Customer Switching

The *Picturephone*® System:

Customer Switching Systems

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Many customers for Picturephone® *service will likely be business and industrial enterprises, having PBX, centrex, or key telephone service. This paper discusses switching systems for business customers, and describes how* Picturephone *service will be added as a natural extension of telephone service. This paper also serves as an introduction to the detailed papers which describe each of the customer switching system* Picturephone *arrangements.*

I. INTRODUCTION

Customer switching systems furnish service to Bell System customers in every business category. Such systems range in size from only two or three telephones up to many thousands of extension telephones. Because of the potential value of face-to-face communications to business customers, facilities have been made available so that they can subscribe to *Picturephone* service as part of customer switching system service.

The customer switching category includes several basic types of service. One type, known as Private Branch Exchange (PBX) service, is obtained from switching equipment located on the customer's premises. It permits connections to be set up quickly between the telephone users at the same business location, without the need for connecting to, and switching through, a central office. PBX systems also permit the customer's employees to place and receive calls to and from the central office via switches which provide a form of concentration when fewer central office paths are needed than customer stations. In PBX service, all calls from the central office, and some to the central office, are completed with the aid of the customer's operator, or attendant, who provides many useful services such as accepting calls for the concern and directing them to particular employees, aiding in the placing of outgoing calls, and screening them when

desired by the customer. Figure 1 shows a modern attendant's position arranged to handle *Picturephone* service.

Small customer switching complexes which do not require attendant aids to the extent desired in PBX service are very numerous. Key Telephone Systems (KTS) are used to meet such customer requirements.

A third type of customer switching service, centrex, is a variation on PBX service which has been made available in the past decade. With one form of centrex service, called centrex-CU, stations are served by PBX-type equipment (on the customer's premises), and calls can be directly dialed to any other telephone in the exchange and toll network with the identity of the calling station recorded at the exchange or toll switching office when required for charging purposes. Also, incoming calls can be directly dialed to the station without attendant assistance. However, the attendant is still retained in centrex service to handle calls directed to the main number of the business concern or to render assistance on calls that need to be transferred or require other special attention. An equipment variation, generally known as centrex-CO, accomplishes essentially the same service by switching features included in the central office switching equipment.

II. COMMON OBJECTIVES AND PRINCIPLES

In adding *Picturephone* service to customer switching systems the objective has been to make the new service appear to the customer as a natural extension of telephone service, i.e., to provide means so that the action required by station users or attendants to initiate, receive, or extend *Picturephone* calls is compatible with the operation performed on ordinary telephone calls. In line with this objective, customer switching systems with *Picturephone* service have been designed to be consistent with general system principles.[1,2] These include the ability to use common station equipment and common telephone numbers for both telephone and *Picturephone* calls, with the *Picturephone* switching function brought into play through the use of the identifying # prefix generated by the 12th button of a *Touch-Tone®* station set. Included also in the *Picturephone* customer switching system designs is a distinctive signal on incoming calls, created by a new tone ringer at PBX, centrex and key telephone stations and also by a distinctive lamp signal on key telephone stations.

As is the case with non-*Picturephone* customer switching systems, answer supervision is returned by the attendant or station, whoever

Fig. 1—A modern PBX or centrex attendant position, arranged to handle *Picturephone* service.

answers first, and this causes charging to begin and persist throughout the call at *Picturephone* rates. Incoming *Picturephone* calls in centrex service are prevented from being directly completed to non-*Picturephone* stations in order to avoid unwanted charges. However a PBX or centrex attendant can complete *Picturephone* calls to a non-*Picturephone* station, if desired. Similarly, customer initiated transfers from a *Picturephone* to a non-*Picturephone* station are possible.

When *Picturephone* service is furnished by centrex switching equipment on the customer's premises, that equipment must be arranged for automatic identified outward dialing (AIOD) and must home on a central office equipped with local automatic message accounting (LAMA) equipment. In a similar manner, when centrex service is derived from central office equipment, the central office must be equipped with LAMA. The use of automatic station identification and LAMA is required since it is not planned at present to route *Picturephone* calls via a centralized automatic message accounting (CAMA) office either for operator identification or automatic charge recording.

III. SWITCHING SYSTEMS

Since there are a number of standard systems that provide customer switching service, it was necessary first to decide upon those systems that should be arranged for *Picturephone* service, and the general manner of incorporating the video capability in them. Systems were chosen on the basis of having the most potential use for *Picturephone* service, considering both present and future customers. The manner of adapting them—or the question of adapting them at all—became a function of the nature of the system and the economics of accomplishing the functions. In this connection it should be noted that no attempt has been made to provide facilities to serve all stations of large customer installations, since it was judged that these customers would not elect, at least initially, to subscribe to the service for all of their employees.

Picturephone service has been adapted to the 701 step-by-step PBX system which presently provides PBX and centrex service to a large number of Bell System customers. To minimize modifications of existing 701 PBX systems, an auxiliary switching arrangement, the 850A PBX³ has been developed which is automatically called into use to handle both audio and video components of the *Picturephone* traffic generated by, or destined for, stations obtaining regular telephone service from the 701 PBX.

The 757 PBX system represents one of the Bell System's newer packaged crossbar PBX systems which can furnish PBX and centrex service. Since its use has been steadily growing, it too has been made capable of furnishing *Picturephone* service. Designs have been consolidated, and the 850A auxiliary switching arrangement designed for the 701 PBX is also capable of functioning in a similar manner with the 757 PBX.

Picturephone service capability has also been added to the No. 101 Electronic Switching System (ESS), presently the Bell System's most versatile customer switching system with respect to range of customer sizes and variety of service features. As described in a companion article, any one of the family of switch units comprising this system can be arranged to provide *Picturephone* service.⁴ For this system, the video component of the service is handled through the use of a wideband switch unit controlled, via the audio switch unit, by the stored program information in the control unit.

The No. 5 crossbar system has been arranged so that *Picturephone* service capability can be made available to centrex-CO lines. An optional wideband remote switch controlled from the *Picturephone* central office can be used on the customer's premises.⁵ As discussed

in Ref. 5, not all centrex features will be available on *Picturephone* calls until a later development. The No. 1 ESS will also be arranged for the service at a later date.

It was found that *Picturephone* service for KTS customers could be more economically provided with a new system rather than by modifying existing systems. Accordingly the 1P2 system has been developed for use where *Picturephone* key telephone service is desired.[6] The 1P2 system can also be used as a separate entity to furnish *Picturephone* service to PBX and centrex stations when their number does not justify modifying the major system.

Figure 2 illustrates the general method of adding video switching to the systems just discussed.

IV. PBX/CENTREX CUSTOMER OPERATING FEATURES

4.1 *General*

In developing customer operating features for PBX and centrex *Picturephone* service, a basic precept has been that the video features in the different PBX and centrex systems be consistent with each other and coordinate with the "service package" concept currently underlying the PBX and centrex marketing philosophy. The latter means that each of the features in the current telephone service array will have, to the extent possible, a companion video feature, and these features will be optionally available in groups, or individually, to complement the regular telephone service packages or individual options, respectively.

Technologically, the video features are of interest primarily with respect to whether they are station user oriented or attendant oriented (in which case they generally affect the station user also). Accordingly, the features will be discussed from these viewpoints.
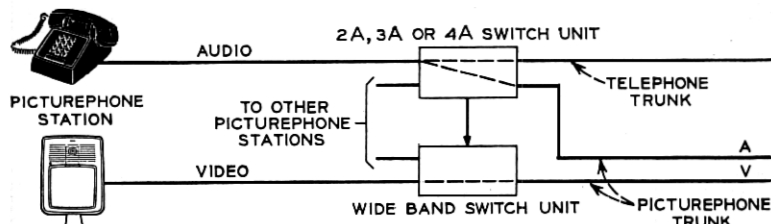
4.2 *PBX and Centrex Station Features*

The basic communication functions available to a station user are: communication with another inside station and communication with someone outside. With *Picturephone* service, video capability will be present on directly dialed inside and outside calls in a straightforward simple manner. PBX and centrex systems are designed so that the digits dialed to identify the station, either on an inside call or when called from outside, can be the same whether the call is made on a telephone basis or on a *Picturephone* basis,* except that on a
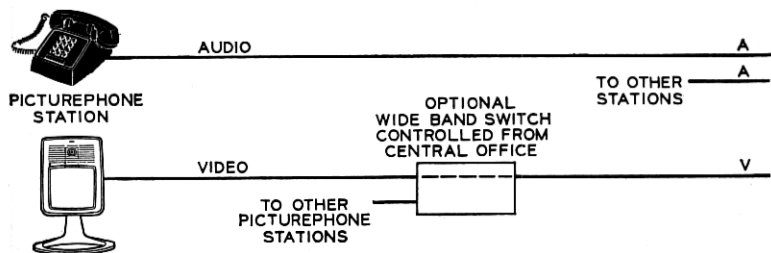
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* If a separate system is used to provide *Picturephone* only service, a common number for *Picturephone* and telephone service is, of course, not possible.
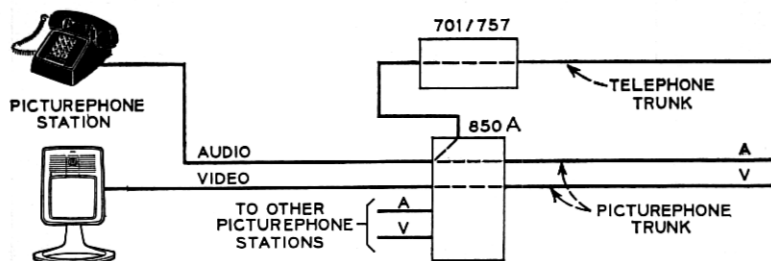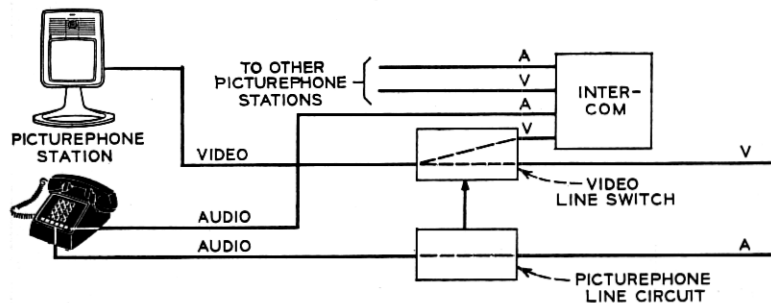
Fig. 2—General method of adding video switching to customer switching systems.

Picturephone call the station number must be preceded by the identifying # prefix. If the station number is preceded by the # prefix but the call is for a non-*Picturephone* station, it will be routed to a recorded announcement to avoid unwanted charges. If the *Picturephone* station to which the call is directed is in a hunting group with other *Picturephone* and telephone stations, the *Picturephone* call will hunt over only the *Picturephone* lines in the group. A *Picturephone* line will appear busy to the system for subsequent *Picturephone* and telephone calls if it is in use on either type of call.

PBX and centrex station features involving transfer functions of one kind or another result in some interesting video service features. Present systems can accomplish a number of variations of the transfer function, each variation being somewhat differently named depending upon the point in the call at which the function occurs, and the details of the function. Not all systems are capable of all variations. In general, the transfer function can occur (*i*) before the call is answered, (*ii*) at the instant of answer, or (*iii*) while the call is in process. Table I shows a tabulation of calls in these categories, together with a brief description of the telephone service and the video counterpart.

4.3 *Attendant Features*

The ability to have an operator, or attendant, assist in the handling of calls is fundamental to PBX and centrex service and perhaps is one of the most important features. An attendant is an employee of the customer and, as such, functions as a "telephone receptionist" portraying her company's image. In the development of *Picturephone* service for PBX and centrex customers, provision has been made so that this concept can be enhanced where desired by the customer through the use of video telephony for the attendant.

It was decided to provide attendant service only with consoles such as the one shown in Fig. 1 since they not only represent the modern trend, but the alternative—cord switchboards—would be unnecessarily cumbersome to implement and operate. However, for those existing installations where cord switchboards prevail, the service can be implemented through the use of an auxiliary console for handling *Picturephone* calls only.

With respect to console operation, the objectives have been (*i*) that the attendant perform the same relative functions on *Picturephone* calls as on telephone calls handled at present standard consoles, and (*ii*) that the video operating procedures be identical with, or natural extensions of, the standard telephone operating procedures. The

TABLE I—SOME SERVICES INVOLVING TRANSFER FUNCTIONS

	Function*	Telephone Service	Picturephone Counterpart
Transfer occurs before answer	Call forwarding—busy line	Incoming direct inward dialed calls transferred to attendant if station is busy or does not answer.	Incoming direct inward dialed Picturephone calls transferred to attendant if station is busy or does not answer.
	Call forwarding—don't answer		
	Call forwarding	Station pre-sets system to route incoming calls to another station.	Route Picturephone calls to another or night station if video equipped, otherwise route to recorded announcement.
	Night service	System pre-set to route incoming calls to night station.	
Transfer occurs at answer	Call pick-up	A call for a station in a group can be answered by another in the group by dialing special code.	Only video-equipped station can pick-up Picturephone call.
	Trunk answer from any station	Stations can pick-up incoming trunk calls by dialing special code.	Not activated for Picturephone service.
Transfer occurs while call is in process	Call transfer—individual	Called station can transfer incoming trunk call to another station.†	Transfer can be made to video or non-video station.
	Consultation hold	Outside party can be held while station calls another inside party.†	Same. If other party is video, visual communication can be made.
	Add-on	Station can add another inside party to call from outside after the "consultation hold" phase.†	Added station can be video-equipped or not. If video, the station initiating the add-on has visual communication with outside party.

* All functions not available with all systems.
† 101 ESS extends service to station-to-station and outgoing calls.

principal extension of the service occurs when the attendant is equipped with a *Picturephone* set which permits her to see and be seen.

New communication procedures will be recognized to result from this added capability. This occurs because during the establishment of connections, the attendant is "in the middle" of communications between inside and outside parties, a process which involves accepting voice instructions from one of the parties, taking action to advance the call—an action which sometimes involves communication with the other party, returning sometimes to communicate with the originating party and, in some calls, communicating at the same time with both parties. Under these conditions of communication, a question arises as to who should see whom.

Simulation was resorted to in order to demonstrate and develop processes which intuitively appeared logical. With a few exceptions, the general rule evolved was that the video connection should follow the audio connection; that is, the parties that hear each other should also see each other. Where the attendant is involved with both calling and called parties at the same time, the video path to the attendant is not completed. Figure 3 shows "who sees whom" sequences during the process of some typical attendant operations.

It will be noted from the illustrations on Fig. 3 that another new feature has been introduced in the process of providing video service for the attendant. This is the capability to transmit a stationary image to video telephone parties outside the customer group when no live picture would otherwise be transmitted. These stationary images will represent patterns or concepts devised by the customer, and will be changeable by the customer. The images are generated by a video-image generator (VIG) and the capability can be provided at the customer's option.

In order to take care of different situations that can be encountered with various PBX and centrex systems, three modes have been developed for interconnecting the attendant console with the switching system. In the first, *Picturephone* calls can be diverted to a separate console as was previously mentioned for installations with dial auxiliary cord switchboards. In the second mode, *Picturephone* calls appear on specific pick-up keys on the same console that contains keys associated with telephone inputs. These methods are used with the 701/757 PBX approach and with the No. 5 crossbar system. In the third mode, used with the No. 101 ESS, both telephone and *Picturephone* calls are directed to common pick-up keys on the console. In each of

	PICTURE SEEN BY:		
	OUTSIDE PARTY	ATTENDANT	INSIDE STATION
ATTENDANT ANSWERS INCOMING CALL TO LISTED NUMBER. CALLER REQUESTS STATION			
ATTENDANT RINGS STATION. SPLITS CALL TO ANNOUNCE CALLER			
STATION ANSWERS. ATTENDANT ANNOUNCES CALL. STATION REQUESTS MORE INFORMATION			
ATTENDANT RETURNS TO OUTSIDE PARTY FOR INFORMATION			
ATTENDANT RETURNS TO STATION WHO AGREES TO ACCEPT CALL			
ATTENDANT CONNECTS OUTSIDE PARTY AND RELEASES SELF			
STATION RECALLS ATTENDANT REQUESTS INCOMING CALL BE TRANSFERRED TO ANOTHER STATION			
ATTENDANT RELEASES STATION			
ATTENDANT CALLS OTHER STATION			
OTHER STATION ANSWERS AND IS CONNECTED TO OUTSIDE PARTY			

LEGEND:

ATTENDANT   OUTSIDE PARTY   FIRST INSIDE STATION   OTHER INSIDE STATION

Fig. 3—"Who sees whom" during some typical attendant operations.

these modes of operation, uniform call handling methods have been worked out which achieve the basic operating objectives.

V. KEY TELEPHONE SYSTEM FEATURES

5.1 *General*

The common system principles enumerated in Section II also underlie the *Picturephone* features of KTSs. However, specific service features of these systems differ from PBX and centrex service because of differences in the switching approach.

The KTSs provide service similar to PBX services insofar as they permit (*i*) controlled switching access between stations and lines to the central office (or to a PBX) and (*ii*) intercommunication with other stations of the customer group without the need for switching through the central office. Their operating features differ largely because of the difference in line access methods and the use of separate switching entities for the outside and inside functions stated in (*i*) and (*ii*).

The 1P2 KTS[6] developed for *Picturephone* service operates with standard key telephone sets and provides the basic communication features of systems used for audio-only service. Modifications and improvements have been made as dictated by the nature of the video technology.

5.2 *Line Access Features*

With conventional audio KTSs, one or more PBX or central office lines appear on keys at a telephone, and the station user obtains access to a line by operating a particular key. The lines may also be accessed by other key telephones, thus making it possible to connect more than one telephone, individually or at the same time, to a line. The station user may operate a hold key at the telephone to hold a call on a particular line and permit picking up another line.

When KTSs are arranged for *Picturephone* service, the same general capabilities for accessing one or more lines at one or more stations are present. However, to avoid video interference when more than one station is bridged to a line, only one video path is enabled at a time. Audio paths can still be bridged.

Line access arrangements have been developed in accordance with the above which contain improved features to enhance the value of the service to the customer. For example, where key telephone service is used by a customer having a secretary, the customer may wish to

have a *Picturephone* set without providing one for his secretary, but at the same time will want her to continue her usual practice of answering and sometimes initiating calls for him. The *Picturephone* KTS line access design provides for this by giving both stations audio access to the line, with video access only to the principal's *Picturephone* set. The secretary can then answer and initiate *Picturephone* calls on an audio basis and turn them over to the principal when desired who can continue on a *Picturephone* basis. To initiate a call, the secretary's telephone must, of course, be equipped for *Touch-Tone* calling in order to key the necessary prefix.

If a *Picturephone* set is provided for the secretary, she may enjoy full *Picturephone* service except that when both telephones are on the line at the same time, only one *Picturephone* set will be connected. The system is arranged to give preference to the principal's station. This type of service can be extended to two or more *Picturephone* lines and to more than two stations.

Another service variation allows a number of principal stations to share one or more lines. As in the previous concept, each principal might have a *Picturephone* set with a telephone set only for a secretary or other subordinate; although as before, the subordinate could also have a *Picturephone* set. With this service, when any one group (i.e., principal and subordinate) is using a line, access is denied to all other groups and the associated line lamp is lighted at the stations of the other groups. A line in use can be transferred from one group to another by placing it on hold and, through some separate means, such as an intercom, directing the other group to pick it up. With this service, incoming calls can be caused to ring and flash at a station user designated to act as attendant who, after answering the call, can place it on hold and, in a manner similar to the group transfer described above, can direct the proper station to pick it up.

5.3 *Intercom Service*

Intercommunication between *Picturephone* stations is obtained by a separate switching entity. Station access to the intercom system is via a separate button on the key telephone set. Two intercom arrangements have been developed. One, accessible to ten stations, allows one *Picturephone* conversation at a time; the other, of larger capacity, provides access for up to 27 stations and up to three conversations can be held at the same time.

5.4 *Add-On Service*

Another party can be added to a *Picturephone* call that has been set up via the line access or intercom facility, in a manner generally similar to audio-only key telephone service. For example, an intercom call can be added to a central office call, or to a PBX call; or a PBX call can be added to another PBX call or to a central office call. When the calls are conferenced, the audio lines are bridged; but as in PBX service, the question of "who sees whom" arises. Since the station user originating the "add-on" has primary control of switching via the keys on his telephone set, the system has been arranged so that he can view and be viewed by the station associated with the particular access button depressed at his station. If he wishes, he may switch the video path from one to the other of the connected stations by depressing the associated access button.

VI. SUMMARY

This article discusses customer switching systems, their services and their features, with emphasis on how *Picturephone* service will be added to provide a useful and natural extension of telephone service. Customers served by video-augmented systems can provide for their employees the opportunity to conduct visual business communications with each other and with outside associates. These opportunities generally will be present on all communications normally provided by PBX, centrex and Key Telephone Systems.

VII. ACKNOWLEDGMENTS

The planning of *Picturephone* service for customer switching systems involved the contributions of many people at the American Telephone and Telegraph Company and Bell Telephone Laboratories.

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