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SIGNALING SYSTEM

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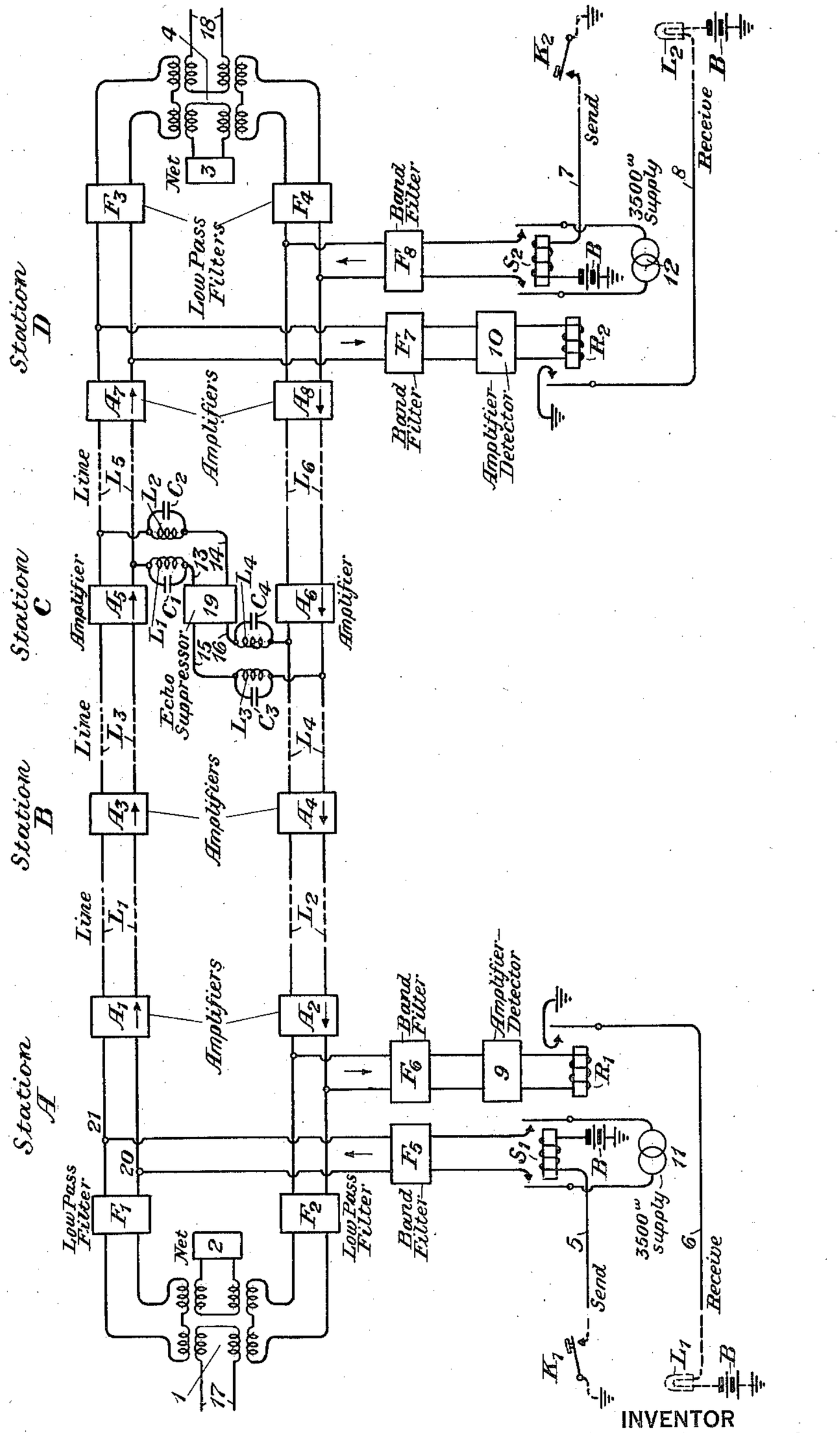

INVENTOR

M. L. Almquist

BY

ATTORNEY

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SIGNALING SYSTEM

Milton L. Almquist, Maplewood, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

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This invention relates to electrical circuits and, more particularly, to electrical signaling systems, and especially to such systems as are adapted to signaling over circuits of the four-wire type.

In the telephone plant it is common practice to pass ringing or supervisory or other auxiliary signals over circuits of the local type by means of direct current channels derived from the talking pairs. In the toll plant, however, it is frequently desired to use the derived direct current channels for telegraph circuits and it is accordingly necessary to obtain the auxiliary signaling channels by other methods.

One of the objects of this invention is to provide an alternating current method for auxiliary signaling over toll circuits in such cases. An additional object of the invention is to provide means for preventing interference between the talking and auxiliary signaling channels at points on the circuits at which intermediate echo suppressors are used.

Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

In the accompanying drawing there is shown a circuit of the four-wire type consisting of the line sections L_1 to L_6, inclusive, connecting the stations A, B, C and D. Each station includes two one-way amplifiers, of which the odd numbered ones, i. e., A_1, A_3, A_5 and A_7 serve to amplify the currents transmitted from station A to station D and the even numbered ones, i. e., A_2, A_4, A_6 and A_8 serve to amplify the currents transmitted in the reverse direction. These amplifiers will preferably be of the vacuum tube type and are well known in the art. Although only four stations are shown in the drawing, it will be understood that additional stations may be involved in the cases of the longer circuits. In such cases the additional stations will be of the type shown at station B. Station C includes echo suppressing equipment **19** of the type designed for use at intermediate stations. This equipment is required at only one point on the circuit.

At the terminal stations A and D, the two branches of the four-wire circuit are combined to form a two-wire circuit by means of the usual hybrid coil arrangements **1** and **4**. Networks **2** and **3** serve to balance the two-wire lines **17** and **18**, respectively, and in conjunction with the hybrid coil arrangements just mentioned permit independent transmission in the two directions between the two-wire and four-wire portions of the circuit.

The amplifiers A_1 to A_8, inclusive, and the lines L_1 to L_6, inclusive, have transmission characteristics whereby they will transmit frequencies up to about 4500 cycles, whereas only the frequencies between about 250 cycles and 2750 cycles are ordinarily employed for transmission of speech. This leaves a frequency band from 2750 cycles to 4500 cycles which may be used for other purposes, such as supervisory or other auxiliary signaling. In this description it will be assumed that a frequency of 3500 cycles will be used for this purpose, although other frequencies within the band not required for intelligible speech might, of course, be employed. Furthermore, it will also be assumed that the same frequencies will be used in each direction, although there is no fundamental reason why different frequencies might not be used if desired.

The filters F_1 to F_8, inclusive, which may all be of any type well known in the art, are provided to prevent interference between the speech currents and the supervisory signaling currents. Filters F_1, F_2, F_3 and F_4 are of the low pass type and serve to keep the supervisory signaling currents from reaching the two-wire portion of the circuits **17** and **18** (and hence the subscribers). They also serve to remove any components of the speech currents which might be of the proper frequencies to be passed by the signaling band filters F_5, F_6, F_7 and F_8. The latter filters prevent the normal speech currents from reaching the supervisory signaling equipment.

The supervisory signaling equipment consists of the 3500-cycle sources **11** and **12**, the sending relays S_1 and S_2, the amplifier-detectors **9** and **10** and the receiving relays R_1 and R_2 at stations A and D, respectively. The amplifier-detectors may be made in any of the various forms which are well known in the art.

The operation of the signaling system is as follows: To transmit an auxiliary signal from station A to station D, the key K_1 is closed, applying ground over lead **5** to relay S_1 and battery B. Relay S_1 operates and connects the 3500-cycle source **11** through the armatures of relay S_1 and through the filter F_5 to the circuit at points **20** and **21**. The auxiliary signaling current is kept from the two-wire circuit **17** by the filter F_1, but is transmitted through the amplifier A_1 to line L_1 and thence through the succeeding amplifiers and line sections to station D. At station D the aux-

iliary signaling current is kept from the two-wire circuit 18 by filter F_3, but is transmitted by filter F_7 to the amplifier-detector 10, the output of which causes the operation of relay R_2. Relay R_2 connects ground over lead 8 to the lamp L_2 and battery B, causing the lamp to light.

In a similar manner, the closure of key K_2 at station D causes 3500-cycle current to be transmitted over the other half of the four-wire circuit to station A, where it causes the operation of relay R_1 and the lighting of lamp L_1.

At station C, means are provided to prevent the echo suppressor 19 from operating on the auxiliary signaling currents and interfering with the speech transmission, which means also serve to prevent interference with the auxiliary signaling when the suppressor is operated in its normal manner by speech currents. Said means consist of the tuned circuits made up of the inductances L_1 to L_4, inclusive, and the capacitances C_1 to C_4, inclusive, as shown. These inductances and capacitances are selected so that the L_1, L_2, C_1, C_2 combination and the L_3, L_4, C_3, C_4 combination are each anti-resonant at the auxiliary signaling frequency. Their impedances are therefore high at the auxiliary signaling frequency and low at other frequencies, such as those in the speech band, and the auxiliary signaling currents will therefore be kept out of the echo suppressor, while speech currents will be transmitted to it and the suppressor will function in its normal manner when they are present.

It will be apparent that the action of the suppressor is such that when currents are sent into it over leads 13 and 14, a short circuit is placed on leads 15 and 16, and vice versa. The high impedance of the tuned circuits at the auxiliary signaling frequency and their low impedance at speech frequencies also serve to render the short-circuiting action of the suppressor ineffective as regards the auxiliary signaling currents, while not interfering with its action in eliminating speech currents. The speech channels and the auxiliary signaling channels are therefore independent of each other and simultaneous transmission may take place without interference between them, even when an echo suppressor is involved.

It will be understood that the current or currents which are called auxiliary currents hereinabove may be any current or currents whatever; they may be, for example, carrier frequencies which are used in carrier telegraphy; they need not be used for the transmission of intelligence having some definite relation to the special currents flowing in opposite directions over the four-wire circuits. It will be further understood that the frequency assigned to sources 11 and 12 need not be 3500 cycles and that they need not be equal in value, for indeed they may have different frequency values located anywhere in the frequency spectrum above the voice band or range.

While the invention has been disclosed as embodied in a specific form, it will be understood that it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a signaling system, the combination of a four-wire circuit, means including networks terminating said four-wire circuit at both ends which permit only speech currents to flow in opposite directions at said ends, means connected to two of the four wires of said circuit for signaling over said two wires in one direction with alternating current having a frequency outside the speech band, means connected to the other two wires of the four-wire circuit for simultaneously signaling over said other two wires in the opposite direction with alternating current having a frequency outside the speech band, and means including parallel tuned circuits resonant at the frequencies of said alternating currents for preventing the currents employed in said alternating current signaling means from affecting, interrupting or interfering with the transmission of the speech currents in opposite directions.

2. In a signaling system, the combination of a four-wire circuit, a pair of networks, one terminating each end of the four-wire circuit, a two-wire circuit connected to each network over which only speech currents flow in opposite directions, means coupled to two of the wires of the four-wire circuit for signaling over said two wires in one direction with alternating current having a frequency above the speech band and below the cut-off point of said two wires, means coupled to the other two wires of the four-wire circuit for simultaneously signaling over said other two wires in the opposite direction with alternating current having a frequency above the speech band and below the cut-off point of said two wires, and means comprising a plurality of anti-resonant circuits for preventing the higher frequency alternating currents from affecting or interfering with the transmission of the speech currents in the opposite direction.

3. The combination of a four-wire signaling circuit, an echo suppressor, and anti-resonant circuits having the same frequency characteristics, two of which respectively interconnect two of the wires of the four-wire circuit in series with one side of the echo suppressor and two more of which respectively interconnect the other two wires of the four-wire circuit in series with the other side of the echo suppressor, the anti-resonant circuits continually preventing all currents having the frequency characteristics of said anti-resonant circuits from reaching the echo suppressor.

4. The combination of a four-wire circuit suitable for the transmission of currents in opposite directions, an echo suppressor having two pairs of terminals, and four anti-resonant circuits, two of which have the same frequency characteristics and respectively interconnect one pair of terminals of the echo suppressor in series with two of the wires of the four-wire circuit and the other two of which have the same frequency characteristics and respectively interconnect the other pair of terminals of the echo suppressor in series with the other two wires of the said four-wire circuit, the anti-resonant circuits continually preventing all currents having the respective frequency characteristics of said anti-resonant circuits from reaching the echo suppressor.

5. In a system for signaling with speed currents and with auxiliary currents simultaneously, the combination of a four-wire circuit, networks terminating each end of said four-wire circuit, two-wire circuits coupled to said networks over which only speech currents may flow in opposite directions, echo suppressing circuits interconnecting two of the wires of the four-wire circuit with the other two of its wires, auxiliary means coupled to two of the wires of said four-wire circuit for signaling over said two wires in one direction with current having a frequency above the speech band, auxiliary means coupled to the other two wires of said four-wire circuit for simultaneously signaling over said other two wires in the opposite

direction with current having a frequency above the speech band, and means including parallel tuned circuits for preventing the alternating currents employed in said auxiliary means from operating the echo suppressing circuits and for preventing interference with the auxiliary signaling means by operation of the echo suppressing circuits by speech currents.

6. In a signaling system, the combination of a four-wire circuit, networks terminating said four-wire circuit at both ends which permit only speech currents to flow in opposite directions at said ends, means connected to two of the four wires of said circuit for signaling over said two wires in one direction with alternating current having a frequency above the speech band, means connected to the other two wires of the four-wire circuit for simultaneously signaling over said other two wires in the opposite direction with alternating current having a frequency above the speech band, means including parallel tuned circuits resonant at the frequencies of said alternating currents for preventing the currents employed in said alternating current signaling means from affecting or interfering with the transmission of the speech currents in opposite directions, and means including said parallel tuned circuits for preventing the speech currents from affecting or interfering with said signaling means.

MILTON L. ALMQUIST.