CALL PROCESSING

DESCRIPTION

NO. 2 ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section describes the functions of the No. 2 Electronic Switching System (ESS) as a local telephone central office under the control of a stored program. The majority of the actions of the system are determined by the sequences of instructions coded and stored in memory.

1.02 This practice is reissued to include centrex and range extended calls and to incorporate changes and updates since the last issue. Since this reissue is a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The No. 2 ESS stored program may be divided into general categories as follows:

- The call processing programs which provide telephone service and operational features.

- The maintenance and administrative programs which maintain an operational system in the presence of troubles and diagnose faulty units.

This section deals with the service and operational features provided by the No. 2 ESS; the call processing programs which provide these features, and supervision of lines, trunks, service circuits, and circuit junctors which are controlled by the call processing programs. The maintenance and administrative programs, circuits, and equipment for No. 2 ESS are described in other sections.

CALL PROCESSING REQUIREMENTS

1.04 The No. 2 ESS has no individual line or supervisory relays to indicate call originations or terminations on lines or trunks. Call input information is furnished to the active control unit (CU) by scanners that monitor lines, trunks, and various other circuits. Each point to be monitored is connected to a current-sensing device called a ferrod which senses the absence or presence of current flow, depending on the state of the scanned circuit. In this manner, call input information is received in response to periodic scans of the ferrods by the input/output (I/O) programs.

TYPICAL CALL

1.05 During a call processing operation, a typical call goes through four basic stages.

- Originating service request

- Digit reception and interpretation

- Ringing connection and answer detection

● Talking connection and call disconnect.

A. Originating Service Request

1.06 When a customer originates a call by going off-hook, current flows through the ferrod associated with the line causing an off-hook indication. The off-hook state is sensed by the CU through the scanner, and the originating line number information is stored in call store (CS). To avoid degradation of voice transmission, a cutoff contact is placed between the line terminal and the ferrod windings (Fig. 1A). When a connection from a line to a digit receiver is established on a service request, the cutoff contact is opened, removing the ferrod from the path. Upon detection of a service request a path is selected and connected, and supervision is transferred from the calling line via a wire junctor to a customer digit receiver (CDR) ferrod (Fig. 1B). The CU, via a peripheral decoder, then operates relays in the CDR that cause dial tone to be sent to the calling line. Dial tone is removed by relay operation as soon as the first pulse of the frist digit is received.

B. Digit Reception and Interpretation

1.07 Dial pulses are counted and recorded in CS by the CU wired logic. When the first digit is completed, a check is made to see if a 0 or 1 has been dialed, either of which may require different translation procedures. Next, the second and third digits are detected and recorded. A translation of the first three dialed digits (assuming a 0 or a 1 had not been dialed) tells the CU the call type (intraoffice, interoffice, etc) and the number of additional digits to except (seven, in the case of an intraoffice call).

C. Ringing Connection and Answer Detection

1.08 After receipt of the dialed digits, a connection is established between the called line and a ringing circuit (Fig. 1C). A path is established from an idle circuit junctor to the calling line, and another path is reserved from the circuit junctor to the called line. Audible ringing tone is applied to the calling line through the circuit junctor while the called line is being rung. Every 100 milliseconds the ringing circuit ferrod is scanned for off-hook (answer), and the circuit junctor ferrod is scanned for on-hook (abandonment).

D. Talking Connection and Call Disconnect

1.09 When the called line answers, audible ringing tone is turned off in the circuit junctor, the ringing circuit is disconnected and the previously reserved talking path to the called line (Fig. 1D) is established. During the talking state, the circuit junctor ferrods are scanned every 100 milliseconds to detect a change to on-hook by either line. An on-hook indication is timed for 200- to 300-milliseconds to safeguard against momentary on-hook conditions or hits which would cause disconnect prematurely. In No. 2 ESS calls are under the control of the calling party, but a timeout feature prevents the calling party from holding the connection to the called line for any length of time by failure to go on-hook. If the called party goes on-hook but returns within 11 seconds, the connection is left established, otherwise the connection is released. If the calling party goes on-hook first, the connection is released. If either party remains off-hook for 11 seconds following disconnect, dial tone is returned to the party representing a new origination.

2. SUPERVISION AND SIGNALING

2.01 Each customer line has an appearance on a line trunk switch (LTS) frame which contains the first two stages of the line trunk network (LTN). Associated with each line is a line ferrod which is the initial supervisory point for all line service requests as shown in Fig. 2.

2.02 After a line service request is detected the calling line is connected via the LTN to a CDR (Fig. 3), and supervision is transferred to the CDR ferrod. There are two types of digit receivers, a customer dial pulse receiver (CDPR) (used if a customer has a rotary dial telephone) and a combined receiver (used if the customer has TOUCH-TONE® service). Either of the CDRs provides dial tone to indicate that the ESS is ready to serve the line service request. The CDPR is capable of receiving only dial pulses. The combined receiver will receive both dial pulses and TOUCH-TONE calling signals.

2.03 In an intraoffice call the calling line is supervised at a CDR ferrod until a ringing connection is established. If the requested number is idle, a ringing circuit is connected to the called line. Otherwise, a connection is established between the calling line and a busy tone circuit. Audible ringing tone is supplied to the calling line by a

LEGEND:
LS - LINE SCANNER
TS - TRUNK SCANNER
JG - JUNCTOR GROUPING FRAME
LTS- LINE TRUNK SWITCH FRAME
LTN-LINE TRUNK NETWORK
NCJS-NETWORK CONTROL JUNCTOR SWITCH FRAME
PD-PERIPHERAL DECODER

A. LINE SUPERVISION

B. DIGIT RECEPTION

C. RINGING

D. TALKING
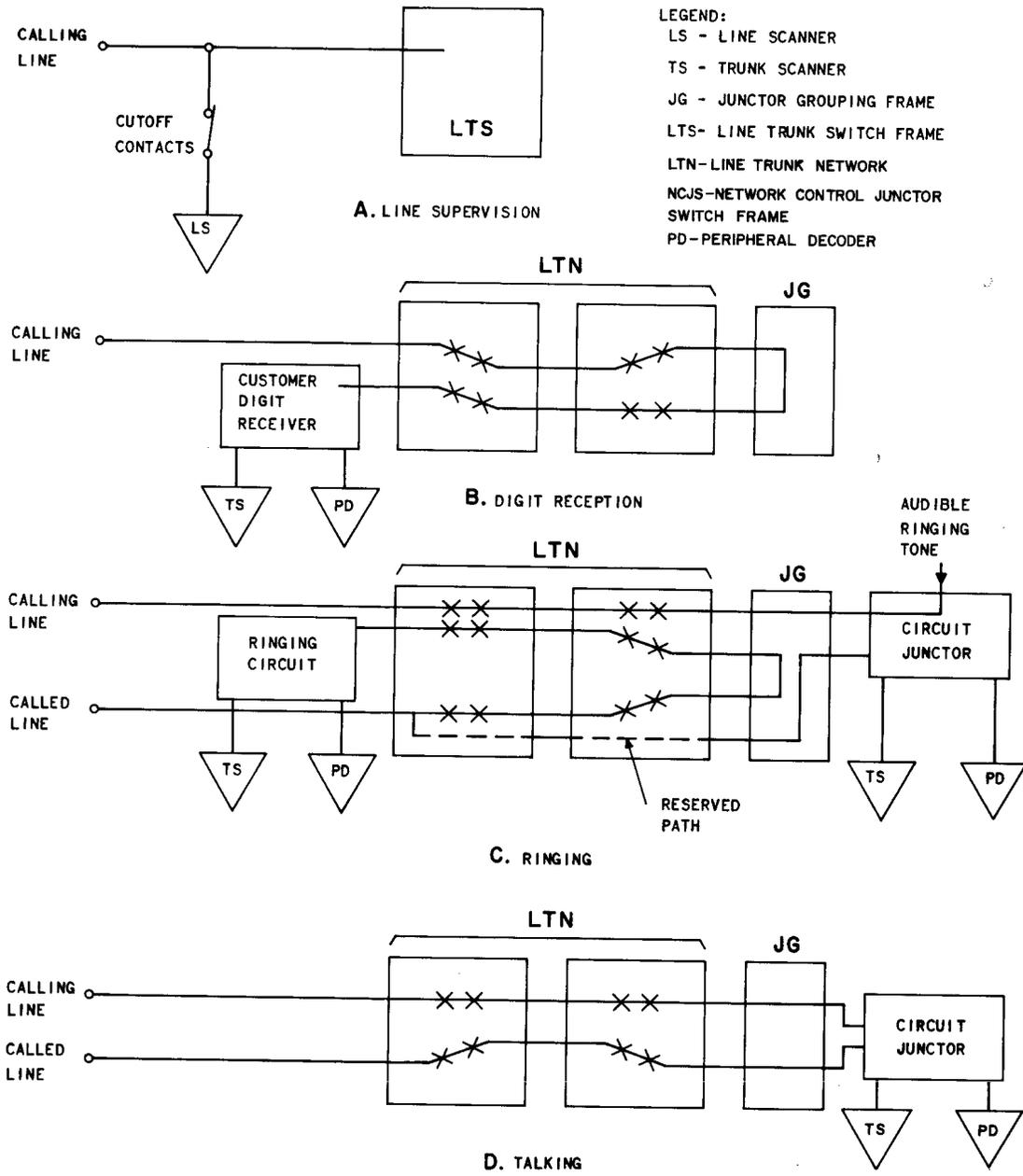
Fig. 1—Typical Connections for an Intraoffice Call

circuit junctor (Fig. 4). The circuit junctor ferrod provides supervision of the calling line to detect if a call is abandoned during ringing. If the requested number is in another central office, an outgoing trunk and digit transmitter are used and supervision of the line is transferred to the trunk ferrod upon completion of outpulsing.

2.04 Ringing is provided through the use of a small number of ringing circuits. Each

ringing circuit provides supervision for the called line during ringing until the call is answered or abandoned. Ringing is provided through a ring trip circuit that stops the flow of current as soon as the called line answers.

2.05 In intraoffice calls a circuit junctor provides the talking battery and supervises the lines after the calling and called lines are connected (Fig. 5). Two ferrods are associated with each

LTS

CUSTOMER'S LINE

CUTOFF CONTACTS

LINE FERROD

SUPERVISORY FERROD

-48V

NOTE:
LTS - LINE TRUNK SWITCH
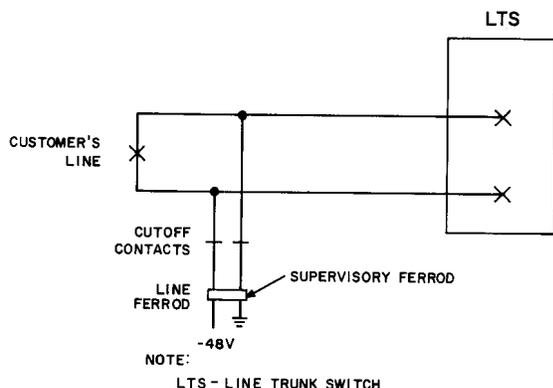
Fig. 2—Idle Customer Line Supervised at its Line Ferrod

LTN

CALLING LINE

LINE FERROD

CUSTOMER DIGIT RECEIVER

SUPERVISORY FERROD

WIRE JUNCTOR
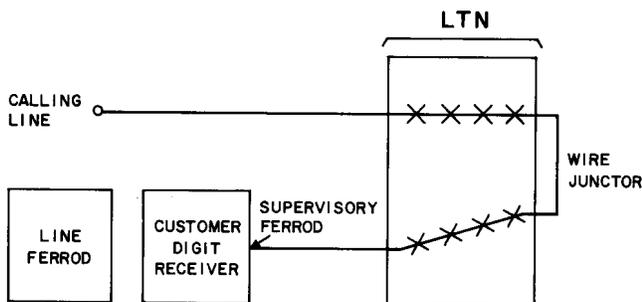
Fig. 3—Line Supervised at Customer Digit Receiver During Dialing

circuit junctor; one to supervise each line. The circuit junctor ferrods now supervise the lines for an on-hook. At the termination of the call, supervision is returned to the line ferrod. The transfer of supervision from one circuit to another during the various stages of an intraoffice call is shown in Fig. 6.

2.06 If the call destination is in another central office, an outgoing trunk circuit to that office is selected and a digit transmitter is connected to the trunk circuit to transmit the called number. The No. 2 ESS outgoing trunks provide both supervision of the calling line and supervision toward the distant office.

2.07 Two types of digit transmitters (dial pulse and multifrequency) are provided by the No. 2 ESS. Both of these transmitters have the capability to detect the on-hook or off-hook state of a distant office trunk, to detect start pulsing signals from a distant office, and to generate the correct outgoing signals. Since the digit transmitter is connected to an outgoing trunk during the outpulsing stage of an outgoing call, the supervision of the calling line remains at the CDR until outpulsing is completed. The switching network connections and supervisory points during outpulsing are shown in Fig. 7. After outpulsing, while ringing is being applied in the distant office, and during talking, the supervision of both the calling line and outgoing trunk is at the trunk circuit as shown in Fig. 8.

LTN

CALLING LINE

RESERVED PATH

CALLED LINE

RINGER CIRCUIT

CALLED LINE SUPERVISORY FERROD

WIRE JUNCTOR

CALLING LINE SUPERVISORY FERROD

CIRCUIT JUNCTOR

AUDIBLE RINGING TONE

Fig. 4—Supervision of Calling and Called Lines During Ringing

LTN
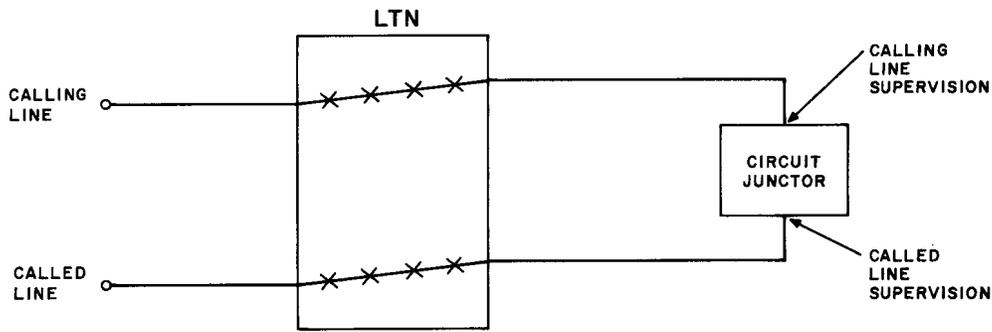
Fig. 5—Calling and Called Lines Supervised at Circuit Junctor During Talking
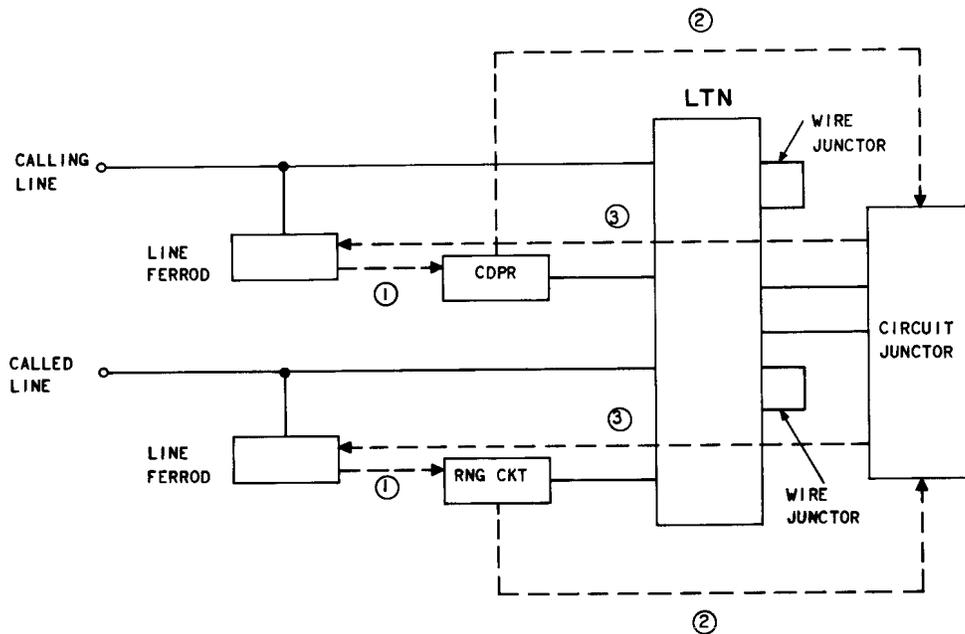
Fig. 6—Transfer of Supervisory Points During an Intraoffice Call

2.08 If a call is incoming from another central office, the CU connects a digit receiver to the incoming trunk circuit via the LTN. The trunk circuit is placed in a bypass state so the digit receiver is connected directly to the incoming transmission facility with no bridging or series impedances. Audible ringing tone is supplied to the distant calling party during ringing by the incoming trunk circuit.

2.09 The No. 2 ESS office provides two types of trunk circuits for incoming calls from step-by-step offices. A loop bylink trunk circuit is used for loop signaling and an E and M trunk circuit is used for toll signaling.

3. PROGRAMS INVOLVED IN CALL PROCESSING

3.01 In a program-controlled system such as the No. 2 ESS, the circuits involved in advancing a call from one stage to another stage do not perform call processing actions. Control signals generated by programs cause the circuits to change from one state to another. Similarly, external

LTN
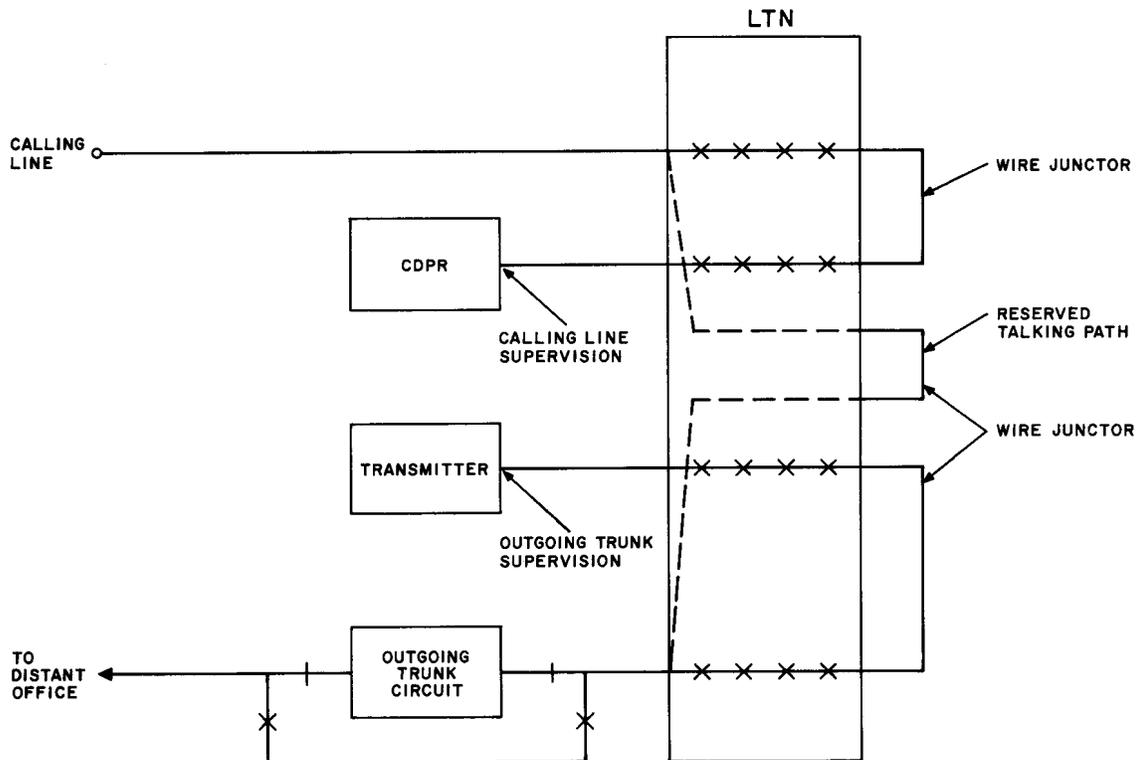
Fig. 7—Supervision of an Outgoing Call During Outpulsing

LTN
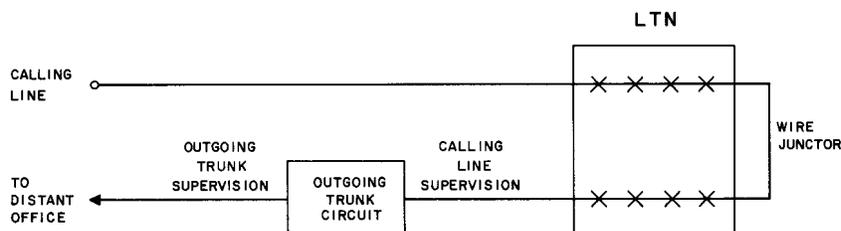
Fig. 8—Supervision of an Outgoing Call During Ringing and Talking

control signals or changes in circuit states do not directly cause any ESS actions to take place. The control signals activate scan points which are read and interpreted by programs. The programs determine the meanings of the scanner readings and perform the necessary logic to decide what action should be taken.

3.02 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 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 (CS) to store data while processing the call. In many cases, areas of CS are assigned at the origination of a call and are dedicated to the call throughout a particular phase.

3.03 The programs associated with call processing are generally classified in three categories (Fig. 9) as follows:

   (a) Interrupt Programs: These programs specialize in collecting input information (line service request, digits, etc) to be processed or in
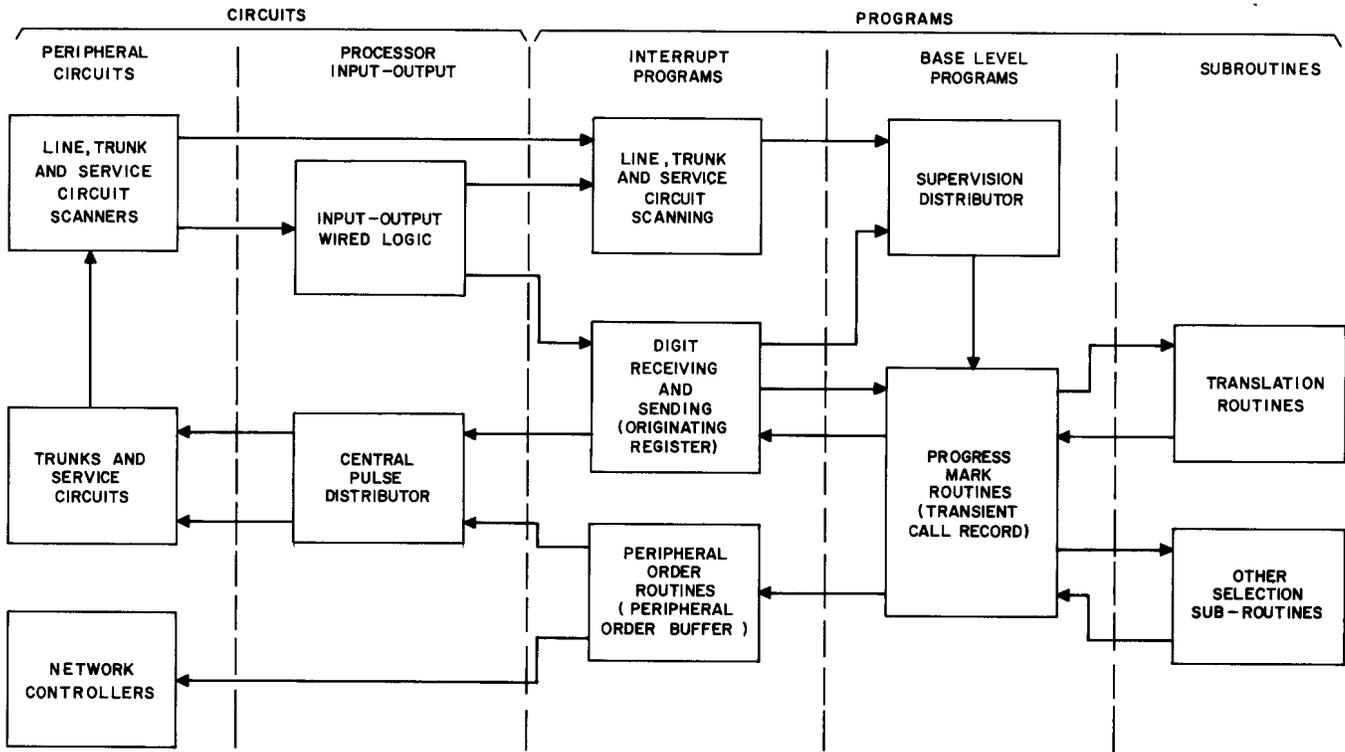
Fig. 9—No. 2 ESS Call Processing Information Flow

transmitting output information that has resulted from processing. For example, the interrupt program (I/O 25) which operates on a 25-millisecond cycle is given control of the central processor every 25 milliseconds by a timed interrupt. Line scanning is initiated during each cycle. Each interrupt task (digit receiving, trunk scanning, hit timing) is executed on a fixed time base in multiples of 25-millisecond interrupts.

(b) Base Level Programs: These programs specialize in processing information pertaining to a call in progress and in advancing a call to completion. For example, the digit interpretation program determines the routing of a call.

(c) Subroutines: These programs specialize in frequently used functions that are not related exclusively to one type of call or to one phase of a call. The subroutine programs are called upon, when needed, by various base level programs to perform specialized tasks. For example, a base level program can call a translation subroutine to determine the equipment number that corresponds to a given directory number.

3.04 The No. 2 ESS base level programs function in a cycle called the base level program scan. This consists of passing control from the call processing routines to the base level maintenance monitor, then back to the input monitor. The base level maintenance monitor (BLMM) in No. 2 ESS controls which maintenance programs are to be run at the end of any program scan. Detection, diagnosis, and resolution of conflicting requests also are done by the BLMM. BLMM administers removal of faulty equipment from service to prevent its use and restoration of equipment to service after a test has been performed to determine that the fault has been repaired.

INPUT FUNCTIONS

3.05 The input functions at interrupt level detect No. 2 ESS inputs and report changes of ferrod states to call control programs which analyze the report and perform required actions. All input monitoring for line service requests is done by a wired logic line scanner, while trunk and service circuit inputs are monitored by a supervisory trunk scan routine.

3.06 Some of the input functions are as follows:

- Detection of origination

- Digit collection routine

- Supervisory trunk scan routine

- Hit timing routine.

A. Detection of Line Origination

3.07 The line ferrods are scanned continuously by a wired logic line scanning circuit. When this circuit finds a line ferrod in the off-hook state, it stops. During the next 25-millisecond input/output (I/O) interrupt, the I/O program will record the row address of the off-hook in a hit timing list and restart the scanner. The ferrod row is rescanned 50 to 75 msec later. If the ferrod still indicates on off-hook, the I/O program will update the last-look bit of the corresponding line in CS. The program then reports a line origination to the input monitor by recording it in the line origination hopper (Fig. 10).

B. Digit Collection Routine

3.08 After an origination is detected, the dialing connection program (Fig. 11) selects an originating register (OR). An OR consists of eight words of CS used for digit reception and sending. A CDR is then selected and its scan point number is recorded in the first word of the OR (Fig. 12).

This word also contains information that determines if the CDR is for dial pulse or TOUCH-TONE® calling. The dialing connection program also determines the line class, makes several checks such as power cross and continuity, and connects the line to the CDR. The call is placed in the digit state and dial tone is returned to the calling line. The I/O circuit begins scanning the CDR ferrods and storing digits in the OR as they are detected.

3.09 For line digit receiving when the digit detection routine (Fig. 13) detects the first digit in the incoming digit area of the OR, the routine sends an order to the CDR (via the peripheral decoder) to remove dial tone.

3.10 Digits are accumulated in the incoming digit area (Fig. 14) of the OR by the wired logic. When an interdigital interval of 125 milliseconds is recognized by the digit detection routine, the new digit is stored in the digit storage and the digit count is incremented by 1. A digit flag is set to indicate to the digit interpretation program that a new digit has been received.

C. Supervisory Trunk Scan Routine

3.11 This routine detects a number of signals because incoming trunks, outgoing trunks, circuit junctors, and a variety of service circuits may be intermixed in a trunk scanner. All ferrod state changes are detected by comparing the present state of each ferrod row scanned with the last look

Fig. 10—Detection of Line Origination

LINE ORIGINATION
PROGRAM

IS
DENIED
SERVICE

YES

NO

SELECT
ORIGINATING
REGISTER

DISCONNECT
LINE
FERROD

ADVANCE TO
NEXT TCR

DIAL
PULSE OR
TOUCH—TONE

TOUCH-TONE

DIAL PULSE

SELECT CUSTOMER
DIAL PULSE
RECEIVER (CPDR)

SELECT COMBINED
CUSTOMER
DIGIT RECEIVER
(CDR)

LINE
CLASS

OTHER

TWO PARTY

MANUAL

CONNECT LINE TO
CDPR, MAKE POWER
CROSS TEST START
DIAL TONE, CHECK
CONTINUITY

CONNECT LINE TO
CDPR, MAKE POWER
CROSS TEST, MAKE
PARTY TEST

MAKE
POWER TEST,
CONNECT LINE

PLACE CALL
IN DIGIT
STATE

START DIAL TONE
CHECK CONTINUITY

ADVANCE
TO NEXT TCR

Fig. 11—Dialing Connection Program, Functional Flow Chart

WIRED LOGIC READS

WIRED LOGIC WRITES

T Ø N	Ø P S	C N T	SCAN POINT NUMBER		
			SCANNER | SCANNER ROW | FERROD		
INCOMING DIGIT AREA			OUTGOING PULSE COUNT	S P R	M B S | S N D | N D G
DP COUNT					
SENDING INDEX		R P T	NO MON | BYL TRK | INC TRK	SENDING FUNCTION	
REC SUP	SND SUP | F A L | R D Y		STOP SENDING CODE	INCOMING DIGIT COUNT	OUTGOING DIGIT COUNT
DIGIT 0	DIGIT 1	DIGIT 2	DIGIT 3
DIGIT 4	DIGIT 5	DIGIT 6	DIGIT 7
DIGIT 8	DIGIT 9	DIGIT 10	DIGIT 11
DIGIT 12	DIGIT 13	DIGIT 14	DIGIT 15

TØN – TONE (RECEIVER)
ØPS – OUTPULSE SPEED (10 OR 20 PPS)
CNT – SCANNER CONTROLLER
SPR – SIGNAL PRESENT (TOUCH-TONE® OR MF)
MBS – MAKE BREAK STATUS
NDG – NEW DIGIT
RPT – REPORT BIT FOR BYLINK TRUNK

NO MON – NO MONITOR REPORT
BYL TRK – BYLINK TRUNK
INC TRK – INCOMING TRUNK
REC SUP – RECEIVER SUPERVISION
SND SUP – SENDER SUPERVISION
FAL – FAILURE
RDY – READY

Fig. 12—Typical Originating Register Layout

OR
INCOMING DIGIT AREA

① →

DIGIT DETECTION ROUTINE
1. DETECT FIRST PULSE
2. RELEASE DIAL TONE

② →

CDR

WIRED LOGIC
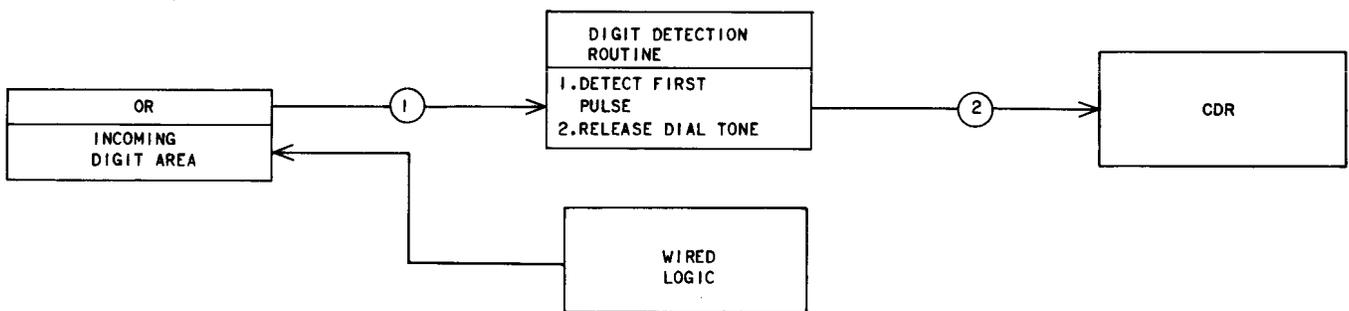
Fig. 13—Release of Dial Tone

ØR	
INCOMING DIGIT AREA	
DIGIT FLAG	
DIGIT COUNT	
DIGIT STORAGE	

DIGIT DETECTION ROUTINE
1.DETECT NEXT DIGIT
2.MOVE DIGIT TO STORAGE
3. INCREMENT DIGIT COUNT
4.SET DIGIT FLAG
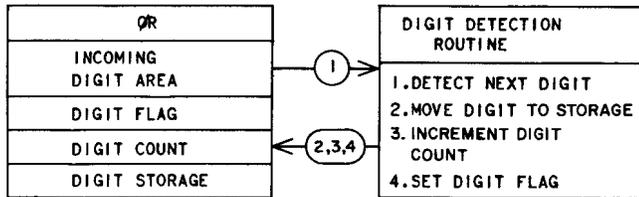
Fig. 14—Reception of Digits

at that row. Any changes detected by the supervisory trunk scan routine are reported to the hit timing routine by recording which ferrods changed state.

3.12 Normally supervisory indications are scanned at a 100-millisecond rate. The No. 2 ESS also has a fast trunk scan which provides a 50-millisecond scan rate to detect supervisory signals from certain operator type trunks and a 50-millisecond bylink scan for signals received from step-by-step office (bylink) trunks.

D. Hit Timing Routine

3.13 This routine receives inputs from the supervisory trunk scan routine via the hit timing list. Fifty milliseconds after an entry is stored in the hit timing list, the hit timing routine reads the scanner row specified by the scanner row number. If the change still exists the hit timing routine updates the scanner last look bits to indicate a change of state. The program then enters the change in either the off-hook hopper or the on-hook timing list whichever applies. If on the second scan, the ferrod has changed back to its previous state, a hit is assumed and the program does not recognize a change in supervision.

OUTPUT FUNCTIONS

3.14 The base level programs process parts of a call at a very high speed and on a time-shared basis. However, to operate relays in trunk circuits to activate network controllers, or to record call charge information on magnetic tape takes a relatively long time. Since processing of other calls cannot be delayed to wait for completion of these actions, the output function called determines what action needs to be performed, and buffers data for another output interrupt program which specializes in converting the buffered data to the desired action.

3.15 Some of the output programs are as follows:

- Peripheral Order Buffer Execution Program

- Digit Transmission Routine

- Automatic Message Accounting (AMA) Program.

A. Peripheral Order Buffer Execution Program

3.16 Peripheral unit orders are sent to the peripheral decoders, scanner controllers, and network controllers by the peripheral order buffer execution program to control peripheral circuits. Data is stored in 16-word CS areas called peripheral order buffers (POBs). The POB execution program reads and executes orders from the POBs, checks that the correct sequence of events occurs, and reports the success or failure of the requested action to the base level program.

B. Digit Transmission Routine

3.17 A call terminating in another central office requires that the called number be transmitted to that office in a form the office is able to accept. There are two types of signaling used by No. 2 ESS; dial pulsing and multifrequency pulsing. The digit transmission routine controls the outpulsing of digits to the appropriate transmitter circuit and reports completion of sending to the base level outpulsing program.

3.18 When digits are to be transmitted over an outgoing trunk, the trunk is connected to a sender circuit, and the OR for this call is initialized for sending. The I/O 25 program sends dial pulse digits during OR scan by operating a peripheral decoder (PD) point. The sender circuit then sends a continuous train of dial pulses over the trunk. After a timing interval has elapsed, the sending program disables the PD point which stops the pulses and an interdigital interval to separate the pulsed digits is then timed. MF sending is done entirely by I/O programs.

C. Automatic Message Accounting (AMA) Program

3.19 The No. 2 ESS uses a multientry Automatic Message Accounting Format. Initial, answer, and disconnect entries are placed in a call store buffer during the progress of a call and subsequently recorded on an incremental magnetic tape recorder.

These entries are not held in call store but are written on the tape as they occur.

SUBROUTINES

3.20 Most base level programs use a number of subroutine programs during the progress of call. Some of the functions of subroutines are as follows:

(a) Request a change in a network configuration or relay circuit states

(b) Obtain translation information

(c) Select or idle network paths and service circuits.

3.21 Some of the subroutine programs associated with call processing are as follows:

- Translation Program

- Path Hunt Program

- Circuit Selection Program

- Peripheral Order Buffer (POB) Programs

- Coin Control Program.

A. Translation Program

3.22 The translation program accesses the translation tables in program store and the recent change area of CS for information concerning lines and trunks. Some of the information obtained for lines is:

- Translation from terminal equipment number to calling line class and directory number

- Translation from dialed office code to routing and charging information

- Translation of dialed directory number to terminal equipment number and called line class.

The information obtained from translations concerning trunks is:

- Translation from scan point number to trunk group and member number

- Translation from scan point number to terminal equipment number or peripheral decoder number

- Translation from trunk group and member number to scan point number.

B. Path Hunt Program

3.23 The path hunt program records pertinent information about a path in the network map at the time a connection is made or removed. The network map is an area of CS that records the busy/idle status of all links in the network. Using the network map the path hunt program can reserve a path from one terminal to another until the called party goes off-hook. After a connection is established, the path hunt program uses areas of CS called terminal memory records (TMRs) to store information concerning the status of trunks, service circuits or circuit junctors used in the call.

C. Circuit Selection Program

3.24 The circuit selection program searches for idle trunks in a trunk group when a service request indicates a path through a particular trunk group. It can also call the path hunt program, make a second trial if all the paths to the first selected trunk are busy, or call a translation program to find an alternate route if all trunks are busy in the first-choice route. The circuit selection program also controls the selection of service circuits.

D. POB Programs

3.25 The peripheral order buffer (POB) programs are made up of the POB loading subroutine and the POB execution program. The POB loading program selects a POB and loads it with the necessary information to cause the desired action. The POB execution program reads the POB order and executes it. Orders are sent out every 50 milliseconds (every other I/O 25 scan). When the requested peripheral actions have been successfully completed, the POB execution program records the success in an area of CS called a transient call record (TCR). The POB loading program recognizes the success report in the TCR and returns control to the call processing program that originally called it.

E. Coin Control Program

3.26 The coin control program controls the processing of certain phases of coin station calls. It performs such functions as coin testing and the collection and return of coins. The coin control program is called by the call processing or local charging programs.

4. SUPPLEMENTARY CALL CONTROL PROGRAMS

4.01 To handle call types other than the simple intraoffice call, the No. 2 ESS uses several other call control programs. Some of these programs are:

- Outgoing call program

- Local charging program

- Operator Program

- Permanent signal and partial dial program.

A. Outgoing Call Program

4.02 The outgoing call program selects the proper outgoing trunk to the distant office based on the route index obtained from the three-digit translation. It then selects a transmitter circuit which is compatible with the dial pulse or MF signaling expected by the distant office.

4.03 After the circuit selections are made, the outgoing call program calls a POB program to place the outgoing trunk and the transmitter in the proper states to test the continuity and polarity of the transmission path to the distant office, to send a seizure signal, and to detect a start pulsing signal. The outgoing call program then transmits the called number through the use of digit transmission routines capable of generating outgoing signals.

B. Local Charging Program

4.04 The local charging program administers charging actions on local coin and message register lines. The local charging program may handle either prepay or dial tone first coin lines. Some of the arrangements that may be handled by the local charging routine are:

- local unlimited coin

- local overtime coin

- coin zone service.

Message register charging by the local charging program can be either timed or untimed.

C. Operator Program

4.05 The actions required for calls to switchboard operators are different from other types of calls. When a call destination is an operator, control is passed to the operator program. Some of calls controlled by the operator program are calls to:

- Directory assistance operators

- Toll operators

- Coin operators

- Business office operators

- Intercept operators, or

- Repair service operators.

Each type of operator has unique functions and signaling arrangements that must be controlled by the operator program.

D. Permanent Signal and Partial Dial Program

4.06 The permanent signal and partial dial program handles call attempts which become permanent signals or partial dials. When a permanent signal or partial dial is detected, the program connects the call to an announcement requesting the customer to go on-hook. If an off-hook still exists after completion of the announcement, receiver-off-hook tone is applied for 40 seconds. If these actions do not succeed in clearing the condition, the line is connected to an operator who monitors the line for possible customer assistance. The system reports the line to a high and dry program which periodically monitors the line and prevents the line from tieing up the system. (See Section 232-116-101 for a detailed description.)

5. CALL STORE MEMORY

5.01 In a stored program system such as the No. 2 ESS, as hardware actions change so must

the controlling data be changed. The CS provides the temporary storage for this data and, in effect, links together the various parts and maintains continuity of each call. Some of the areas of CS used for this purpose have already been discussed in preceding text. The remainder of this part describes the CS areas used in the processing of calls.

LINE ORIGINATION HOPPER

5.02 The line origination hopper (LOH) is an area in CS that contains new line off-hook indications in the form of line TENs. Originations are detected by I/O 25 line scanning program and are stored in the LOH.

OFF-HOOK HOPPER

5.03 The off-hook hopper (OFHH) is an area of CS that contains scan point numbers being referred to the input monitor by the interrupt program. These scan point numbers are the result of supervisory scans of circuit junctor, trunk, and service circuit ferrods and represent new off-hook changes.

ON-HOOK TIMING LIST

5.04 Supervisory changes to on-hook detected by the interrupt program are timed and compared at base level with other supervisory reports to eliminate momentary hits and to discriminate between flash signals and on-hooks. The area of CS used to record these supervisory changes is called the on-hook timing list (ONTL). This timing function is associated with circuit junctor, trunk, and service circuit scan point changes. All off-hooks must last for at least 250 milliseconds before they are reported as valid off-hooks. Therefore, the on-hook timing list is checked by the input monitor program for all scan point changes that have been in the list for longer than 250 milliseconds. Any off-hook scan point change that follows an on-hook change by less than 250 milliseconds on a trunk side ferrod is considered a trunk flash. All other such changes are eliminated as hits. A flash is detected by matching all of the scan point numbers in the off-hook hopper against the scan point numbers in the on-hook timing list before the off-hooks are processed. When a match is detected, a flash report is processed for that scan point number.

QUEUE

5.05 The queue is an 8-entry list, each entry consisting of one word, used by the input monitor program. Queue entries are created when supervision cannot be reported to a TCR on a previous execution of the input monitor program. The queue, rather than containing supervisory transitions as do the OFHH and ONTL, contains actual supervisory signals (on-hook, off-hook, flash).

PERIPHERAL ORDER BUFFER (POB)

5.06 A POB is an area of the CS used to record data for changing the states of low speed circuits. This data is transmitted to peripheral units (network frames, peripheral decoders, and scanners) to establish a particular connection or to cause a particular action (Fig. 15). When a base level program has information the program desires to send to a peripheral unit, the POB loading program is called to select and load a POB. The POB execution program then controls the rate at which the information is sent from the POB to the peripheral units.

TRANSIENT CALL RECORD (TCR)

5.07 Basically, call processing in No. 2 ESS is controlled by TCRs and the programs associated with them. A TCR is associated with each active nontalking call in the system. The TCR (Fig. 16) consists of eight call store words and controls the progress of the call from origination until an answer signal has been received and the connection is placed in a talking state. The TCR also controls the actions taken to disconnect a call.

5.08 The first word of the TCR contains a progress mark which is the address of the program used to reinitiate the processing of a call on each main program loop. For example, if a party is dialing, the program addressed by the progress mark inquires if any new digits are present or if the customer has timed out or gone on-hook. During the main program loop, each TCR is accessed and control is transferred to the program indicated by the progress mark. That program then inquires if there is any new information associated with the call. If nothing is new, the same progress mark is left in the TCR and the next TCR is accessed. When new information is indicated the program acts upon that information and generates any output required. If the completion of this

BIT 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

WORD	
0	PROGRESS MARK
1	SEQUENCE POINTER
2	NETWORK PATH A INFORMATION
3	
4	NETWORK PATH B INFORMATION
5	
6	TCR POINTER
7	CIRCUIT A INFORMATION AREA
8	SPN A
9	PDN A
10	CIRCUIT B INFORMATION AREA
11	SPN B
12	PDN B
13	CIRCUIT C INFORMATION AREA
14	SPN C
15	PDN C
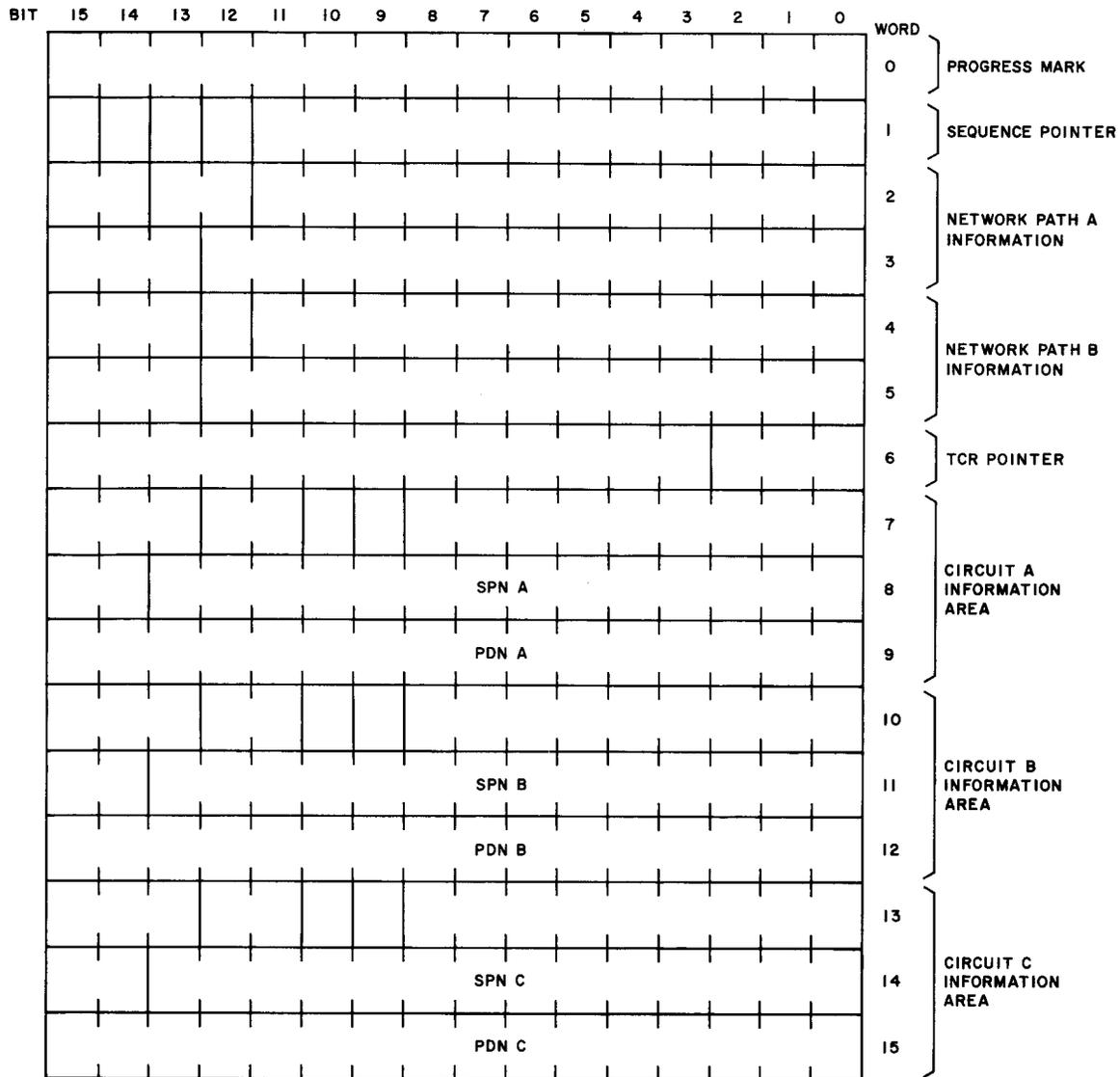
LEGEND:
TCR - TRANSIENT CALL RECORD
PDN - PERIPHERIAL DECODER NUMBER
SPN - SCAN POINT NUMBER

Fig. 15—Typical POB Layout

action changes the state of the call, a new progress mark is written into the TCR to reflect the new state.

ORIGINATING REGISTER

5.09 Originating registers are used by the I/O interrupt programs for Fig. 4 receiving and sending. The layout of an OR is shown in Fig. 12. The upper four words contain control data for interface between the wired logic, the I/O 25 digit handling programs, and the TCR progress mark routines. The lower four words contain an area for storing digits.

NETWORK MAP

5.10 The network map is an area of CS that maintains a record of the busy-idle status

PROGRESS MARK (PM)											S U P
L/T	"A" PARTY										
L/T	"B" PARTY										
POB	PRTY S|P	S T R	C F R	C B V	T F R		F L H	E O T	F S T	TIMER	
ORIGINATING REGISTER ADDRESS											
DGN		"A" SERVICE CIRCUIT									
"B" SERVICE CIRCUIT											
CIRCUIT JUNCTOR OR AUXILIARY ADDRESS											
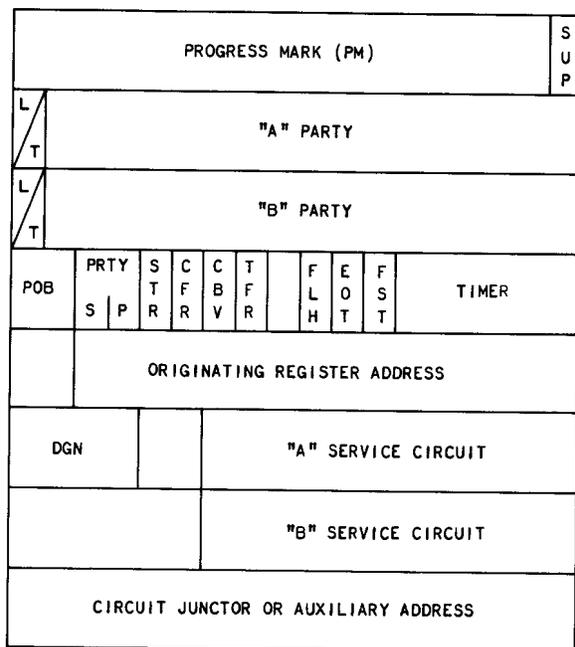
```
SUP  - SUPERVISION FLAG
 LT  - SET I IF PARTY IS A LINE, 0 IF A TRUNK
PRTY - P SET I IF "A" IS 2-PARTY LINE
       S SET I IF 2-PARTY LINE IS TIP, 0 IF RING
STR  - SECOND TRY IN PROGRESS
CFR  - CONFERENCE IN PROGRESS
CBV  - CHANGE ABBREVIATED OPERATION
TFR  - TRANSFER CALL
FLH  - DISTINGUISH FLASH SUPERVISION FROM ON HOOK
EOT  - ENTER ON TIME OUT FLAG (DIGIT INTERPRETATION)
FST  - SECOND TIME OUT IN PROGRESS
DGN  - DIGIT NUMBER
POB  - PERIPHERAL ORDER BUFFER STATES
```

Fig. 16—Typical Transient Call Record Layout

of every link and junctor in the network. It also contains the line status bits.

TERMINAL MEMORY RECORD

5.11 A TMR is an area of CS assigned to each trunk, junctor, and service circuit used to record the current established paths through the switching network. Information is recorded in the TMR by path selection routines. The POBs that control network actions are loaded from path information in the TMRs. A TMR can be in one of three states (Fig. 17):

● *Idle*—An idle TMR indicates that a circuit junctor, trunk, or service circuit is presently idle. The first TMR word is cleared to zero to indicate an idle condition.

● *Transient*—If a circuit junctor, trunk, or service circuit is associated with a call in a nontalking (transient) state, the TMR contains the CS address of the TCR associated with the call.

● *Stable*—A stable TMR indicates that a circuit junctor or trunk is in a talking state.

STABLE TIMING ENTRIES

5.12 A stable timing entry is a 2-word area of CS used to time a coin or message register call in a stable (talking) state. Timing of stable local overtime and coin zone calls is required to perform coin functions; and/or call in a coin operator at the end of the initial and each overtime period. Timing of message register calls is needed to allow pulsing of the message registers. The stable timing entries are also used for several miscellaneous timing and memory functions connected with charging and custom calling services.

6. PROCESSING AN INTRAOFFICE CALL

6.01 The following is a description of an intraoffice call between two individual lines served by the same central office and illustrates how the program, CS, and other equipment are used to process the call. It should be remembered that the various registers, POBs, hoppers, network map, etc, are all areas of the CS.

6.02 Each call control program performs a specific function which is usually related to a stage in the progress of a call. In a normal intraoffice call, some of the call control programs responsible for the handling of the call at various stages are as follows:

● Line Origination Program

● Digit Reception and Interpretation Program

● Ringing and Answer Detection Program

● Disconnect Program.

LINE ORIGINATION

6.03 A line origination is detected by the wired logic line scanner and is then hit timed by the origination detection routine and placed in the line origination hopper. The input monitor program

IDLE TMR

ALL ZERO

STABLE JUNCTOR TMR

O			X PARTY TERMINAL
STE	AMA	PATH	Y PARTY TERMINAL

2 CALL STORE WORDS

STABLE TRUNK TMR

O		X PARTY TERMINAL				
STE	AMA	PATH	CLG		TDM	WIRE JUNCTOR

TRANSIENT JUNCTOR TMR

I		TCR POINTER	SUPV
	PATH		

TRANSIENT TRUNK OR SERVICE CKT TMR

I		TCR POINTER	SUPV
	PATH		WIRE JUNCTOR

SUPV - SUPERVISORY FUNCTION
STE - STABLE TIMING ENTRY PROVIDED
AMA - AMA DISCONNECT ENTRY IS NECESSARY
CLG - INDICATES WHETHER CIRCUIT IS CALLING
      OR CALLED PARTY
TDM - TANDEM CALL
TCR - TRANSIENT CALL RECORD
TMR - TERMINAL MEMORY RECORD

Fig. 17—Terminal Memory Record Format

examines the line origination hopper for entries and upon detecting an entry, selects an idle TCR and stores the line's terminal equipment number (Fig. 18). The address of the line origination progress mark routine is stored and the TCR progress mark routine takes control of the call some time later.

6.04 The line origination program obtains information about the line. Some examples of the information needed are provided by the following questions.

● Does the customer have a rotary dial telephone or TOUCH-TONE telephone?

● Is the line an individual party, 2-party line, or multiple party line?

● Is it a PBX trunk?

● Is it a coin line?

● Is it a manual line?

● Is the line denied service for some reason?

Initial Actions For Connection of Line to Digit Receiver (Fig. 19)

6.05 The line origination routine calls the translation program and gives it the terminal equipment
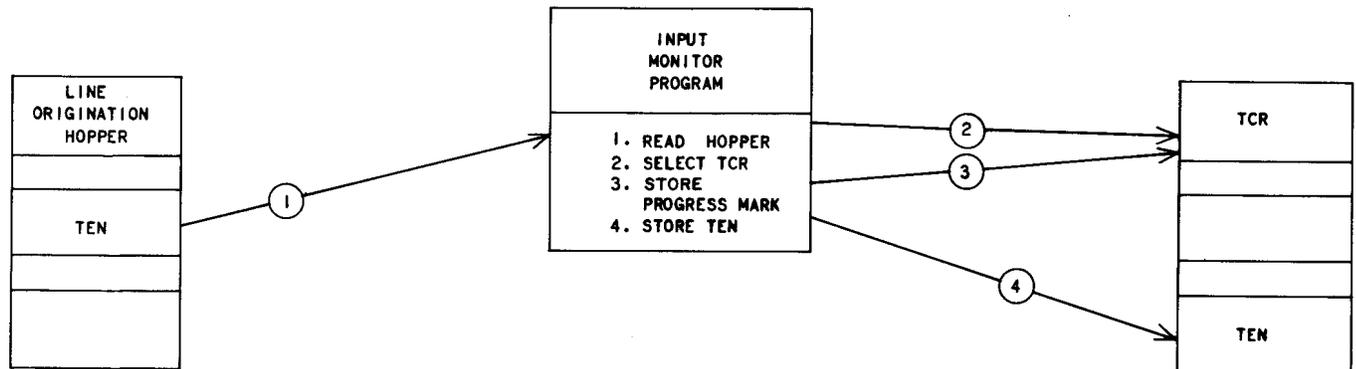
Fig. 18—Initializing TCR

number of the customer. The translation program returns with the calling line class information containing the following:

(a) Combined or dial pulse receiver required

(b) Class of line (manual, individual, party, centrex or coin)

(c) Screening information (for use in 3-digit translation)

6.06 The line origination routine stores the originating class information in the TCR. When the answers to the above questions have been obtained, the first action of the program is to find an OR to store the number that the customer will be dialing. Then the program calls a circuit selection subroutine to select an idle digit receiver. The circuit selection program then calls the path hunt subroutine to find an idle path from the calling line to the digit receiver.

6.07 The POB programs are then called to establish the necessary connection to receive dialed information from the customer. The POB loading program loads a POB with network, relay, and scan data required to provide the power cross test, the network connection between the customer line and the digit receiver, the transfer of supervision check, and the application of dial tone.

Final Actions For Connection of Line To Digit Receiver (Fig. 20)

6.08 The POB execution program sends the data in the POB to establish the receiver connection. The successful completion of the POB establishes a configuration as shown in Fig. 21; the calling line is connected to the digit receiver by a path through the LTN. The digit receiver applies dial tone and provides supervision for abandonment. The POB is released when the POB action is complete and control returns to the line origination program. The line origination program then transfers control to the digit interpretation program via a new progress mark in the TCR.

DIGIT RECEPTION AND INTERPRETATION

6.09 The digit reception and interpretation program is responsible for counting and interpreting digits as the customer dials them, and for determining the routing of the call. It also determines if a called number is idle or busy, determines the disposition of a call if it cannot be completed, and performs interdigital timing. A functional flow of the digit reception and interpretation program is shown in Fig. 22.

6.10 The digit collection routine provides information to the digit interpretation routine by reporting via the ØR when a digit is received or when an abandonment is detected. If no digits are received for an interval of 10 seconds and the caller is still off-hook, the program passes this information to
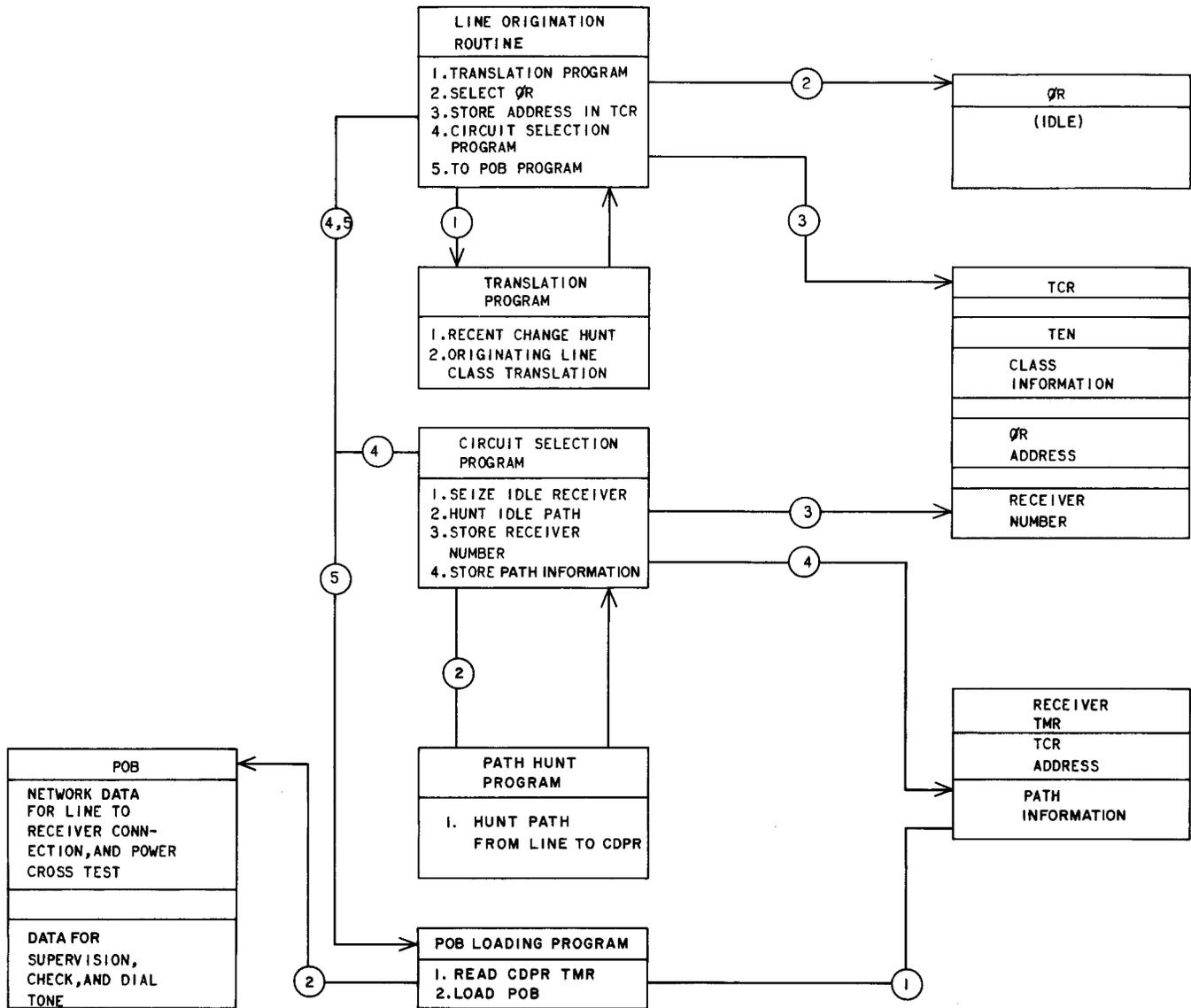
Fig. 19—Initial Actions for Connection of Line-To-Digit Receiver

the permanent signal and partial dial program for further processing. As the digits are received, some are counted by the digit interpretation program and stored. Others are interpreted to determine what course of action to follow. For example, the first digit is always examined since interpretation after the second digit depends on what the first digit was. In most cases involving intraoffice calls, no examination is necessary and the second digit is stored.

Interpretation of First Three Digits (Fig. 23)

6.11 Upon receipt of the third digit, an interpretation of the first three digits is made to determine routing of the call.

6.12 If the first three digits represent an office code in the same numbering plan area, four more digits are expected. If the first three digits represent a foreign area code, then seven more
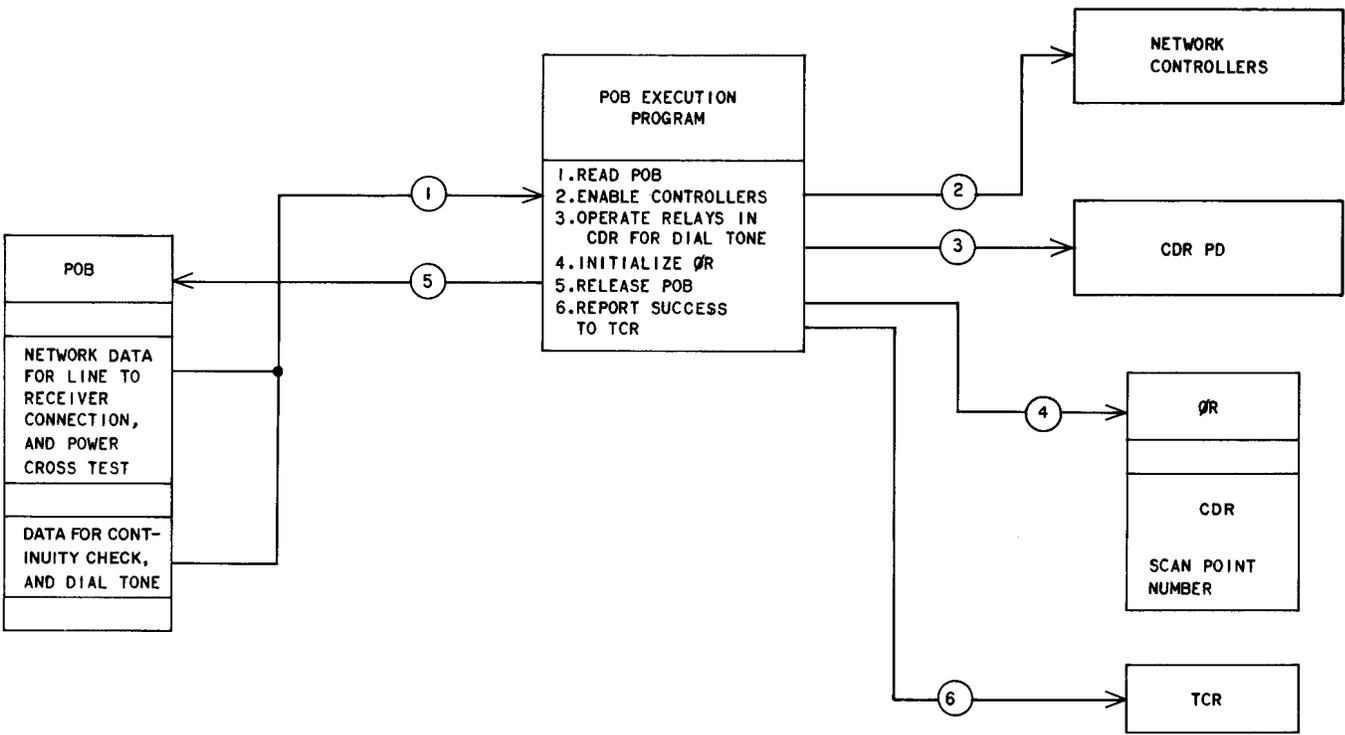
Fig. 20—Final Actions for Connection of Line-To-Digit Receiver

Fig. 21—Receiver Connection
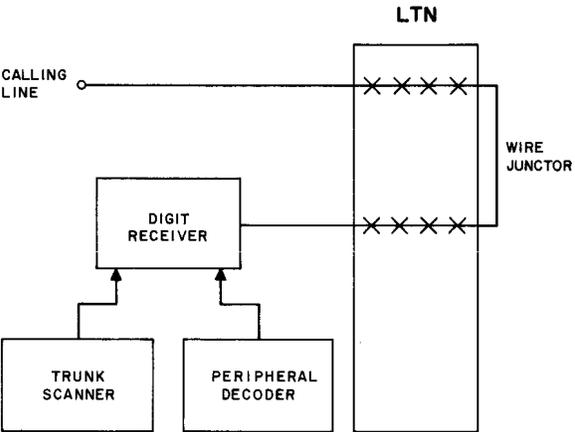
digits are expected. The three digit translation output determines whether the call is an intraoffice call or an outgoing call. If the call is outgoing, it may be possible to determine from this translation the first-choice trunk group. However, some foreign area codes require six digits to be dialed before a route can be chosen. The translation program called by the digit interpretation program returns the information about the call to the digit interpretation program which indicates whether:

(a) An invalid code was dialed

(b) An interoffice code was dialed (expect seven digits)

(c) An interoffice code was dialed (expect ten digits)

(d) An intraoffice code was dialed

(e) The call is a charge call or free call.

The digit interpretation program stores the 3-digit translation information in the TCR for use later in the call.

Interpretation After End of Dialing (Fig. 24)

6.13 For an intraoffice call additional digits beyond the third digit are stored and counted until seven digits have been received. If the call is outgoing, the digit interpretation program turns the call over to the outgoing call program.

6.14 In an intraoffice call, when the digit interpretation program determines that the seventh digit has been received, it then calls a translation subroutine to translate the directory number. The translation program converts the dialed directory number to a terminal equipment number and terminating class information. The digit interpretation program then examines the called line status bit to determine if the line is busy or idle. If the line is idle, the program marks the line status bit busy, and stores the information from the translation tables in the TCR.

Initial Actions For Ringing Connection (Fig. 25)

6.15 The ringing portion of the digit interpretation programs calls a circuit selection subroutine to select an idle ringing circuit and a path from it to the called line. A talking path through a circuit junctor to the called line is reserved. At this point the digit interpretation program calls the local charging and AMA programs to determine if the call is chargeable. If chargeable, an initial AMA entry is made which includes the calling directory number, the called directory number, charge information, and call identity. The local charge information is entered in CS and includes the call identity and charging data. The digit interpretation program next calls the POB loading program to load data into a POB to initiate ringing.

Initial Actions For Audible Ringing Tone Connection (Fig. 26)

6.16 The digit interpretation program also instructs the POB loading program to load a POB to initiate audible ringing tone to the calling line. The POB loading program reads the path information from the circuit junctor TMR and loads the POB with the necessary order for establishing the connection between the circuit junctor and the calling line.

Final Actions For Ringing Connection (Fig. 27)

6.17 The POB execution program is called in to read the POB and execute ringing. This order conducts a power cross test, closes the ringing path, performs a pretrip test, and applies 20-cycle ringing voltage to the called line. If ringing is successful, success is reported to the TCR and the POB is released.

Final Actions For Audible Ringing Tone Connection (Fig. 28)

6.18 The POB execution program is instructed to initiate audible ringing to be calling line. This audible ringing order releases the CDPR relays, enables the network controller, and operates circuit junctor relays to apply audible ringing tone to the calling line. If the audible ring connection is successful, the success is reported to the TCR and the POB is released.

6.19 The called line is now being rung and the calling line receiving audible ringing tone. The calling line is connected to a circuit junctor through the LTN; the called line is connected to the ringing circuit through the LTN, and a path through the LTN to a circuit junctor is reserved for the called line. This configuration is shown in Fig. 29.

RINGING AND ANSWER DETECTION

6.20 The ringing and answer detection program detects an answer by the called customer and establishes the talking connection (Fig. 30). This program controls intraoffice or incoming calls from ringing until the called party answers and a talking path is established. An answer is indicated when the supervisory trunk scan program detects the transition of the ring trip ferrod to an off-hook state (Fig. 31).

Initial Action For Talking Connection (Fig. 32)

6.21 When answer has been detected the supervisory trunk scan program loads the trunk scan point number in the off-hook hopper after performing hit timing. Upon detecting an entry in the hopper, the input monitor program delivers the trunk scan point number to the translation program which translates the trunk scan point number into the circuit type and the address of its associated TMR.

ENTRY

HAS CALL
BEEN ABANDONED

YES → DISCONNECT LINE FROM CDPR

NO

IDLE CDPR AND OR

WAS INTER-DIGIT TIMEOUT OCCURRED → YES → TO PARTIAL DIAL PROGRAM

IS THIS A COIN LINE

YES → RETURN COIN

NO

FIRST DIGIT INTERPRETATION

IS FIRST DIGIT ZERO → YES → TO OPERATOR PROGRAM

NO

IDLE LINE STATUS BIT

ADVANCE TO NEXT TCR

TRANSLATE FIRST THREE DIGITS

IS THIS AN AREA CODE

YES → EXPECT 7 MORE DIGITS → OUTPULSE TO FOREIGN AREA OFFICE

NO

INTRAOFFICE CALL → YES → EXPECT 4 MORE DIGITS → A

NO

OUTGOING OFFICE CODE → YES → EXPECT 4 MORE DIGITS → OUTPULSE TO DISTANCE OFFICE

NO

SERVICE CODE → YES → TO OPERATOR PROGRAM

NO

INVALID CODE-ROUTE TO INTERCEPT OPERATOR

A

TRANSLATE 4 DIGIT DIRECTORY NUMBER

IS THIS A VALID NUMBER → NO → TO INTERCEPT OPERATOR PROGRAM

YES

IS CALLED LINE BUSY → YES → CONNECT CALLING LINE TO BUSY TONE

NO

RESERVE TALKING PATH

SELECT RINGING CIRCUIT

MAKE INITIAL CHARGE ENTRY IF NECESSARY

IDLE THE OR

MAKE POWER CROSS TEST, CONNECT CALLED LINE TO RINGING CIRCUIT, APPLY RINGING

DISCONNECT CALLING LINE FROM CDPR, CONNECT LINE TO RESERVED PATH CIRCUIT JUNCTOR, PLACE JUNCTOR IN THE AUDIBLE RINGING STATE

IDLE THE CDPR

PLACE TCR IN RINGING STATE

ADVANCE TO NEXT TCR

Fig. 22—Digit Reception and Interpretation Program—Functional Flow Chart
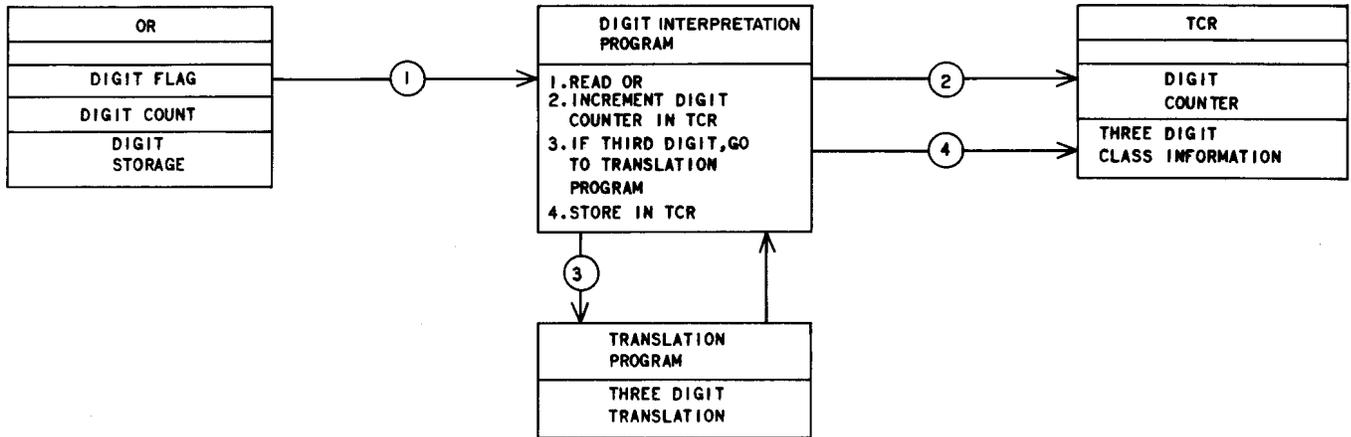
Fig. 23—Interpretation of First Three Digits
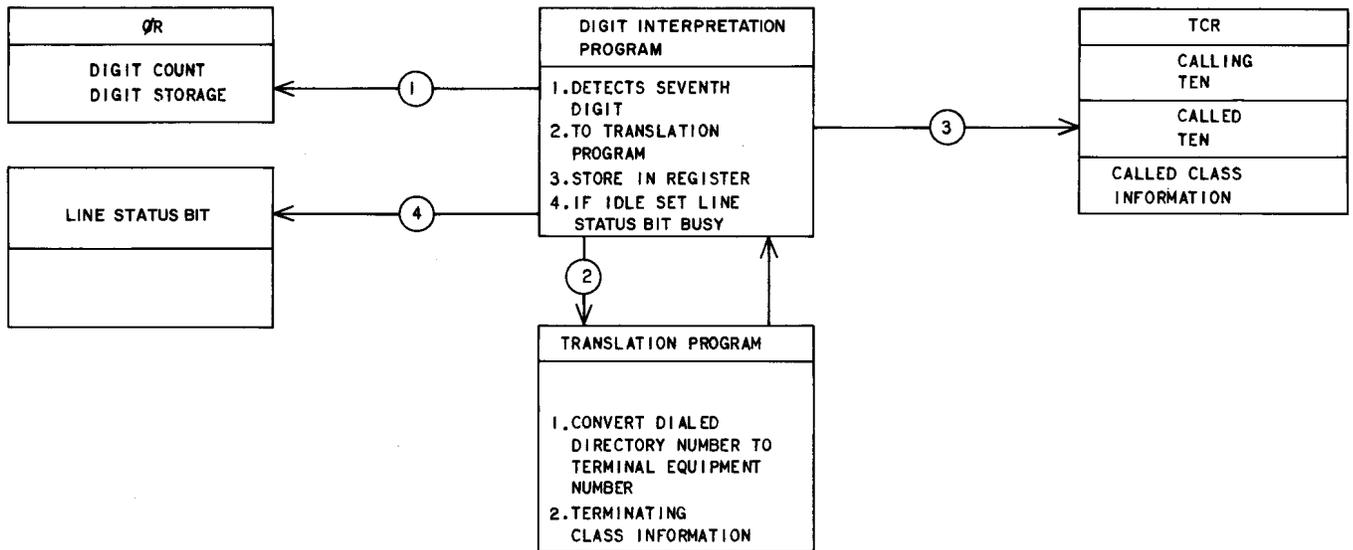
Fig. 24—Interpretation After End of Dialing

This information is used to report the answer to the ringing and answer detection program.

6.22 Upon receipt of the report, the ringing and answer detection program calls the POB loading program to load data in a POB to release any operated relays in the ringing circuit, to set up the path (the one previously reserved) from called line to the circuit junctor, and to check that supervision of the called line is transferred to the circuit junctor.

Final Actions For Talking Connection (Fig. 33)

6.23 When the ringing connection is released, the circuit junctor is placed in the talking state and audible ringing tone is released from the calling line. The ringing and answer detection program then idles the ringing circuit and its path. The local charging and AMA programs are called to record the answer time, if necessary. The call is placed in a stable talking configuration (Fig. 34) and the TCR is idled. Supervision is now maintained by the supervisory trunk scan program.
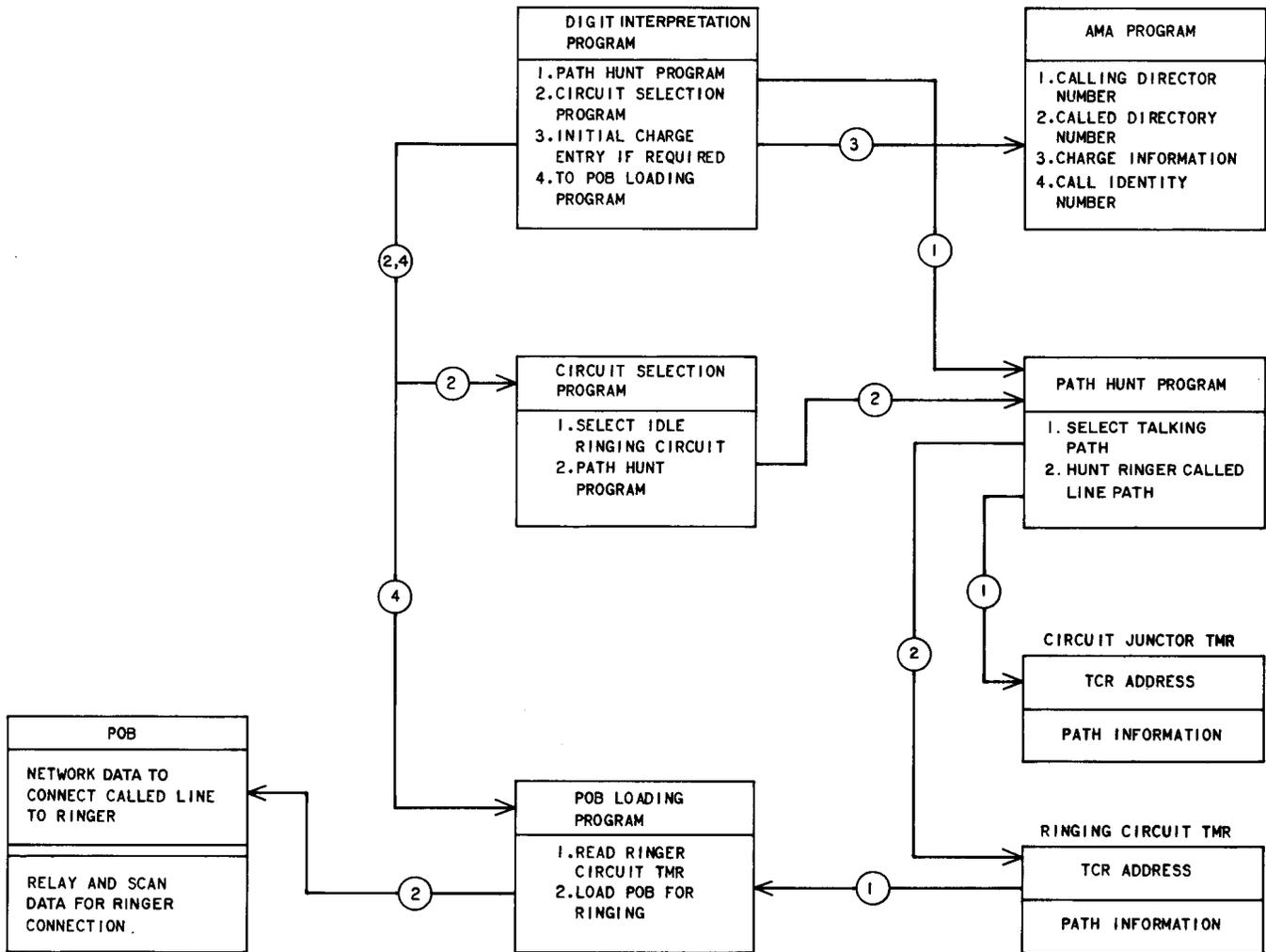
Fig. 25—Initial Actions for Ringing Connection

DISCONNECT

Detection of On-Hook And Hit Timing (Fig. 35)

6.24 The supervisory trunk scan routine examines the state of the circuit junctor ferrods and the circuit junctor last look bits every 100 milliseconds. If a ferrod in the row disagrees with its last look bit the supervisory trunk scan routine places the scanner row address in the hit timing list. The hit timing routine records the scan point number of the on-hook in the on-hook timing list after 50 milliseconds after a rescan to ensure it is a valid on-hook.

Detection of Disconnect (Fig. 36)

6.25 Further timing is done in the on-hook timing list for 250 milliseconds to eliminate line hits. If an off-hook is not received after 250 milliseconds the entry in the on-hook timing list is processed. The input monitor program delivers the junctor scan point number to the translation program which returns information about the circuit junctor and the customer line that went on-hook. A TCR to disconnect the call is set up and control of the call is then transferred to the TCR disconnect program via a new progress mark.
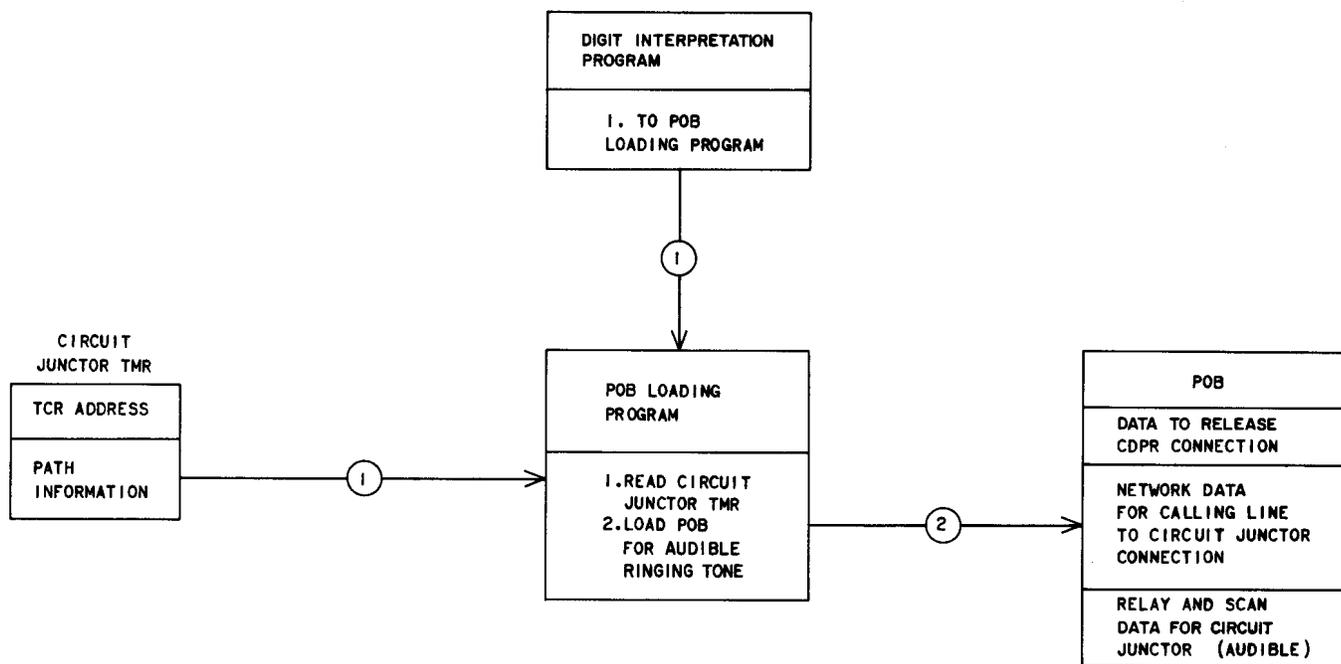
Fig. 26—Initial Actions for Audible Ringing Tone Connection
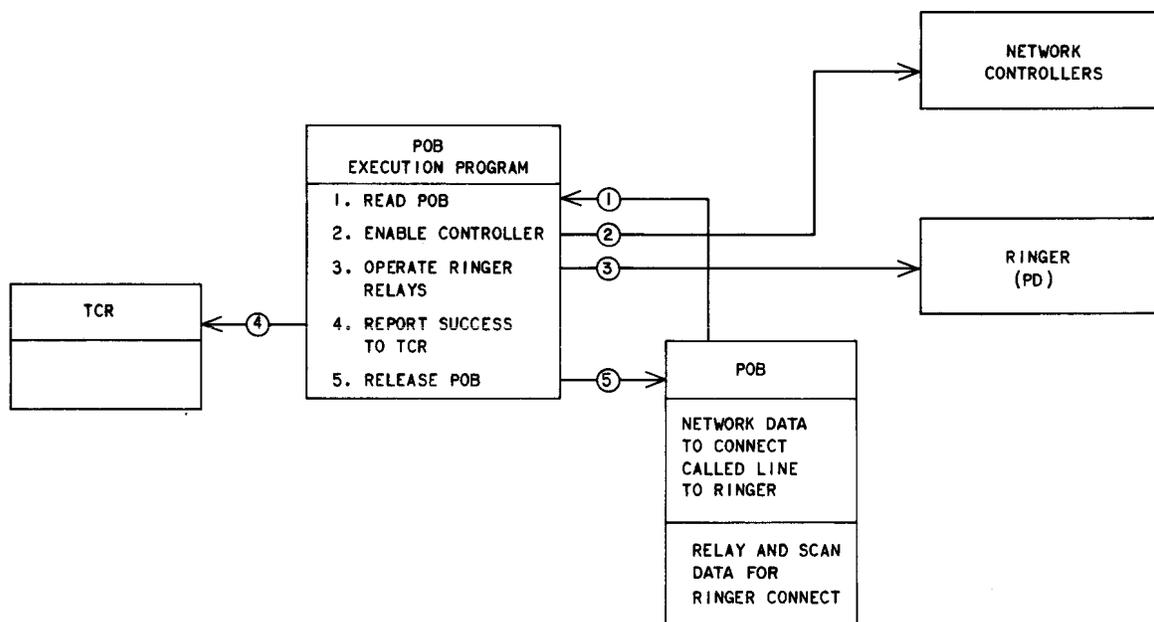
Fig. 27—Final Actions for Ringing Connection

Fig. 28—Final Actions for Audible Ringing Tone Connection

LEDGEND:

PD   PERIPHERAL DECODER
TS   TRUNK SCANNER
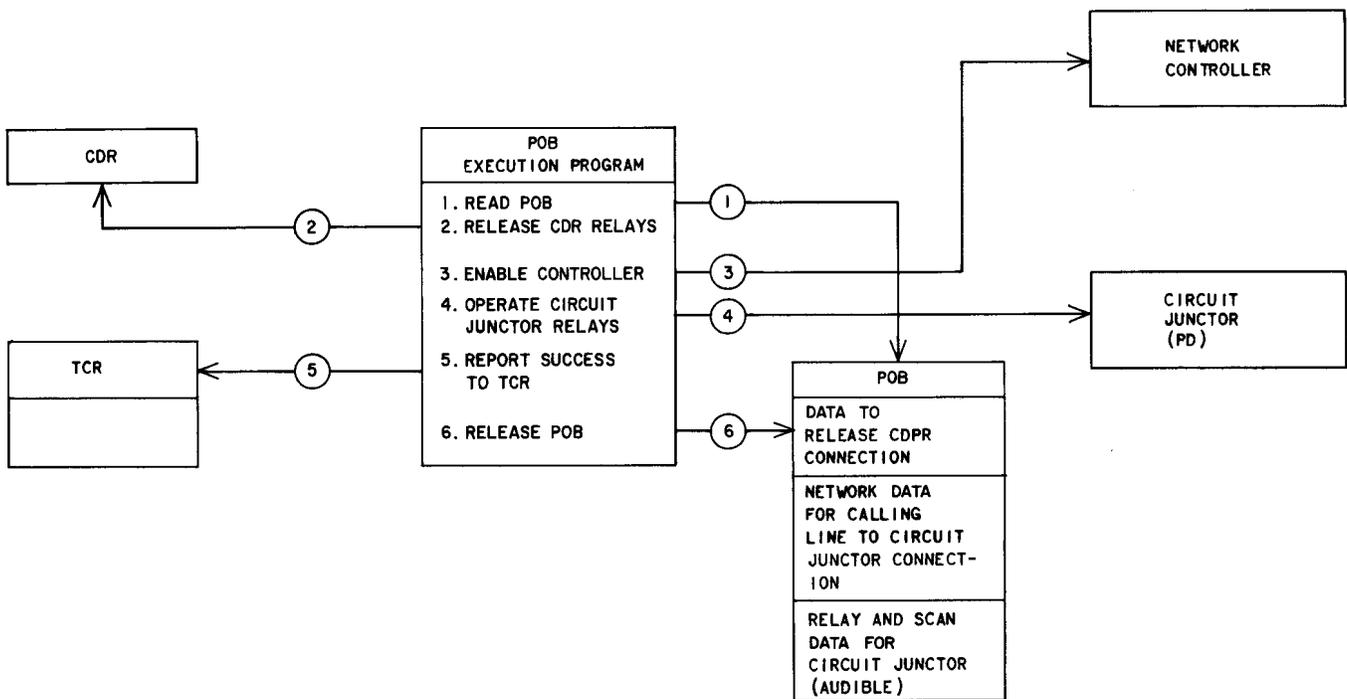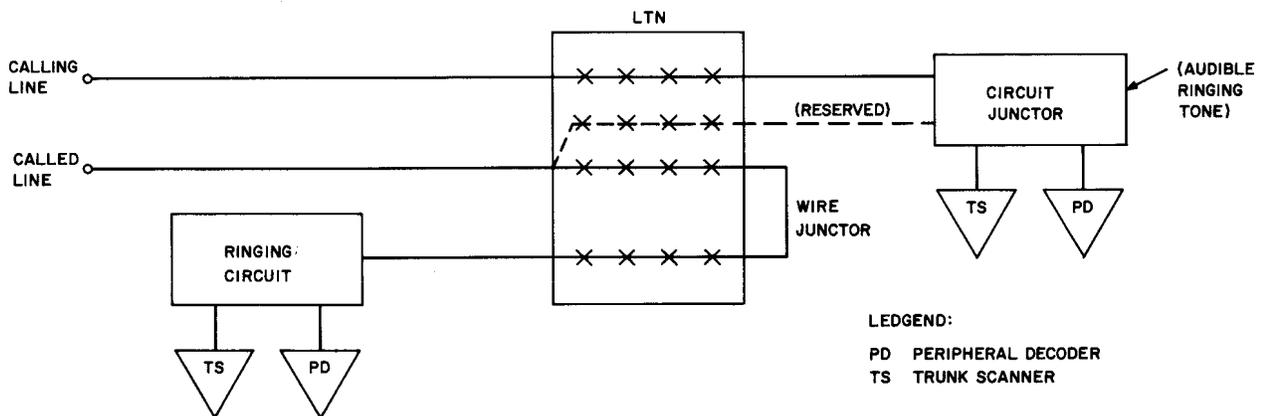
Fig. 29—Ringing and Audible Connections

TCR Disconnect Program (Fig. 37)

6.26 The functions of the TCR disconnect program are as follows:

(a) To provide calling line control of the call (but not permitting the calling line to keep a called line permanently tied up)

(b) To signal disconnect to a distant office over an incoming or outgoing trunk

(c) To remove a talking connection at disconnect

(d) To idle any lines or trunks involved in the call

```
      CALLED CUSTOMER
          ANSWERS
             |
             v
   +------------------+
   | DISCONNECT CALLED|
   | LINE FROM RINGING|
   | CIRCUIT,CONNECT  |
   | CALLED LINE TO   |
   | CIRCUIT JUNCTOR, |
   | PLACE JUNCTOR    |
   | IN TALK STATE    |
   +------------------+
             |
             v
   +------------------+
   | IDLE RINGING     |
   | CIRCUIT STATUS   |
   +------------------+
             |
             v
   +------------------+
   | MAKE CHARGE      |
   | ANSWER ENTRY     |
   +------------------+
             |
             v
   +------------------+
   | PLACE CALL       |
   | STABLE           |
   +------------------+
             |
             v
       ADVANCE TO
        NEXT TCR
```
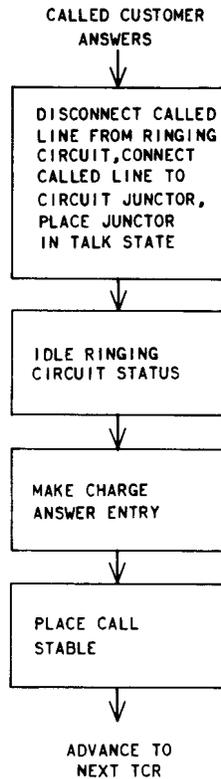
Fig. 30—Ringing and Answer Detection Program, Functional Flow Chart

(e) To call in other programs to handle special conditions such as flashing for custom calling services.

(f) To idle the call path memory.

6.27 To determine the treatment for a disconnecting call, the TCR disconnect program first obtains translation information about the parties of the call. The following questions are examples of the information needed:

- Type of call to be disconnected?

- Which party (calling or called) is providing the supervision?

When a line goes on-hook the following checks are made:

- Does the line have custom calling services?

- Is the line a coin line?

Different actions are called for depending on the answers to these questions.

6.28 If the customer has any custom calling services, the disconnect program transfers
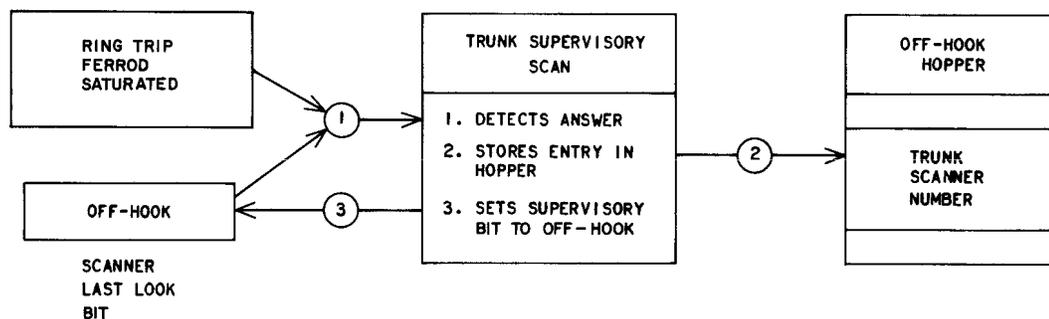
Fig. 31—Detection of Answer

to the custom calling program. Otherwise the disconnect program starts disconnect action by determining which customer went on-hook so that proper timing can be performed before disconnecting the call.

Initial Disconnect Actions (Fig. 38)

6.29 If the calling line goes on-hook first, the disconnect program calls the AMA program to record the call identity and disconnect time, if
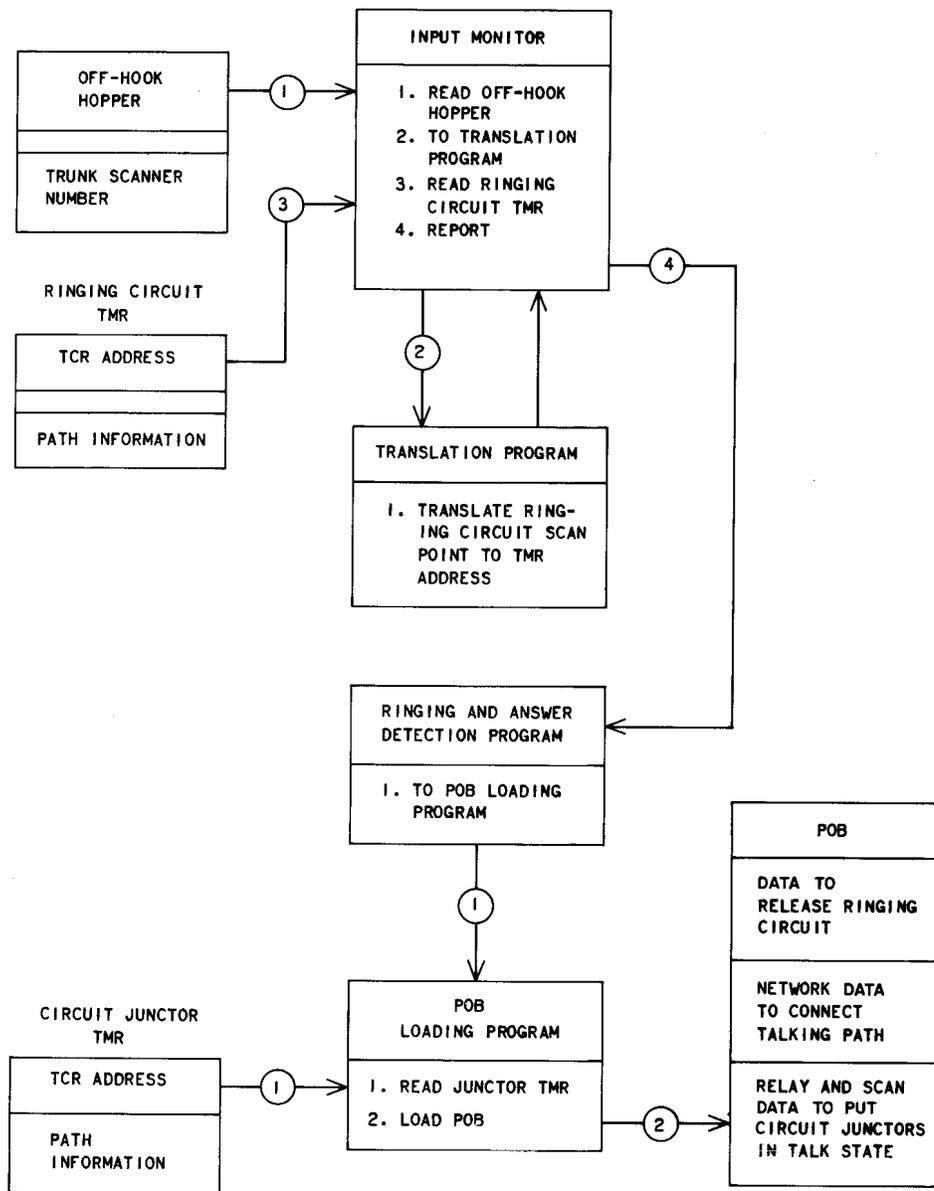
Fig. 32—Initial Action for Talking Connections

necessary. If the called line goes on-hook first and does not reoriginate within 11 seconds, the AMA program is called to make disconnect entries if needed. The disconnect program then calls the POB loading program to load a POB to idle the circuit junctor and to restore the line ferrods of the two lines.

Final Disconnect Actions (Fig. 39)

6.30 After POB execution, the disconnect program calls the path hunt program to idle the path

memory and calls the translation program to convert the terminal equipment numbers to the line status bit addresses and idle the calling and called line status bits. The disconnect program then releases the TCR.

6.31 The parties involved in the conversation may not necessarily perform the actions in the order given above. The called party may not hang up the telephone within 11 seconds, or the calling customer may initiate another call very shortly after hanging up and before the called party goes
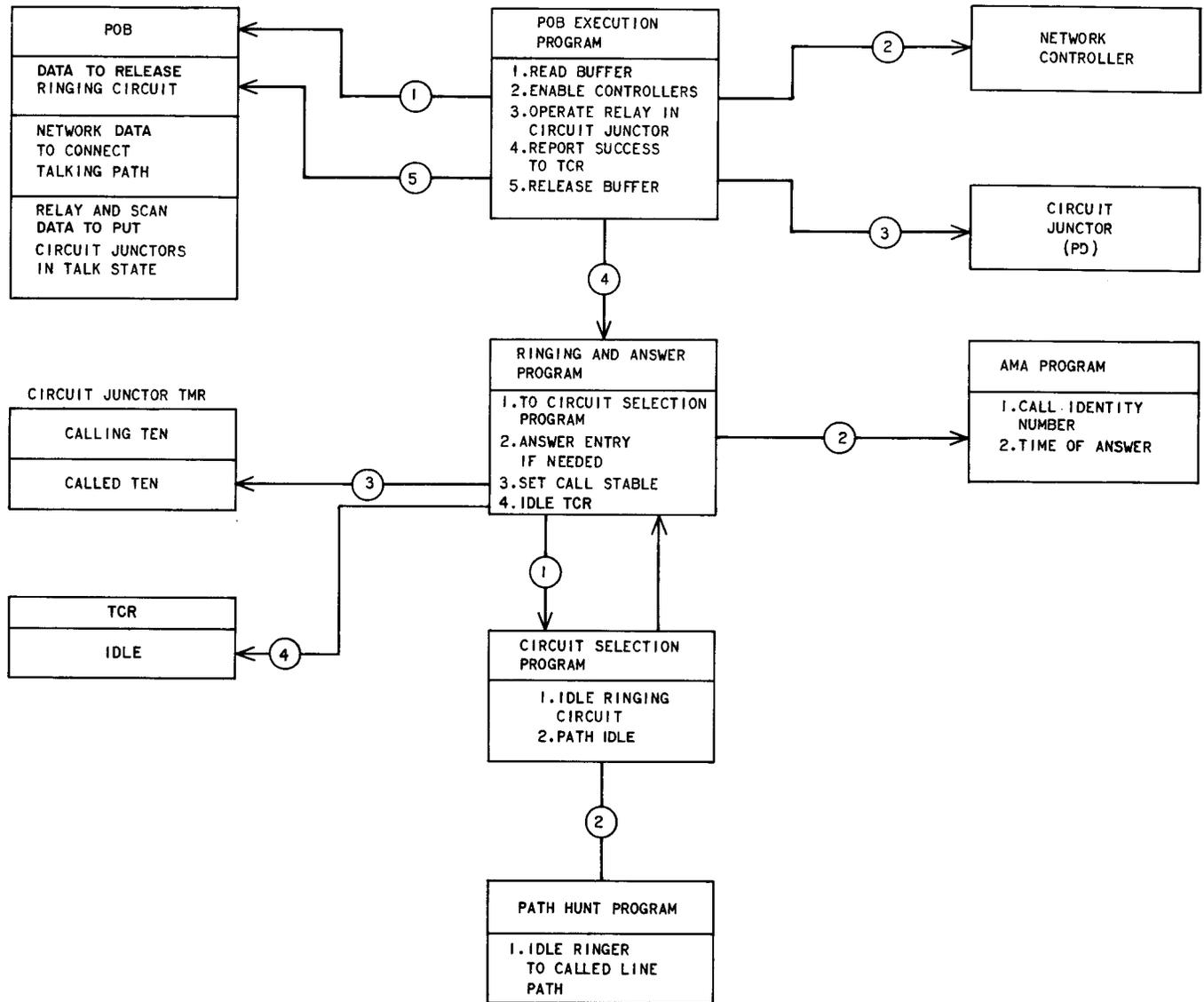
Fig. 33—Final Actions for Talking Connections

on-hook. In either case, the switching network connection is removed and the lines are idled. If the called party goes on-hook first, the called party is permitted 11 seconds to pick up the telephone and still find the original existing connection if the calling party has not hung up in the meantime.

6.32 The disconnect program also calls a local charging program to determine if a coin collect or coin return must be performed.

7. OTHER TYPES OF CALLS

7.01 This description illustrates how the equipment and the CS memory are used to process other types of calls. It is assumed that these calls are noncoin calls excluding charging. Some of these types of calls are:

- Outgoing Call

- Incoming Call

LTN

CALLING LINE

CALLED LINE

CIRCUIT JUNCTOR

TRUNK SCANNER
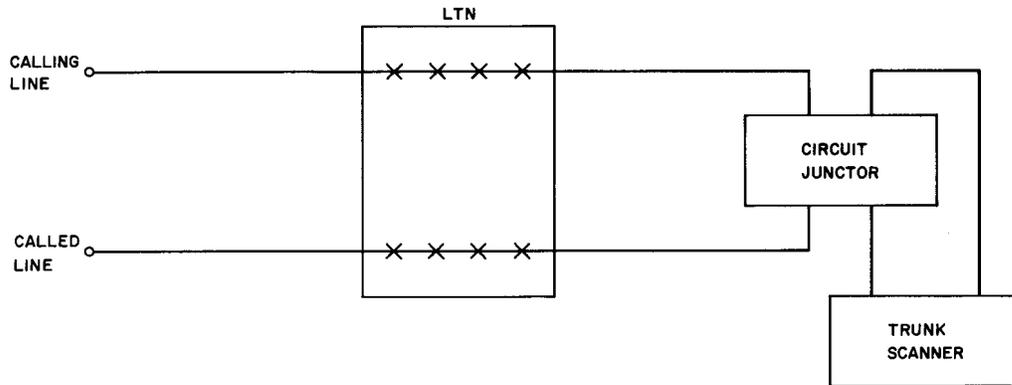
Fig. 34—Stable Intraoffice Talking Connection

A

(SATURATED)

CIRCUIT JUNCTOR FERRODS

B

(UNSATURATED)

A BUSY

B BUSY

TRUNK SUPERVISORY SCAN PROGRAM

1. DETECT ON-HOOK
2. STORE IN HIT TIMING LIST
3. TO HIT TIMING PROGRAM

HIT TIMING PROGRAM

1. SCAN AFTER 50 MILLISECONDS IF THE FERROD IS STILL UNSATURATED AND STORE IN ON-HOOK TIMING LIST
2. SET CIRCUIT JUNCTOR LAST LOOK BIT ON-HOOK

HIT TIMING LIST

SCANNER ROW ADDRESS

LAST LOOK ADDRESS

ON-HOOK TIMING LIST

JUNCTOR SCANNER NUMBER

TIME OF ON-HOOK

Fig. 35—Detection of On-Hook and Hit Timing

- Range Extended Call

- Reverting Call

- Assistance, Service Code, and Direct Distance Dialing Calls

- Manual Call.

OUTGOING CALL

7.02   An outgoing call is a call from a No. 2 ESS customer line to a line in a distant office. For simplicity, the calling customer is assumed to have an individual line in the central office, and the pulsing required between the No. 2 ESS and the distant office is multifrequency.
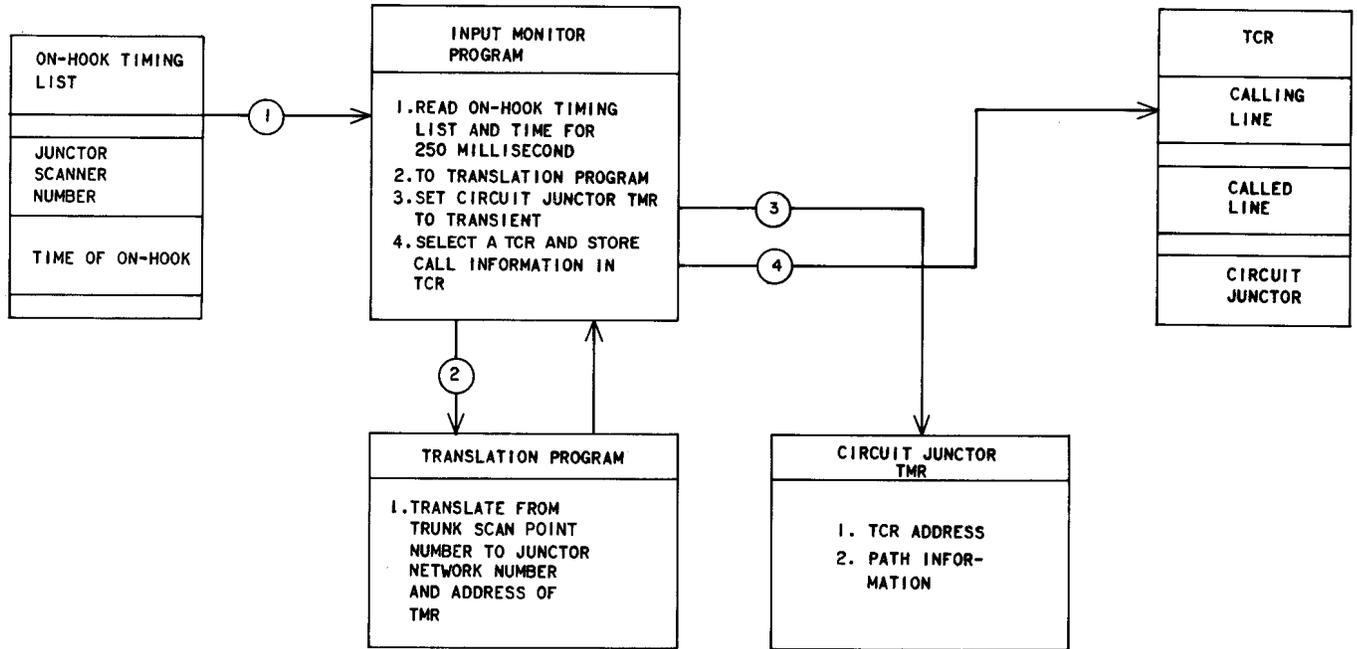
Fig. 36—Detection of Disconnect

7.03 The call is processed as a regular intraoffice call until the third digit is detected and recorded in the CS.

7.04 The 3-digit translation indicates that an outgoing call is being dialed and that outpulsing starts after all seven digits are received. (This is true because of the assumed multifrequency signaling. In the case of dial pulses, outpulsing is usually started after the third digit is received.) The 3-digit translation provides a route index number which is stored in the TCR and is used to derive routing, alternate routing, and signaling information.

7.05 When the last digit is received, an outgoing trunk and a path to the calling line are selected and the path information is stored in the TMR. A multifrequency transmitter and path to the outgoing trunk are selected. The scan point number of the outgoing trunk and the identity of the transmitter are recorded in the TCR. The TCR also has the address of the ØR that contains the digits to be outpulsed. The calling line is still being supervised by the CDR at this point.

7.06 The POB program is then called to establish the path between the outgoing trunk circuit

and the multifrequency transmitter (Fig. 7). The outgoing trunk circuit is put in a bypass state and a seizure signal is sent to the distant office. Trunk continuity to the distant office is checked by the multifrequency transmitter and a wink signal is returned from the distant office to start outpulsing. The called line number is then outpulsed to the distant office via MF pulsing.

7.07 A check is made at this time to see if the outgoing trunk is routed to a Centralized Automatic Message Accounting (CAMA) office. If it is, the calling line number is outpulsed to the CAMA office after a second start-dial signal is returned. For CAMA calls, no charging is done at the No. 2 ESS office. If the No. 2 ESS has local AMA (LAMA) equipment, charging is handled in the same manner as an intraoffice call.

7.08 At the completion of outpulsing, the transmitter is released. The supervision of the outgoing trunk is transferred from the transmitter to the outgoing trunk circuit. The previously reserved network path between the calling line and the outgoing trunk circuit is established and checked.

7.09 The CDR, the OR, and transmitter are all released. Every 100 milliseconds the trunk

ENTRY
POINT

DOES
LINE HAVE
CUSTOM CALLING
SERVICES

YES → TO CUSTOM
CALLING PROGRAM

NO

CALLING
OR CALLED
PARTY ON-
HOOK

CALLED

CALLING

AMA
RECORDS DISCONNECT
TIME IF NEEDED

MONITOR CALLING
AND CALLED
PARTIES FOR
II SECONDS

MONITOR THE
CALLING AND
CALLED PARTIES
FOR
II SECONDS

CALLED PARTY
OFF-HOOK

YES → RETURN CALL TO
STABLE TALK STATE

NO

REMOVE AND
IDLE CALLING
TO CALLED
LINE CONNECTION

YES

CALLING PARTY
OFF-HOOK

CALLING
PARTY ON-
HOOK

YES

NO

NO

COLLECT OR
RETURN COIN
IF COIN LINE

YES

CALLED PARTY
ON-HOOK

TIMED
OUT

YES

NO

NO

IDLE LINE
STATUS AND
TCR

TIME
OUT

NO

ADVANCE TO
NEXT TCR

AMA
RECORDS DISCONNECT
TIME (II SECONDS
IF NEEDED)

YES

Fig. 37—TCR Disconnect Program Functional Flow Chart for Disconnecting an Intraoffice Call

Fig. 38—Initial Disconnect Actions

scanner scans the outgoing trunk circuit for an answer (off-hook) or a possible abandonment by the calling line (on-hook).

7.10 When the called customer answers, the trunk circuit TMR is marked to the stable talking state and the TCR is released.

7.11 When the 100-millisecond supervisory trunk scan routine detects a change to on-hook on the outgoing trunk circuit, the change is entered in the on-hook timing list. When on-hook timing is completed, a TCR is selected. If the calling lines goes on-hook first, the connection is released and disconnect supervision is sent to the called line end. The outgoing trunk is not idled until the trunk circuit goes on-hook. If the called party goes on-hook first, and does not reoriginate for 11-seconds the connection is released and the TCR is idled.

7.12 The trunk TMR 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.

INCOMING CALL

7.13 In this discussion, it is assumed that the ESS is processing an incoming call to an individual line. Fig. 40 illustrates the network connections for the different phases of processing an incoming call.

7.14 When the 100-millisecond supervisory trunk scan routine reads the row containing the scan point of an incoming trunk circuit, a seizure will appear as a mismatch between the scanner reading and the associated last look word. The trunk scan point number of the trunk causing the
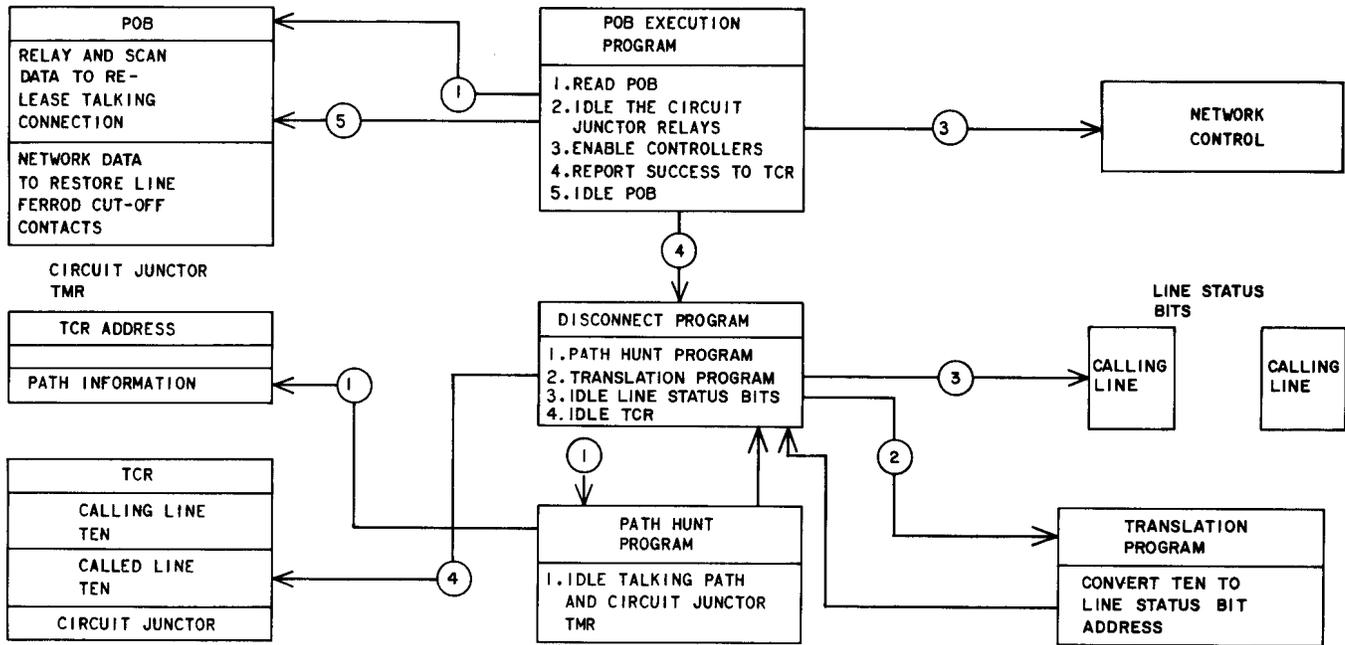
Fig. 39—Final Disconnect Actions

mismatch is recorded in the off-hook hopper after hit timing of 50-milliseconds. The input monitor program reads the trunk scan point number from the hopper and calls the translation program to determine that the trunk is incoming.

7.15 An idle TCR is selected, and the trunk scan point number is recorded. The translation program determines the type of digit receiver (multifrequency or dial pulsing) to be connected to the trunk, the number of digits to be received, and the type of start dialing signal required. This information is recorded in the TCR.

7.16 When the type of digit receiver is determined, an OR is selected, an idle digit receiver is seized, and the network map is searched for a path between the incoming trunk and the digit receiver. The path information is recorded in the receiver TMR.

7.17 A POB is loaded to make and check the connection. The OR associated with the digit receiver is prepared to store the incoming digits. 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 directory number.

7.18 The call is then handled to completion in the same manner as an intraoffice call.

7.19 When an on-hook is detected by the supervisory trunk scan routine and hit timing is completed, a TCR is selected to handle the disconnect. If the distant end disconnects first, the incoming trunk is made available for reseizure and a period of 11 seconds is timed. During this time, the No. 2 ESS customer is being scanned at the trunk every 100 milliseconds for disconnect. The connection is released when the ESS customer disconnects or the 11-second timeout occurs. If the trunk is reseized in the meantime, the connection is released immediately and both the line and trunk are treated as new originations.

7.20 If the ESS customer disconnects first, the distant office is notified of the disconnect after hit timing is completed. The ESS waits 40 seconds for a disconnect signal from the distant office. When the ESS receives the disconnect signal or when the timing period ends, the connection is released.

LTN

FROM
DISTANT
OFFICE

INCOMING
TRUNK
CIRCUIT

WIRE
JUNCTOR

DIGIT
RECEIVER

A. DIGIT RECEPTION

LTN

FROM
DISTANT
OFFICE

INCOMING
TRUNK
CIRCUIT

RESERVED
NETWORK
PATH

AUDIBLE
RINGING
TONE

CALLED
LINE

RINGING
CIRCUIT

WIRE
JUNCTOR

B. RINGING

LTN

FROM
DISTANT
OFFICE

INCOMING
TRUNK
CIRCUIT

WIRE
JUNCTOR

CALLED
LINE

C. TALKING
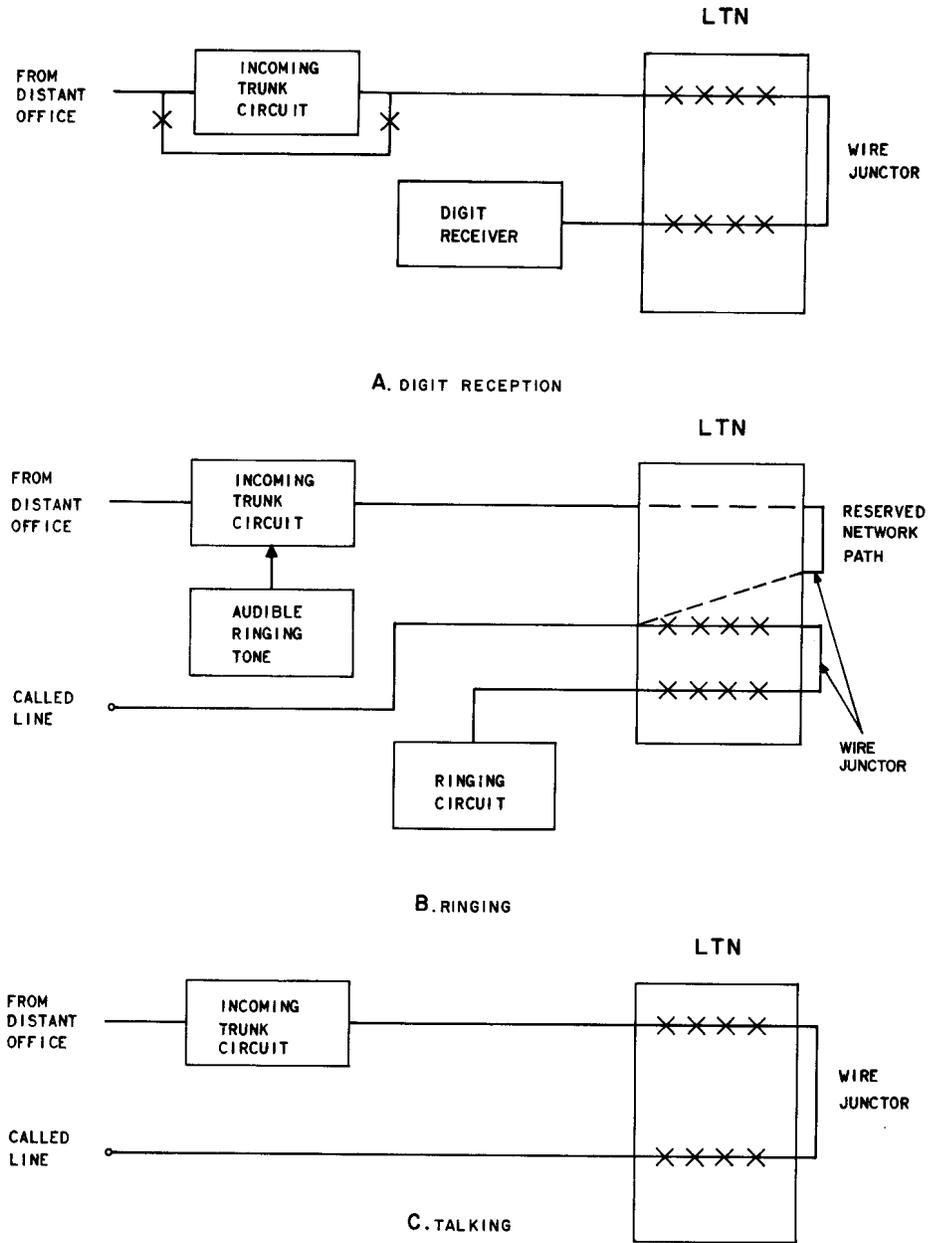
Fig. 40—Incoming Call Connections

RANGE EXTENDED CALLS

7.21 Calls involving lines that are range extended are processed basically in the same manner as regular intraoffice or interoffice calls with a few exceptions. Range extended lines require the use of B-link amplifiers to provide 5 db of gain in the talking state. In addition the digit receivers must be placed in the range extended state boosting the battery feed to 72 volts. The following description covers the case of an intraoffice call involving two range extended lines and covers only the special actions required for range extension. In cases where only one of the lines is range extended or the call is interoffice, the nonrange extended party is handled in the same manner as

previously described for a regular interoffice or intraoffice call. Fig. 41 shows the network connections for calls involving range extended lines.

7.22 All decisions and actions for range extension are controlled by the POB programs. When a bid for service is recognized and the translation indicates the originating party is range extended a POB is loaded to:

    (a) operate a relay to place the digit receiver in the range extension dial tone state and

    (b) set a flag for the I/O 25 digit routine to place the digit receiver in the range extension digit state after the first digit is detected.

7.23 After the digits are collected and processed the audible ring POB is used to turn on a B-link amplifier to provide amplified audible ringing tone to the calling party. Upon answer by the called party, B-link amplifiers must be turned on for both parties to establish a talking connection. The amplifiers are turned on after the network path is closed and before supervision is transferred to the circuit junctor. This allows the trunk ferrod to operate properly.

7.24 When disconnect is detected, the B-link amplifiers are turned off before the line ferrods are restored and at the same time the junctor circuit is idled.

REVERTING CALL

7.25 A reverting call (Fig. 42) is a call between two customers who share the same party line; therefore, both lines have the same terminal equipment number.

7.26 The call is processed as a regular intraoffice call until all seven digits are detected and recorded in the OR.

7.27 The directory number translation indicates that the calling and called terminal equipment numbers are the same. The reverting call is handled in one of the following ways depending upon the option selected by the operating company:

    ● Operater Assistance

    ● 2-Party Selective, 4-Party Semiselective, and Divided Code ringing

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

    ● Return Busy.

A. Operator Assistance

7.28 For flat rate or message rate customers, the call is routed to an operator over a recording-completing trunk (Fig. 43A). From the trunk switchboard position or from the reception of an identification tone, the operator recognizes that assistance is needed in the completion of a reverting 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. The operator then dials the called number over a local toll switching trunk (Fig. 43B). When the connection is set up, ringing is applied under operator control (Fig. 43C). Throughout the conversation, the call is supervised via the local toll switching trunk (Fig. 43D). After both parties disconnect, the connection is taken down and the trunk is released.

B. 2-Party Selective, 4-Party Semiselective and Divided Code Ringing

7.29 After dialing is completed, the ESS returns busy tone until the calling customer hangs up. The busy tone is removed and reverting ringing is applied to both parties. When either customer on the party line removes the receiver from the switchhook, ringing is removed and a talking connection is established to a circuit junctor. When both customers hang up and the disconnect is detected at the circuit junctor disconnect timing is completed and the connection is released.

7.30 With 2-party lines, regular ringing is applied to the called customer; special reverting ringing is (1/2 second on and 2-1/2 seconds off) is applied for the calling customer.

7.31 With 4-party lines, the semiselective 4-party ringing transmits a standard ringing tone (2 seconds on and 4 seconds off) to the calling party.

A. INTRAOFFICE CALL - BOTH PARTIES RANGE EXTENDED

B. INTRAOFFICE CALL - ONE PARTY RANGE EXTENDED

C. INTEROFFICE CALL - INVOLVING A RANGE EXTENDED LINE
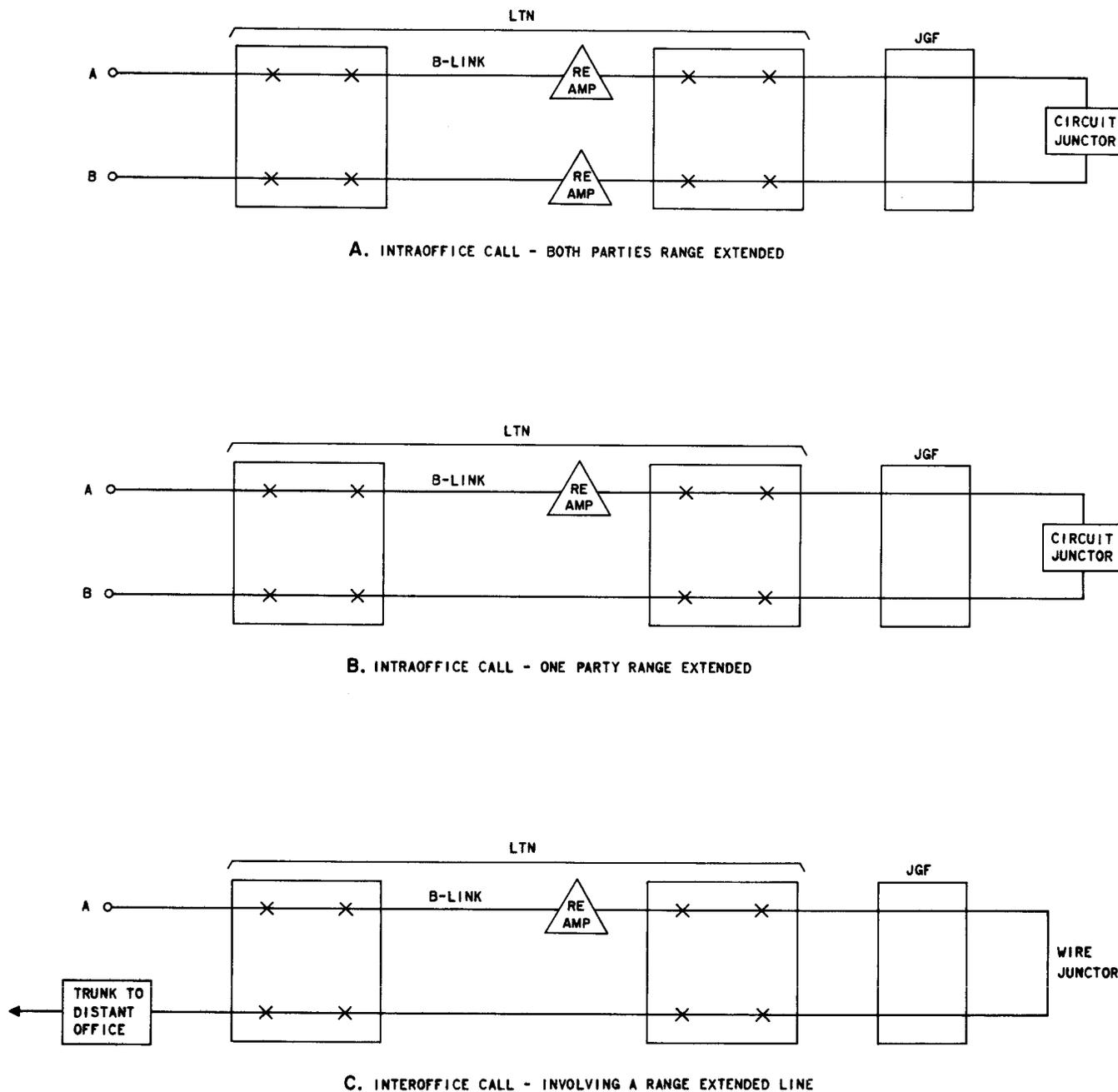
Fig. 41—Network Connections for Calls Involving Range Extended Lines

C. 2-Party Selective, 4-Party Full Selective, and 8-Party Semiselective Ringing

7.32 After the seventh digit is received, the ESS returns dial tone to the calling customer (4- and 8-party only) as a request to dial an additional digit that identifies the customer station and ringing code.

7.33 When the eighth digit is received, the ESS removes the dial tone and returns busy tone to the calling customer. When the calling customer hangs up, the ESS removes the busy tone and

LTN

A-RINGING CONNECTION

LTN

B-STABLE TALKING CONNECTION
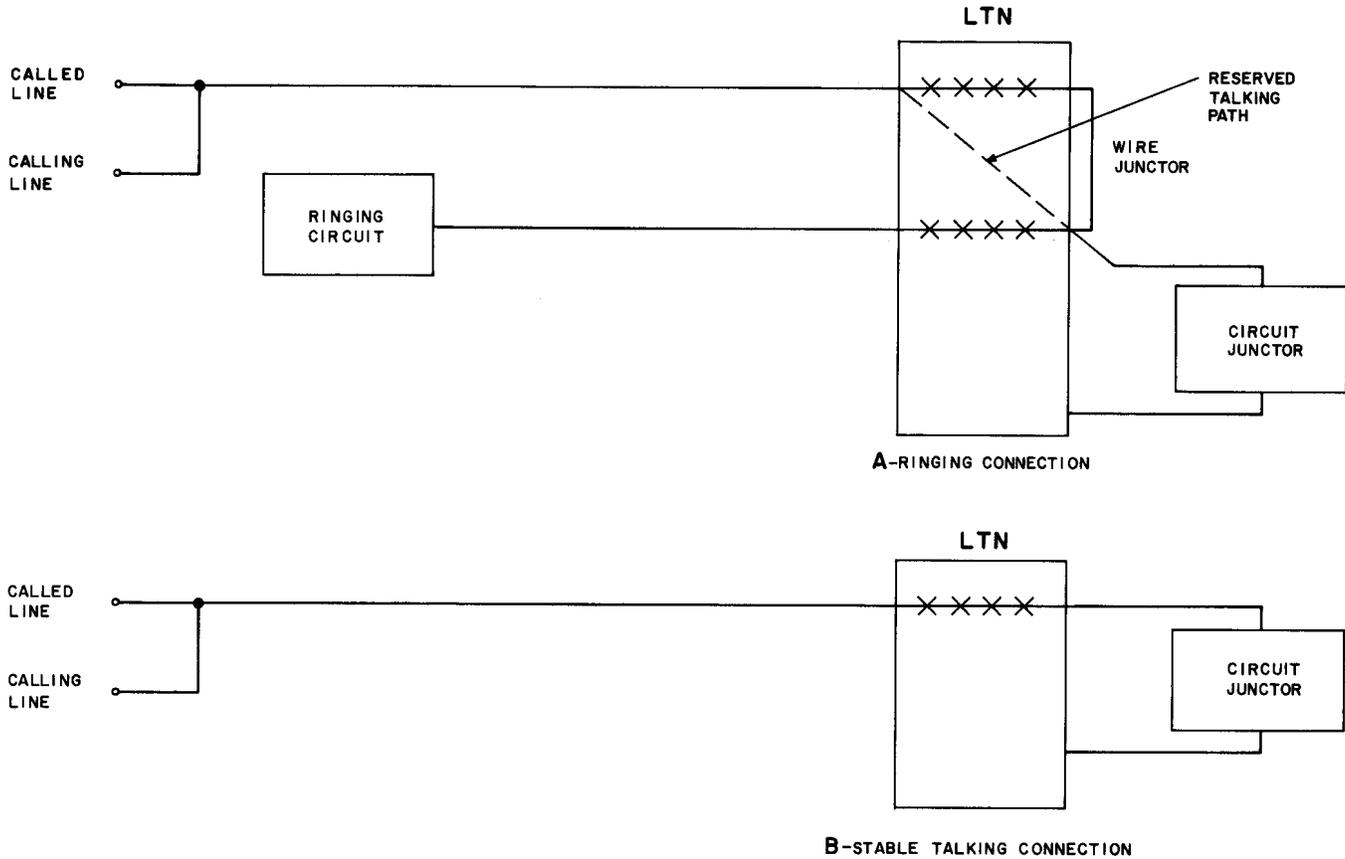
Fig. 42—Connection on Reverting Call

connects ringing to the calling and called stations. If the calling and called stations are on the same side of the line (have the same polarity), only the called line ringing code is applied. In other cases, each party is rung with the proper code.

7.34 When either customer on the line removes the receiver from the switchhook, ringing is released and the talking connection is established.

7.35 For any of the reverting call arrangements described previously, 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 10 seconds after receiving dial tone.

7.36 With 4- and 8-party lines, the number translation for the called line indicates the ringing code that should be applied. The calling party ringing code is applied to the opposite side of the line. If both customers are on the same side of the line, only the called party is rung.

D. Return Busy

7.37 In this arrangement no provisions are made for calls between parties sharing the same line. When such a call is attempted, busy tone is returned to the calling line.

OPERATOR ASSISTANCE, SERVICE CODE, AND DIRECT DISTANCE DIALING CALLS

7.38 Operator assistance and service code calls are treated as outgoing operator calls. Direct distance dialing (DDD) calls are handled as regular

LTN

RECORDING
COMPLETING
TRUNK

WIRE
JUNCTOR

SWBD

A. REVERTING CALL ROUTES TO OPERATOR

LTN

TRUNK
DIGIT
RECEIVER

TOLL
SWITCHING
TRUNK

WIRE
JUNCTOR

SWBD

B. OPERATOR DIALING

LTN

RINGING
CIRCUIT

AUDIBLE
RINGING
TONE

TOLL
SWITCHING
TRUNK

RESERVED
TALKING
PATH

SWBD

C. RINGING

LTN

TOLL
SWITCHING
TRUNK

WIRE
JUNCTOR

SWBD

LEGEND:

o LINE ON-HOOK
● LINE OFF-HOOK
SWBD SWITCHBOARD

D. TALKING

Fig. 43—Reverting Call—Operator Completed

outgoing calls. A translation of the dialed digit or digits indicates:

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

(b) The kind of supervision the trunk requires

(c) Whether or not outpulsing is required.

Outpulsing is required for DDD calls and calls to operator switchboard positions through another office.

A. Operator Assistance Calls

7.39 After the first digit is received and the customer had dialed a 0, an operator trunk is seized. Audible ringing tone is sent to the customer until the operator answers. When the operator answers, a talking connection is established. Both the operator and the customer must disconnect before the connection is released. If the office allows special (0+) toll calls (such as credit card, collect), 4-second timing is ap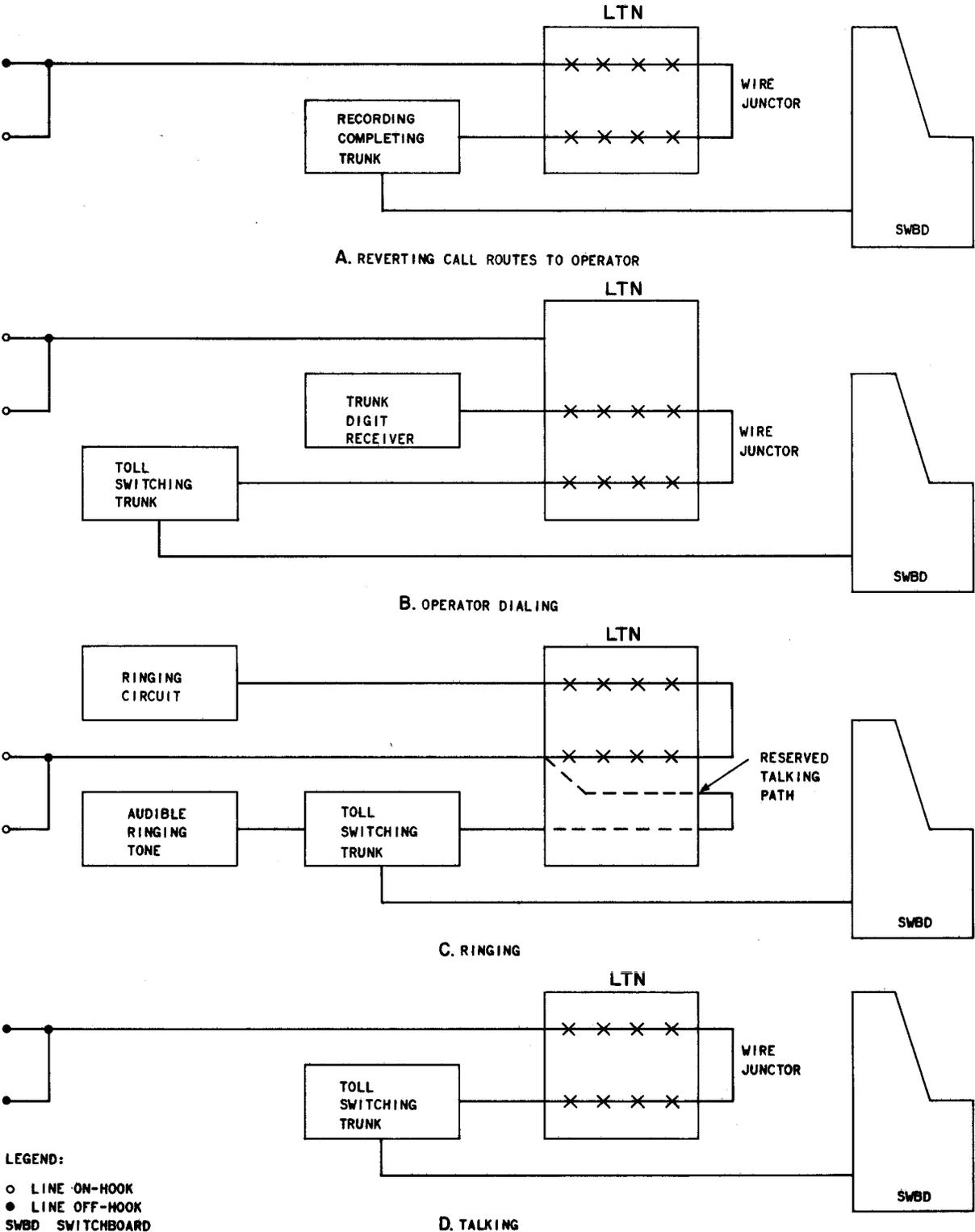plied after the digit 0 is received to determine if additional digits will follow. If so, both the calling and called number will be outpulsed over the trunk to assist the operator in completing the call.

B. Service Code Calls

7.40 Calls to a service code operator (long distance, repair service, business office, information, etc) follow a pattern similar to that of assistance calls. A translation of the dialed digits indicates how to terminate the call. Audible ringing tone is sent to the customer, and a lamp signal 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.

C. Direct Distance Dialing Calls

7.41 A translation of the area code digits plus the office code, if necessary, indicates how to terminate the call. Then the outgoing call program selects the appropriate trunk and outpulses the digits.

MANUAL CALL

7.42 A dial office can serve manual lines that require the assistance of an operator to originate calls. When a manual line goes off-hook, the line's terminal equipment number translation indicates this is a manual service line. The false cross and ground and the power cross tests are made; then a digit receiver is connected to a line and the transfer of supervision is checked but dial tone is not applied. The digit receiver is then released and a connection is established to an operator as though the customer had dialed 0. The operator completes the call as requested by the customer.

8. CALL CONDITIONS

8.01 The following are some of the conditions which may occur during the processing of a call:

- Permanent Signal

- Partial Dial

- Dialing Before Receipt of Dial Tone

- Vacant Code

- Blank (or Unequipped) and Unassigned Numbers

- Free Number

A. Permanent Signal

8.02 When a customer origination is detected, the ESS establishes the dialing connection, returns dial tone to the customer, and waits for the dialed digits.

8.03 If dialing is not started within 16 seconds (10 seconds under heavy traffic conditions), the line is judged to have a permanent signal condition. The dialing connection to the line is released and the permanent signal program is entered.

8.04 The line is connected first to an announcement circuit, then to a receiver off-hook tone, and finally to an operator, any of which can be omitted by local office option. If the permanent signal cannot be cleared, the line ferrod is opened

and the line is entered in the high and dry list, where it is examined periodically for on-hook.

B. Partial Dial

8.05 After the customer dials the first digit, each interdigital interval is monitored. If the interdigital interval exceeds the allowable 10 second limit, an insufficient number of digits has been dialed. The dialing connection is released, and the customer line is connected to either a partial dial announcement. Then the partial dial is treated in the manner as described for the permanent signal.

C. Dialing Before Receipt of Dial Tone

8.06 If the customer dials before receiving dial tone, the first digit of the called directory number is either unrecorded, causing a partial dial condition, or mutilated, causing a wrong number or a vacant code condition.

D. Vacant Code

8.07 A vacant code is either an office code or a foreign area code not accessible to the local central office customer or operator. A vacant code is handled in the same manner as an unassigned number.

E. Blank (or Unequipped) and Unassigned Numbers

8.08 A blank (or 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 not assigned to any customer. When the called number is recognized as a blank or an unassigned number, the calling customer line is connected to a blank number announcement or to an operator via an intercept trunk or to an Automatic Intercept System (AIS).

F. Free Number

8.09 A free number is a directory number that any local customer can call without charge (no AMA record kept or no coin charge 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.

9. CHARGING

CHARGING ON COIN CALLS

9.01 Coin lines may be either prepay or dial tone first. There are two types of *prepay* coin lines: loop start and ground start. On prepay loop start coin lines, an initial coin test is required before dial tone is returned to the customer. No initial coin test is required on ground start coin lines because the coin deposit is required to close the loop and cause an origination. Dial tone first coin lines are always loop start, but the initial coin test, is at the completion of dialing if required. For calls from dial tone first lines to operators, service codes, and free numbers, the coin test is not done, and therefore; the customer can reach an operator or other assistance without a coin.

A. Local Coin Call With No Overtime Charging

9.02 A local coin call is a call within the local calling area of the coin customer. After the initial coin test, if required, the call proceeds as a normal intraoffice or interoffice call. If either customer disconnects before the end of a 750 ms charge delay after answer recognition, the coin deposited is returned. If the disconnect occurs after the charge delay, the coin deposit is collected.

B. Local Coin Call With Overtime Charging

9.03 A local coin call with overtime charging is treated like a regular local coin call until the end of the charge delay. After the charge delay, a stable timing entry (STE) is set up to time the call during the initial interval. This interval can be from 1 to 6 minutes and is determined by a translation of the charge index. If the call terminates prior to 30 seconds before the end of the initial interval, the coin deposit is collected.

9.04 Thirty seconds before the end of the interval the STE will time out and talking connection will be broken. The coin deposit is then collected by the coin control circuit and the talking connection is reestablished. This collect alerts the customer that an additional coin deposit is required if the call is to continue. After the collect, the interval timing is continued to allow the additional deposit or to allow the parties to terminate their conversation. If the call terminates during the remaining 30-seconds, any additional deposit which has been made will be returned.

9.05 If the call remains in the talking state and the end of the timing interval is reached, then a test for a coin deposit is made. If a coin is present, an STE is set up to time the overtime period. The overtime period is also determined by the charge index and may or may not be the same length as the initial period. Again the coin will be collected 30 seconds before the end of the overtime interval if the call is still in progress and the customer is allowed 30 seconds to make an additional deposit for the next period.

9.06 If a coin is not present at the end of a timing interval, both parties are connected to an overtime monitoring operator (Fig. 44). An optional recorded announcement may precede the operator connection. The operator will request an additional deposit and disconnect when satisfied the deposit has been made. If a coin is present and both parties are still off-hook they will be reconnected and the overtime charging interval timing initiated.
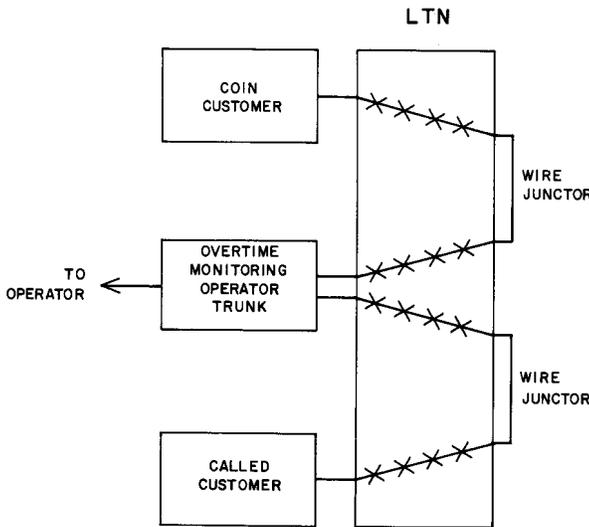
Fig. 44—Connection for Local Coin Call to An Overtime Monitoring Operator

C. Coin Zone Call

9.07 A coin zone call is a call dialed by a coin customer to a point outside the local calling area. When a coin zone call is recognized at the end of dialing, the calling customer is connected to a coin zone operator. The operator is alerted

by one of eight rate lamps which indicate the charge for the initial period as determined by the charge index. The operator requests the initial deposit and disconnects. An inactive STE is then set up which stores the charge information. The call proceeds as a normal call until the end of the charge delay. The STE is then activated to time the initial period as described previously for a local coin overtime call. Thirty seconds before the end of the initial interval the coins are collected.

9.08 At the end of the initial interval both parties are connected to a coin zone operator to time the overtime interval (Fig. 45). The operator is alerted to the overtime charge by the appropriate rate lamp. The operator times the rest of the call and requests the additional charge at the end of the call.
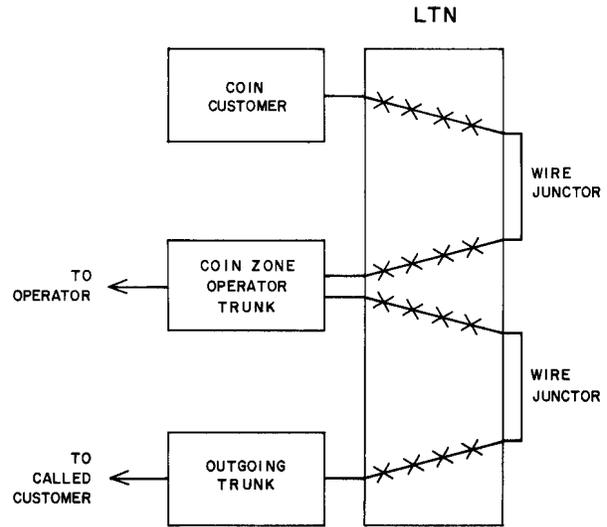
Fig. 45—Network Connection for Coin Zone Call In Overtime

9.09 A required coin return cycle is also made on all called coin lines at the completion of the call to eliminate the possibility of a coin line originating a call with a 5 cent deposit.

CHARGING ON MESSAGE REGISTER CALLS

9.10 At the completion of dialing, when it has been determined from the charge index that message register charging is necessary, an inactive STE is set up to time the initial period in the same

manner as for a coin zone call. At the end of the charge delay, the STE is activated to charge the initial period if the call is to be timed, or cleared if the call is not timed. Each initial or overtime interval can be from 1 to 6 minutes and any number of message units (pulses) from 1 to 15 can be received at the beginning of each interval. A peripheral decoder point connected to the message register circuit is operated and released repeatedly to accomplish the billing.

AUTOMATIC MESSAGE ACCOUNTING

9.11 If the office is arranged for local AMA, initial, answer, and disconnect entries are placed in the AMA buffer during the progress of the call. The initial entry made at the completion of dialing contains the calling number, the called number (if required), and other charging information. The answer and disconnect entries made during the answer and disconnect states of call, respectively, contain the answer and disconnect times. Each entry also contains a call identity index which is used to associate the entries to a particular call.

9.12 The entries are removed from the AMA buffer and recorded on an incremental magnetic tape recorder in a multientry format. The magnetic tapes are later processed at an accounting center.

9.13 The office can be arranged for CAMA with no charging done at the No. 2 ESS office. If the No. 2 ESS office does local charging and AMA, charging outgoing calls are handled in the same manner as for intraoffice calls.

10. CUSTOM CALLING SERVICES

10.01 A No. 2 ESS customer can subscribe to one or a combination of custom calling services. The custom calling services now available to No. 2 ESS customers are:

- Call Waiting
- 3-Way Calling
- Call Forwarding
- Speed Calling.

CALL WAITING

10.02 A conference circuit is used to implement call waiting. Three parties may be connected to the circuit and the states of the call changed by changing states in the conference circuit. A split relay in each port isolates the party on the port from the other conferees when it is operated and bridges the party into the conference when released. A tone relay on each port gives a tone to the party directly from a conference port, eliminating the need for a connection to a tone circuit. Port 0 is used to return call waiting tone and ports 1 and 2 return audible ringing tone.

10.03 Call waiting is initiated when the calling party dials a party who is already in a stable talking state and has the call waiting service. At this point, the call waiting program selects a conference circuit, and a TCR which is designated as a permanent conference record (PCR) to monitor the conference circuit. The called party, who becomes the controlling party, is connected to port 0 with call waiting tone to signal that a call is waiting. The calling party is connected to port 2 in the split state with audible ringing tone to indicate that the called party is being alerted, and the third party (the party originally talking to the present called party) is connected to conference port 1. The tone to the controlling party lasts 0.3 seconds and is repeated once after 10 seconds if the controlling party does not respond to the first tone signal. After the controlling party has heard call waiting tone and flashes, bridging to the third party is accomplished by releasing the split relay in port 2 and operating the split relay in port 1. Each successive flash will cause the controlling party to be bridged to the party from whom he is presently split. Call waiting is terminated by an on-hook from any of the involved parties. However, an on-hook from the called (controlling) party with a party in a split state causes the called party to be rung. When the called party answers, the calling and called parties are connected in a stable talking connection.

THREE-WAY CALLING SERVICE

10.04 A third party may be added to an existing call if it is in a stable talking state. Three-way calling service is initiated by a flash from a stable talking connection. When a party with 3-way calling flashes, the 3-way calling program is entered and 3-way calling is initiated. A

conference circuit and two consecutive TCRs are selected for use in the conference and the second party is connected to port 1 of the conference circuit. The party requesting 3-way calling is connected to a digit receiver and an OR and is associated with the first TCR selected. Then the controlling party is given dial tone and a bit in the TCR is set to 1 so that a second flash by the controlling party will be recognized as a conference signal. The second TCR becomes the PCR for the conference.

10.05 With the LO-1 program, a flash by the controlling party before reaching a talking state with the third party, reestablishes a connection with the second party and releases the conference circuit. This allows the controlling party to disconnect from a tone or recorded announcement, or to reestablish the conference when the third party number is misdialed. With the EF-1 generic program, a flash before reaching the talking state with the third party results in a 3-way connection immediately. The requirement for a flash before establishing the three-way connection gives the controlling party an opportunity to have a private conversation with the third party before the second party is added. After a 3-way connection is established, the controlling party may remove the last added party by flashing. The controlling party may terminate the conference by going on-hook. If either of the other two parties goes on-hook, the call is returned to a stable 2-party connection.

CALL FORWARDING

10.06 Call forwarding is a service that enables a subscriber to forward incoming calls to another directory number. Call forwarding is initiated when a customer dials the access code (72# or 72 + timeout) and the directory number to which calls are to forwarded. The customer first dials the access code, then on receipt of the second dial tone dials the desired directory number. The system records the call forwarding entry in CS and completes a connection to the directory number being forwarded to. If the called party answers, a call forwarding is activated.

10.07 If the called party cannot be reached, the customer can activate the transfer by redialing the same directory number within 2 minutes. On the second attempt, confirmation tone is returned indicating the entry has been processed.

10.08 The customer may terminate call forwarding by dialing a cancellation code (73# or 73 + timeout). Confirmation tone is returned indicating that call forwarding has been cancelled.

10.09 Each time a party with call forwarding is dialed, the call forwarding entries are searched for an active call forwarding entry. Normal call treatment will result if no entry is found. For an active entry, the stored number is placed in the OR as if it had been dialed by the calling party, and the digit interpretation routines are reentered. The call forwarded line is then given a short ring to indicate that a call has been forwarded, and the call is completed to the "forwarded to" line.

SPEED CALLING SERVICE

10.10 Speed calling is a service that enables a subscriber to call a number of selected directory numbers by dialing abbreviated codes. The customer may subscribe to 1-digit speed calling, which allows up to eight stored codes, or 2-digit speed calling with 30 codes or both 8- and 30-code service.

10.11 When the customer dials an abbreviated code, the speed calling routine is entered. The abbreviated code is used to access the directory number stored in the speed calling list. The digit interpretation program is then re-entered using the stored directory number and the call is then processed as a normal call.

10.12 A customer may change the speed calling list by dialing special access codes (74# or 74 + timeout for an 8-code list and 75# or 75 + timeout for a 30-code list). A second dial tone is then received and the customer dials the 1- or 2-digit code to be changed followed by the new directory number to be assigned to this code. After dialing is completed, the new number is translated and the speed calling entry is made in the list. Confirmation tone is then returned to the customer to indicate the request was handled successfully.

11. OPERATION OF NO. 2 ESS WITH SWITCHBOARDS

11.01 Some calls require the assistance of an operator and are directed to a switchboard. The switchboard most commonly used is called the combined toll and dial service attendant (DSA)

switchboard. The kinds of traffic handled at DSA switchboards are shown in Fig. 46.

OUTGOING TRAFFIC TO OPERATOR

11.02 A customer who dials 0 or the long distance code (211) is routed to a combined toll and DSA operator. The dialed digit 0 tells the ESS what kind of trunk to select. While the operator is being alerted by a lamp indication, the calling customer hears audible ringing tone. When the operator answers, a talking connection is established.

INCOMING TRAFFIC FROM OPERATOR

11.03 An operator completes a call to a No. 2 ESS customer by seizing either a toll switch or a no-test trunk to the No. 2 ESS. (No-test trunks are used by operators for testing and verifying purposes.) Seizure of the trunk is detected during the supervisory trunk scan. A translation of the trunk scan point number informs the input monitor program that the trunk is incoming. Further translation by the TCR program specifies

the trunk class, the number of digits to be received, and the type of digit receiver to be used. If the operator seizes a toll switch trunk, the call is processed in the same manner as any other incoming call.

11.04 To access a busy line in the No. 2 ESS, the operator seizes a no-test trunk. The TCR program operates the appropriate no-test vertical crosspoint and connects the operator to the busy line. Fig. 47 shows the network connections for a no-test call to a busy line. All no-test calls are under control of the TCR. A call from a no-test trunk to an idle line connects with the same network switching as a regular call. A no-test vertical is not used.

12. NO. 2 ESS CENTREX CALL PROCESSING

GENERAL

12.01 This part describes the actions taken by the system to process various centrex calls.
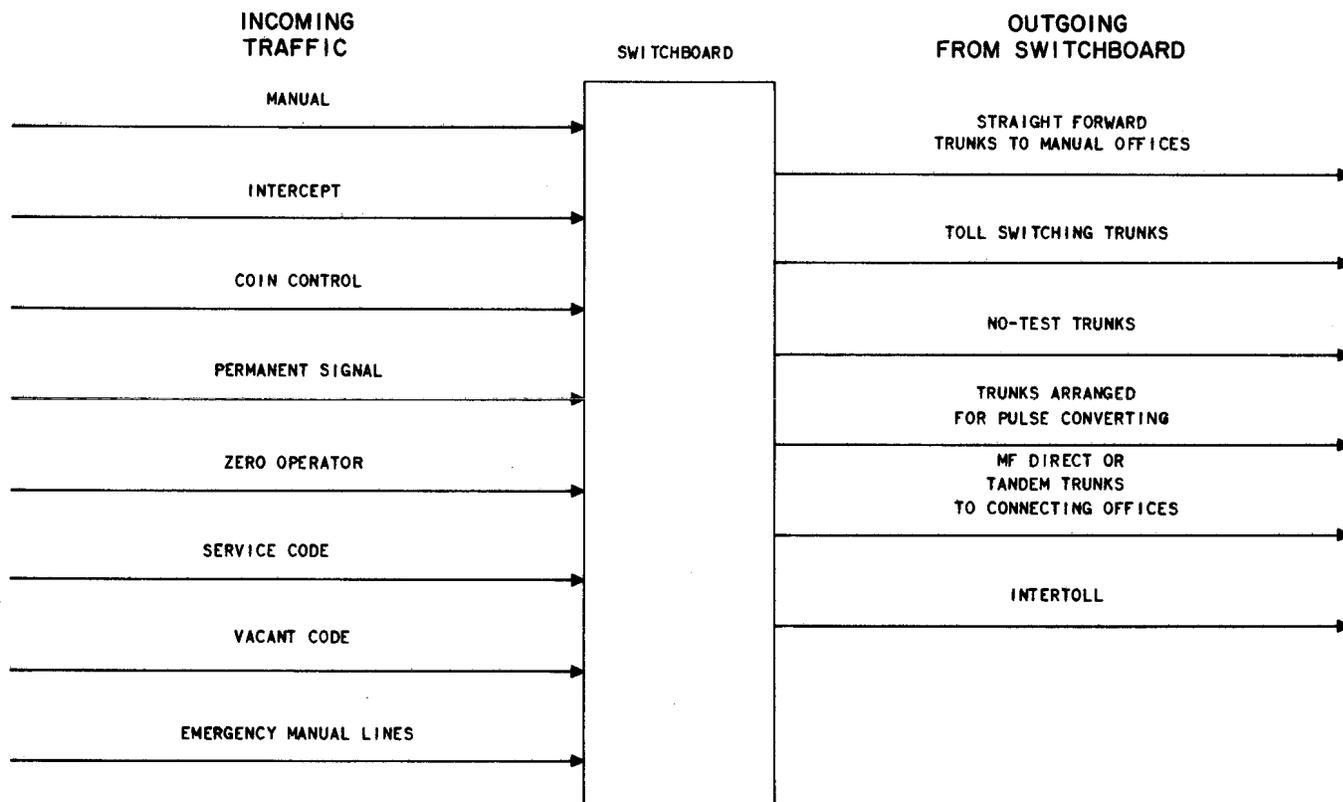
Fig. 46—Traffic at Switchboard Associated with a No. 2 ESS Office

LTN

LTS   **NCJS**

CUSTOMER A

CIRCUIT
JUNCTOR

CUSTOMER B

NO TEST TRUNK

WIRE
JUNCTOR

SWBD

NO-TEST VERTICAL

A. INTRAOFFICE CALL

LTN

LTS   **NCJS**

CUSTOMER A

WIRE
JUNCTOR

CUSTOMER B

OUTGOING
TRUNK

NO TEST TRUNK

WIRE
JUNCTOR

SWBD

NO-TEST VERTICAL

B. INTEROFFICE CALL
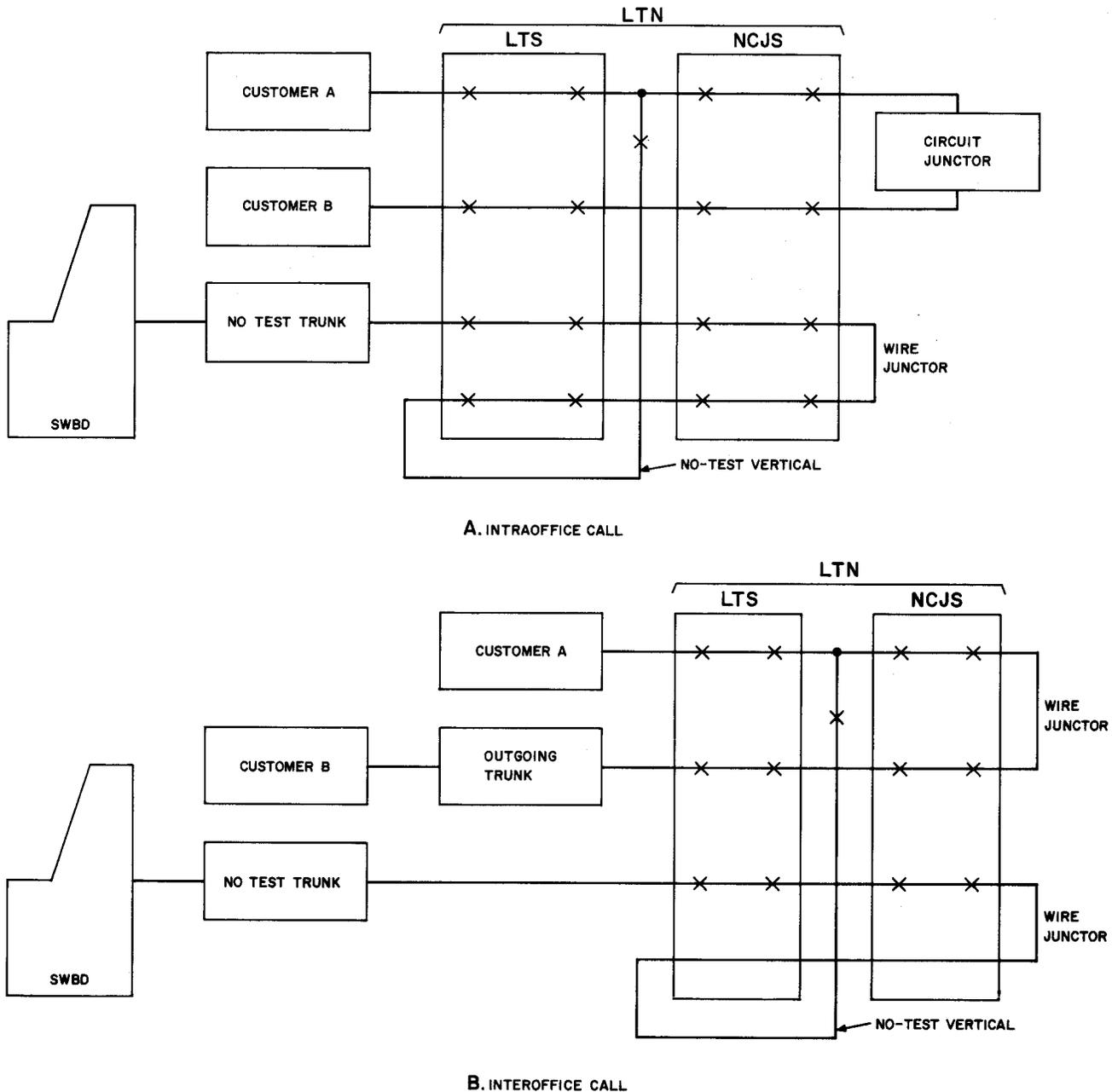
Fig. 47—Network Connections for No-Test Call to Busy Line (Customer A)

Only the portions of call processing that are unique to the centrex feature are discussed.

CENTREX PROGRAMS INVOLVED IN CALL PROCESSING

A.   Centrex Translation Program

12.02   The centrex translation program is a collection of subroutines designed to access

translation information unique to centrex service. These subroutines are used to retrieve:

● Centrex station data,

● Information common to a given centrex group,

● Information about each attendant and associated data link, etc.

12.03 Translation data peculiar to centrex service is located in various parts of noncentrex translators as well as in translators specifically designed for centrex service.

12.04 Each centrex customer group has a 32-word centrex block in translations which uniquely identifies it as one of 127 possible centrex customers. This block contains information such as:

● customer options,

● number of and information about attendants serving the customer,

● charging and billing treatment, and

● information concerning the customers dialing plan.

12.05 Included in the centrex block is the first in a set of digit interpreter tables. Entries in this table contain information needed to interpret the first digit dialed by the customer extension. If the first digit is enough to specify the call type, a "terminal" entry in the table is reached which identifies the type of call. Otherwise the entry points to the next digit interpreter table which is used to interpret the second digit, and so on. This entire set of digit interpreter tables is called the "dialing tree."

B. Centrex Digit Interpretation Program

12.06 Originations are handled by the line or trunk origination program in the same manner as noncentrex calls. If the calling party is a centrex line or attendant, the TCR is loaded with a centrex access treatment (CAT) code which indicates the restrictions to be applied to the calling party.

12.07 After each digit is collected, control is given to the centrex digit interpretation program. This program then accesses the appropriate digit interpreter tables in translations using the digits stored in the OR. The dialed digits are used to access the entries of the digit interpreter tables until either a terminal entry is found or an indication of invalid dialing is reached. In the

latter case the call is routed to the partial dial program.

12.08 If a terminal entry is reached, control is passed to the appropriate routine for processing the particular type of call dialed. One exception to this is the case of a call forwarded centrex line attempting to dial anything other than attendant access or the code for deactivating the call forward access. These attempts are routed to a special tone to remind the caller that the extension is call forwarded.

C. Centrex Trunk Program

12.09 For calls leaving the centrex customer group, control is given to the centrex trunk program by the centrex digit interpretation program after the dialed digits have been recognized as a trunk access code. At this point the calling party is recognized as a centrex line, trunk or an attendant. The centrex trunk program performs CAT code screening using the 4-bit CAT code stored in the TCR to determine the restrictions of the calling party. If the selected restriction bit in the first word of the terminal entry is zero, the call is denied and the calling party is given centrex partial dial treatment. If the bit selected is a one, the call is allowed to continue. From this point the centrex trunk program actions depend on the type of access code dialed.

12.10 The centrex trunk program handles the followng types of calls:

● wide area telephone service (WATS) access,

● tie trunk or foreign exchange (FX) trunk access,

● common control switching arrangement (CCSA) trunk access,

● manual outgoing tie trunk access,

● tandem tie trunk dialing access,

● most economical routing (MER) access.

D. Centrex Custom Calling Program

12.11 The centrex custom calling program is a collection of base level programs and

supporting subroutines which implement the following No. 2 ESS custom calling services:

- Call Pickup

- Directed Call Pickup

- Code Call and Code Call Pickup

- Trunk Answer From Any Station

- Call Hold

- Speed Calling

- Call Forwarding

- Call Forwarding-Busy Line

- Call Forwarding-Don't Answer

- Call Transfer

- Paging

- Recorded Dictation

12.12   These programs are transferred to when the centrex digit interpretation program determines that the service has been requested by a centrex customer. The exact digits that must be dialed by a customer to access a particular custom calling service or centrex trunk vary and are assigned on a per centrex customer basis.

E.   Attendant Programs

12.13   The attendant programs are a collection of programs that respond to attendant actions and provide an interface with the No. 2 ESS and the attendant data link facilities. Some of the functions of these programs are:

- Receive information from attendant consoles in the form of encoded key signals, act on them, and pass the information to the sytem call processing programs

- Transmit data messages to the consoles to change the states of lamps at the request of call processing programs.

- Control services which are unique to the attendant such as: camp-on, attendant

controlled conference, attendant control of facilities, etc.

- Control calls that are directed to the attendant consoles.

CALL STORE MEMORY ASSOCIATED WITH CENTREX CALLS

12.14   In addition to the CS areas discussed earlier in this section, centrex call processing requires the use of two unique areas of CS; the OR extension and the centrex scatter table.

A.   Originating Register Extension

12.15   Due to the unique nature of centrex customer groups more CS space is needed than is provided in the OR for digit storage. This additional information is stored in an OR extension (Fig. 48) which is addressed whenever the OR is addressed. The OR extension also is needed:

- To replace the sender list

- To store the charge index normally stored in the last word of the OR

- To store special billing numbers and simulated trunk group numbers for centrex CO

- To store AIOD information for centrex CU

- To allow for expansion of OR capability for up to 24-dialed digits

- To allow more temporary storage for centrex CO

- To store CAMA information (future).

B.   Centrex Scatter Table

12.16   The centrex scatter table (Fig. 49) is an area of CS used for storing information concerning call forwarded extensions and for keeping track of extensions involved in calls in the system. Each scatter table entry consists of two CS words. The line's TEN is stored in the low 15 bits of word 0. The high bit of this word is 0 for call forwarding and 1 for keeping track of the line while it is involved in a call. Word 1 is used to save the TEN of the *forwarded to* line for call forwarding. If the line is not forwarded, word 1
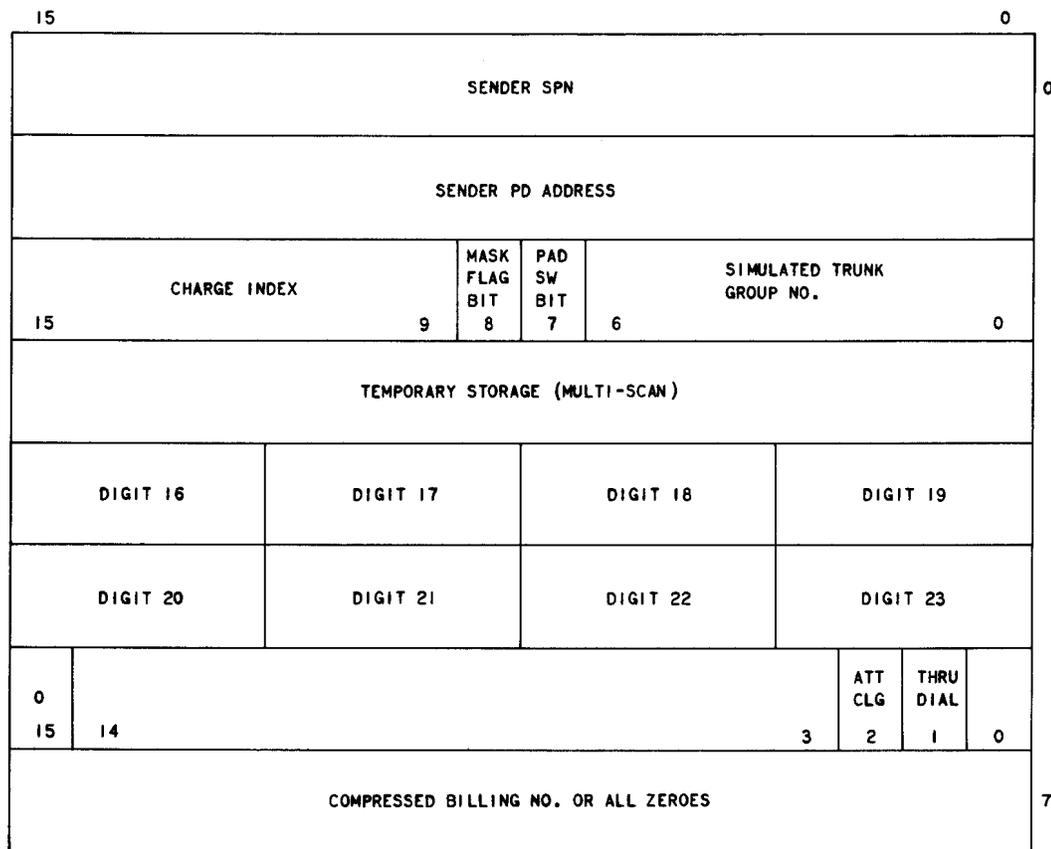
15   0

SENDER SPN				0
SENDER PD ADDRESS				

CHARGE INDEX (15 ... 9)	MASK FLAG BIT 8	PAD SW BIT 7	SIMULATED TRUNK GROUP NO. (6 ... 0)

TEMPORARY STORAGE (MULTI-SCAN)

DIGIT 16	DIGIT 17	DIGIT 18	DIGIT 19
DIGIT 20	DIGIT 21	DIGIT 22	DIGIT 23

0 15	14 ... 3	ATT CLG 2	THRU DIAL 1	0

COMPRESSED BILLING NO. OR ALL ZEROES	7

Fig. 48—Originating Register Extension

includes the scan point number (SPN) or the pseudo scan point number (PSPN) of the circuit to which the extension is connected and bits indicating the hold or camp-on state of the extension.

CENTREX CALLS

A. Calls from Centrex Lines

12.17 After the centrex digit interpretation program accesses the digit interpreter table and the terminal entry indicates an extension has been dialed, information from the terminal entry needed for terminating translation is stored in the TCR. The dialed digits are then retrieved from the OR and, along with any prefix digits supplied by the digit interpreter table terminal entry, are used to perform a directory number translation.

12.18 After the directory number translation is performed, a check is made to determine that the calling party centrex number matches the called party centrex number. This comparison is made for every call except for direct inward dial (DID) or common control switching arrangement (CCSA) calls. This prevents improper access of private business subscriber lines. Additional checks are made to determine the "change speed calling" and "call forward activate" situations to allow transfer of control to the centrex custom calling proram when appropriate.

12.19 If at this point the call is determined to be a DID or CCSA call to the listed directory number, control is passed to the attendant call processing routine. But for an extension to extension call, the called line is tested for being call forwarded. If so, the "forwarded to" line's translation data and TEN are substituted in the TCR and control is passed back to the point where the called party checks are made.

12.20 If the called line is not call forwarded it is checked for a busy indication. If the

WORD 0	I	TEN		
WORD I	HOLD BITS	SPN OR PSPN		

15 14 13   0

0		TEN				
I	I	0		X	X	RECEIVER 10-BIT NO.

15 14 13 12 11 10 9   0

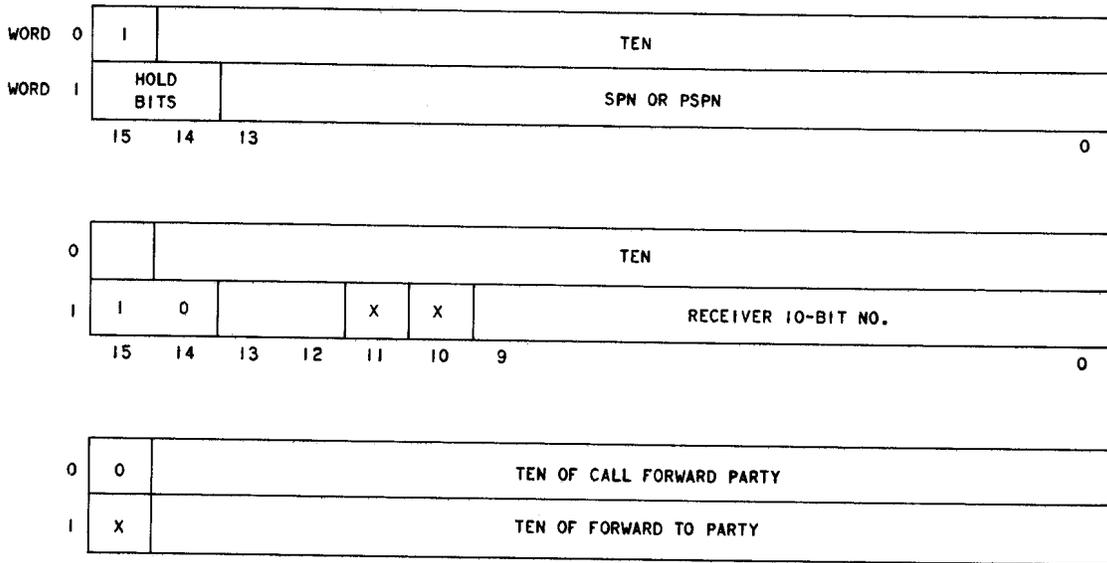| 0	0	TEN OF CALL FORWARD PARTY
I	X	TEN OF FORWARD TO PARTY

Fig. 49—Centrex Scatter Table Layouts

called line is idle, it is checked for terminating restrictions and dialing error treatment is returned to the caller if appropriate. If these checks indicate that the called party is not restricted, control is passed to the digit interpretation program for processing toward a ringing connection. The remainder of the call processing, ringing, answer detection, disconnect etc. is handled in the same manner as previously described for noncentrex calls.

12.21 If the line busy test indicates that the called line is busy, a check is made to see if the called line has the station hunt feature. If not, busy tone is returned to the caller. If the line has station hunt, control is transferred back to the directory number translation using the specified directory number.

12.22 In addition the centrex station may be allowed the following types of calls:

- Wide Area Telephone Service (WATS) Access

- Tie Trunk or Foreign Exchange Trunk Access

- Manual Outgoing Tie Trunks (including Paging)

- Tandem Dialing Arrangement

- Most Economical Routing

12.23 In all trunk access code cases the centrex trunk program first performs centrex access treatment (CAT) code screening. This screening is performed by comparing the CAT code stored in the TCR from the calling party originating translation to the appropriate "restriction bit" of the terminal entry in the dialing tree. If the restriction bit is a zero, that particular access code is denied to the centrex station and the calling party is given partial dial treatment. If the restriction bit is a one the call is allowed to continue.

Wide Area Telephone Service

12.24 In the case of WATS, the terminal entry will indicate a simulated group is needed for this call. A simulated group is a software device used where the service is sold on a per facility basis, but where no physical equipment is associated with that service. Simulated groups are needed for all WATS access codes. Simulated group processing will check that a member is available and increment the count of busy members. If no member is available, the call is routed to reorder treatment. Second dial tone is returned

and control is given to the normal noncentrex digit interpretation program for normal routing of a WATS call.

Tie Trunk or Foreign Exchange Trunk Access

12.25 If a tie trunk or foreign exchange trunk access code is dialed, CAT code screening is first performed. Next the access code digits are deleted unless the outpulse access (OA) bit in the dialing tree terminal entry is set. The charge index is set to indicate a free call since the tie trunk or foreign exchange trunk is a rented private facility. A check is made at this time to determine if the trunk group is under attendant control (the AC of feature) and that a member of the trunk group is available. If a trunk member is available and not dendied access by the attendant, a special digit collection mode is entered. In this mode a timer is initialized to four seconds and re-set to four seconds each time a new digit is received. If four seconds elapse between digits it is assumed dialing is complete. At this point the call processing that remains is basically the same as noncentrex outgoing calls. Code call access is handled by the program in similar manner to that of a tie trunk except the number of digits to be dialed into the code call circuit is fixed (rather than depending on a four second time-out.)

Manual Tie Trunks

12.26 Manual tie trunks are those over which no digits are outpulsed. Program sequence is the same as for tie trunk cases up to the second dial tone check (second dial tone would presumably not be required). Following this the manual trunk case is picked out for special handling. If a paging access code was dialed, a tone and recorded announcement is used (connected to paging equipment). In this application, the calling party is connected to the paging circuit, the digit receiver and OR are idled, and a special monitor progress mark is set up to handle the calling party disconnect. If the manual trunk does not involve paging, control is passed to the outgoing trunk program just beyond the point where sending complete has been recognized. The outgoing trunk program then completes the call normally.

Tandem Dialing Arrangement

12.27 Special call handling is required for the tandem dialing case (sometimes referred to as 1XX cut-through). In this arrangement it is necessary to set up an overlap outpulsing situation in which the calling party is able to simultaneously dial digits and hear dial tone when provided from a distant switch. Usually the calling party dials access codes which are recognized in succeeding switching machines and expects to be given dial tone from each as a signal to continue dialing. This dialing state is maintained until ten seconds have elapsed between digits. At that point dialing is assumed to be complete and normal call handling again occurs.

Most Economical Routing

12.28 Most economical routing (MER) is a customer option which permits the calling party to dial an access code followed by a directory number and have the machine select the "most economical route" among tie trunks, FX trunks, WATS bands or exchange trunks. If the first route is blocked (a busy simulated group or busy private trunk group) the route index is examined to see if alternate routes exist. If so, the alternate routes are searched for an idle circuit. If none is found, the calling party is given reorder tone.

B. Centrex Custom Calling Services

12.29 This description covers the following custom calling services:

- Call Pickup

- Directed Call Pickup

- Code Call and Code Call Pickup

- Trunk Answer From Any Station

- Call Hold

- Speed Calling

- Call Forwarding

12.30 The custom calling services are activated via customer dialed codes. The exact digits which must be dialed by the customer to access a particular custom calling service may vary and are assigned on a per centrex customer basis.

Call Pickup

12.31   Call pickup is a service which allows a centrex customer to answer any call directed to another station line within his own preset call pickup group. This is accomplished by dialing the call pickup access code while the extension to be picked up is being rung.

12.32   Before the called line is rung the centrex number and pickup group number are obtained from the line's terminating translation and stored in the TCR associated with the call. When the party picking up the call goes off hook and gets dial tone, control is passed to the centrex digit interpretation program to interpret the dialed digits. If the call pickup code has been dialed, the centrex number translator indicates that a special service access code was dialed. The restrictions of the picking up line are then checked to determine if this service is valid. If so, control is transferred to the centrex custom calling program.

12.33   The custom calling program hunts through the TCRs to find a transient call with the same centrex number and pickup group number. If a qualifying TCR is found, the program attempts to find a path between the originator of the pickup and the extenion being rung. If a path is found, ringing is removed from the called party and the line is idled. The originator of the pickup is disconnected from the CDPR and the CDPR and OR are released. The originator of the pickup is then connected to the calling party.

12.34   If the program finds no qualifying TCR or no path is found, the originator of the pickup is connected to reorder tone and the original ringing connection remains intact.

12.35   The originator may originate call pickup from either an idle or busy state. If the originator were initially in a busy state, the *call hold* service must be used before call pickup is attempted.

Directed Call Pickup

12.36   Directed call pickup is a service which allows a station user to answer calls directed to another station line in the same centrex group by dialing the unique answer code of the station to be answered.

12.37   After the originator of directed call pickup gets dial tone, control is passed to the centrex digit interpretation to interpret the dialed digits. If a directed call pickup answer code has been dialed, the centrex number translator will indicate such. The centrex digit interpretation program then checks that the originating party is an extension or a tie trunk belonging to a group that has the directed call pickup service. After all of the digits have been received and the necessary prefixing has been designated by the centrex number translator, the four-digit translation program retrieves the terminating translation words for the extension dialed. This translation indicates the line's TEN and whether or not it is a centrex line. If it is a centrex line, control is passed to the centrex custom calling program.

12.38   The centrex custom calling program searches through the TCRs to find one that is in a ringing state, has the desired TEN, and has centrex number equal to that of the originator of directed call pickup. If a TCR is found that meets these qualifications, the program is combined with the call pickup program and the call is processed to completion as described earlier for call pickup service.

Code Call and Code Call Pickup

12.39   The centrex code call feature allows attendants and station users to dial an access code and a 2 or 3 digit called party code to activate signaling devices with a coded signal to alert the party they wish to reach. The called party can then dial an answering code from any station within the same centrex group and be connected to the calling party.

12.40   When an attendant or station dials the code call access code, the centrex trunk program secures the code call interface circuit for outpulsing the coded digits. After the coded digits are outpulsed, the calling party is connected to the code call interface circuit.

12.41   When an attendant or station dials the code call pickup access code (which is different from the code call access code), the centrex digit interpretation program handles the call in the same manner as call pickup until the code for code call pickup is read out of the centrex number translator. Control is then passed to the centrex custom calling program.

12.42 After the necessary checks on the originator of code call pickup have been made, a hunt is started through the TCRs to find one with the appropriate progress mark and a centrex number that matches the centrex number of the line originating code call pickup.

12.43 If a qualifying TCR is found, the program attempts to find a path between the originator of code call pickup and the calling party. If a path is found, the calling party is disconnected from the code call circuit and the calling and answering parties are connected.

Trunk Answer From Any Station

12.44 If a centrex customer group has the trunk answer service, a call that is made to the attendant when Night Service is in effect causes the night station to be rung and audible devices on the customer premises to be operated. The incoming call may then be answered by any nonrestricted station in the centrex group by dialing a special answer code.

12.45 If a night station is call forwarded, the station designated to receive the forwarded call is rung and if that station is equipped with a trunk answer audible device, it will be operated. Similarly, if the night station is busy and that station has a hunt number, that number will be rung, and any associated trunk answering audible device will be activated.

12.46 When the attendant incoming and outgoing calling program recognizes that a call to the attendant should be given night service treatment, it checks the centrex number translator to determine if the centrex has a night service number and the trunk answer feature. If night service is in effect and the centrex has trunk answer, a trunk answer bit in the TCR is set to one. The call then proceeds in the same manner as any incoming call until the centrex number and pickup group number are retrieved from translations. At this point a special group number (255) is written into the TCR as a pickup number. A POB order is then sent to connect the ringer to the tip lead of the night station. This causes the trunk answering audible devices to be operated.

12.47 When another station dials the trunk answer code, a hunt is made through the TCRs to find one which contains the same centrex number

as the originator of trunk answer, and contains pickup group number 255. If a TCR is found that qualifies, the call is processed to completion in the same manner as discussed for call pickup.

Call Hold

12.48 The *call hold* service allows a station user to place on *hold* any call involving his station by flashing the switchhook and dialing a hold code. This frees the station for originating another call or returning to a previously held or camped-on call. Only one call per station can be held at a time and the held call cannot be added to the other call.

12.49 When a station first flashes the switchhook, the centrex custom calling program checks that the station has one of the centrex custom calling services. If it does, a 3-port conference circuit is selected and a path reserved from the flashing station to port 0 of the circuit. The held party which was originally connected to the flashing station is then connected to port 1 of the same conference circuit. A TCR is then selected to be used as a permanent conference record (PCR). This PCR monitors the supervisory states of the parties involved. The flashing station is then connected to a digit receiver, given special dial tone, and the conference bit in the TCR is set to one.

12.50 When the centrex digit interpretation program discovers that a special service code has been dialed, it checks the station's restriction code to determine if the service is allowed. If call hold is allowed, and control is passed to the centrex custom calling program.

12.51 The centrex custom calling program first determines whether the controlling station has a previously held call by looking at its scatter table entry. If the controlling station is trying to place a call on hold and has no previously held call, it is given second dial tone, the conference bit in the TCR is cleared, and the path to port 0 of the conference circuit is idled. At the same time a special progress mark is placed in the PCR to monitor the held call and retrieve the call when the controlling station wishes. Any new call that is attempted is handled by the line origination and digit reception programs in the normal manner as if the controlling party had just originated. The

only exception is that the controlling party cannot be camped-on by an attendant.

12.52 The controlling party may retrieve the held call by either flashing and dialing the hold code or going on-hook.

Retrieval of Held Call Using Dial Hold

12.53 If the controller flashes and dials the hold code, a retrieve-off-hook signal and the controller's CDPR number is written into the controller's scatter table entry. When the holding PCR recognizes the retrieve-off-hook message in the controller's scatter table entry, the program attempts to find a path between the controller and port 0 of the conference circuit. If a path is available, the connection between the controller and the held party is reestablished. The TCR is idled and the PCR now has control of the call.

12.54 If a path between the held party and the controlling party is not found, a not-retrieved signal is written into the controller's scatter table entry passing control back to the TCR. The conference circuit is idled and the PCR is cleared. The held party after timeout is treated as a new origination. The controller's scatter table entry state bits are set to indicate no held call and the controller is connected to reorder tone.

Retrieval of Held Call By Going On-Hook

12.55 If the controlling party goes on-hook with a call still held, a retrieve-on-hook signal is written into the party's scatter table entry and the associated TCR is cleared. When the PCR recognizes the retrieve-on-hook message in the scatter table entry, it attempts to ring the controller of the held call. To do this, a reserve path must be selected between the controller and port 0 of the conference circuit, a ringer must be selected, and a path between the controller and ringer must be found. In the event no path is found, all connections are released and the held call is treated as a new origination. If the path hunts were successful, the ringer is connected to the controller, and audible ring is applied to port 1 (held party) of the conference circuit.

12.56 Both the controller and the held party are supervised at this point. If the held party goes on-hook, the controller is disconnected from the ringer, all network paths are released and the

held party and PCR are idled. If the controller goes off-hook and the held party remains off-hook, the controller is disconnected from the ringer and connected to port 0 via the previously reserved path. The connection between the controller and the held party is then reestablished.

Speed Calling

12.57 Speed calling is a service which permits a centrex customer to call frequently dialed numbers by dialing an abbreviated number consisting of from one to four digits. This number of digits is dependent upon the customer selected dialing plan. Two sizes of speed call lists are offered, a six code list and a thirty code list.

12.58 The centrex custom calling program retrieves the called directory number from translations by using the abbreviated code dialed, the list selector from the calling line's translations and a pointer to the expansion table from the centrex group translation. The called directory number is unpacked from the speed calling format and inserted into the digit reception area of the OR already associated with the call. The OR is initialized to look as if the customer had actually dialed the number found in the speed calling list and the call proceeds in the normal manner.

12.59 Extensions with six-code lists may make changes to their speed call lists by dialing a special change speed call access code followed immediately by the speed call code to be changed and then the number (including any access codes) to be assigned to the speed call code. The successful completion of this operation results in a confirmation tone sent to the customer. Dial changes to 30-code lists are limited to extensions that have the "change-thirty" bit set in their line expansion.

Call Forwarding

12.60 The call forwarding service allows a centrex extension to condition the central office so that calls destined for that particular extension are forwarded to another extension or to the attendant. A extension may forward his calls by first dialing the special call forward activate code, (which may be different for each centrex group) receiving second dial tone, and dialing the extension to which forwarding is desired. Alternately, the extension may forward his calls to the attendant by dialing the call forward activate code followed by the

attendant access code. The attendant may activate forwarding if desired by dialing the access code, receiving second dial tone and the extension wanting his calls forwarded. If the extension has forwarding privileges, another dial tone is returned and the number the calls are to be forwarded to is dialed. In all cases, if the program is successful in initiating call forwarding confirmation tone is returned to the user.

12.61 Call forwarding may be deactivated either by the extension or by the attendant for an extension. If the extension dials the deactivate code, a search is made for the call forwarding entry and when this entry is found it is converted to a nonforwarding type of entry. Confirmation tone (4 bursts of dial tone at one-half second intervals) is returned to the user. When the attendant dials the deactivate code, second dial tone is returned. The attendant then dials the extension number. The extension's call forwarding entry is cleared if one existed, and confirmation tone is returned to the attendant.

C. Attendant Calls

12.62 The following is a description of calls involving an attendant console. The calls that are discussed are:

- incoming calls to the attendant

- outgoing calls from the attendant

- camp-on to busy station

- attendant control of facilities

- attendant controlled conference.

Incoming Calls To The Attendant

12.63 This description covers incoming calls to the attendant. Included in this category are listed directory number (LDN) calls, dial "0" calls, or calls involving manual lines or trunks that are routed directly to an attendant.

12.64 When the system recognizes that a call to an attendant is being made, the attendant incoming and outgoing calling program selects an idle attendant loop and a path to the source port of the loop. If a loop and a path are available, the calling party is disconnected from the CDPR

and is connected to the source port of the attendant loop. Audible ringing is returned to the calling party and the incoming call indicator lamp associated with the calling party is turned on and the attendant receives an audible signal. The source port lamp is lighted to indicate the type of call being processed (i.e., 60 interruptions per minute (ipm) for LDN calls and 120 interruptions per minute for dial "0" calls).

12.65 If an attendant is not available, the attendant selection routine attempts to place the incoming call in an attendant waiting queue. Upon successful entry into the queue, an audible ringing signal is returned to the calling party. When an attendant becomes available the call is removed from the queue and processed as described previously.

12.66 If the attendant queue is full, control is returned to the attendant incoming and outgoing calling program which returns busy tone to the calling party.

Call Forwarding-Don't Answer

12.67 If a centrex extension that has the call forwarding-don't answer feature receives a DID or CCSA call, the extension is rung for 12 to 60 seconds (timing is variable as a customer group option). If the line is not answered before the timing period elapses an attempt is made to transfer the call to the attendant or to a specified centrex extension. To determine where to transfer the call, the called line's translation is examined for a hunt number. If that hunt number is zero the call is routed to the attendant. In the event that an attendant is not available, an attempt is made to place the call in the attendant waiting queue. If the attendant queue is full or night service is in effect, call forwarding will be deactivated. The called station continues to be rung and control is passed to the ringing and answer detection program.

12.68 If the called line's translations indicate a hunt number of nonzero (i.e., another extension) a directory number translation is done on the hunt number. The call is then routed to the hunt number if it is idle. If the hunt number is not idle ringing continues on the original called extension and ring timing is restarted.

Call Transfer Attendant

12.69   Another type of incoming call to the attendant is effected by the call transfer attendant (CTA) feature. CTA allows a centrex line involved in an incoming DID or CCSA to transfer the call to an attendant. CTA may be initiated in one of two ways:

(1)   by flashing from a centrex line with the CTA feature, or

(2)   by flashing and dialing "0" from a centrex line with any of the following services:

call transfer-individual,

call transfer individual-all calls,

or call hold.

Flash From Centrex Line

12.70   When CTA is initiated from a centrex station with the CTA feature that does not have add-on, the attendant incoming and outgoing calling program attempts to select two consecutive TCR's to process the call. When the TCR's have been selected, the the TCR used previously is transferred to the second of the selected TCR's and the original TCR is idled. The second TCR is now used as a PCR of the call. The first TCR is loaded with the calling party identification. After the TCR and PCR have been selected, an attempt is then made to select an idle attendant loop.

12.71   If an attendant is available, the original calling-called connection is released, the controlling party is connected to the attendant source port, and the source port lamp flashes at 120 ipm to alert the attendant of an incoming call. The noncontrolling party is connected to the destination port of the same attendant loop and the destination port lamp lights steadily.

12.72   If an attendant is not available, an attempt is made to place the call in the attendant waiting queue. If the queue is full, busy tone is returned to the controlling party. When the call is placed in the queue, an attempt is made to select a 3-port conference circuit. If this attempt is successful the noncontrolling party is connected to port 1 and the controlling party to port 0. Audible ring is then returned to both parties by connecting

a junctor circuit to port 2 of the conference circuit and placing the junctor in the audible state. This allows the two parties to converse over audible ring. The PCR monitors both the controlling port and the junctor circuit for state changes. The TCR looks for attendant available supervision. When an attendant becomes available, the call is processed as described in 12.71.

Flash And Dial 0 From a Centrex Line With Call Transfer-Individual

12.73   When a centrex line with the Call Transfer-Individual feature wishes to transfer a call to the attendant, it is accomplished by first flashing then dialing 0. The flash sets up a 3-port conference circuit and two TCRs as described previously. The noncontrolling party is connected to port 1 and a path is reserved between the controlling party and port 0. The controlling party is then connected to a digit receiver. Upon receipt of dial tone, the controlling party dials 0.

12.74   The attendant incoming and outgoing calling program recognizes the bid for an attendant and determines if an attendant is available. If so, the controlling party is disconnected from the receiver and connected to the attendant loop circuit (connected to the source port if the controlling party is the original calling party, to the destination port if the controller is the called party). The noncontrolling party is disconnected from port 1 of the conference circuit and is connected to the mate port of the attendant loop. The lamp associated with the noncontrolling party lights steadily and the lamp associated with the controlling party flashes at 120 ipm awaiting answer by the attendant.

12.75   If an attendant is not available, an attempt is made to place the call in the attendant waiting queue. If the queue is full, busy tone is returned to the controlling party. If it is not full, the controlling party is disconnected from the digit receiver and the receiver and path are idled. The controlling party is then connected to port 0 of the conference circuit.

Outgoing Calls From The Attendant

12.76   An attendant originates a call by operation of the START key while connected to a loop. With an idle loop, the attendant monitor program selects a TCR, loads the attendant origination progress mark and the pseudo-scan point

number (PSPN) of the source port into the TCR the attendant monitor program then writes the TCR address in the source terminal memory record (TMR). The attendant origination program selects a digit receiver and an OR just as in line originations. However, it also sets the attendant bit in the TCR and the "suppress attendant supervision" (SAS) bit in the OR. In addition, the attendant trunk circuit is placed in a special "hold source" state prior to connection to the digit receiver. Once the receiver connection is made and dial tone is turned on, call processing merges with the digit reception program for centrex stations. Two types of situations require special treatment for the attendant to originate a call: joint holding of centrex stations on the source port, and a loop with an idle source port and a stable destination port.

Joint Holding of Centrex Lines

12.77 A centrex station that is connected to the source port of an attendant loop remains connected to that loop, even though the customer may be on-hook. The connection from the station to the source port is broken only when the attendant releases. This feature, called joint holding, eliminates the need for the centrex station to remain off-hook while the attendant is attempting to establish a call on the destination port. Joint holding can be initiated in two ways. The first way is when the attendant originates a call on an idle source port to a centrex line in the same customer group. The station is not rung until the attendant operates the SIG SRC (signal source) key. Until the SIR SRC key is operated, the line is connected to the source in an on-hook state. The second way is when a centrex line goes on-hook while it is connected to the source port with the attendant still connected to the loop or with the loop held. While the station is on-hook a TCR monitors the status of the line and the attendant. If the line goes off-hook, the call is set stable and the TCR is cleared. If the attendant operates the RLS (release) key, supervision causes the TCR to disconnect the station and idle it. Attendant operation of the START key causes the TCR to set up an origination on the destination port.

Attendant Origination With Idle Source Port, Stable Destination Port

12.78 This type of origination occurs when the source port is idle and a stable connection exists on the destination port to a line or trunk.

Upon operation of the attendant console START key, the destination party is switched to the source port and the destination port is initialized for an origination by the attendant.

Camp-On To Busy Station

12.79 When the attendant dial a busy station the attendant services program checks to see if the camp-on feature is allowed. If not, control is returned to the centrex digit program and busy tone is returned to the attendant. If camp-on is allowed, the TCR is flagged to monitor the progress of the call and a camp-on code is written into the camped-on station's scatter table entry. The DEST lamp on the attendant console flashes at 60 IPM. When the attendant releases from the loop, camp-on tone is then applied to the camped-on station. The camped-on line is disconnected from the current party and connected to the tone circuit for two seconds then restored to the original stable connection. The attendant services program monitors the camped-on scatter table entry to determine if the line picks up the camp-on call.

12.80 The camped-on party may pick up the call in one of the two ways. The first way is for the camped-on station to go on-hook. In this case a ringing connection is established and the call is handled as a normal call. The second method involves flashing and dialing the call hold code to hold the current call. In this case the station will be connected directly to the destination port of the attendant loop.

12.81 As long as the camped-on station has not picked up the camp-on, a timed reminder recalls the attendant to the loop every 30 seconds until the camped-on party picks up the call or the calling party abandons.

Attendant Control of Facilities

12.82 The attendant control of facilities (ACOF) feature allows the attendant to control access to selected trunk groups by centrex stations. When the feature is activated by the attendant, calls attempting to use the controlled facility will be intercepted by the attendant (or optionally by a recorded announcement). The attendant is not prevented from accessing the trunk group by this feature and may establish a connection for the station.

12.83 Trunk group access may be controlled by the attendant in two ways: operating a key or dialing a special code.

Key Control

12.84 The attendant may control trunk group access by operation of a key. The key has an associated scan point that is scanned every 250 milliseconds. Operation of the key saturates this scan point. When a change is detected in the state of the scan point, the translation of the key scan point number accesses a table of trunk groups under control of the particular key. A bit in the status block of each group is set to indicate activation of control. If an ACOF lamp on the console is assigned for a trunk group, this lamp will light when control is activated.

Dial Control

12.85 When dial control is used to activate ACOF the attendant dials the "call forward" code followed by a trunk access code. The attendant services program then activates ACOF for the dialed trunk group. The attendant may deactivate ACOF by dialing the "call forward cancel" code followed by the trunk access code.

Attendant Controlled Conference

12.86 The attendant has the facilities to set up conference connections with five other parties using a 6-port conference circuit and the CONF keys on the attendant console.

12.87 When a stable connection exists between a party and the attendant source port, operation of an equipped CONF key causes the attendant monitor program to set the source TMR transient and load the attendant conference progress mark into the TCR. A second TCR is also selected to monitor the conference until it is terminated. This TCR is called the 6-port conference record (SPCR). A 6-port conference circuit is then selected and paths are selected and connected from the first two ports to the attendant and the source party, respectively. The psuedo-scan point numbers of the attendant, and the 6-port conference circuit are written into the SPCR. The connections are set stable and the CONF lamp on the attendant console is turned on.

12.88 When the attendant wishes to add an additional party to an existing conference, a stable connection is established to the desired party on the destination port in the normal manner. Operation of the CONF key at this point causes the attendant monitor program to set the destination TMR transient. The next idle port on the conference circuit and a path from that port to the destination party is selected and the connection is made, thus moving this party from the destination port to the conference port.

12.89 If a party other than the attendant goes on-hook, the POB loading program marks a bit in the SPCR to indicate an on-hook status. An on-hook is placed in the on-hook timing list for the trunk side of the conference port for which the party disconnected. The busy/idle status bit for the port is then zeroed in the SPCR to make it available for another party.

12.90 If the attendant releases the conference by operation of the RLS SRC key, a progress mark is written into the TCR to place on-hooks in the on-hook hopper for the trunk side of every busy conference port. This terminates the conference. The TCR waits for all six TMRs to be idled, then the status bit in the trunk group status block for the 6-port conference circuit is zeroed and the SPCR and TCR are cleared. This also happens when all conferees disconnect from the conference circuit and the attendant alone is left.

Attendant Recall

12.91 When the attendant releases from the conference, the conference remains associated with the attendant loop. When a station or tie trunk in the same centrex group as the controlling attendant flashes, that attendant is recalled. The attendant is signaled with an audible signal, flashing conference lamp, and a flashing source lamp. A subsequent flash by the same party (or another station or tie trunk in the same centrex group) will cancel the recall.