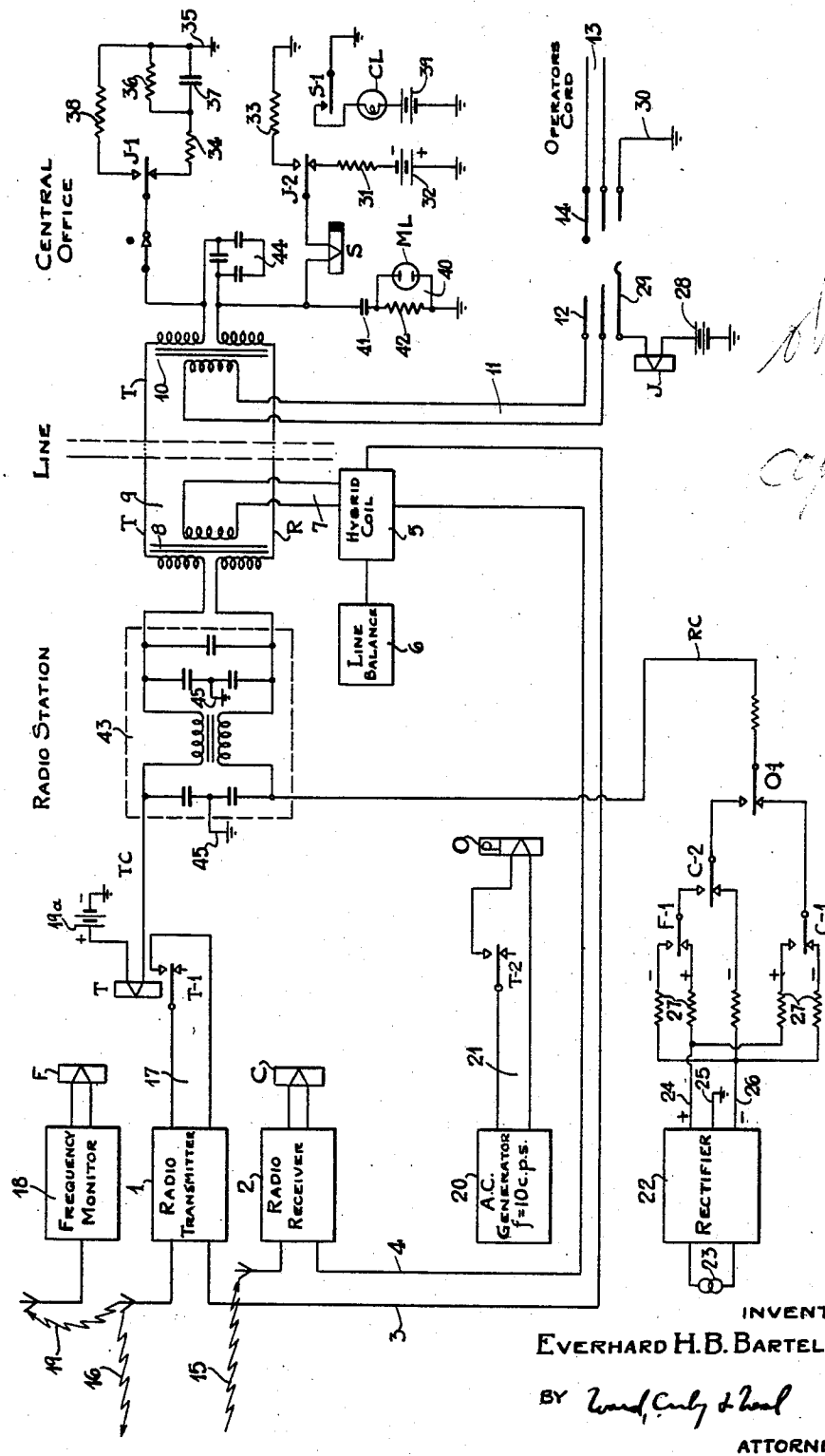


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 SIGNALING AND CONTROL SYSTEM FOR CARRIER
 TELEPHONE TRUNK CIRCUITS
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SIGNALING AND CONTROL SYSTEM FOR
CARRIER TELEPHONE TRUNK CIRCUITSEverhard H. B. Bartelink, Bronxville, N. Y., as-
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7 Claims. (Cl. 250-6)

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This invention pertains to supervisory signaling systems for use in conjunction with radio or carrier current telephone toll lines.

Where radio or carrier current telephone links are employed on toll lines interconnecting central offices, the radio or carrier terminal stations will in general be located at points more or less remote from the central offices which they respectively serve. The connection between the radio or carrier terminal station is ordinarily completed over a two-wire, two-way low frequency circuit which is coupled through a hybrid coil to the radio or carrier current transmitter input, and also to the radio or carrier current receiver and demodulator output.

It is necessary that the central office operator be kept advised, by means of appropriate supervisory signals, as to the status of the radio or carrier link at all times, and that she have the requisite means at her disposal at the central office switch board, for appropriately controlling the operation of the radio or carrier link during as well as between calls. Thus, the operator must be advised as to when a call is incoming over the radio or carrier link, and also as to when the distant central office has disconnected. The operator upon answering the call, must have means available at the switch board for switching on the outgoing carrier of the local radio or carrier current transmitter, and for thereafter observing when the transmitter is operating and on frequency. It is also desirable that these various supervisory signaling and control functions be carried out over the same pair of wires as is used for voice frequency transmission between the central office and the radio or carrier current terminal station.

The present invention provides simple and effective circuits and apparatus for accomplishing these various operations including: a control circuit for switching the radio transmitter carrier on and off from the central office; a control circuit to advise the central office operator that an incoming call is being received by the radio transmitter; and a control circuit to advise the operator whether or not the radio transmitter is operating to provide outgoing carrier of the correct frequency.

The invention will be described with particular reference to a radio link in a toll line interconnecting central office exchanges, although it will be understood that the same circuits and apparatus are equally applicable to carrier current wire circuits, inasmuch as the high frequency terminal equipment is fundamentally the same in each in-

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stance, so that the supervisory signaling and circuit control problems are the same.

The invention comprises, in general terms, a two-conductor, two-way, voice frequency circuit extending from a central office to a radio station, at which point it is linked, for voice-frequency transmission, through a hybrid coil to the input of a radio transmitter and to the output of a radio receiver. In addition to transmitting the voice frequencies, the two-conductor circuit also provides, over each conductor, a separate supervisory or control signaling circuit between the radio station and the central office. The voice-frequency circuit is metallic, while the signaling circuits employ ground return. The voice-frequency and signaling circuits are suitably isolated from one another by means of appropriately constructed and disposed filter circuits, transformers and condensers.

At the radio station, the following signaling equipment is provided: a carrier relay responsive to carrier incoming to the radio receiver; a transmitter relay for switching on the outgoing carrier of the radio transmitter; a frequency monitor and associated relay responsive to outgoing carrier of the radio transmitter for indicating when the transmitter is operating and on the correct frequency; and a polarized oscillating relay energized from a low-frequency alternating current generator under control of the transmitter relay for purposes to be explained.

The signaling and control circuit equipment provided at the central office comprises: a slow-acting supervising relay for energizing a call lamp to indicate when a call, incoming over the radio link, has been placed or terminated; an alternating current, frequency monitor signaling device, responsive to the low-frequency generator and polarized relay aforesaid, for indicating when the radio transmitter is operating and on the correct frequency; and a jack relay responsive to insertion of the operator's cord plug into the toll line jack, for switching on the outgoing carrier of the radio transmitter and for extinguishing the call lamp when the incoming call has been answered.

One conductor of the two-wire, voice-frequency circuit is employed as a direct current, ground return circuit, for energizing the transmitter relay from the central office to switch on the outgoing carrier, upon insertion of the operator's cord plug in the toll line jack. The remaining conductor of the two wire-circuit provides a direct current, ground return circuit, for energizing the central supervising relay from the radio station in re-

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sponse to incoming calls; and also as an alternating current circuit for energizing the central office frequency monitor signaling device from the radio station, when the radio transmitter is operating and on frequency. These operations are achieved, in accordance with the invention, by the application of positive or negative or alternately positive and negative voltages to the radio station end of the conductor to which the supervising relay and frequency monitor signal devices are connected at the central office. These voltages are applied to said conductor through contacts of the frequency monitor, carrier and polar relays, in accordance with the operations thereof and in such manner as to effect the various signaling functions above referred to.

The single figure of the drawing illustrates, in circuit diagram form, a preferred embodiment of the invention.

Referring to the drawing, there is illustrated diagrammatically a radio station comprising, a radio telephone transmitter 1 and a radio telephone receiver 2, the voice frequency input and output of which are respectively connected over circuits 3, 4, to a hybrid coil 5, provided with a line balancer 6, and thence over a circuit 7 and through transformer 8 to a two-wire, two-way, voice-frequency circuit 9 extending to a central office, and thence through transformer 10 thereat, to conductors 11 terminating at jack 12 on a switch board at the central office. The operator's cord 13 is provided with a plug 14, insertable in jack 12, for answering a call incoming from the radio station over the two-conductor radio circuit 9.

For advising the central office operator as to when a call is incoming to the radio station, there is provided thereat a carrier relay C, which responds to carrier current, indicated at 15, incoming to radio receiver 2. Also there is provided means whereby the central office operator may switch on the outgoing carrier, indicated at 16, of radio transmitter 1, said means including transmitter relay T which controls, through its armature and front contact T-1, a circuit 17 for switching on said outgoing carrier. The transmitter relay is energized from negatively grounded battery 19a over a circuit which includes the TC conductor of the two-wire circuit 9 extending to the control office. For advising the operator as to when transmitter 1 is operating and on frequency, there is provided a frequency monitor 18 and associated frequency monitor relay F, which responds to the outgoing carrier as indicated at 19, when the carrier is being transmitted on the correct frequency.

In addition to the equipment above described, there is provided at the radio station a low-frequency, alternating current generator 20, for generating a frequency on the order of ten cycles per second, as indicated, the output of this generator being connected over a circuit 21 and through an armature T-2 and associated front contact of the transmitter relay T, to the winding of a polarized oscillating relay O. Also there is provided a rectifier 22 for converting a source of alternating current 23 into a low voltage, direct current to provide a direct current output voltage of positive polarity between an output conductor 24 and a grounded conductor 25, and also to provide a corresponding voltage of negative polarity between an output conductor 26 and said grounded conductor 25. The positive output lead 24 is wired in multiple, through current-limiting resistors, such as 27, to a back contact of an arma-

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ture F-1 of the frequency monitor relay F, and also to a front contact of an armature C-1 of the carrier relay C. The negative output lead 26 is similarly wired in multiple to the front contact of armature F-1 of the frequency monitor relay F, and also to back contacts of armatures C-1 and C-2 of the carrier relay C. The C-1, C-2 armatures of the carrier relay are in turn connected to back and front contacts respectively of an armature O-1 of the oscillating relay O, this armature in turn being connected to the lower conductor RC of the two-wire circuit 9 extending to the central office.

Referring now to the central office, there is provided a jack relay J, connected between the negatively grounded battery 28 and the ring conductor 29 of jack 12, this relay being energized when the operator's cord plug 14 is inserted in jack 12, owing to the ground 30 connected to the ring conductor of the plug 14. There is also provided at the central office a slow-acting supervising relay S, the winding of which is connected between the lower conductor RC of the two-wire circuit 9, and an armature J-2 of the jack relay, the associated back contact of which is connected through a current-limiting resistor 31 to positively grounded battery 32, and the associated front contact of which is connected through a similar resistor 33 to ground.

The supervising relay S is provided with a grounded armature S-1, the associated front contact of which is connected through a call lamp CL to negatively grounded battery 35. There is also provided at the central office an alternating current signaling device 40, responsive to low frequency alternating current and comprising a condenser 41 connected in series with a resistance 42 to ground, the resistance 42 in turn being connected in shunt to a frequency monitoring lamp or neon tube ML. The signaling device 40 is connected to the lower conductor RC of the two-wire circuit 9.

The jack relay is provided with a second armature J-1, which is connected to the central office end of the upper conductor T of circuit 9, this armature having a back contact connected through a low resistance 34, of about a thousand ohms or so, and thence in series to ground at 35 through a high resistance 36 of megohm or so, the high resistance being shunted by a by-pass condenser 37 of about a microfarad capacity. The associated front contact of armature J-1 is connected through a low resistance 38 of about a thousand ohms or so, to ground at 35.

It will be observed that the upper conductor TC of the two-wire circuit 9, provides a direct current path from grounded battery 19a through the winding of relay T at the radio station, and over conductor TC to armature J-1 of the normally deenergized jack relay at the central office. The transmitter relay T is thus normally deenergized owing to the high resistance path to ground through the J-1 armature and back contact of the J relay through resistors 34, 36, the latter, as stated, being of the order of a megohm or so. On the other hand, when the J relay is energized, this in turn energizes the transmitter relay T over the low resistance path to ground through the J-1 armature and front contact, and low resistance 38 to ground at 35. Accordingly, the transmitter relay T will be energized when the operator's cord plug 14 is inserted in jack 12 to energize the jack relay J.

Reverting now to the lower conductor RC of circuit 9, it will be observed that the central

office end of this conductor is normally connected through the supervising relay S to negative battery 32 through the J—2 armature and back contact of the normally deenergized jack relay 12. On the other hand, the radio station end of conductor RC normally extends in series through the O—1 armature and back contact of the normally deenergized polar relay O, and thence through the C—1 armature and back contact of the normally deenergized carrier relay C, to negative battery supplied over lead 26 of rectifier 22. Although this provides a direct current path from the negative voltage lead 26 at the radio station over conductor RC to one terminal of the winding of the supervising relay S at the central office, nevertheless this relay is normally deenergized owing to negative battery, likewise normally supplied to the opposite terminal of this winding from battery 32 through the J—2 armature and back contact of the jack relay.

However, upon receipt of incoming carrier 15 to radio receiver 2, the carrier relay C will operate to transfer its C—1 armature from its back to its front contact, whereupon positive voltage from the rectifier output conductor 24 will be applied to the C—1 armature, and thence over conductor RC to the supervising relay S at the central office, which will thereupon operate owing to positive battery now applied to one terminal of its winding, and negative battery from source 32 applied to the opposite terminal thereof. The resulting operation of the supervising relay will thereupon energize the call lamp CL from battery 39 through the front contact and grounded S—1 armature of the supervising relay. In this way, the operator is apprized as to an incoming call.

When the operator answers the call by inserting her cord plug 14 into jack 12, the jack relay J is energized as aforesaid, to transfer its J—1, J—2 armatures from their back contacts to their front contacts. The supervising relay remains momentarily operated, since its winding is now grounded at the central office through the jack relay J—2 armature and front contact, the latter being connected to ground through resistor 33. At the same time, the transmitter relay T is energized from battery 19a, over conductor T and through the J—1 armature and front contact of the jack relay, to ground at 35 through the low resistance 38. Energization of the transmitter relay closes, through its T—1 armature and front contact, the circuit 17 for switching on the carrier 16 outgoing from the radio transmitter 1. Operation of the T relay also connects, through its T—2 armature and associated front contact, the low frequency generator 20 to the oscillating relay O.

The oscillating relay O is thereby energized from the low frequency source 20, alternately to switch its O—1 armature between its associated back and front contacts, at the frequency of source 20. However, assuming for the moment that the outgoing carrier 16, 19 from the radio transmitter 1 is not on the air as yet, or is not outgoing on the proper frequency, the frequency monitor relay F will not be actuated. Under these circumstances, it will be noted that positive voltage is applied to both the back and front contacts of the oscillating relay through the C—1, C—2 armatures and front contacts of the carrier relay C, owing to energization of the carrier relay by the incoming carrier, in consequence of which the supervising relay S will remain en-

energized at the central office, to hold the call lamp CL energized.

As soon, however, as the carrier 16, 19 is outgoing from transmitter 1 on the proper frequency, the frequency monitor relay F will be energized, to apply, through its F—1 armature and front contact, a negative voltage to the front contact of the oscillating relay armature O—1, while positive voltage remains applied to the back contact thereof as aforesaid. In this case, the oscillations of the O relay will put voltage reversals on the RC conductor extending to the central office, thus reducing substantially to zero the current flowing in the winding of the slow acting supervising relay S, which thereupon releases to extinguish the call lamp CL. At the same time, however, alternating current at the frequency of operation of the oscillating relay O, is caused to flow through the alternating current frequency monitoring device 40 at the central office, thereby to illuminate the monitoring, neon lamp ML. The operator is thus advised that carrier is outgoing from transmitter 1 on the proper frequency, and also that carrier is incoming to radio receiver 2 from the distant or calling station.

When the operator at the distant central office disconnects, the incoming carrier to the radio receiver 2 will cease, whereupon the carrier relay C will release, to which its C—1, C—2 armatures from their associated front to their associated back contacts. Negative voltage therefore appears on both front and back contacts of the O—1 armature of the oscillating relay O, thereby to terminate the transmission of alternating current over the RC conductor, thus extinguishing the frequency monitoring lamp ML. At the same time, the application of negative voltage to both contacts of the O relay, again energizes the supervising relay S at the central office, which in turn energizes the call lamp CL, thus advising the operator that the distant central office has disconnected.

If the local central office operator should remove her cord plug 13 from jack 12, while the call is in progress, the transmitter relay T will release to switch off the out-going carrier at its T—1 armature, and also to disconnect generator 20 from the oscillating relay O at its T—2 armature. Accordingly, the frequency monitoring lamp ML is extinguished, but the supervising relay S and the call lamp CL are energized, until the distant operator has disconnected, due to the fact that the carrier relay C remains operated until then, thereby to apply positive voltage through its C—1 armature and front contact to the RC conductor.

The signaling and voice frequency circuits of the two-wire circuit 9 are isolated from one another by means of the isolating transformers 8, 10, and associated filter circuits 43, 44. It will be noted in this connection that one winding of each of the transformers 8, 10 has interposed at its midpoint one of the filter circuits 43, 44, which filters off to ground at 45, the higher harmonics of the alternating current from the signaling circuits; while the interposition of the two-winding transformers 8, 10 in the voice frequency circuits prevents the direct current signals from entering the voice frequency circuit.

Operation of the signaling circuits under the various conditions which occur may be restated as follows:

1. *System idle.*—At the radio station, the C relay is released, because there is no incoming carrier. The T relay is released due to release

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of the J relay at the central office. Hence, the F and O relays are released. Negative voltage is accordingly applied to the RC conductor. At the central office the J relay is released, because the operator's cord circuit plug is disconnected from jack 12. The supervising relay is released because negative voltage is applied to both sides of its winding terminals, that of the RC conductor one side, and that of battery 32 through the back contact and J-2 armature of the J relay, on the other. The call lamp CL is accordingly extinguished. Also the ML lamp is extinguished, because no alternating current is applied to the RC conductor.

2. *Incoming calls.*—The C relay is energized by the incoming carrier, and thus applies positive voltage to the RC conductor. The supervising relay is accordingly actuated to energize the call lamp CL.

3. *Call answered.*—Insertion of plug 14 in jack 12 energizes the J relay. This in turn actuates the T relay to switch on the outgoing carrier from the radio transmitter, and also to energize the oscillating O relay from generator 20.

If the outgoing carrier is not on the air, or is not on frequency, the F relay will remain deenergized, in which case positive battery will be applied to the RC conductor on both contacts of the O relay, since the carrier relay C remains operated by the incoming carrier. Hence, no alternating current is applied to the RC conductor and the monitoring lamp ML remains deenergized. On the other hand, the supervising relay remains energized to ground through the J-2 armature and associated front contact of the J relay. The call lamp CL thus remains lighted.

When the outgoing carrier is on the air, at the correct frequency, the F relay will operate, to put negative voltage on the front contact of the O relay, the back contact of which receives positive battery as aforesaid. Square-wave alternating current voltage is thus applied to the RC conductor, which energizes the monitoring lamp ML at the central office, but deenergizes the S relay and with it the call lamp CL, which is extinguished.

4. *Disconnect.*—Release of the circuit by the distant central office will switch off the incoming carrier and thus release the C relay. This restores negative battery to both contacts of the O relay, to extinguish the monitoring lamp ML at the central office, and to energize the S relay and with it the CL lamp which relights, thus signaling the central office operator to disconnect. When the operator removes her cord plug from jack 14, the J relay will release to extinguish the CL lamp by application of negative voltage to both terminals of the S relay winding, which releases. This also releases the T relay which in turn releases the F and O relays, thus restoring the system to its idle condition.

If the operator pulls the plug 14 before the incoming carrier is off, the J, T, F and O relays will release. The C relay will remain actuated by the incoming carrier, and hence will apply positive battery to the RC conductor. The ML lamp will be extinguished, but the S relay will be energized and with it the CL lamp, until the distant operator has disconnected.

I claim:

1. In a communication system: a carrier current transmitter and receiver; a two-conductor circuit connecting the same to a central office; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for

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switching on carrier current outgoing from said transmitter; a supervising relay at the central office; means including said carrier relay and one conductor of said two-conductor circuit, for energizing said supervising relay in response to incoming carrier; and means including the remaining conductor of said two-conductor circuit and switching means at the central office for energizing said transmitter relay to switch on the outgoing carrier.

2. In a communication system: a carrier current transmitter and receiver; a two-conductor circuit connecting the same to a central office; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for switching on carrier outgoing from said transmitter; a supervising relay at the central office and a call lamp responsive thereto; means including said carrier relay and one conductor of said two-conductor circuit, for energizing said supervising relay and call lamp in response to incoming carrier; and means including the remaining said conductor, a jack having a sleeve conductor, a jack relay connected to said sleeve conductor and an operator's cord plug at the central office, for energizing said transmitter relay upon insertion of said plug in said jack, thereby to switch on carrier current outgoing from said transmitter.

3. In a communication system: a carrier current transmitter and receiver; a two-conductor circuit connecting the same to a central office; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for switching on carrier current outgoing from said transmitter; a frequency monitor having a frequency monitor relay connected in its output and responding to said outgoing carrier when of a preselected frequency; a source of low-frequency alternating current and a polar relay energizable therefrom upon actuation of said transmitter relay; a supervising relay, a jack relay and an alternating current signaling device at the central office; means including contacts of said carrier and polar relays, and a first conductor of said two-conductor circuit, for energizing said supervising relay in response to incoming carrier; means including said jack relay and the second conductor of said two-conductor circuit, for energizing said transmitter relay to switch on the outgoing carrier; and means including contacts of said frequency monitor, carrier and polar relays and said first conductor, for extinguishing said supervising relay and energizing said alternating current signaling device while carrier current is incoming to said receiver and concurrently outgoing from said transmitter on said preselected frequency.

4. In a communication system: a carrier current transmitter and receiver; a two-conductor circuit connecting the same to a central office; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for switching on carrier current outgoing from said transmitter; a frequency monitor having a frequency monitor relay connected in its output, and responding to said outgoing carrier when of a preselected frequency; a polar relay energizable from a low-frequency alternating current source in response to actuation of said transmitter relay; a supervising relay and a low-frequency signaling device connected to a first conductor of said two-conductor circuit at the central office, the opposite end of said first conductor being connected to an armature of said polar re-

lay, said armature having back and front contacts connected respectively to a pair of armatures of said carrier relay, said carrier relay armatures having back contacts connected to a negative voltage source, and front contacts respectively connected to a positive voltage source and to an armature of said frequency monitor relay, the latter said armature having back and front contacts respectively connected to said positive and negative voltage sources; and means including a jack relay at the central office and the second conductor of said two-conductor circuit, for energizing said transmitter relay and for concurrently switching a winding terminal of said supervising relay from a negative voltage source to ground at the central office.

5. In a communication system: a carrier current transmitter and receiver; a first speech-frequency circuit coupled to the transmitter input and to the receiver output through a hybrid coil; a transformer coupling said speech-frequency circuit to a two-conductor circuit extending to a central office; a transformer coupling said two-conductor circuit to a second speech-frequency circuit thereat; each said transformer including a winding connected in series with a condenser between said two conductors, thereby to provide separate, direct current signaling paths over the individual conductors and a speech-frequency circuit over said conductors jointly; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for switching on carrier current outgoing from said transmitter; a supervising relay at the central office; means including said carrier relay and a first said conductor, for energizing said supervising relay in response to incoming carrier; and means including the second said conductor and switching means at the central office, for energizing said transmitter relay to switch on the outgoing carrier.

6. In a communication system: a carrier current transmitter and receiver; a first speech-frequency circuit coupled to the transmitter input and to the receiver output through a hybrid coil; a transformer coupling said speech-frequency circuit to a two-conductor circuit extending to a central office; a transformer coupling said two-conductor circuit to a second speech-frequency circuit thereat; each said transformer including a winding connected in series with a condenser between said two conductors, thereby to provide separate, direct current signaling paths over the individual conductors and a speech-frequency circuit over said conductors jointly; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for switching on carrier outgoing from said transmitter; a supervising relay at the central office and a call lamp responsive thereto; means including said carrier relay and a first of said conductors, for energizing said supervising relay and call lamp in re-

sponse to incoming carrier; and means including the remaining said conductor, a jack, and associated jack relay and operator's cord plug at the central office, for energizing said transmitter relay upon insertion of said plug in said jack, thereby to switch on carrier current outgoing from said transmitter.

7. In a communication system: a carrier current transmitter and receiver; a first speech-frequency circuit coupled to the transmitter input and to the receiver output through a hybrid coil; a transformer coupling said speech-frequency circuit to a two-conductor circuit extending to a central office; a transformer coupling said two-conductor circuit to a second speech-frequency circuit thereat; each said transformer including a winding connected in series with a condenser between said two conductors, thereby to provide separate, direct current signaling paths over the individual conductors and a speech-frequency circuit over said conductors jointly; a carrier relay responsive to carrier current incoming to said receiver; a transmitter relay for switching on carrier current outgoing from said transmitter; a frequency monitor and associated frequency monitor relay responsive to said outgoing carrier when of a preselected frequency; a source of low-frequency alternating current and a polar relay energizable therefrom upon actuation of said transmitter relay; a supervising relay, a jack relay and an alternating current signaling device at the central office; means including contacts of said carrier and polar relays and a first of said conductors, for energizing said supervising relay in response to incoming carrier; means including said jack relay and the second of said conductors, for energizing said transmitter relay to switch on the outgoing carrier; and means including contacts of said frequency monitor, carrier and polar relays, and said first conductor, for extinguishing said supervising relay and energizing said alternating current signaling device while carrier current is incoming to said receiver and concurrently outgoing from said transmitter on said preselected frequency.

EVERHARD H. B. BARTELINK.

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Disclaimer

2,454,498.—*Everhard H. B. Bartelink*, Bronxville, N. Y. SIGNALING AND CONTROL SYSTEM FOR CARRIER TELEPHONE TRUNK CIRCUITS. Patent dated Nov. 23, 1948. Disclaimer filed Nov. 8, 1950, by the assignee, *Automatic Electric Laboratories, Inc.*

Hereby enters this disclaimer of claims 1 and 2 of said patent.
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