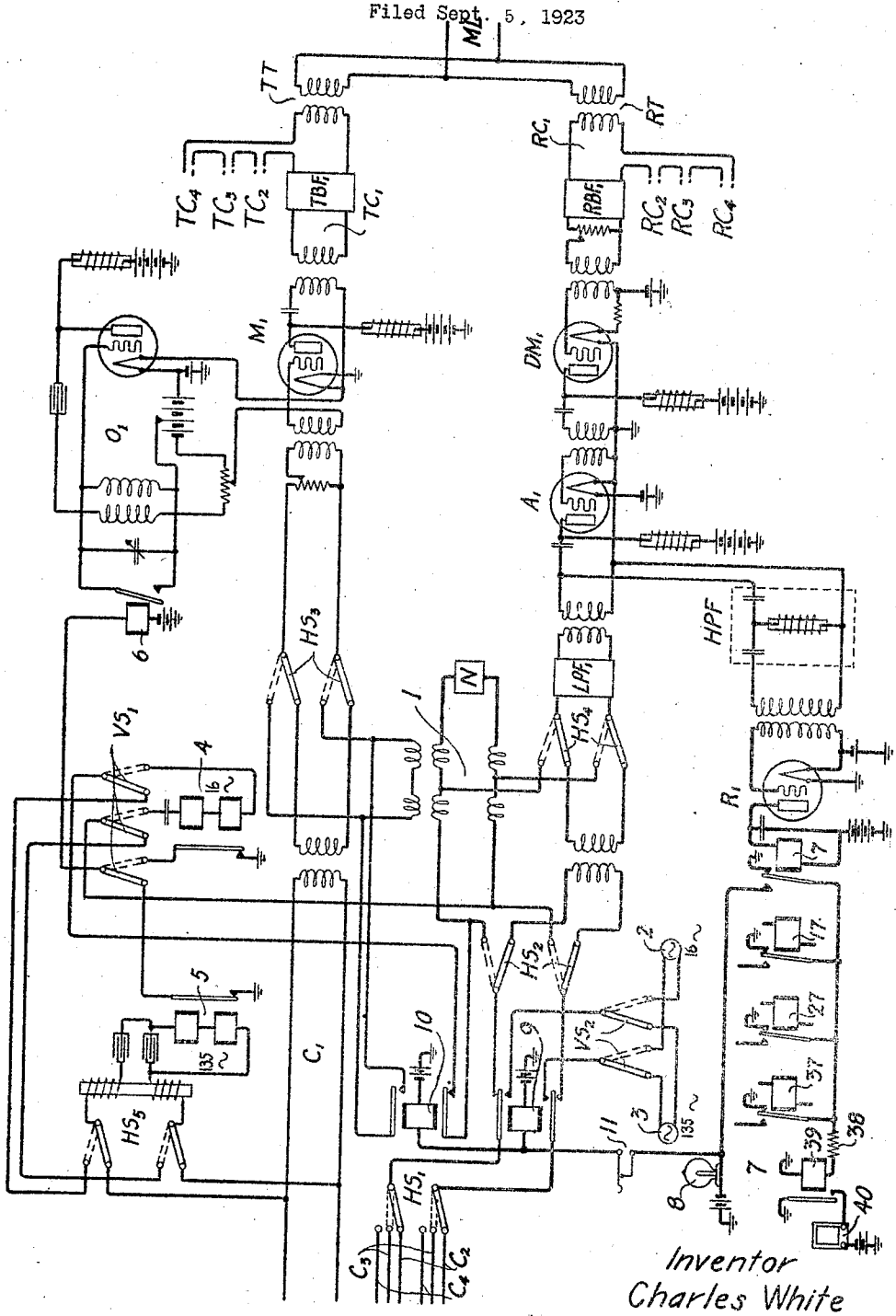
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C. WHITE

CARRIER SIGNALING SYSTEM

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Inventor
Charles White
by E. W. Griggs Atty.

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CHARLES WHITE, OF WEST ORANGE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

CARRIER-SIGNALING SYSTEM.

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To all whom it may concern:

Be it known that I, CHARLES WHITE, a citizen of the United States of America, residing at West Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Carrier-Signaling Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to a carrier signaling system.

According to the ordinary practice in multiplex carrier wave telephone systems, the transmission and receiving branches at each end of each high frequency channel of the system are coupled to low frequency circuits or lines terminating locally or extending to distant stations.

The low frequency circuits or lines may be two-way circuits wherein signals are transmitted in opposite directions over the same circuits or two one-way circuits in which the signals are transmitted in one direction over one circuit and in the opposite direction over the other circuit.

A two-way low frequency circuit, ordinarily known as a two-way circuit is coupled to a transmitting branch and associated receiving branch of a high frequency channel by means of a hybrid coil and associated low frequency line balancing network.

The two one-way low frequency circuits, commonly known as a four-wire circuit, are ordinarily connected one to a transmitting branch and the other to the associated receiving branch of the high frequency receiving channel.

Some of the channels of the multiplex carrier telephone system may be terminated in two-wire low frequency circuits and others in four-wire circuits. Furthermore, one end of a high frequency channel may be terminated in a two-wire circuit and the other end in a four-wire circuit.

Depending upon service conditions, a high frequency channel of such a multiplex carrier telephone system may for a period of time be coupled to a two-wire circuit and for another period to a four-wire circuit. Furthermore, it is frequently desirable to quickly effect a change in the character of the termination of one or more of the high frequency channels of a multiplex carrier telephone system.

This invention contemplates switching arrangements by which such a change in carrier channel termination may be quickly effected.

Another feature of the invention relates to the provision of signal receiving apparatus which may be associated with either a two-wire or a four-wire circuit and the high frequency channel with which the appropriate low frequency circuit is coupled.

The apparatus and circuits illustrated in the drawing represent that required at a terminal station of a multiplex carrier telephone system.

As is well known, a multiplex carrier telephone system comprises a high frequency main line terminating at each end in a plurality of transmitting and receiving branches. The transmitting and receiving branches are associated in pairs and coupled to terminating low frequency circuits or lines. Carrier currents of different frequencies are employed for the different channels of the system. In the particular system illustrated, the carrier frequencies for transmission in one direction are comprised within a frequency range entirely different from that of the frequencies employed for transmission in the opposite direction.

For the purpose of the present invention, it is not necessary to disclose an entire multiplex carrier telephone system but only the apparatus required at one of the terminal stations thereof.

The portion of the system illustrated in the drawing comprises a high frequency main line ML coupled by means of transformers TT and RT to the transmitting and receiving branches of the various channels of the system.

A single high frequency transmitting branch TC_1 is shown in detail while three others, TC_2, TC_3 and TC_4 are indicated.

Likewise, one receiving branch RC_1 is shown in detail while three others, RC_2, RC_3 and RC_4 are indicated.

The various transmitting branches are similar except as to the difference in the constants required due to the different frequency carrier currents employed in the

channels, so that a description of one transmitting branch will suffice.

The transmitting branch includes a modulator M_1, to which carrier current of the frequency assigned to the channel is supplied from an oscillator O_1, and a transmitting band filter TBF_1

The modulator M_1 may be of any well known type, such, for example, as an electronic valve of the type disclosed in Fig. 42 of the article entitled "Carrier current telephony and telegraphy" by Colpitts and Blackwell, published in the Transactions of the American Institute of Electrical Engineers, Vol. 40, 1921.

The transmitting band filter TBF_1, which may be of the type disclosed in U. S. patent to Campbell, No. 1,227,113, May 22, 1917, is designed to pass currents of the carrier frequency assigned to the channel and of the frequencies within the upper or lower side band thereof and to suppress currents of all other frequencies.

The receiving branches are alike except as to the constants of some of the apparatus thereof due to he different carrier frequencies employed in the different channels. Consequently, a description of one such branch will suffice.

The receiving branch RC_1 includes a receiving band filter RBF_1, a demodulator DM_1, an amplifier A_1, a low pass filter LPF_1, a high pass filter HPF_1 and a rectifier R_1.

The receiving band filter RBF_1, of the type disclosed in the Campbell patent supra, is designed to pass currents of the carrier frequency assigned to the channel and of the frequencies within the upper or lower side band thereof and to suppress currents of all other frequencies.

The demodulator, amplifier and rectifier may be of any well known type, such as the electronic valve type disclosed in Fig. 42 of the Colpitts and Blackwell article supra.

The low pass filter LPF_1, of the type disclosed in said Campbell patent, is designed to pass currents of frequencies below the upper limit of the voice range and suppress currents of higher frequencies. The high pass filter, also of the type disclosed in the Campbell patent, is designed to pass currents above the upper limit of the voice range and to suppress currents of lower frequencies.

The input of the transmitting branch TC_1 and the output of the receiving branch RC_1 may be terminated in a two-wire low frequency circuit or a four-wire low frequency circuit.

In order that the termination of the transmitting and receiving branches of a high frequency channel may be readily and quickly changed, switching apparatus for this purpose is provided.

This switching apparatus comprises switches HS_1, HS_2, HS_3 and HS_4. When these switches are in the position shown in full lines, the transmitting branch TC_1 is connected to one of the one-way circuits C_1 and the receiving branch RC_1, is connected to the one way circuit C_2. These two one-way circuits together form a four-wire low frequency terminating circuit.

When the switches are in their dotted line positions, the transmitting branch TC_1 and receiving branch RC_1 are coupled to a two-wire low frequency terminating circuit C_3 by means of hybrid coil 1 and its associated low frequency balancing network N. The hybrid coil and its associated balancing network serve to conjugately relate the transmitting and receiving branches with respect to the connected two-wire low frequency terminating circuit.

Some two-wire low frequency terminating circuits extend to stations equipped for transmitting thereover 16 cycle signaling current, while others extend to stations equipped for transmitting thereover 135 cycle signaling current. Usually, the stations in which the distant end of the four-wire low frequency circuits terminate are equipped to transmit thereover 135 cycle signaling current.

It is, therefore, necessary that the signal receiving and transmitting apparatus at the carrier terminal station connected to the system be of a type suitable to receive and transmit signaling current of the proper frequency.

Therefore, at the terminal station there is provided a source 2 of 16 cycle signaling current and a source 3 of 135 cycle signaling current. There is also provided a receiving relay 4 responsive to the 16 cycle ringing current and a signal receiving relay 5 responsive to the 135 cycle signaling current transmitted from the respective distant stations over their connecting two-wire low frequency lines or circuits. Relay 5 is also responsive to 135 cycle signaling current transmitted over a 4 wire circuit from a distant station.

Switches VS_1 and HS_5 control the connection of the proper receiving relay to the connected terminating circuit and switches VS_2 control the connection of the proper source of signaling current to the connected terminating circuit. The switches VS_1, VS_2 and HS_5 are shown in their full line position connecting the proper receiving relay and source of signaling current to the four-wire terminating circuit.

The operation of the system as shown and as thus far described is as follows:—

The 135 cycle signaling current incoming over the low frequency circuit C_1 actuates relay 5 which opens its contact, releasing relay 6. The closure of the contact of relay 6 short-circuits the frequency determining

circuit of oscillator O_1 so that the flow of carrier current over the main line from the terminal station is interrupted.

When a signal is incoming over the high frequency main line ML as indicated by the cessation of flow of the carrier current, relay 7 in the output circuit of rectifier R_1 releases, causing the lighting of a signal lamp 8 and the operation of relays 9 and 10. Relay 9 connects the source 3 of 135 cycle signaling current to the low frequency circuit C_2. Relay 10 closes its upper contact thereby short-circuiting a winding of the hybrid coil 1 and preventing singing during the ringing operation.

When it is desired to terminate the transmitting and receiving branches TC_1 and RC_1 in a two-wire low frequency circuit equipped with transmitting and receiving signal apparatus of the 135 cycle type, the switches HS_1, HS_2, HS_3, HS_4 and HS_5 are moved to their dotted line positions and switches VS_1 and VS_2 are left in their full line position. The 135 cycle signaling current incoming over low frequency circuit C_3 actuates receiving relay 5 as before, causing the release of relay 6 so that transmission of carrier current over the main line is interrupted.

When a signal incoming over the high frequency line is indicated by the interruption of the flow of carrier current thereover, relay 7 releases as before, causing lamp 8 to light and relays 9 and 10 to operate. Relay 9 connects 135 cycle ringing current from source 3 to the low frequency circuit C_3. Relay 10 functions as before, short-circuiting the winding of the hybrid coil 1. It also opens its lower contact thereby disconnecting relay 5 from the low frequency circuit during the ringing operation.

It is assumed that low frequency line C_4 is equipped at its distant end with apparatus for transmitting 16 cycle ringing current and with signal receiving apparatus responsive to 16 cycle ringing current transmitted from the carrier terminal station.

When the transmitting and receiving branches of the high frequency channel are to be terminated in the two-wire low frequency line or circuit C_4, switches HS_2, HS_3 and HS_4 remain in their dotted line positions, switches VS_1 and VS_2 are moved to their dotted line position and switch HS_1 is moved to connect to the terminals of the low frequency line C_4. Switch HS_5 may be in either of its positions.

The 16 cycle signaling current incoming to the carrier terminal station over low frequency circuit C_4 actuates relay 4 which releases relay 6 thereby interrupting the flow of carrier current over the main line.

Ringing signals incoming over the main line, as indicated by the absence of carrier current therefrom, release relay 7 whereupon lamp 8 lights and relays 9 and 10 operate. Relay 9 connects 16 cycle source 2 to the connected low frequency line C_4. Relay 10 short-circuits the winding of the hybrid coil 1 and opens the circuit of relay 4.

While only one end of one channel of a multiplex carrier system is shown equipped with switching apparatus for terminating the transmitting and receiving branches of such channel in either a four-wire or a two-wire low frequency line and for connecting the proper signaling apparatus to the connected terminating circuit, it is to be understood, of course, that both ends of a high frequency channel may be similarly equipped and both ends or one end only of all other channels may be similarly equipped.

The rectifier relays of the other receiving branches RC_2, RC_3 and RC_4 are indicated by relays 17, 27 and 37. Each of these relays controls a lamp similar to 8 and relays similar to 9 and 10 associated with their respective receiving branches. The operating circuit for relays 9, 10 and lamp 8 includes the normally open contact of relay 7 and the normally closed contact of one of the relays 17, 27 or 37. These normally closed contacts normally short-circuit resistance 38 and relay 39 so that so long as one of the relays 7, 17, 27 and 37 is energized, relay 39 will not operate. However, when all of these relays 7, 17, 27 and 37 are released as would be the case upon a failure of the main line ML, relay 39 would then operate to close the circuit of an alarm signal 40. The combined resistance of relay 39 and resistance element 38 is so great, however, that when included in circuit with relays 9 and 10 of receiving branch RC_1 and the similar relays of the other receiving branches which are now all connected in parallel, the amount of current received by each of such parallel connected relays is insufficient to cause the operation thereof. Therefore, no signaling current is connected to any of the low frequency terminating circuits when the high frequency line fails, but an alarm signal is given.

The circuit including relays 9, 10 and lamp 8 may also include a switch 11 whereby this circuit may be opened should the oscillator at the distant terminal supplying carrier current received by receiving branch RC_1 fail for any reason. The other receiving branches may be similarly equipped.

The invention set forth herein is of course, susceptible of various other modifications and adaptations.

The invention claimed is:

1. In a signaling system, a carrier wave channel terminating in a transmitting branch and a receiving branch, a two-wire low frequency circuit, a four-wire low frequency circuit, two sources of low frequency

signaling current of respectively different character, two low frequency signal receiving branches and two-way switches which, when in one position, connect the two-wire low frequency circuit to the transmitting and receiving branches and to one of said sources of low frequency signaling current and one low frequency signal receiving branch and, when in the other position, connect the four-wire low frequency circuit to the transmitting and receiving branches and to one low frequency signal receiving branch.

2. In a signaling system, a carrier wave channel terminating in a transmitting branch and a receiving branch, a two-wire low frequency circuit, a four-wire low frequency circuit, signal receiving apparatus, and two-position switches which when in one position connect the two-wire low frequency circuit to the transmitting and receiving branches and the signal receiving apparatus to the connected low frequency circuit and when in the other position connect the four-wire circuit to the transmitting and receiving branches and the signal receiving apparatus to the incoming leg of the four-wire circuit.

In witness whereof, I hereunto subscribe my name this 29th day of August A. D., 1923.

CHARLES WHITE.