The 800A PBX serves up to 80 station lines and is designed particularly for the customer who needs a small PBX. Its main features are flexibility and economy, making it possible to furnish modern, electronic PBX service to small customers at the lowest cost.

Electronic Switching For Small PBXs

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THE 800A PBX is an electronic switching system specifically designed for customers who need up to 80 station lines. Combining simplicity and versatility, the 800A is intended to serve a wide variety of small customers, from those requiring basic dial service or those who have outgrown Key Telephone Systems to those requiring high traffic capacity and a wide variety of service features.

To achieve versatility and economy, the 800A embodies a number of special design concepts and techniques. Chief among these is a thorough application of the plug-in building-block principle in system, circuit, and physical design. Services, traffic capacities and optional features are arranged in groups and designed as more or less autonomous units of circuitry. These units are contained in plug-in equipment packages, which can be integrated into the system easily, either in the shop or in the field.

Eight alternative packages of switching equipment offer capacities of four different numbers of lines (30, 44, 60 and 80), equipped for either light or heavy traffic. Each switching network package includes the circuits necessary for selecting paths through the network.

The technique of "distributing" control equipment cuts to a minimum the basic common control required in all installations, particularly in the smaller sizes. Service features are available in three standard packages—called series 100, 200 and 300. The latter two are "add-on" packages. Again each package includes control circuits for the equipment providing the service.

Series 100 service is basic PBX service. An attendant uses a small console to receive incoming calls. She routes calls to desired extensions by dialing, and can transfer calls from one station to another. As in other PBX systems, station users can dial other stations or outside numbers without the attendant's help. Or, alternatively, the stations can dial the attendant and request

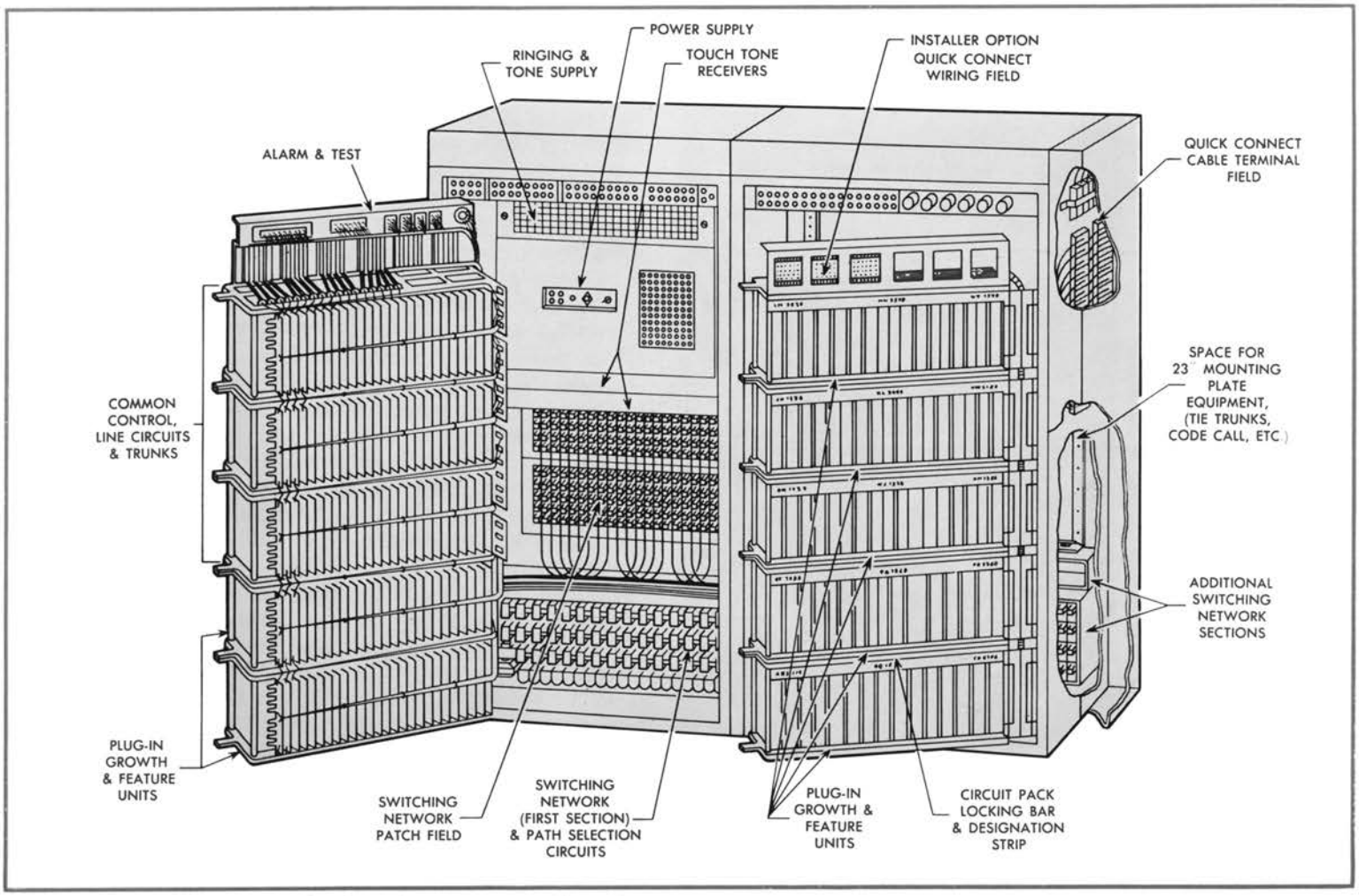
The basic cabinet containing 800A PBX equipment is as high and as deep as a common, five-drawer filing cabinet, and about twice as wide. On the desk in the foreground is the operator's console, including direct station selection keys (on the right). One cabinet holds equipment for a basic system, serving up to 60 lines with series 100 service, or fewer lines with additional features.

her to establish a call for them to an outside number. Other normal PBX features are provided; groups of stations can be arranged for hunting (a call to a busy station is automatically routed to another in the group); night connections can be made; stations can be restricted from dialing certain codes.

Plug-in packages furnish series 200 service, which has additional features controlled by the attendant. With this package, she selects stations either by pushbuttons or by dialing. Lamps under the pushbuttons light to indicate busy stations. She can also set up conference calls, and place an incoming call in a "camp-on" state (waiting to be automatically connected to a busy station when it becomes idle).

Series 300 service includes all the 100 and 200 features and additional station services. Facilities at the attendant's console permit incoming calls to be answered at any station when the console is unattended. Any station can transfer a call from a central-office trunk to another station by flashing the switchhook and dialing the extension number.

The attendant's console is similar to a CALL DIRECTOR® set, but was designed specifically for use with the 800A system. One feature that is unique to this console is the use of a single supervisory lamp, rather than the two used in most systems. Although this requires that a single lamp flash at different rates to indicate different conditions, it permits simplifying the



The equipment arrangement in the cabinets makes all equipment as readily accessible as possible, yet allows small cabinets. The left-hand cabinet furnishes a basic system plus some features; the right-hand one contains equipment for added capacity and other features. The quick-connect cable terminal field, shown mounted on the right-hand cabinet, is cut away to show its internal structure and the layout of the inside of the cabinet, where space is provided for additional equipment.

console itself and the related circuitry.

The attendant answers an incoming call by pressing a key associated with the incoming trunk. After receiving the desired number, she presses the "start" key, waits for dial tone, and dials the station. She releases from the connection by pressing the "position release" key.

This operating procedure is further simplified with series 200 service. After pressing the "trunk" key to answer a call and determining the desired station, the attendant has only to press the associated "DSS" (direct station selection) key to select that station. The "position release" key is operated to release the attendant from the connection.

In addition to the series 100, 200 and 300 services, optional equipment and features such as TOUCH-TONE® calling, tie trunks, and cord switchboards are available with the 800A.

The high reliability of modern electronic components, combined with the relatively small number of components in the 800A, made it possible to eliminate redundancy (supplying duplicate equipment so that if one unit fails a replacement would be automatically switched into service) as a way of achieving reliability in the control circuits.

The common control is the portion of the control circuitry that is not distributed among the switching and other packages. It consists of three main parts: a line scanner for locating and marking line circuits, an idle circuit scanner for locating and marking trunk circuits, and a

800A PBX SERVICE PACKAGES

SERIES 100	SERIES 200
Attendant call director plus features: • Station to station calling • Direct outward dialing • Station hunting • Code restriction-internal • Power failure transfer • Attendant transfer	Series 100 Plus:— • Attendant direct station selection • Attendant camp on • Indication of camp on • Attendant conference
	SERIES 300
	Series 200 Plus:— • Dial transfer • Consultant hold • Add on conference • Trunk answer any station

OPTIONAL FEATURES

• *TOUCH-TONE* calling	• Code call
• Tie trunks	• Paging
• Toll denial	• Recorded telephone dictation
• Dial conference	• Cord switchboard

Series 100 is basic PBX service with the 800A, series 200 enables the attendant to perform some additional services, and series 300 gives station users further control. Aside from the three service packages, optional services can be provided by adding appropriate equipment in allocated mounting spaces.

call sequencing logic for controlling the establishment of connections.

The switching network consists of three stages of ferreed-type switches containing dry-reed sealed contacts as crosspoints. Line circuits are connected to one side of the network, and trunk circuits to the other side. Since connections can only be made between lines and trunks, the dial pulse (or TOUCH-TONE) register is connected to both sides so it can be used for calls from either trunks or stations. Intercom trunks on the trunk side of the network are used to route calls from one station back through the network to another station and to provide supervision on those calls.

Connections through the switching network are established by a process called "end marking." For an outgoing call, the line scanner locates and connects to the line originating the call. This "marks" a point on the line side. The idle circuit scanner similarly marks an idle trunk on the trunk side of the network. With these two marks, the call sequencing logic directs the selection circuits to select a path through the network, connecting the two points, and then causes the path to be closed. End-marked switching, with path selecting circuits built in with the networks, makes possible the interchangeable switching packages that lend the 800A much of its versatility, making it readily adaptable to a variety of traffic conditions and requirements.

All circuit actions are accomplished with wired logic. There is no central memory to which continual reference for instructions and other information is required. Logic functions are wired into the circuits, so that one signal causes a number of circuits to respond in a preassigned sequence, depending on the type of signal and the states of other parts of the system.

A call is originated in the system when a handset is lifted at one of the stations. This transmits a request for service to the common control, which starts the line scanner searching for the line connected to the off-hook station. The scanner locates the line and "marks" its connection to the switching network. The call sequencing logic also causes the idle circuit scanner to select an idle dial pulse register and mark its connection to the trunk side of the network. The switching network is directed to connect the marked line and register. The register supplies dial tone to the station line. This register/dial-tone connection normally takes about 60 milliseconds. 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 register, the service request from the others starts the line scanner again.

When the caller finishes dialing, the register signals the call sequencing logic, which examines the dialed number in the register and directs the idle circuit scanner to select a suitable trunk. A central office trunk is selected if "9" has been dialed, an attendant trunk for "0", etc. The register then identifies and marks the calling line by "calling back" through its switching network connection to the line. The network is now directed to make a new connection between the line and the selected trunk.

If the call is to another telephone in the PBX, the idle circuit scanner selects an intercom trunk. The called and calling lines are then connected to it through the switching network. The call sequencing logic uses the dialed number stored in the register to select the called line. Calls between stations require two paths through the switching network, of course, rather than the one required to connect a station to a central-office or attendant trunk.

A call from the attendant to a station goes through a central-office or attendant trunk. Since

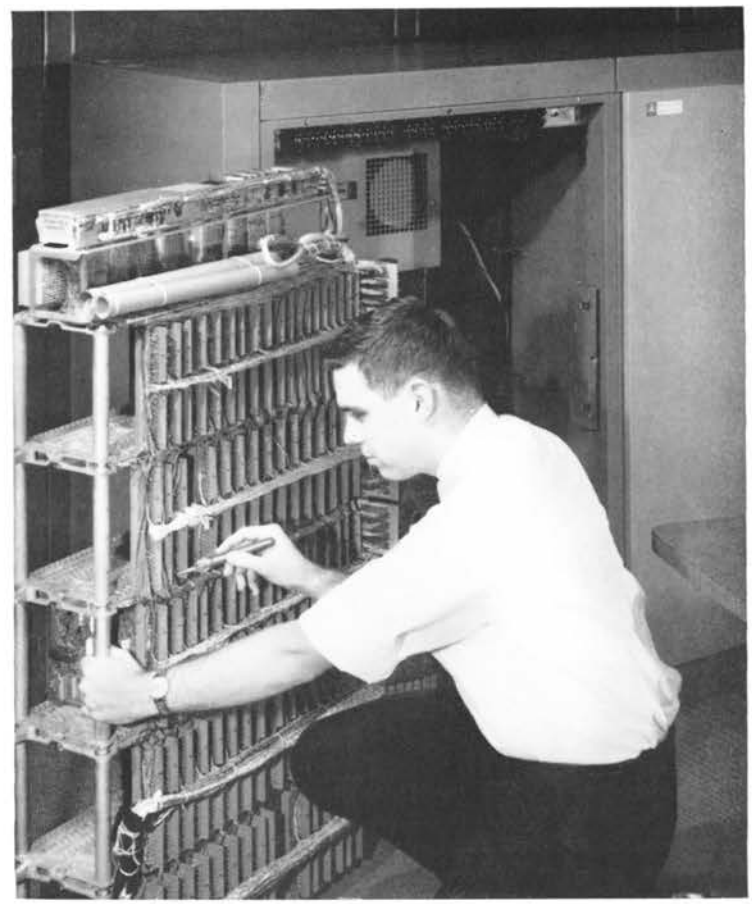
there is only one attendant console, the idle circuit scanner is not used. The attendant is connected to a register appearance on the line side of the switching network. After dialing, the call sequencing logic selects the called line, and the register identifies the originating trunk by calling back. The call sequencing logic then directs the switching network to establish a connection between the trunk and the line.

Camp-on service, included as part of the series 200 plug-in equipment package, lets the attendant place an incoming call in a waiting state until a busy station becomes idle. The attendant connects the central-office trunk used for the call to a camp-on (holding) trunk at the line side of the switching network. The number of the called station is stored in this trunk. The common control then checks the busy station at about one-second intervals and completes the call automatically when the station becomes idle. During the first check of the busy station, a 440-Hz tone is applied for half a second to notify the station of the waiting call.

Station users can transfer incoming calls from central office trunks to another station without attendant assistance with the series 300 feature package. The connection from the central-office trunk to the station is removed by flashing the switch hook. The trunk is placed on hold and connected to a Call Transfer circuit—part of the series 300 equipment package. A dial pulse register is connected to the station through the Call Transfer circuit. The station receives dial tone, and the user may dial any other station—say station B. Station B is connected to the Call Transfer circuit when the register is disconnected.

Station B rings. When it goes off hook, users at the two stations can converse privately (consultation hold). When the user at the first station flashes the switch hook again, the trunk circuit is added to the talking connection in the Call Transfer circuit, establishing a three-way or add-on conference. When either station hangs up, the Call Transfer circuit releases and a connection is made directly from the trunk to the remaining station. The transfer sequence can be repeated as desired.

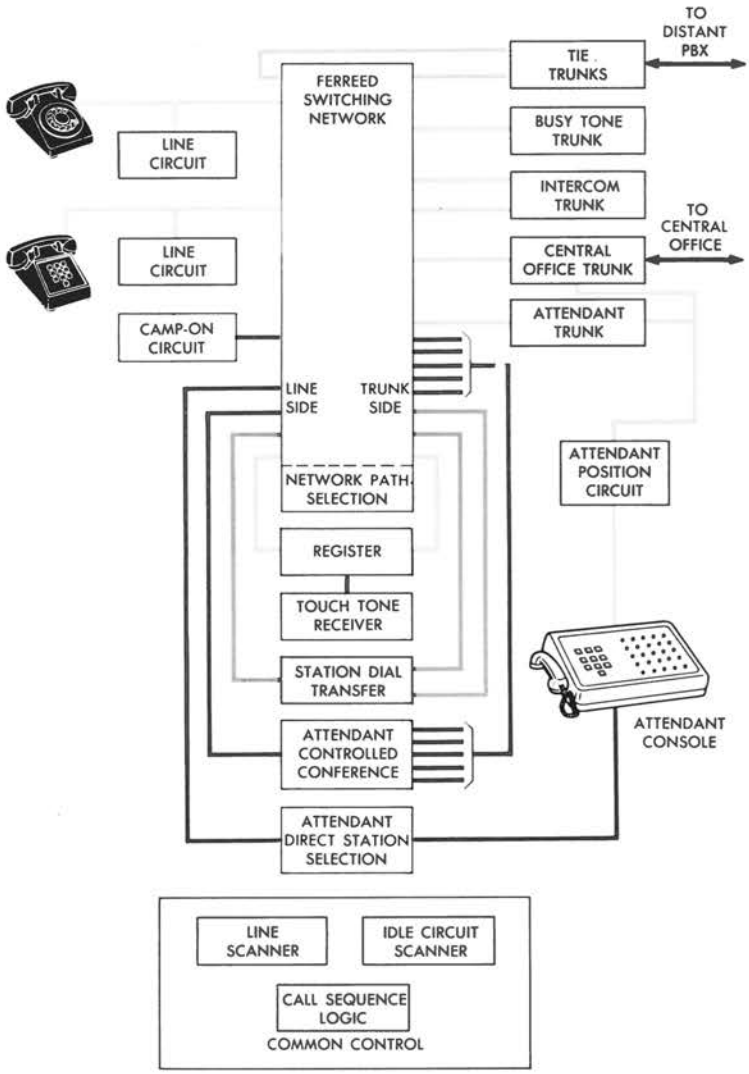
A close relationship among system, circuit and physical design is a necessity in most development projects. This has been especially true in the case of the 800A PBX. Physical design has played a major role in making the 800A compact and economical, and in carrying out the versatility and flexibility that are integral to the overall design concepts.



A laboratory technician applies the logic test probe to a circuit pack terminal on one of the central office trunk circuits. The circuit pack connectors are arranged so all connections are accessible from the back, without removing the circuit pack.

Early analysis showed that the use of modular thin-film logic packages would produce a compact, low-cost system. Circuit packs with thin-film units require less mounting space than their discrete-component counterparts. This resulted in a 20 per cent reduction in the number of printed wire boards and connectors, and also reduced the cost of assembling and wiring the system.

Relatively large (8 inches square), epoxy-clad metal printed-wire boards are used throughout the 800A. Using large boards reduces system wiring but retains the functional modularity that lends economic flexibility, ease of growth, and ready replacement for maintenance. Epoxy-clad metal boards, relatively new in the Bell System, are mechanically rugged. Printed-circuit paths on both sides of the board are used economically, since they can be connected electrically by "plated-through" holes. Each board has a tough, venti-



In this block diagram, the light grey lines connect the components of the basic system with series 100 service. The green lines show additional connections for series 200 service, while equipment connected with the dark grey is for series 300. The common control is required in all systems, whatever their size.

lated plastic cover protecting the circuit devices. Each cover includes an inexpensive plastic ejection lever, molded as part of the cover, for removing the circuit pack from its carrier.

Physical interchangeability of several circuit packs contributes to system compactness. For example, different kinds of central office trunk units may be used interchangeably in the same circuit pack carrier slot.

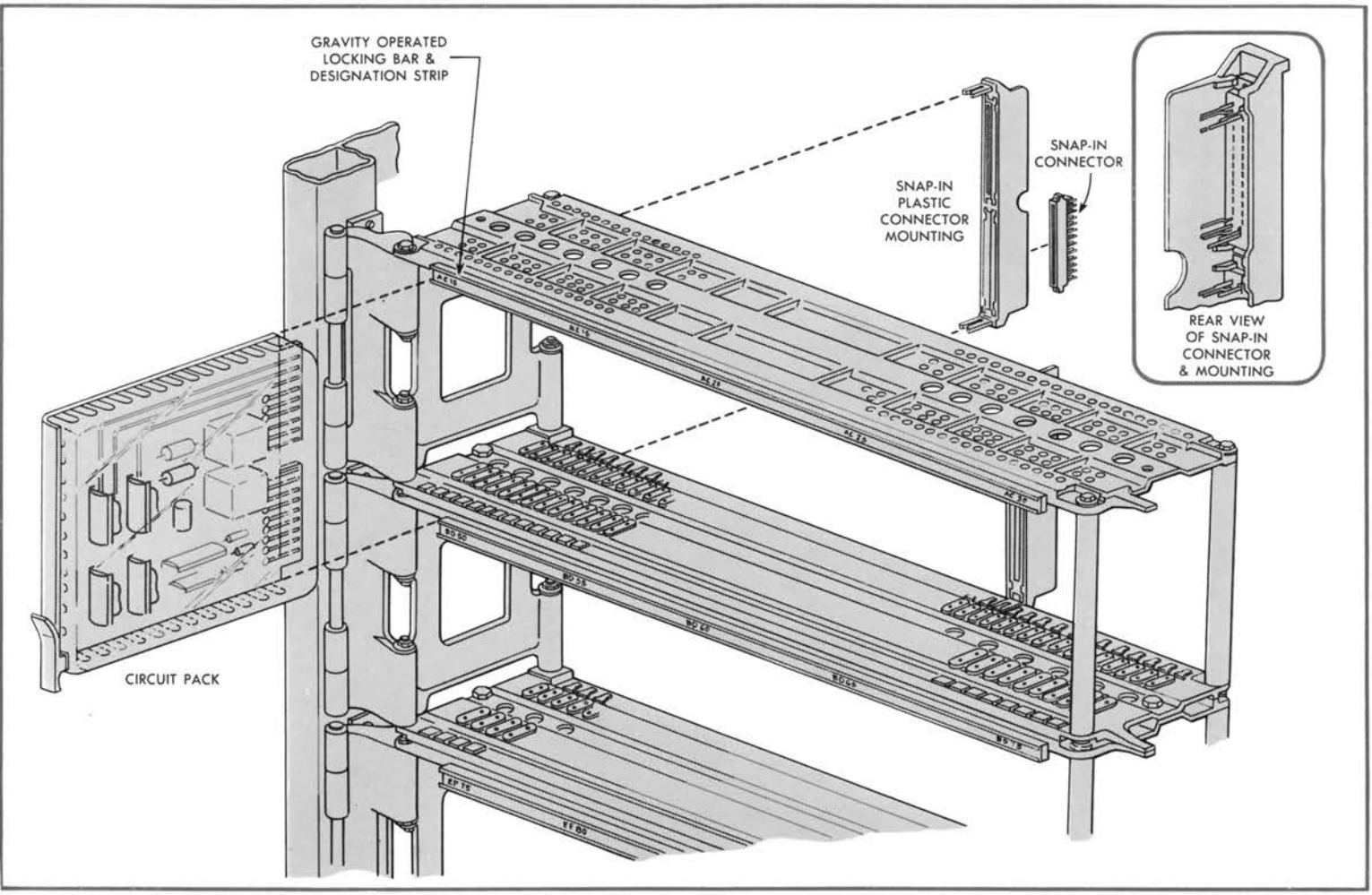
The circuit pack carriers are self-supporting. Each can be bolted to the carriers above and below to form an integral, swing-out gate. The carriers are die cast, providing the accurate dimensions required for easy assembly without special fixtures, and no machining of the parts is necessary. The identical top and bottom plates have molded-in: slots for the circuit packs, ventilation holes, and mounting bosses for snap-in plastic parts, all adding little to the cost. The use of snap-in plastic parts for mounting the circuit pack connectors to the carrier substantially reduces the cost of assembly. A group of assembled circuit-pack carriers, mounted in the cabinet, costs only half as much as an equivalent assembly of sheet metal units attached to a separate, hinged gate. Each carrier has a simple circuit-pack designation strip that also serves as a gravity-operated locking bar preventing packs from working out of their connectors because of vibration.

Equipping the system with one of the eight plug-in switching network packages determines the basic line size and traffic capacity. The networks are self-contained packages. Each consists of a group of ferreed matrices and path selection devices, is mounted on a removable subframework, and plugs into the rest of the system. This facilitates initial installation and field interchange.

A "patch-field" associated with each switching network package further adds to system flexibility. This unique feature permits adjusting the network traffic distribution in the field to meet a customer's specific traffic pattern, simply by rearranging small plugs connecting each line and trunk to the network.

The complete system, including power and tone supplies, is contained in one or two cabinets. The internal equipment varies with the number of station lines, trunks and optional services. Each cabinet, 57 inches high, 28 inches deep and 34 inches wide, is designed to blend harmoniously with office furniture. It is the same height and depth as a standard filing cabinet. It has snap-on cover panels for easy access to the equipment. An optional, "quick-connect" terminal field permits rapid connection of station line and central-office cables to the system. The terminal field is designed to be mounted on either side of the cabinet or located remotely, and connects to the system with plug-ended cables. It increases the width of a cabinet by three inches.

The cabinet also accommodates several 23-inch mounting plates, used for a variety of optional tie trunks and equipment for TOUCH-TONE calling, paging, and recorded dictation services. A third cabinet, externally identical to the others, is arranged for adding other supplementary serv-



The die-cast carriers for the circuit packs can be bolted together, forming a swing-out gate that is bolted to the cabinet post. Plastic snap-in connector mountings are readily installed, held in place by mounting bosses cast as part of the carrier.

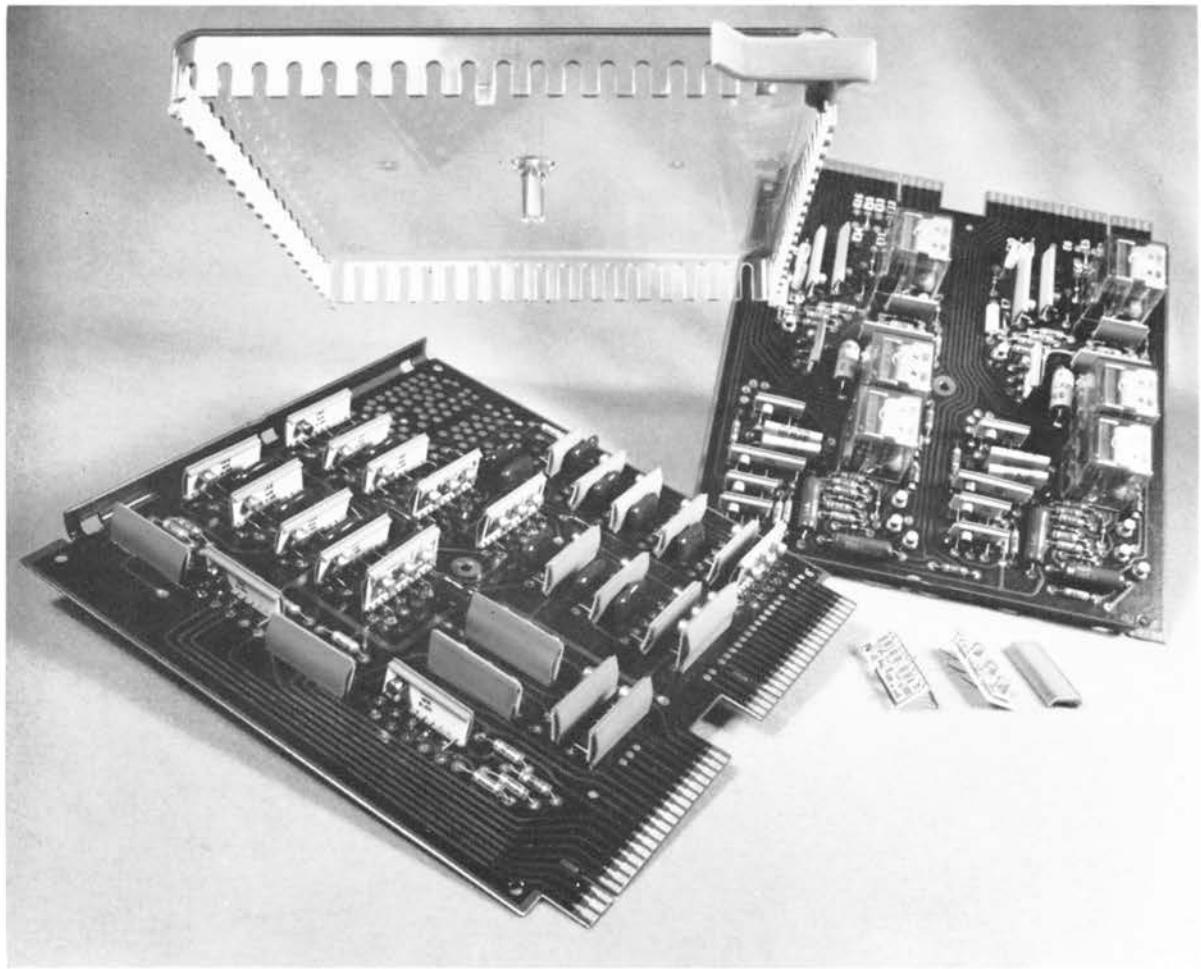
ices to the system. Additional tie trunks and key telephone equipment can be installed here.

A comprehensive environmental test program was part of the 800A's development. These tests were designed to ensure that the system would satisfactorily endure shipping, handling, and storage, as well as use on a customer's premises. Laboratory tests simulated all these conditions, with the system operating or not as appropriate. The nonoperating tests, simulating shipping and storage conditions, included low-temperature tests at —40 degrees Fahrenheit, sudden ambient temperature changes of 100 degrees Fahrenheit, a relative humidity of 95 per cent for 240 hours, and vibration tests with forces of 2.5 g's over the range 5 to 50Hz. (The latter tests simulate transportation and rough handling of crated and uncrated equipment.) Some structural design modifications, before production, resulted from these tests. Other features, such as the circuit pack locking bar, clearly demonstrated their worth.

High ambient temperature tests were also conducted with the system operating under varying traffic conditions, including the expected busy-hour traffic load. These showed that the system could operate satisfactorily at ambient temperatures up to 110 degrees Fahrenheit. Further work being done in this area should permit operation up to 130 degrees.

Repairs can be accomplished entirely by replacing plug-in components or repairing interconnecting wiring. Since wiring failures are infrequent, most repairs will be made by exchanging plug-in equipment units or circuit packs.

Fuses, alarms, and some built-in test equip-



The lower printed wire circuit pack, part of the common control circuit, contains 42 logic gates—a total of 204 thin-film resistors and 42 transistors—on its 28 thin-film logic packs. Each printed wire board makes 55 square inches of usable space available. On this board, five square inches of it, in the upper corner, are left unoccupied for future use. The plastic cover includes a molded ejection lever for removing the circuit pack from a board carrier. When the cover is attached to the board, the lever will be at the lower front corner of the installed board. The upper circuit pack contains components for two attendant trunk circuits, including thin film logic packs and miniature relays.

ment are contained inside the cabinet at the front and near the top. Control keys are provided so the system can be stopped while it is processing a test call. The states of various circuits can then be analyzed to locate a trouble. Since there are several of each of the traffic circuits (trunks, registers, etc.), a "make busy" key and a selector switch are included so a repairman can route test calls to specific circuits. This permits quickly locating a failure in circuits of this type. Failures in the common control equipment can be located either by analyzing the symptoms or by replacing, one at a time, the common control circuit packs (a basic system contains only nine).

A pocket-size probe for logic signals is available with the system. This probe, which indicates the presence of a logic signal by turning on an internal lamp, can be used for signal tracing when a failure cannot be easily cleared by exchanging plug-in units. The probe detects signals as short as one microsecond. A plug-ended cable access circuit is located in the top of the cabinet for attaching traffic measuring equipment.

The 800A PBX will serve the small customer well. It has the versatility to meet the needs of a wide variety of customers, and to serve each one economically. It is expected to furnish a valuable addition to the service the Bell System provides.