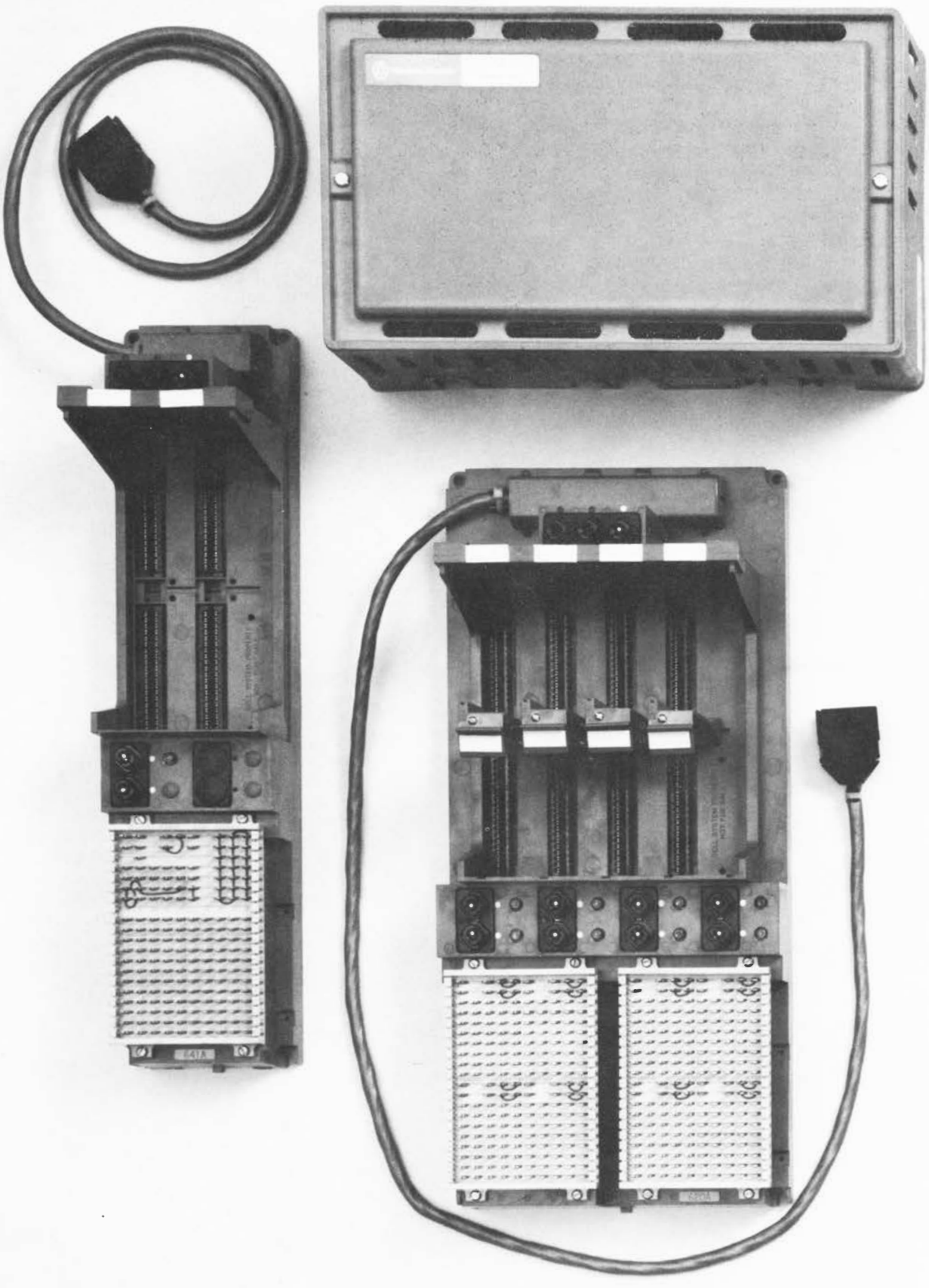
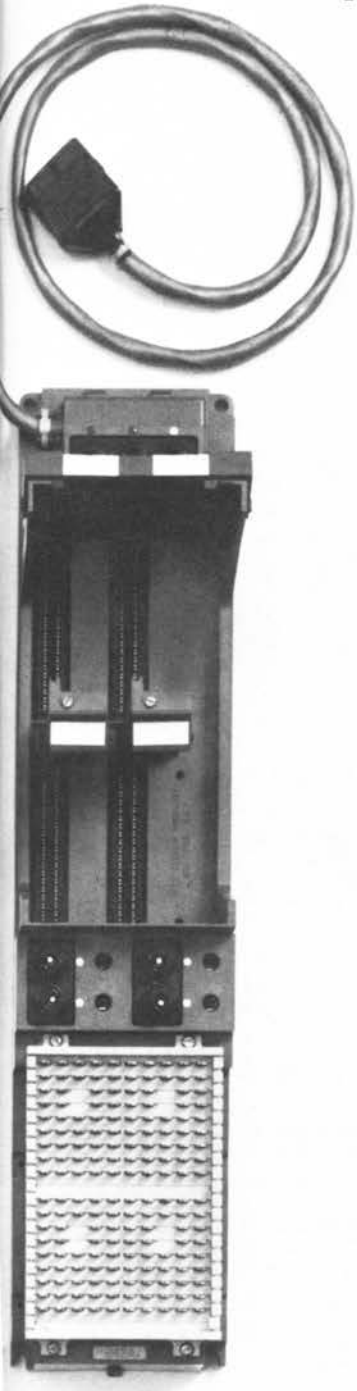


Installing Key Telephone Equipment? Modular Panels Make It Simpler



Stanley E. Bush and James L. Simon

A system of modular panels for the 1A2 Key Telephone System simplifies installation on customer premises because equipment connections are labeled and prewired at the factory. Maintenance is also simpler because of built-in indicator lamps, self-indicating fuses, improved power units, and a symmetrical arrangement of components.

SINCE THEIR INTRODUCTION IN 1938, key telephone systems have enjoyed wide acceptance by customers as a fast and flexible communications service. Because of this, they are a large and important part of today's Bell System business. Each year, Bell System Operating Telephone Companies purchase from Western Electric over $200 million worth of apparatus, circuitry, and equipment for key telephone systems. Moreover, the Operating Companies spend an additional $100 million a year installing these systems and $200 million more reinstalling or rearranging existing systems (see *Key Telephone Systems: The Latest Chapter*, RECORD, *March 1966*, and *Advances in the 1A2 Key Telephone System*, RECORD, *October 1970*).

Over the past several years, many customer installations have been studied to get detailed data on how this money is being spent. These studies were aimed primarily at identifying the labor expenditures for installing, rearranging, and replacing equipment on the customer's premises. Study results showed that a significant amount of the work of installing large key telephone systems (those that are mounted on relay racks in key equipment rooms) had become routine—mounting and connecting hardware—and could be done in the factory if suitably

Basic elements of the modular panel system for the 1A2 key telephone. At top: the power unit. At bottom (left to right): the 641A panel for providing dial-selective intercom service; the 620A panel for central office and PBX *lines, tie lines, and manual intercom service; and the 642A panel for miscellaneous features.*

designed equipment were available. Based on this analysis, a new equipment system called modular panels was developed by Bell Labs engineers.

The design objectives of modular panels are to:

- Prewire and label all standard connections at the factory so that craftspeople will be free for the more challenging aspects of the installation.
- Provide a uniform arrangement of electrical connections so that all key telephone system installations, regardless of size, can be standardized and new features can be added to systems without removing equipment or rewiring.
- Retain all the flexibility of the 1A2 key telephone system, since this is one of the system's most important features.

Before describing these new panels in detail, we will first review the various steps involved in installing a key telephone system. Two categories of wiring are found in every 1A2 installation: (1) a series of standard electrical connections that are common to all customers, regardless of how they want their lines arranged, and (2) the remaining connections that customize the system to each customer's specific requirements. It is the first category to which this discussion is addressed. For a typical 1A2 system of sixty lines (without modular panels), a craftsperson would have to make the following standard connections (see illustration on page 255):

- Mount eight separate elements—a 7-foot relay rack, five 584-type panels, a power supply, and an equipment termination field (a network of terminals).
- Connect the power supply to the five panels by means of strapping wire between screw-terminal connections.
- Run equipment cables from the panels to the termination field.
- Plug the equipment cables into the panels.
- Connect the equipment cables by hand to the termination field using quick-connect blocks (plastic blocks containing a number of electrically-common, push-type terminals).

By contrast, if the same 1A2 system were installed using modular panels, the craftsperson would simply do the following:

- Mount eight modular panels and the power supply unit to a wall.
- Plug the power cords from the panels into the power unit.

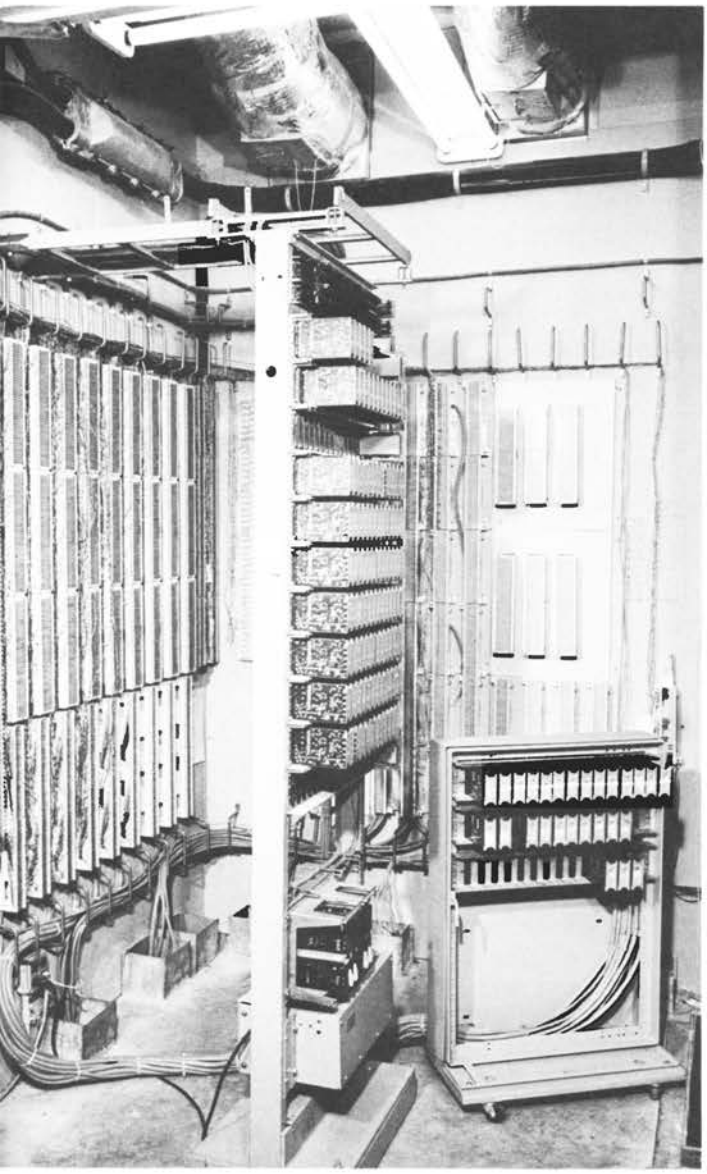
With modular panels, installation time is reduced substantially because the panels—which are assembled and prewired at the factory—contain the equipment termination field and all standard connections. Installation of the remaining "customized" connections is essentially unchanged from previous practices because customer requirements vary so widely that prewiring is not practical.

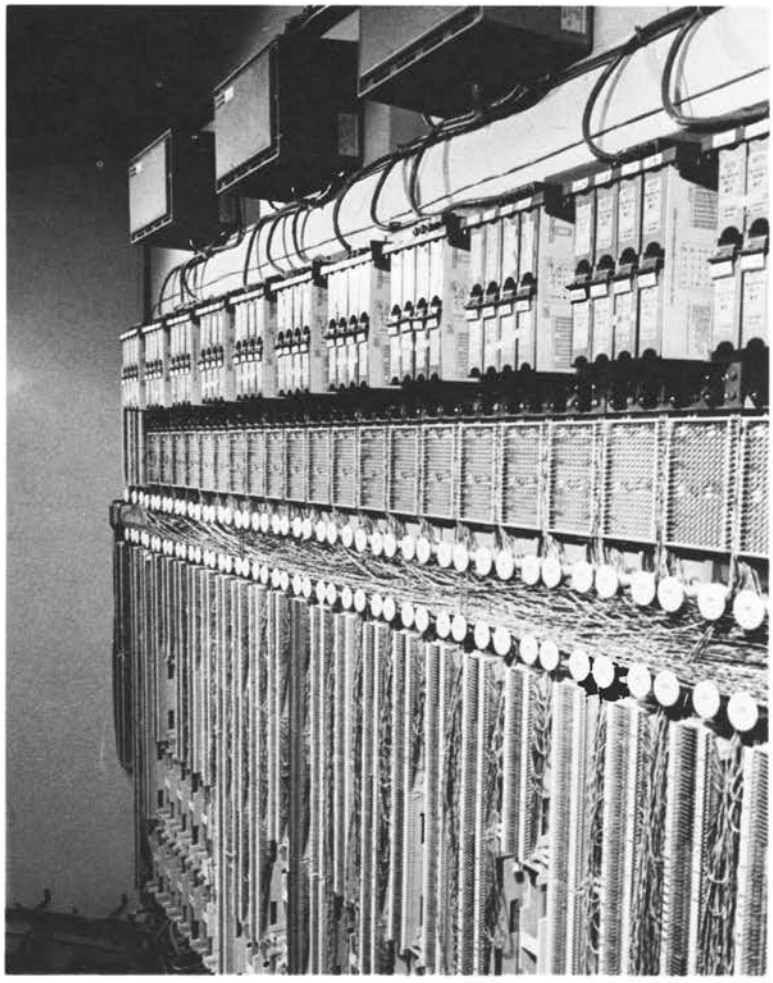
Three different modular panels have been developed for the 1A2 system (see illustration, page 252): (1) the 620A, for circuits that provide central office and PBX lines, tie lines, and manual intercom service, (2) the 641A, for dial-selective intercom service that lets a user dial other stations with one or two digits, and (3) the 642A, for miscellaneous features, the most prevalent of which is the circuit that lets a user add a third party to a telephone conversation. By using these three panels in proper combination, any set of features of the 1A2 may be provided easily and economically.

Each modular panel is a rectangular, one-piece plastic molding, 23-inches high and either 4¼ or 8½ inches wide, into which are inserted a variety of components—fuse sockets, lamp sockets, connectors, and quick-connect clips. A flexible printed-wiring sheet is placed over pins which project from these components, and the entire assembly is soldered by a mass production technique called wave soldering. To complete the assembly, a protective sheet of rigid plastic is applied over the soldered connections and the plug-ended power cable is attached. The ability to assemble all these components in a small and reliable package was facilitated by recent developments in plastic molding and in flexible printed-circuit technology.

While each modular panel has different circuitry, all have some physical features in common that make maintenance and installation simple. For example, the physical dimensions of the panels are such that they line up exactly with the existing arrays of station terminals—those "customized" connections on the customer premises for central office, PBX, and tie lines (see *Connective System for Customer Premises*, RECORD, *August 1972*). In addition, the elements of each panel are arranged in a standard format; from top to bottom, the elements are:

- Power cable with plug.
- Assembly of input-power fuses.
- Array of connectors to receive the printed wiring boards that supply the system features.
- Array of fuses and lamps which correspond spatially to the circuits they protect.





The old and the new. Photographs show two typical 1A2 key telephone systems of about 100 lines each. At left is a system installed without modular panels. Above is a 1A2 system installed with modular panels, which eliminate much repetitive mounting and connecting of hardware on customer premises and assure that key telephone systems of all sizes are installed uniformly.

• Equipment termination field, which is arranged in segments to correspond to the layout of connectors, lamps, and fuses.

This spatial symmetry makes organization of the job easier. BSP (Bell System Practices) instructions are clear and well illustrated with pictures to clarify installation and trouble-shooting.

Lamps are used in the modular panels as a maintenance aid, giving repair personnel the same visual information about line circuits that a customer gets at the telephone set. That is, a steady "on" lamp indicates a busy line, "flashing" (½ second on, ½ second off) indicates an incoming call, and "winking" (off for about 1/40 second every ½ second) indicates a line on hold. Therefore, when a craftsperson enters the equipment closet to make changes or troubleshoot a system, lighted lamps indicate which lines are in use. The craftsperson leaves the "lighted" circuits in place until the call is completed and the light goes out.

These lamps can also be used to test the lines. For example, craft personnel can place an incoming call to a line to see if the light begins to flash; they can "pick up" the line by shorting the appropriate lead to ground, which simulates a station going offhook, to see if the light goes steady. When they connect the test set across the line and remove the grounded lead, the line circuit enters the "hold" condition, and the lamp should "wink." Through procedures such as these, the craftsperson can use lamps to help isolate a variety of troubles.

The fuses in the modular panels also help simplify maintenance. The size of each fuse is indicated by color, both on the fuse itself and on

Evolution of a Modular Panel

Forty or fifty years ago it was not uncommon to see several telephone sets lined up on a busy executive's desk. In those days each telephone was wired directly to its own line and thus could be used for only one call at a time. This meant, for example, that if an executive received two or three calls simultaneously, the only way he could "hold" a call was to take the receiver off the cradle. Also there was no way for him to answer calls selectively. If the executive were holding a conference in his office, the meeting would be interrupted or disturbed every time a phone rang. It is easy to understand why key telephones—which allow a customer to handle more than one call with a single telephone—have been so widely accepted by businesses since being introduced in 1938.

The key telephone is a customer-controlled switching system that gets its name from the keys—a generic term for the pushbuttons, turnbuttons, and levers used for picking up and holding lines. With a key telephone, customers can signal from one station to another, transfer calls between stations, and hold a call on one line while talking on another. But today's key telephones have a versatility that goes beyond meeting that original need for a single phone which could handle more than one call. Some of the services now available to customers: access to any number of central office or PBX lines (more than one phone can have access to a line), choice of manual or dial intercom, and several miscellaneous options such as add-on conference circuits and direct-line hookups.

To provide services of this type, every key telephone system has two physical aspects to it: (1) the telephone instrument itself, from which the customer operates the system and (2) an equipment cabinet or arrangement of apparatus that provides the functions of switching, signaling, and transmission. It is the latter category to which modular panels—the subject of this RECORD article—belong.

Modular apparatus panels have evolved from a "building block" design concept that had its beginnings in the Bell System's first key telephone system, the 1A. The objective of this concept was, of course, to make the systems easier and more economical to install. Before the introduction of the 1A system, every telephone company developed special line-switching arrangements called "wiring plans," that in effect made each multiline telephone installation a custom job. To eliminate the need for special engineering of this type in the 1A system, Bell Laboratories developed standardized assembly units, called key telephone units or KTUs, that supplied line switching and service features for up to six lines. This meant, for example, that features in the 1A system could be changed by merely changing these units; usually, one KTU performed a single function in a system.

As the 1A became more widely used, installation of all but the smallest systems became hard to manage because there were almost as many different KTUs as there were business customers. This situation led to the introduction of the 1A1 system in 1953, wherein several commonly-used KTUs were interconnected and wired at the factory as a package. For installations of less than 14 lines, several of these multifunction packages were combined into a unit (called a key service unit) and offered as a complete 1A1 system. In addition, equipment cabinets were redesigned to handle larger systems (more than the six-line capacity of the 1A), mounting arrangements were simplified, and better access to terminations was provided.

In 1964, the 1A2 system was developed. From a user's standpoint, the services provided by the 1A2 are much the same as those offered by the 1A1. The principal difference is in their physical installation—the 1A2 being more compact in size, and easier to install and maintain. Solid-state components, printed-wiring, and miniature relays replaced the older types of equipment. The newer KTUs have plug-in circuit boards, push-on terminals that eliminate the screw terminals previously used to interconnect these units (see *Quick-Connect Clip Terminal,* RECORD, *June 1962*), and printed wiring that eliminates most of the units' internal wires. The concept of packaged KTUs continues: most repairs can be made by simply replacing a plug-in unit, while service features can be changed by adding or changing KTUs. Two types of equipment-mounting arrangements are being used: (1) factory-wired packages of Key Service Units (containing KTUs) for small installations of up to 14 lines and (2) 23-inch mounting panels that are prewired at the factory to provide certain combinations of service features for larger installations. Connections to the Key Service Units and the mounting panels also employ the "quick clip" terminals. The mounting panels are installed in equipment rooms on the customer's premises or in other centralized locations, such as a telephone office, where 23-inch racks are preferable to cabinets.

With the development of modular panels, the latest step in simplifying the installation of key systems has been taken. As described more fully in the accompanying article, three different modular panels (each containing a variety of components and connections) are used in combination to provide all the features and services of the 1A2 systems.

the panel (in the form of a dot). When the colors on the panel and the fuse match, the craftsperson knows that the proper size fuse is being used. Additionally, whenever a fuse blows, a built-in colored indicator in the fuse becomes visible, enabling the craftsperson to pinpoint the faulty circuit quickly.

The equipment termination field is laid out symmetrically so that a craftsperson can see which terminals are associated with each circuit. The field comes from the factory with the names or codes for its various connections molded into the panel face. Normally, the termination field has enough terminals to connect five telephones or "pickups" to each line. If additional capacity is necessary, the craftsperson can mount a standard termination backboard near the panels and then interconnect the two termination fields by

strapping wire. The modular panels and the termination backboards are both modular in concept and come in the same sizes. In addition, the panels' termination blocks are color-coded red and yellow in accordance with existing practices for backboard wiring.

Wiring and connection information is on a plastic card which slides into its own mounting bracket on each modular panel. A craftsperson, however, still has to refer to appropriate BSPs when installing the "miscellaneous" circuits whose connections differ depending upon which of the various features is being provided. Nevertheless, the BSPs and other documents will be greatly simplified because the various items previously identified and described separately (the 1A2 key circuits, power supplies, panels, etc.) are now combined and described together as a single system —giving the craftsperson all information needed about an installation in a single place.

Two new power units have been designed which also help simplify installation of 1A2 key systems: the 79B2, which has four receptacles, and the 90B1, which has ten receptacles. Three features important to craftspersons are:

- The power cables from the panel are simply plugged into the power units (no hand wiring is necessary).
- The capacity of a power unit is related directly to the number of power receptacles it has; that is, a power unit with ten receptacles is used for an installation of up to ten modular panels, etc.
- Each power unit contains all the interrupted ac voltages required for the ringing and lamp signals.

Based on the data from the studies of customer installations mentioned earlier, and correlated by experience in the field, modular panels promise a potential savings of about 80 percent in installation time for that part of an installation involving the power units, equipment, and equipment termination field. While the original intent of these panels was to reduce predetermined and repetitive installation work, equipment costs have also been reduced 10 percent by eliminating cables previously used to connect the relay rack equipment to the equipment termination field. The potential labor and equipment savings to the Bell System from the new modular panels exceed $10 million annually. Repair and troubleshooting will also be enhanced by the neater installations, well-organized equipment, pictorial BSPs, and predesignated terminals.

Before the development was complete, Bell Laboratories sent all Bell System Operating Telephone Companies a copy of the BSPs, working models of the three modular panels, and a power unit. Each Operating Company was asked to evaluate the BSPs and the modular system design by installing the panels and power unit at their plant training schools or engineering offices. From these evaluations the Operating Companies identified improvements which were incorporated into the system—such as color coding of the terminal blocks—and recommended several supplemental features—including dust covers and various prepackaging arrangements—which are now under development. Bell Labs engineers also visited several Operating Companies to discuss the design philosophy behind the panel system.

At the Holmdel, N. J., location, Bell Labs engineer Robert McAlonie adjusts the dial tone on a new 1A2 key telephone system with modular panels. This installation is used by the Bell Labs Customer Telephone Systems Department, which is responsible for development of the 1A2 and its peripheral equipment.

During the fourth quarter of 1973, initial production of the modular panels began and the first installation took place in Columbus, Ohio. Since then, more than a thousand panels have been ordered by the Operating Companies.

Work is now continuing on designing modular panels for all sizes of key systems, including the installations now being served by key service units (see "Evolution of a Modular Panel," page 256). In addition, the modular panel concept is expected to be applied to all new developments in the 1A2 system.

Since their beginnings, key telephone systems have been designed with a dual purpose—better service for the customer, and more versatile and economical equipment for the Operating Companies. The modular panel system for installing key telephones is continuing this tradition by making the craftsperson's job easier and helping hold down the costs to our customers. □