

board, and parallel to these again and still closer to the operator is a row of small levers or keys. The operator wears a band around the head, to which is attached a receiver placed immediately over her left ear, and a transmitter or mouth-piece so adjusted that she may conveniently speak into it while it is not in immediate proximity to her lips. Both the receiver and the transmitter are connected by cords with the main board. In virtue of this device the operator is free to use both hands to make the necessary connections.

When a subscriber rings up central or lifts the phone from the hook, a light immediately glows within the glass covered orifice on the lower half of the vertical board at the point at which the phone is connected by wire with the Main exchange. This light is an indication to the operator that a subscriber is calling central. She thereupon takes with one hand one of the plugs to which a cord is attached and inserts it in the hole or socket (technically termed the 'jack') corresponding to the light which is glowing, at the same time pressing forward one of the levers or keys. This connects her with the calling subscriber, of whom she requests the number desired. On receiving the number she takes the end of the other cord—there are a pair of cords with a plug at the end of each—and inserts its plug in the hole or socket (the 'jack') on the upper half or 'multiple' portion of the board which bears the number requested. She then throws the lever back which connects for a moment the machine generating current, and takes a little portion of that current to ring the bell of the called subscriber. The plugs inserted in this way effect the desired connection between the phones. As soon as the operator connects with the subscriber by inserting the plug in the hole at which his phone connects with the main exchange, the light beside this hole, which has been her signal, is extinguished, and one of the small lights on the keyboard begins to glow. Its companion light glows also once the connection is made, and until the other phone is taken down for purposes of conversation. Once the conversation begins both of the signal lights go out. When the conversation ends, as each subscriber hangs up his phone, the companion lights opposite the companion plugs begin again to glow. It is then the duty of the operator to remove the plugs from the holes into which they have been placed, and thus sever the connection and extinguish the lights. This work of making and severing connections is the main duty of the operators. In other words, an operator is continually answering subscribers, covering the board with such connections as are requested and as rapidly clearing the board whenever conversations are ended; putting up and taking down connections.

A more complete description of the switchboard and duties of operators will be had from the following extracts taken from an article on 'The Telephone Exchange,' by S. J. Larned, General Superintendent of the Chicago Telephone Company, which appears at page 686 and subsequent pages of the July, 1907, number of 'The World To-day':—

'Supposing a number of lines, all leading in to the central office or exchange, it is necessary to provide there means whereby the user, or subscriber as he is called, may be able to signal whenever he desires service, and may then have his line promptly brought into contact with the line of any other subscriber to the system with whom he wishes to converse. The second subscriber must be signalled by ringing his bell. When the two subscribers have finished their conversation, their wires must be as quickly separated again so that each may be immediately free and available for con-

nection with other subscribers, for these wires or lines may be likened to single-track railway spurs leading into the subscriber's premises, each of considerable length, but capable of admitting and carrying but one car or message at a time. The most watchful care and systematic handling is necessary in order to permit the handling of a maximum traffic in both directions without collisions and tie-ups.

'There are connected to the Chicago Exchange more than 130,000 telephones.* The system must stand ready at any moment to bring together any two of these for conversation. Leaving out of count possible connections with other towns and cities, this means that the machinery must be capable of making on an instant's notice, any one of nearly seventeen billion possible combinations. The end of the conversation must be accurately noted and the lines promptly disconnected. Before connection is made it must be ascertained that the line asked for is not already carrying another message or temporarily disabled or unavailable for any other reason.

'In establishing connections, all the above conditions and many others must be noted and allowed for, and yet the time consumed in each step of the process of connection must be measured as seconds or even fractions of a second.

The switchboard designed to meet these requirements is a highly complicated machine both as to extent and flexibility. The subscribers' line wires are at that point (i.e., the exchange) separated and their ends arranged in an orderly manner in rows, or strips, on what is called the terminal or main distributing frame. Each wire is numbered in the order of its appearance on this frame, and a careful record kept of the cables it passes through, the route it takes and the subscriber's telephone which it finally reaches.

'At the main frame or distributing board, above mentioned, are terminated, in a manner similar to the line wires, all the wires from the switchboard. Every line wire must be permanently connected to some one of the switchboard wires; but it is sometimes necessary to change their relation for various reasons, such as the shifting of a given telephone from one underground wire to another, because of the moving of a subscriber's office, &c. For this reason, a short length of easily replaced, flexible wire is used to continue the line wire through the distributing frame to the switchboard wire. This connecting link is technically known as a jumper.

'We have now traced the line wire well on its way to the switchboard, but it is again interrupted by a second distributing board, known as the intermediate distributing frame, where it is divided into two branches. One branch is for outward traffic, the calls which the subscriber originates himself, and it runs to what is called the answering jack. The other branch is for inward traffic; that is, calls made for the subscriber by others, and it runs to that part of the switchboard called the multiple, which will be described later.

'The switchboard itself consists of a long, continuous framework, in which are mounted the answering jacks, the multiple and other parts not yet mentioned, and before which frame sit operators, who connect and disconnect line wires, as ordered by the subscribers.

The answering jack is the point at which contact is made with subscriber's line by an operator, in response to his call. The device with which a connection is established between two lines is called a pair of cords. It consists of a set of flexible wires or conductors, generally of tinsel, incorporated in a braided linen cord. At each end, the cord terminates in a metal plug, which, when pushed into an answering jack, makes a contact between the subscriber's line and the tinsel conductor of the cord. When therefore the two plugs, or pair of cords, are inserted in the spring jacks of two different lines, those lines are connected together and in a condition for conversation.

'Just over ever answering jack in the face of the switchboard is mounted a small electric lamp, known as the line lamp. By a rather complicated arrangement of apparatus, this lamp is lighted whenever the telephone receiver at the corresponding subscriber's station is picked up. Its glowing is the signal to the operator that the sub-

* In Toronto there were on January 1, 1907, 14,900 phones.