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TWO-WAY CARRIER WAVE SYSTEM

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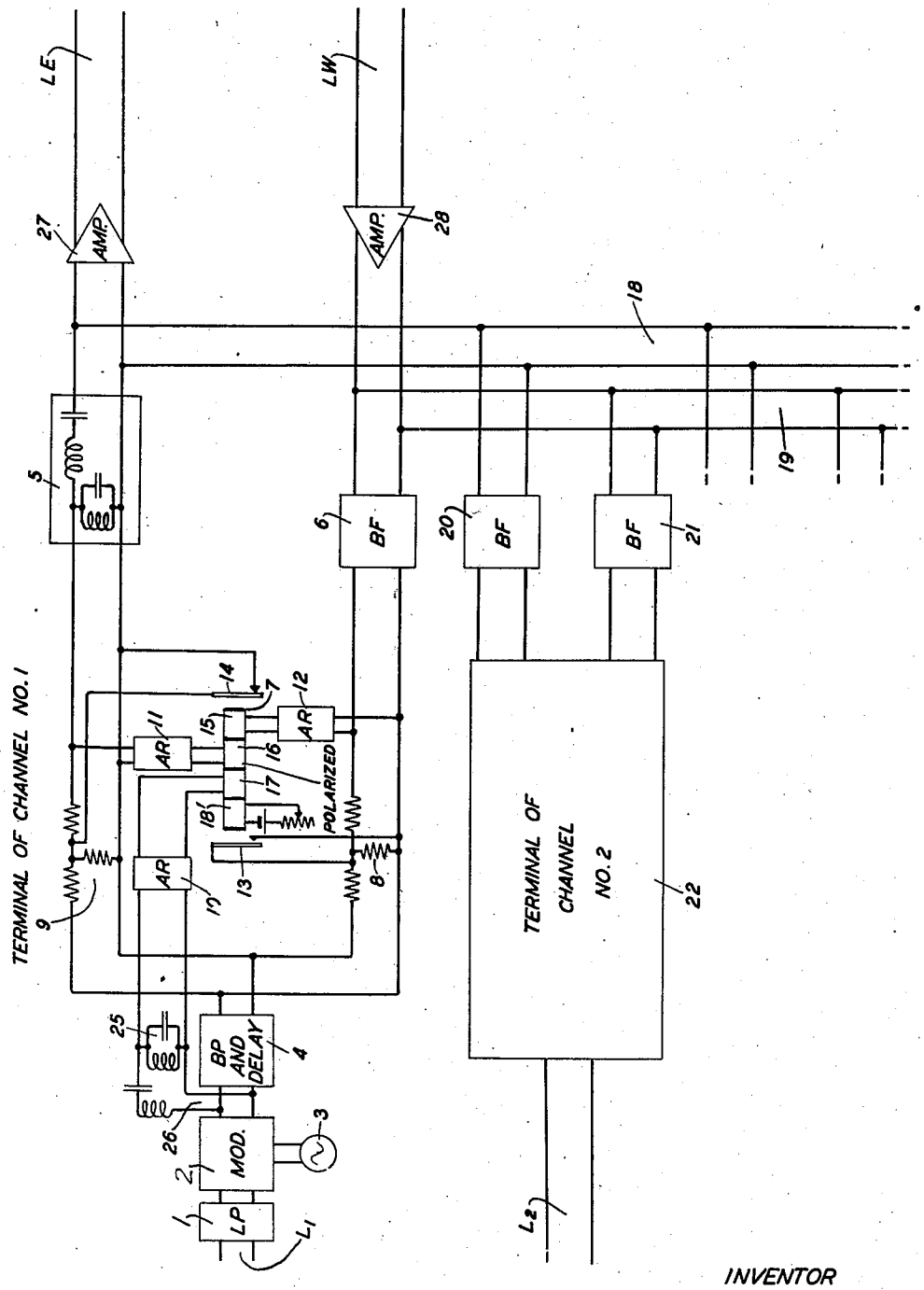

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TWO-WAY CARRIER WAVE SYSTEM

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5 Claims. (Cl. 179—15)

The present invention relates to two-way carrier current transmission, and more particularly to carrier telephony.

An object of the invention is a simplified type of two-way terminal circuit for carrier signaling such as carrier telephony.

A further object is to provide amplification of transmitted or received waves in a system using the same modulator-demodulator for sending and receiving and the same frequency band for both sending and receiving.

The existence of practical forms of modulator-demodulator or "modem" circuits, such as those using copper-oxide or other non-linear resistance devices, suggests the desirability of a carrier terminal using one or several two-way channels each on a two-wire basis rather than on the usual four-wire basis. In such a system each two-wire voice line would contain a modem unit through which the transmitted and received waves pass in opposite directions, thus avoiding the cost and complexity of hybrid balancing circuits or other equipment necessary for separating outgoing from incoming waves for the purpose of modulation and demodulation.

A difficulty arises in such simplified terminal circuits, however, when attempt is made to introduce amplification. Even if the main carrier lines are operated on a four-wire basis, it is very difficult to use terminal amplifiers if a high frequency hybrid balance is required. In a multiplex system, for example, the requisite balance to secure a practical degree of amplification would involve balancing some kind of a network against a number of bi-directional channels each including a modem unit and band filter, at best a costly and difficult procedure.

In accordance with the present invention the necessity of line balance is avoided by the use of terminal switching circuits associated with each channel for rendering the channel terminal unidirectional for either transmitting or receiving, under control of waves sent through the system.

A better understanding of the invention and its various features and objects will be had from the following detailed description in connection with the accompanying drawing, of which the single figure shows a schematic circuit diagram of a terminal of a multiplex carrier current system in accordance with the invention.

In the drawing two main multiplex carrier lines LE and LW are shown connected to the west terminal. It will be understood that a similar terminal is connected to these two lines at the east station. The line LE transmits a number of side-bands eastward from the terminal circuit shown and includes a common amplifier 27 for amplifying all of the side-bands transmitted over the line LE. Line LW transmits a number of side-bands westward and includes an amplifier 28.

A number of low frequency lines L_1, L_2, etc. are assumed to lead up to the terminal circuit shown in the drawing, these lines being voice frequency lines of any suitable type. Each such voice line is equipped with modulating and demodulating apparatus and is arranged for connection to both of the main lines LE and LW in a manner now to be described.

Considering the line L_1 as typical, this line includes a low-pass filter 1, a modulator-demodulator or modem 2 supplied from a carrier source 3 and a band filter 4. The modem unit 2 is any suitable type of bi-lateral modulator-demodulator, one example being a circuit of bridge configuration including copper oxide rectifiers in the four arms of the bridge as disclosed, for example, in United States Patent 1,959,459 to F. A. Cowan, granted May 22, 1934, or in an application for United States patent of R. S. Caruthers, Serial No. 723,691, filed May 3, 1934. The band filter 4 is selective of one of the two side-bands produced by the modem unit and preferably is sufficiently long or is otherwise constructed to give an appreciable delay to the waves transmitted through it.

The terminals of the band filter 4 remote from the modem 2 are connected to each of the lines LE and LW by connection respectively to the bus conductors 18 and 19 for these two lines. The transmitting branch leading from the band filter 4 includes resistance network 9 and a portion of filter 5 selective to the same side-band as filter 4. This filter 5 is indicated as comprising but a single filter section which prevents channel 1 from dissipating the energy of channels 2, 3 etc. by offering high impedance to the currents utilized by these latter channels. The receiving branch leading from line LW to the band filter 4 includes a single section filter 6 which may be a duplicate of filter 5, and a resistance network 8. The transmitting and receiving branches are rendered alternately operative by means of a switching circuit shown in the form of polarized relay 7, the armature 14 of which normally short-circuits the shunt resistance of network 9 and the armature 13 of which is adapted when attracted to short-circuit the shunt impedance of network 8. The normal position of the armatures, that is, the position which they occupy

when the circuit is either idle or in receiving condition, is that shown in the drawing.

It will be understood that the other lines L_2, etc. are similarly equipped with terminal apparatus, that for the line L_2 being generally indicated by the rectangle 22. Filters 20 and 21 are simple or single section type filters similar to filters 5 and 6 except that they are designed to pass the side-band frequencies utilized by channel 2. The bus conductors 18 and 19 are indicated as leading to two other branch circuits representing other channels that may be used for communication with other voice frequency lines, there being no special significance in the number of channels indicated.

The switching apparatus associated with each channel will be better understood from tracing through an operational cycle in connection with the switching circuit shown for channel 1. As stated, this circuit is shown in the normal or receiving condition. In this condition, the armatures 13 and 14 of polarized relay 7 are held in their retracted position by the aid of biasing winding 18' shown connected to a suitable battery and variable resistance which may be used to regulate the strength of the bias current.

When speech is received over the voice line L_1 it passes through low-pass filter 1 into modem unit 2 where it modulates the carrier wave from the source 3. One of the side-bands, for example the lower side-band resulting from such modulation, is selectively transmitted through the band filter 4 which, as stated, is constructed to introduce a slight delay in this side-band. Some of the output from modem 2 passes into circuit 26 and is impressed on the amplifier-rectifier 10, the rectified output of which flows through the winding 17 of the relay 7 and causes that relay to attract its armatures 13 and 14. The single section filter 25 is preferably used to make the rectifier 10 responsive to the side-band that is not transmitted over the line, that is, responsive to the upper side-band, in this case.

It is assumed that the amount of delay introduced into the side-band waves by the filter 4 is substantially that required for the relay 7 to operate, or at least to cause the separation of armature 14 from its back contact. The breaking of the short circuit at the armature 14 around the shunt element of resistance network 9 allows the side-band current selected by the filter 4 to be transmitted through the network 9 and thence through filter 5 to amplifier 27 and line LE. Some of the side-band currents on the output side of the network 9 pass into the amplifier-rectifier 11, the rectified output of which flows through the winding 16 of the relay 7 in a direction to aid the winding 17 to hold the armatures 13 and 14 of the relay 7 in their attracted position. The relay 7 remains energized as long as voice currents continue to come in on the line L_1. When a substantial pause is made by the talker on line L_1 current flow ceases in the windings 16 and 17 of the relay 7 and the armatures 13 and 14 of the relay are allowed to fall back after a suitable hang-over period.

Assuming that no speech is coming from the talker on line L_1 but that a talker on the voice line associated with the distant terminal, channel 1, of the lines LE and LW starts to talk, this results in sending out from the distant terminal on the line LW a voice side-band in a manner similar to that described above in connection with the transmission from line L_1 into the line LE. This side-band as received over the line LW is amplified at 28 and is selectably transmitted through band filter 6. Part of the energy of this side-band passes into amplifier-rectifier 12, the rectified output of which flows through winding 15 of relay 7 which is so poled as to aid the bias winding 18' in holding the armatures 13 and 14 in a retracted position. The received side-band passes through network 8 and band filter 4 to the modem 2 where it is demodulated with carrier waves from the source 3 and the resulting low frequency or voice frequency wave passes through the low-pass filter 1 out on to the line L_1. One purpose for the selective network 25 in the branch circuit 26 is to prevent an appreciable amount of the received side-band from finding its way into amplifier-rectifier 10. The fact that one side-band only of the modulated wave is transmitted whereas both side-bands are produced by the modem 2 upon transmitting provides a margin of selectivity between outgoing and incoming waves for control of amplifier-rectifier 10. Even if this selectivity margin were not present, however, it will be noted that the rectified currents from amplifier-rectifier 10 flowing through winding 17 are opposed by currents in both the windings 15 and 18' and they would, therefore, be ineffective in causing attraction of the armatures 13 and 14. The amplifier-rectifier 11 is maintained unaffected by the received side-band so long as the armature 14 maintains a short circuit in shunt of the branch to which amplifier-rectifier 11 is connected.

If the party on the line L_1 should start to talk while speech is in progress in the opposite direction over the circuit, he will be unable to obtain control of the switching circuit since the relay 7 maintains its armatures in their retracted position by the combined effect of current in windings 15 and 18' which are strong enough to predominate over current flowing in the single winding 17.

If the circuit is in the transmitting condition, that is, with relay 7 operated to attract its armatures 13 and 14 by virtue of speech coming in on line L_1, the party at the distant terminal is unable to gain control of the switching circuit at the terminal shown since in that case current is flowing in both windings 16 and 17 in the manner described above; the effect of current in the winding 17 predominates over the current in bias winding 18'; and the effect of current in winding 16 offsets that of current in winding 15. Moreover, the effectiveness of the winding 15 is reduced by virtue of the short circuit across the shunt impedance of network 8 on account of the attraction of the armature 13.

The single section filters 5, 6, 20 and 21, etc. are used adjacent the high frequency line to prevent disturbances in the parallel-connected channel circuit by operation of the switching circuit. If it were not for these filters, the operation of relay 7 in placing low impedance shunts across the transmitting and receiving branches of channel 1 would deleteriously affect the shunt impedance across the terminals of channel 2 and the other channels. Filters 5, 6, etc. offer such a high impedance outside their bands that the change of impedance effected by the switching operations in any given channel have no effect on neighboring channels. These terminal sectional filters 5, 6, etc. are not necessarily additional filters but may be the end sections that would ordinarily be present in the channel band filter 4 as that would ordinarily be constructed.

While a multi-winding relay has been shown for accomplishing the switching, it will be understood that the invention is not limited to this specific type of apparatus but that any other suitable circuit controlling means may be employed at this point. It will be understood that the invention is not to be construed as limited to the details that have been shown and described but that the scope is indicated by the appended claims.

What is claimed is:

1. In a carrier wave system, two main lines transmitting modulated carrier waves in respectively opposite directions, a voice line terminating in a two-way modulator-demodulator circuit and band filter, a branch circuit leading from said band filter to each of said two main lines, and switching apparatus controlled by waves sent through the system for rendering said branch circuits alternately operative or inoperative for enabling two-way transmission to be carried out between said main lines and said voice line.

2. In a carrier wave system, a two-wire voice-frequency line including at a terminal thereof a modulator-demodulator unit and a carrier wave filter, a carrier transmitting circuit containing an amplifier, a carrier receiving circuit containing an amplifier, each of said circuits being operatively associable with said filter through a switching apparatus, and means for operating said switching apparatus under control of waves sent through the system to operatively associate said circuits one at a time with said filter.

3. In a carrier wave system, an eastward one-way line, a westward one-way line, each line containing a one-way amplifier, means transmitting modulated carrier waves of the same frequency range over each line, comprising at a terminal common to said lines, a modulator-demodulator unit and a carrier wave filter, a switch for operatively associating the terminals of said filter opposite the terminals that are connected to the modulator-demodulator unit with said lines one at a time, and means acting in response to waves sent through the system for controlling said switch.

4. In a two-way carrier system, a modem unit for modulating carrier waves for transmission and demodulating received waves, a band filter connected to said modem unit for selectively transmitting and receiving one side-band of a modulated wave and suppressing the opposite side-band, a carrier wave transmitting circuit, a carrier wave receiving circuit, a switch for operatively associating the terminals of said band filter with said circuits one at a time, means to control said switch by energy in said receiving circuit for effecting association with one of said two circuits and means to control said switch by energy of the side-band that is suppressed by said filter for effecting association with the other of said two circuits.

5. In a multiplex carrier wave system, an eastward line, a westward line, a plurality of two-way lines, a wave modulating and demodulating equipment and a band filter associated with each two-way line, a sending and a receiving carrier wave branch from each of said band filters to said eastward and westward lines, respectively, switching circuits for rendering said carrier wave branches effective one at a time, and impedance devices in said branches for properly terminating said band filters under the different conditions of operation of said switching circuits.

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