transmitting waves from said line, and a unilateral path connecting said circuits, said path having a transmission loss always greater than zero.

12. A two-way signaling system comprising a two-wire, two-way transmitting line, a circuit for transmitting waves to said line, a circuit for transmitting waves from said line, a passive impedance network, and means responsive to changes in signal waves for selectively establishing a signal transmitting connection through said network in either of said circuits.

13. A duplex radio telephone system of the four-wire type comprising a two-wire, two-way circuit and two one-way line sections for transmitting to and from said two-wire circuit, respectively, a radio transmitter and a radio receiver connected respectively to said one-way line sections, said transmitter and said receiver operating in the same frequency band, a signal frequency band transposing device, and means responsive to transmission in one direction in said system for operatively connecting said device for purposes of transmission in said one direction into one of said one-way line sections and for disabling the other of said one-way line sections for transmission purposes.

14. A two-way signaling system comprising two one-way circuits for oppositely directed signals, a one-way amplifier in each of said circuits, a one-way secrecy device, common to said two circuits, having an input end and an output end and having one of said ends connected between said amplifiers with said amplifiers similarly pointed with respect to said one end, and a Wheatstone bridge network connecting said other end to each of said circuits.

15. A system for two-way transmission of signal waves of a band of frequencies, comprising a two-way two-wire portion and a four-wire portion connected thereto, unilaterally transmitting means in said four-wire portion for transposing sub-bands of the signaling frequency band, and signal controlled means for rendering said unilaterally transmitting means effective for both directions of transmission in the system.

16. A two-way signaling system normally biased for transmitting in one direction only, comprising a unilaterally transmitting device having a transmission loss greater than zero, and signal controlled means for connecting said device to transmit in opposite directions in the system.

17. The method of operating a one-way secrecy device for a two-way signaling system, which comprises operatively connecting the device for transmitting in opposite directions in the system.

18. In a transmission system, paths for repeating signaling currents in opposite directions between separate points in said system, said paths having a uni-directionally transmitting portion in common, means associated with one of said paths and responsive to signaling currents therein for increasing the transmitting efficiency of that path and for substantially simultaneously reducing the transmission efficiency of the oppositely directed repeating path, whereby the effect of troublesome echo currents is reduced.

19. A system in accordance with claim 18 and in which said oppositely directed repeating paths are normally inoperative to trans-

mit between said points in said system, said means associated with said one repeating path being responsive to signaling currents therein for making that path operative and the oppositely directed path inoperative.

20. A system according to claim 18 in which said uni-directionally transmitting portion comprises a one-way transmission device having its input normally connected to the oppositely directed repeating paths so as to be operative to receive and transmit signaling currents therefrom.

21. A system according to claim 18 and in which one of said repeating paths is normally short-circuited in the output of the common uni-directionally transmitting portion thereof, said means associated with the path responsive to signaling currents therein comprising means for removing the short-circuit.

22. A system according to claim 18 and in which the means associated with said one of the oppositely directed paths for increasing the transmission efficiency of that path in response to signaling currents therein comprises a switch operative to remove a normal short-circuit across that path.

23. A system according to claim 18 and having a network common to the signaling paths in opposite directions for delaying propagation of signaling currents there-through for a time interval at least as long as that required for operation of the means associated with said one repeating path in response to signaling currents therein to increase the transmitting efficiency of that path and to reduce the transmitting efficiency of the oppositely directed path, whereby the setting up of local singing circuits is prevented.

24. A system according to claim 18 in which the means for reducing the transmitting efficiency of the repeating path opposite in direction to the path transmitting signaling currents comprises means responsive to said signaling currents for effectively disconnecting said opposite path from the input of said uni-directionally transmitting portion, whereby echo currents are kept out of said uni-directionally transmitting portion.

25. A system according to claim 18 and in which the input of the uni-directionally transmitting path of the system is normally permanently connected to portions of both of the oppositely directed repeating paths so as to receive signaling currents from either path, while during the transmission of signaling currents in said system, the output of said uni-directionally transmitting portion is connected to one or the other of said oppositely directed paths depending on the direction of transmission of signaling currents.

26. A system in accordance with claim 18 in which the input of said uni-directionally transmitting portion of the system is con-

5 nected to the oppositely directed repeating paths in such manner as to prevent operation of the means associated with said one repeating path for increasing the transmitting efficiency of that path and decreasing the transmitting efficiency of the oppositely directed path by signaling currents in said oppositely directed path.

10 27. A system in accordance with claim 18 in which the portions of the repeating paths for opposite directions feeding into the input of the uni-directionally transmitting portion of the system are connected in conjugate relation, whereby operation of the transmission efficiency changing means associated with said one repeating path by signaling currents in the oppositely directed repeating path is prevented.

15 28. A system in accordance with claim 18, in which said uni-directionally transmitting portion comprises a one-way transmission device having its input connected to the oppositely directed repeating paths, and each of said oppositely directing repeating paths include a uni-directionally transmitting device operative by signaling currents therein and feeding said one way transmission device.

25 In witness whereof, I hereunto subscribe my name this 19th day of January, 1928.

30 ROBERT C. MATHES.

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