Five key telephone services have been developed specifically for PICTUREPHONE® systems. Such services include line, intercom and conference arrangements that offer businessmen a variety of features to make the Picturephone set easy and convenient to use.

Key Systems for Picturephone® Service

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MANY BUSINESS TELEPHONES look different from home telephones because of the buttons and lamps used for special business services and for greater communications versatility. By using these buttons and lamps, a businessman and his secretary may, for example,

• have multiple lines on one telephone set, any of which can be used to place or receive a call,

• place one call on "hold" while answering another,

• call extension telephones within a company by dialing fewer digits than are needed for telephone calls through a central office,

• manually alert ("buzz") other telephones directly without the need to dial, and

• add another party to set up a three-way conference call.

Such business telephone sets, plus the switching and transmission equipment that serve them, are called key telephone systems.

Since key systems play important roles in business communications, it is apparent that similar systems arrangements were needed for PICTUREPHONE® service (see special Picturephone issue of the RECORD, *May/June 1969*). And in fact, five Picturephone services are presently being offered. One, called single-group line service, allows a boss and his secretary (a "single group") to be served by a line—either a central office (CO) line or a private branch exchange (PBX) line. A second service, called multigroup line service, permits up to nine boss-secretary groups to share a single

CO or PBX line. The third of the five services is called single-link intercom and allows up to ten Picturephone sets to share a single intercom link, while a fourth service—multilink intercom—places up to twenty-seven Picturephone sets on
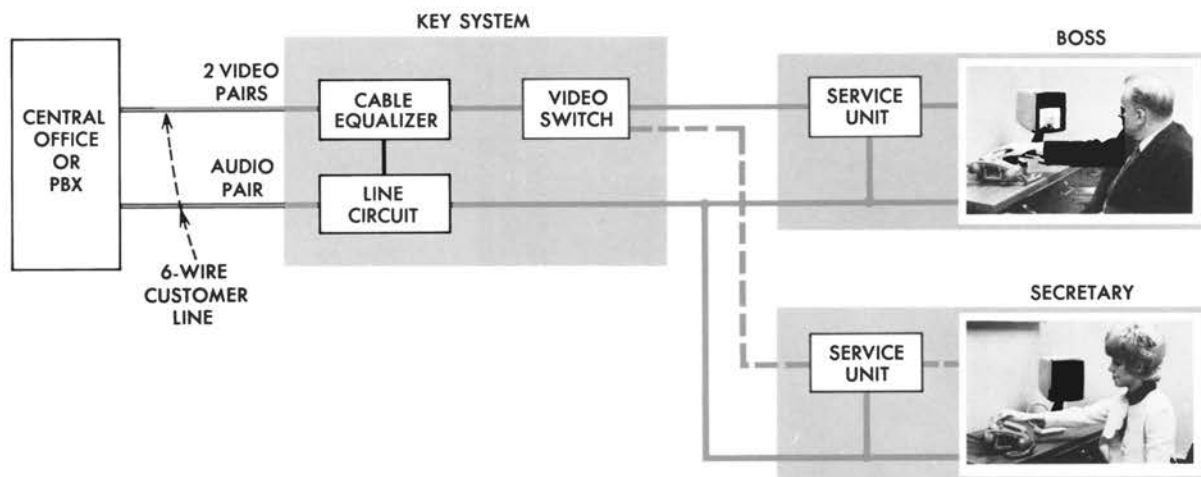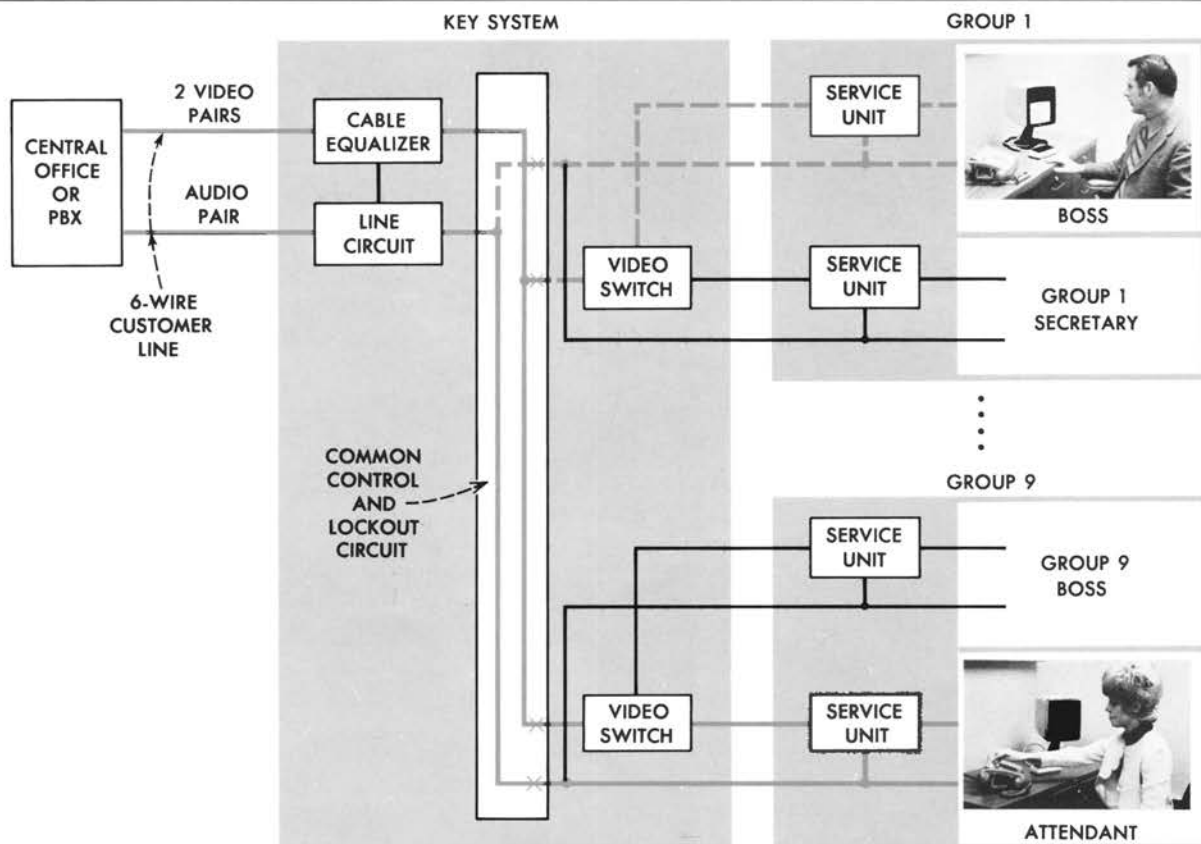
Single-group service is designed for a boss and a secretary, each having access to the same PICTUREPHONE® *PBX or central office line. On an incoming call, the secretary may answer the call, place it on hold, and then alert the boss to pick up the line.*

Multigroup service permits sharing of one PBX *or central office line by up to nine boss-secretary groups. One of the secretaries would normally be designated the attendant, and she would answer all incoming calls. For example, on an incoming call the attendant places the call on hold and signals the boss in group 1 to pick up. Once the party is on the line, any other station going off-hook on the* PBX *or* CO *line will be given a busy tone. If desired, secretaries may be provided with audio-only service.*

up to three intercom links. Add-on-conference, the fifth service, allows a third party to be included in a call. In addition, of course, these Picturephone systems offer services included in the audio-only type key telephone systems.

A TOUCH-TONE® telephone set and a speakerphone are an integral part of the Picturephone station. Video calls are placed by simply preceding the called number with the Touch-Tone button labeled # (the # is omitted for telephone calls). Incoming Picturephone calls are distinguished from ordinary telephone calls by a tone ringer (bell for telephone) and a red lamp (white for telephone). Normal flashing rates are used to indicate hold, ringing, and busy.

Single-group line service. With single-group line service, if the boss and secretary are off-hook on the same line, both will receive audio, but video will appear only at the boss's station. The block diagram at the top of the opposite page shows a typical key system installation for a single-group arrangement. Additional lines can be connected to a station by adding a line circuit, a video switch, and a video cable equalizer for each line.

On an incoming Picturephone call, the CO or PBX applies a Video Supervisory Signal (VSS) to the incoming video pair before ringing is applied to the audio pair. The cable equalizer detects VSS and switches the line circuit to the video mode. When the line circuit detects ringing, the called party hears a distinctive ring (tone ringer) and sees a flashing red lamp. When the call is answered, ringing ceases, the red lamp becomes steady, and the video switch extends the video and "turn-on-set" signal to the called Picturephone station. When a call is placed on hold, a winking red lamp appears under the line button of the telephone set. During hold, the video switch is released, resulting in a blank screen for both parties. When the user re-establishes the connection, video as well as audio communications can be continued.

To originate a Picturephone call, the user goes off-hook, causing the line circuit to light the corresponding white lamp in the set. He then presses the # button, followed by the telephone number of the called station. When the CO or PBX detects a video call, a burst of VSS is sent to the video cable equalizer. Once the equalizer has detected the VSS, the line circuit is switched to the video mode; the line circuit in turn switches the lamp in the telephone set from steady white to steady red. The system returns to the idle state when all stations are again on-hook.

When the line is idle, the video transmit and receive pairs are connected together on the line

FEATURES PROVIDED BY BOTH SINGLE-LINK AND MULTILINK INTERCOMS
• Privacy
• Secretarial Bridging of Intercom Line Appearance
• Station Hunting from a Primary Station to a Secondary Station When the Primary Station is Busy on Another Line
• System Busy Tone
• DSS (Direct Station Selection)
• Audio-Only Stations Permitted

FEATURES PROVIDED ONLY BY SINGLE-LINK INTERCOMS
• PBX or CO Line Add-On
• Pre-Set Audio-Only Conference

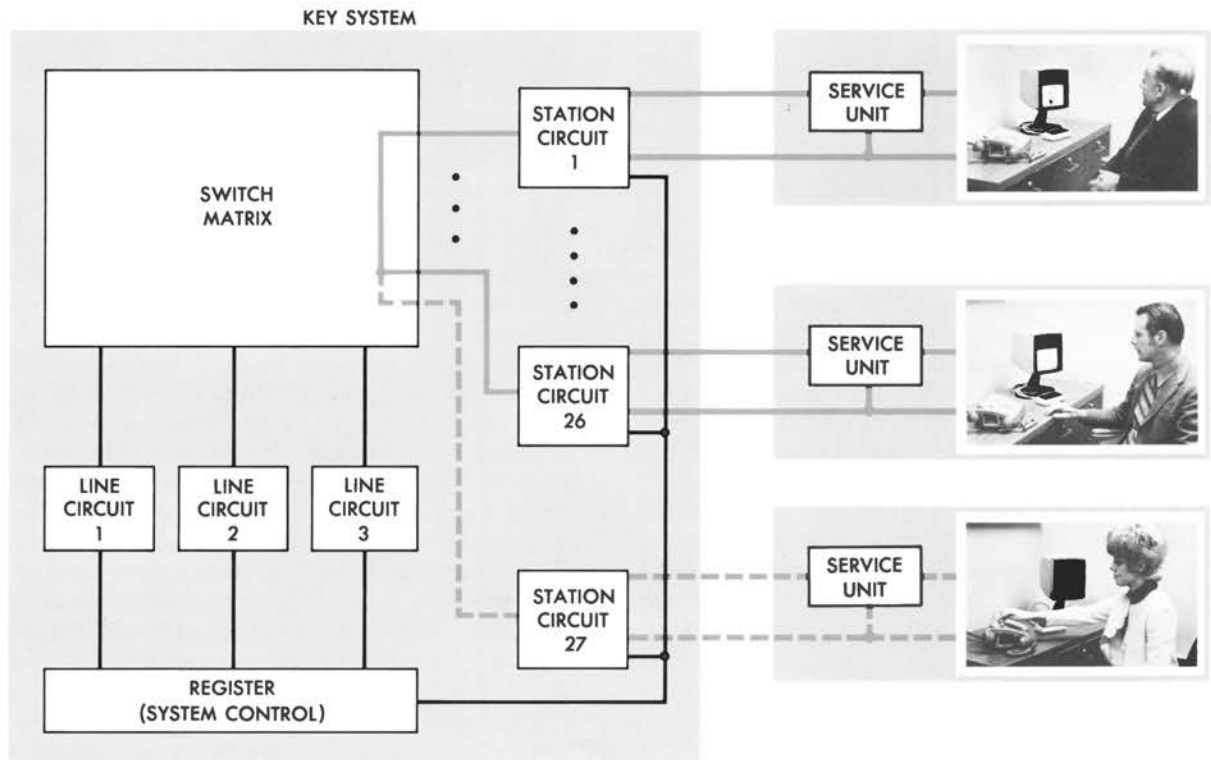| FEATURES PROVIDED ONLY BY MULTILINK INTERCOMS |
| --- |
| • Hold |
| • Register Recall |
| • Paging Trunk Access |
| • Attendant Operation |
| • PBX or CO Line Add-On Transfer |

side of the equalizer circuit. This "loopback" is to allow the loop to be tested from the central office. Loopback is removed when the line circuit is in the video mode and a station is off-hook, and is not reconnected until the system is idle—that is, not until VSS is no longer being received and all stations are on-hook. This logic allows a video signal to be transmitted over the customer loop for transmission testing, and also prevents a user from seeing himself on the Picturephone screen if the person to whom he is talking goes on-hook. If power fails at the line circuit, cable equalizer or station set, loopback is removed to prevent the CO or PBX from completing video calls to that line.

Multigroup line service. The multigroup system, serving up to nine boss-secretary groups on a shared line, is shown at the bottom of the opposite page. It uses a line circuit, a cable equalizer, and a common control and lockout circuit. The illustration shows the secretaries with access to the video picture, but audio-only service can also be provided. When any one boss-secretary group is using the line, access is denied to all others. Any member of a Picturephone group who inadvertently

Talking and video paths (color lines) and control paths (black lines) of the single-link intercom. The system has a capacity for a maximum of 10 stations on a single audio-video link. Other system features are privacy, PBX or central office line add-on, direct station selection, and preset audio-only conference. Some or all stations may be equipped for Picturephone service.

Talking and video paths (color lines) and control paths (black lines) for multilink intercom service can serve up to 27 stations on a maximum of 3 audio-video links. A third station (audio only) such as station 27, which is shown in the illustration, may be added to an established two-station video connection by either the register recall or direct station selection features. Other features such as PBX or central office line add-on transfer, hold, paging trunk access, and attendant operation are also provided.

goes off-hook on a busy line will receive a busy signal. A call can be transferred by signaling another group to pick up the line.

With the multigroup system, a station in one group will usually be designated as the "attendant," and all incoming calls will ring and flash at that location. During ringing, the lamp associated with each line remains steady at all non-attendant stations unless those stations go off-hook during ringing, in which case they will receive a busy tone. When the attendant knows the station that the party is calling, the incoming call can be placed on hold and the proper station can be signaled. The signaling may be done by direct station selection as described below or by using an intercom (audio or video). When the called party answers, the call will be transferred, and the attendant and other groups will be locked out.

An optional Direct Station Selection (DSS) arrangement lets the attendant alert a station to an incoming Picturephone call. With this arrangement, the attendant places the line on hold and operates the proper DSS button, which activates a flashing red lamp and audible tone ringer associated with the Picturephone line to be picked up. When the user answers, the call will be transferred, and the attendant will be locked out.

Video "loopback" is provided with multigroup service, as described for single-group service.

Intercom service is entirely separate from service over central office or PBX lines, and, as stated earlier, it consists of single-link and multilink types. For example, stations having access to the single-link intercom can have either single-group or multigroup Picturephone line service or telephone-only line service. An intercom button is required at each station having access to an intercom system. Features common to both the single-link and multilink intercoms include:

• privacy (one user cannot break into another's call),

• secretarial bridging of intercom line appearance (secretary can break into boss's call),

• station hunting from a primary station to a secondary station when the primary is busy on another line (call spills over to secretary when boss is already on the phone),

• system busy tone for lines in use,

• direct station selection, and

• provision for audio-only stations.

Single-link intercom. Single-link intercom service provides a private line (# plus one digit) among a group of ten stations or fewer, some or all of which are equipped for Picturephone service. Single-link intercom service is provided by

the units shown at the top of the opposite page, and consists of a station circuit for each station, a common control to allow access to one station and exclude all others, a tone and lamp control, and Touch-Tone dial receiving equipment. The two features provided by single-link intercoms that are not available in multilink are PBX or CO line add-on (multilink intercom provides a similar feature called line add-on transfer), and pre-set audio-only conference.

With single-link intercom service, incoming and outgoing calls follow the procedures described for line services related to dialing and station alerting. If a call is in progress, the intercom line lamp will light steadily at all stations that have intercom access. If a station goes off-hook while a call is in progress, the user will receive a busy tone.

When a station goes off-hook to originate a call, the station and common-control circuits are seized, thereby preventing other stations from originating a call on the intercom. The station is connected to a battery-feed circuit and the terminated video path. The calling party hears the dial tone, and all stations receive a steady white lamp signal; but if the # digit is dialed, indicating a Picturephone call, the lamps change to steady red.

Once dialing is completed, the common control circuit tests to see whether the called party is busy. If the called party is busy on another line, a busy tone is returned to the calling station; if the station is idle, ringing is applied. When the called party answers, ringing ceases, the Picturephone set is turned on, and the video paths are connected in a transmitter-to-receiver fashion. The system remains in the busy state until all parties hang up.

Once an intercom call has been established, one of the parties can answer an incoming call on another line while the other intercom party remains off-hook. After answering the incoming call, the party may return to his conversation on the intercom. In this way, intercom users can "hold" an intercom call.

Secretarial bridging of an intercom line appearance, hunting when a primary station is busy on another line, and preset audio-only conference are standard audio key system features. The DSS feature available with the single-link intercom is the same as that described for multigroup line service.

Multilink intercom. Multilink intercom serves customers who require greater capacity than that available in the single-link type. It is a common control system and, as stated earlier, handles up to 27 stations on a maximum of three links. The following features are available with multilink
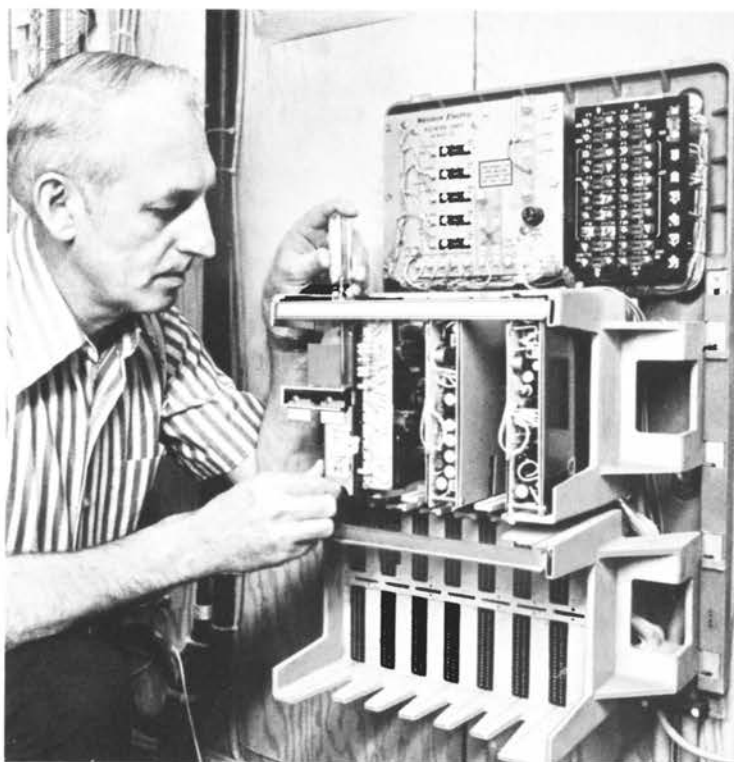
A craftsman installing a 650 Key Service Unit (KSU), which is equipped for line service for a single boss-secretary group.
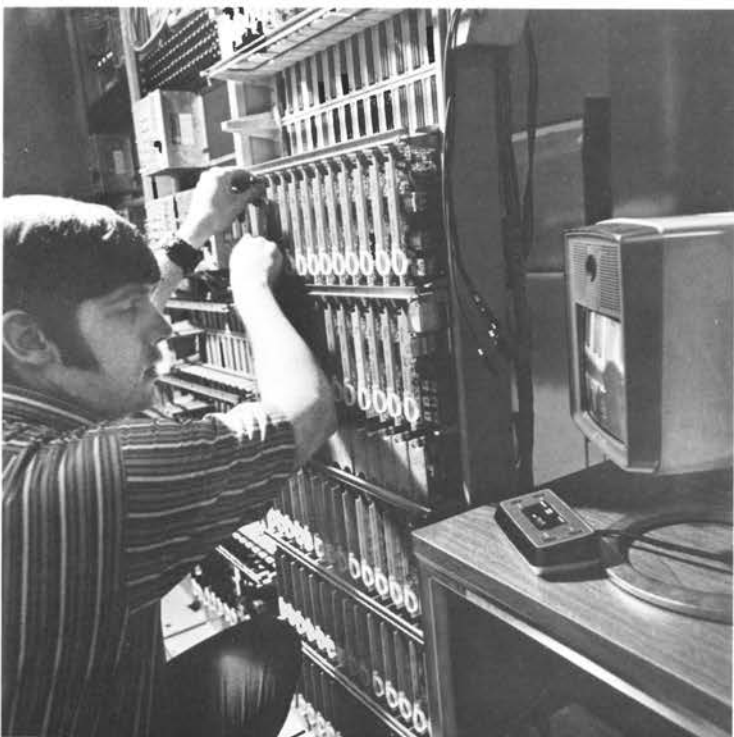
A multilink Picturephone intercom, one of two intercoms offered, undergoing field-trial testing. System can handle 27 stations.

service but not with single-link: hold, PBX or CO line add-on transfer, paging trunk access, attendant operation, and register recall. A block diagram, shown at the bottom of page 274, illustrates the multilink system, which consists of a register, the three link circuits, a switch matrix, and a station circuit for each station.

The register, which contains the basic system logic, consists of a Touch-Tone receiver, a selector circuit, and a logic circuit for controlling the system. The link circuit supervises calls and handles selective signaling; the station circuit connects the stations to the system and controls the video, lamp, and ringer switching. The switch matrix connects selected stations to a link circuit and locks out all other stations.

When a station goes off-hook to originate a telephone call, the register is seized and prevents other stations from originating calls at the same time. The register identifies the calling station and also activates an idle link, which operates the matrix crosspoint associated with the calling party. Since Touch-Tone dialing is involved to originate Picturephone calls, the tones are coupled to the register. Once dialing has been completed, the register tests to see whether the called station is busy; if it is, a busy signal will be returned. If the called station is idle, the call can then be completed. After the station answers, the intercom link will remain busy until all stations are placed on-hook.

When the register detects the # used for Picturephone calls, it signals the link to switch the station circuit into the Picturephone mode (i.e., red lamp, tone ringer). The viewing path through the switch matrix is controlled by the station circuits, which connect the transmitters and receivers of the calling and called parties in the proper transmitter-receiver combinations. When both parties have been connected to the switch matrix, the link circuit prevents additional stations from being added in a Picturephone mode to the existing two-party call. Third and fourth parties can be added (audio only) to an existing call by two methods: DSS and register recall. The intercom call can be placed on hold, which results in a distinctive winking red lamp.

The DSS feature may be used to call a Picturephone intercom station by going off-hook, dialing the # digit, and depressing the DSS key associated with the called party. After a two-party call has been set up, either party may add (audio) stations to the call by using the DSS feature. A DSS key is required for each specific station that a user signals directly.

After a call has been established on a given

link, either party, if equipped with a register recall button, can add stations (up to a total of four parties) to the call by depressing the register recall key. The register is connected to the proper link, returning dial tone to the calling party. The dial and status tones that result are the same as for a normally dialed call. The first two parties will have a video connection; the third and fourth parties will have only an audio connection. Station status tones (busy, ringback, etc.) can be retired by depressing the register recall key a second time.

Now let's look at the PBX or CO line add-on transfer feature. Assume that a two-party intercom Picturephone call has been established, and that one of the intercom users wishes to add a CO party. The controlling party first places the intercom call on hold, selects a CO line and then dials the CO party. When the CO party answers, the controlling station depresses the add-on key associated with the CO line, which causes the CO line audio pair to bridge the loop of the link in use. The intercom station in control selects the party to be viewed by depressing either the line or intercom button. The controlling party is seen by the party who has depressed the button, but the third party receives a blank screen. All three parties, however, have continuous audio. If either intercom station goes on-hook, the video from the added-on line is transferred to the remaining party.

The purpose of the paging feature is to provide microphone access to a public address system owned by the customer. The paging control circuit replaces a station circuit and serves as the interface between the intercom and the customer's loudspeaker paging circuit. The paging control circuit automatically disconnects when the intercom station disconnects (calling party control).

An attendant position, which has the same appearance in the system as a normal station circuit, can also be provided. The attendant may or may not have a Picturephone set, as desired. The position would normally be assigned the station code "0," but is not restricted to this code. If a user does not have access to a PBX or CO line (audio or video) and if an attendant position is equipped, the attendant can give the user access to an outside line.

Add-on conference. Add-on conference service is provided for single-group and multigroup line users as well as for single-link intercom customers. Conferencing is provided between: (1) two PBX lines, (2) one PBX or CO line and a single-link intercom line, and (3) one CO line and one PBX line.

Assume that a two-party Picturephone call has been established on a CO line and that one of the parties wishes to add an intercom station. The controlling party places the CO call on hold, accesses the intercom, and dials the desired party. When the intercom party answers, the controlling station depresses the add-on-conference key, causing the intercom audio pair to bridge the CO line in use. The controlling station chooses the desired video connection by depressing the line button associated with the station to be viewed. When the conference is completed, the controlling party may continue to talk to either party when the third party hangs up, or he may drop both parties by hanging up himself.

Circuits for all of the above Picturephone key systems consist of solid-state elements, miniature flat-spring relays and assorted components assembled on key telephone units (KTU's), which plug into equipment arrangements wired together into one assembly. The wired and factory-tested assemblies are connected (at the time of installation) by using plug-in cables and quick-connect wall-mounted terminal blocks. The plug-in, modular design of the assembly minimizes the time that has to be spent on the customer's premises for installation and maintenance.

The two types of equipment units shown on the opposite page are available to house Picturephone key equipment; a wall-mounted key service unit (KSU) accommodates the small installations, while floor-mounted, seven-foot frames handle the larger installations and the multilink intercom system.

The equipment is wired to accept the full complement of circuit packs and is tested before shipping to the field. The various service features and options are implemented by inserting or removing a circuit pack or by replacing one circuit-pack code by another in dedicated positions.

Two cable pairs in standard inside wiring are required to carry the video signal between a Picturephone set and the Picturephone key equipment, regardless of the number of Picturephone lines or intercoms associated with the station. All of the video switching functions take place at the Picturephone key equipment location. Audio connections associated with the Picturephone lines and intercoms, such as tip and ring, use a standard wiring plan for key telephone systems. Pair assignments within the cable are made to reduce video crosstalk.

Further experience in the field will undoubtedly point to requirements for new Picturephone key services not provided by those described. Nonswitched Picturephone tie lines, computer interaction with present intercom designs, and new video-conferencing systems are but a few of the services that lie ahead.