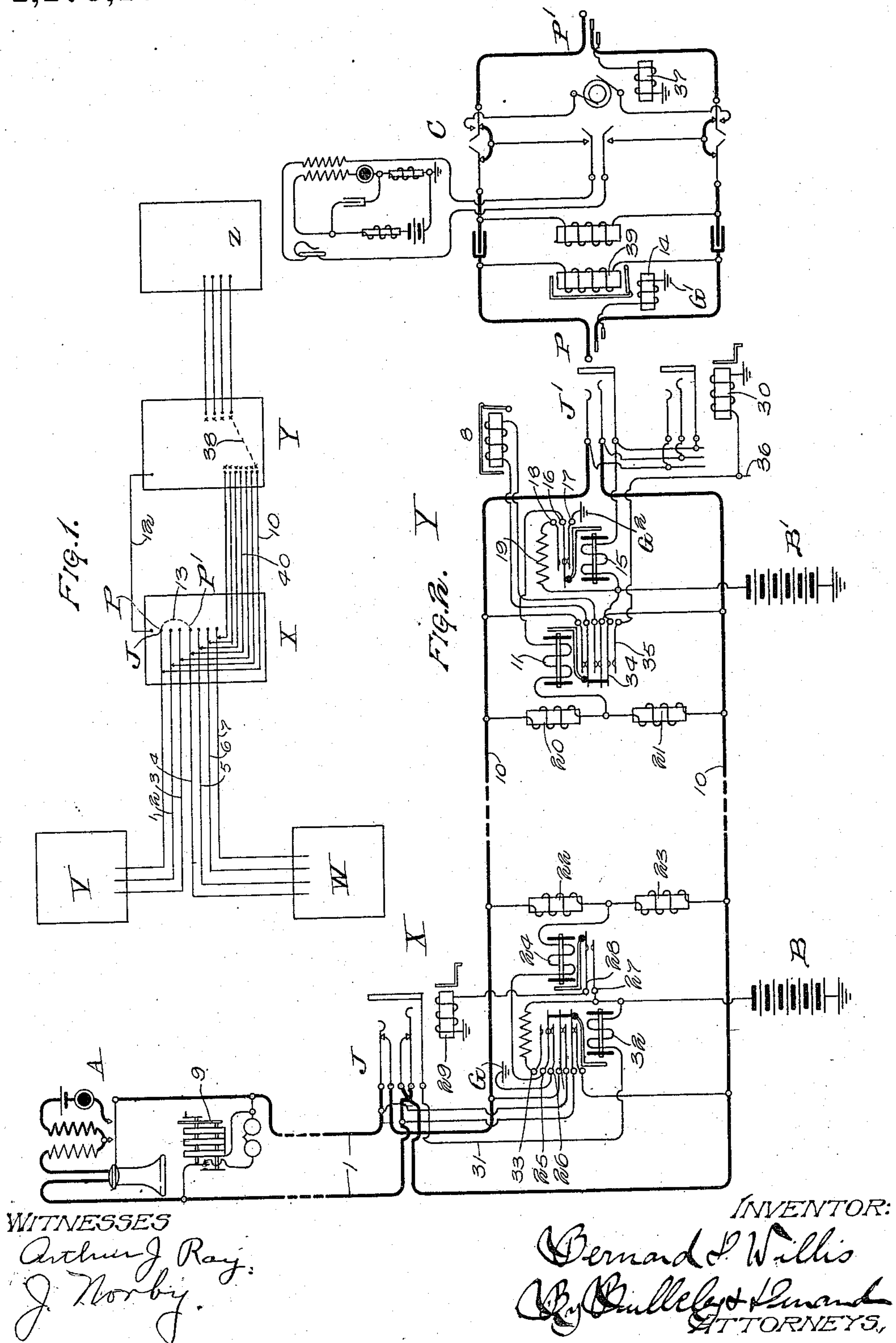


B. D. WILLIS.
TELEPHONE SYSTEM.
APPLICATION FILED APR. 18, 1913.

1,175,104.

Patented Mar. 14, 1916.



UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, BERNARD D. WILLIS, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to an improvement in telephone systems, and more particularly to an improved trunking arrangement for establishing connection between a calling and a called subscriber's line, together with improved means for operating signaling devices over part of the established talking circuit.

My invention relates specifically to an arrangement of trunks which terminate at each end in an operator's board and in the provision of a signal at each end of the trunk whereby, when one operator has made connection with a trunk, the operator at the other end will be notified of this fact.

My invention further contemplates the employment of so-called phantom circuits for operating these signals—that is, circuits which make use of the talking conductors, and yet do not interfere in any way with the transmission of talking current. In this way I avoid the use of any special or third wires associated with the trunks extending between the two operators' positions.

A further object of my invention is the provision of a system comprising a main exchange and an operator's toll-board or exchange. This toll-board is usually connected with the main exchange by trunk lines which are associated together in the form of cables. These cables have high capacity and are therefore inefficient for talking purposes. I therefore terminate the toll lines in this branch or toll-board and provide means for establishing connection between two or more lines terminating in this toll-board directly at the toll-board, whereby the talking circuit does not pass through the cables which extend to the main office.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which—

Figure 1 is a diagrammatic lay-out of a telephone system showing five exchanges V, W, X, Y and Z, the exchanges X and Y having access in common to a set of trunk lines which, it will be assumed, are in the

form of cables. Fig. 2 is a diagrammatic representation of the system, showing a telephone belonging to one of the exchanges V or W connected with the exchanges X and Y.

In order to explain the details of the system more fully, we will assume, first, that the subscriber at station A in exchange V wishes to establish connection with a subscriber at exchange W; and, second, we will assume that the subscriber at station A wishes to establish connection with a line associated with the exchange Z. The subscriber A, in order to establish connection with a subscriber in the exchange W, signals his exchange V, and is thereupon placed in connection with one of the lines, line 1, for example, which extends to exchange X and is there connected to a cable 10, by which the connection is extended to the exchange Y. A signal 8 is normally connected with the trunk 10 at the exchange Y. After this connection is set up, the subscriber operates his generator 9 in the usual manner to transmit signaling current through the jack J in the exchange X and through the signal relay 8, cable trunk 10 and the closed contacts of the relay 11 in the exchange Y. Upon observing the signal, the operator at the exchange Y inserts the plug P into the jack J' and, upon ascertaining that the subscriber A is calling a subscriber in exchange W, notifies the operator at exchange X over an order wire 12 (Fig. 1) that the subscriber on line 1 wishes to be connected with exchange W. The operator at exchange Y then withdraws the plug P from the jack J', thus disconnecting the cord from the cable 10. The operator at exchange X then completes the connection between line 1 and the exchange W over line 4 (Fig. 1), for example, as indicated by the dotted line 13. It will be observed that at the time the operator at exchange Y answered the call from the station A by inserting the plug P into the jack J' a circuit was established through the coil 14 in the cord circuit C and the relay 15 in series through the third conductor. The relay 15, upon energizing, attracts its armature and operates to shift the spring 16 out of engagement with a grounded contact 17 and into engagement with the spring 18. As a result of this operation a circuit is established from battery B' through the re-

sistance 19, springs 18 and 16 and through the coil 11, after which it divides and passes through the coils 20 and 21 over both sides of the line 10, joining again at the other end after passing through the coils 22 and 23 and continuing through the coil 24, and thence through the normally closed springs 25 and 26 to ground G. The relay 24 at the exchange X, upon energizing, presses the springs 27 and 28 into contact, thereby establishing an energizing circuit for the signal relay 29, which relay, as long as it remains energized, indicates to the operator having access to the line 1 that this line is in use. The relay 11 at the exchange Y, upon energizing in series with the relay 24 at the exchange X, performs two functions, namely, that of disconnecting the line signal relay 8 from the line and of closing an energizing circuit for the signal relay 30. This relay 30, of course, indicates, as long as it remains energized, that line 1 is in use. It will be understood that if in exchange Y there are a number of operators who have access to the line 1, there will be a signal relay 30 for each operator; and in the exchange X if there should be more than one operator having access to the line 1, there will be a signal relay 29 for each operator in that exchange.

Returning now to a consideration of the conditions existing as a result of the operator at exchange X establishing connection between lines 1 and 4 by means of the conductor 13 (Fig. 1). This conductor 13, it will be assumed, represents a cord circuit similar to the cord circuit C (Fig. 2). The line 4 is provided with a jack in the exchange X similar to the jack J. This is true of all the other lines 2, 3, 5, 6 and 7. In establishing the connection between lines 1 and 4, the operator merely plugs the answering end of her cord into the jack J of the line 1 and the calling end of her cord into the jack J of the line 4. When the plug P of this cord is inserted in the jack J, the line 1 is disconnected from the cable line 10 by the separation of the normally closed springs in the said jack J. Furthermore, a circuit is established from ground G' in the cord through the coil 14, conductor 31 and through the relay 32 at exchange X to battery B. The relay 32, upon energizing, shifts the spring 25 out of engagement with the spring 26 and into engagement with the spring 33. An answering circuit is thus set up from battery B at exchange X over the phantom circuit including the coils 24, 22, 23, 20, 21 and 11 to ground G² at exchange Y, the springs 16 and 17 of the relay 15 being normally in contact. The relay 11 is thus energized and, as previously stated, performs two functions, namely, first, the cutting off of the line the line signal 8 by separating the normally closed contacts, and,

second, the closing of the springs 34 and 35, thereby energizing the signal relay 30, as well as any other signal relays connected with the lead 36, thus notifying all operators at the exchange Y that line 1 is in use.

When the operator inserts the calling plug P' of the cord into the jack J of the line 4, a similar circuit is established through the relay 37 at the calling end of the cord and a relay, similar to the relay 32, in the trunk conductor 40 (Fig. 1), connecting the exchanges X and Y. This relay operates in the same manner as has been described in connection with the relay 32 (Fig. 2) to give a signal at exchange Y for indicating that line 4 is in use.

It will thus be observed that when the subscriber at station A is connected with a subscriber at exchange W, as indicated in Fig. 1, the operator at exchange Y is notified that both lines 1 and 4 are unavailable for further connections for the time being. It will also be observed that during the maintenance of this connection the cables lines 10 and 40 are disconnected from the lines 1 and 4 and serve, while thus disconnected, to maintain signals at the exchange Y to indicate to said exchange operator that said lines are in use.

We will now consider the conditions when the subscriber at substation A is given connection with a line running to exchange Z, which line may terminate in any suitable exchange apparatus. In some instances it need not terminate in exchange apparatus at all, but may terminate in a subscriber's telephone station, in which case, of course, it would not necessarily run to any exchange. The operator at exchange Y, upon receiving the signal, as heretofore explained when the subscriber at station A initiated the call for exchange W, inserts the plug P into the jack J', energizing the relay 15, which in turn energizes relays 11 and 24, as already explained. The relay 11 disconnects the line signal 8 from the line and the relay 24 closes the circuit of the signal 29, which indicates to the exchange operator X that line 1 is in use. The operator, upon ascertaining that the subscriber at station A wants a line to exchange Z, completes the connection by inserting the calling plug P' into a line running to said exchange, as indicated by the dotted line 38 (Fig. 1). The connection from this point on can be completed in any well-known or suitable manner.

After the conversation is terminated, the subscriber at station A, upon ringing off, will energize the disconnect signal relay 39, whereupon the operator will take down the connection, restoring the circuits to normal condition, which will result in the de-energization of the signal relays 29, 30, etc., at both exchanges X and Y, indicating

at these exchanges that line 1 is now available for use.

It will be observed that when a connection is established from either of the exchanges V or W in the direction of the exchange Z, the trunk conductor 10, over which conversation is taking place, is utilized for maintaining a signal at the exchange X to indicate that the line corresponding to that signal is in use notwithstanding the fact that said cable line is connected to the line extending to the exchange V to which it corresponds and to the cord circuit C at the exchange Y.

It will thus be seen that I have devised a very efficient form of telephone system, and one in which the signals are operated over trunk lines without the employment of any additional conductor, the signaling circuit including the two sides of the line in parallel, so as not to interfere in any way with the voice currents which are passing over the two sides of the trunk line in series.

While I have illustrated my invention in connection with a particular form of system, and in connection with cord circuits of a particular type, it is, of course, to be understood that my invention is capable of wide variation without departing from the scope of my invention.

What I claim as my invention is:—

1. In a telephone system, a main operator's board, a branch operator's board, lines terminating in said branch board and provided with an extension extending from said branch to said main board, a signal at said main board associated with each of said extensions, and controlled over a circuit comprising both sides of said extension in parallel, another signal at said main-board, means whereby a subscriber in making a call over one of said lines operates said other signal, means by which the operator at the main board can then obtain connection with the calling subscriber to ascertain the number of the called subscriber, and means at the branch board for establishing connection between the calling line and a called line when said called line terminates in said branch exchange, said connection excluding said extensions between the branch and the main office.

2. In a telephone system, a main exchange, a branch exchange, lines terminating in said branch exchange, extensions for said lines normally connected thereto and terminating in said main exchange, means whereby a subscriber when calling extends a connection over said extensions to said main exchange, a line signal associated with each extension at the main exchange, for indicating to the operator when a call is being made, means at the branch exchange for establishing connection between

two lines terminating in said exchange, which connection excludes the extension extending from said branch to said main exchange, another signal associated with each extension at the main exchange and controlled over a circuit comprising both sides of said extension in parallel to indicate that the line is in use.

3. In a telephone system, a main operator's board, a branch operator's board, lines terminating in said branch board and provided with an extension extending from said branch to said main board, a signal at said main board associated with each of said extensions, and controlled over a circuit comprising both sides of said extension in parallel, another signal at said main-board, means whereby a subscriber in making a call over one of said lines operates said other signal, means by which the operator at the main board can then obtain connection with the calling subscriber to ascertain the number of the called subscriber, and means at the branch board for establishing connection between the calling line and a called line when said called line terminates in said branch exchange, and for disconnecting the extension lines normally connected to the two connected lines.

4. In a telephone system, a main exchange, a branch exchange, lines terminating in said branch exchange, extensions for said lines normally connected thereto and terminating in said main exchange, means whereby a subscriber when calling extends a connection over said extensions to said main exchange, a line signal associated with each extension at the main exchange for indicating to the operator when a call is being made, means at the branch exchange for establishing connection between two lines terminating in said exchange, and for disconnecting the extension lines normally connected to the two connected lines, another signal associated with each extension at the main exchange and controlled over two sides of said extension in parallel to indicate that the line is in use.

5. In a telephone system, a main exchange, a branch exchange, lines terminating in said branch exchange, extensions for said lines normally connected thereto extending to said main exchange, means for establishing a talking circuit between two of said lines and for eliminating the extension of one of said lines from the talking circuit, a signal at either end of said extensions, and means for operating the signal at either end of an extension when the operator at the other end of the same is using the same.

6. In a telephone system, an operator's board, two lines terminating therein, means for establishing a connection between said lines, a second operator's board, an extension

sion circuit normally connected to each of said lines and terminating in said second operator's board, whereby a talking circuit may be extended from said lines to said second board, a signal at said second operator's board, and means whereby, when the first operator establishes connection between said two lines, said extension circuits are employed to operate said signals to indicate to said second operator that said lines are in use.

7. In a telephone system, an operator's board, lines terminating therein, means for establishing connection between two of said lines, a second operator's board, extension circuits for each of said lines normally connected thereto for use in extending a talking circuit to said second board, a signal on said second board associated with each of said extension circuits, means whereby, when the first operator establishes connection between two of said lines, the corresponding extension circuits are disconnected from said two lines, and means operated over these extension circuits for operating the signals associated with the second operator to indicate that the two connected lines are in use.

8. In a telephone system, two operators' boards, a trunk line terminating in a spring jack in each of said boards, a signal for said trunk on each of said boards, and means whereby, when the operator at either board connects with said trunk, a line circuit is closed from ground through battery and over the two sides of the trunk line in parallel to ground, means controlled by the closure of said circuit for operating said signals to indicate that the trunk is in use, and a line signal associated with one end of said trunk also operated over said trunk.

9. In a telephone system, two operators' boards, a trunk line terminating in said boards, a pair of impedance coils bridged across each end of said trunk, a connection to each bridge at a point between said coils to one pole of a battery, means controlled by either operator making connection with said trunk for connecting the opposite pole of the battery to one of said bridges, whereby a circuit is completed over the two sides of said trunk in parallel, a signal for said trunk on each of said boards controlled by the closure of said circuit, and a line signal associated with one end of said trunk also operated over said trunk.

10. In a telephone system, a main operator's board, a branch operator's board, lines terminating in said branch board and provided with an extension extending from said branch to said main board, signals at said main board associated with each of said extensions, means whereby a subscriber in making a call over one of said lines operates said signal on the main operator's board,

means by which the operator at the main board can then obtain connection with the calling subscriber to ascertain the number of the called subscriber, means at the branch board for establishing connection between the calling line and a called line when said called line terminates in said branch exchange, said connection excluding said extensions between the branch and the main office, and a busy signal controlled over a circuit comprising both sides of said extension in parallel.

11. In a telephone system, a main exchange, a branch exchange, lines terminating in said branch exchange, extensions for said lines normally connected thereto and terminating in said main exchange, means whereby a subscriber when calling extends a connection over said extensions to said main exchange, a line signal associated with each extension at the main exchange for indicating to the operator when a call is being made, means at the branch exchange for establishing connection between two lines terminating in said exchange, which connection excludes the extension extending from said branch to said main exchange, and a busy signal controlled over a circuit comprising both sides of said extension in parallel.

12. In a telephone system, a main operator's board, a branch operator's board, lines terminating in said branch board and provided with an extension extending from said branch to said main board, signals at said main board associated with each of said extensions, means whereby a subscriber in making a call over one of said lines operates said signal on the main operator's board, means by which the operator at the main board can then obtain connection with the calling subscriber to ascertain the number of the called subscriber, means at the branch board for establishing connection between the calling line and a called line when said called line terminates in said branch exchange, and for disconnecting the extension lines normally connected to the two connected lines, and a busy signal controlled over a circuit comprising both sides of said extension in parallel.

13. In a telephone system, a main exchange, a branch exchange, lines terminating in said branch exchange, extensions for said lines normally connected thereto and terminating in said main exchange, means whereby a subscriber when calling extends a connection over said extensions to said main exchange, a line signal associated with each extension at the main exchange for indicating to the operator when a call is being made, means at the branch exchange for establishing connection between two lines terminating in said exchange, and for disconnecting the extension lines normally connected to the two connected lines, and a busy signal controlled over a circuit comprising both sides of said extension in parallel.

trolled over a circuit comprising both sides of said extension in parallel.

14. In a telephone system, two operators' boards, a trunk line terminating in a spring jack in each of said boards, a signal for said trunk on each of said boards, and means whereby, when the operator at either board connects with said trunk, a line circuit is closed from ground through battery and over the two sides of the trunk line in parallel to ground, means controlled by the closure of said circuit for operating said signals to indicate that the trunk is in use, and a line signal associated with one end of said trunk operated over a circuit comprising the two sides of said trunk in series.

15. In a telephone system, two operators' boards, a trunk line terminating in said boards, a pair of impedance coils bridged

across each end of said trunk, a connection to each bridge at a point between said coils to one pole of a battery, means controlled by either operator making connection with said trunk for connecting the opposite pole of the battery to one of said bridges, whereby a circuit is completed over the two sides of said trunk in parallel, a signal for said trunk on each of said boards controlled by the closure of said circuit, and a line signal associated with one end of said trunk operated over a circuit comprising the two sides of said trunk in series.

Signed by me at Chicago, Cook county, Illinois, this 4th day of April, 1913.

BERNARD D. WILLIS.

Witnesses:

ARTHUR J. RAY,
J. NORBY.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."