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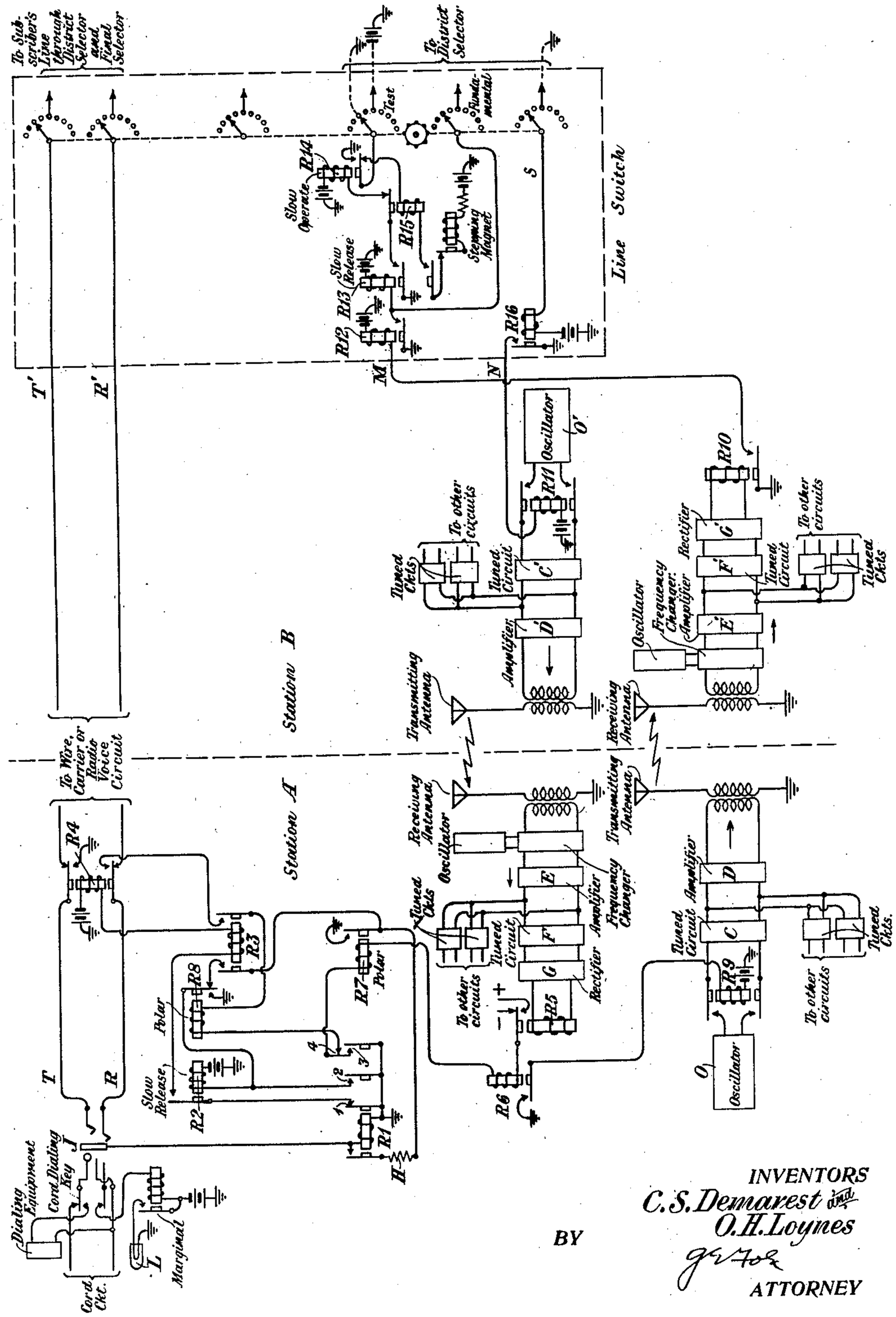

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TELEPHONE SIGNALING SYSTEM.

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This invention relates to telephone signaling systems, and more particularly to arrangements for transmitting supervisory signals and dialing pulses between central office stations equipped for automatic switching.

In the operation of a group of telephone circuits by improved traffic methods, a number of supervisory signals and, in machine switching areas, dialing pulses must be transmitted between central office stations. Facilities for the transmission of these supervisory signals and dialing pulses are sometimes not available, as in the case of radio speech channels; and, in the case of wire circuits, they cannot always be obtained unless there are sacrificed facilities for the transmission of Morse telegraph signals over the telephone circuits. Furthermore, with the present standard facilities for signaling over voice circuits, certain precautions must be taken in order to guard against interference with the signal currents by the voice currents and in order to reduce the interference from other voice circuits and the interference caused in other voice circuits.

It is the object of applicants' invention to transmit supervisory signals and dialing pulses in cases in which the facilities cannot be obtained by wire means, as in the case of radio speech channels; and, in the case of wire circuits, to transmit such signals and pulses without any sacrifice of Morse telegraph facilities, and without any of the types of interference mentioned above.

Applicants accomplish this object by transmitting all the supervisory signals and all the dialing pulses for a group of voice circuits over a common radio channel between the central office stations.

The arrangement described below and shown diagrammatically in the accompanying drawing is one suitable for transmitting by applicants' means the signals and pulses employed in the toll line dialing method of operation, in which the operator at the outgoing station can dial directly a subscriber in a distant machine switching area without first dialing the distant central office board.

With reference to the accompanying drawing, station A is a telephone central office station equipped with dialing apparatus and connected with a distant central office station B, which is equipped for machine switching, by a plurality of voice channels, which may be ordinary wire circuits, carrier circuits, or radio channels. For the sake of simplicity, the system is shown equipped for operation only in the direction station A to station B, that is, for the completion of a call from a subscriber directly connected to station A to a subscriber in the district of station B. It will be readily understood, however, that in accordance with applicants' invention, a system such as that shown may be and normally is equipped for operation in either direction.

At station A, in association with each voice channel, there are the following elements usually found at automatic central office stations: a toll cord circuit, an annunciator and a jack associated with this circuit, dialing apparatus, and a switch for connecting this apparatus to the toll cord circuit. At station B there is the usual machine switching equipment, including a line switch and the district and final selector apparatus.

At each station applicants provide means for transmitting radio signals and means for receiving radio signals. In addition there are associated with each voice channel at each station, means for producing high frequency signaling current, means for suitably tuning the radio receiver, and means for associating the signaling current producers with the radio transmitting apparatus and for associating the radio receiving apparatus with the signal annunciator (first station) or the machine switching apparatus (second station). For each voice channel served there is required one radio signaling frequency for signaling in each direction, the signaling current producer associated with that channel at each station producing an alternating current of a predetermined frequency, and the receiver at the other station being correspondingly tuned by the circuit associated with the channel.

The details of the signaling system will be clearly understood from the following description of the operation thereof in connection with a call from station A to a subscriber reached through station B. When the subscriber in the district of station A places the call, the operator at station A inserts a cord equipped for dialing, into the jack J. Battery from the sleeve of the cord

causes relay R^1 to operate, and in turn to operate relay R^2, which is a slow release relay. When the operator operates her key in the cord circuit which causes the dialing equipment at her position to be associated with the cord, the sleeve of the cord circuit is opened, and relay R^1 is permitted to release. With relay R^1 released and slow release relay R^2 held in its operated position by circuit means to be described below, ground is connected through a back contact of relay R^1 and the make contact of relay R^2 to a circuit including the windings of relays R^3 and R^4. Relays R^3 and R^4 operate and complete the following circuit: battery "−", back contact of relay R^5, windings of relays R^6, R^7 and R^8 make contact of relay R^3, lower make contact of relay R^4, over lead R to the cord circuit, through the dialing equipment in the cord circuit, back over lead T, and to ground at the upper make contact of relay R^4. Relays R^8 and R^7 are polar relays R^8 operating when "−" battery is connected to the circuit at relay R^5, and R^7 operating when "+" battery is connected to the circuit. It is understood that neither of these two relays will respond to battery of the opposite polarity. Upon the completion of the circuit traced above, relay R^6 and the polar relay R^8 will operate. The operation of relay R^8 holds relay R^2 operated after the release of relay R^1. The operation of relay R^6 causes the operation of relay R^9. The operation of this latter relay connects the oscillator O, which produces a signaling current of high frequency, through the tuned circuit C associated with the voice channel under consideration and the common amplifier D to the transmitting antenna at station A, from which a radio signal is sent to station B.

At station B the initial radio signal is received from station A, is changed in frequency (an oscillator being associated with the frequency changer), and is passed through the common amplifier E′, the tuned circuit F′ associated with the voice channel under consideration, and the rectifier G′ to the relay R^{10}, which operates. The operation of relay R^{10} connects ground over the lead M to relay R^{12} of the line switch. The line switch now functions to prepare the automatic switching equipment to receive dialing pulses. Only so much of the machine switching apparatus is shown and only so much of the automatic operation is discussed herein as appears to be necessary to a full understanding of applicant's invention. The relay R^{12} is what is usually termed the "pulsing" relay of the line switch. When it operates in response to the operation of relay R^{10}, it causes the operation of relay R^{13}, a slow release relay, and also prepares a path from ground to the fundamental lead of the machine switching circuits. When relay R^{13} operates, it closes a circuit including the winding of relay R^{14}, a slow operating relay, which does not operate at this time, as explained below. The operation of relay R^{13} also closes a circuit from ground through a battery, the winding and armature of the stepping magnet, the winding of relay R^{15}, and the armature of relay R^{14} over the test lead to ground. The closing of this circuit results in the operation of the stepping magnet and also in the operation of relay R^{15}. The operation of this latter relay breaks the path through the winding of the slow operating relay R^{14} and prevents the immediate operation of that relay. The stepping magnet functions in a well-known manner to operate the brush arms of the line switch in association with corresponding banks of contacts. When an idle sender is found, the test lead is connected through apparatus not shown but well understood in the art and through battery in the district selector mechanism to ground, this battery being of such polarity as to oppose the battery in the stepping magnet circuit. The operation of the stepping magnet then ceases. Relay R^{15} releases, and relay R^{14} operates, placing ground over its armature to the test lead for the operation of the necessary busy signal. In addition, the automatic operation of the line switch extends the path from the armature of the pulsing relay R^{12} over the fundamental lead to the district selector. Also ground from the district selector is connected over lead S to relay R^{16}. The line switch is now ready to receive the dialing pulses, and the operation of relay R^{16} causes the operation of relay R^{11}, which controls the signal transmitter of station B. When relay R^{11} operates, it connects the oscillator O′, which produces signaling current of high frequency, through the tuned circuit C′ associated with the voice channel under consideration and the common amplifier D′ to the transmitting antenna of station E. It is to be noted that during the operations described above the initial radio signal from station A to station B has been continued, causing the continued operation of relay R^{10} and the responsive operation of relay R^{12} in the line switch.

The responsive radio signal transmitted from station B, upon the completion of the primary operation of the line switch, is received in the receiving antenna of station A, is changed in frequency, and is passed through the common amplifier E, the tuned circuit F associated with the voice channel under consideration, and the rectifier G to relay R^5, which operates. The operation of relay R^5 disconnects the armature of that relay from "−" battery and connects it to "+" battery, that is, it reverses the polarity of the battery through the dialing equipment, the circuit having been traced above. This reversal of the battery through the

dialing equipment indicates to the operator at station A that the machine switching equipment at station B is in condition to receive dialing pulses. She then operates her cord dialing apparatus, causing the circuit completed through her dialing equipment to be opened intermittently. Relay R^6, of course, follows the dialing pulses, and relay R^9 responds, thereby interrupting the radio signal originated in oscillator O and transmitted to station B.

The dialing pulses transmitted over the radio channel from station A cause the machine switching equipment at station B to select the subscriber called. This operation is briefly described as follows: Relay R^{10} follows the radio signal pulses and connects ground intermittently to the line switch pulsing relay R^{12} over lead M. Relay R^{12} transmits the pulses over the fundamental lead to the selector apparatus. The machine switching equipment then automatically establishes connection from the leads T' and R' through the line switch, district selector, and final selector to the called subscriber's line. The line switching equipment functions in such a manner as to cause ground to be placed over lead S, and through relay R^{16} over lead N, before the subscriber removes his receiver from the switch-hook, and to be replaced after the subscriber returns his receiver to the hook. If the subscriber jiggles his switch-hook, ground is placed intermittently on lead S and on lead N, and relay R^{11} is caused to follow the operation of the switch-hook.

At station A, while the called subscriber is being rung automatically at station B, relay R^5 remains operated in response to the continuous radio signal from station B. Accordingly, the "+" battery is steadily connected to the circuit through the dialing equipment; and the polar relay R^7 is operated, and the polar relay R^8 is released. The operation of relay R^7 holds relay R^2 operated through a make contact of relay R^3 and the back contact of relay R^8. When the operator has completed her dialing operations and restores her cord dialing key to normal, a connection is again completed over the sleeve of jack J to relay R^1, which re-operates. Since relay R^7 is operated, resistance H is connected to ground over the make contact of relay R^7 in parallel with relay R^1. The value of this resistance H is so chosen that the marginal relay in the sleeve circuit of the toll cord operates and lights the supervisory lamp L in the toll cord.

When the called subscriber answers through station B, the radio signal received from station B ceases, and accordingly relay R^5 at station A releases, reversing the battery again and causing the release of polar relay R^7 and the operation of polar relay R^8. The release of relay R^7 removes the resistance H from the sleeve circuit, causing the marginal relay in the toll cord to release and extinguish the lamp L. This signal indicates to the operator at station A that the called subscriber has answered through station B. When the called subscribed at station B jiggles his switch-hook, relay R^5 at station A follows the switch-hook operation, causing relay R^7 to respond, placing resistance H in parallel with relay R^1 intermittently and causing the flashing of the supervisory lamp L in the toll cord.

When the operator at station A completed the dialing operation and restored her cord dialing key, thereby permitting relay R^1 to re-operate, relays R^3 and R^4 released and connected relay R^7 to ground through a make contact of relay R^1. Relay R^6 remains operated throughout the period of the connection. Accordingly, relay R^9 remains operated, and the radio signal transmitted from oscillator O remains on the signaling channel during the above period.

When the subscriber in the district of station B has finished the call, ground is automatically placed over lead S and, through the operation of relay R^{16}, over lead N to relay R^{11}, causing a signal to be sent to station A which indicates to the operator at station A that the conversation is completed. She then removes the toll cord from the jack J, releasing relays R^1, R^2, R^6, R^7 and R^9. The release of relay R^9 results in the discontinuation of the radio signal transmitted to station B and causes the machine-switching equipment at station B to return to normal in response to the release of the pulsing relay R^{12} in the line switch.

While applicants' invention has been disclosed in one specific embodiment which is deemed desirable, it is to be understood that it is capable of embodiment in other and different forms without a departure from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a telephone system, a first central office station, a second central office station, a voice channel connecting said stations, signal announcing means at the first station, automatic line selecting and switching means at the second station, means at each station for generating and transmitting radio signals, means at each station for receiving radio signals transmitted from the other station, automatic means at the first station, responsive to primary signaling operations at said station, for operating the radio signal generating and transmitting means at said station to send an initial radio signal to the second station, automatic means at the second station, responsive to said initial radio signal received from the first station, for effecting a primary operation of the automatic selecting and switching means,

automatic means at the second station, responsive to the termination of said primary operation of the selecting and switching means, for operating the radio signal generating and transmitting means at said station to send a responsive primary radio signal to the first station, automatic means at the first station for effecting a primary operation of the signal announcing means in response to said responsive primary signal received from the second station, automatic means at the first station, responsive to secondary signaling operations at said station, for operating the radio signal generating and transmitting means at said station to send a secondary radio signal to the second station, automatic means at the second station, responsive to said secondary signal received from the first station, for effecting a secondary operation of the selecting and switching means, automatic means at the second station, responsive to signaling operations at said station for operating the radio signal generating and transmitting means at said station to send a secondary radio signal to the first station, and automatic means at the first station for effecting a secondary operation of the signal announcing means at said station in response to said secondary signal received from the second station.

2. In a telephone system, a first central office station; a second central office station; a plurality of voice channels connecting said stations; automatic line selecting and switching means at the second station; means at each station for transmitting radio signals; means at each station for receiving radio signals; and the following means associated with each voice channel at their respective stations: signal announcing means at the first station; means at each station for producing radio signaling current of a frequency peculiar to that station and to the voice channel; means at each station for tuning the radio receiving means at that station to the peculiar frequency produced at the other station and corresponding to the voice channel; automatic means at the first station, responsive to primary signaling operations at said station, for connecting the radio signaling current producing means to the radio signal transmitting means at said station, causing said transmitting means to send an initial radio signal, of the peculiar frequency, to the second station; automatic means at the second station, responsive to said initial radio signal received from the first station, for effecting a primary operation of the automatic selecting and switching means; automatic means at the second station, responsive to the termination of said primary operation of the selecting and switching means, for connecting the radio signaling current producing means to the radio signal transmitting means at said station, causing said transmitting means to send a responsive primary radio signal, of the peculiar frequency, to the first station; automatic means at the first station, responsive to said primary radio signal received from the second station, for effecting a primary operation of the signal announcing means; automatic means at the first station, responsive to secondary signaling operations at said station, for connecting the radio signaling current producing means to the radio signal transmitting means at said station, causing said transmitting means to send a secondary radio signal, of the peculiar frequency, to the second station; automatic means at the second station, responsive to said secondary signal received from the first station, for effecting a secondary operation of the selecting and switching means; automatic means at the second station, responsive to signaling operations at said station, for connecting the radio signaling current producing means to the radio signal transmitting means at said station, causing said transmitting means to send a secondary radio signal, of the peculiar frequency, to the first station; and automatic means at the first station, responsive to said secondary signal received from the second station, for effecting a secondary operation of the signal announcing means at said station.

3. In a telephone system, a first central office station including a toll cord circuit, a dialing apparatus and an annunciator and a jack all associated with said circuit, and a switch for connecting the dialing apparatus to said circuit; a second central office station equipped with machine switching apparatus including a line switch; a voice channel connecting said stations; means at each station for generating and transmitting radio signals; means at each station for receiving radio signals transmitted from the other station; automatic means at the first station, responsive to the connection of the toll cord circuit and the jack and the subsequent connection of the dialing apparatus to said circuit, for closing a grounded circuit through the dialing apparatus to a current source of a certain polarity and simultaneously therewith operating the radio signal generating and transmitting means at said station; automatic means at the second station, responsive to an initial radio signal received from the first station, for causing the operation of the line switch to prepare a path for the transmission of dialing pulses; automatic means at said second station, responsive to the completion of said operations of the line switch, for operating the radio signal generating and transmitting means at said station to send a radio signal to the first station; automatic means at the first station, responsive to the reception of

said radio signal from the second station, for reversing the polarity of the current source through the dialing apparatus; automatic means at the first station, responsive to the operation of the dialing apparatus, for interrupting the radio signal transmitted from said station; automatic means at the second station, responsive to the interruption of the radio signal received from the first station, for transmitting dialing pulses over the line switch to cause the machine switching apparatus to connect the voice channel to the subscriber's line associated with said station; automatic means at the first station, responsive to the termination of the operation of the dialing apparatus, for operating the annunciator; automatic means at the second station, responsive to switch-hook signals over the line switch, for operating the radio signal generating and transmitting means at said station to send an interrupted radio signal to the first station; and automatic means at the first station for terminating the operation of and re-operating the annunciator in response to the reception of said interrupted radio signal from the second station.

4. In a telephone system, a first central office station; a second central office station, a plurality of voice channels connecting said stations; means at each station for transmitting radio signals; means at each station for receiving radio signals; dialing apparatus at the first station; machine switching apparatus at the second station, said apparatus including a line switch; and the following elements and means associated with each voice channel at their respective stations: a toll cord circuit at the first station; an annunciator and a jack associated with said circuit at the first station; a switch for connecting the dialing apparatus to said circuit at the first station; means at station for producing signaling current of a frequency peculiar to that station and to the voice channel; means at each station for tuning the signal receiving means at that station to the peculiar frequency produced at the other station and corresponding to the voice channel; automatic means at the first station, responsive to the connection of the toll cord circuit and the jack and the subsequent connection of the dialing apparatus to said circuit; for closing a grounded circuit through the dialing apparatus to a current source of a certain polarity and simultaneously therewith connecting the signaling current producing means to the radio signal transmitting means at said station; automatic means at the second station, responsive to an initial radio signal, of the predetermined frequency, received from the first station, for causing the operation of the line switch to prepare a path for the transmission of dialing pulses; automatic means at said second station, responsive to the completion of said operation of the line switch, for connecting the signaling current producing means to the radio signal transmitting means at said station, causing said transmitting means to send a radio signal, of the peculiar frequency, to the first station; automatic means at the first station, responsive to the reception of said radio signal from the second station, for reversing the polarity of the current source through the dialing apparatus; automatic means at the first station, responsive to the operation of the dialing apparatus, for interrupting, in accordance with the operation of said apparatus, the radio signal, of the peculiar frequency, transmitted from said station; automatic means at the second station, responsive to the interruption of the radio signal, of the predetermined frequency, received from the first station, for transmitting dialing pulses over the line switch to cause the machine switching apparatus to connect the voice channel to the subscriber's line associated with said station; automatic means at the first station, responsive to the termination of the operation of the dialing apparatus, for operating the annunciator; automatic means at the second station, responsive to switch-hook signals over the line switch, for disconnecting the current producing means and the radio signal transmitting means at said station and reconnecting the same in accordance with said switch-hook signals, causing said transmitting means to send an interrupted radio signal, of the peculiar frequency, to the first station; and automatic means at the first station for terminating the operation of and re-operating the annunciator in response to the reception of said interrupted radio signal from the second station.

In testimony whereof, we have signed our names to this specification this 18th day of May, 1926.

CHARLES S. DEMAREST.
OWEN H. LOYNES.