CENTREX CENTRAL OFFICE SERVICE

GENERAL DESCRIPTION

NO. 2 ELECTRONIC SWITCHING SYSTEM

CONTENTS PAGE

CONTENTS PAGE

FIGURES PAGE

1. GENERAL

1.01 This section describes in general the centrex service available for use in conjunction with the No. 2 ESS. The features available with this system are explained, a general explanation of the basic system operation is given, and the equipment used is described.

1.02 The No. 2 ESS centrex service is a centralized telephone communications exchange service using the data handling capabilities of a nearby No. 2 ESS central office. For centrex service the EF-1 generic program is required for the No. 2 ESS.

1.03 No switching equipment is installed at the centrex customer premises. All centrex subscriber lines are directly connected to a No. 2 ESS central office in the same manner as regular telephone subscriber lines.

1.04 Centrex programs and translations at the No. 2 ESS, to which the customer group is connected, indicate which subscriber lines are part of a centrex customer group and determine the treatment the subscriber lines will receive.

1.05 Each centrex customer is equipped with one or more 1B- or 2B-type universal cordless telephone consoles to provide attendant services.

1.06 A centrex data loop interconnects the attendant consoles at the customer premises with the No. 2 ESS central office. This loop is a transmission path which provides 2-way data communications between the central office and the consoles. (See 4.09.)

1.07 Each centrex customer group is assigned at least one ***listed directory number (LDN).*** All calls to the LDN are routed in the order of their arrival to an attendant associated with that particular customer group.

1.08 Call distribution is provided to spread the load evenly to all attendants and to prevent a new call from being switched to a console before the attendant is ready to answer it. A queuing arrangement is provided for calls to the attendant when all attendants are busy. Up to four calls per attendant may wait until an attendant becomes available. As attendants become available, the waiting calls are routed to them in the order of their arrival.

1.09 Centrex stations may be equipped with either TOUCH-TONE® or rotary dial telephones.

1.10 Centrex service requires the use of two additional specialized equipment units other than the attendant consoles and the station telephones:

- A centrex data link frame provided at the ESS central office
- A centrex console control cabinet installed at the centrex customer group premises.

These units are used to implement data transmission between the centrex customer location and the central office.

1.11 A block diagram of a typical centrex customer group is shown in Fig. 1. Only one console is shown, although on larger centrex installations additional consoles may be provided to handle greater attendant traffic. The centrex station telephones are connected directly to the switching network just as noncentrex subscribers are connected. The attendant trunk and loop circuits are connected to the network to provide a talking path for the attendant. Only one talking path is provided for each attendant console since an attendant can be connected to only one call at a time. The data

loop provides the 2-way data path. The system is controlled by the No. 2 ESS control unit. Tie trunks and ***foreign exchange (FX)*** trunks through which a centrex customer group may have access to other switching systems are also connected to the network.

1.12 The use of the word "party" in this document does not imply only Plain Old Telephone System (POTS) party lines, but is meant to mean "party" in its most general sense, including centrex extension, POTS lines (including party lines), trunk, etc.

2. CENTREX FEATURES AND RESTRICTIONS

2.01 Any centrex group may have certain features associated with it. These features and the associated restrictions are described in the following paragraphs.

CENTREX FEATURES

2.02 This part gives an alphabetical listing of No. 2 ESS centrex features and their descriptions.

Add-On

The add-on feature enables a centrex party to add another party to an existing incoming call (DID, CCSA, or certain tie trunks) to establish a 3-party conference without attendant assistance.

Attendant Call Forwarding

Attendant call forwarding allows the attendant to call forward any station in the centrex group, providing the station has the call forwarding feature.

Attendant Camp-On and Indication of Camp-On

Attendant camp-on allows the attendant to camp-on to a busy station line and hold an incoming call until the called party becomes idle. This feature applies to all attendant calls. The called station receives a half-second burst of tone when the attendant releases from the incoming call. This short burst of tone indicates that the incoming call is camped-on. When the called party becomes idle, it is automatically rung and connected to the incoming call upon answer.

Attendant Conference

Attendant conference allows the attendant to establish a conference connection using the 6-port conference circuit. Up to five conferees plus the attendant may be included.

Attendant Control of Facilities (ACOF)

Attendant control of facilities, also referred to as attendant control of trunk group access, allows the attendant to restrict dial access of all stations to tie lines, FX lines, and ***wide area telephone service (WATS)*** by dialing a particular code or operating special keys. When control is activated, calls to these facilities may be routed to the attendant for subsequent completion, to recorded announcement, or to tone. When dial control is used, a lamp on the attendant console can be provided to give a visual indication of control activation.

Attendant Hold

Attendant hold allows the attendant to put any call in progress on hold by operating a momentary key for the purpose of supervising the call throughout its duration and at the same time releasing the attendant from the loop.

Attendant Joint Holding of Station

Attendant may hold a party busy and be connected to it even though the party might be on-hook.

Attendant Position (Console)

A centrex customer may use either single or multiple 1B- or 2B-type attendant consoles to answer and complete centrex group calls requiring assistance. A console is the standard attendant's position for all centrex service.

Attendant Restriction

See Miscellaneous Trunk Restriction.

Attendant Thru-Dialing

Attendant thru-dialing allows the attendant to dial a trunk access code, receive second dial tone, and pass this second dial tone to the SOURCE party (a centrex extension), thereby allowing this SOURCE party to complete dialing.

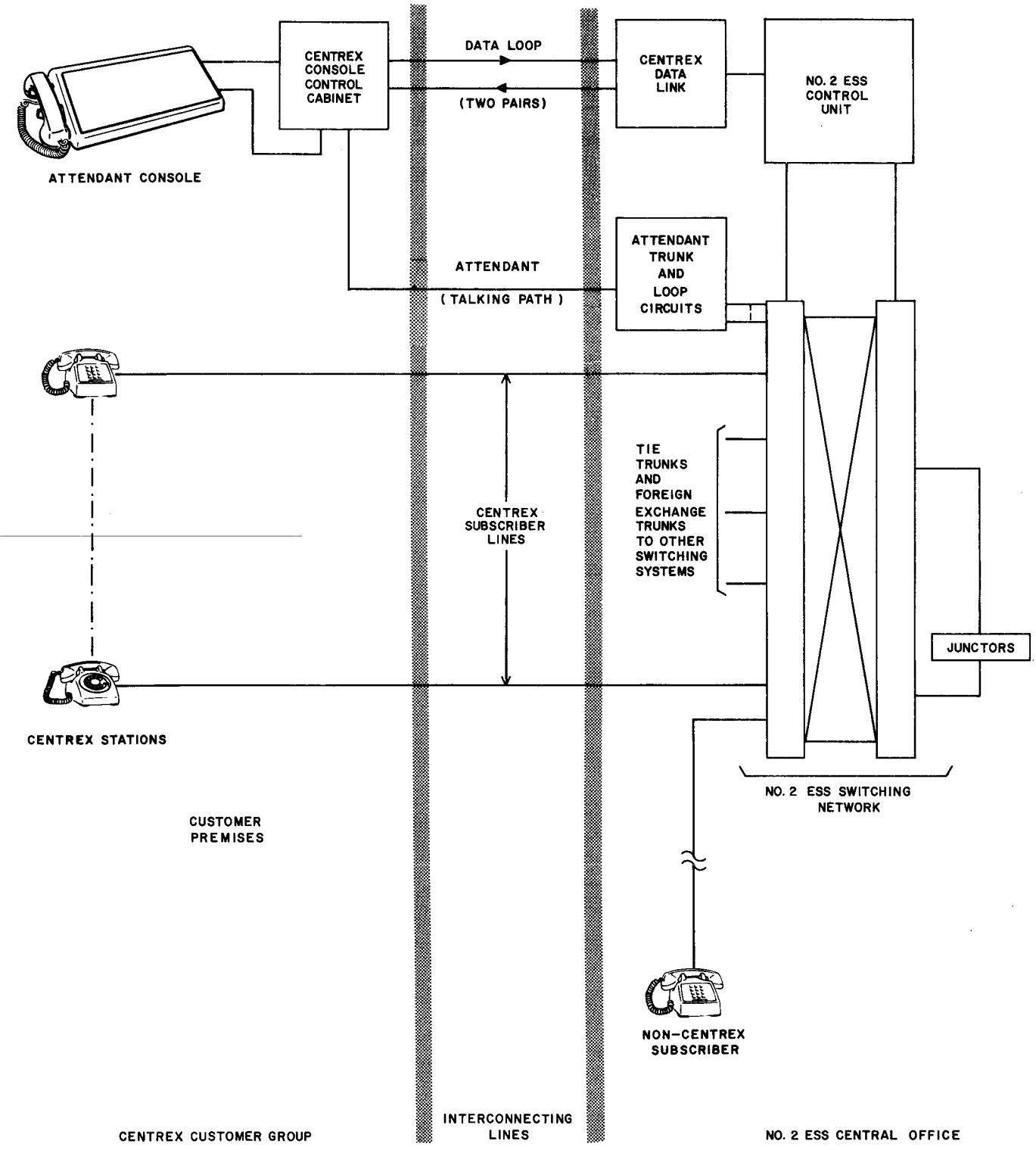


Fig. 1—No. 2 ESS Centrex System

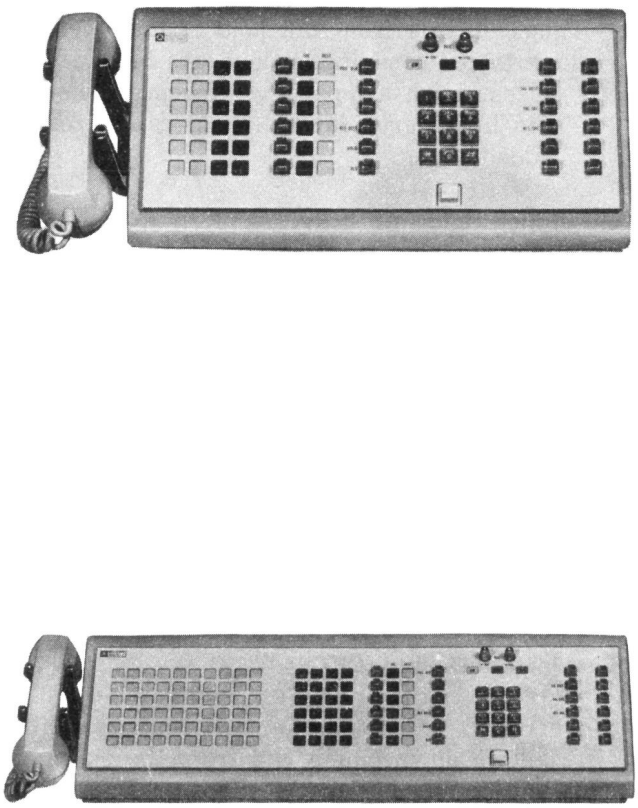


Fig. 2—Attendant Consoles

Busy Verification of Lines

Busy verification of lines allows the attendant to verify the busy or idle state of centrex lines and to break in on the conversation. When the attendant is connected to a busy line, tones are applied periodically to the line to alert the talking parties to the presence of the attendant.

Call Forwarding

When activated by a centrex extension or an attendant, call forwarding automatically routes calls intended for that station line to any other station line selected within the same centrex system.

Call Forwarding—Busy Line

Call forwarding—busy line automatically routes incoming DID or CCSA calls to the attendant or a preselected centrex station when the called party is busy.

Call Forwarding—Don't Answer

Call forwarding—don't answer automatically routes incoming DID or CCSA calls to the attendant when the called party remains unanswered after a time interval specified by the customer. (The exact time is an option varying between 11 and 58 seconds for each centrex group.)

Call Forwarding—Don't Answer—All Calls

Similar to call forwarding-don't answer but works for all calls.

Call Hold

Call hold allows a centrex extension to hold any call in progress by flashing the switchhook and then dialing a call hold code, thus freeing the same line for originating another call, answering an attendant camp-on call, or returning to a previously held call.

Call Pickup

Call pickup allows a centrex extension to answer any calls directed to another centrex extension within a specified preset pickup group. This is accomplished by dialing a special code while the called party is being rung. If more than one station line in the pickup group has an unanswered incoming call, the individual call to be answered is selected at random.

Call Transfer—Attendant

Call transfer—attendant allows the called centrex extension, to transfer an incoming call (DID, CCSA, or certain tie trunks) to the attendant by flashing the switchhook. The attendant may then transfer the call to a third party. Certain stations with custom calling features may receive dial tone and have to dial the attendant access code to reach the attendant.

Call Transfer—Individual

Call transfer-individual allows a centrex extension to transfer an incoming call (DID, CCSA, or certain tie trunks) to another party without attendant assistance. This feature is related to add-on. The centrex extension effecting the transfer may disconnect either during the ringing or after the added-on party has answered and verified completion of the transfer.

Call Transfer—Individual—All Calls

Call transfer—individual—all calls allows a centrex extension to transfer any established call to another party without the assistance of the attendant. This feature is related to Threeway Calling. The centrex extension effecting the transfer may disconnect either during ringing or after the added-on party has answered and verified completion of the transfer.

Code Calling

Code calling allows attendants and centrex extensions to dial an access code and a called party code to activate signaling devices (bells, gongs, horns, etc) with a coded signal corresponding to the called code. The called party can then be connected to the calling party by dialing an answering code from any nonrestricted station within the centrex system.

Code Restriction

Code restriction is a feature that denies selected centrex extension completion of dialed outgoing change network calls to selected office and area codes. The restricted calls are transferred to an announcement, or to a tone. Similar to Toll Restriction.

Common Control Switching Arrangement (CCSA) Access

CCSA service is a method of interconnecting various business locations of a large customer by means of a unique switching arrangement and dedicated facilities. This service provides for access to and from this private network.

Consultation Hold

Consultation hold allows a station user to hold an incoming call (DID, CCSA, or certain tie trunks) and originate a call to another party for private consultation. Consultation hold differs from call hold in that the held party for consultation hold can be added on to establish a 3-party conference, whereas the held party for call hold can never be added on.

Consultation Hold—All Calls

Consultation hold—all calls permit a centrex extension to hold any existing call and originate a call to another party for private consultation.

Dial Access to Attendant

Dial access to attendant allows centrex extensions or tie trunks to reach the centrex attendant by dialing an attendant access code (usually dial 0).

Direct Inward Dialing (DID)

DID is a centrex service feature which allows an incoming call from the exchange network (not FX or WATS) to reach a specific centrex extension without attendant assistance.

Direct Outward Dialing (DOD)

Direct Outward Dialing allows a centrex extension to gain access to the exchange network without the assistance of the attendant by dialing an access code and receiving a second dial tone. The user may then proceed to dial the desired exchange network number. Access is always provided to the local central office, which must be the No. 2 ESS serving this customer group.

Directed Call Pickup

Directed call pickup enables the centrex extension (from any unrestricted station within the centrex system) to answer calls directed to a specific station line in the centrex system by dialing a unique answer code of the party to be answered.

Flexible Numbering of Stations

Flexible numbering of centrex extensions allows station numbers to be assigned at the time of installation in accordance with a customer desired numbering plan.

Foreign Exchange Trunk Access (FX)

FX trunks enable a centrex customer to receive and originate calls from a central office other than the one from which the centrex is served. FX trunks connect to the switching network of the No. 2 ESS central office and terminate as a line in the distant central office. When seized at the far end, the trunk is automatically connected to the centrex customer group attendant or to a specified centrex extension. On outgoing calls, dial access is provided on a dialing code basis for each group of FX trunks.

Identified Outward Dialing (IOD)

IOD is a centrex service feature that provides either automatic or operator identification of the centrex extension to permit individual station billing on toll calls.

Incoming Call Identification

Incoming call identification allows the attendant to identify visually the type of incoming calls being received (LDN, 0, intercept, conference, etc) by means of call indicator lamps on the console.

Indication of Camp-On

This feature, which is always provided with attendant camp-on (except under special cases such as data stations), provides an audible burst of tone to the busy called party connection to indicate that the incoming call is camped on. Subsequent bursts of tone are applied each time the attendant leaves the waiting connection after reverifying the caller's desire to wait. This feature can interrupt data set transmission. Centrex extensions expecting to use data facilities can be restricted from having this feature.

Listed Directory Number (LDN) Service

Listed directory number service provides incoming exchange network calls to be placed to the attendant(s) via the assigned listed local telephone directory number. Any given centrex customer may have one or more listed directory numbers.

Manual Line Service

Manual line service provides centrex extensions that are arranged to alert the attendant (or predefined centrex extensions) when the centrex extension goes off-hook for service. Dial tone is not provided to these lines and all originating connections are made by the attendant (or predefined centrex extensions). Terminating connections to such lines may be dialed directly.

Miscellaneous Trunk Restriction

Miscellaneous Trunk Restriction denies either attendants and/or centrex extensions and/or incoming tie trunks the ability to use certain access codes to gain access to the following:

- attendant (dial 0)
- local exchange
- tie trunks
- FX trunks
- CCSA trunks
- WATS
- most economical routing
- recorded telephone dictation
- paging
- code call
- code call pickup
- trunk answer from any station
- trunk flash request

Most Economical Routing (MER)

Most economical routing allows the switching machine to select the most economical route when the centrex extension dials a most economical routing access code prior to dialing a toll call. MER calls are allowed to select various WATS bands, FX facilities, CCSA trunks, or local exchange network.

Night Service and Power Failure Transfer—Attendant

Night service is implemented at the attendant's console by operation of the "NITE" key on the console. Only one "NITE" key is provided for any one customer group. Night service is canceled by a second operation of the "NITE" key. When night service is in effect, all calls to the listed directory number are routed to a preselected station. All other calls, including direct inward dialing calls, are handled in the normal manner. The night station may have the station hunting or call forward features, which would allow incoming night calls to be redirected to still another station. A centrex customer with multiple listed directory numbers may have multiple night service numbers (or a single number as desired). Also, a centrex customer may have a separate night service number for dial 0 calls (separate from LDN night service numbers). Finally, some centrex customers may have no night stations. Incoming LDN calls, while night service is in effect for one of these customers, receive reorder.

When night service is in effect, certain calls that are routed to night stations may be transferred to other centrex stations by means of the trunk-answer-from-any-station feature.

Power failure transfer is a feature which allows calls to the attendant during a power failure condition to be routed to the preassigned night station(s).

Pad Switching

Pad switching allows for switching transmission pads in or out of centrex tie trunks on calls involving VNL facilities.

Paging, Loudspeaker

Paging permits attendants and station users of centrex tie trunks to have dial access to customer-owned loudspeaker paging equipment for the purpose of voice paging.

Paging, Radio

Radio paging allows attendants and centrex extensions to dial customer-owned radio paging equipment to selectively alert by tone or page by voice individuals carrying pocket radio receivers. Optional arrangements may be provided whereby the paged party may be connected to the calling party by dialing an answering code from any station within the PBX or centrex system.

Recorded Telephone Dictation

Recorded telephone dictation permits access to and control of customer-owned dictating equipment by centrex extensions within the centrex system.

Reserve Power

Reserve power provides an alternate, independent source of power to maintain attendant telecommunications service for a limited time during a power failure at the customer location. This feature is always provided with centrex service.

Restriction From Outgoing Calls

(See Miscellaneous Trunk Restriction.)

Simulated Facilities Group

A simulated facilities group is a software device used to restrict certain services sold on a limited access basis. The simulated facilities group simulates physical hardware facilities and is assigned on a per customer basis. The quantity of facilities purchased is stored in memory and used to identify and control the number of calls for a given service of a particular customer at a given time. This feature is currently used for WATS service, local exchange access (Dial 9) and LDN service.

Speed Calling

Speed calling allows centrex extensions and attendants to the station to dial the selected numbers using fewer digits than normally required. This feature is offered on a per station basis. On an optional basis, centrex extensions and attendants can directly change the contents of a speed call list by dialing special codes. Also, certain speed call lists can be shared among centrex extensions or among centrex extensions and attendants.

Station Hunting (Series Completion)

Station hunting provides for automatically redirecting a call to a preselected station within the centrex system when the called centrex extension is busy. In the No. 2 ESS, the number of lines busy tested is limited to 12 for any call.

Station-to-Station Calling

Station-to-station calling allows the centrex extension to dial directly other stations within the same centrex system (customer group) without the assistance of the attendant by dialing a predetermined number of digits (2, 3, 4, or 5).

Switched Loop Operation

Switched loop operation is an attendant position feature whereby calls requiring attendant assistance are automatically switched to one of six loops appearing as keys on an available console attendant position. When the attendant's work on the call is completed, the call may be released from the loop.

Tandem Tie Trunk

A tie trunk group is defined in the No. 2 ESS as a tandem tie trunk group when calls may be switched ***beyond*** the ***next*** switching point. Otherwise it should not be defined as a tandem tie group.

Tandem Tie Trunk Dialing

Tandem Tie Trunk Dialing is a method of allowing centrex extension to dial over private tie trunk facilities which may be switched through several additional switching points, under control of the originating party.

Threeway Calling

Threeway Calling allows a centrex extension to add another party to an established connection. Any line with this feature has both consultation hold—all calls, and call transfer—individual—all calls. The ability to hold one party with privacy exclusion while dialing and talking to another party and the ability to add the third party in a 3-way connection are combined in the Threeway Calling function.

Thru Dialing

Thru dialing allows the attendant to dial a trunk access code, receive second dial tone, and pass this second dial tone to the SOURCE party (a centrex extension), thereby allowing this SOURCE party to complete dialing.

Tie Trunk Access

Tie trunks provide one or more 1- or 2-way circuits interconnecting two centrex or PBX systems. Tie trunks can be either automatic or dial repeating and may be dial-selected by centrex extension or the attendant.

Timed Reminders

Timed reminders provide a method for automatically alerting the attendant, after a prescribed time interval, to a camped-on or an unanswered call completed through the attendant console; timed reminders give the attendant a reminder to provide the calling party with a progress report.

Toll Restriction

Toll restriction permits centrex extensions to access the local central office and dial local service area calls, but prevents completion of toll calls or calls to the toll operator without the assistance of the attendant.

TOUCH-TONE Calling

TOUCH-TONE calling offers greater speed and convenience in dialing through the use

of pushbuttons instead of a rotary dial to transmit digits via audible tones to the switching equipment. Some or all of the centrex extensions may be equipped with TOUCH-TONE pads. The attendant positions are always equipped with TOUCH-TONE pads.

Trunk Answer From Any Station

Trunk answer from any centrex station allows incoming calls normally directed to the attendant to activate a common alerting signal on the customer's premises (associated with the night station) when the attendant positions are in night service. These calls may then be answered by any unrestricted station user in the centrex system who dials a special trunk answer code.

Trunk Group Busy Lamps

Trunk group busy lamps provide the attendant at a console position with a visual indication when all trunks in a group are busy. The outgoing or 2-way trunk groups that may be equipped with this feature on a selective basis are FX, tie lines, CCSA, and WATS. In addition, trunk group busy lamps may apply to 6-port conference circuits, paging trunks, code call trunks, and recorded telephone dictation trunks. Simulated trunk groups may also be associated with TGB lamps.

Two-Way Splitting

Two-way splitting allows the attendant to consult privately with either party on a call completed through the attendant position.

Wide Area Telephone Service (WATS) Access

WATS access allows centrex extensions the ability to place calls over extensive geographical areas at a flat monthly rate.

Outward WATS Service

Outward WATS service is a direct distance dialing service whereby a customer has the ability to make calls to specified bonds with a special tariff based on a unlimited or limited usage.

CENTREX STATION RESTRICTIONS

2.03 Various restrictions may be assigned as options to centrex stations or trunks. These restrictions are as follows.

Centrex Access Treatment (CAT) Code Restrictions

2.04 A centrex access treatment code allows or denies each centrex station the use of certain services, such as the following:

- access to tie lines
- FX lines
- local CO access (dial 9)
- attendant access (dial 0)
- dial dictation
- paging equipment
- WATS

Unrestricted

2.05 An unrestricted centrex station may originate calls to intragroup stations, tie lines, FX lines, local central office access, and the attendant. However, these stations may be limited through the use of toll restriction or through the use of centrex access treatment (CAT) code restrictions. In addition, an unrestricted centrex station may receive all types of calls.

Fully Restricted Terminating (Inward Restricted)

2.06 A fully restricted terminating centrex extension is only allowed to receive calls from other centrex extensions (not DID, attendant, nor incoming tie trunk calls, for example). A fully restricted terminating centrex extension is not necessarily limited in its use of originating service. This station is limited by the toll restriction feature and by the CAT code.

Fully Restricted

2.07 A fully restricted centrex extension is the same as a fully restricted terminating extension in that neither can receive any calls except extension to extension. In addition, a fully restricted station

cannot place any calls except extension to extension. This is accomplished by assigning a CAT code that prevents access to local CO (dial 9), attendant (dial 0), and any other applicable trunk access codes.

Denied Origination

2.08 Denied origination prohibits a centrex extension from originating calls of any kind.

Denied Terminating

2.09 A denied terminating centrex extension is not allowed to receive calls. All calls to this station are routed to tone or recorded announcement.

Manual

2.10 Calls originating from manual centrex extensions and FX lines, are routed to the attendant or to a specified extension for handling.

CENTREX ATTENDANT CONSOLE DESCRIPTION

2.11 Attendants are normally provided with a 1B- or a 2B-type universal cordless telephone console (Fig. 2).

2.12 Each console is equipped with a number of lamps and keys, a TOUCH-TONE key set, and an audible signal. The lamps and the audible signal indicate service requests or supervisory signals needed for the attendant to serve the centrex installation. The keys depressed indicate requests by the attendant for actions at the central office. For method of attendant console operations, reference should be made to Section 540-576-302—Centrex Station Equipment and Attendant Equipment, 1B- and 2B-Type Attendant Consoles with Switched Loop Operation, Method of Operation.

2.13 No switching occurs at the centrex premises as a result of operating keys on the attendant console. Depressing these keys causes a data message to be encoded and transmitted via a data loop circuit to the No. 2 ESS office to which the centrex customer group is connected. At the No. 2 ESS office this data message is interpreted and any necessary switching actions are performed.

A. Console Lamps and Audible Signal

2.14 The console lamps and the audible signal indicate service requests or supervisory states of loops and trunks to the attendant. Some lamps have an appearance on a single console in a customer group and others appear on all consoles in the group. The audible signal is controlled in the same manner as the lamps.

The states in which the lamps may appear are as follows:

- DARK—Lamp continuously off
- STEADY—Lamp continuously on
- WINK—Lamp on 1.75 seconds and then off 0.25 seconds
- 60 ipm (interruptions per minute)—Lamp flashes once per second
- 120 ipm—Lamp flashes twice per second.

2.15 Some lamps may appear in one of several states while others may only appear in either the steady or the dark (inactive) state.

2.16 The audible signal is sounded whenever a new call is switched to the console or whenever a party on the established call recalls the attendant.

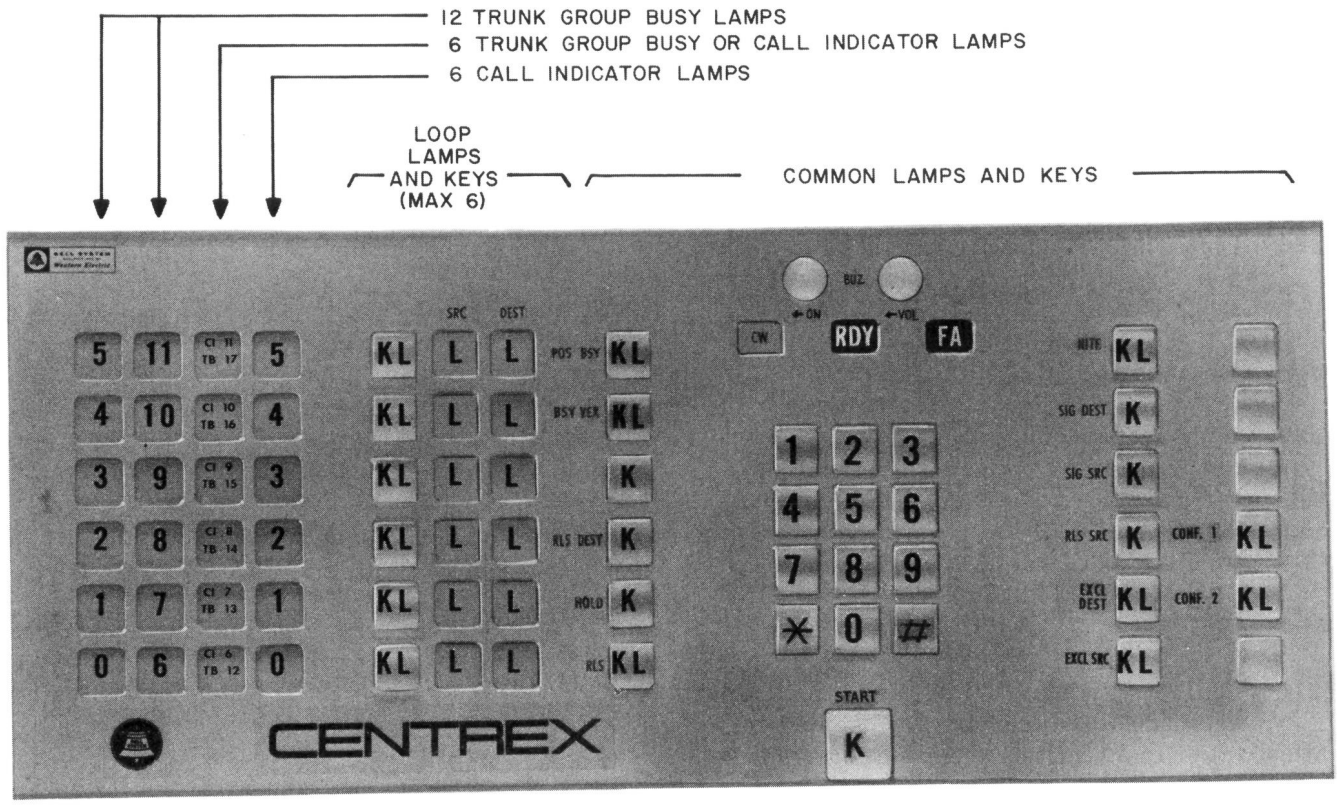
B. Console Keys

2.17 Console keys, when depessed by an attendant, indicate requests for specific actions at the central office.

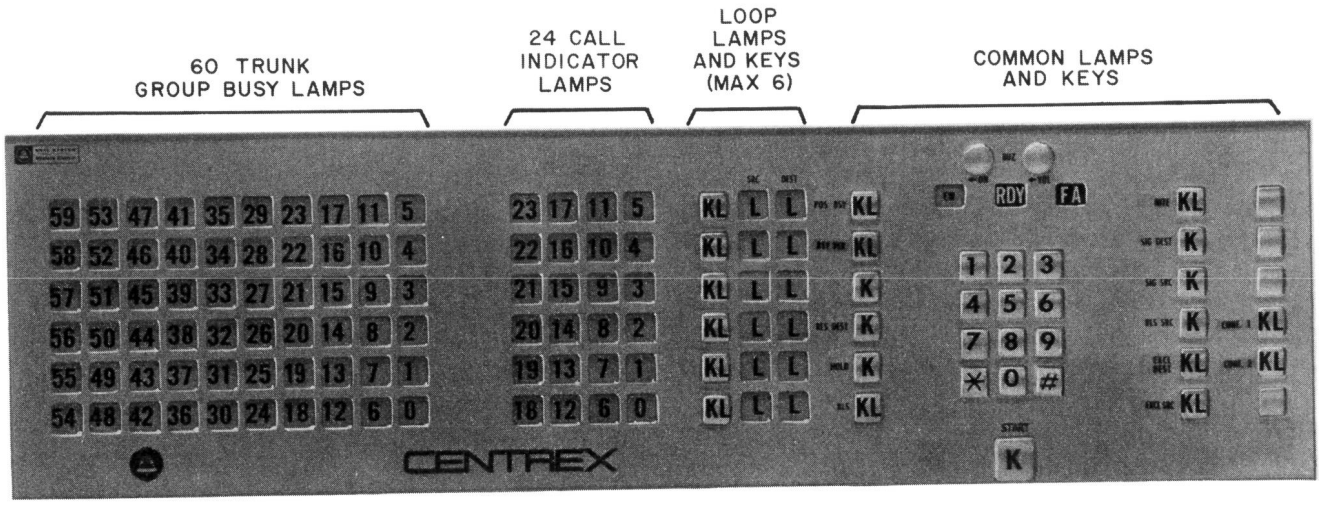
2.18 Console keys may be described in three basic functional groups.

(a) ***Loop keys (lighted keys):*** Loop keys affect the attendant's relation to the loop circuits. For example, they provide access to a calling or called party already on an attendant loop position.

(b) ***State keys:*** The state keys affect the overall state of the console by initiating the night-service condition, by causing a console to appear busy, etc.



1B TYPE ATTENDANT CONSOLE



2B TYPE ATTENDANT CONSOLE

K–KEY
L–LAMP
KL–KEY AND LAMP COMBINATION

Fig. 3—Attendant Console Lamp and Key Arrangements

(c) ***Call processing keys:*** The call processing keys are used in normal call processing functions such as requests for dial tone in order for an attendant to dial.

C. Console Lamp and Key Arrangement

2.19 Fig. 3 illustrates the physical arrangement of the lamps and keys on a (1B27G and 2B38G attendant) console. The lamps and keys are arranged into four groups: the loop lamps and keys, the common lamps and keys, the optional trunk group busy lamps, and the optional call indicator lamps.

Loop Lamp and Key Functions

2.20 The loop lamps indicate to the attendant the state of a call on a console which is presently associated with the particular loops. This group contains the key lamps (lighted keys), the source lamps, and the destination lamps.

2.21 ***Loop Keys:*** The loop keys, when momentarily operated, cause the attendant circuit to be connected to the loop indicated and thus to the call, if any, on that loop circuit. If the attendant is already connected to the loop, operation of the loop key may be used to remove an exclude condition on the loop (see 2.29 and 2.30).

2.22 ***Key Lamps:*** The key lamps, contained within the loop keys, indicate how an attendant is presently associated with calls. These lamps may be operated to either of two active states. When a key lamp is in the steady state, the attendant is connected to that particular loop. When a key lamp is in the wink state, this indicates to the attendant that a call is being held on this loop but the attendant is not connected.

2.23 ***Source (SRC) Lamps:*** The SRC lamps indicate the status of the calling party. These lamps may be operated to one of four active states: steady, wink, 60 ipm, and 120 ipm. Each of these states is interpreted by an attendant as a service request or as a supervisory state of the calling party.

2.24 ***Destination (DEST) Lamps:*** The DEST lamps indicate the status of the called party. These lamps may also be operated to one of four active states.

Common Lamp and Key Functions

2.25 The common keys are used in call processing functions common to all calls. The common lamps indicate the overall state of the console to the attendant and provide supervisory information common to all calls.

2.26 ***Audible Signal:*** The audible signal is also a part of the common lamp and key group. It is sounded whenever a new call is switched to the console or whenever a party on an established call recalls the attendant. The buzzer-on (BUZ ON) key controls the operation of this signal, and the buzzer volume (BUZ VOL) control adjusts its volume.

2.27 ***Busy Verification (BSY VER) Key:*** The busy verification feature allows the attendant to connect to any busy station to verify whether it is actually busy. Another party cannot be connected to the busy connection. When the attendant interrupts a busy call, the talking parties are alerted to the attendant's presence by an interrupted 440-cycle tone.

2.28 ***Calls Waiting (CW) Lamp:*** The CW lamp lights to inform the attendant that one or more calls are waiting to be answered when the console becomes available for another call. The CW lamp is multipled to all consoles in the customer group.

2.29 ***Conference (CONF 1 and 2) Key:*** The CONF keys are used to seize a 6-port conference bridge. The attendant must have a party on the SOURCE port of the currently active attendant loop in order to seize this bridge. When the conference bridge is seized, the party on the SOURCE port is moved to port 1 of the bridge, and the SOURCE port is connected to the controlling port (port 0) of the conference bridge. Subsequently, the attendant may dial additional conferees which appear on the DESTINATION port of the attendant loop. When the attendant operates the CONF key, the party on the DESTINATION port will then be moved to the next available port on the conference bridge. A maximum of five conferees plus the attendant is allowed.

2.30 ***Exclude Destination (EXCL DEST) Key:*** The EXCL DEST key is used to implement the 2-way splitting feature described in 2.02 under centrex service features. When momentarily

operated, this key causes the connection to be split and enables the attendant to talk with only the source party. The lamp within this key is lighted when this feature is in effect. The exclude can be removed by operating the loop key.

2.31 ***Exclude Source (EXCL SRC) Key:*** The EXCL SRC key is also used to implement the 2-way splitting feature. When momentarily operated, this key causes the connection to be split and enables the attendant to talk with only the destination party. The lamp within this key is lighted when this feature is in effect. The exclude can be removed by operating the loop key.

2.32 ***Fuse Alarm (FA) Lamp:*** The FA lamp is not used with the No. 2 ESS centrex service.

2.33 ***Hold (HOLD) Key:*** The HOLD key, when momentarily operated, releases the attendant from the loop but holds the call on the console. To make the console available for new calls, the attendant must follow the operation of the HOLD key with the operation of the RLS key. The attendant may be reconnected to a held loop by again operating the loop key.

2.34 ***Night (NITE) Key:*** The NITE key activates the night operation feature as described in 2.02. Only one NITE key is provided per customer group and this is located on the "primary" attendant console. The operation of the NITE key will not affect the handling of direct inward dialing calls or calls already waiting in the attendant queue.

2.35 ***Position Busy (POS BSY) Key:*** When the POS BSY key is operated on the console, the console appears busy to all new incoming calls. Its operation, however, does not prevent the attendant from completing calls already on the console or from making outgoing calls. Unplugging the attendant headset from the console also makes a console appear busy to new calls and removes power from the console.

2.36 ***Ready (RDY) Lamp:*** The RDY lamp is not used with the No. 2 ESS centrex service.

2.37 ***Release (RLS) Key:*** When the RLS key is momentarily operated, it releases the attendant from the loop to which the attendant has been connected. The lamp within this key is lighted when the console is ready to receive a new incoming call.

2.38 ***Release Destination (RLS DEST) Key:*** The RLS DEST key is used to clear the equipment on the destination side of a connection. The occasion may be a keying error made by the attendant, the need to release a centrex extension on a request to transfer a call, or the need to release an extension-busy signal.

2.39 ***Release Source (RLS SRC) Key:*** The RLS SRC key is used to clear the equipment on the source side of the connection when, for example, a calling party fails to disconnect or when an attendant wishes to clear troubles on the source side.

2.40 ***Signal Destination (SIG DEST) Key:*** The SIG DEST key provides the attendant with signaling facilities which can signal the party on the destination side of the connection. This signal is a flash to recall a central office operator.

2.41 ***Signal Source (SIG SRC) Key:*** The SIG SRC key enables the attendant to signal the party on the source side of a connection. The signal may be either a flash for signaling a central office operator or may be regular ringing current for station telephones.

2.42 ***Start (START) Key:*** The START key is used to request dial tone for the attendant in order for the attendant to key (dial) a number.

2.43 ***TOUCH-TONE Key Set:*** The keys of the TOUCH-TONE key set are for keying the digits of the called number.

Trunk Group Busy Lamps

2.44 Trunk group busy lamps are available as an optional feature. They indicate whether or not all trunks in a particular trunk group assigned to a centrex customer are busy. These lamps are multipled to all consoles in the customer group. Fig. 3 illustrates the number and the placement of these lamps on the consoles. (See 4.09.)

Call Indicator Lamps

2.45 The call indicator lamps are available as an optional feature. They may be assigned to indicate either the type of call (listed directory number, dial 0, recall, etc) or its source (such as a particular tie trunk). When a call is routed to a console equipped with call indicator lamps, a

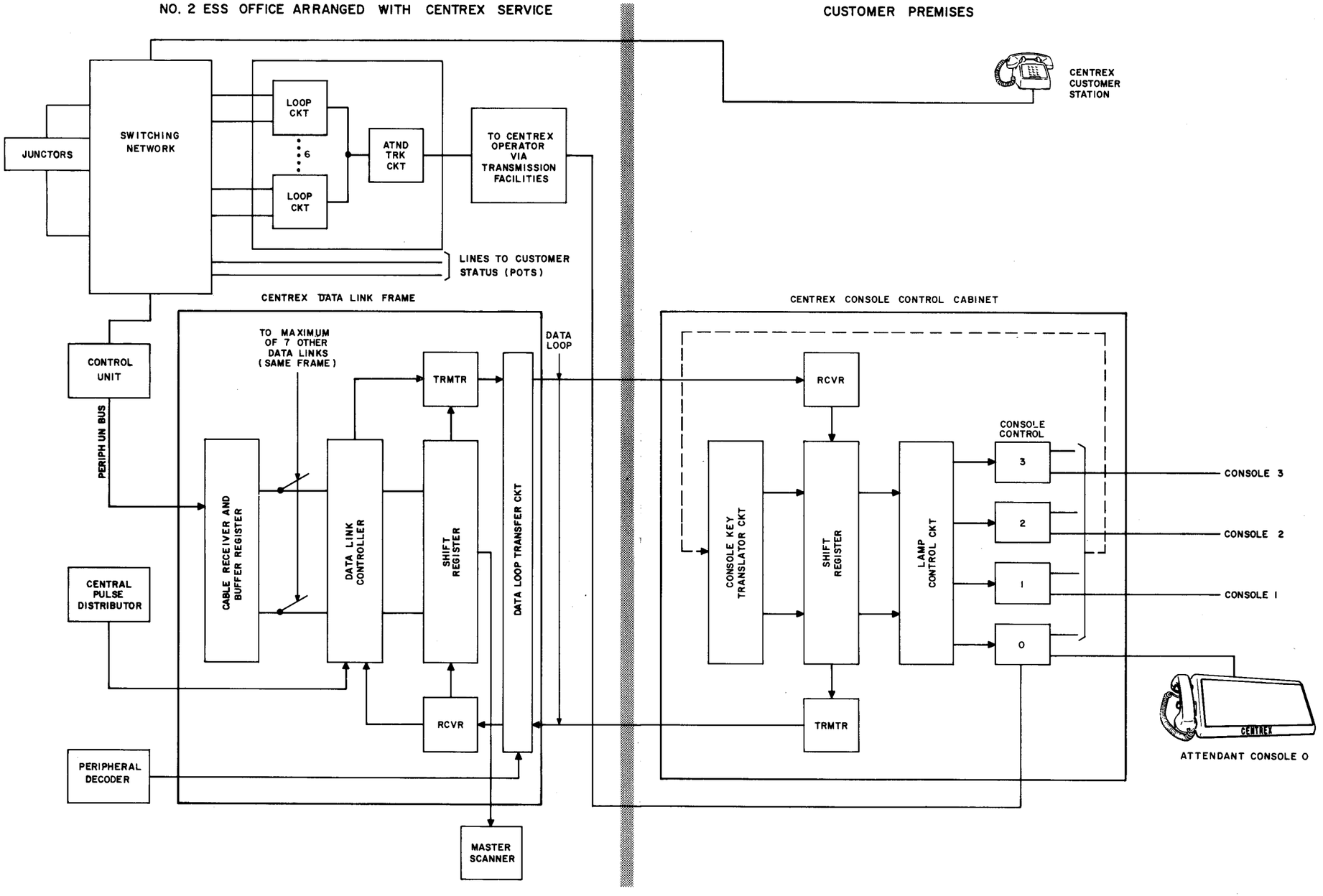


Fig. 4—Centrex Service—Block Diagram

single lamp in the call indicator lamp field lights. This indication remains on the console as long as the attendant is connected to the loop. Fig. 3 illustrates the number and the placement of these lamps on the consoles.

3. SYSTEM ORGANIZATION AND OPERATION

3.01 Fig. 4 is a block diagram of a centrex system equipped with an attendant console. The data loop used for the transmission of key signals and lamp data is shown.

3.02 Centrex operation is under control of the control unit in a No. 2 ESS central office. Portions of the existing call store and program store are assigned for the use of each customer group. Scan points, peripheral decoder points, duplicated central pulse distributor points, and connections to the duplicated peripheral buses are supplied for centrex operation.

3.03 A centrex data link frame, which provides the interface between the central office and the data loop, is located in a No. 2 ESS central office. One data link unit is used in conjunction with each data loop. Up to eight data links and one data link controller are mounted in each frame. Each data link contains a key signal receiver circuit, a lamp data transmitter circuit, and connections to the common control equipment.

3.04 The data link controller appears as a peripheral unit on the system peripheral unit bus. The main function of this controller is to receive data messages from the control unit and to steer them to the proper data link.

3.05 A centrex console control cabinet is located at the customer premises. This cabinet provides the interface between the consoles and the data loop. In Fig. 4, connections are shown to only one attendant console; however, up to four 1B- or four 2B-type consoles may be controlled by one console control cabinet as described in 4.09. Each console control cabinet can accommodate a maximum of four console control units. A console control unit is required for each attendant console. In addition to the console control units, each console control cabinet contains a transmitter, a receiver, a lamp control circuit, and a power supply, all of which are common to all consoles connected to the console control cabinet.

CENTREX DATA LOOP DESCRIPTION AND OPERATIONS

3.06 The centrex data loop is a peripheral unit that provides 2-way data communications between a No. 2 ESS central office and the remotely located attendant consoles. A data loop consists of two separate 2-wire unidirectional data links. These data links are interconnected at the central office end and at the remote centrex end by means of transmitting and receiving circuitry in such a way that the two links form a complete loop.

3.07 The No. 2 ESS transmits attendant console lamp state changes via the data link to the remote centrex location and receives key signals from the attendant via the data link. These key signals are interpreted as requests for specific actions concerning calls that are associated with the console.

3.08 Data is transmitted serially in the form of a 26-bit word which contains 24 information bits plus 2 additional bits. The two additional bits are used as leading control bits to start a shift register at the customer end of the data loop. This register temporarily stores the data message when lamp data is being transmitted to the consoles. When key signal data has been transmitted to the ESS central office, these two additional bits are absorbed and are not used.

3.09 A 26-bit shift register is located at both the No. 2 ESS central office end and the remote centrex end of the data loop to receive and temporarily store data. Fig. 4 illustrates the data shift registers and their connections to the transmit and receive circuitry at both the central office end and at the remote end of a data loop.

3.10 The data shift register located at the central office end of a data loop accepts the 24 bits of data from the peripheral unit bus and temporarily stores it before it is transmitted as lamp data to the remote centrex end of the data loop. In addition, this register is also used to receive and temporarily store key signal data originating from the remote end. The control unit at the central office can read out the contents of this register via scan points when key signal data is received.

3.11 The data shift register located at the remote end accepts and temporarily stores 24 bits of data originating from keys being depressed on the consoles. This data is transmitted as key signal

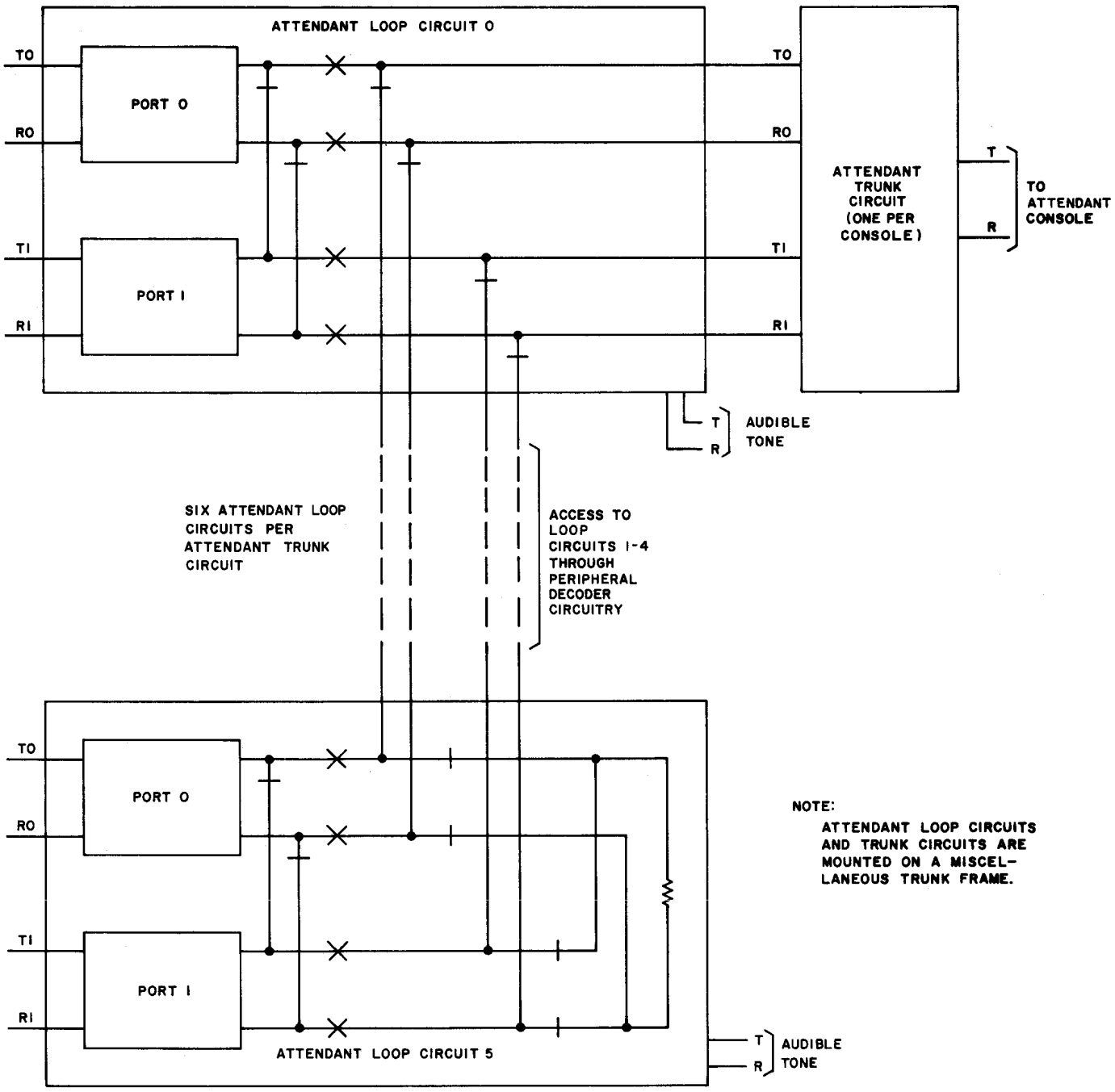


Fig. 5—Attendant Trunk and Loop Circuits

data to the central office end of the data loop. In addition, this register receives and temporarily stores the lamp data transmitted from the central office end of the data loop. This data is used for controlling the console lamps.

3.12 Transmission on the data loop is controlled by the circuitry located in the central office; however, a request to transmit the contents of a register may be initiated by either the control unit at the central office or by the attendant console circuitry at the centrex premises. When either the control unit or the console requests to transmit a data word, the two data registers interchange their contents simultaneously. Normally only one of these registers contains a valid word when a data transmission occurs. Since the two registers always interchange their contents simultaneously, a dummy word is usually transmitted in one direction. Data is transmitted serially at a rate of 1400 bits per second. Voice frequencies are used for transmission of data and no special line equalization is necessary.

A. Lamp Data Transmission

3.13 Service requests and other supervisory signals are sent as lamp data from the No. 2 ESS central office to the remote centrex location by means of the data loop. Lamp data is sent from the control unit over the peripheral bus to the common control equipment in a centrex data link frame. The common control equipment selects the proper lamp data transmitter, which is enabled by the central pulse distributor. From here, the data is loaded into a register and transmitted serially as binary coded signals by means of the data link to the data receiver at the centrex customer location. The lamp control circuit decodes the message and stores it in a lamp state memory unit. The lamp state memory then operates the selected console lamps to the desired state.

B. Lamp State Memory

3.14 A bipolar ferreed is associated with each active lamp state. These ferreeds are mounted in 241C, 1 by 8 switches. Ten of these comprise a lamp state memory in which the active lamp states of an attendant console are stored. One lamp state memory is provided for each console. The operation of a ferreed in a lamp state memory actuates the corresponding active state by connecting the selected lamp either to ground for steady or to a lamp interrupter for wink, 60 ipm, or 120 ipm. Three additional 241C, 1 by 8 switches are used as a separate lamp state memory for the optional call indicator lamps.

C. Lamp State Changes

3.15 Each change of a lamp state on a console requires the complete updating of the whole lamp group of which the lamp is a part. This is accomplished by the transmission of 24-bit word. During the updating operation, all ferreeds in the selected group are released, thus erasing the previous lamp states. For each active bit in the lamp state code of the new word received, the corresponding ferreed in the selected lamp group is operated. An all zero code in a particular lamp code position causes that lamp to be extinguished when the code word is received at the remote centrex installation.

D. Trunk Group Busy Lamp Memory

3.16 A trunk group busy memory unit is provided for each customer group equipped with the 2B-type consoles. This is required to provide additional memory capacity for the trunk group busy lamps available on these consoles. Since each 2B-type console can provide memory for 12 trunk group busy lamps, and the optional trunk group busy lamp memory unit in the console control cabinet can provide memory for an additional 24 trunk group busy lamps, the following shows the memory capacity available with the 2B-type consoles:

- One 2B console—36 trunk group busy lamps
- Two 2B consoles—48 trunk group busy lamps
- Three or more 2B consoles—60 trunk group busy lamps.

E. Key Signal Transmission

3.17 Key signals originating from an attendant console are encoded by an associated key translator located in the centrex console control cabinet at the customer premises (Fig. 4). From here they are transmitted in serial form as binary coded signals to the No. 2 ESS central office where they are received by a key signal receiver. The key signal receiver temporarily stores this data in a data shift register. The contents of the register

are read out via scan points by the attendant monitor program at base level.

F. Attendant Monitor Program

3.18 The attendant monitor program periodically tests the central data units at the No. 2 ESS central office for the presence of key signals received from the remote attendant consoles. When a key signal is detected, a key signal present scan point is energized and the appropriate action is taken. The attendant monitor program is given control once every base level scan.

3.19 Several scan points are provided to inform the system as to the state of the data link — that is, whether or not the data link is in the process of transmitting or of receiving data or whether or not there is any information loaded in the shift register waiting to be read by the control unit. These scan points must be checked before lamp data is loaded into the shift register for transmission to the remote end of the data loop.

ATTENDANT LOOP CIRCUITS

3.20 Each attendant console is equipped with six loop circuits (Fig. 5). These loop circuits give the attendant voice access to calls associated with the console. The loop circuits are located on the miscellaneous trunk frame at the No. 2 ESS office to which the customer group is connected. Each loop has two appearances on the network. When the two ports are interconnected, the loop circuit provides a talking path for the source party and the destination party. At the attendant's request the two paths may be split and connected through to the attendant trunk circuit. Here the attendant may be connected to either the calling or the called party individually, excluding the other to both, for a 3-way connection. The attendant excludes either the called or calling party from a connection by operating either the exclude destination (EXCL DEST) key or the exclude source (EXCL SRC) key.

3.21 No particular loop circuit is confined to any one source. A call from any source (station, tie line, etc) requiring attendant service may appear on any of the loop circuits on the attendant console.

3.22 All calls requiring attendant actions are handled on a switched loop basis; that is, call information is displayed on a console only as long as the attendant requires this information. The call is switched off the loop and connected directly through the network when the attendant completes work on the call.

ATTENDANT TRUNK CIRCUIT

3.23 An attendant trunk circuit (Fig. 5) is provided as a speech path for each attendant console. This circuit is basically a 3-port circuit. One port connects to the console talking pair, the other two ports connect to the loop circuit. By means of peripheral decoder circuitry, the two ports of the attendant trunk circuit are connected to only one loop circuit at a time. The two ports are used during the progress of a call for connecting the attendant to stations, trunks, etc.

3.24 ***4-Wire Attendant Trunk Circuit:*** A 4-wire attendant trunk circuit is optionally available for customer groups having long-haul tie trunks which may be used in tandem operation. The 4-wire path is used in such cases to provide improved transmission characteristics. This circuit replaces the 2-wire attendant trunk circuit shown in Fig. 5.

3.25 Each attendant trunk circuit and attendant loop circuit is equipped with scan points for supervision. The scan point associated with the attendant trunk circuit indicates whether or not the attendant's headset is plugged in. The one scan point associated with each port of each loop is to supervise a line which may be connected to that port.

3.26 The attendant may only work on one call at a time; therefore, only one attendant trunk circuit is provided per console.

CENTREX SWITCHING OPERATIONS

3.27 Fig. 6 is a block diagram illustrating the connections between centrex customer groups and a No. 2 ESS switching network. Two customer groups are shown. Both groups are shown equipped with attendant consoles, and one of these groups is also shown equipped with the optional features for recorded telephone dictation, paging, and code calling. Calls which do not require attendant services, such as direct inward dialing, direct outward dialing, and station-to-station calls, are switched directly through the network with no appearance on an attendant console. The associated data circuit is not involved with such calls.

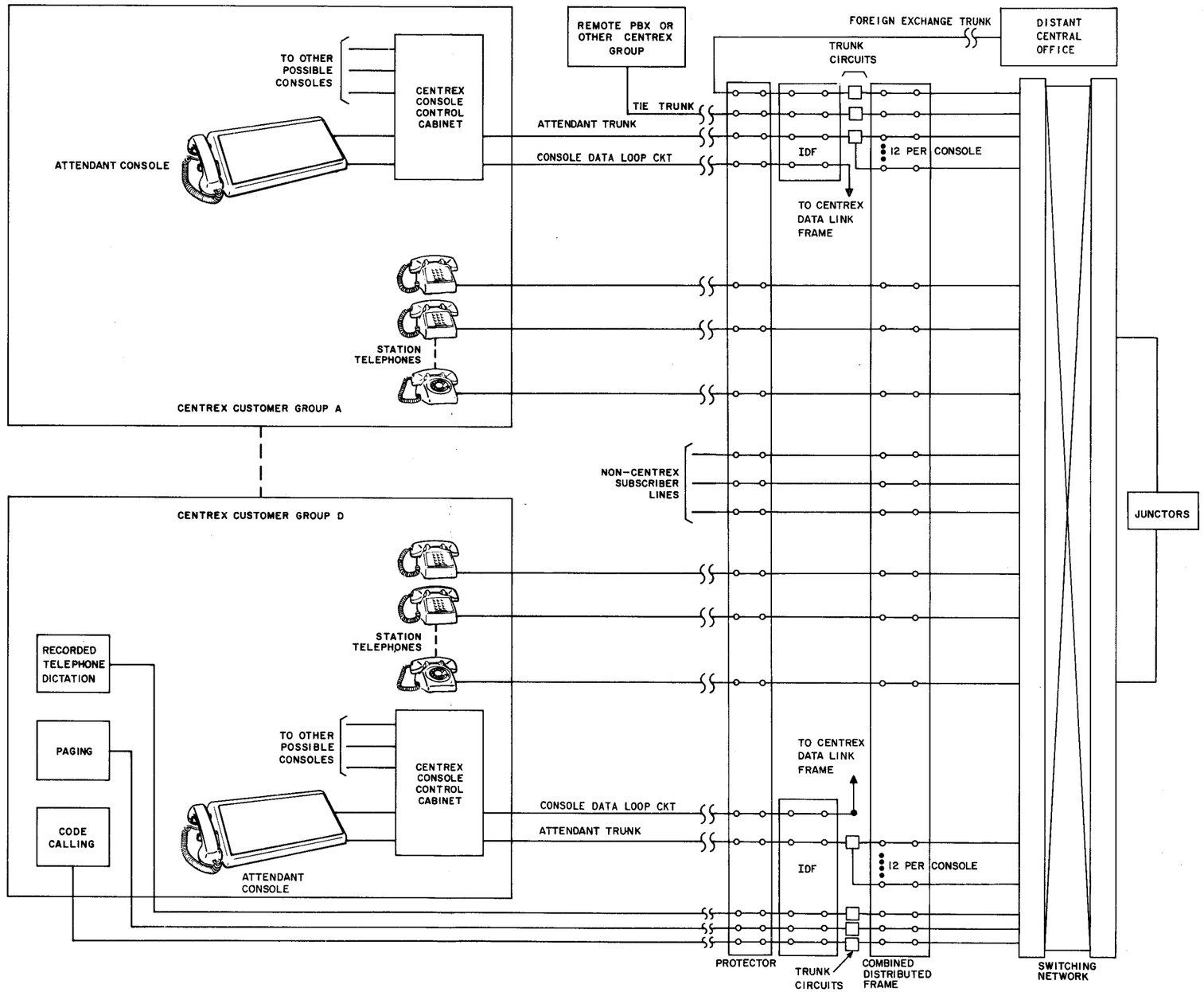


Fig. 6—Centrex Connections to a No. 2 ESS Switching Network

3.28 The attendant trunk can be seen terminating on the switching network. In reality, an attendant trunk has twelve appearances on the network via the six attendant loop circuits.

3.29 The centrex data loop circuits can be seen connecting through the distributing frames to the centrex data link frame. These circuits are not switched and have no appearance on the switching network.

CENTREX TRUNK FEATURES

3.30 Trunk circuits may be assigned for the exclusive use of any centrex customer group. These trunks are used to interconnect the centrex customer group with other switching systems.

3.31 Tie trunks are provided to interconnect a centrex customer group with other local centrex systems, dial central offices, distant and local dial or manual PBXs, etc. Foreign exchange trunks are provided to interconnect the centrex group with other central offices. Special trunk circuits are provided for the optional code calling, paging, and recorded telephone dictation features.

3.32 Since centrex customer groups may be interconnected with such a variety of switching systems, a wide variety of trunk circuits and trunk treatments are necessary.

3.33 Translation memory is used to specify the particular treatment for each trunk circuit. The controlling program directs the trunk operations through the use of this memory.

3.34 The following is a list of the various types of trunk services available for centrex use:

- Two-Way Dial
- Outgoing Dial—Incoming Manual
- Outgoing Manual—Incoming Dial
- Two-Way Manual
- Incoming Dial
- Outgoing Dial
- Incoming Manual
- Outgoing Manual.

3.35 A special trunk circuit is provided for the following optional centrex features:

- Code Calling
- Dial Paging
- Voice Paging
- Recorded Telephone Dictation.

3.36 Some additional specialized equipment is installed at the customer premises for the code calling, paging, and recorded telephone dictation features.

INTERCONNECTIONS

3.37 Each centrex data link frame is equipped with scan points, peripheral decoder points, duplicated central pulse distributor points, and connections to the duplicated peripheral unit bus.

A. Central Pulse Distributor Points

3.38 Each centrex data link frame is provided with one bipolar (duplicated) central pulse distributor point per data link. One polarity is used to gate data into the data register from the peripheral unit bus; the other causes the data link to go into the transmit mode.

B. Peripheral Decoder Points

3.39 One peripheral decoder point is assigned per data link. This point is supplied for a maintenance function. It is used to switch the data loop from a normal loop to a local loop condition in order to aid in isolating troubles in the data loop circuitry.

C. Scan Points

3.40 The data link frames share a common fuse alarm scan point with several other types of peripheral units. This scan point is interrogated at 2-second intervals. If a data link or the common equipment on a data link frame develops a power failure due to a blown fuse, this scan point changes state, an alarm is sounded, and a TTY message is printed out.

3.41 Each data link has two scan points which indicate the power-on status of each end of the data link. One scan point monitors the power at the central office end, while the other monitors the presence of an idle 700-Hz signal on the data link from the customer end. One scanner row per data link frame is assigned for this function.

3.42 Each centrex data link is equipped with a key signal present scan point. This scan point is saturated when a key signal is received from an attendant console at the remote centrex location. Before any lamp data is transmitted from the No. 2 ESS central office to the remote location, this scan point is examined to determine whether or not there is a key signal stored in the data register. If a key signal is present, lamp data transmission is delayed until the key signal has been read out. Key signal present scan points are scanned once per base level scan. An entire scanner row of 16 scan points is assigned for the exclusive use of the key signal present and the all seems well functions for one data link frame (eight scan points for the key signal present function and eight for the all seems well function). This scanner row and the one mentioned above for the central office power and 700-Hz idle signal must be adjacent. If there are more than eight data links in a central office, two additional scanner rows are necessary for each frame but need not be adjacent to those from other frames.

3.43 Two 16-point information scan rows are assigned per data link to provide access to the centrex data unit shift register. These scan points are assigned in adjacent rows. Twenty-six of the scan points are delegated to read the contents of the shift register; three are assigned to indicate the state of the data link for maintenance and checking purposes; and three are spares. These scan points are scanned whenever a key signal is present and/or lamp transmission is to take place. This can occur once per base level scan.

AUTOMATIC MAINTENANCE AND TESTING

3.44 Automatic trunk circuit, attendant console, and data loop testing features are provided; these are consistent with the overall No. 2 ESS maintenance philosophy. Refer to the 232 series Bell System Practices for details.

A. Trunk Testing

3.45 Where possible, centrex tie trunks, FX trunks and CCSA trunks are tested in the same manner as normal interoffice trunks. Only those trunks going to offices which can connect the trunk to selected test circuits can be tested.

B. Console and Data Loop Testing

3.46 A parity bit is transmitted with each data link message and checked at both ends of the data link to insure correct transmission. If a data link error occurs, the message is retried in order to eliminate transient errors.

3.47 A data link diagnostic is run automatically if data link errors persist. The diagnostic is also run every night on all data links and may be requested at any time by TTY input.

3.48 The data link diagnostic progresses in steps from the simplest loading and unloading of the shift register to sending a maintenance message out to the far end and back again, which checks all the transmitting and receiving circuitry at both ends.

3.49 A console lamp and key exercise is provided so that a person at the console can verify the lamp and key memory, translation and display equipment.

4. CENTREX EQUIPMENT DESCRIPTION

4.01 In addition to attendant consoles and station telephones, two additional specialized equipment units are used for centrex operation. These are the centrex data link frame (Fig. 7) located in the No. 2 ESS office and a centrex console control cabinet (Fig. 8) which is located at the customer premises.

CENTREX DATA LINK FRAME

4.02 Each centrex data link frame (Fig. 7) is a standard 7-foot frame which can house up to eight data links and a data link controller. The controller appears as a peripheral unit on the system peripheral unit bus and provides the interface for the data loops to the central office control unit. The main functions of the controller are to receive messages from the control unit and to steer them to the proper data link. Each data link contains

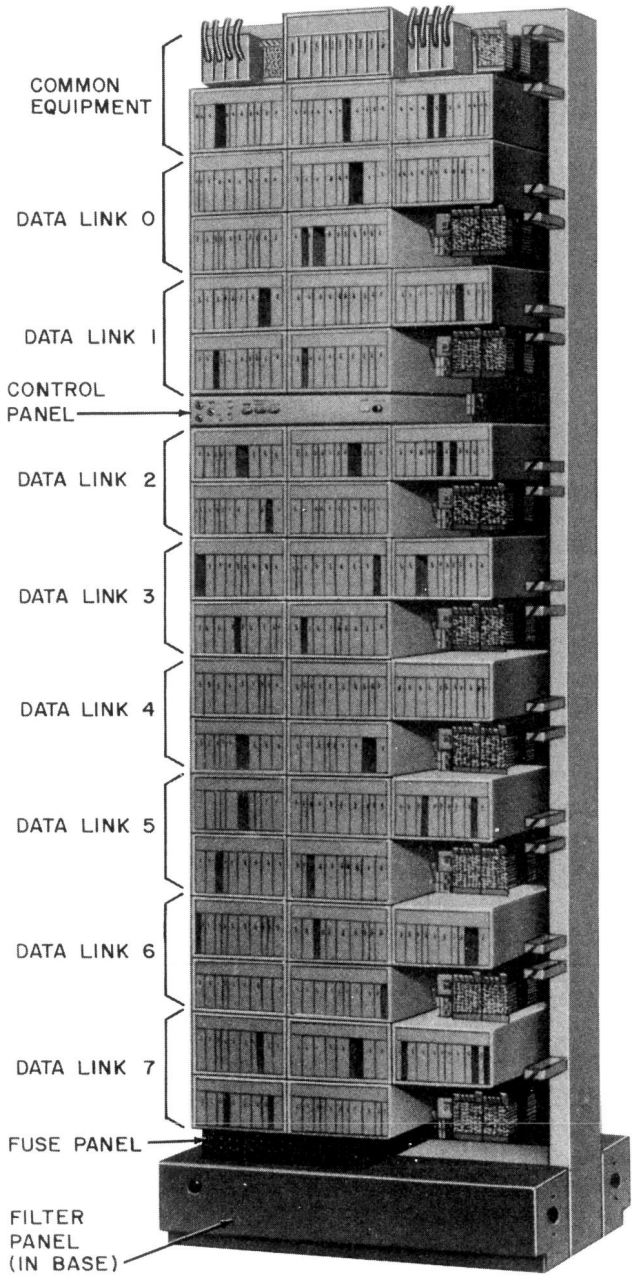


Fig. 7—No. 2 ESS Centrex Data Link Frame

a key signal receiver, a lamp data transmitter circuit, and connections to the common controller. The maximum number of centrex data link frames to be used in No. 2 ESS is four.

CENTREX CONSOLE CONTROL CABINET

4.03 Each centrex customer group may be provided with a centrex console control cabinet (Fig. 8). This cabinet provides the interface between the data loop and the attendant consoles. One console control cabinet can control up to four attendant consoles. (See 4.09.)

4.04 Part of the equipment in a console control cabinet is common to all consoles controlled by that cabinet, and other equipment is added as additional consoles are installed.

COMMON EQUIPMENT

Common Control Equipment

Power Supply

Trunk Group Busy Memory

ADDED EQUIPMENT PER CONSOLE

Console Control Equipment

4.05 The console control cabinet provides the following functions:

(a) Encodes attendant console key signals

(b) Transmits key signals as data to the central office

(c) Receives lamp data from the central office

(d) Decodes lamp data received from the central office

(e) Provides timing

(f) Furnishes local power

(g) Provides the lamp interrupter circuitry

(h) Contains the lamp state memory

(i) Contains a pulser circuit for controlling ferreeds in the lamp state memory.

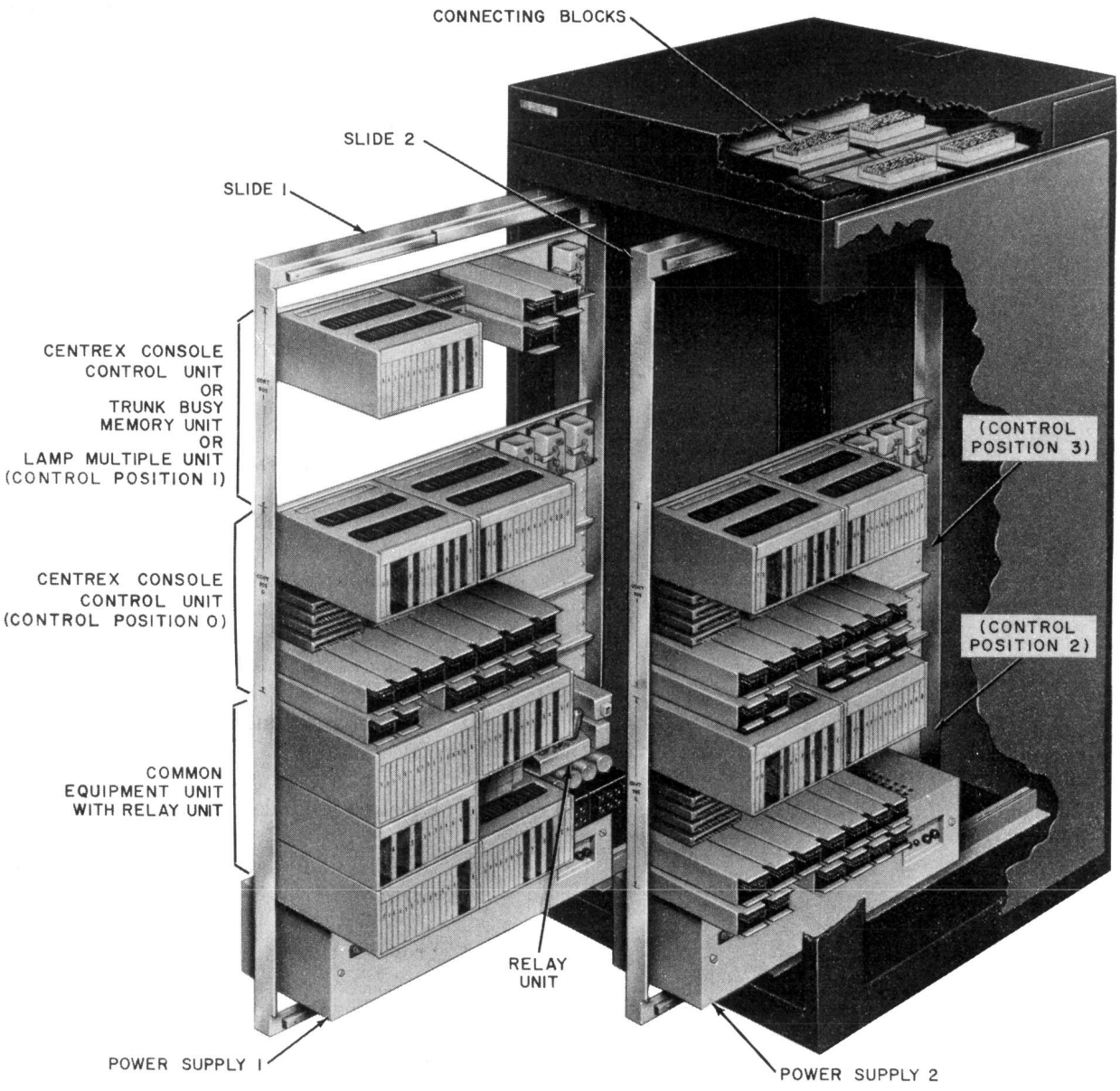


Fig. 8—No. 2 ESS Centrex Console Control Cabinet

4.06 ***Centrex Console Control Cabinet Power Requirements:*** The centrex console control cabinet located at the customer premises is designed to operate from a standard 117-volt ac power line. This power is supplied by the centrex customer on whose premises the console control cabinet is located.

4.07 The power drain varies according to the number of consoles provided and the amount of attendant traffic.

4.08 A centrex console control cabinet fully equipped with four attendant consoles requires a maximum of 240 watts (approximately 2 amperes) at periods of peak traffic. At periods when attendant traffic is low, power drain is reduced to a minimal amount.

SHARING OF CENTREX CONSOLE CONTROL CABINETS

A. Console Control Cabinet and Data Loop Equipment

4.09 When 1B consoles are used, the first centrex console control cabinet in a centrex customer group can serve up to four consoles. In the case of 2B consoles, however, 24 additional trunk group busy lamps are provided by substituting a trunk busy memory circuit in the console 1 position (see Fig. 8). This restricts the first console control cabinet to serving only up to three of the 2B type consoles. Additional console control cabinets can serve up to four of either 1B- or 2B-type consoles.

4.10 When a centrex customer group is provided with a console control cabinet and the busy hour traffic at their location does not require the full compliment of attendant consoles, the vacant control positions may, under certain limiting conditions, be used by other nearby centrex customer groups.

4.11 Restrictions on sharing a centrex console control cabinet are imposed by the available lamp state memory space and the common busing arrangements in the console control cabinet. This includes the multiple appearances of the common trunk group busy and calls waiting lamps on all consoles in a multiconsole customer group. The distance between centrex customer groups desiring to share the facilities of a console control cabinet is also a limiting factor. Customer groups may not be further than 1000 feet from the console control cabinet. They may be up to 2000 feet apart if the console control cabinet is located centrally between the two customer groups.

B. Methods of Sharing

4.12 A single console customer group is defined as a centrex customer group which uses only one 1B-type console.

4.13 A multiconsole customer group is defined as a centrex customer group which uses either more than one 1B-type console or one or more 2B-type consoles including the trunk busy memory circuit.

4.14 A multiconsole customer may not share a link with another multiconsole customer.

4.15 If a multiconsole customer does not occupy all the console positions of one console control cabinet, the customer must be given adjacent positions starting with the first console position. The positions left vacant may be assigned to control single console customers until all such vacancies have been filled.

4.16 When a multiconsole customer requires all four console positions available in a console control cabinet but not all the control positions of an additional console control cabinet, the customer may occupy any of the control positions of the additional console control cabinet. Any remaining vacancies may be assigned to control single console customers.

4.17 Since a centrex customer group using a single 2B-type console is considered a multiconsole customer regardless of the number of consoles employed, a centrex customer group with a 2B-type console cannot share a console control cabinet with another customer using a 2B-type console.

4.18 A centrex customer group requiring only a single 1B-type console never requires a console control cabinet to be installed if there is a console control cabinet in the vicinity with a single vacant control position.

4.19 All the previously explained methods of sharing may be accomplished by changes in plug-in type units within the centrex console control cabinet. No wiring changes are necessary.

4.20 One trunk group busy memory must be provided for a customer group equipped with 2B-type consoles. It always occupies control position 1 (the second control position) of the first cabinet associated with the customer group.

C. More Than Eight Console Control Cabinets

4.21 When more than eight console control cabinets are required for a single customer group, a lamp multiple unit must be used in control position 1 of the ninth console control cabinet (numbered 8). See Fig. 8.