

# Private Branch Exchanges

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A CENTRAL office, functionally considered, is that part of a telephone system which connects any subscriber in the area served by it to any other in the same area, or which acts as the first of a chain of connecting centers when the subscriber called is at a more remote location. A private branch exchange serves a group of stations within a single establishment in a closely parallel manner. That there are 130,000 private branch exchanges in use in the Bell System is a striking fact which makes one realize the importance of

tan, for example, there are about 9500 central-office operators while the P. B. X. attendants number approximately twenty thousand.

In the very early days a single telephone in any one residence or place of business was ample. The telephone was so superior to former methods of communication, by mail or messenger, that its easy accessibility to each individual that might have occasion to use it never occurred to any one as being at all necessary. Nor did it seem necessary to have telephonic means of communication between persons within a single establishment—much smaller at that time than are some of our gigantic corporations now. As the telephone came to be used more and more, however, and as greater numbers of employees in every office or factory found occasion to take advantage of its time-saving possibilities, a demand naturally arose for more than one station in the larger establishments. There arose also a need for the telephone for intercommunication; a bookkeeper in the office found much time and energy could be saved if he could talk directly with a clerk in the shipping room. Out of these demands arose the private branch exchange, or P. B. X. as it is colloquially termed, a private central office serving directly its own stations.

A P. B. X. was not, of course, the



*Fig. 1—The 505 P. B. X. uses neither cords nor plugs; all switching is done by manipulating keys mounted on the face of the cabinet*

this rapidly growing part of the telephone plant. In some of the larger cities P. B. X. attendants outnumber central-office operators; in Manhat-



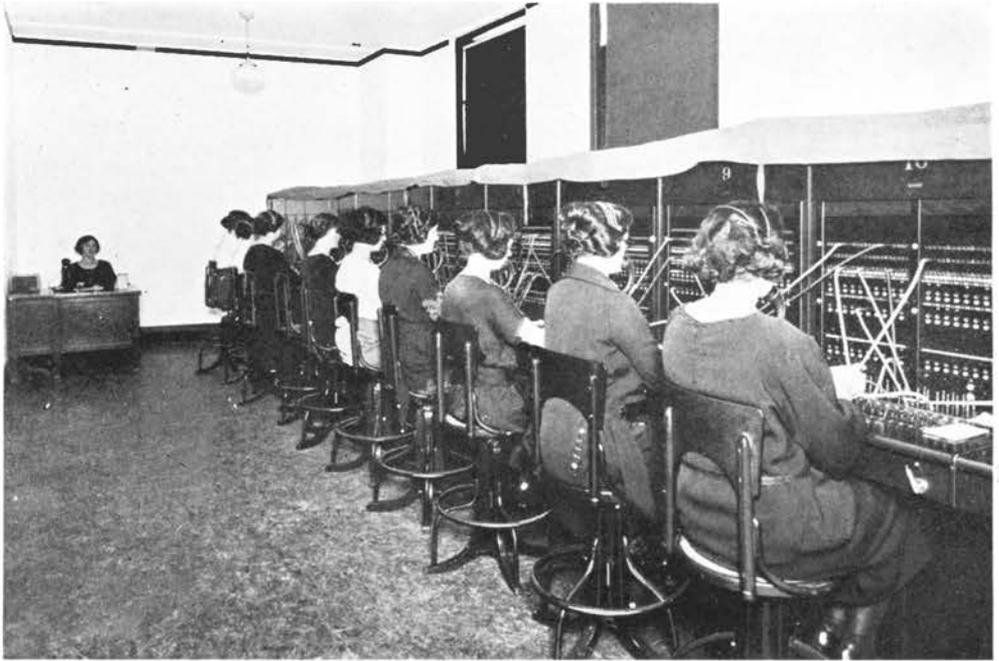
*Fig. 2—A large 604-type P. B. X. installed in Bell Telephone Laboratories*

only solution possible. There could have been the same multiplicity of stations within the establishment and the same possibility of intercommunication, had each station had its own line to the main central office and its own number. Any station could have called another by passing through the central office operator, and so far as the members of the organization were concerned there would have been little difference except that the station designation numbers might have been longer.

From the standpoint of some one calling in from the outside, however, there is a considerable difference. The outsider often does not know the name of the person he wants to talk to; he knows what he wants to find out or what knowledge he wants to impart but that is all. If for any establishment there were only a long list of names and numbers in the directory he would be helpless. Obviously the only satisfactory solution

is to have but a single number for any one establishment and a single person—or, for the larger concerns, a single group of persons—to answer all incoming calls. This person, the P. B. X. attendant, with intimate knowledge of the organization could connect the incoming call to the station that could most effectively deal with it. Thus the need for an attendant was paramount in calling the P. B. X. into existence and the attendant is still of primary importance to the modern P. B. X. system.

If there are fifty telephone stations in the local establishment they will never all want to talk with the outside simultaneously. At any one time some stations will not be in use at all and some may be talking to other local stations, leaving only a small remainder making demands for outside service. The ratio of central-office trunks to stations, therefore, is always less than unity although it varies over a considerable range depending



*Fig. 3—A medium sized P. B. X. of the manual type is the 600-C*

on the type of business. The attendant and the P. B. X., of course, always partially, and occasionally entirely, offset the savings due to the reduction in number of trunks. The attendant, however, performs so many useful services that she is generally regarded as an asset rather than an expense.

Differences in types of business as well as differences in size naturally affect the P. B. X. equipment furnished for the subscriber. In some organizations most of the calling is between members within the organization, whereas in others practically no local calls are made. In some places conditions favor dial service while in others the manual system offers certain advantages. Differences in the number of stations to be served necessarily make a difference in the type of P. B. X. furnished. Thirty-five varieties of P. B. X. have been made in the past and probably more

will be built in the future as methods of doing business change and as telephone apparatus and equipment improve. There has never been this number in standard use, however, at any one time. At present only six types are standard and stocked and this number probably fairly represents the number standardized at any one time in the past.

In the manual class the range of size varies from the small 505 type, with a maximum of seven stations and three central-office trunks, to the large 604-C which, as used by the Consolidated Gas Company of New York, has 1650 station lines, 221 trunks to central offices, and 175 tie lines to other branch exchanges, and requires 42 attendants during the busy part of the day.

The small 505-type board uses no cords or plugs but all connections are made by keys on the front of the board. It is so small that it can be

placed on an ordinary desk, and may be operated by a clerk who may also have other duties. Contrasting with this the larger exchanges, such as the one in our own Laboratories, have all the appearance of a central office. Between these extremes are other types and sizes such as the 550\* and the 600-C.

Each type of board is made necessary by the conditions of service that it has to meet and by the number of lines that it must serve. The cordless 505 type is compact and seems very simple but actually would become difficult to operate if the number of lines were increased to any great extent. To locate an operated key from the large number all exactly alike becomes somewhat trying. A cord plugged into a jack, on the other hand, is easy to see and so as the number of lines increases better results are secured with cords.

The No. 1 and No. 2 intercommunicating sets, which do not require attendants for local calls, are interesting because of their small size. Lines run from each station to every other, and each station is in reality its own P. B. X. as a key is depressed corresponding to the line wanted and no other switching equipment is required. Except for this very small unit, private branch exchanges not requiring an attendant for local calls have been designated for the larger installations only. The present standards are the 700 and the 740\*\* dial-types, the former of which may have any capacity up to one approaching that of a central office. Both of these boards may dial an outside number without the

aid of the local attendant. The 740-A, only recently developed, has a maximum capacity of eighty-eight station lines and will serve subscribers with a smaller number of local stations.

There is a large and increasing demand for tie-line intercommunication

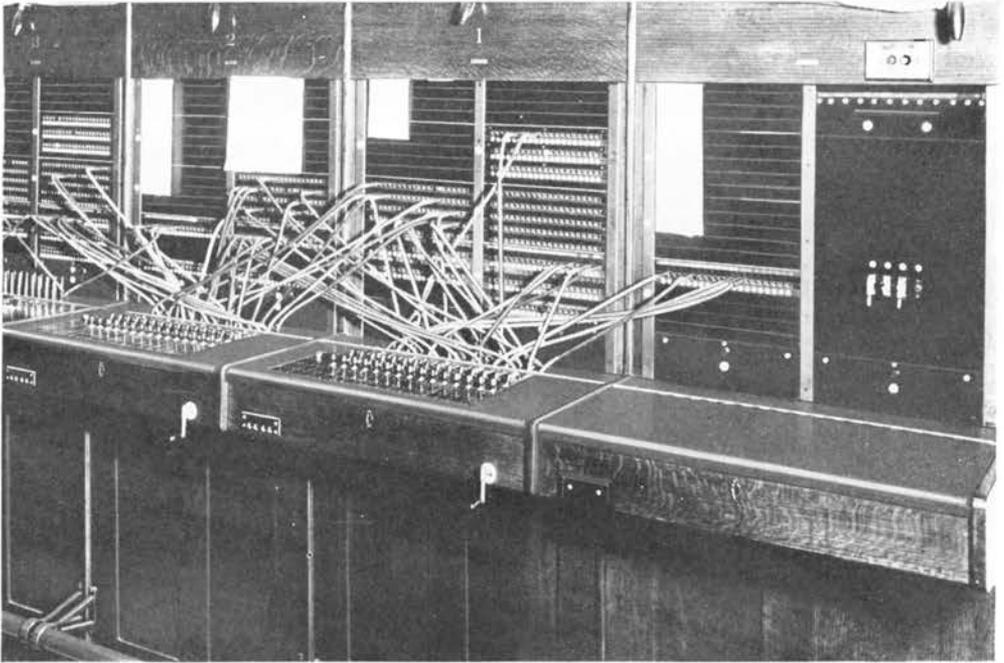


*Fig. 4—Dial-type private branch exchanges have usually been made in the larger sizes as indicated by this section of a 700 type*

between P. B. X.'s. Large organizations, such as public service companies, often have a number of private branch exchanges located at different points throughout the city. The tie-lines may be arranged for dial or manual service, depending upon the type of P. B. X. and the requirements of the subscribers. When tie-lines are provided between dial P. B. X.'s the circuits can be arranged, if desired, so that a station in one P. B. X. can dial any station in another. At Bell Laboratories there are direct tie-lines to and from nine other Bell System P. B. X.'s in and around New York City.

\* The latest design of this type, known as the 551, is described in BELL LABORATORIES RECORD for July, 1928.

\*\* Described in BELL LABORATORIES RECORD for August, 1928.



*Fig. 5—A P. B. X. of the dial type as a rule has a group of manual positions for the answering of incoming calls. The above is a part of a 700 P. B. X.*

Of the 115,000 P. B. X.'s manufactured by the Western Electric Company during the period from 1910 to 1926, 96% were of the small sizes. Of these 9% were of the No. 2 and No. 4 types, the latter of which is now no longer standard, the other 87% being about equally divided between the 505 and the 550 types. Naturally, there are fewer of the very large boards so it is not surprising that in

this same period only a score or more of these have been manufactured, although additional sections are being made continually to take care of the expansion of the existing boards. These figures make it easier to understand that in some central offices in the business section of New York City approximately seventy-five per cent of the total working lines terminate in private branch exchanges.