Dec. 28, 1948. E. H. B. BARTELINK 2,457,434

SIGNALING SYSTEM FOR TWO-WAY DIALING OVER RADIO AND CARRIER TELEPHONE CIRCUITS

Filed Feb. 20, 1947 2 Sheets-Sheet 1

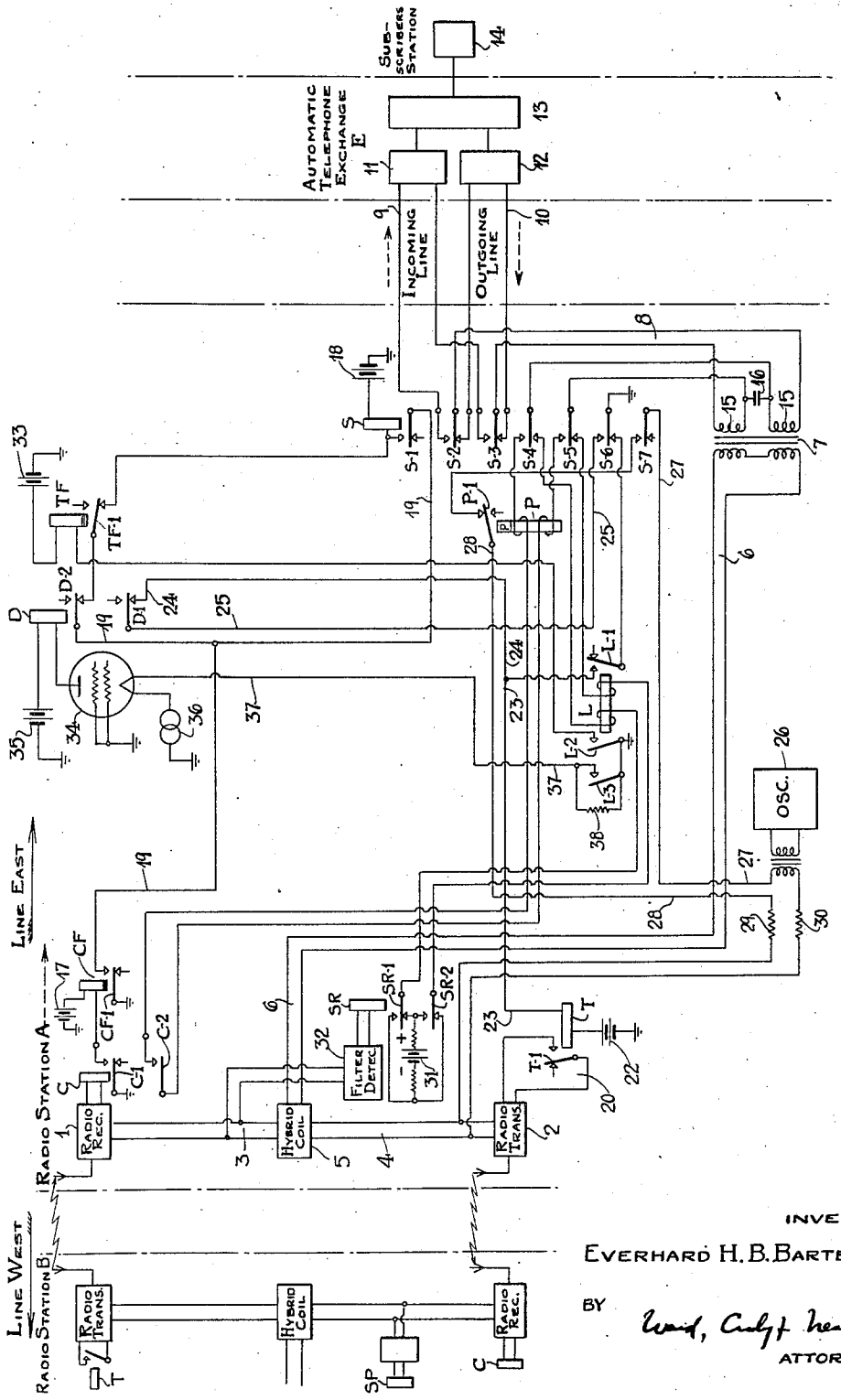


Fig. 1.

INVENTOR
EVERHARD H. B. BARTELINK.

BY Ward, Cahoon & Neal.
ATTORNEYS.

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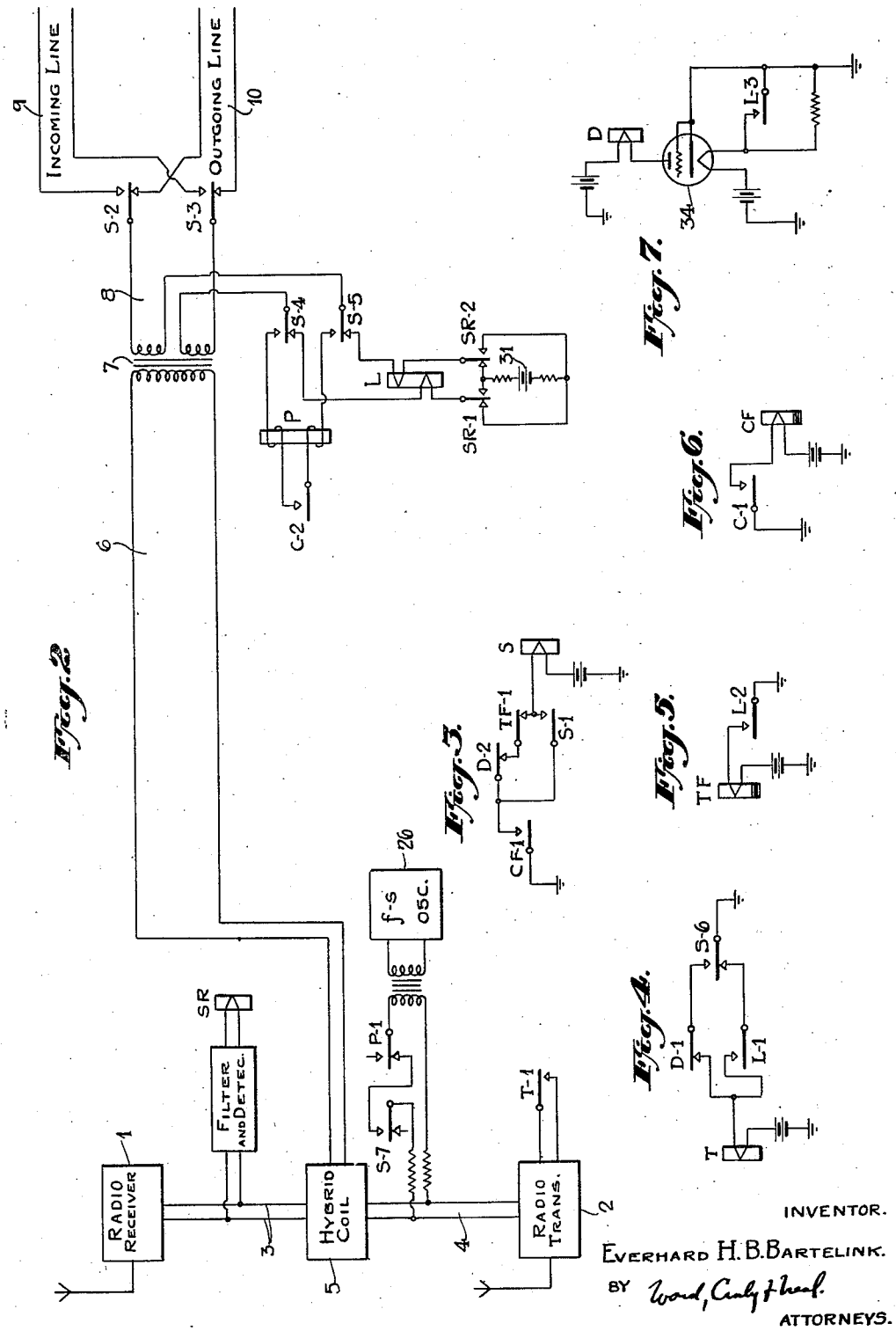


Fig. 2.

Fig. 7.

Fig. 6.

Fig. 3.

Fig. 5.

Fig. 4.

INVENTOR.
EVERHARD H. B. BARTELINK.
BY Ward, Cauley & Heal
ATTORNEYS.

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SIGNALING SYSTEM FOR TWO-WAY DIALING OVER RADIO AND CARRIER TELEPHONE CIRCUITS

Everhard H. B. Bartelink, Bronxville, N. Y., assignor to General Telephone Corporation, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 250—6)

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This invention pertains to signaling circuits for use in conjunction with radio or carrier current circuits of automatic telephone systems employing dialing pulses for effecting station selection. A primary object of the invention is to provide novel and relatively simple and economical circuits and apparatus for effecting two-way dialing, supervision and circuit control over radio or carrier current links or channels interconnecting automatic telephone exchanges or central offices.

The invention is grounded on the concepts of switching the carrier current on and off, of interrupting the same in accordance with dialing pulses, and of modulating the same with special tones or frequencies as means for extending the dialing, supervision and circuit control functions over the radio or carrier current links aforesaid.

The invention will be described with particular reference to a two-way radio link interconnecting a pair of automatic central office exchanges, although it will be understood that identical signaling circuit arrangements are applicable to carrier current telephone line circuits, since a two-way radio link is the substantial equivalent of a two-way carrier telephone line circuit, as regards principles of operation and terminal equipment employed, so that the signaling problems are the same. That is to say, in each instance, and at the terminals of the radio or carrier link, a two-wire, two-way, voice frequency telephone circuit extends to a hybrid coil, one branch of which connects to the input of the radio transmitter or carrier current oscillator, whereby the speech input modulates the outgoing carrier; while the other branch of the hybrid coil connects to the output of the radio receiver or carrier current demodulator, whereby the speech-modulated incoming carrier is, after demodulation, transmitted to the two-wire, voice frequency circuit. It will be evident, therefore, that the same types of circuits and apparatus will be required for effecting two-way dialing, supervision and circuit control over a carrier current telephone line as is required in the case of a radio link.

Since the radio stations or carrier telephone circuit terminals, as the case may be, are in general located at greater or lesser distances from the automatic telephone exchanges which they serve, I propose, in accordance with the preferred modification of my invention, to connect each radio station or carrier telephone line terminal to its associated automatic exchange, over a pair of two-conductor lines, one an "outgoing line" to

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handle calls outgoing from the central office to the radio link or carrier line, and the other an "incoming line" to handle calls incoming to the central office from the radio link or carrier circuit.

When the system is idle, as well as on outgoing calls, the outgoing line is connected through back contacts of a normally deenergized sequence relay and through a two-winding isolating transformer to the two-wire, speech frequency line extending to the hybrid coil of the radio station or carrier terminal equipment. On incoming calls, however, the sequence relay is energized to transfer the two-wire connection from the hybrid coil to the incoming line, the sequence relay remaining thus operated until the call is completed.

The carrier current of the radio or carrier current transmitter is under control of a transmitter relay which, when energized, switches on the outgoing carrier, this relay being sufficiently rapid in operation to follow dialing pulses. On outgoing calls, the transmitter relay is under control of a fast-operating line relay which responds to dialing pulses received from the central office over the outgoing line, and thus, by correspondingly actuating the transmitter relay, transmits the outgoing dialing pulses over the radio or carrier link by interruption of the outgoing carrier.

The line relay is connected to a battery of reversible polarity at the radio station or carrier terminal, and is normally connected to the outgoing line through back contacts of the sequence relay, so that when a call is placed on the outgoing line, a direct current loop circuit is completed at the central office on this line to energize the line relay, in turn to energize the transmitter relay and thus switch on the outgoing carrier. Dialing pulses are transmitted to the line relay by interruption of the direct current.

Energization of the line relay energizes a slow-acting transmitter follower relay, which is unresponsive to dialing pulses and which prevents the sequence relay from operating to disconnect the line relay, in the event an attempt is made to place an incoming call while an outgoing call is in progress.

The outgoing carrier transmitted to the distant radio station or carrier terminal, operates a carrier current actuated relay thereat. This carrier relay, which is sufficiently fast-acting to follow dialing pulses, in turn operates a slow-acting carrier follower relay which is unresponsive to dialing pulses. The carrier follower relay in turn energizes the sequence relay at the distant station through contacts of the normally deenergized

transmitter follower relay thereat. Operation of the sequence relay in turn operates the transmitter relay at the distant station to switch on the radio transmitter carrier thereat, and also connects the two-wire connection from the hybrid coil thereat to the incoming line extending to the distant central office. It also disconnects the line relay thereat and substitutes therefor a two-winding polarized relay, the windings of which extend at their inner terminals to normally open contacts of the carrier relay. Therefore, operation of the carrier relay in response to dialing pulses received over the radio or carrier link, completes through its contacts and the polarized relay windings, a loop over the distant incoming line for transmitting the dialing pulses thereover to the distant telephone exchanges serving the called station. The polar relay provides reverse battery supervision on the connection. So long as this relay receives normal battery current or no current from the central office, its armature will be on the spacing contact. In this position, it prepares a circuit, which is completed upon energization of the sequence relay as above explained, to modulate the carrier incoming from the distant radio station or carrier terminal, with a supervising frequency or tone. This supervision frequency remains on until the distant or called subscriber lifts his receiver from the switch hook and thereby reverses the battery from the distant dial exchange. This battery reversal operates the polar relay at the distant radio station or carrier terminal, from its spacing to its marking contact, and thereby disconnects or removes the supervision frequency from the carrier incoming to the calling station.

The supervision frequency is, as above explained, transmitted to the radio station or carrier terminal originating the call, whence upon demodulation, it energizes a supervising relay thereat, which in turn controls the polarity of the battery applied to the line relay thereat. Thus, the supervising relay will apply reverse battery through the line relay to the outgoing line originating the call, until the called station has answered. When this occurs, the supervision frequency will be removed from the incoming carrier, as above explained, thereby causing the supervision relay to release at the originating end of the call, and thus apply normal battery to the outgoing line connected to the calling station. This advises the calling station that the called subscriber has answered.

The above describes the operation of the signaling circuits of my invention in general terms, during the progress of establishing a telephone connection from one automatic central office exchange over the radio or carrier link to a distant automatic exchange. The establishment of such a connection involves the transmitting equipment at one end of the radio or carrier link and receiving equipment at the other end thereof. It will be understood, of course, that since this transmitting and receiving equipment is duplicated at each end of the link, the above generalized description covers the operation of the transmitting equipment on outgoing calls, as well as the operation of the receiving equipment on incoming calls.

It will be evident from the above generalized description that the signaling circuits of this invention are characterized by the following novel features of operation. An incoming call will operate a sequence relay and keep it operated until the call is completed. Also, on incoming calls,

the sequence relay will energize the transmitter to transmit the outgoing carrier. When the circuit is being utilized for an outgoing call, the line relay controlling the transmitter follower relay prevents the sequence relay from operating, to establish a connection for an incoming call. On an incoming call, a supervision tone is put on the line until the called subscriber removes his receiver from the switch hook. On an outgoing call, reception of the supervision frequency from the distant station will control the battery polarity applied to the line relay. Fast and slow-operating relays are employed to transmit dialing pulses on the one hand, and to hold circuits during dialing on the other hand. At the conclusion of an outgoing call, a delay relay, provided in the circuit and to be described hereinafter, will, by interrupting the circuits until all relays have been cleared, prevent an incoming call from "locking up" the system.

Referring now to the drawings:

Fig. 1 shows a complete circuit diagram of the signaling system of the invention, as applied to a radio transmitting and receiving station connected over incoming and outgoing lines to an automatic telephone exchange, the latter being shown diagrammatically; while

Figs. 2 to 7 inc. are circuit diagrams of the signaling system of Fig. 1, wherein, however, the operating and control circuits for various of the individual relays are separately illustrated. Fig. 2 shows the radio transmitting and receiving station in simplified form, together with connections therefrom to the incoming and outgoing lines, this figure also including the operating windings for the line, polar, carrier and supervising relays and also the source of supervision frequency. Fig. 3 shows the operating circuits for the sequence relay; Fig. 4 those for the transmitter relay; Fig. 5 that for the transmitter follower relay; Fig. 6 that for the carrier follower relay; and Fig. 7 that for the delay relay.

Referring to the drawings, and particularly to Fig. 1, there is shown a radio station A and a portion of a radio station B, comprising a two-way radio link. Station A comprises a radio telephone receiver 1 and a radio telephone transmitter 2. The voice frequency output of the receiver and the voice frequency input of the transmitter are connected respectively over conductors 3, 4 and through a hybrid coil 5 to a two-wire line 6. Line 6 is connected through a two-winding audio-frequency transformer 7, and over a pair of conductors 8, to the armatures S—2, S—3 of the normally deenergized sequence relay S, the front and back contacts of which armatures are connected respectively to "incoming" and "outgoing," two-wire lines 9, 10 extending to an automatic telephone exchange E, at which the incoming line terminates on incoming terminal equipment 11, while the outgoing line terminates on outgoing terminal equipment 12. The terminals 11, 12 are linked to the dial-actuated selecting equipment 13 of the automatic exchange, to which the subscribers' stations, such as 14, are connected.

The two-winding transformer 7 serves to separate the voice frequency circuit from the direct current dialing and signaling circuits. To this end, there is interposed at the midpoint of the transformer winding 15, a condenser 16, the opposite terminals of which are respectively connected to armatures S—4, S—5 of the sequence relay S, the back contacts of which armatures are respectively connected to winding terminals of a two-winding line relay L, while the front contacts

of said armatures are respectively connected to winding terminals of a two-winding polar relay P.

Thus, when relay S is deenergized, the speech circuit 6, 7, 8 is connected to the outgoing central office trunk line 10, the direct current signaling circuit of which includes, at the radio station, the line relay L. Contrarywise, when relay S is energized, the speech circuit 6, 7, 8 is connected to the incoming trunk line 9, the direct current signaling circuit of which includes the polar relay P. The functions of these relays have been touched upon in the foregoing general description of the invention and will be explained more in detail hereinafter.

The remaining portions of the circuit, together with the operation thereof, will now be described, first, with reference to "incoming calls," i. e., calls incoming to radio station A from radio station B, and then with reference to "outgoing calls," i. e., calls outgoing from radio station A to radio station B.

Incoming calls

On incoming calls, the carrier current actuated relay C, connected to the radio receiver 1, is energized by carrier current transmitted from the radio transmitter of station B. Relay C is a quick-acting relay which follows the dialing pulse interruptions of said carrier current. Operation of relay C connects ground at its grounded armature C—1 to the carrier follower relay CF to energize the same from battery 17. The CF relay is of the slow-release type, such that it will remain operated during reception of dialing pulses, actuating relay C.

If radio station A is not in use when incoming carrier current is received from station B, the CF relay, upon operating, will energize the sequence relay S, over a circuit traced from the grounded armature CF—1 and front contact of the CF relay, thence through the upper armature D—2 and back contact of the normally released delay relay D, thence through the armature TF—1 and back contact of the normally released, transmitter follower relay TF, and thence through the winding of the S relay to the negatively grounded battery 18. The operation of the S relay over the circuit traced, will complete a holding circuit for thereafter holding the S relay operated under control of the CF relay, this holding circuit being traced from battery 18 through the winding of the S relay and thence through its front contact and armature S—1 over connection 19 to ground through the front contact and grounded armature CF—1 of the CF relay. As explained below, the S relay can not be operated over the circuit above traced, if radio station A is busy when an incoming call is received from station B, because, in that event, the transmitter follower relay TF will be operated, and will thus open at its TF—1 contacts, the operating circuit of the S relay above traced.

The operation of the sequence relay S completes an operating circuit for the normally deenergized, transmitter relay T, energization of which in turn completes, through its armature T—1 and front contact, a connection 20 which switches on the carrier of radio transmitter 2, and thereby transmits outgoing carrier to the radio receiver at station B. The operating circuit for the T relay is traced from the negatively grounded battery 22, thence through the T relay winding and over connections 23, 24, through the lower back contact and armature D—1 of the normally deenergized delay relay D, and thence over connection 25 to the front contact and grounded armature S—6 of the S relay.

Relay S in operating also transfers at its S—2, S—3 contacts, the speech circuit 6, 7, 8 from the outgoing central office trunk line 10 to the incoming line 9; and concurrently disconnects at its contacts S—4, S—5, the line relay L from the direct current signaling circuit, and substitutes therefor the polarized relay P. It will be noted that the inner terminals of the polar relay windings are connected respectively to the C—2 armature and associated front contact of the carrier relay C.

The polar relay P provides reverse battery supervision of the connection over the incoming line to the telephone exchange E, while the contacts C—2 of the carrier relay C, busies the line and transmits the dialing pulses to the exchange in response to dialing pulse interruptions of the carrier transmitted from radio station B to radio station A. So long as the polar relay P receives normal battery current or no current, its armature P—1 will make contact with its upper or spacing contact. This prepares a circuit, completed upon operation of the S relay, for applying a supervision frequency *f*—S from one oscillator 26 to the input of radio transmitter 2, for transmission to the distant radio station B. This circuit is traced from the upper terminal of oscillator 26 over conductor 27 through the S—7 armature and front contact of the S relay, thence through the spacing contact and P—1 armature of the P relay, thence over conductor 28 and through a resistance 29 to one side of the radio transmitter input circuit 4, the opposite side of which is connected through a similar resistance 30 to the opposite terminal of oscillator 20.

This supervision frequency remains on the line until the called subscriber, such as 14, removes his receiver from the switch hook and, by so doing, reverses the battery applied over the incoming line 9 from the dial telephone exchange E. This battery reversal operates the polar relay P from its upper or spacing contact to its lower or marking contact, thereby to disconnect the *f*—S oscillator 26.

Energization of the C relay by the incoming carrier from station B has, by closing its C—2 contacts, prepared for dialing, the loop which includes the polar relay, the upper and lower halves of winding 15 of transformer 7, and the incoming line 9 extending into the central office. In addition, dialing tone is now received from telephone exchange E over line 9, which is transmitted over the speech circuit 6, 7, 8, through hybrid coil 5, and over line 4 to the input of radio transmitter 2, for radio transmission to the radio receiver of station B, and thence over the associated outgoing trunk line to the automatic exchange at the calling end and thence to the calling subscriber. Upon receipt of the dial tone transmitted in this way, the calling station receives a signal that the connection is ready for dialing, so that the calling station may now proceed to dial. This operates the C relay at station A according to the digits dialed. As stated, the CF relay is sufficiently slow in operation to remain operated during this dialing process.

Upon completion of the call, when the calling subscriber hangs up, the carrier current transmitted from station B to station A is switched off (as will be explained below in connection with calls outgoing from station A), resulting in the release of the C relay at station A, the release of which in turn releases relays CF, S and T, thereby

restoring the signaling system at station A to normal.

If the subscriber at the called end, such as 14, should hang up before the calling subscriber does, this will again reverse the battery applied at the telephone exchange E to the incoming line 9, the resulting current reversal of which in the polar relay P will return its armature from its marking to its spacing contact. This in turn will put supervision frequency *f*—S from the oscillator 26 back on the line.

It is to be noted that the supervision frequency can be transmitted from station A only on calls incoming thereto from station B, since it is only on such calls that the S relay is energized to connect the *f*—S oscillator 26 to the transmitter 2. As will be explained below, in connection with calls outgoing from station A, the S relay thereat will remain deenergized during the entire call.

Outgoing calls

On outgoing calls, the dial telephone exchange E is connected, as above explained, to radio station A over the outgoing trunk 10, and thence through the armatures and back contacts S—2, S—3 of the normally released S relay, to line 6, 7, 8. Thus, the voice frequency circuit from exchange E is connected directly to the hybrid coil 5 of the radio station. Also, the direct current signaling circuits of line 10 are connected to the line relay L via the armatures and back contacts S—2, S—3, S—4, S—5 of the sequence relay S.

The line relay is energized over this circuit from battery 31, connected across the inner terminals of the line relay windings, through contacts and armatures SR—1, SR—2 of the supervision relay SR. Battery 31 is connected in one polarity through the back contacts of these armatures, and is connected in the opposite polarity through the front contacts thereof. Thus, operation of the SR relay reverses the battery applied to the outgoing line. The SR relay is energized by the supervision frequency f_S transmitted from radio station B, in the manner above explained in connection with calls incoming to station A, and to this end is connected to the output of radio receiver 1 through a filter and detector circuit 32, which transmits only the supervision frequency. The SR relay is thus normally deenergized to impress battery of normal polarity on the outgoing line 10, but operates upon receipt of the supervision frequency to reverse the battery polarity until the called subscriber answers. However, these battery reversals do not release the L relay, which remains continuously energized until the called subscriber hangs up.

When the line relay L is thus energized upon receipt of a call incoming from exchange E, it energizes the transmitter follower relay TF over a circuit extending from the negatively grounded battery 33 through the TF relay winding, and thence to ground through the front contact and grounded armature L—2 of the L relay. This relay TF is of the slow-release type which remains energized during reception of dialing pulses. Energization of the TF relay opens, at its back contact TF—1, the operating circuit for the S relay, as above traced for incoming calls, and since the TF relay remains thus operated during the entire outgoing call, i. e., until the calling subscriber hangs up, the S relay can not be energized by incoming carrier received from station B for the duration of the outgoing call.

A second contact of the L relay closes a circuit for the transmitter relay T, traced from the T relay winding, over connection 23, and through the front contact and armature L—1 of the L relay, and thence to ground through the back contact and grounded armature S—6 of the now deenergized S relay. The resulting operation of the T relay switches on the carrier of the radio transmitter 2, as above explained, to provide outgoing carrier to station B.

When the outgoing dial pulses are now received from telephone exchange E, they will be transmitted through relays L and T. That is to say, relay L will respond to the dial pulses and will in turn, by opening and closing its L—1 contacts, correspondingly operate the T relay. Operation of the T relay in response to these dialing pulses thus interrupts the carrier transmitted to station B, which in turn causes the C relay thereat to correspondingly operate and release, the transmission of the dial pulses thence to the calling station being the same as that above described for calls incoming to station A.

Throughout the call outgoing from station A, the S relay is, as above explained, continuously deenergized, and therefore the supervision frequency of oscillator 26 will not be transmitted to station B on outgoing calls. On the other hand, station B operates as above described in connection with calls incoming to station A. That is to say, it will transmit supervision frequency to station A until the called subscriber has answered, thus operating the SR relay at station A to reverse the battery applied to the outgoing line from source 31. In addition, the central office connected to station B will return dial tone to the subscriber originating the call, and connected to exchange E.

The operation of the line relay L on outgoing calls also operates the delay relay D, which latter will remain operated for some time after completion of the outgoing call, in a manner and for reasons now to be explained. The D relay is connected in the plate circuit of an electronic tube 34, and is energized therein from the negatively grounded plate battery 35. The cathode of tube 34 is energized over a circuit extending from ground through a low voltage, direct or alternating current source 36, and thence to the cathode and over conductor 37 through a front contact of the L relay, the associated armature L—3 of which is grounded. A resistance 38 is bridged between this armature and its associated front contact for normally energizing the cathode of tube 34 to some extent, but insufficient to energize the D relay, while the line relay is released. Upon operation of the line relay, however, this resistance is shunted out by the relay contacts, whereupon the cathode of tube 34 is energized sufficiently to operate relay D. Upon subsequent release of the line relay, however, the D relay will not release for some time thereafter and until the cathode of tube 34 has cooled sufficiently to reduce the plate current of the tube below the release current for the D relay. The purpose of this delay in the release of the D relay following the release of the L relay at the conclusion of an outgoing call, is to delay the operation of the circuit on subsequent incoming calls for a sufficient length of time to assure that all other relays are restored to their normal conditions, particularly the T and S relays, the operating circuits of which are under control of the D relay upon release of the L relay. An additional purpose for thus delaying the release of the D relay is to prevent "locking" of the radio system, i. e., energization of the S relays at both stations A and B.

On incoming calls, operation of the S relay, as above explained, completely disconnects the line relay L at the S—4, S—5 contacts of the S relay. This prevents operation of either the delay relay D or the transmitter follower relay TF for the duration of an incoming call, since the operating circuits for both of these relays are completed through contacts of the line relay.

The separate wire circuits 9 and 10 for handling incoming and outgoing calls, between the central office and the radio station, may of course be replaced by a single two-wire circuit, inasmuch as all of the functions of two-way dialing and supervision are provided by the relay circuits included in the radio station terminal equipment, in which event this single two-wire circuit from the central office would become permanently connected to line 8, and contacts S—2, S—3 of the S relay omitted.

I claim:

1. In a two-way dial telephone signaling system for relaying signals between a low frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay and unresponsive to dialing signals; a sequence relay energized by said slow-release relay for connecting said wire circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of the carrier relay; a line relay; means including release contacts sequence relay for connecting said line relay to said wire circuit, said line relay responding to dialing pulses incoming over said wire circuit; and means including said line relay for energizing said carrier wave transmitter, to transmit outgoing carrier and for interrupting the same in response to dialing signals incoming over the wire circuit.

2. In a two-way dial telephone signaling system for relaying dialing signals between a low frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay and unresponsive to dialing signals; a transmitter relay for energizing said transmitter to transmit outgoing carrier, said relay responding to dialing signals; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said wire circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of the carrier relay; a line relay; means including release contacts of sequence relay for connecting said line relay to said wire circuit, said line relay responding to dialing signals incoming over said wire circuit; and means including said line and transmitter relays, for interrupting the outgoing carrier in response to dialing signals incoming over said wire circuit.

3. In a two-way dial telephone signaling system for relaying signals between a low frequency wire circuit and a carrier wave circuit; a carrier wave transmitter and receiver; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to the carrier relay and unresponsive to dialing signals; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said wire circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of the carrier relay; a line relay and a transmitter follow relay; means including release contacts of said sequence relay for connecting said line relay to said wire circuit and for energizing the same; said transmitter follow relay responding to energization of said line relay to prevent energization of said sequence relay while the line relay is actuated; said line and transmitter relays responding to dialing signals incoming over said wire circuit for correspondingly interrupting the carrier outgoing from said transmitter.

4. In a two-way dial telephone signaling system for relaying signals between a voice frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay and unresponsive to dialing signals; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said wire circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of the carrier relay; a line relay; means including release contacts of said sequence relay for connecting said line relay to said wire circuit; a slow-release transmitter follow relay responsive to said line relay, when energized, for preventing energization of said sequence relay; means including operate contacts of said line relay for energizing said transmitter relay, said line and transmitter relays responding to dialing signals incoming over said wire circuit for repeating said signals in the outgoing carrier; a delay relay; and means including operate contacts of said line relay for energizing said delay relay, said means thereafter delaying release of said delay relay for a preselected interval following deenergization of said line relay.

5. In a two-way dial telephone signaling system for relaying signals between a low frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a polar relay; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said wire circuit to contacts of the carrier relay through windings of the polar relay for repeating in said circuit the dialing pulse operation of said carrier relay; said polar relay being unresponsive to voltage of one polarity impressed on said wire circuit, but responding to voltage of the opposite polarity impressed thereon; a source of supervision frequency; means including release contacts of said polar relay and operate contacts of said sequence relay for impressing said supervision frequency on said transmitter to modulate the outgoing carrier thereof; a line relay; means including release contacts of said sequence relay for connecting said line relay to said wire circuit; a voltage source for energizing said line relay over said wire circuit when so connected; a supervision relay energized by supervision frequency incoming to said receiver, for impressing said voltage source in one polarity on said line relay, and for

reversing said polarity upon deenergization of said supervision relay; and means including operate contacts of said line relay for energizing said transmitter relay, said line and transmitter relays responding to dialing pulses incoming over said wire circuit for correspondingly interrupting the carrier outgoing from said transmitter.

6. In a two-way dial telephone signaling system for relaying signals between a low-frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; an incoming and an outgoing wire circuit; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said incoming circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of said carrier relay; a line relay; means including release contacts of said sequence relay, for connecting said line relay to said outgoing circuit, and for energizing said relay; and means including operate contacts of said line relay, for energizing said transmitter relay, said line and transmitter relays responding to dialing pulses, for interrupting the outgoing carrier in response to dialing signals received over said outgoing line.

7. In a two-way dial telephone signaling system for relaying signals between a low-frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; an incoming and an outgoing wire circuit; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said incoming circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of said carrier relay; a line relay; means including release contacts of said sequence relay, for connecting said line relay to said line outgoing circuit, and for energizing said relay; means including operate contacts of said line relay, for energizing said transmitter relay, said line and transmitter relays responding to dialing pulses, for interrupting the outgoing carrier in response to dialing signals received over said outgoing line; and a transmitter follow relay, responsive to said line relay, for preventing operation of said sequence relay during energization of the line relay.

8. In a two-way dial telephone signaling system for relaying signals between a low-frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; an incoming and an outgoing wire circuit; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said incoming circuit to contacts of said carrier relay for repeating in said circuit the dialing pulse operation of said carrier relay; a line relay; means including release contacts of said sequence relay, for connecting said line relay to said outgoing circuit, and for energizing said relay; means including operate contacts of said line relay, for energizing said transmitter relay, said line and transmitter relays responding to dialing pulses, for interrupting the outgoing carrier in response to dialing signals received over said outgoing line; a transmitter follow relay, responsive to said line relay, for preventing operation of said sequence relay during energization of the line relay; and means including a delay relay responsive to operation of said line relay, said means thereafter delaying release of said delay relay for a preselected interval following release of said line relay.

9. In a two-way dial telephone signaling system for relaying signals between a low-frequency wire circuit and a carrier wave circuit: a carrier wave transmitter and receiver; an incoming and an outgoing wire circuit; a carrier relay responsive to carrier current incoming to said receiver and to dialing interruptions thereof; a slow-release relay responsive to said carrier relay; a transmitter relay for energizing said transmitter to transmit outgoing carrier; a polar relay; a sequence relay energized by said slow-release relay for energizing said transmitter relay and for connecting said incoming circuit to contacts of said carrier relay through windings of the polar relay for repeating in said circuit the dialing pulse operation of said carrier relay, said polar relay being unresponsive to voltage of one polarity impressed on said incoming circuit, but responding to voltage of the opposite polarity impressed thereon; a source of supervision frequency; means including release contacts of said polar relay and operate contacts of said sequence relay, for impressing said supervision frequency on said transmitter to modulate the outgoing carrier thereof; a line relay; means including release contacts of said sequence relay for connecting said line relay to said outgoing circuit; a voltage source for energizing said line relay over said circuit when so connected; a supervision relay energized by supervision frequency incoming to said receiver, for impressing said voltage source in one polarity on said line relay, and for reversing said polarity upon release of said supervision relay; and means including said line relay for energizing said transmitter relay, said line and transmitter relays responding to dialing pulses, for interrupting the outgoing carrier in response to dialing signals received over said outgoing line.

EVERHARD H. B. BARTELINK.

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Disclaimer

2,457,434.—*Everhard H. B. Bartelink*, Bronxville, N. Y. SIGNALING SYSTEM FOR TWO-WAY DIALING OVER RADIO AND CARRIER TELEPHONE CIRCUITS. Patent dated Dec. 28, 1948. Disclaimer filed Nov. 8, 1950, by the assignee, *Automatic Electric Laboratories, Inc.*

Hereby enters this disclaimer of claim 1 of said patent.

[*Official Gazette December 5, 1950.*]