# SWITCHING SYSTEMS MANAGEMENT
# NO. 1 AND NO. 1A ELECTRONIC SWITCHING SYSTEMS (2-WIRE)
# CALL PROCESSING DESCRIPTION

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## 1. GENERAL

**1.01** This section describes the call processing operation in the No. 1/1A electronic switching system (ESS). The network administrator should be knowledgeable of call processing fundamentals in order to better perform problem analysis, capacity determination, and equipment utilization.

**1.02** This section is reissued to include No. 1A ESS in the call processing description, to delete all references to the service link network found in some No. 1 ESS offices, and to make miscellaneous changes and corrections.

**1.03** The title for each figure includes a number(s) in parentheses which identifies the paragraph(s) in which the figure is referenced.

**1.04** Prior to reading this section, the reader should be familiar with the ESS components and their functions. Refer to the descriptive sections of Dial Facilities Management Practices (DFMPs) Division H, Section 6b, for this information.

### CALL PROCESSING FUNDAMENTALS

**1.05** In call processing, all system functions are carried out by central control (CC) under the direction of the generic program. Neither the program nor CC individually has the ability to carry out any of the ESS functions. Together, the programs and CC provide the sequence and logic of call processing.

**1.06** The call processing programs are an organized set of instructions that control a call from origination to disconnection. Some of the call processing programs may be called by other call processing programs (referred to as clients of the called upon programs) to perform specific functions. Some of these programs are basically input-output programs; other programs advance the call. Each program requires the use of call store to store data while processing the call. In many cases, areas of call store are assigned upon the origination of a call and are dedicated to the call throughout a particular phase.

**1.07** The programs associated with call processing are generally broken into three categories as follows.

(a) ***Input-Output Programs:*** These programs detect changes in the outside environment (eg, an off-hook condition) that constitute inputs to the ESS and produce changes in the outside environment (eg, digit transmission) that constitute outputs from the ESS. Examples of the input programs are the supervisory line scan program, dial pulse scan program, TOUCH-TONE® digit detection program, ringing trip scan program, supervisory scan programs, and the hit timing program. Some of the output programs are the digit transmission program and the call charge recording program.

(b) ***Call Control Programs:*** These programs are related only to processing information pertaining to a call in progress and in advancing the call to completion. Some of the call control programs for an intraoffice call are the dialing connection program, digit analysis program, and the disconnect program. Other call control programs are the outpulsing program and the operator program.

(c) ***Service Routine Programs:*** These programs specialize in frequently used functions that are not related exclusively to one type of call or one phase of a call. The service routine programs are called upon, when needed, by client call control programs. For example, a call control program can request a service routine translation program to determine the line equipment number that corresponds to a given directory number. Other service routine programs are the network control program, the change in circuits program, and the coin control program.

Fig. 1 illustrates the interrelationship of the various programs in the call processing functions of the No. 1/1A ESS.

**1.08** Control signals generated by these programs cause the circuits to change from one state to another state. Similarly, external control signals or changes in circuit states do not directly cause any ESS actions to take place. The control signals activate ferrods which are scanned and then interpreted by programs. The programs determine the meanings of the scanner states and perform the necessary logic to decide what action should be taken.

**1.09** Call origination information is furnished to the CC (or signal processor in No. 1 ESS offices) by scanners that monitor lines, trunks, and various other circuits at regular intervals. Each line is monitored by a current-sensing device called a ferrod. Depending on the state of the scanned ferrod, each interrogation results in a pulse or no-pulse output. In this manner, call origination information is received in response to a cycle type of operation executed by the ESS. For example, when a customer originates a call, current flows through a ferrod of a line scanner which changes its state. Every 200 milliseconds, the CC (or signal processor) examines the state of a particular line ferrod and recognizes a change in the line by comparing the state of the line ferrod stored in memory from the previous line check.

**1.10** The central office (No. 1 ESS only) may or may not have a signal processor. In a central office without a signal processor, call processing system functions are carried out by CC under the direction of a program. In a central office with a signal processor, the signal processor performs call processing input and output functions (for example, scanning of lines and trunks for service requests, answers, disconnects, etc). By performing these highly repetitive and time-consuming functions for CC, the signal processor enables CC to perform other system functions at the same time. The CC and signal processor function simultaneously and independently. When the signal processor has information that is ready for further processing by CC, the signal processor stores this information in its call store, and, at the appropriate time, CC reads this information. When CC has information for the signal processor, it stores this information in the signal processor call store, and, at the appropriate time, the signal processor reads this information.

***Note:*** In this section unless otherwise indicated, all call processing system functions refer to a central office ***without a signal processor*** and the call store used refers to the CC call store.

## 2. PROGRAMS INVOLVED IN CALL PROCESSING

### BRIEF DESCRIPTION OF PROGRAMS INVOLVED

**2.01** The call processing programs can be grouped into four functional areas:

(a) Dialing connection

(b) Analysis of dialed digits

(c) Ringing connection and answer detection

(d) Call disconnect.

#### A. The Dialing Connection

**2.02** The dialing connection consists of program action required to prepare the ESS system to receive digits when dialed by the calling customer. This action can be divided into two categories: service request from lines and service request from trunks. The dialing connection program performs the following functions during these operations:

(a) Service request from lines

(1) Connects customer line to digit receiver,

(2) Seizes an originating register, and

(3) Applies dial tone.

(b) Service request from trunks

(1) Connects incoming trunk to digit receiver,

(2) Seizes an incoming register, and

(3) Returns start dial signal to the distant office.

#### B. Analysis of Dialed Digits

**2.03** Analysis of dialed digits consists of program action to determine the destination of a call entering the ESS network. This operation can be divided into two areas: digit analysis for lines

and digit analysis for trunks. Specific functions related to each area are listed below:

(a) Digit analysis for lines

(1) Records and analyzes dialed digits received from a customer line,

(2) Removes dial tone, and

(3) Applies and removes second dial tone, if required.

(b) Digit analysis for trunks

(1) Records and analyzes digits received from trunks using dial pulse, multifrequency, revertive, or step-by-step dial pulse outpulsing.

(2) Stores, unloads, and converts digits received from trunks receiving revertive pulses.

(3) Stores, unloads, and analyzes digits received from trunks receiving step-by-step dial pulses (often called by-link pulsing).

### C. Ringing Connection and Answer Detection

**2.04** Alerting the called customer consists of program action on intraoffice and incoming calls to control ringing and answer detection. This operation can be grouped into two categories—regular ringing and answer detection, special ringing and answer detection. Specific functions performed by each category when activated are listed below:

(a) Connects ringing circuit to the called line

(b) Connects audible ringing tone to the calling line or trunk

(c) Establishes talking connection, if the call is answered

(d) Removes all connections, if the call is abandoned before answer.

### D. Call Disconnect

**2.05** Call disconnect consists of program action required to control disconnection of a call and the eventual restoration of the line, trunk, or both to an idle state. This operation is controlled by the disconnect program which performs junctor and trunk disconnects and places trunks on the guard timing list where they remain for about one second before being idled. Specific functions performed by the disconnect program are:

(a) Detecting flashing for special services, from those lines and trunks permitted to flash,

(b) Providing calling line control of the call,

(c) Signaling disconnect to a distant office over an incoming or outgoing trunk,

(d) Removing talking connection at disconnect,

(e) Restoring to idle any lines or trunks involved in the call,

(f) Calling in other programs to handle special conditions.

## BRIEF DESCRIPTION OF RELATIONSHIP TO OTHER FUNCTIONS

**2.06** The relationship between the call processing programs and other functions performed by ESS programs can be grouped into the following two areas:

(a) Memory usage

(b) Program interfaces.

### A. Memory Usage

**2.07** Call registers are engineered groups of call store locations seized from a link list of idle registers and used to store call-related information. The type of call register associated with a call is dependent upon the origin of the call being processed, which constitutes one of the following: an incoming register, an originating register, a trunk and line test panel register, a maintenance register, or a master control center register.

**2.08** When processing a call, the ESS programs may encounter various busy conditions (eg, all customer dial pulse receivers busy). When this condition occurs, the call is delayed by having it wait in a queue (waiting list) until the register or hardware necessary to continue processing the call becomes available.

**2.09** The path memory annex (PMA) register is used to store path memory information (eg, path from calling customer line to the called customer line).

**2.10** The peripheral order buffer (POB) is a block of call store memory used to load network, scanning, and signal distribution orders that will be executed a short time later.

**B. Program Interfaces**

**2.11** The scanning program action consists of detecting and reporting changes of electrical states during various stages of call processing operations. Some of the specific functions performed for the call processing programs are:

(a) Detecting and reporting service requests

(b) Detecting dialed digits

(c) Detecting call answer

(d) Detecting the disconnect signal

(e) Detecting and reporting the execution of a POB.

**2.12** The peripheral control program is used to interconnect lines, trunks, service circuits, and tone sources that may be used during the call processing operation (eg, connect customer dial pulse receiver to the customer line).

**2.13** The charging program is used to collect, assemble, and store data pertinent to billable calls (eg, message rate and toll calls). A block of call store memory is used until all information is collected. The data is then assembled and stored in a temporary buffer storage area. Later, this information is compiled for customer charges.

**2.14** The translation program consists of service routines used to transform known data supplied by a client program into related data returned to the requesting program. This program provides the call processing programs with related information about customer lines, directory numbers, trunks, service circuits, junctors, office codes, rates, routes, and other miscellaneous items.

**2.15** The outpulsing program is used by the call processing programs to control and coordinate the transmission of signals representing digits required to complete a call between two subscribers, served by different central offices.

**2.16** The operator functions programs are used by the call processing programs to control calls which must be routed to assistance operators, toll operators, information operators, business office operators, intercept operators, and repair service operators. The operator functions programs perform each function and signaling arrangement for the various operators.

**2.17** The special line services programs are used by the system to enhance the customer's call making progress. When a customer dials the required coding for access to a special line service, the call processing program transfers control to a special line service program after checking to see if the customer is allowed to use this service. Examples of these services are:

(a) Temporary transfer or call forwarding—allows the customer with an individual line to have all incoming calls forwarded to another line.

(b) Add-on and conference calling—enables a customer with an individual line to establish a call among three parties without operator assistance.

(c) Call waiting—informs a customer whose line is busy that an incoming call is waiting. The customer is allowed to hold the present connection while answering the new call.

**2.18** The Centrex call processing programs are used to process calls to and from a subscriber line served by a Centrex. These programs use the data handling capabilities of the POTS call processing programs to complete their functions. The data handling capabilities consist of the six basic stages of a telephone call: (1) detection of a service request, (2) analysis of digits dialed, (3) alerting the called customer, (4) establishing a talking connection, (5) call disconnect, and (6) charging.

**2.19** The coin function program performs the required program action for handling calls from a coin phone. This action includes testing for the presence of coins, collecting coins deposited, and returning coins deposited. This program has responsibility for the coin zone operator, overtime

monitoring operator, and stuck coin operator functions. The POTS call processing programs use the coin function program to perform the above functions when a customer originates a call from a coin-operated phone.

**2.20** When a failure (hardware or software) occurs while a function is being performed by a call processing program, program control may be transferred to the appropriate maintenance program. The transfer of control may be caused by a system interrupt, a software integrity check, a system performance test, a system printout, or by placing an item of hardware on the appropriate maintenance diagnostic request list.

## 3. CALL PROCESSING DESCRIPTIONS

**3.01** The descriptions in this part cover the following aspects of call processing where appropriate.

(a) Detection of a service request

(b) Supervision of call's progress

(c) Dialing connection

(d) Digit analysis

(e) Ringing connection and answer detection

(f) Establishment of talking connection

(g) Call disconnect.

### PROCESSING AN INTRAOFFICE CALL

**3.02** The following description covers an intraoffice call between an individual line (with dial pulsing and no special services) and another individual line served by the same end office. This description illustrates how the program, call store temporary memory, and equipment are used to process the call.

**3.03** In order to ***detect a service request,*** the ESS scans each customer's line. The location of a customer's line in the central office is identified by an eight digit number, known as the line equipment number (LEN).

**3.04** To detect an LEN origination, CC executes the supervisory line scan program located in program store every 200 milliseconds. This program is used to detect all off-hook conditions in an office. The hardware used to actually scan a line is the line scanner located on the line switch frame (LSF). The line scanner interrogates the ferrod sensor associated with each LEN in the office. This type of ferrod sensor may also be referred to as a "line ferrod."

**3.05** When a customer picks up the receiver, the line ferrod is saturated and changes from an on-hook condition to an off-hook condition. The line ferrod is scanned, and the line scanner forwards the status to CC. To find out whether the off-hook condition was detected previously, CC compares the present status with the prior line status record in call store. If the status information indicates that the line was previously on-hook, CC concludes that this is a new service request and changes the busy-idle bit associated with the LEN in call store from an on-hook to an off-hook status.

**3.06** Recognizing the request for service, CC commences to ***establish a dialing connection.*** CC then translates the line scanner number into the LEN, which is stored in an originating register.

**3.07** CC processes the LEN through the LEN translator. The LEN translation provides CC with specific information about the originating line, such as:

(a) Directory number (DN)

(b) Class of service (individual, multiparty, coin, etc)

(c) Whether a dial pulse or TOUCH-TONE receiver is required

(d) Any special features associated with the line.

**3.08** CC analyzes the information to determine whether the call will proceed any further. The LEN translation information is also stored in the originating register.

**3.09** CC selects an idle customer dial pulse receiver (CDPR) by consulting the busy-idle status

of equipment. (The area where this information is stored, is referred to as the network map.) If the LEN is a TOUCH-TONE line, a customer TOUCH-TONE receiver (CTTR) is selected. Fig. 2 illustrates the dial tone connection through the networks.

**3.10** CC next checks the network map for a path from the customer's line through the line link network (LLN) and the trunk link network (TLN) to the CDPR. Status information for all network paths is kept in the network map. CC reserves an available path by changing the busy-idle bits associated with the links to a busy state in the network map. The network orders necessary to establish the path are loaded into a POB.

**3.11** The dialing connection program then calls in the change in circuits program, which loads the POB with an order to operate the dial tone relay. The orders or instructions now stored in the POB, referred to as a work list, consist of the following items:

(a) Enable LSF

(b) Close path

(c) Enable LJSF

(d) Close path

(e) Enable TJSF

(f) Close path

(g) Enable TSF

(h) Close path

(i) Enable trunk signal distributor

(j) Operate relay in CDPR to give dial tone to the calling line.

**3.12** Up to this point in the call, no mechanical work has been done. The customer is still waiting for dial tone. No switches have closed; no relays have been operated. Call processing up to this point, has been strictly the storage of data in memory. CC has been preparing for the physical work of closing the network path and providing dial tone through the CDPR. To accomplish this, CC executes the peripheral order buffer execution program, which distributes the instructions in the work list over the bus system to the central pulse distributor, trunk signal distributor, and the network controllers.

**3.13** The first item on the work list is carried out by the central pulse distributor (CPD). CC sends the enable address of the particular LSF to the CPD. Once the address of the LSF is received, the CPD enables the network controller. The enabled network controller opens the gate to permit instructions from CC to be sent through the peripheral unit bus (PUB) system. The instruction from CC tells the network controller to close particular crosspoints in the first two stages of switching in the LSF. The enable/close path instructions continue through the networks until all eight stages of switching have been physically connected through the LLN and TLN. When the last stage is closed, the connection is complete through the trunk distributing frame (TDF), and the miscellaneous trunk frame (MTF) or universal trunk frame (UTF).

**3.14** The next step is to give dial tone to the customer. Through instructions from CC, CPD enables the trunk signal distributor. CC then instructs the trunk signal distributor to operate a relay within the CDPR, which results in dial tone to the calling line.

**3.15** From the beginning of this call, the line scanner has had complete supervision of the calling line. All actions from the time the customer's line goes into an off-hook condition, have been observed. As soon as dial tone is given to the calling line, supervision is passed to the master scanner. When the first pulse of the first dialed digit is received, the trunk signal distributor releases the relay in the CDPR; dial tone is removed from the customer's line.

**3.16** As the digits are dialed, they are stored in the junior originating register. The ***digit analysis*** program interrogates the junior originating register for the pulse count and for the originating register address and stores both of these items in the digit hopper. The program detects the entry in the digit hopper, stores the pulse count in the originating register, and increments a digit counter. When the digit analysis program recognizes that the third digit has been received, the program delivers the first three digits to the translation program. The translation program uses the digits

as input into translations containing trunking and routing information.

**3.17** For an intraoffice call, the 3-digit translation produces a normalized office code number. The normalized office code number and the fourth digit are translated into a number group number between 000 and 127. The number group number represents a DN thousands block. The number group number and the fifth, sixth, and seventh digits are translated into the called DN. When the digit analysis program determines that the entry in the digit hopper is the seventh digit, the program shuts off the scanning programs by properly marking the activity bit associated with the CDPR scan point to inactive.

**3.18** With all seven digits dialed, the digit analysis program transfers to the translation program, which, using the called DN as input, performs a DN translation. The DN translation provides, as output, the following information:

(a) the equipment location (may be a route index or an LEN)

(b) class of service

(c) any special features.

**3.19** If the equipment location is a route index, the route index routes the call to a trunk group, to an intercept announcement, etc. If the equipment location is an LEN, the LEN and terminating class of service are derived.

**3.20** CC then executes the ringing and answer detection program, which has control of the next phase of call processing—***ringing connection and answer detection.*** During the DN translation, the translation program checks to see if the terminating line is busy by looking at its busy-idle bit in the network map.

**3.21** If the terminating line is busy, the busy tone route index is derived, via translation, and an idle busy tone circuit is selected. From the route index, a trunk group number (TGN) is derived. The translation program performs a TGN-to-trunk network number (TNN) translation to derive a TNN assigned to an idle busy tone circuit. Then a TNN-to-trunk switch number (TSN) translation supplies the trunk signal distributor point that operates a trunk circuit cut-through relay associated with the idle busy tone circuit. CC is then directed to connect the originating line to the TNN assigned to the idle busy tone circuit and to supply busy tone to the originating line. When the originating line disconnects, the on-hook condition is noted by the trunk scanner, and the disconnect program loads a POB with orders to release the connections between the originating line and the busy tone circuit. The peripheral order buffer execution program restores the circuit to idle.

**3.22** If the terminating line is not busy, the call proceeds. Although the ringing and answer detection program is responsible for establishing the ringing and answer connection, other programs must be employed. CC selects an idle power ringing circuit and an audible ringing tone circuit. Once this is accomplished, CC, using the network control program, checks the network map for an available path from the called line to the ringing circuit. The path is reserved by changing the state of the busy-idle bits associated with the path, and the POB is loaded with the instructions to establish the path. An idle junctor circuit on the junctor frame is also selected. The network map is checked for an available talking path from the calling and called lines to the junctor circuit on the junctor frame. This path is reserved.

**3.23** The network control program stores the path information for the ringing connection and the talking path in the ringing register in call store. The information is used when the answer is detected.

**3.24** The peripheral order buffer execution program is then executed. The POB work list contains the instructions to:

(a) Disconnect the originating line from the CDPR,

(b) Establish the connection from the originating line to the audible ringing tone circuit, and

(c) Establish the connection from the power ringing circuit to the terminating line.

Intraoffice call connections are illustrated in Fig. 3. Supervision of the calling line is done at the audible ringing circuit. The called line is supervised at the power ringing circuit.

**3.25** The ringing trip scan program next scans the ring trip ferrod in the ringing circuit ten times per second. A saturated state of the ring trip ferrod indicates an off-hook condition when the called line answers.

**3.26** The ringing and answer detection program, using the network control program, loads the POB with orders to:

(a) Release the ringing connection between the originating line and the audible ringing tone circuit,

(b) Release the connection between the terminating line and the ringing circuit, and

(c) Establish the previously reserved talking path between the originating and terminating lines via a junctor circuit.

Fig. 4 illustrates the intraoffice call talking connection.

**3.27** With the ***talking connection*** established, the junctor circuit is recorded in a busy state in the supervisory junctor circuit memory in call store. The supervision of the calling and called lines takes place at the junctor circuit. The junctor scanner located on the junctor frame scans both sides of the junctor circuit for an on-hook or disconnect condition. When an on-hook condition occurs, it is detected by the junctor scanner. The status of the junctor circuit is reported to the hit timing program by the supervisory junctor scan program.

**3.28** A hit timing period of 200 to 300 milliseconds is started by the hit timing program to determine if a hit, flash, or actual disconnect has occurred. If a ***disconnect*** is evident at the end of the hit timing period, both sides of the junctor circuit are restored to an idle state in the supervisory junctor circuit memory in call store.

**3.29** The disconnect program works in conjunction with the network control and the change in circuits program to:

(a) Change the status of the paths to an idle state in the network map, and

(b) Load the POB with orders to release any circuit relays used in the duration of the call and to restore the line ferrod.

During the talking connection, the line ferrod is released from the calling line when the CDPR is connected.

**3.30** When the peripheral order buffer execution program processes the instructions of the network control program and the change in circuits program, the connections are released.

## INTRAOFFICE CALL USING A SIGNAL PROCESSOR

**3.31** The signal processor (SP) is required only in larger No. 1 ESS offices. It performs for CC those highly repetitive and time-consuming tasks which would severely limit the number of lines and trunks that a CC alone could serve. These tasks include such activities as the supervisory scanning of lines and trunks for service requests, answers, disconnects, the scanning of service circuits such as dial pulse and multifrequency (MF) receivers, and the control of outpulsing to distant offices.

**3.32** An SP operates under the control of program instructions which are stored in its own call stores. Normally, when an SP has information that is ready for further processing by CC, it stores this information in its call store. The CC reads this information at appropriate times after momentarily interrupting the SP. When CC has information to be used by the SP, it again interrupts and stores this information in the signal processor's call store.

**3.33** The functions performed by CC and the SP during the processing of an intraoffice call are illustrated in Fig. 5A through D. In this description, it is assumed that the intraoffice call is between an individual line (with dial pulsing and no special services) and another individual line served by the same central office. It should be kept in mind that a call is not processed to completion before another call is processed. Overlapping is consistent in processing calls.

**3.34** The processing of an intraoffice call in a No. 1 ESS office with a signal processor is very similar to the processing in an ESS without an SP. The initial steps are handled by the SP. When the calling customer initiates a call, the changed state of line ferrod associated with his line is noted by the line scanner. The supervisory line scan program reports this status to the SP which changes the state of the line busy-idle bit in the SP call store to busy. The line scanner number

is also loaded into a line service request hopper in SP call store.

**3.35** CC enters at this point, and, using the line scanner number and the translation program, converts the line scanner number into the LEN. The LEN translation output is stored in an originating register, after which CC selects an idle CDPR. CC checks the network map for a path from the customer's line to the CDPR. This path is reserved by changing the busy-idle bits associated with the path to a busy state in the network map.

**3.36** CC loads the network orders necessary to establish the path into a POB in the SP's call store. Through the peripheral order buffer execution program, SP unloads the POB at 25 millisecond intervals and establishes the network connections preparing to give dial tone to the customers. The SP is still in control at this point.

**3.37** Before the paths are closed through the LLN and TLN, a false cross and ground test is performed. The line crosspoints are then closed and a power cross test is performed; if the calling line is a party line, a party test is performed to determine party identity.

**3.38** SP instructs the signal distributor to operate the dial tone relay in the CDPR to give dial tone to the calling customer. Supervision of the line is passed from the line scanner to the master scanner at the CDPR. A junior originating register is seized by the SP. This register is associated with the CDPR and is prepared to count dial pulses. The address of the originating register is also stored in this junior originating register. The dial tone connection is now complete. In addition to the LEN of the calling line, the originating register holds the identity of the junctor and the CDPR used in the connection. This information makes it possible to release the connection if the call is abandoned. It usually takes less than 300 milliseconds to return dial tone to the calling customer.

**3.39** From this point on in the call, the call processing functions of an intraoffice call in a No. 1 ESS office with an SP, proceed in the same manner as in a No. 1 ESS without an SP. Refer to paragraphs 3.16 through 3.30 for a description of the digit analysis, ringing connection and answer detection, and disconnect functions.

## PROCESSING AN INTEROFFICE CALL

### A. Outgoing Call

**3.40** This description covers a call from a No. 1/1A ESS customer to a line in a distant crossbar office. The calling customer is assumed to have an individual line with dial pulsing. The pulsing required between the ESS and the distant office is MF.

**3.41** The call is processed as an intraoffice call until the third digit is detected. At this point, the office code translation indicates an outgoing call and that outpulsing starts after all seven digits are received. The office code translation provides the call type (seven-digit interoffice in this case), number of digits to be outpulsed, route index, charge index, and screening information (Is customer allowed to make this type of call?) for this call. This output information from the translation program is stored in the originating register.

**3.42** When the last digit is received, CC seizes an outpulsing register and then selects an idle outgoing trunk and an MF transmitter. (The selection of a transmitter depends upon the type of receiver at the distant office.) The identity of the outgoing trunk, the type of supervision, the number of digits to be transmitted, and the identity of the transmitter are recorded in the outpulsing register.

**3.43** A path is needed between the outgoing trunk and the transmitter. To locate path information, CC checks the network map in call store. The busy-idle bits associated with an idle path are changed to a busy state and the path is reserved. The path information is stored in the outpulsing register and the instructions to establish this path are loaded into the POB.

**3.44** CC must also find and reserve a path from the calling customer's line to the outgoing trunk. Once this path is found, CC reserves it, and uses it later as the actual talking path through the network. This path information is also stored in the outpulsing register.

**3.45** Fig. 6A illustrates the connection between the outgoing trunk circuit and the MF transmitter. The outgoing trunk circuit is placed in a bypass state (clear metallic path), and a seizure signal is sent to the distant office. Trunk continuity

to the distant office is checked by the MF transmitter. If the check is successful, a wink signal is returned from the distant office.

**3.46** The digits in the originating register are transferred to the junior originating register associated with the particular MF transmitter. Then the dialed number is outpulsed to the distant office. The central pulse distributor is used to operate and release relays to generate and control the tone signals used in outpulsing. Upon completion of outpulsing, the transmitter is released.

**3.47** Next the reserved path from the calling line through the networks to the outgoing trunk is established. Once this path is established, the outpulsing register and CDPR are released. Up to this point of the call, the CDPR has had complete supervision. With the establishment of the path from the calling line to the outgoing trunk, the supervision of the calling line is transferred to the outgoing trunk circuit. At this point, the distant office supplies the audible and power ringing. The trunk scanner, under the supervision of the supervisory trunk scan program, scans the outgoing trunk every 100 milliseconds for answer detection or possible abandonment (on-hook). When the called party answers, the ringing connection is then used as the actual talking connection as illustrated in Fig. 6B.

**3.48** Via the outgoing trunk, the trunk scanner continues to scan the talking connection for an on-hook condition. When an on-hook condition is noted, the trunk scanner forwards the status to CC; CC calls in the hit timing program and the hit timing period is started. The hit timing program times the duration of the on-hook signal to distinguish among hits, flashes, and true disconnects. (A hit is a line that goes from on-hook to off-hook within 200-300 milliseconds.) If the customer has any special features, which are requested by a switch hook flash, the disconnect program performs flash timing. If a flash occurs, the disconnect program transfers to the program which controls the special features. At the end of the hit timing period, the results are reported to the disconnect program which decides the appropriate actions to be taken on the disconnected call. The disconnect program is used to control the disconnect of a call and to eventually restore the line to an idle state.

**3.49** When hit timing is completed, a disconnect register is seized. If the calling line went on-hook first, the connection is released; disconnect supervision is sent to the called line end. The outgoing trunk is not idled until the distant office returns on-hook supervision. If the called line went on-hook first, a timed released period of 10 to 11 seconds is initiated. If the calling line goes on-hook during the 10- to 11-second interval or if a time-out occurs, the connection is released. The disconnect register is released after a guard timing interval of 750 milliseconds during which the outgoing trunk cannot be reseized. This interval allows enough time for all the relays in the distant office to release.

### B. Incoming Call

**3.50** For this description, it is assumed that the ESS office is processing an incoming call to an individual line. A trunk to the ESS office is seized at the distant office. This action is detected by the ferrod sensor associated with the trunk. This ferrod sensor may also be referred to as a "trunk ferrod".

**3.51** During the 100-millisecond supervisory scan of trunks initiated by the supervisory trunk scan program, CC reads the row containing the scan point of the incoming trunk circuit. CC checks the busy-idle bit in call store associated with this trunk circuit and detects a mismatch between the scanner reading and the associated trunk busy-idle bit. CC cannot conclude from the mismatch whether a seizure or an answer has been detected, since the trunk scanner supervises for outgoing trunk answers as well as incoming trunk seizures. To clarify the type of call being processed, the trunk scanner address of the trunk causing the mismatch is recorded in the trunk service request hopper.

**3.52** Then the trunk scanner number is used as input information into trunk translations. The translation information indicates that the trunk is incoming (which means that a seizure has been detected). The translation information also specifies the TNN, which identifies the network location of the trunk.

**3.53** The TNN is stored in an incoming register and is converted into the program store address of the translation information for the trunk. This information is used to determine the type of digit receiver (MF, dial pulse, etc,) to connect to the trunk, the number of digits to expect, and the type of supervision required (ground start,

sleeve lead, reverse battery, etc,). This translation information is stored in the incoming register. (An exception to this procedure exists for the step-by-step immediate dial (by-link) incoming trunk. In this case, a special directed scan detects dial pulses via a ferrod in the incoming trunk circuit. The same ferrod also indicates the origination of the call.)

**3.54** When the type of digit receiver is determined, CC selects an idle digit receiver and checks the network map in call store for an available path from the incoming trunk to the incoming receiver. CC reserves this path by changing the busy-idle bits in call store to a busy state. The POB is loaded with the orders needed to establish the reserved path from the incoming trunk to the incoming receiver. The path information is stored in the junior incoming register. The path, once established, is a trunk-to-trunk junctor connection, as shown in Fig. 7A.

**3.55** The junior incoming register associated with the digit receiver is prepared to store the pulse count. The incoming trunk circuit is put in the bypass state, and the start dialing signal is transmitted to the distant office which in turn transmits the last four digits of the called line DN.

**3.56** Upon completion of each digit, the pulse count is taken from the junior incoming register and, via a digit hopper, is recorded in the incoming register that is administering the call. When the last digit is completed, the digits received are converted to the program store address of the DN translation for the called line. An output of the DN translation is the LEN for the called line. This LEN is converted to the location of the line busy-idle bit in the call store. This bit indicates that the called line is idle.

**3.57** The ringing phase of the call starts as a ringing register and a POB is seized; then, the incoming register is released. A search of the network map results in the selection of a reserved talking path from the incoming trunk to an audible ringing tone circuit and from a power ringing circuit to the called line. Also a talking path between the incoming trunk and the called line is reserved (Fig. 7B). The information for all these paths is stored in the ringing register. The orders for the ringing connections are loaded into a POB with the signal distributor and scanner orders for a power cross test and a party test. Ringing is applied. Fig. 7B illustrates an incoming call ringing connection.

**3.58** Every 100 milliseconds, the ringing circuit is scanned for an answer. The incoming trunk is scanned for a possible abandonment. When the called customer anwers, ringing is automatically tripped by the ringing circuit. The ringing connections and the ringing register are released. Answer supervision is returned to the orignating office. The previously reserved talking path is established (Fig. 7C); the temporary memory is brought up to date. The connection is now supervised via the trunk scanner for disconnect.

**3.59** When the 200-millisecond trunk supervisory scan detects a change to on-hook on either the line or trunk side of the incoming trunk, hit timing (200 to 300 milliseconds) is started.

**3.60** After the hit timing period, a disconnect register is seized. If the distant end is disconnected first, the incoming trunk is made available for reissue and a timed release period of 10 to 11 seconds is started. During this time, the ESS customer is being scanned at the trunk every 100 milliseconds for disconnect. The connection is released when the ESS customer disconnects or the timed release period ends. If the trunk is reseized in the meantime, the connection is released immediately and the line is supervised via the line scanner. If the ESS customer remains off-hook beyond the timed release period, the call is treated as a new call origination.

**3.61** If the ESS customer is disconnected first, when hit timing is completed, the distant office is notified of the disconnect. The ESS starts a timing period of 35 to 45 seconds when waiting for the disconnect signal from the distant office. When the ESS receives the disconnect signal or when the timing period ends, the busy-idle bits in call store associated with the line and trunk are changed to an idle state; the connection is released.

## PROCESSING OTHER TYPES OF CALLS

### A. Tandem Calls

#### Introduction

**3.62** This description covers the call processing functions of a call requiring ESS tandem

switching. The following are the basic tandem functions:

(a) Interconnect several end offices, which allows the provision of extended area service to these offices

(b) Connect a 7- or 10-digit call to the toll network from a local office equipped with local automatic message accounting

(c) Forward incoming calls from the toll network to other local offices

(d) Receive and interpret a uniform number of digits per incoming call on a given trunk group in which the digits received at the ESS are not the originally dialed digits, but have been subjected to processing (ie, digit deletion or code conversion) at a preceding office

(e) Receive and interpret a uniform number of digits per incoming call on a given trunk group in which the digits received are those originally dialed

(f) Receive and interpret a variable number of digits per incoming call on a given trunk group

(g) Screen incoming tandem and some local calls for routing purposes on the basis of received digits and incoming trunk group

(h) Delete up to six digits and prefix up to three digits on tandem calls.

**3.63** A No. 1/1A ESS office can be arranged to switch interlocal traffic, as well as handle originating and terminating traffic. To have interlocal tandem capabilities, the tandem feature must be programmed into memory. No hardware modifications are required. Just as specific translation information is required for DNs or line equipment numbers, special translation data is necessary for the tandem feature. Once this tandem translation information is developed, it is programmed into local tandem tables. Fig. 8 illustrates the capability variances in ESS offices with and without the tandem feature.

**ESS Tandem Calls**

**3.64** A tandem call through an ESS office involves the same call processing operations as an incoming and outgoing call, with one exception. The tandem call requires additional translation via the tandem tables.

**3.65** A customer in the originating office places a call that will be switched through the ESS-tandem to the terminating office. The first indication of this call is the seizure of a trunk in the ESS. The supervisory trunk scan program is used to detect all requests or seizures of trunks. When a trunk is seized, a change in the state of the ferrod sensor associated with the trunk is noted by the trunk scanner. The status of the ferrod is forwarded to CC, which uses the trunk scanner address as input information into the trunk translations. The translation provides:

(a) the type of trunk (in this case, an incoming trunk) and

(b) the TNN of the trunk.

**3.66** CC then uses the TNN as input to the TNN-to-TGN translator. This translation yields the following output:

(a) Type of incoming receiver (dial pulse or MF) to connect to the incoming tandem trunk.

(b) Expected number of digits to be sent from the originating office.

(c) Trunk group number.

**3.67** The TGN is in turn used as input into the TGN primary tables. The TGN table yields the tandem table number, which is stored in the incoming register.

**3.68** CC selects an idle incoming receiver of the type signified in a prior translation and checks the network map in call store for an available path from the incoming trunk to the incoming receiver. An available path is reserved by changing the map's busy-idle bits associated with the path to a busy state. The POB is loaded with the instructions required to establish this path, a trunk-to-trunk junctor connection as illustrated in Fig. 9. The peripheral order buffer execution program then establishes this path.

**3.69** At this point in the call, a wink signal is transmitted to the originating office to indicate that the ESS-tandem is ready to receive the outpulsed digits. The MF digit detection program detects the digits from the incoming trunk, and interrogates the scan points associated with the MF incoming receiver 100 times per second.

**3.70** Up to this point of the tandem call, all of the call processing operations involved have been identical to those required for a regular incoming call to an ESS end office. Now the operations deviate from those of a regular incoming call.

**3.71** A No. 1/1A ESS used for tandem completion can receive, translate and route 3, 4, 5, 6, 7, 10 or a variable number of digits on an incoming group. The quantity of incoming digits depends on the type of equipment originating to the ESS and the type of routing to and from the ESS tandem.

#### 4-, 5-, or 6-Digit Tandem Call

**3.72** For this example, the originating office outpulsed only the last four digits of the called number. The first three digits (NXX Code) were deleted in the originating office. The four digits are received by the incoming receiver and stored in an incoming register. To continue processing the call and routing it to the terminating office, the NXX code is restructured from tandem tables in program store. These tables contain programmed information related to digit interpretation. Fig. 10 illustrates the translation of a 4-digit tandem call.

**3.73** Using the tandem table number, which was previously stored in the incoming register, the translation program indexes down the tandem head table for the address of the common block. The common block provides access to four levels of digit interpretation. The input into the common block is the first digit received; the output is the NXX code. This process restores the called number to seven digits.

**3.74** The call is next directed to the 3-digit translation tables, and the call is handled as a regular outgoing call from this point on. CC uses the NXX code as input into the 3-digit translation tables. The output information is the outgoing trunk group to the terminating office and other routing information.

**3.75** CC selects an idle outgoing trunk and transmitter. CC stores the outgoing trunk and transmitter locations in an outpulsing register in call store. CC now requires an available path from the incoming trunk to the outgoing trunk. This procedure differs from a regular outgoing call, where CC sets up a path from the calling customer's line to the outgoing trunk. CC checks the network map for an available path. The path is reserved by changing the busy-idle bits associated with the path to a busy state; the path is used later in the actual talking connections. CC loads the POB with the instructions needed to establish the path from the incoming to the outgoing trunk. Fig. 11A illustrates the reserved path.

**3.76** The network map is also consulted for an available path between the transmitter and the outgoing trunk. Once this path is reserved, CC establishes the path from the transmitter to the outgoing trunk. Fig. 11B illustrates this connection.

**3.77** A wink signal from the terminating office is transmitted to the ESS-tandem; this indicates that the terminating office is ready to receive outpulsed digits (called number). The transmitter outpulses the required digits and is released. When the outpulsing is completed, the peripheral order buffer execution program establishes the reserved path from the incoming trunk to the outgoing trunk. The terminating office then supplies the regular and audible ringing to the called and calling lines.

**3.78** The trunk scanner scans the outgoing trunk for an answer detection. Answer supervision is transmitted over the path to the originating office. The trunk scanner then scans the talking connection (Fig. 11C), every 100 milliseconds for an on-hook condition. When the change in the state of the trunk ferrod signifying this condition occurs, the busy-idle bits in the network map are restored to an idle state; the call is disconnected.

#### 7-Digit Tandem Call

**3.79** A 7-digit tandem call involves the same call processing operations as a 4-, 5-, or 6-digit call, with one exception. To clarify this exception, it is assumed that all call processing steps have

been completed to the point of the TNN-to-TGN translation. The output information is as follows:

(a) Type of incoming receiver

(b) Number of expected digits outpulsed from the originating office; in this case, seven digits

(c) Trunk group number.

**3.80** The TGN is processed through the TGN primary tables. The output indicates that no further digit interpretation is required and directs the call to the 3-digit translation tables. After receiving the digits and using the NXX code as input, the tables provide the outgoing trunk group to the terminating office and other routing information. The remainder of the call processing operations for the 7-digit tandem call are the same as those for the 4-digit tandem call. Fig. 12 illustrates the translation process for the 7-digit tandem call.

#### 5-Digit Tandem Call Terminating in the ESS Tandem

**3.81** A 4-, 5-, 6-, or 7-digit tandem call can terminate in the ESS tandem. The description of a 5-digit call is used as an example. It is assumed that the call has progressed to the point of the TNN-to-TGN translation, which provides the following output:

(a) Type of incoming receiver

(b) Number of digits to expect (in this case, five digits)

(c) Trunk group number.

**3.82** The TGN is then translated through the TGN primary tables. The output provides the tandem table number which is stored in the incoming register.

**3.83** The network map is checked for an available path from the incoming trunk to the incoming receiver. The path is reserved by changing the associated busy-idle bits to a busy state. The POB is loaded with instructions necessary to establish the path. The peripheral order buffer execution program then establishes this path.

**3.84** A wink signal sent to the originating office indicates that the ESS tandem is ready to receive digits. The MF digit detection program interrogates the scan points associated with the incoming receiver 100 times per second. The digits are received by the incoming receiver and stored in the incoming register. Five digits were outpulsed from the originating office. The first two digits of the NXX code were deleted by the originating office. At this point, CC, looking at the TGN, cannot distinguish whether the call is a tandem or a local completion call.

**3.85** Using the tandem table number, which was previously stored in the incoming register, the translation program indexes down the tandem head table from the address of the common block. The common block provides access to five levels of digit interpretation.

**3.86** The first digit received is processed through the common block. Assume that the calling party dialed 446-1234; only the last five digits were outpulsed to the ESS-tandem. The digit "6" is used as input into the common block; the output information is the NXX code. At this point, the called number is restructured to the original seven digits.

**3.87** The call is directed to the 3-digit translation tables; the NXX code is processed through these tables. The output is a normalized office code indicating that this is an incoming call terminating in the ESS office.

**3.88** The translation processes the called DN through the DN translation. The LEN class of service, and any special features are the output of this translation. With the determination of the LEN, the balance of the call processing functions are handled as any regular incoming call. Fig. 13 illustrates the tables used on a 5-digit tandem call.

### B. Reverting Calls

**3.89** A reverting call is a call between two customers who share the same line; therefore, both customers have the same LEN. The call is processed as a regular intraoffice call until all seven digits are detected and stored in the originating register.

The DN translation indicates that the calling and called LENs are the same and a reverting call is

in progress. The reverting call is processed in one of the following ways depending upon the option selected by the Telephone Company.

(a) Operator assistance

(b) 2-party selective, 4-party semiselective, and divided code ringing

(c) 2-party selective, 4-party full selective, and 8-party semiselective ringing

**Operator Assistance**

**3.90** For flat or message rate customers, the call is routed to an operator over a recording-completing trunk (Fig. 14A). In the DN translation, a special route index is used specifically to connect the party line customer, who has dialed another party on the same line, to the operator. The operator recognizes that assistance is needed in the completion of a reverting call either from the reception of an identification tone or from the particular trunk being used by the call. The operator requests the called number from the calling customer and instructs the customer to hang up, to wait long enough for the called party to answer, and to go off-hook again.

**3.91** While the calling customer is waiting, the operator dials or pulses the called number using a local toll switching trunk (Fig. 14B). When the connection is set up, ringing is applied by the operator (Fig. 14C).

**3.92** The operator verifies that the connections are properly completed before making out the message-rate ticket or leaving the call. Throughout the conversation, supervision is under control of the operator via the local toll switching trunk (Fig. 14D). After both parties disconnect, the connection is taken down by the operator, and the trunk is released.

**2-Party Selective, 4-Party Semiselective, and Divided Code Ringing**

**3.93** If the office is equipped to have reverting calls handled automatically, a check is made to determine whether the originating party has message-rate service. If it has, the call is handled by a special operator.

**3.94** Otherwise, a special route index, obtained from the DN translation, is used to automatically connect a customer to another party on the same line. The ESS returns busy tone until the calling customer hangs up. Then the busy tone is removed, and revertive ringing is applied (Fig. 15A). When any customer on the party line removes the receiver from the switchhook, ringing is removed, and a talking connection is established to a holding trunk (Fig. 15B). When both customers hang up, the disconnect is detected at the holding trunk and disconnect timing is completed and the connection is released.

**3.95** With 2-party lines, regular ringing is applied for the called customer; special revertive ringing, which is 1/2 second on, and 2-1/2 seconds off, is applied for the calling customer.

**3.96** With 4-party lines, the dialed number translation for the called line indicates that the ringing code should be applied on the called side. Revertive ringing is applied to the other side of the line. If both customers are on the same side of the line, only the called ringing code is transmitted.

**2-Party Selective, 4-Party Full Selective, and 8-Party Semiselective Ringing**

**3.97** With this particular option, the ESS returns special high tone to the calling customer as a request to dial an additional digit that identifies the customer's station and ringing code.

**3.98** When the eighth digit is received, the ESS removes the high tone and returns busy tone to the calling customer. When the calling customer hangs up, the ESS removes the busy tone and connects ringing to the calling and called stations. If the calling and called stations are on the same side of the line and have the same polarity, only the called line ringing code is applied. In other cases, revertive ringing is returned to the calling station. When any customer on the line removes the receiver from the switchhook, ringing is tripped, and the talking connection is established.

**3.99** For the 2-party selective, 4-party full selective, and 8-party semiselective ringing, the network connections are released if:

(a) The calling party fails to hang up within 20 seconds after receiving the busy tone signal,

(b) The calling party fails to dial the station digit within 20 seconds after receiving high tone, or

(c) Neither the called nor the calling party removes the receiver after ringing has been applied for three minutes.

### C. Assistance, Service Code, and Direct Distance Dialing Calls

**3.100** Assistance, service code, and direct distance dialing (DDD) calls are handled like outgoing calls. The translation of the dialed digit or digits indicates:

(a) The type of trunk required to complete the call,

(b) The type of supervision the trunk requires, and

(c) Whether or not outpulsing is required. (Outpulsing is required for DDD calls and when operator switchboard positions are reached through another office.)

#### Assistance Calls

**3.101** Assume that 0 is used for the operator assistance code in an office. After the customer has dialed 0 for operator assistance, the digit is translated and an operator trunk is seized.

**3.102** Audible ringing tone is transmitted to the customer, and a lamp signal is sent to the operator. When the operator answers, a talking connection is established. Both the operator and the customer must disconnect before the connection is released.

#### Service Code Calls

**3.103** Calls to a service code operator (long distance, directory assistance, repair service, etc,) follow a pattern similar to that of assistance calls. The translation of the digits indicates that a special service code has been dialed; any routing needed to terminate the call is also provided.

**3.104** Audible ringing tone is sent to the customer and a lamp indication is sent to the operator. The audible ringing connection is released, and the talking connection is established when the operator answers. The talking connection is released when the customer disconnects.

#### Direct Distance Dialing Calls

**3.105** When the first three digits of a DDD call are translated, the translation indicates an interoffice code or a foreign area code and that ten digits may be expected. The translation output also provides either outgoing trunk group routing or additional translation if ten digits are expected. CC selects an idle outgoing trunk and appropriate transmitter. The call then progresses as a regular outgoing call.

### D. Manual Calls

**3.106** A dial office can serve manual customers who require operator assistance on all originating calls. When a manual customer goes off-hook, the LEN translation indicates that this is a manual service line. An appropriate digit receiver is connected to the line, but dial tone is not applied. The transfer of supervision to the master scanner is checked; the false cross and ground and the power cross tests are made. The digit receiver is then released. A connection, using an operator trunk, is established to an operator as though the customer had dialed "0". The operator completes the call as requested by the customer.

## 4. CALL CONDITIONS

**4.01** Various conditions may occur during the processing of a call. The following conditions are discussed in this part:

(a) Permanent signal

(b) Partial dial

(c) Dialing before receipt of dial tone

(d) Vacant code

(e) Blank (or unequipped) and unassigned numbers

(f) Free number

(g) Called line busy

(h) Call abandon.

### A. Permanent Signal

**4.02** When a customer origination is detected, the ESS establishes the dialing connection, returns dial tone to the customer, and waits for the dialed digits. If dialing is not started within 16 to 24 seconds (under heavy traffic conditions, this interval is reduced to 5 to 10 seconds), the line has a permanent signal condition. The dialing connection to the line is released; a permanent signal register is seized.

**4.03** The line is connected first to an announcement trunk for one complete announcement cycle. A receiver off-hook tone is next initiated via a tone trunk, for 40 to 50 seconds. If the permanent signal condition still exists, an option may be selected by the Telephone Company to terminate the connection at an operator's position. If this option is designated, connection is made to an operator, who may listen and talk on the line. The purpose of the operator is to provide assistance to customers, especially in an emergency situation.

**4.04** If the permanent signal cannot be cleared, the permanent signal register is released; the cutoff contacts are closed; and the line is entered on a high and wet high priority list (HPL). The line remains on the HPL until it is cleared or the HPL is filled. Overflow from the HPL is loaded into the high and wet low priority list (LPL). A packing and bumping routine is used to load subsequent permanent signals such that newer ones are loaded in the HPL and previous permanent signals are bumped to the LPL, provided the previous lines have been identified on a printout.

**4.05** The line is printed on the local test desk teletypewriter on a scheduled 1/4-, 1/2-, 3/4-hour, or hourly basis as specified by the telephone company. In the event of outside plant or similar trouble, an immediate printout occurs when the number of permanent signal entries exceeds a predetermined number within a specified time interval. This printout occurs at the local test desk and the master control center teletypewriters.

**4.06** All permanent signal entries are scanned for on-hook at a rate dependent on office load, the actual size of list, and whether the entry is on the HPL or LPL. Every second, a check is made to determine if the last 3 E-E cycles were less then 120 milliseconds (ms) each. If all three cycles were equal to or less than 120 ms, a segment (a block of 50 or less HPL or LPL entries) is scanned for on-hook. If any of the three preceding E-E cycles is greater than 120 ms, the scanning of the HPL is deferred until three consecutive acceptable E-E intervals occur. One segment of the LPL is scanned after one of the two possible HPL segments has been scanned on an alternating basis. Lines found on-hook are removed from the HPL or LPL (whichever applies) and are marked idle so that full service is resumed.

### B. Partial Dial

**4.07** After the customer dials the first digit, each interdigital interval is monitored. If the interdigital interval exceeds the allowable 16- to 24-second limit, an insufficient number of digits has been dialed. The dailing connection is released, and the customer's line receives one of the following treatments as specified by the Telephone Company:

(a) The line is connected to a vacant code announcement for 39 or 40 seconds. This provides for one complete announcement cycle followed by a quiet period of 15 to 27 seconds. If no disconnect occurs during this period, the line is treated as described in paragraphs 4.02 through 4.06.

(b) The line is timed for 25 seconds during which it is connected to overflow tone for one full announcement cycle. If no disconnect occurs during this period, the line is treated as a permanent signal as described in paragraphs 4.02 through 4.06.

### C. Dialing Before Receipt of Dial Tone

**4.08** If the customer dials before receiving dial tone, the first digit of the called DN is either unrecorded or mutilated. An unrecorded digit results in a partial dial condition; a mutilated digit causes a wrong number or a vacant code condition.

### D. Vacant Code

**4.09** A vacant code is an office code or a foreign area code that is not accessible to the local central office customer or operator. For example, when a vacant code is detected on an originating call, the ESS connects the calling customer to a vacant code announcement and after two cycles of announcement, may then connect the customer to an operator via an intercept trunk. When a vacant

code is detected on an incoming tandem or toll call, the ESS connects the incoming trunk to an overflow tone circuit.

### E. Blank (Unequipped) and Unassigned Numbers

**4.10** A blank (unequipped) number is a number outside the assigned capacity for a particular office. An unassigned number is a number within the assigned capacity for a particular central office but is not assigned to any customer.

**4.11** When the called number is recognized as a blank or an unassigned number, the ESS connects the called customer line to a machine intercept announcement or to an automatic intercept system for intercept treatment. If provided by local option, the intercepted call can be cut through to an operator after two cycles of announcement.

### F. Free Number

**4.12** A free number is a DN that any local customer can call without charge; no automatic message accounting record is kept or no coin charge is made. A customer, in a distant office, calling a free number in the called office, may or may not be charged depending on the incoming trunk class.

### G. Called Line Busy

**4.13** When the called line is found busy, the busy tone route index is derived via translations and an idle busy tone circuit is selected. After further trunk translations, the originating line is connected to the busy tone circuit which supplies busy tone to the originating line. When the originating line disconnects, the ESS removes the busy tone connection.

### H. Call Abandon

**4.14** If an originating customer disconnects before the talking path is established, an abandon condition has occurred. If dial tone has not been removed, the digit analysis program stops the scan program and marks the abandon indication in memory to prevent any further action on the call. Then the system takes the required action to drop the call connection.

**4.15** When an originating customer disconnects during ringing, the ringing program begins the abandon procedure by reporting the abandon to all registers on the call. Any lines associated with the call are restored and verified, and all network connections are dropped.

## 5. CHARGING ON COIN AND NONCOIN CALLS

### CHARGING ON COIN CALLS

**5.01** A coin control circuit is used at least once in every coin call to perform one or more of the following functions:

(a) Test for the presence of a coin

(b) Collect deposited coins

(c) Apply a tone to indicate that additional coins must be deposited

(d) Return deposited coins.

**5.02** Whenever this coin control circuit is required during an established talking connection, the talking connection is released. A new path from the coin line to a coin control circuit is established, as shown on Fig. 16. The appropriate functions are performed, and the talking connection is reestablished.

**5.03** Loop start and ground start are the two types of coin lines. On loop start coin lines, a test for coin is made before the call is completed. With a ground start coin line, the presence of the coin initiates the service request; therefore, no coin test is required.

### A. Local Coin Call — No Overtime Charging

**5.04** A local coin call is a call within the coin customer's local calling area. The origination is detected in the usual manner by the supervisory line scan program. The LEN translation for the calling line indicates that the call is originating from a coin box and specifies the type of digit receiver that is required.

**5.05** The dialed digits are stored in an originating register. When dialing is completed, a coin charge register in call store is used to administer the phase of timing and charging the call immediately after ringing. When the called line answers and the talking path is established, a charge delay interval of two to four seconds is timed before

the call is considered chargeable. The coin charge register is released.

**5.06** The path memory records that a coin line is involved and that a coin is to be collected upon disconnect. At the end of the call, a disconnect register requests a coin control circuit to perform the coin collection action before releasing the network condition.

### B. Local Coin Call — With Overtime Charging

**5.07** This type of call is treated like the local coin call with no overtime charging until the end of the charge delay interval. The coin charge register is retained and used to administer a 5-minute timing period. If the call terminates within 4.6 minutes, the coin is collected via the coin collect circuit, and the coin connections are released.

**5.08** If the call continues beyond 4.6 minutes, a coin control circuit is called into the connection (Fig. 16). The ESS collects the deposited coin and sends a tone to the coin customer to alert the customer that an additional deposit is required.

**5.09** The talking path is then reestablished. Twenty-four seconds later, after a 5-minute timing period, if no disconnect has been detected, the coin control circuit is used again to check for the second coin deposit. The presence of a coin results in another 5-minute timing period. If a coin is not present, both the calling and called customers are connected to an overtime monitoring operator via the local coin overtime circuit. This activity is illustrated in Fig. 17.

**5.10** The overtime operator requests the coin deposit if the call is to continue. When the operator is satisfied that the second coin is deposited, the operator releases the connection. Another coin test is made via the coin control circuit. If the coin is present, the 5-minute timing period is started again. If the coin is not present, the operator is flashed again.

**5.11** After disconnect is recognized, any coins present are collected and the connection is then released.

### C. Coin Zone Call

**5.12** A coin zone call is a call made by a coin customer to a point outside the local calling area. When a coin zone call is initiated by a coin customer, the routing and charging information are determined from the called area code and/or office code.

**5.13** The calling customer is connected to a coin zone operator trunk. The operator is alerted when one of the eight rate lamps associated with the trunk is lighted. The operator requests the additional coin deposit and then releases the connections. The call proceeds through outpulsing to ringing. A 2- to 4-second charge delay interval is initiated after the called customer answers. After the charge delay interval, the initial charge period, (which can be 1, 2, 3, 4, or 5 minutes), is timed. Twenty-four seconds before the end of the initial charge period, the deposited coins are collected via a coin collect circuit.

**5.14** If the call continues after the initial charge period, the ESS determines the overtime charging rate. The ESS connects both the called and coin customers via the coin zone trunk to an operator and alerts the operator to the overtime charge by flashing a rate lamp. The operator can request the overtime charge immediately or can tell the coin customer to signal when the call ends. Fig. 18 illustrates the network connection for a coin zone call.

**5.15** A unique feature of the No. 1/1A ESS, on calls that terminate to a coin station, is that upon disconnect by the coin line, a coin check is made and if a coin is present, the coin is returned.

## CHARGING ON NONCOIN CALLS

### A. Automatic Message Accounting (AMA)

**5.16** The charging information that pertains to a call is accumulated initially in call store. The information pertaining to one call is assembled as a single entry and stored temporarily in the tape buffer area. When enough entries have been accumulated to fill this 100-word block, the information is transferred to the magnetic tape of the AMA recorder at the master control center. The data is recorded on the tape as a series of binary coded decimal numbers in groups of varying

length. The tape is forwarded to an accounting center and is used to compute the charges.

**5.17** Usually AMA records are not kept for noncharge calls such as assistance, operator, official numbers, and incomplete calls. The details of incomplete calls can be recorded upon request; the request is entered via the teletypewriter. An AMA record can also be created for incompleted calls that are under service observation.

### B. Centralized Automatic Message Accounting (CAMA)

**5.18** CAMA enables No. 1/1A ESS to provide toll billing for local offices in which local automatic charging facilities would be too expensive for the volume of traffic involved. CAMA can be provided with automatic number identification (ANI) or operator number identification (ONI).

**5.19** CAMA calls originating in local offices are routed to an ESS CAMA tandem office on special trunk groups. When a customer in a local office dials a number requiring CAMA facilities, the originating office seizes an idle CAMA-ONI or CAMA-ANI outgoing trunk and outpulses the called number. (The type of trunk depends on the CAMA service requirements of the originating office.) These CAMA outgoing trunks may be either multifrequency (MF) or dial pulse (DP) types. The CAMA calls come into the CAMA office on dedicated trunk groups consisting of CAMA-ONI or CAMA-ANI incoming trunks. These CAMA incoming trunks have appearances on the trunk link network in the CAMA office. After the called number has been transmitted to the CAMA office, the CAMA office prepares to receive the calling DN either automatically using the ANI feature or by a CAMA operator using the ONI feature.

**5.20** For ANI calls, the CAMA office signals the originating office to begin transmission. The originating office returns, via MF signaling over DP or MF trunks, an information digit which specifies the type of handling required for that call and the calling DN (in most cases). If a DN is returned, AMA records are automatically made and the call is allowed to complete. If the information digit specifies that the originating line has special trunk billing or multiparty service or if the originating office ANI equipment fails to operate properly, the call is forwarded to a CAMA operator who then attempts to determine the calling DN.

**5.21** For ONI calls, the originating office sends the called DN via DP or MF pulsing over DP or MF trunks, respectively, to the CAMA office. After receiving the called number, the CAMA office connects the CAMA incoming trunk to a ***CAMA operator trunk*** that terminates at a CAMA operator position. The operator attempts to ascertain the calling DN and transmits it to the CAMA office for AMA records using MF pulsing. Then the call is allowed to complete.

## 6. OPERATION OF NO. 1/1A ESS WITH SWITCHBOARDS

**6.01** Some calls require the assistance of an operator and, therefore, are directed to a switchboard. The switchboard most widely used is called the combined toll and dial system "A" (DSA) switchboard. The types of traffic handled at the DSA switchboard are illustrated in Fig. 19.

**6.02** Some service code calls are answered by an information operator or a repair clerk rather than DSA operator. Permanent signal, partial dial, and vacant code calls may appear at the DSA switchboard according to the options in individual offices.

### A. Outgoing Traffic to Operator

**6.03** A dial customer who dials "0" or the long distance code is routed to a combined toll and DSA operator over a specific group of trunks. The dialed digit "0" or the code translation, handled by the translation program indicates to the ESS what type of trunk to select. While the operator is being alerted by a lamp indication, the calling customer hears an audible ring. When the operator answers, the talking connection is established.

### B. Incoming Traffic from Operator

**6.04** An operator completes a call to a No. 1/1A ESS customer by seizing either a regular or a no-test trunk to the ESS. (No-test trunks are used by operators for testing and verification purposes.) Seizure of the trunk is detected via the trunk scanner. A translation of the trunk scanner number informs CC that the trunk is incoming and specifies the trunk network number. The trunk network number translation gives the trunk class, the number of digits to be received, and the type of digit receiver to be used. Until the completion of dialing, the call is assigned to an incoming register. If the operator used a regular

trunk, the call is processed like any other incoming call.

**6.05** If the operator seizes a no-test trunk, this fact is indicated by the trunk network number translation. When dialing is completed, if the called line is busy, CC operates the associated no-test vertical crosspoint and connects the operator to the busy line as shown in Fig. 20A or 20B. No-test calls are controlled by an operator register if the called line is busy.

## 7. CALLS USING A NO-TEST VERTICAL

### A. Operator No-Test Calls

**7.01** No-test calls are originated by toll or DSA operators to lines which may be either busy or idle. This is usually done at customer request to verify whether a called line is legitimately busy or is in a trouble condition, or to enable an operator to break in on a call in an emergency situation.

**7.02** To initiate a no-test call, the operator dials the DN on a no-test trunk. If the called line is idle, the operator no-test trunk is identified by the ESS as a toll switch trunk and the call is controlled by the toll switch program. The call is then indistinguishable from a toll switch controlled-ring call and the connection is made through the network. The operator can ring the line if there is appropriate circuitry associated with the trunk.

**7.03** If the called line is found busy, control of the call is assumed by the operator no-test program and continues until the operator disconnects. A check is made to see if temporary transfer is activated; if so, busy tone is returned. If not, a call trace is initiated. If the call trace indicates that the line is connected to a network path but is not controlled by a master control center register or a permanent signal register, a connection is established between the operator and the called line via a no-test vertical. A check is made every 500 milliseconds to determine if the line connection has changed; if there is no change, a new call trace is initiated and a new no-test connection set up.

**7.04** If a line being verified is originally idle, ringing is possible as stated in paragraph 7.01. However, once a no-test connection has been established, the line cannot be rung, even if it subsequently goes on-hook.

**7.05** When the operator disconnects from the no-test call, the no-test connection is taken down. The path associated with a busy line is not disturbed.

### B. Local Test Desk Calls

**7.06** The local test desk must have access to any line in any office served by that test desk. This is necessary so that maintenance personnel can, upon receipt of a complaint, verify that trouble does exist and, if so, whether it is located in the central office or the associated outside plant. Idle lines are connected to the test desk directly via the network, and busy lines are connected to the test desk via the no-test vertical. Either connection allows the use of the voltmeter and associated circuitry for testing the line.

**7.07** To initiate a test desk call, the tester seizes a test desk trunk by operating the keypulsing (KP) key. The dialing connection program assumes control, seizes an incoming register and connects the trunk to an appropriate receiver. Information dialed by the tester is collected and stored by the digit analysis program for trunks. After receiving the last digit (ST), the digit analysis program detects that this trunk is a local test desk trunk and transfers control to the local test desk program. When restoral of the KP key is detected, the test request can be processed. (The KP key must be restored before any connections are made.) The test call may encounter an idle line, a busy line, the office permanent busy number, a line on a list, or steady or interrupted tone.

**7.08** If the line under test is idle, a network connection is established between the local test desk trunk and the line under test. The trunk is placed in the bypass state to provide a clear testing path.

**7.09** If the test desk program finds the line under test busy, a call trace is initiated to determine if the line is on a stable and valid connection, if the line is on a list, or if the line is in an invalid condition.

**7.10** When a stable and valid connection is found, a connection from the test desk trunk to that path is made via the no-test vertical. The trunk is placed in the bypass state so the tester can perform voltmeter tests. At 400 millisecond intervals, path memory for the line under test is

examined. If a disconnect occurs, the no-test connection is abandoned, a new trace is requested and the busy-line process repeated. When the trace finds the line idle, the line is treated as though it were initially idle.

**7.11** A line may be found on a list (eg, dial tone queue, line service request hopper, disconnect register, and high and wet list). Of these lists, only lines that are on the high and wet list are tested. Lines on the other lists are considered in an unstable condition.

**7.12** When the line under test is found on the high and wet list, it is removed from the list, an idle line connection is made as described in paragraph 7.08, and tests can proceed as if the line were idle.

**7.13** If a line trace results in an invalid line condition (the line is busy but not in a call path or on a list) a second trace is initiated after 400 milliseconds. If the invalid condition is found the second time, an idle line connection is made.

## 8. CENTREX CALL PROCESSING

### A. Basic Centrex Service

**8.01** The basic Centrex service is a dial private branch exchange (PBX) system, which has been equipped to provide direct inward dialing (DID) to stations without requiring the attendant position.

**8.02** The word Centrex is derived from two words, CENTRal and EXchange. The intent is to serve one or more subscribers from a central switching machine located either on the customer's premises, called Centrex CU, or on Telephone Company property, referred to as Centrex CO.

**8.03** Centrex is a combination of individual line service and dial PBX service. Individual line service could include, for example, DID and station identification on outward dialed calls. Centrex service is specifically designed to serve large business customers efficiently, with flexible and dependable communication.

**8.04** The following guidelines are considered for the customer requiring Centrex service:

(a) Approximately 100 or more PBX stations

(b) High ratio of incoming central office calls that could be dialed directly to the station user

(c) A need for identification of outgoing calls by station line number

(d) Availability of customer property, if a Centrex CU is being considered.

**8.05** Fig. 21 illustrates the differences in the physical arrangements of the Centrex CO and CU. This discussion deals primarily with the Centrex CO arrangements.

**8.06** For further information on Centrex equipment arrangements, Centrex memory requirements, and Centrex service capabilities, refer to DFMP Division H, Section 6r and BSP Sections 231-118-331 and 966-102-100.

### B. "0" Attendant Call

**8.07** The following description of a "0" attendant call shows the interrelation of the equipment and the common block as well as some of the additional operations that are required on a Centrex call. Fig. 22 illustrates the call processing sequence of a "0" attendant call.

**8.08** Each Centrex station is directly connected to a line switch frame in the ESS office. The removal of the station's receiver results in a change of the line ferrod from an on-hook condition to an off-hook condition. The line scanner observes the change in status and forwards this information to CC. CC then processes the station's LEN through the LEN translator.

**8.09** This translation provides the following information:

(a) An abbreviated class code designated for Centrex only. This abbreviated class code is used as input into the originating class expansion table.

(b) A class selector which is used later as input into the secondary expansion table for further translation, and

(c) The billing number index, which is the last three digits of the Centrex station.

**8.10** The call next progresses to the originating class expansion table, which provides the address of the secondary expansion table. The class selector, provided in the primary translation word, is then used to index the secondary expansion table. Located within this table is a block of data for each group of Centrex stations which have the same common features. The following items are provided:

(a) Centrex group number: The Centrex group number is a 4-digit number that is used to identify this Centrex customer's common block in memory.

(b) Number group: The number group is the NXX plus the fourth digit. The primary translation word provides the last three digits of the Centrex station. The secondary expansion table provides the remaining digits of the calling station, restructuring the number up to seven digits.

(c) Line equipment number class (LENCL) words: The LENCL words contain the originating options for the calling Centrex station, for example, the type of receiver (dial pulse or TOUCH-TONE) required by the LEN. In addition, the LENCL words provide the originating major class and a treatment code.

(d) Call indicator lamp number: The call indicator lamp indicates to the console attendant the origin of the call currently being processed.

(e) Additional routing and charging information is provided.

**8.11** After the information in the secondary expansion table is determined, the call is processed as a regular outgoing call up to the point when the proper type digit receiver is connected to the station's line. At this point, the originating Centrex station receives dial tone from the ESS; then the user dials "0" to reach the attendant.

**8.12** When the digit 0 is detected, the ESS passes the Centrex group number and the dialed digit to the translation program. The translation program uses the Centrex group number to locate the customer's common block.

**8.13** To determine the handling of the digit "0" the translation uses the "0" as input into the first level digit interpreter table in the Centrex common block. (The common block contains the first level digit interpreter table. A Centrex group can have up to five levels of digit interpretation associated with the dialing pattern for the Centrex stations.) The "0" is used to index the first level digit interpreter table. The output indicates that this is an "0" attendant call; and also provides a screening DN that is associated with the attendant for identification purposes. In this case, the purpose of the screening DN is to locate which call indicating lamp to light on the attendant's console. The screening DN is processed through the DN translations. The translation is routed through all the tables to the DN auxiliary block, which provides the following:

(a) Centrex group number associated with the screening DN.

(b) "0" call indicating lamp: Identifies which lamp on the console is designated for "0" attendant.

(c) Attendant class of service: This is the key item of information that routes the call to the attendant.

**8.14** To obtain the still unknown console group number, the Centrex group number is processed through the master head table. The output is the address of the specific Centrex head table, which provides the console group number that is associated with the call indicator lamp.

**8.15** Each Centrex customer has a console group record associated with the consoles. CC next checks the console group number record area in call store to determine if any consoles in the customer's console group are available to handle this call. The console group record provides information relating to the status of the consoles in the group. Fig. 23 is an illustration of the console group record. The following 8-word block of information resides in the console group record:

(a) Word 0: Console idle longest—
A console register in call store is provided for each console in a group. This word contains the address of the console register signifying which console has been idle for the longest period of time.

(b) Word 1: Console idle shortest—
This word contains the address of the console

register identifying which console has been idle for the shortest period of time.

(c) Word 2: Address of first loop register in queue—

(1) Loop registers are used to store information for every call that terminates on, or is waiting to terminate on, the attendant console. A maximum of ten loop registers per console may be used. Although the attendant may have control of six calls on the console (six loops in use simultaneously), only one of the calls would have an established connection on the console, utilizing the attendant trunk for voice transmission and one attendant loop circuit. An example of the type of information stored in a loop register is path memory; if the call is incoming, the path from the incoming trunk to the attendant console is stored in the loop register.

(2) If the attendant has six calls on the console, and another call is placed to the console, it is queued in memory. The seventh call requiring the use of the loop register is placed as the first loop register in queue. The address of this specific loop register is provided in the second word of the console group record. Information pertaining to the seventh call is stored in this loop register.

(3) When the attendant releases a call from the console, the call in the first loop register placed in queue is connected to the console.

(d) Word 3: Address of last loop register in queue—

(1) One console can have a maximum of four calls in queue, each requiring the use of a loop register. The calls placed in queue hear an audible ringing tone; they do not realize that the console is busy, and that their call is in queue (waiting). At this point, the attendant console could have control of six calls and four calls in queue. Another call, placed to the console receives busy tone.

(2) Word 3 contains the address of the last loop register in queue.

(e) Word 4: Console queue peg count— Word 4 contains a peg count of the number of calls in queue for the console group for a given period of time.

(f) Word 5: Queue usage count and queue overflow count—

(1) Queue usage count is a count of the number of calls presently in queue.

(2) Queue overflow count indicates the number of times calls are placed to a console group and receives a busy signal because the maximum number of four calls are already in queue.

(g) Word 6: Number of consoles in group— This word contains the number of consoles in this console group. The number of calls presently in queue (word 5) is compared to the number of consoles in the group. If the number of calls in queue equals four times the number of consoles, the call receives a busy tone and proceeds no further.

(h) Word 7: Console maintenance information— Word 7 provides specific maintenance information about the console group, indicating, for example, if any consoles are out of service.

**8.16** After all of the eight words in the console group record have been identified, the call is directed to the console register which has been idle the longest period of time. The "0" attendant call terminates on that console. The console register provides a route index that is used to determine what attendant loop circuits are associated with this specific console. The route index is used as input into additional routing translations. The output information provides the TGN that is associated with the six attendant loop circuits on the MTF. Once the TGN is determined, an idle attendant loop circuit is seized. A network connection from the Centrex station's LEN to the attendant loop circuit is established as a line-to-trunk junctor connection. The data link in the ESS central office then transmits lamp signal information over the data loop to the console control cabinet. The cabinet decodes these signals and:

(a) lights the specific call indicator lamp associated with the "0" attendant calls,

(b) lights the source lamp at 120 IPM, and

(c) activates the audible buzzer indicating that a call is waiting on the console.

The attendant depresses the loop key and answers the call. This action results in the establishment of the path from the attendant trunk to the attendant loop circuit and provides a voice transmission path from the station to the attendant console.

### C. Intra-Centrex Group Call

**8.17** Removal of the Centrex station's receiver results in a change in the line ferrod from an on-hook condition to an off-hook condition. The line scanner observes the change in status and forwards this information to CC. CC then processes the station's LEN through the LEN translator.

**8.18** This translation provides the following information:

(a) An abbreviated class code which is used as input into the originating class expansion table,

(b) A class selector which is used later as input into the secondary expansion table for further translation, and

(c) The billing number index which is the last three digits of the Centrex station.

**8.19** The call next progresses to the originating class expansion table, which provides the address of the secondary expansion table. The class selector, provided in the primary translation word, is then used to index the secondary expansion table. Located within the table is a block of data for each group of Centrex stations which have the same common features. This expansion provides the station's Centrex group number, number group, LENCL words, and other routing information as described in paragraph 8.10.

**8.20** CC analyzes this translation information and connects the proper type digit receiver to the station's line. At this point the originating station receives dial tone. The station user then dials the extension number. (A Centrex group can have 2-, 3-, 4-, 5-, 6-, or 7-digit extension numbers. For this example, 4-digit extension numbers are assumed.)

**8.21** When the first dialed digit is detected, the ESS again uses the Centrex group number to locate the customer's common block. The dialed digit is then used to index the first level digit interpreter table. The final data for Centrex extensions (data type 2) is usually found in the first level digit interpreter table. The following data is provided by the data type 2 entry:

(a) Normalized office code,

(b) Prefixed digit 1,

(c) Prefixed digit 2,

(d) Number of additional digits to be collected, and

(e) Number of digits to be deleted.

**8.22** In this example of dialing a 4-digit extension, no digits are deleted, no digits are prefixed, but three more digits are collected. The dialed extension's DN is constructed from the normalized office code (which directly represents the office code) and the collected digits. The DN is used as input into the DN translator. The station's terminating major class is obtained from the DN translation to verify that the called station is allowed to receive calls. (An intra-Centrex call is not screened as a call made into the message network which is routed through the 3-/6-digit translator.) The associated LEN is also provided so that audible and power ringing can be applied to the connection. If the called station answers, the two stations are connected via either a line-to-line junctor circuit or an intraoffice trunk circuit.

### D. Incoming Call to a Listed Directory Number

**8.23** The first indication of the incoming call is the seizure of a trunk on the MTF or UTF. All the processing steps are the same as those required for a regular incoming call up to the point where the called DN is restructured to the full seven digits. Once the number is complete, a DN

translation is required. The DN auxiliary block provides the following:

(a) Terminating major class code indicates to the program that this call is to terminate on the attendant console

(b) Call indicator lamp associated with the listed directory number

(c) Centrex group number.

**8.24** Although, at this point of the call, the translation has provided the call indicator lamp and the centrex group number, the console group with which the call indicator lamp is associated, is unknown. To find this information, the Centrex group number is processed through the master head table; the output is the address of the Centrex head table, which in turn provides the address of the Centrex common block associated with the listed DN. The Centrex common block provides the console group number associated with the call indicator lamp.

**8.25** The call is next directed to the console group record in call store. Before the call is processed any further, the translation program compares the number of consoles in the group (word 6) to the number of calls presently in the queue (word 5). If the number of queued calls equals four times the number of consoles in the group, the calling party receives a busy tone. If the maximum number of calls are not in queue, the call is directed to the console register. Word 0 of the console group record provides the address of the console register associated with the console that has been idle the longest period of time. The console register provides a route index which is used to determine which of the six attendant loop circuits on the MTF are associated with this particular console.

**8.26** Using the route index as input, the translation program accesses additional routing translations to provide the specific TGN that is assigned to the attendant loop circuits. An idle attendant loop circuit is seized; a reserved path is set up from the incoming trunk to the attendant loop circuit; an audible ringing tone circuit is connected to the incoming trunk. Fig. 24A illustrates these activities.

**8.27** The data link transmits lamp information over the data loop to the console control cabinet. From this information, the console control cabinet determines which call indicator lamp is associated with the listed DN, and which SOURCE lamp is to be lit in the switched loop section of the console.

**8.28** When the attendant answers the call, the previously reserved path from the incoming trunk to the attendant loop circuit and attendant trunk is established. Fig. 24B illustrates this connection. The attendant determines the station to which the call is to be completed and depresses the START key on the console.

**8.29** A CTTR is then connected to the unused path (port) of the attendant loop circuit. The attendant keys the called station number on the console. An idle ringing circuit is connected to the called Centrex station; the called station is rung. Fig. 25A illustrates this activity.

**8.30** If the attendant releases before the called station answers, the attendant loop circuit is released from the attendant trunk, allowing the attendant to receive additional incoming calls. The incoming trunk still remains connected to the first port of the attendant loop circuit; the second port remains connected to the audible ringing circuit. The two ports of the attendant loop circuit are bridged, providing a path for the audible ringing to be returned to the calling party. Fig. 25B demonstrates these connections. The SOURCE lamp on the console remains steadily lit while the DESTINATION lamp winks. This configuration remains the same until the called party answers or the attendant reenters the connection by depressing the LOOP key on the console.

**8.31** If the called Centrex station answers, an attempt is made to establish a direct link between the incoming trunk and the called line as shown in Fig. 26A. The attendant loop circuit is released; the SOURCE and DESTINATION lamps on the console are extinguished. If no direct path is available, the attendant loop circuit is maintained to bridge the called line and the incoming trunk.

**8.32** If the called station answers before the attendant releases with the RELEASE key, the called station is connected to the second port of the attendant loop circuit. A 3-way conversation, illustrated in Fig. 26B results, including the calling and called parties and the attendant. The attendant depresses the RELEASE key which causes the

attendant trunk to release from the attendant loop circuit. The console is now free to accept other calls.

### E. Automatic Identified Outward Dialing

**8.33** The automatic identified outward dialing (AIOD) feature provides automatic identification of Centrex CU stations on chargeable outward calls for purposes of individual station billing. In addition, AIOD is used to identify, for sampling purposes, Centrex CU stations making common control switching arrangement calls.

**8.34** The AIOD call is very much like a direct outward dialing (DOD) call except for the translation required for billing purposes. The AIOD call uses a line link network or a trunk link network appearance depending on whether a 1-way or 2-way trunk group is utilized. The AIOD trunks are associated with a multi-line hunt group and are correlated to a special billing number in case the AIOD call cannot be identified by station.

**8.35** The call processing steps required for an AIOD call are described below and are illustrated in Fig. 27. The numbers in parentheses on Fig. 27 correspond with the numbers detailed below.

(1) The Centrex station user lifts the receiver and receives dial tone from the dial equipment at the Centrex.

(2) To place a call outside the Centrex, the user dials a central office access code—generally 9.

(3) The AIOD trunk, which has a line link network appearance, is seized by the Centrex station.

(4) The Centrex ANI equipment identifies the originating station by the four digit station number.

(5) The selected trunk is also identified by the four digit AIOD index number.

(6) The station number and the index number are transmitted over the data trunk to the ESS central office AIOD interface circuit.

(7) CC stores the station number in the AIOD buffer table word reserved in call store for the particular trunk used.

(8) When the Centrex customer seizes the line link network appearance, Step 3, the line ferrod state is changed to off-hook.

(9) The line scanner detects the change in status.

(10) The supervisory line scan program receives notice of the change from the line scanner and forwards this information to CC.

(11) The line scanner address is used as input to the LEN translations to locate the LEN auxiliary block.

(12) The output of the translation is the multi-line hunt group number, terminal number, NXX code, AIOD index number, special billing number, class of service, special features, and whether it is a dial pulse or TOUCH-TONE line.

(13) The NXX Code and the AIOD index number are stored in the AMA register. The special billing number is also stored in an AMA register, in case the station cannot be identified for billing purposes. If this is not an AMA call, this data will be used to delete the station number in the buffer table during the ringing cycle.

(14) CC stores the remaining translation information in the originating register in call store.

(15) CC selects an idle CDPR or CTTR, whichever receiver is appropriate.

(16) The network map is checked for an idle path from the line link network to the trunk link network to the CDPR (or CTTR); this path is reserved.

(17) The peripheral order buffer execution program is executed to close the paths between the networks.

(18) When the path has been established, dial tone is given to the Centrex station. After the first digit has been received, dial tone is removed.

(19) When the customer starts dialing, the dial pulse scan program or the TOUCH-TONE digit detection program is executed. The selection of the program depends on the type of set used by the calling customer.

(20) When the dial pulse scan program determines that a digit has been dialed, it reports this to the digit analysis program.

(21) The digit analysis program counts and detects all digits dialed. These digits are stored in an originating register.

(22) CC uses the first three digits as input into translation tables which contain information on routing and charging.

(23) The output of this translation includes the following:

- Whether the call is local or foreign area call,
- routing and charging information,
- outgoing trunk group,
- type of transmitter to use, and
- number of digits to outpulse.

(24) CC stores the translation information in an originating register.

(25) CC selects an idle transmitter (DP or MF).

(26) CC selects an idle outgoing trunk to the distant office.

(27) CC stores the transmitter and outgoing trunk locations in the outpulsing register in call store.

(28) The network map is checked for an available path between the outgoing trunk and the transmitter; this path is reserved. CC also reserves a path from the calling line to the outgoing trunk; this path is for the talking connection.

(29) The peripheral order buffer program is executed to close the path from the transmitter to the outgoing trunk. A wink signal is sent from the distant office to indicate that the digits may be outpulsed.

(30) The transmitter outpulses the digits and is then released.

(31) The reserved path from the calling line to the outgoing trunk is established through the execution of the peripheral order buffer execution program. If the call has been routed to a CAMA operator at this point in the processing, the CAMA operator interrupts to request the calling number.

(32) The terminating office supplies the regular and audible ringing to the called and calling line.

(33) The trunk scanner scans the outgoing trunk for an answer detection. When the called line answers, the trunk scanner scans every 100 milliseconds to detect an on-hook condition.

(34) When the called line answers, the AMA program is called in.

(35) CC, via the AMA program, requests the NXX code and the AIOD index number from the AMA register.

(36) The AIOD index number is used to locate the station number in the AIOD buffer table.

(37) When the station number is located, the NXX code and the station number are used for the initial AMA billing entry which is stored in an AMA register.

(38) When the trunk scanner detects the on-hook condition, the AMA program is again called in to enter the final billing entry in the AMA register.

(39) The billing information is then transferred to the AMA tape output buffer in call store.

(40) When a predetermined amount of data has been accumulated in the buffer, the contents of the buffer is transferred to an AMA tape.

## 9. REFERENCES

### A. Bell System Practices

(1) Section 231-003-101—Teletypewriter Facility—Description

(2) Section 231-045-105—Call Processing—POTS Software Subsystem Document Description

(3) Section 231-100-101—Signal Processor—Description of System Operation

(4) Section 231-102-101—Junctor, Trunk, and Service Circuits—Desription

(5) Section 231-118-102—Line Translation Data—Description

(6) Section 231-118-103—Trunk Translation Data—Description

(7) Section 231-118-104—Routing and Charging Translation Data—Description

(8) Section 231-118-105—Miscellaneous Translation Data—Description

(9) Section 231-118-331—Centrex CO Recent Change Procedures

(10) Section 231-140-301—Teletypewriter Operating Procedures

(11) Section 231-310-106—Call Processing—Centrex Software Subsystem Document Description

(12) Section 966-102-100—Centrex and PBX-CO Service General Description.

### B. Dial Facilities Management Practices

(1) Division H, Section 6r—Centrex Administration

(2) Division H, Section 6b—System Description

### C. Other References

(1) Translation Guide TG-1A

(2) Translation Output Configuration PA-591003 (No. 1 ESS)

(3) Translation Output Configuration PA-6A002 (No. 1A ESS)

## 10. ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ***AIOD:*** | automatic identified outward dialing |
| ***ALIT:*** | automatic line insulation test |
| ***ANI:*** | automatic number identification |
| ***AMA:*** | automatic message accounting |
| ***CAMA:*** | centralized automatic message accounting |
| ***CC:*** | central control |
| ***CDPR:*** | customer dial pulse receiver |
| ***CPD:*** | central pulse distributor |
| ***CTTR:*** | customer TOUCH-TONE receiver |
| ***DDD:*** | direct distance dialing |
| ***DID:*** | direct inward dialing |
| ***DN:*** | directory number |
| ***DOD:*** | direct outward dialing |
| ***DP:*** | dial pulse |
| ***DSA:*** | dial system "A" |
| ***KP:*** | keypulsing |
| ***LEN:*** | line equipment number |
| ***LJSF:*** | line junctor switch frame |
| ***LLN:*** | line link network |
| ***LSF:*** | line switch frame |
| ***MF:*** | multifrequency |
| ***MTF:*** | miscellaneous trunk frame |
| ***ONI:*** | operator number identification |
| ***PBX:*** | private branch exchange |
| ***POB:*** | peripheral order buffer |
| ***PUB:*** | peripheral unit bus |

| | | | |
|---|---|---|---|
| *SP:* | signal processor | *TLN:* | trunk link network |
| *ST:* | start | *TNN:* | trunk network number |
| *TDF:* | trunk distributing frame | *TSF:* | trunk switch frame |
| *TGN:* | trunk group number | *TSN:* | trunk switch number |
| *TJSF:* | trunk junctor switch frame | **UTF:** | universal trunk frame |

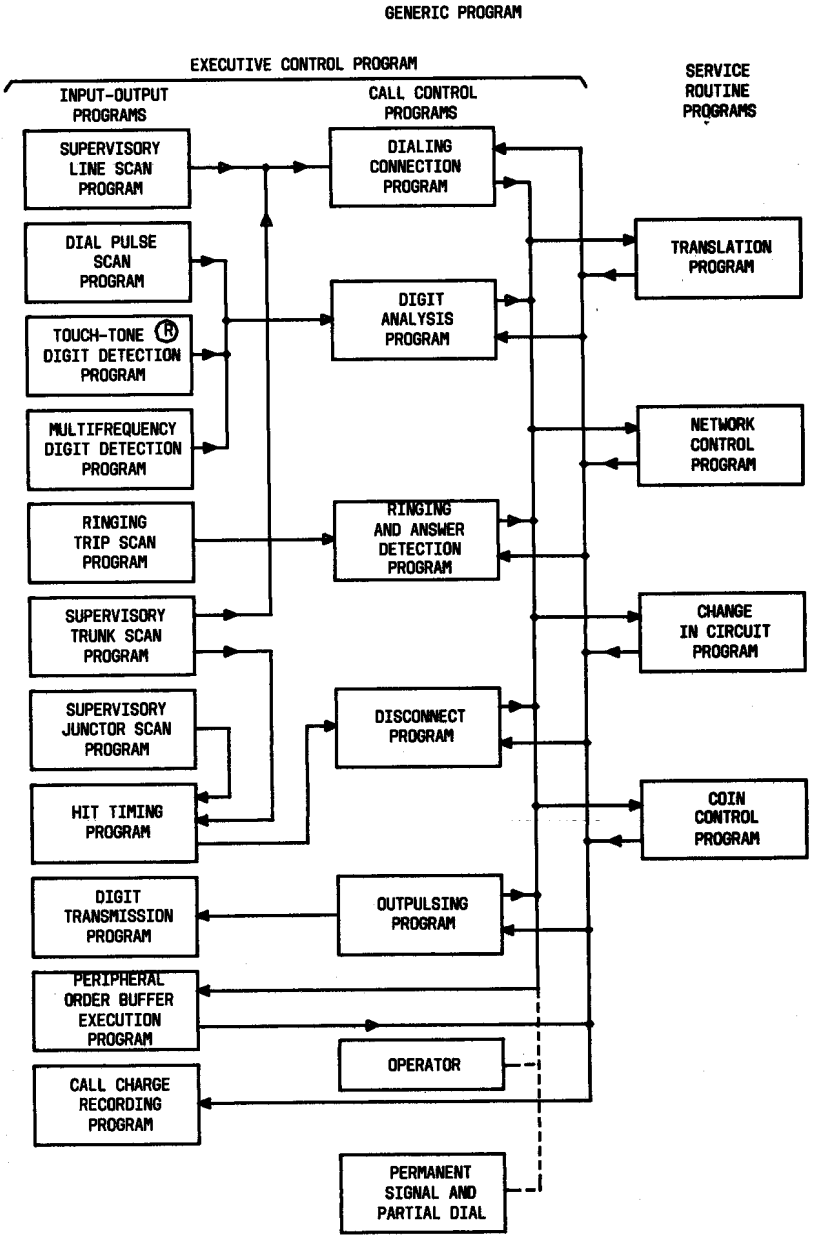



**Fig. 1—Call Processing Functions and Associated ESS Programs (1.07)**

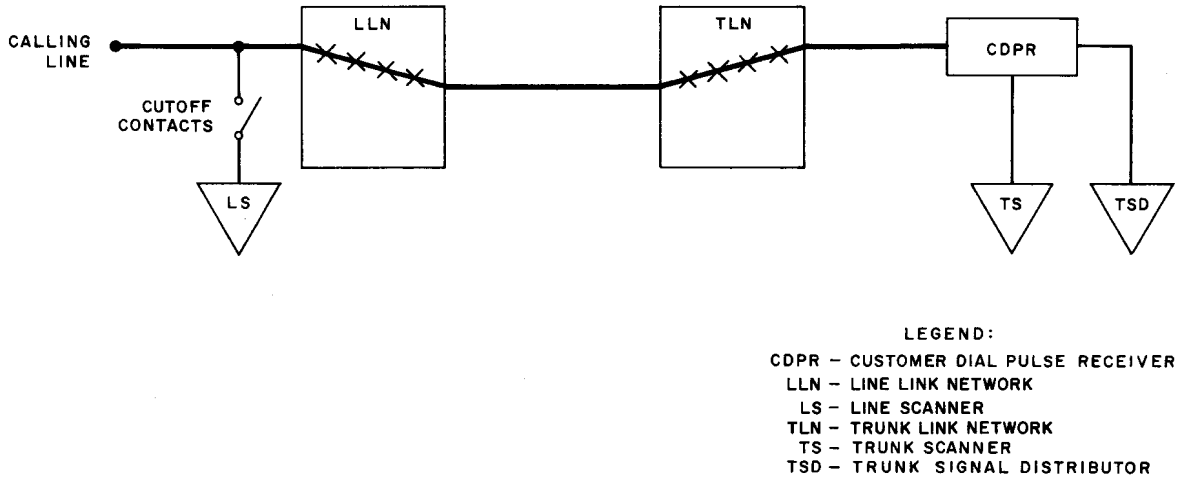



**Fig. 2—Dial Tone Connection (3.09)**

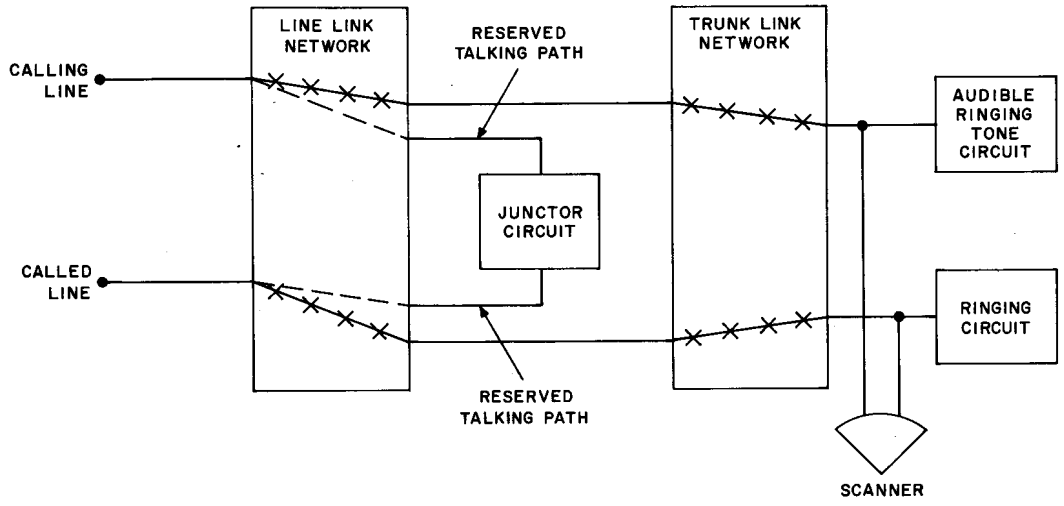



**Fig. 3—Ringing and Audible Connection (3.24)**

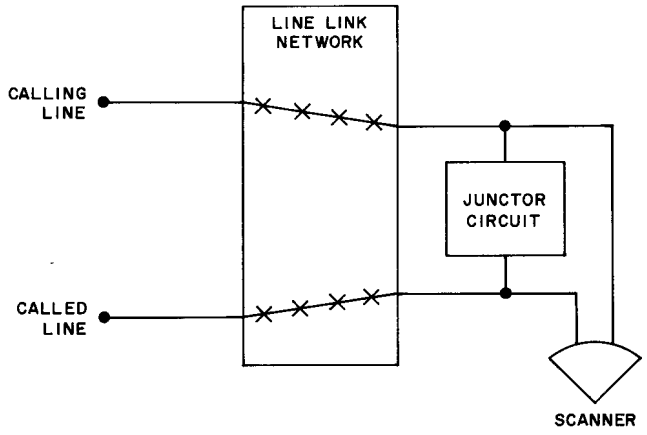
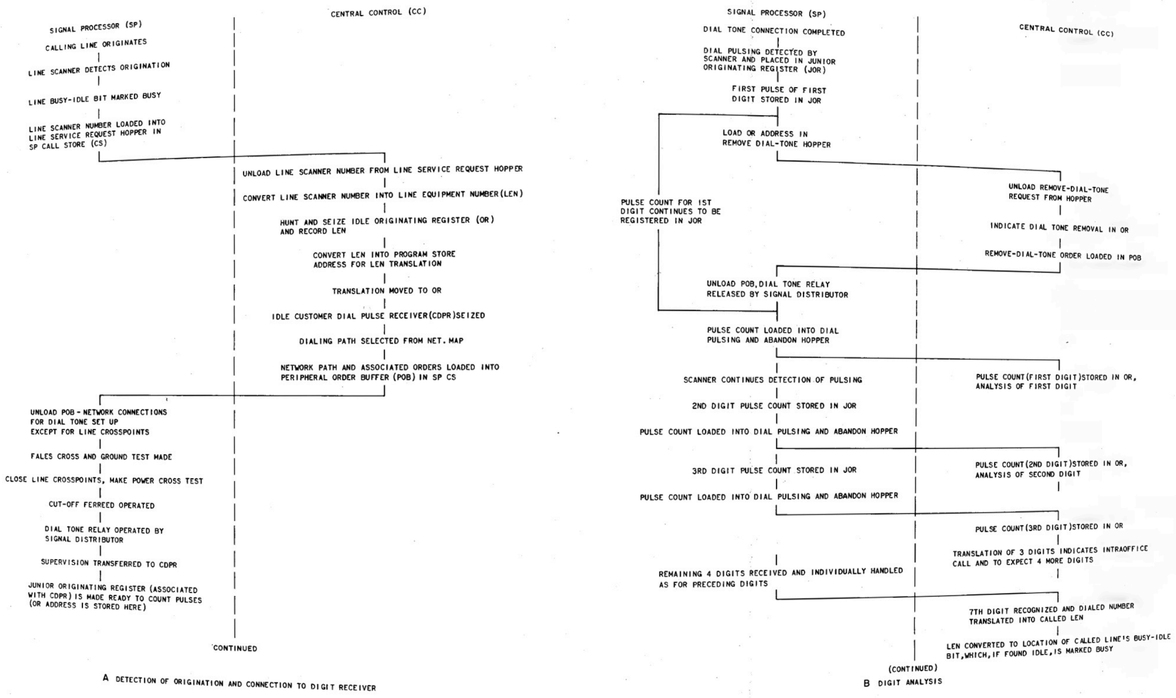


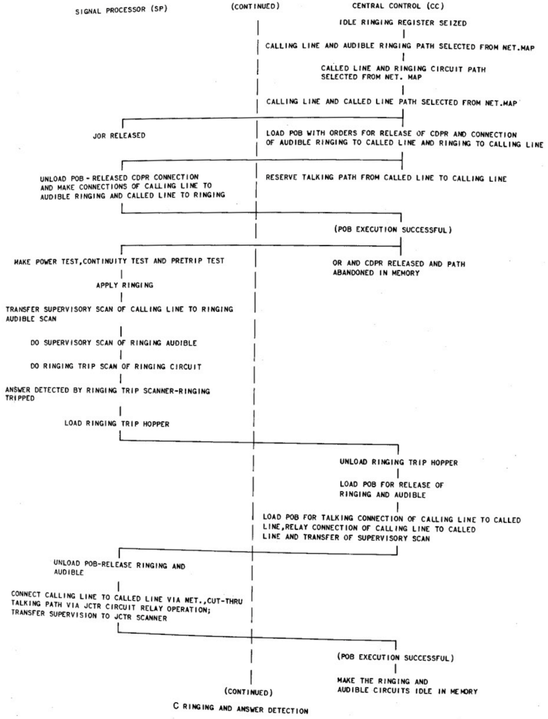

**Fig. 4—Talking Connection (3.26)**



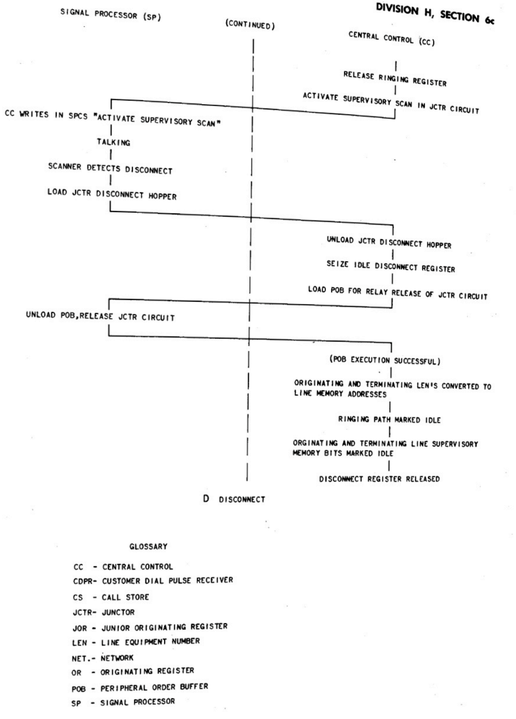

A DETECTION OF ORIGINATION AND CONNECTION TO DIGIT RECEIVER




B DIGIT ANALYSIS




C RINGING AND ANSWER DETECTION




GLOSSARY

CC - CENTRAL CONTROL
CDPR- CUSTOMER DIAL PULSE RECEIVER
CS - CALL STORE
JCTR- JUNCTOR
JOR - JUNIOR ORIGINATING REGISTER
LEN - LINE EQUIPMENT NUMBER
NET.- NETWORK
OR - ORIGINATING REGISTER
POB - PERIPHERAL ORDER BUFFER
SP - SIGNAL PROCESSOR

**Fig. 5—Functions Performed by Signal Processor and Central Control During the Processing of an Intraoffice Call (3.33)**

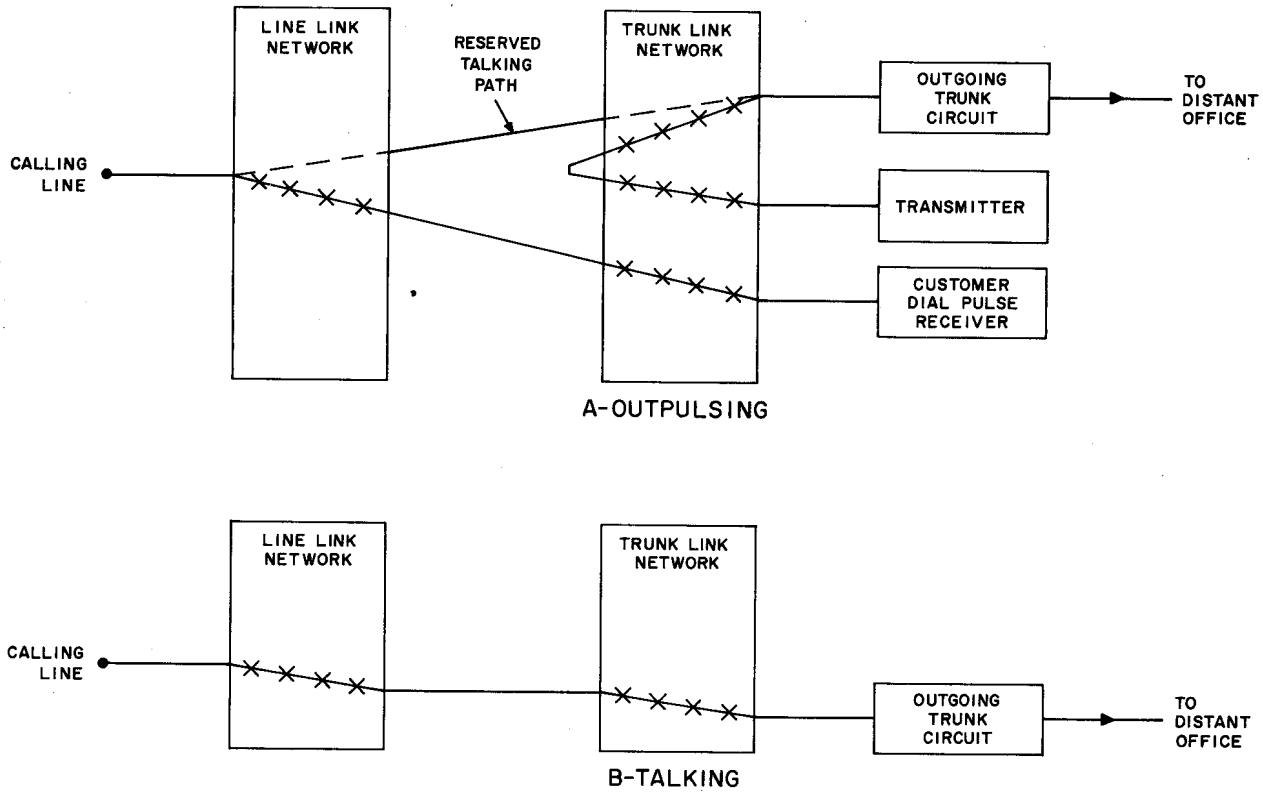



**Fig. 6—Interoffice (Outgoing) Call Connections (3.45) (3.47)**

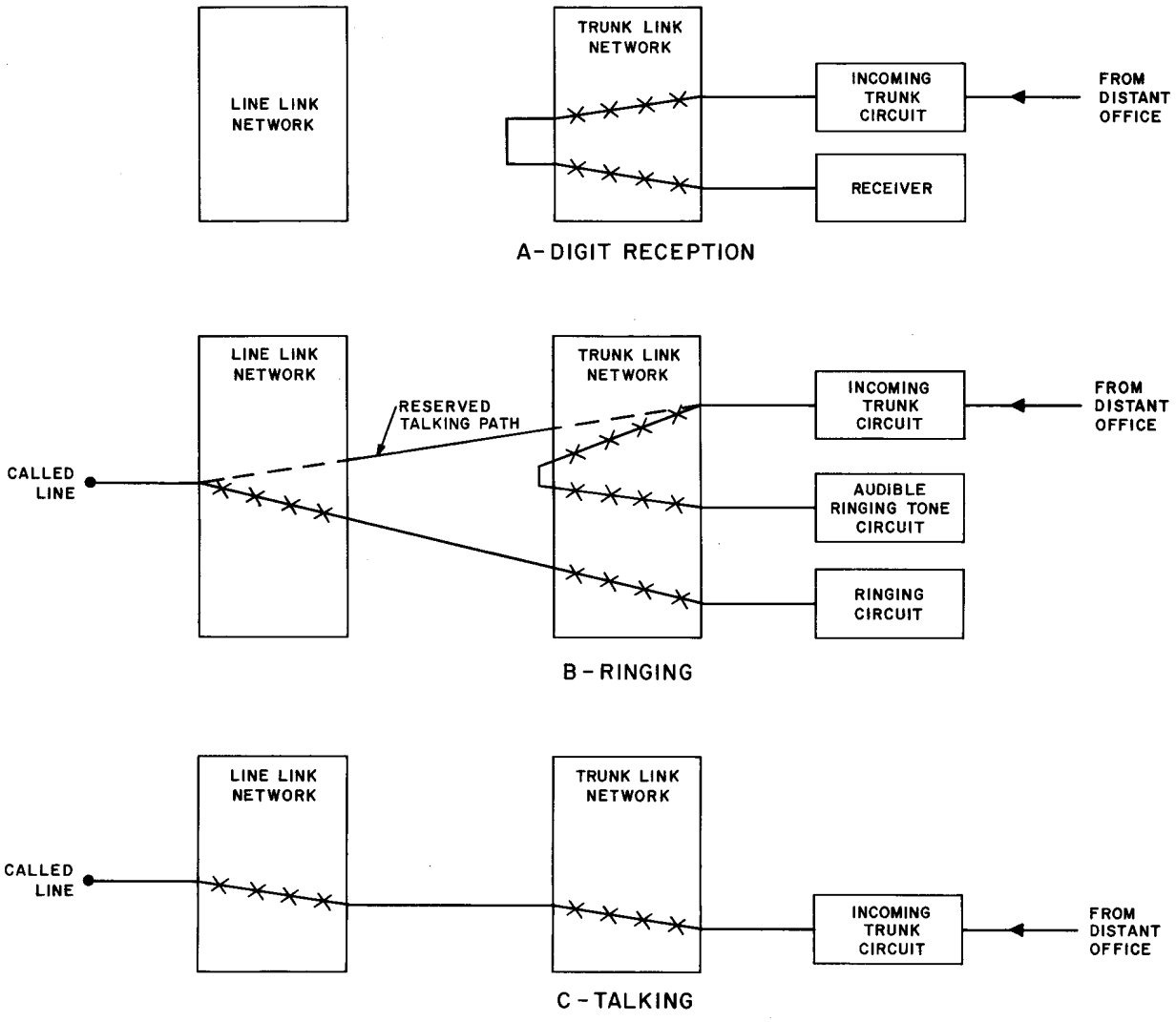



**Fig. 7—Incoming Call Connections (3.54) (3.57) (3.58)**

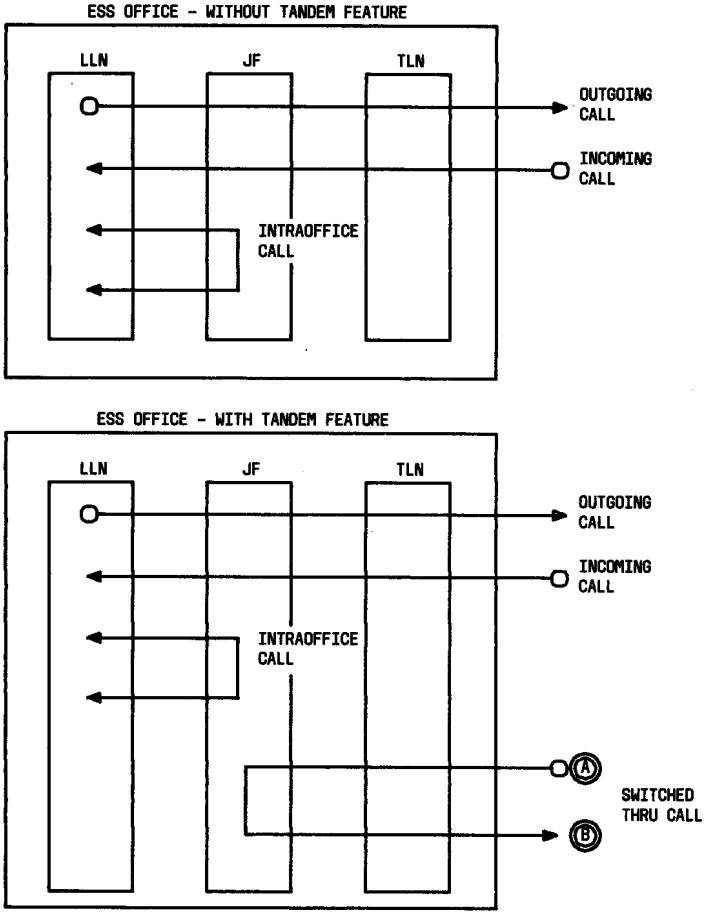



**Fig. 8—ESS Tandem Capabilities (3.63)**

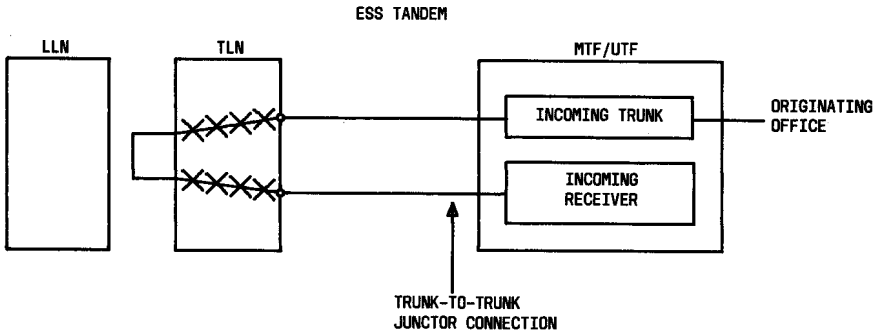



**Fig. 9—Incoming Tandem Trunk to Incoming Receiver Connection (3.68)**

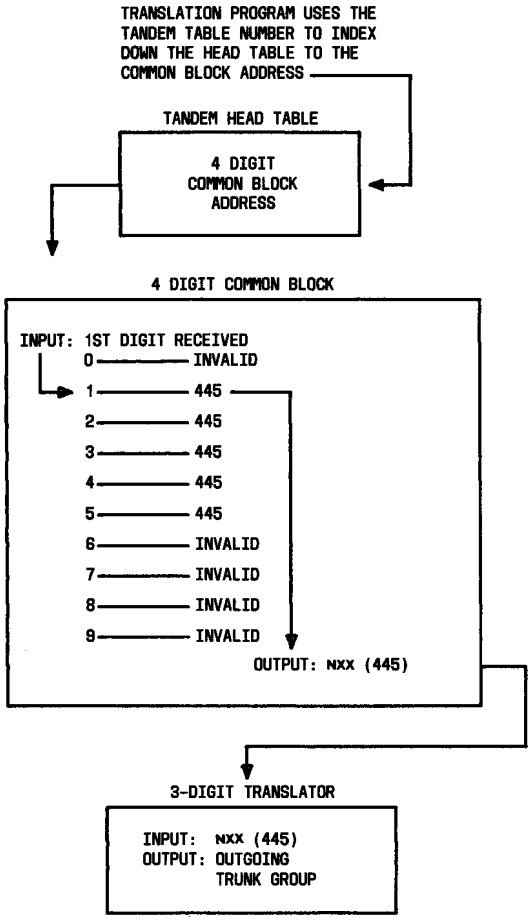



**Fig. 10—Translation of a 4-Digit Tandem Call (3.72)**

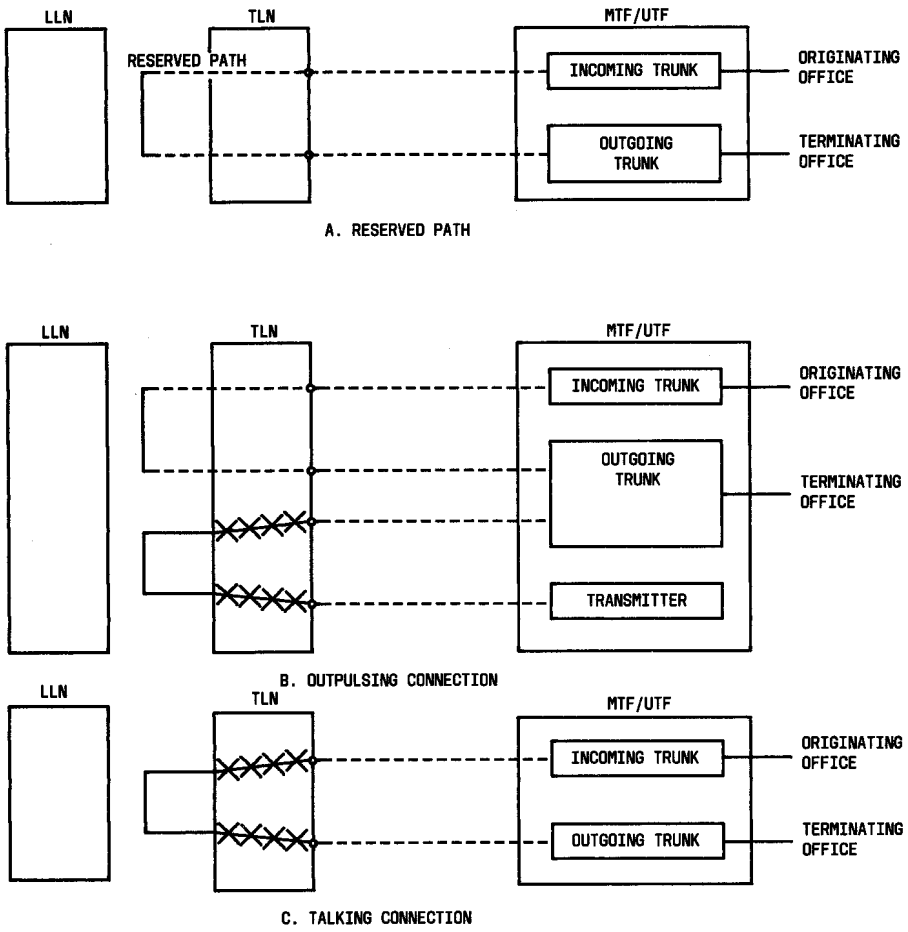



**Fig. 11—Tandem Call Connections (3.75) (3.76) (3.78)**

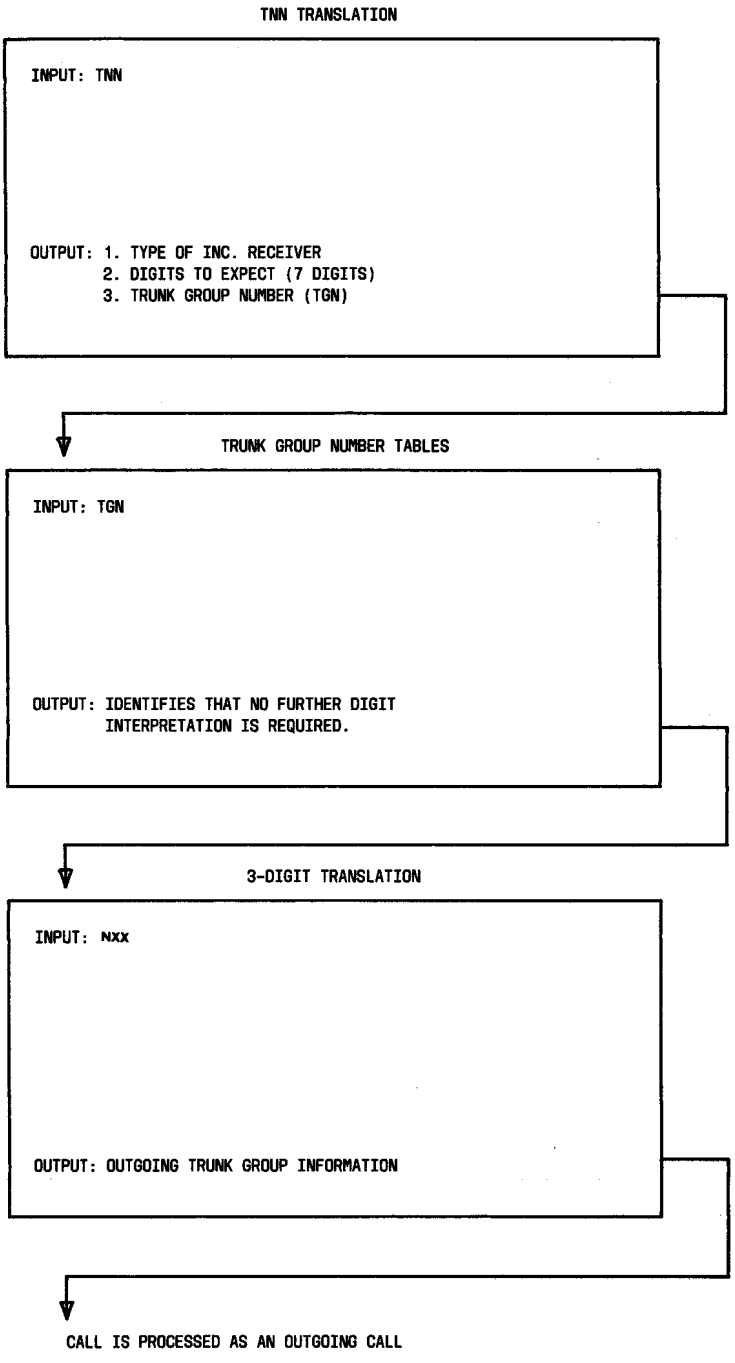



**Fig. 12—Translation of a 7-Digit Tandem Call (3.80)**

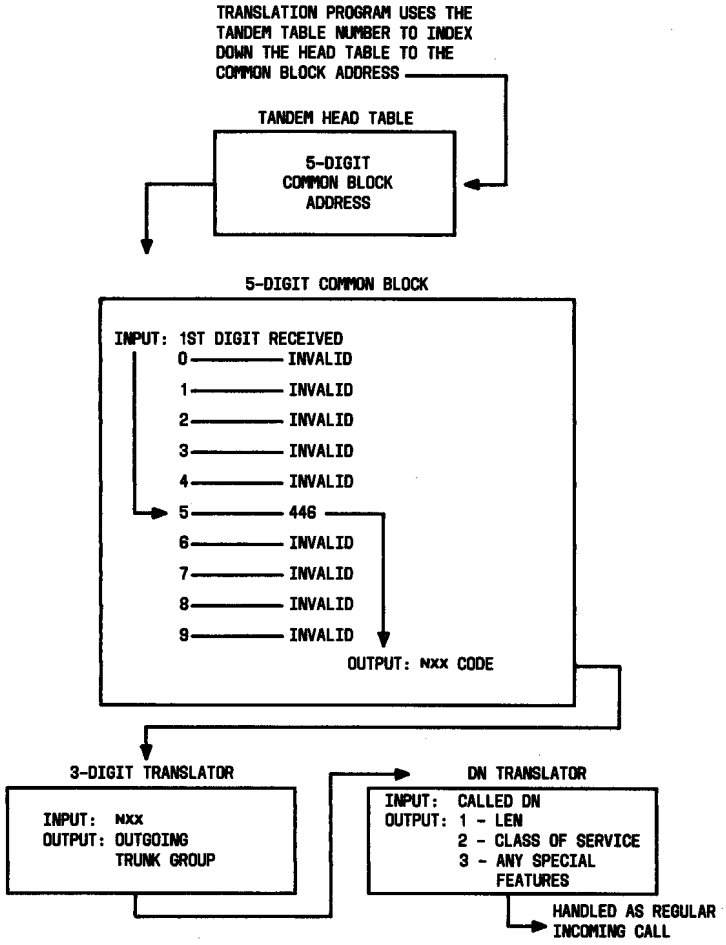



**Fig. 13—Translation of a 5-Digit Tandem Call (3.88)**

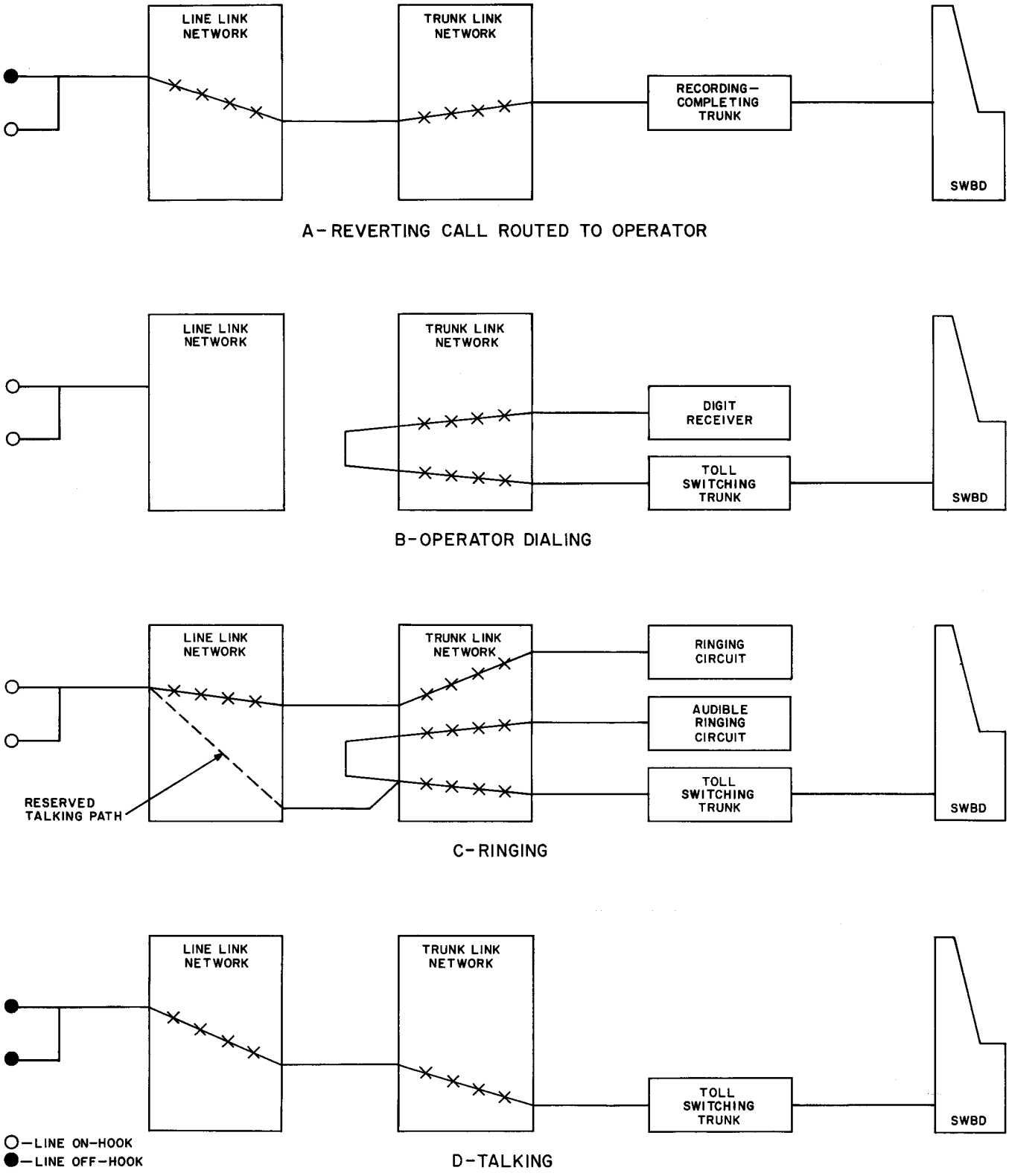
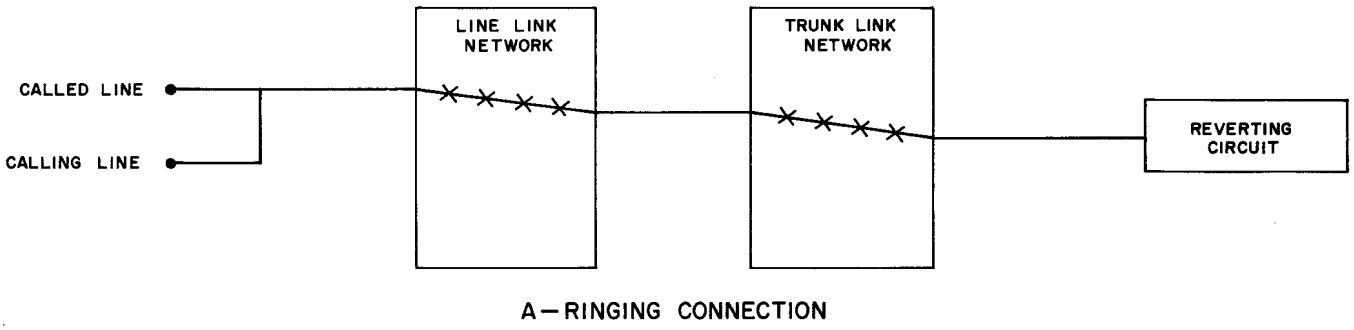
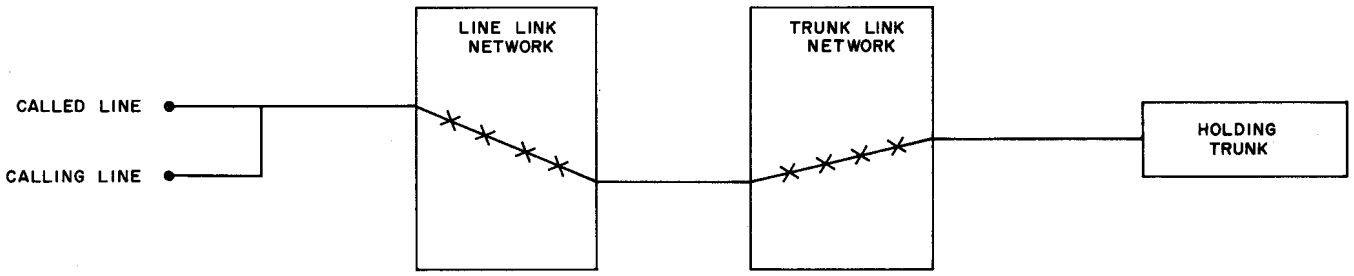



**Fig. 14—Reverting Call-Operator Completed (3.90) (3.91) (3.92)**




A—RINGING CONNECTION




B—TALKING CONNECTION

**Fig. 15—Connections on Reverting Call (3.94)**

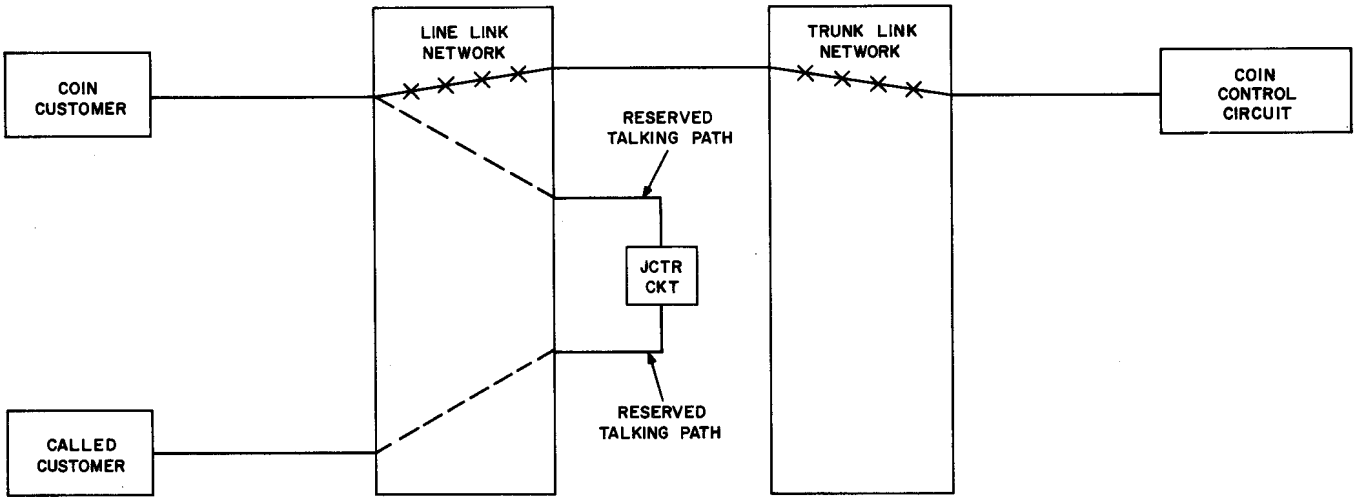



**Fig. 16—Network Connection of Coin Control Circuit (5.02) (5.08)**

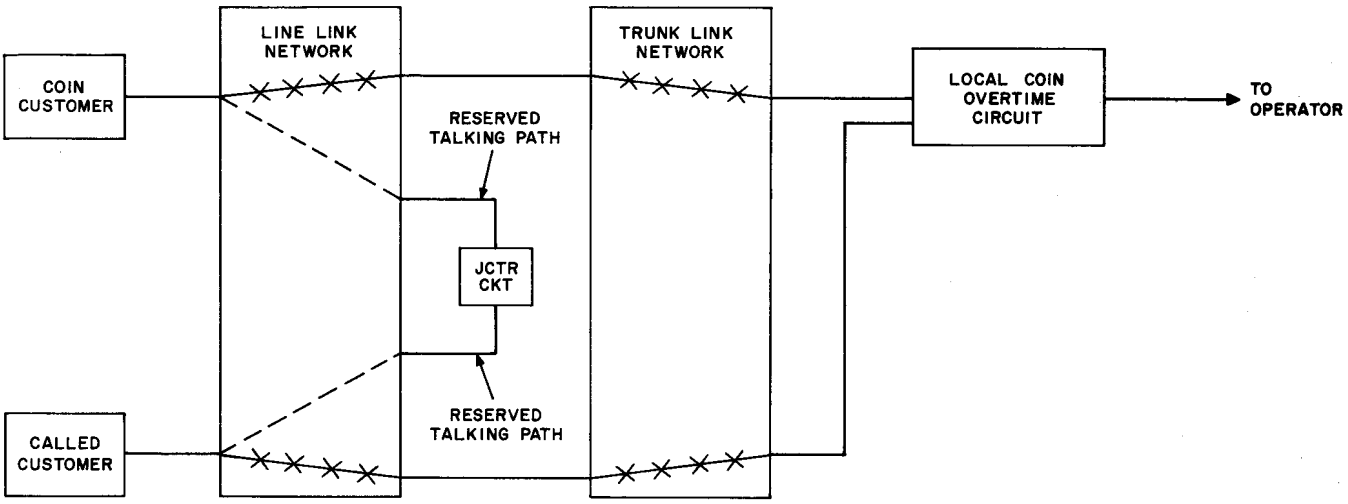



**Fig. 17—Connection for Local Coin Call in Overtime (5.09)**

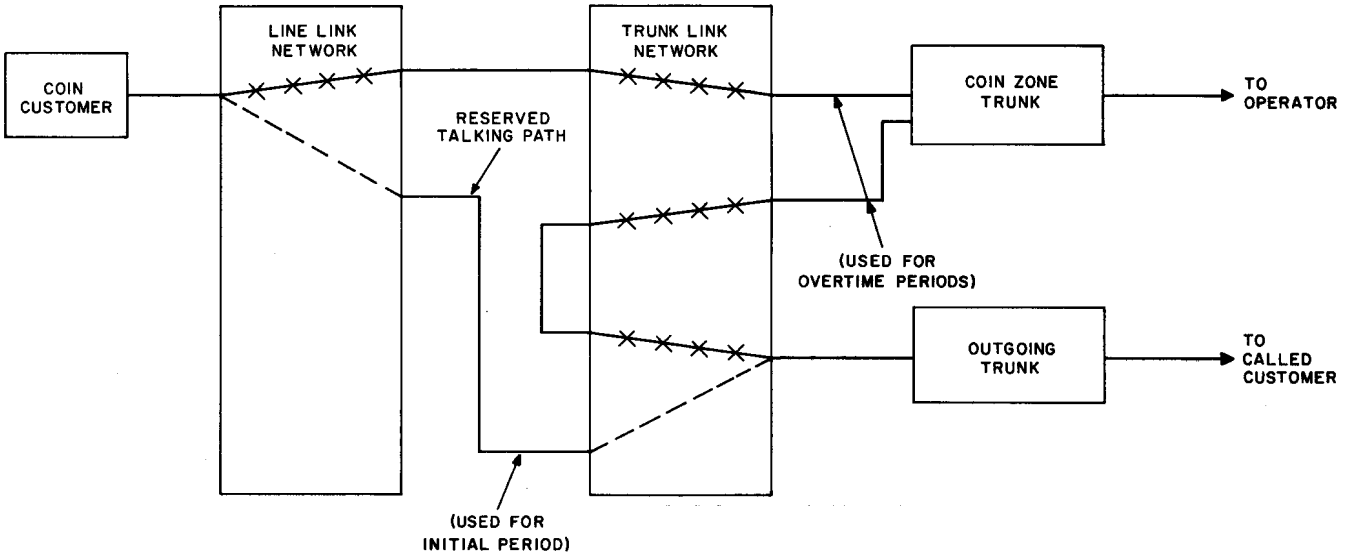



**Fig. 18—Network Connection for Coin Zone Call (5.14)**

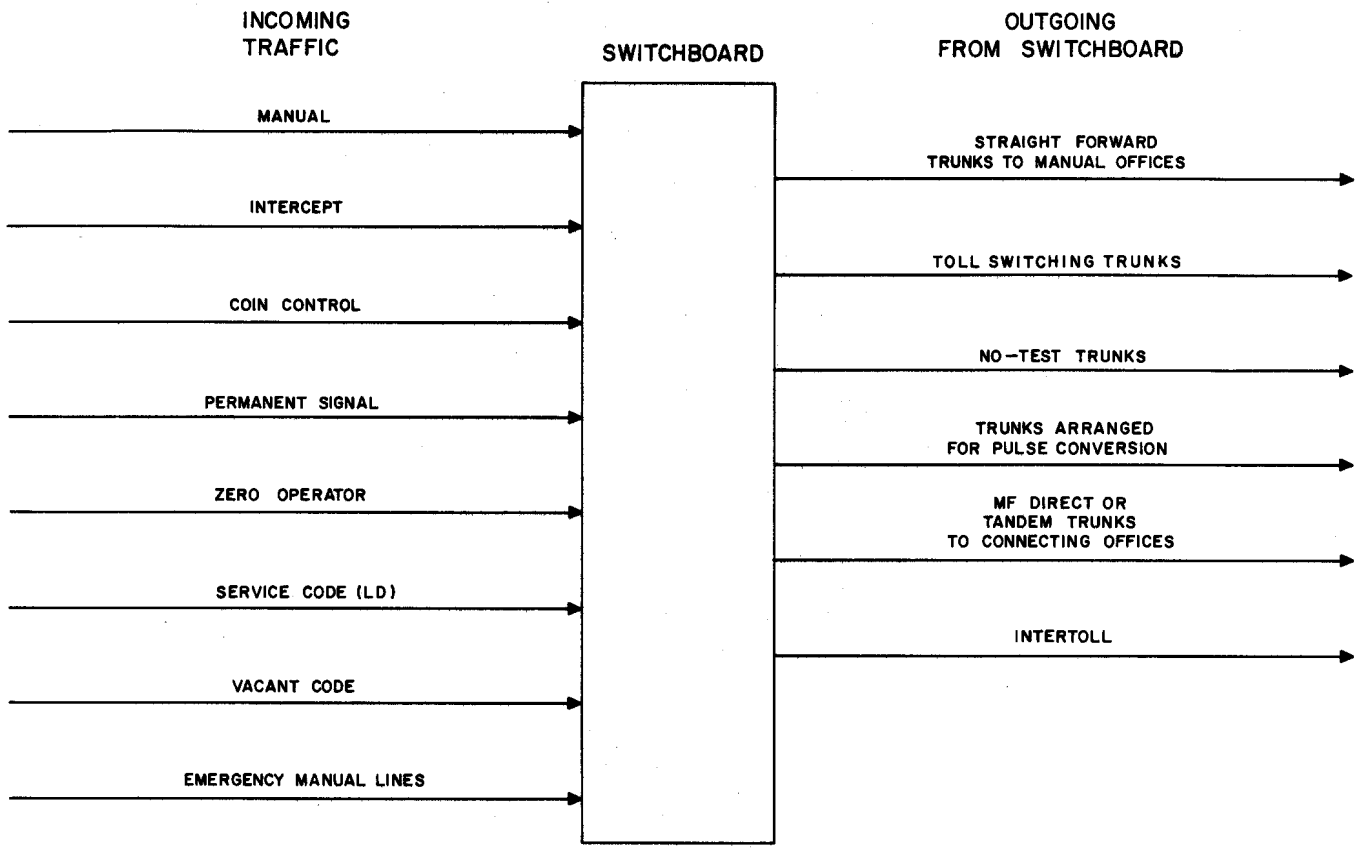



**Fig. 19—Traffic at Switchboard Associated with a No. 1/1A ESS Office (6.01)**

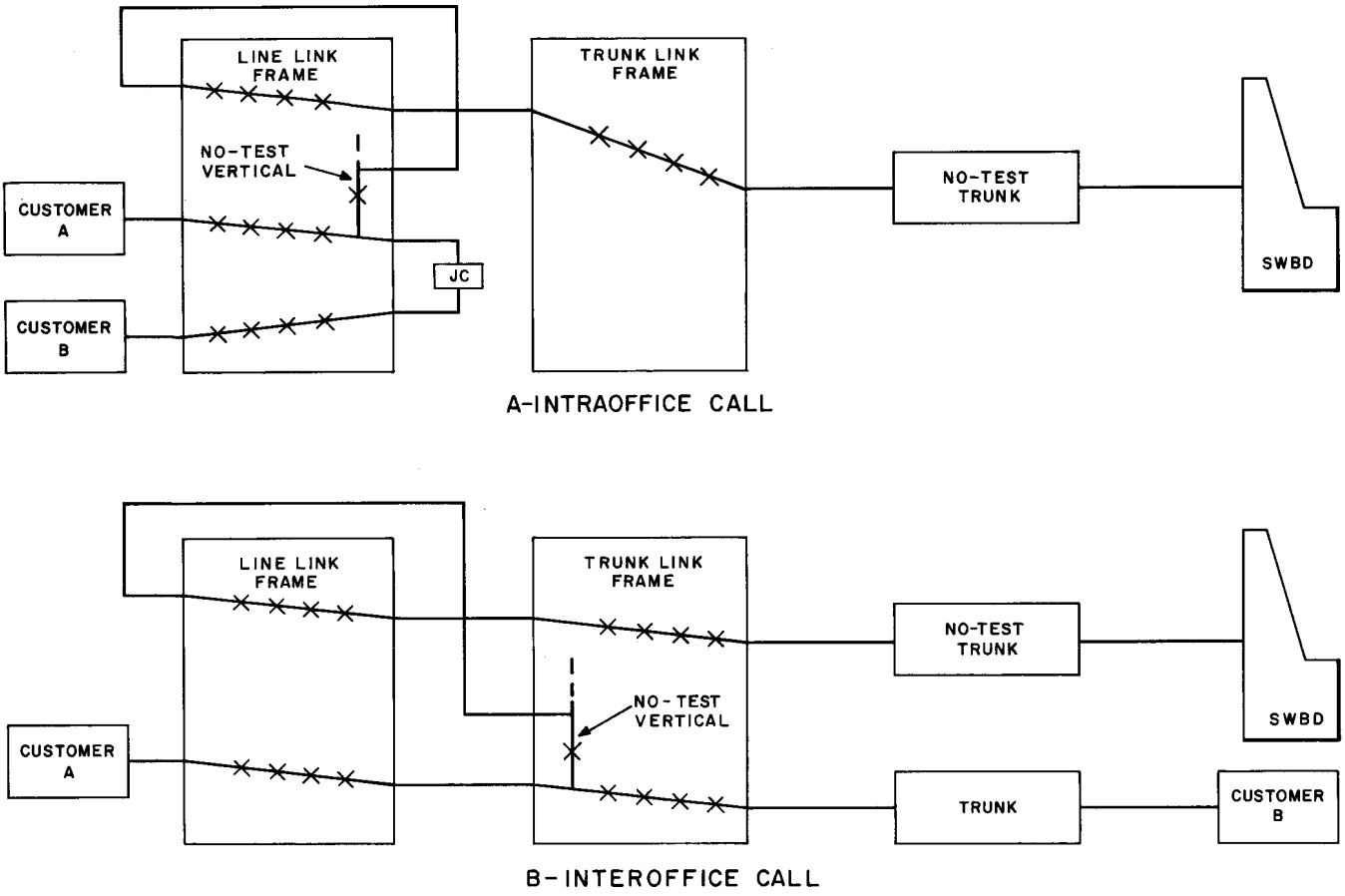



**Fig. 20—Network Connections for No-Test Call to Busy Line (6.05)**

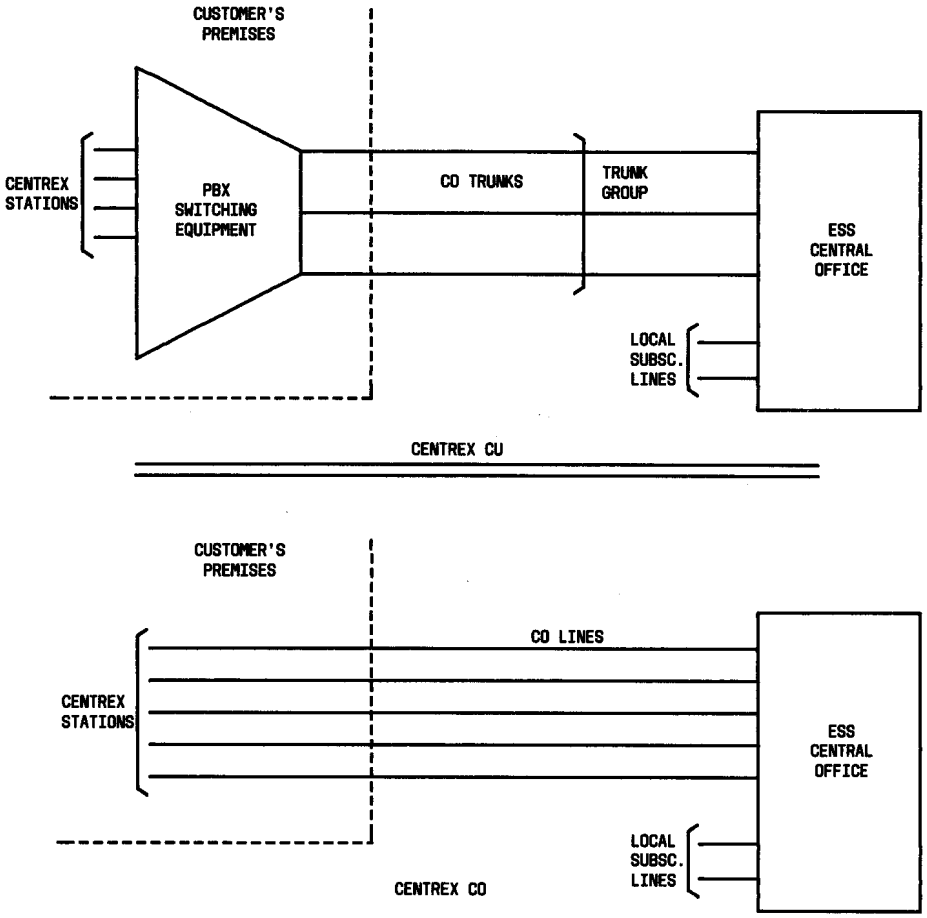



**Fig. 21—ESS Centrex Arrangements (8.05)**

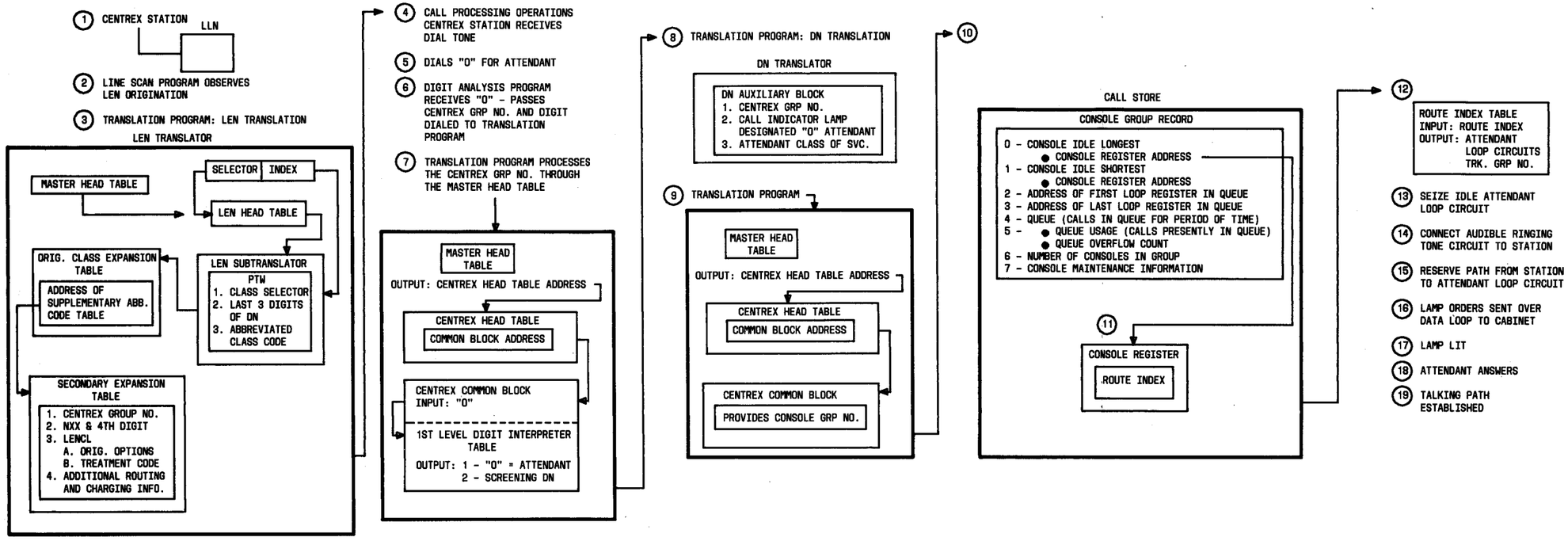



Fig. 22—Processing of a "O" Attendant Call (8.07)

CONSOLE GROUP RECORD

(8 WORD BLOCK OF CALL STORE)

| |
|---|
| WORD 0: CONSOLE IDLE LONGEST (CONSOLE REGISTER ADDRESS) |
| WORD 1: CONSOLE IDLE SHORTEST (CONSOLE REGISTER ADDRESS) |
| WORD 2: ADDRESS OF FIRST LOOP REGISTER IN QUEUE |
| WORD 3: ADDRESS OF LAST LOOP REGISTER IN QUEUE |
| WORD 4: CONSOLE QUEUE PEG COUNT |
| WORD 5: A. QUEUE USAGE COUNT<br>B. QUEUE OVERFLOW COUNT |
| WORD 6: NUMBER OF CONSOLES IN GROUP |
| WORD 7: CONSOLE MAINTENANCE INFORMATION |

**Fig. 23—Centrex Console Group Record (8.15)**

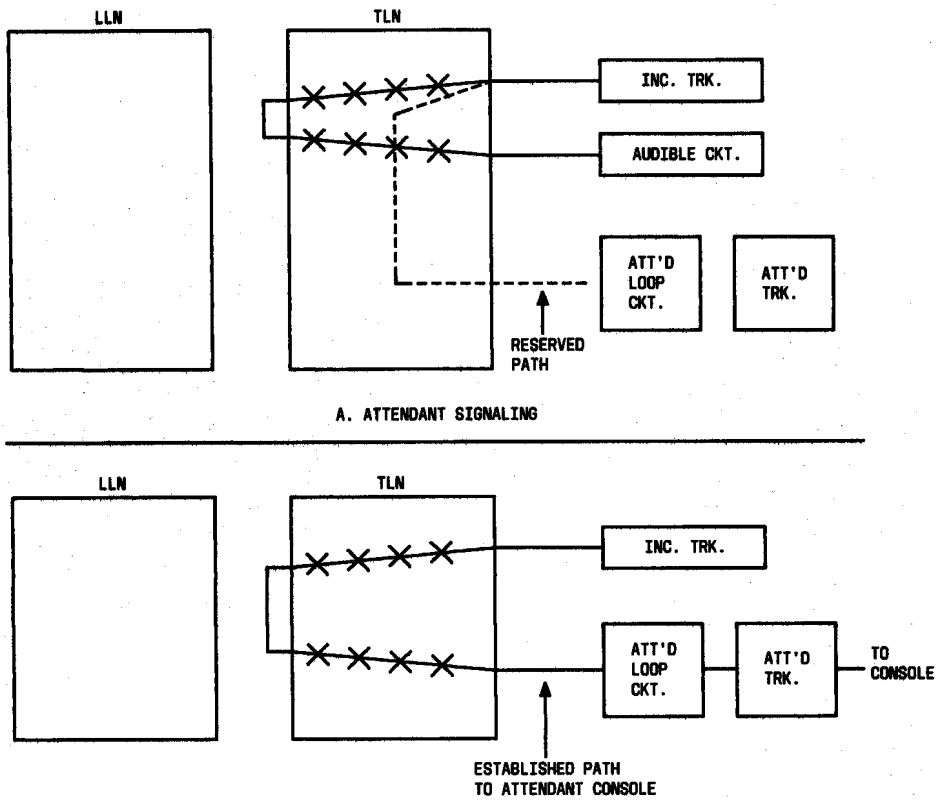
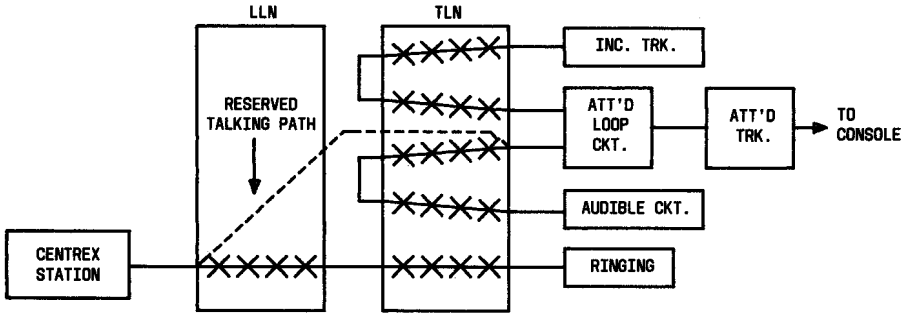
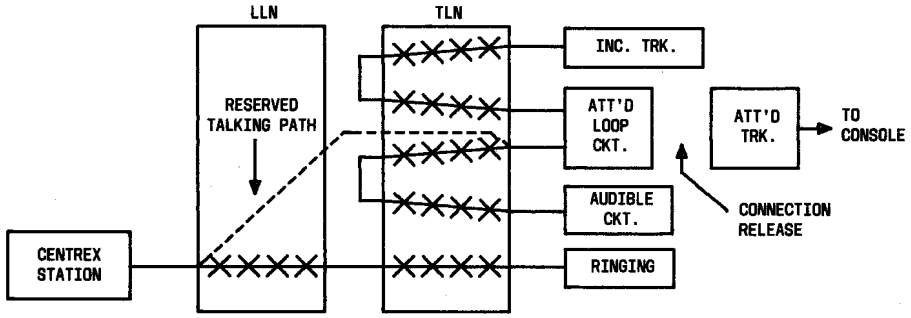



**Fig. 24—Centrex CO Incoming Call to Listed DN-To Attendant Console (8.26) (8.28)**




A. CENTREX STATION RINGING CONNECTION




B. RELEASE OF ATTENDANT TRUNK

**Fig. 25—Centrex CO Incoming Call to Listed DN-Attendant Console to Station Ringing Connections (8.29) (8.30)**

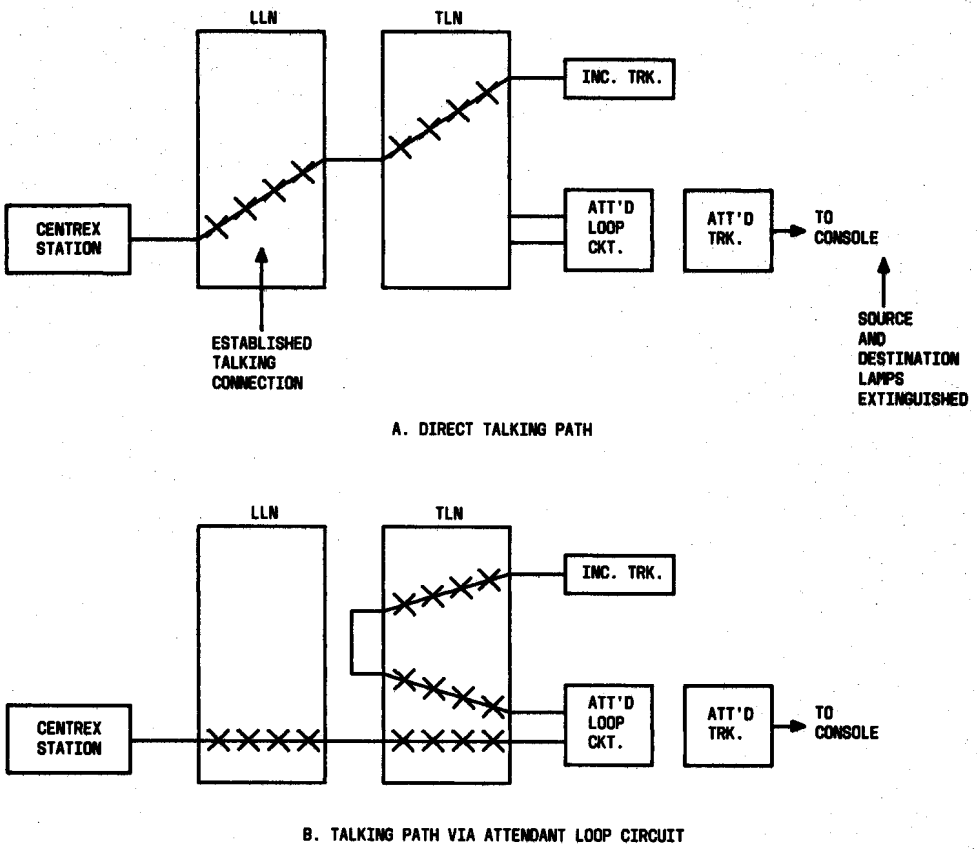



**Fig. 26—Centrex CO Incoming Call to Listed DN-Talking Connections (8.31) (8.32)**

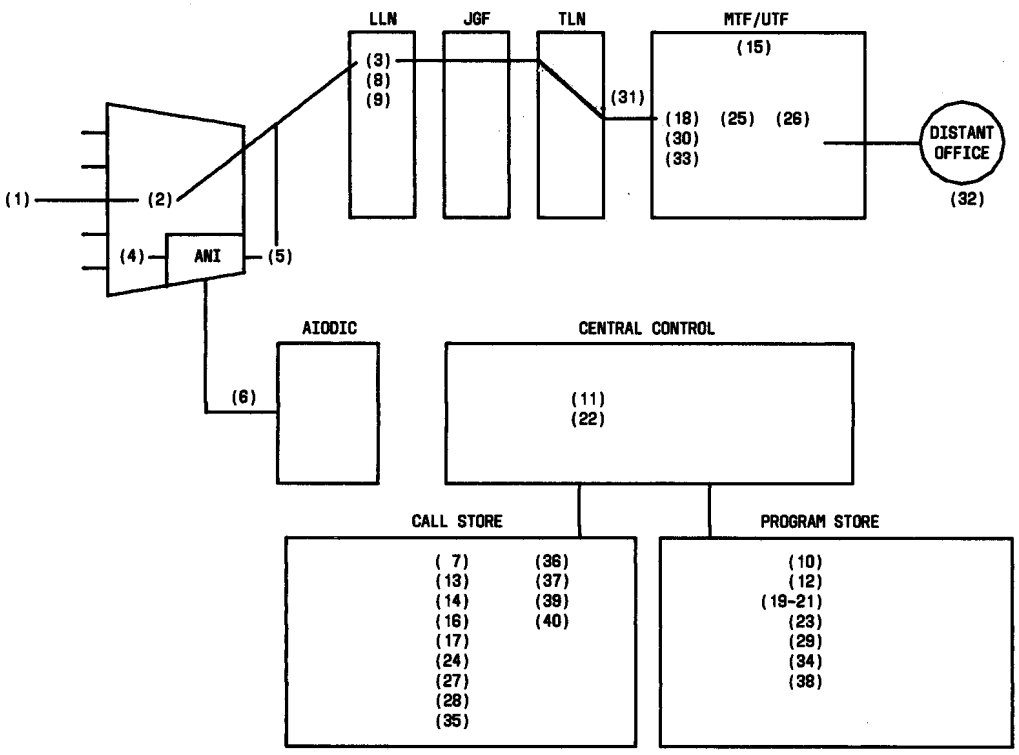



**Fig. 27—AIOD Call Processing Steps (8.35)**