The 1A1 Key Telephone System

L. H. ALLEN *Station Apparatus Development*

A significant portion of Bell System business consists of professional and business telephone installations. Frequently, customers with these installations require access to more than one telephone line. To provide this service without the need for having several telephones on each desk, the Bell System has had key telephone sets available for a number of years. Using such a set, a customer can gain access to any one of several lines by merely depressing a button. To improve this type of service and make it even more versatile, the Laboratories has developed the 1A1 key telephone system.

It has become a common sight in recent years to see telephone sets equipped with four or six push buttons along the front edge. Such sets may be found in doctors' offices, garages, business houses and in executive offices of firms served by PBX's. In fact, they can be used in any situation where access to more than one telephone line is desired. Out of sight of each of these telephones is a cabinet equipped with apparatus similar to that found in a central office. This equipment provides for the necessary signaling, switching, and transmission; together with the telephone and its associated wiring, it constitutes a key telephone system. At the present time these systems are in such demand that about one out of ten telephone sets being manufactured is of the key type.

To provide the widest possible selection of service features for telephone customers, both the original 1A key telephone system and the newer 1A1 system are based on the building block, or feature, principle. In the earliest key telephone system,* each relay assembly, equipped with screw terminals, was a unit. By selecting the proper kind and number of units, a station installer could provide service with features as desired, usually on from two to six lines.

As use of the 1A key telephone system became more widespread, a modification of the small building block principle resulted in the development of larger units. These larger units were intended to supplement the earlier designs, and reduce the installation time by exchanging shop assembly and wiring for similar field work. A variety of service features were also made available in package form; that is, certain models included the apparatus for two, three or four central office or PBX lines in an equipment cabinet. To the telephone user the service features were no different from those in the earlier design, so the system name remained unchanged.

There are five kinds of lines provided for in the 1A key telephone system, but by far the most commonly used is the central office or PBX type which uses five relays per line. A redesign of this circuit reduced the number of relays to three per line. This was the foundation upon which the 1A1 key telephone system was built. Many other improvements, however, were also incorporated in the de-

* RECORD, *June*, 1940, *page* 315.

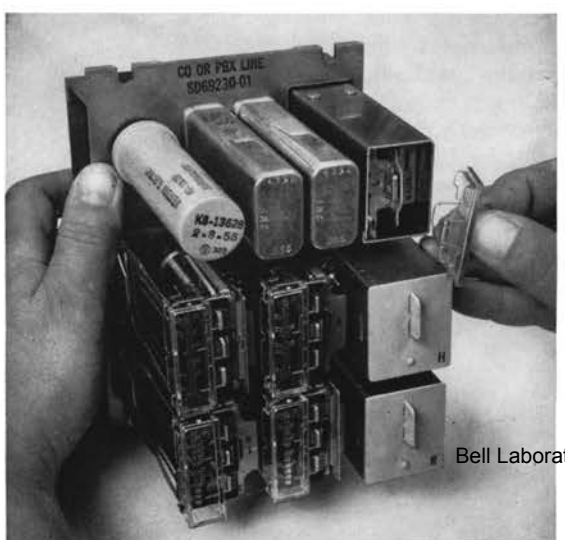
sign of this newer arrangement. Among these are new service features, improved cabinet design with simpler mechanical details and reduced maintenance and greater economy. This new system replaces only the larger units referred to above. The original small unit designs are still being used for the smaller, simpler installations. A typical key telephone installation has three or four lines. However, there are frequent instances where the number is greater.

A much simplified schematic of the three relay line circuit is shown in Figure 2. Each of the relays has a simple function to perform. On an incoming ringing signal the R relay operates and causes lamps to flash at the key buttons of the telephone sets identifying the called line. At the same time an audible signal (ringer or buzzer) is operated. This audible signal may be common to a number of lines or individual to one. The line may be associated with one or a number of telephones.

Depressing the lighted push button and removing the handset from the mounting will operate the A relay, closing the talking conductors through to the telephone set. Ringing is stopped at the central office, and the flashing lamp is changed to steady under control of the A relay. This indicates to all stations that the line is busy.

If the called customer wishes to hold the line, perhaps to make a call on another line, he depresses the hold key. This causes the H relay to operate on current flowing through the telephone set. The H relay remains operated, and causes the line lamp at the telephone sets to wink as a hold signal. This signal serves to remind the user that the first calling customer is waiting to resume conversation. On the upstroke of the hold key the operated line or pick-up key is restored. The held line may be picked up again at any telephone at which the line appears.

Fig. 1 — Joint-use line unit which permits mixing lines of 1A and 1A1 systems in either system.



With the introduction of the 1A1 key telephone system, two new service features were made available on an optional basis. One is the winking hold signal referred to above. This simply removes current from the line lamp about one-fortieth part of each second. The other service feature is an intercommunicating line at a pickup button which provides for selective dialing any one of eight other stations. This provision for intercommunication fills a long felt need for a simple, inexpensive method that avoids a number of push buttons and their associated wiring. The telephone user makes such a call by first observing that the line is idle (the push button not lighted) and then depressing the button. When he selects the line, corresponding lamps at the other eight stations are lighted to indicate that the line is busy. One pull of the dial is all that is required to ring the desired station. That station lamp flashes until the call is answered; it then remains lighted, as do all other station lamps, to signify a busy line. Another feature, available on an optional basis, provides privacy. That is, when a connection has been established between two stations, no other station can hear the conversation.

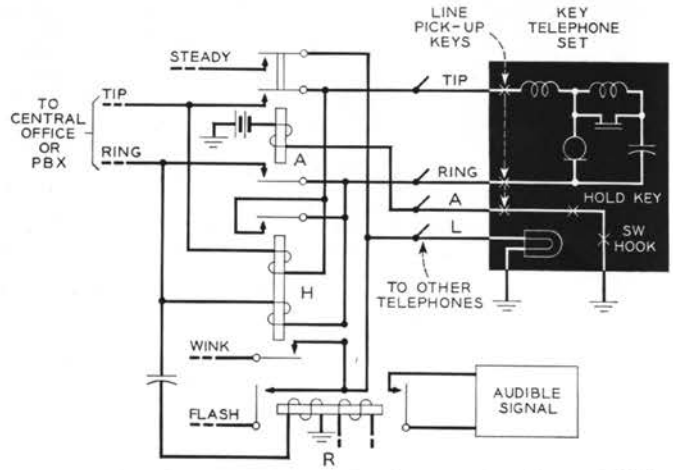


Fig. 2 — Simplified diagram of 1A1 central office or PBX line circuit used in the key telephone system.

To provide an adequate equipment cabinet to house the apparatus for many of the larger installations, the new design was made larger than its predecessor. To illustrate, the usual cabinet employed in the 1A system accommodates four central office lines (without extra optional features), whereas the newly designed cabinet, shown in the headpiece of this article, houses fourteen circuits of the type shown in Figure 1 along with the

Fig. 3 — The author connecting a test lead to a joint-use line key telephone system unit.

equipment common to the key telephone system.

There are many new mechanical features provided in the cabinet. It may be screwed to a wall surface or bolted to two floor stands 10½ inches high, which keeps it out of range of wet floor mops. The ac operated power supply can be attached to the floor-supported stand above the equipment cabinet. The cover is molded of glass-reinforced plastic and includes a sound blanket to minimize noises of apparatus operation. As shown on page 140, the frame of the cabinet is attached to a wooden backboard. The apparatus is mounted on a hinged metal gate which permits access to the rear for wiring and maintenance.

As mentioned earlier, the building block principle has been followed in the 1A1 system. Each of five types of line circuits — the common equipment unit, the wink feature unit, and the dial intercommunicating unit — is built on a unit basis. There is also one unit available for three central office or PBX lines including their associated common equipment. Much thought was given to the physical form each unit should take, and the arrangement adopted is shown in Figures 1 and 3.

The panel construction is common to the new units. Each panel has a vertical dimension of $6\frac{15}{16}$ inches; in the horizontal direction, drilled and tapped holes accommodate apparatus mountings in any multiple of $\frac{7}{16}$ inch. Two rows of panels may be mounted in the cabinet described above. On the rear of each unit is an insulated panel with screw terminals for the circuit connections. Thus, a screwdriver and cutting pliers are the principal tools for making connections.

It is possible to operate the 1A1 system on commercial ac power at 105-130 volts. The power plant provides dc power for the relays and switches, 60-cycle ac power for the lamps, and 20-cycle power for ringing. Where commercial ac power is not available or is subject to interruptions, dc power and 20 cycle ac power from the central office may be supplied over cable feeders.

There are a number of situations involving the use of the 1A1 system where larger installations require different equipment and telephone facilities than those described. However, the basic circuit and panel-type equipment designs lend themselves to a variety of small as well as large centralized installations on relay racks.

Constantly increasing shipments illustrate the popular acceptance of the 1A1 key telephone system. It is expected that the rate of growth will continue as the telephone business expands.

THE AUTHOR

L. H. ALLEN was graduated from the Massachusetts Institute of Technology in 1920. Shortly thereafter, he joined the Systems Development Department of the Western Electric Company and transferred with this department when it became part of Bell Laboratories. Mr. Allen was early engaged in the development of manual and dial systems, and from 1927 to 1936 was concerned with fundamental circuit studies of telephone systems. Subsequently, he engaged in work on crossbar dial, PBX, and stations systems. In 1942, Mr. Allen became supervisor of a PBX and Station group which was concerned with various Bell System and military projects. After World War II, he was for a time engaged in Systems Development studies, and in 1949 became a member of the Station Apparatus Department, where he is in charge of a group concerned with several different types of station systems.