The design of any telephone equipment is always complete and never final. The 608A PBX switchboard, recently designed at Bell Laboratories, is a departure from tradition that results in a new versatility for an old and service-proven Bell System device.

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A Pushbutton PBX Switchboard

Design criteria for a private branch exchange (PBX) switchboard are defined by the nature of the traffic it handles. The similarity of this traffic in most business firms and institutions establishes standard basic operating requirements for any PBX. The logical next steps in the design of a new PBX are toward better service for station users, easier operation for PBX attendants, and greater flexibility to handle different requirements of different users. These should be coupled with the always desirable quality—improved appearance. Easier operation is a major factor which, upon close scrutiny, becomes part of the larger area of human factors.

Many PBX attendants are "doublers in brass" who serve their companies as receptionists and information clerks as well as switchboard operators. A switchboard allowing quick, almost "second nature" operation frees the attendant from preoccupation with technical procedures so she may concentrate on a calling party's request. To help fill these needs, Laboratories' engineers designed the 608A PBX for pushbutton operation. This article describes the operation of this switchboard and its new design features which, combined with the best features of existing switchboards, results in unusual flexibility and a design that encourages improved service.

Its appearance immediately sets off the 608A PBX from its forerunners. A low silhouette—a desirable characteristic in modern industrial design—is achieved with little sacrifice in line and trunk capacity. A fine integration of esthetic and practical design was attained by sloping the jack field toward the back of the board and the keyshelf downward. These slopes enhance the very modern lines of the board and result in a more comfortable operating position for the attendant.

The modern theme was carried into finish and color. The casing, composed of removable panels, is usually painted with textured vinyl, either beige-gray or medium-gray. The jack field and keyshelf, are a contrasting light beige-gray, a pleasing departure from the black of older boards. A customer who wishes to match a particular decor can order the board with unfinished panels

The 608A PBX switchboard is shown here in a three-position multiple arrangement. Each operator's position can be supplied as a single section.

and paint them as he likes. The panels' construction—a unique sandwich of thin outer layers of aluminum with a corrugated cardboard core—is light but very strong and it lessens relay noises from inside the board.

Another advance in switchboard design which yields greater comfort for the attendant is achieved by a novel cord-weight arrangement. Previous boards were either placed on a 6-inch platform or used a double-pulley cord weight to gain space for the long cords required by a multiple board. The platform necessitated a special, higher chair for the attendant; the double pulley was cumbersome. The 608A circumvents either arrangement with a guided-cord weight that rides up or down on a guide rod as the attendant pulls or releases the cord. The rod limits side-to-side movement and guides the cord at an angle toward the back of the casing. This allows longer cords and permits the weight to drop almost to the floor without loss of toe room for the attendant. This arrangement keeps the front of the keyshelf at ordinary chair height and lets the attendant manipulate the cords easily.

Basically, the 608A is a manual cord switchboard for connecting between central office trunks and inside stations, or between stations. Alternatively, it is used as an attendant's position for a dial PBX, the 740E or 701B, for example. The great flexibility of the 608A PBX stems from the fact that with slight modifications it can be adapted to varying traffic conditions. Although the nature of traffic to all PBX switchboards is similar, the volume differs greatly, and it may increase with the customer's business. Some PBX boards are easily handled by one attendant. Others, with hundreds of trunks and thousands of stations, may need as many as twenty.

A customer's choice of a switchboard has generally been determined largely by the volume of traffic. Often, a significant increase in traffic dictates a change to a switchboard with greater capacity. Thus, Operating Companies are faced with the difficult problem of deciding upon the type of switchboard to be installed initially. The new switchboard neatly solves the problem because it plays a dual role as the volume of traffic directs; it may be a single-position board, or a multiple switchboard with any number of positions as shown in the photograph on this page. This is another unique design feature that deserves attention.

The keyshelf of the switchboard section has space for 16 cord pairs. The pushbutton keys and lamps associated with the cords are contained in plug-in units. The relay units for the cords—also plug ended—are installed on shelves inside the board. Additional key and cord units are merely plugged in to meet changing traffic conditions.

The number of station lines is also easily increased. The jack face opening on the basic switchboard is 11½-inches high—sufficient space for nonmultiple and medium sized multiple boards. The jack mountings, which are not as high as on older boards, and the combined lamp and designation strip—rather than a single strip for lamp and another for designation tags—are an example of effective use of space on the new board. For very large multiple boards extension bars are spliced to the framework and the position roof is raised. This increases the jack face opening to 19½ inches and jack strips can be added as they are needed in the additional space. The printed labels with adhesive backing used in the stile strips and the paper forms for designation strips are easily replaced for new or changed numbers. The table on page 163 is a concise summary of the switchboard's capacity and the range of its utility.

For the 608A PBX, the final test of many of the new design features we have discussed lies in how they contribute to the central idea—simplicity of operation. All areas on the compact

board are easily reached. The keyshelf—a one-piece aluminum die casting—contains mounting space for the keys, a transparent bulletin holder, a metal ticket clip, a dial, and the cords. In front of each cord pair are two supervisory lamps and a single pushbutton that replaces the lever-type keys on older boards.

To answer a call the attendant selects a cord pair and presses the TALK pushbutton which then lights. Her headset is connected through the position circuit to the cord by a relay in the cord circuit. She plugs the rear cord into the jack of the calling line or trunk and completes the connection by plugging the front cord into the called line or trunk. On calls to stations, ringing starts automatically and the supervisory lamp winks periodically until the phone is answered. The attendant presses any other TALK button to be released from one cord pair and connected to another or presses the common RELEASE key to disconnect her telephone set from the cord pair.

The pushbuttons are nonlocking. This feature, operating jointly with an electrical interlock chain relay circuit, saves the attendant the bother of restoring keys to "normal" which is necessary on switchboards with locking lever keys. Further freedom from mechanical details is gained because all calls, trunk or station, can be answered with the rear cord and completed with the front cord. On most older boards trunk calls had to be answered with the front cord and station calls with the rear.

Calls from a station to an outside line over a central office trunk may be dialed either by the station user or by the attendant. If the station user dials, the attendant plugs the front cord into a trunk jack and pushes a THRU DIAL button which connects the station directly to the trunk and releases her from the connection. If the attendant completes the call she plugs the front cord into the trunk jack and dials.

Another new idea in the 608A PBX is designed to improve service for the calling party on calls from a central office. On other boards, the attendant trips the ringing on calls from a central office when she plugs a cord into the trunk jack. If she is attending to other tasks and does not operate the TALK key immediately, the calling party no longer hears ringing. In the 608A PBX the attendant may plug into the trunk jack at any time but ringing continues until she presses the TALK button and comes into the circuit. The supervisory lamp flashes as a reminder that a call is waiting and continues to flash until she answers.

Special Signaling Devices

If the attendant leaves the board or is momentarily distracted by another task, she turns on an AUXILIARY SIGNAL key. If a call comes in or a cord supervisory lamp lights with this key on, a tone signal is generated by a transistor oscillator which feeds a small loudspeaker. This is as effective as the usual buzzer, a more pleasant sound and the volume is easier to control. The tone is stopped automatically when the attendant answers the call even if other lamps are still lighted. Many other boards have a foot switch to silence the buzzer.

The new board has other useful signaling devices which in the past were a feature only on large switchboards. For example, the station user does not have to jiggle the switchhook continuously to signal the attendant; he merely presses it once. The supervisory lamp flashes as a recall

608A PBX—LINE AND TRUNK CAPACITY

Type	Manual Switchboard		Dial PBX Attendant's Position	
	Station Lines	Trunks	Station Lines	Trunks
Nonmultiple	360	80	300	80
Three-Panel Multiple, Board—48 inches High	560	120	900	180
Four-Panel Multiple, Board—48 inches High	800	160	1200	240
Four-Panel Multiple, Board—56 inches High	1600	160	2400	480

signal to the attendant. The flashing is accompanied by an audible clicking or a tone signal controlled by the auxiliary signal key.

Among other operating features worth mentioning are nonlocking SPLITTING and DIAL BACK buttons. The attendant pushes the SPLITTING button to exclude a calling party from the circuit while announcing the call to a station. The station user can thus talk to the attendant without being overheard by the caller. The DIAL BACK button permits the operator to transfer the dial, normally associated with the front cord, to the back cord. When these buttons have been operated the circuit may be restored to normal merely by pushing them again. The circuit is automatically restored when another TALK button or the RELEASE button is depressed. A TRANSFER key allows the attendant to connect her headset to a vacant adjacent position. Other pushbuttons permit her to ring manually on the front or back cord, to make a peg count, and to connect to a paging circuit.

The cord circuit is arranged for "delayed thru supervision", that, when the station user hangs up, automatically frees the central office trunk for incoming calls after a short delay. During this delay the station user may depress the switchhook and recall the attendant at the board without disconnecting from the central office.

A number of other features—not so apparent visually—are of great benefit to the PBX customer. Because the 608A is a universal switchboard adaptable to various sizes of offices and to differing traffic conditions it is possible to manufacture it on an assembly-line basis. Thus the basic board and additional plug-in units can be stocked and the customer receives delivery of his switchboard soon after he orders it.

Factory wired multiple cables with solderless wrapped connections are used—another unique feature in switchboard design. These cables use 26-gauge wire which make them lighter and more flexible. Further, they require less ironwork for supports than older multiple cables.

Maintenance of the board is made much easier by virtue of the plug-in units. Defective units may be removed for repairs and replaced immediately with another unit. Cord seats, long-wearing nylon pressed into the die-cast key shelf, also are easily replaced; they are merely pushed out and replaced with new seats.

New pushbutton switchboards are in service at several industrial offices. High praise from customers and from operating companies has supported Bell Laboratories new approach to an old and honored Bell System service.

New Superconducting Ductile Alloys

Two related discoveries that will have important implications in several scientific fields were announced by Bell Laboratories scientists to the Spring Meeting of the American Physical Society last month. One was the discovery of a series of new ductile superconducting alloys; the other, that several other ductile alloys will remain superconducting in extremely high magnetic fields. These discoveries may greatly simplify the problem of making superconducting electromagnetic coils.

B. T. Matthias described new alloys made of molybdenum and technetium (a man-made element) which become superconducting at temperatures higher than for any other ductile alloy. Cryogenic experiments showed that an alloy of molybdenum-technetium is superconducting at temperatures near 16 degrees K. A brittle alloy of niobium-tin, Nb_3Sn, discovered by Mr. Matthias in 1954, has the highest known transition temperature of any superconducting material (RECORD, *March*, 1961).

The second development was described by J. E. Kunzler. He discussed low-temperature experiments with a compound of niobium and zirconium that remained superconducting in a field of 80,000 gauss. Other alloys, niobium-titanium and vanadium-titanium were found to be superconducting materials at liquid helium temperatures.

The new alloys will complement the application of Nb_3Sn. Extrapolation of data from experiments on Nb_3Sn at temperatures between 14 degrees K and 18 degrees K indicate that this material will remain superconducting at temperatures around 4 degrees K in fields of 200,000 gauss and possibly higher. But Nb_3Sn is very brittle and special metallurgical techniques are required to form magnet coils that can withstand the mechanical forces produced by very high fields. The discovery of the more ductile superconducting alloys gives promise of simplifying the problem.

A superconducting electromagnet will make large magnetic fields available for study. These fields can extend the operation of many electronic communication devices to higher frequencies, thus providing increased bandwidth for radio-relay communication systems.

Another attractive application is in the field of thermonuclear fusion for the production of electric power. High fields are needed as "magnetic bottles" to contain high temperature gas plasmas.