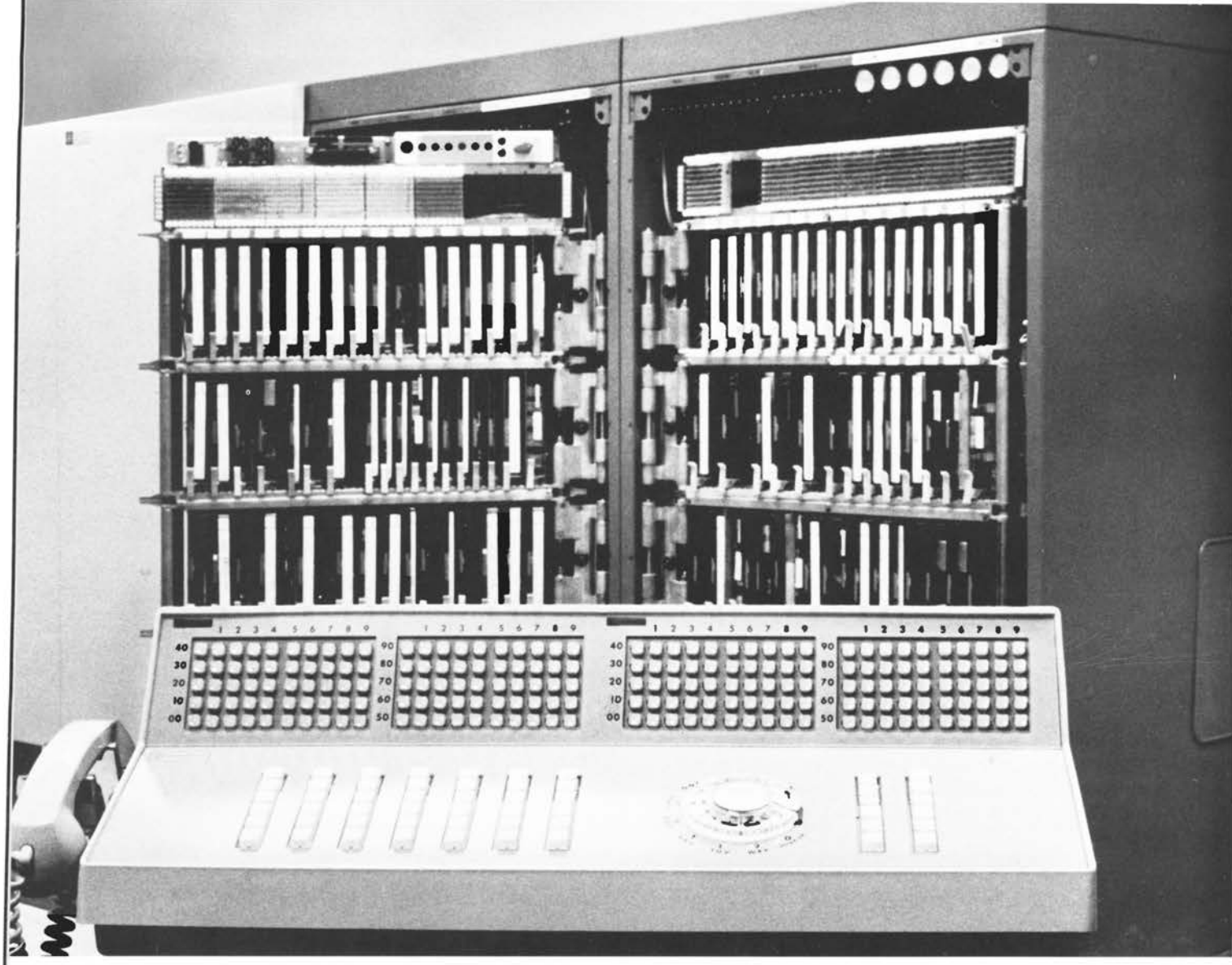


The attendant console for the 801A PBX comes in three sizes. The largest model is shown here, with an open equipment cabinet in the background. The appropriate model for a particular application depends on the number of extensions and features —conference calling, "camp on," and call transfers, for example.

Designed to meet the needs of general business establishments of medium size for an electronic private branch exchange with up to 270 stations and 40 trunks, the 801A borrows from a smaller predecessor. It features easy growth and adjustable traffic capacity.

The 801A: Midi-PBX

Michael S. Lane

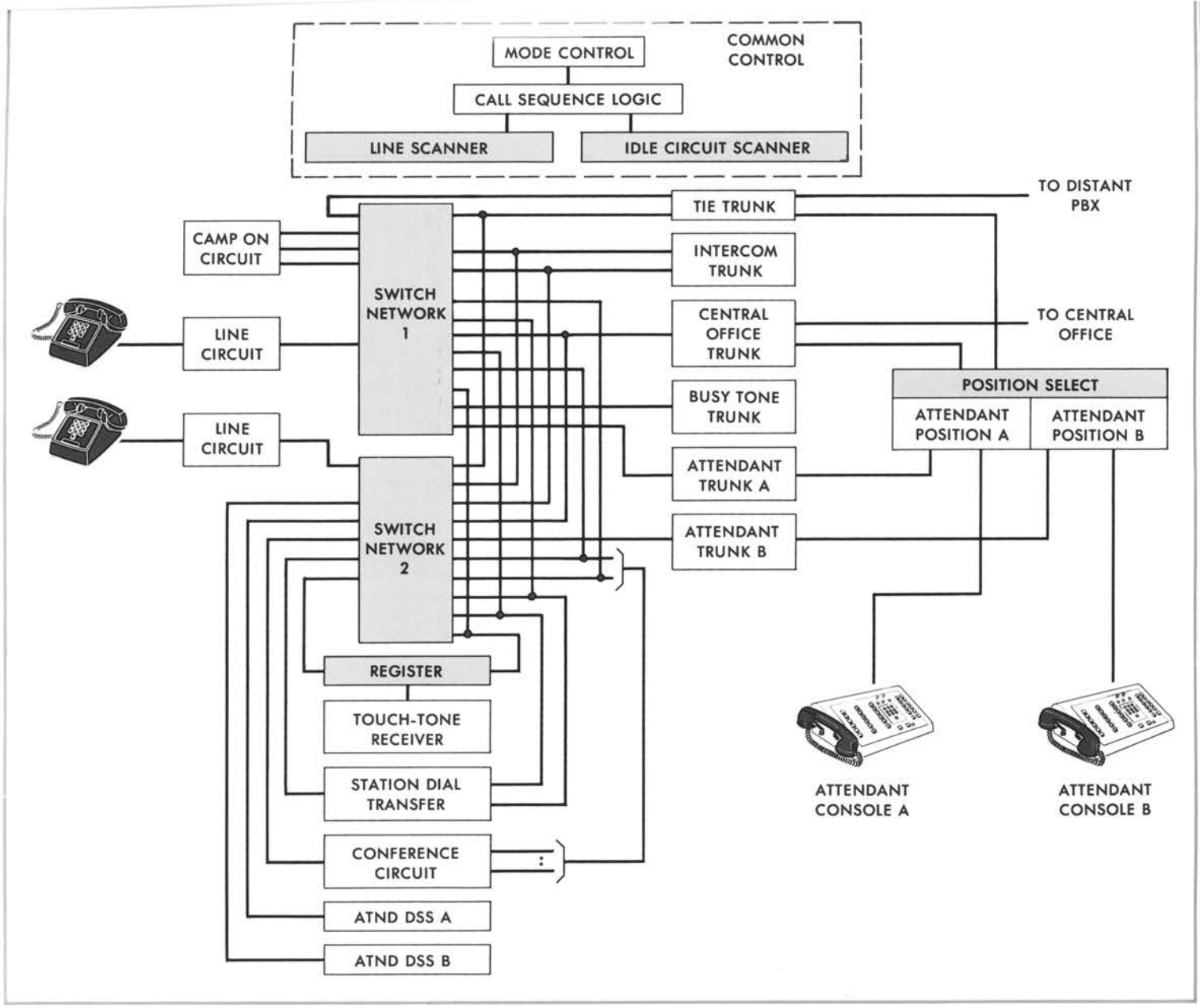
WITHIN RECENT YEARS, electronic private branch exchanges (PBX's) of the dial type have been introduced as an important element of Bell System service. A small electronic dial PBX, the 800A, serving a maximum of 80 extension lines, has been available since 1966 (see *Electronic Switching for Small PBXs*, RECORD, *February 1967*). The latest electronic system to be developed as part of the 800 series of machines is the 801A PBX. Basically an expanded version of the 800A, the 801A provides identical service and identical features, but for many more telephones—up to 270 extensions and 40 central-office trunks. The first 801A PBX began serving the National Life Insurance Company of Vermont in Boston in October of 1971.

Perhaps the most striking characteristic of this new system is the extent to which it uses existing 800A circuitry. All the line circuits and trunk circuits in the 801A are identical to those in the 800A, and these line and trunk circuits account for about 80 percent of the plug-in circuitry in a typical 801A installation. The major portion of the 801A development effort, therefore, centered on accommodating the greater line and trunk capacity by means of additional control circuitry, and options for two attendant positions and three-digit dialing.

In addition to using much of the circuitry already designed for the 800A, the 801A employs a number of proven 800A design concepts. Chief among these is the plug-in building-block principle, which is applied throughout the system's circuit design and physical design. Services and optional features are also arranged in groups and designed as more or less autonomous units of circuitry. These units are contained in plug-in packages and can be integrated easily into the system, either in the shop or in the field. Because the plug-in ferreed switch (see *The Ferreed*, RECORD, *February 1964*) is used as the switching-network element, any of three options—for light, medium, or heavy traffic—can be supplied in a single equipment package.

Like the 800A PBX, the system is packaged in free-standing enclosures similar to filing cabinets, suitable for general office locations. From one to four cabinets are required per installation, depending on the number of lines, the traffic, and the optional features. It is thus possible to choose the most economical equipment package that meets current customer needs, and at the same time allow for future growth.

New and improved techniques for installing and maintaining electronic PBX's are being introduced with the 801A. Task-oriented Bell System Prac-



Common control portion of the 801A PBX (top) finds the line originating a call, selects an idle trunk, and then selects a path through the switching network to connect the line to the trunk. In this way, extensions, attendant positions, central office trunks, and tie trunks can be interconnected. The system provides such features as camp-on, station dial transfer, and conference calls.

tices (BSP's), an improved schematic drawing format, sequence charts, total system preassembly and testing in the factory, and special test aids are all part of this program. Also included are new engineering and ordering procedures.

In contrast to remotely controlled systems such as No. 101 ESS (see *The No. 101 ESS Control Unit*, RECORD, *February 1964*), the 801A is a self-contained system using wired-logic control and ferreed devices for switching. Wired-logic control—distributed among the peripheral circuits such as line and trunk circuitry—minimizes the basic common-control circuitry that is needed. With wired-logic control, the system performs its functions according to a sequence of actions dictated by a permanently connected circuit arrangement; there is no central memory which is referred to for instructions and other information.

The common-control section consists of three main parts: a line scanner, an idle-circuit scanner, and call-sequence logic, as shown in the block diagram above. For an outgoing call, for example, the line scanner locates the line originating the call, enabling this line to "mark" a point on the line side of the network. The idle-circuit scanner then selects an idle trunk, enabling it to

"mark" the trunk side of the network. With these two marks, the call-sequencing logic directs the network control to select a path through the network and then close this path between the two points.

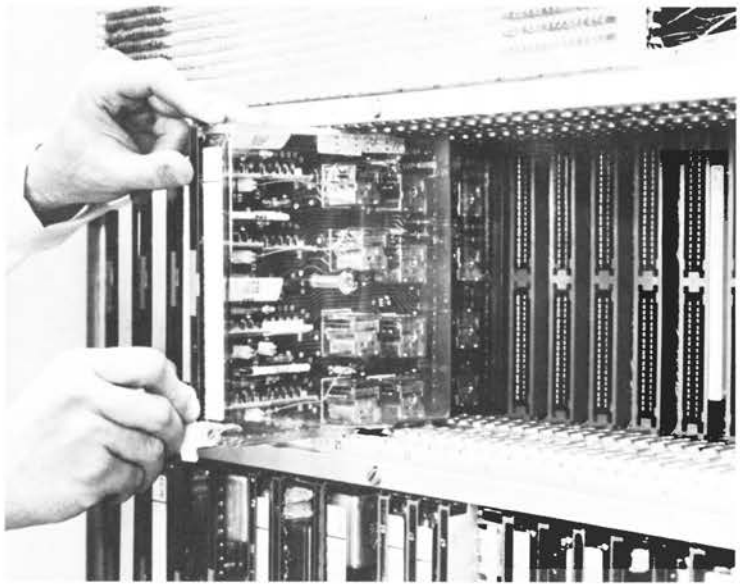
For calls between extensions, an intercom trunk connects stations via the switching network and provides supervision on such calls. For central-office calls, the central-office trunks provide an interface for the attendant and a connection via the switching network to an extension. A register for dial pulses or, optionally, for TOUCH-TONE® signals, is connected to both sides of the switching network so that it can be used for calls from either extensions or trunks.

The 801A customer can be served by two attendants if desired, each with an individual console that provides full access to all directly terminated trunks. This capability is furnished by a special circuit—the "position-select" circuit—which sequences the control signals from the two consoles. With this circuit, and with the aid of pick-up keys and control keys on the console, each attendant can answer incoming calls and connect the calls either to station lines or to tie trunks. In addition each can originate outgoing calls and set up conference calls.

Three models of the attendant's console are available (the largest of the three is shown on page 134). The choice depends on the size and features of the particular 801A system selected. A unique feature in these consoles is the use of a single supervisory lamp instead of the two used in most systems. Although the single lamp must flash at different rates to indicate different conditions, its use simplifies the console and the circuitry associated with the console.

To originate a call, the user lifts a handset at one of the extensions. This action automatically sends a request for service to the common control, which starts the line scanner searching for the line connected to the off-hook extension. The line scanner locates the line, and the common control enables the line to "mark" its connection to the switching network (that is, identify its network port as a terminating point for a new network path). Similarly, the call-sequencing logic causes the idle-circuit scanner to select an idle dial-pulse register. Common control enables the selected register to mark its connection to the trunk side of the network. Now, the switching network connects the marked line to the marked register, and the register supplies dial tone to the calling line.

Normally it takes about 60 milliseconds for the user to receive dial tone. If two or more lines request service simultaneously, the line scanner stops when it reaches any one of the off-hook lines. After this line is connected to a dial-pulse register, the service requests from the other stations start the line scanner again.



A craftsman removes an eight-inch-square logic circuit pack from an equipment cabinet for inspection. The use of such circuit modules in the 801A makes it a simple matter to expand the PBX to accommodate a larger number of stations if necessary.

When the caller finishes dialing, the call-sequencing logic examines the dialed number in the register. If a trunk code has been dialed, the idle-circuit scanner selects a suitable trunk and common control enables that trunk to mark its connection to the network. (A central-office trunk is selected if 9 has been dialed, an attendant trunk if 0 has been dialed.) The register identifies the calling line by "calling back" through its switching-network connection to the line. Common control now enables the line to mark its connection to the network, which makes a new connection, this time between the line and the selected trunk.

If the caller has dialed a number within the PBX system, the idle-circuit scanner selects an intercom trunk. The call-sequencing logic uses the dialed number stored in the register to select the called line. The called and calling lines are then connected to the intercom trunk through the switching network. Calls between stations thus require two paths through the switching network, whereas only a single path is required to connect an extension to a central-office trunk or to an attendant trunk.

If the attendant calls a station, either a central-office trunk or an attendant trunk is used. The switching network connects the attendant to the line-side terminal of a register. After the attendant finishes dialing, the common control selects the called line, and the register identifies the originating trunk by "calling back" over the es-

800A PBX Service Packages

Series 100

Attendant console plus these features:

- Station-to-station calling
- Direct outward dialing
- Station hunting
- Restriction from outgoing calls
- Power-failure transfer
- Call transfer—attendant
- Night service

Series 200

Series 100 features plus:

- Attendant direct station selection
- Attendant camp-on
- Indication of camp-on
- Attendant conference

Series 300

Series 200 features plus:

- Call transfer-individual
- Consultant hold
- Add-on conference
- Trunk answer from any station

Options

- TOUCH-TONE® calling
- Tie trunks
- Toll denial
- Conference calling
- Code call
- Paging
- Recorded telephone dictation

tablished network path. The call-sequencing logic then directs the switching network to connect the trunk to the line.

The features available in the 801A PBX depend on the version selected, as described in the table at left. "Camp-on" service, for example, is included as part of the "Series 200" plug-in equipment package. This feature lets the attendant place an incoming call in a waiting state (that is, on "hold") until the busy station becomes idle. The attendant connects the central-office trunk carrying the call to a camp-on circuit terminated on the line side of the switching network. The number of the called station is also stored in this circuit. At about 1-second intervals, common control checks the busy telephone and completes the call automatically when that telephone becomes idle. During the first check of the busy telephone, a 440-hertz tone is applied for half a second to notify the user that a call is waiting.

Another extremely useful feature is offered by the "Series 300" version of the 801A: station users can transfer incoming calls from central-office trunks without help from the attendant. To transfer a call, the user "flashes" the switchhook; this action disconnects the central-office trunk from that telephone and connects the trunk to a call-transfer circuit, which places it on hold. Next, a dial-pulse register connects dial tone to the requesting telephone through the call-transfer circuit. The requesting user can now dial any other extension—say extension "B".

Extension B is connected to the call-transfer circuit when the dial-pulse register disconnects itself. Extension B rings. When it goes off-hook, users at the two extensions can converse privately, a feature called "consultation hold". When the user at the first extension—"A"—flashes the switchhook again, the trunk circuit is added to the talking connection in the call-transfer circuit, establishing a three-way, or "add-on", conference call. When either extension hangs up, the call-transfer circuit disconnects itself, and the system then connects the trunk directly to the remaining extension. The transfer sequence can be repeated as often as desired.

The basic building block of the 801A system is a transistor-resistor logic (TRL) gate, originally developed for the 800A PBX. Four TRL gates are provided on a single ceramic substrate containing a single silicon chip with four transistors and deposited tantalum thin-film resistors. Several of these ceramics are mounted in turn on a relatively large (8-inch-square) printed-circuit board to provide the various circuit functions required in the 801A. Use of large circuit boards reduces the

number of wire connections in the system, but retains the functional modularity needed for economic flexibility, ease of growth, and ready replacement of parts for maintenance. Many circuit packs are directly interchangeable, thus contributing to system compactness. For example, different kinds of central-office trunks can be inserted interchangeably in the same circuit-pack slot in the equipment cabinet.

Like the logic circuitry, the ferreed switching networks are modularized. Each ferreed switching network module is a self-contained package. One such package is provided for each cabinet. Any of the three traffic arrangements—light, medium or heavy—can be provided in the same network module by providing either plug-in shorting boards or plug-in ferreed switches. A "patch field" for each switching-network package gives the system further flexibility. This feature, which is unique to the 800A and 801A, permits adjusting the network traffic capacity without changing the extension numbers. It is only necessary to rearrange the plugs that connect the lines to the switching network to retain the same station numbers as traffic capacity is altered.

The equipment cabinets are of the 800A type, and are designed to blend with office furniture. Each is 57 inches high, 28 inches deep, and 34 inches wide—the same height and depth as a standard filing cabinet. The cabinet has snap-on cover panels for easy access to the equipment, and may be placed against a wall, since rear access is not required. An auxiliary cabinet, externally identical to the others, can be used for supplementary services; for example, 23-inch mounting plates for optional tie trunk, paging, and recorded dictation equipment can be installed in it.

Installation and ordering have been made easier with a new simplified questionnaire that takes full advantage of the plug-in arrangements for growth and increased traffic capacity in the 801A. Specific ordering information and installation instructions will be generated by a computer, based on the information on the questionnaire. The installation notes will specify the required circuit packs and locations, options for each circuit pack, required plug-in network switches and locations, the line and trunk connections to the switching network, and the cable connections within and between cabinets. A new system preassembly program at Western Electric in Denver will allow complete assembly of a cabinet according to the customer's order with "standard" factory options. The total system will then be tested to insure that the system as received at the customer's location will pass the installation tests dictated by Bell System Practices (BSP's), thus enhancing the initial reliability of the system.

When repairs to the system are necessary, they can be accomplished almost entirely by replacing plug-in components. Experience has shown that wiring failures are infrequent, and that most repairs consist of exchanging plug-in equipment units on circuit packs. To make it easy to locate a defective plug-in unit, a new task-oriented BSP of the flow-chart type has been provided. To help in locating wiring failures, special test connectors have been wired into the common control to allow future use of a portable test facility. The 801A also has special built-in control switches that allow the craftsman to interrupt call sequences and to route test calls to specific circuits. The craftsman can then analyze the state of various circuits by means of sequence charts and a portable tester, a voltmeter, or a logic probe.

Thus, besides filling the gap between large and small PBX systems, the 801A provides features and economies that should appeal to customers and operating companies alike.