

# 1 "ESS\*" SWITCH

## GENERAL DESCRIPTION

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1. GENERAL

- 1.01 This practice describes the operation and major characteristics of the 1ESS switch.
- 1.02 This practice is a general reissue. New subjects added to this document are the carrier interconnect (CI) and the Automatic Message Accounting Teleprocessing System (AMATPS). Since this is a general revision, arrows ordinarily used to indicate changes have been omitted.
- 1.03 The purpose of this practice is to provide a general overall understanding of the 1ESS switch and its applications. Other practices are refer-

enced along with the related subject for more information.

## 1ESS SWITCH OVERVIEW

**1.04** The 1ESS switch is an electronic telephone switching system with numerous features which provide system arrangements for a wide field of uses. The 1ESS switch is compatible with all existing equipment and may be used as a growth unit in existing buildings and as a dial-for-dial replacement without necessity of station modification and with minimum trunking changes at the distant offices. The field use of the 1ESS switch is local, tandem, and toll switching (Fig. 1).

**1.05** The 1ESS switch is an automatic common control type switching system directed by a program and capable of serving up to 98,000 (6-to-1 concentration ratio) customer lines and up to 30,000 trunks, including service circuits. The 1ESS switch differs greatly from electromechanical switching systems in the devices employed as well as in the call handling techniques used. The system makes extensive use of solid-state devices with rapid operating speeds which permit a relatively small quantity of equipment to perform the control functions. System intelligence, control, and actions are determined by a program stored in a semipermanent memory and temporary memory. Variations and changes are accomplished primarily by changing the stored program rather than by changing apparatus and wired logic.

## BASIC SYSTEM TECHNIQUES

**1.06** Some basic system techniques used in the 1ESS switch are:

- Stored program control
- Functional concentration
- Time-shared control
- Optional feature loading
- Modular design
- Plug-in equipment units
- Duplication

- Automatic fault location and system reconfiguration.

**1.07 *Stored Program Control:*** The functions performed by the system are specified by programs consisting of appropriate combinations of precisely defined instructions. Examples of such program instructions are as follows: observe the state of a specified group of lines; add two specified quantities; observe the sign of a specified quantity and decide accordingly which of two alternatives to execute. The program instructions, suitably encoded, are stored in memory units from which they are transmitted one at a time to the control unit for execution. Thus, the operation of the system can be altered considerably by program changes without circuit modifications.

**1.08 *Functional Concentration:*** The system equipment is concentrated in a small number of highly efficient units, each specialized in some broad system function; such as control, input, output, memory, etc. The result is a simple overall equipment organization.

**1.09 *Time-Shared Control:*** A single control unit directs the operation of all other system units in accordance with program instructions. Using electronic devices, the control unit can operate at speeds much faster than the rate at which events associated with a single call occur. Consequently, the control equipment is time shared for all the calls accommodated by the system. Time-shared control is accomplished by subdividing the task required to process a call into small segments and by interweaving the segments with those associated with other calls. In addition, certain operations can be performed concurrently on behalf of a number of calls.

**1.10 *Modular Design:*** Traffic-dependent units are provided in modular blocks so that growth is accommodated economically and conveniently.

**1.11 *Optional Feature Loading:*** The generic program is structured so that many features can be optionally loaded. Only those offices which implement a feature require program store space for that feature.

**1.12 *Plug-in Equipment Units:*** In a major portion of the equipment, circuit components (such as transistors, resistors, etc) are mounted on

SWITCHING NETWORK

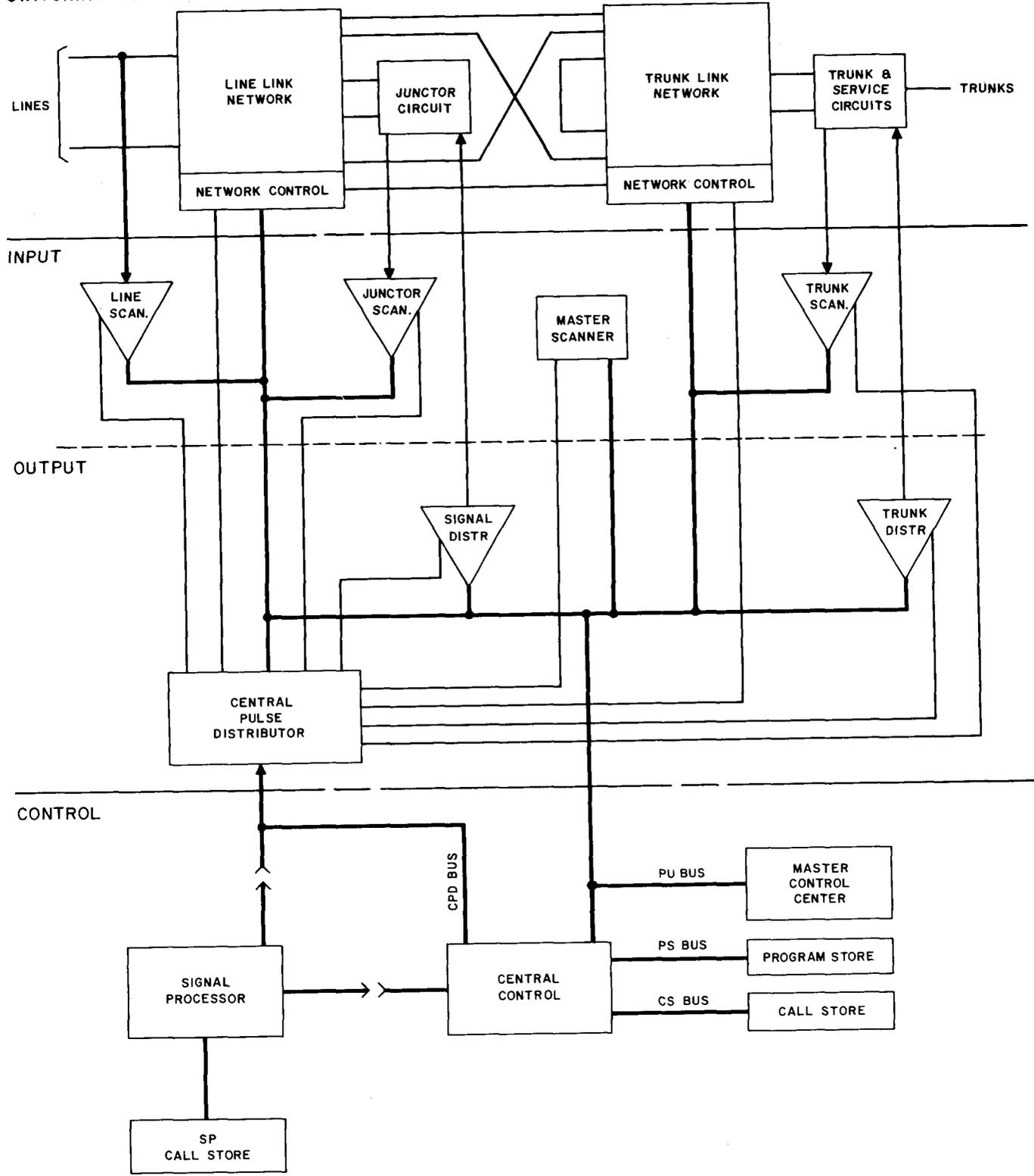


Fig. 1 — 1ESS Switch Functional Schematic

circuit packs as plug-in units with printed wiring. Faulty circuit packs can be quickly replaced.

**1.13 Duplication:** The principle used is that duplicated system components process the same data simultaneously. If an error is detected, the faulty unit is electronically switched out of service.

**1.14 Automatic Fault Location and System Reconfiguration:** The 1ESS switch performs a large portion of its own checking for system troubles. The self-checking scheme provides a system capability to detect a malfunction, to automatically identify the malfunctioning unit, to remove the unit from service, to diagnose the unit, to notify maintenance personnel that a malfunction has occurred, and to provide results of the diagnostic test.

#### PROGRAM INFORMATION

**1.15** The functions performed by the 1ESS switch are controlled by programs consisting of appropriate combinations of precisely defined instructions. The instructions are stored in memory units from which they are transmitted one at a time to the control unit for execution. The stored information consists of three parts.

(a) **Generic program for controlling all system operations:** The 1ESS switch generic program is constructed so that the same program may be used in many different offices regardless of local variations. Two advantages of the generic program are: universal remedy for design error (bugs) and the ability of every office to provide any feature and service associated with the generic program. The two types of generic programs produced are the 1E(CC) and 1E(SP) generic programs. The 1E(SP) generic is designed for larger offices than the 1E(CC) generic. Effective with what would have been CTX-8, Issue 3, the equivalent generic program designation is 1E3.

(b) **Translation Data:** Translation data provides to the generic program information about individual lines, trunks, and service circuits which may require frequency revisions. This data is stored on magnetic memory cards in the program store (PS). However, since information varies from office to office and includes some of the information that changes from day to day, the translation data must be readily changeable. Provision is made to store changes in an area of call

store (CS) memory. This area is called the recent change (RC) area. Translation changes are made with RC input messages from an input/output terminal (IOT) and are stored in the RC area. Subsequently, the changes are transcribed into the PS from the CS by using the memory card writer (MCW).

(c) **Parameter Data:** Parameter data is information to accommodate the variations between offices that use the same generic program. This type of information is called parameters and is generally confined to one memory block (MOD 4) for access by the generic program. The type of office information contained in parameters is of five fundamental types:

- (a) Equipment items
- (b) Software (usually traffic dependent)
- (c) Certain master scanner (MS) and central pulse distributor (CPD) assignments
- (d) Office options
- (e) Translation-parameters compatibility.

#### OPTIONALLY LOADED FEATURE GROUPS

**1.16** Generic programs consist of the following three major parts:

- (a) The base is always required. The base contains routines to provide normal telephone service. It also contains essential maintenance and administration functions.
- (b) Included within the base are base features. These are defined as new features developed for a certain generic base. They are always provided within that base.
- (c) The other part of a generic program is the optional features or optional feature groups. Optional features are those that must be individually selected by each operating telephone company as to whether they desire them in the generic for a particular office or not. Most optional features are separately loadable; that is, if they are not requested, no PS memory space must be allocated to them. Some optional features, however, will be included within the base and their usage con-

trolled by software switches in parameters. For this type of optional feature, PS space is always required even though the office may not have access to that feature.

## CUSTOM CALLING FEATURES

1.17 Some of the major custom calling features provided by the 1ESS switch are as follows:

- (a) **Speed Calling:** The speed calling feature permits a customer to dial abbreviated codes for frequently called numbers. Speed calling is sometimes called abbreviated dialing. This feature is available for individual lines or on a group (centrex) basis. Speed calling allows the dialing of a number by using a code which has fewer digits than the called directory number. The customer changable speed calling feature allows the customer to assign and make changes to the code list and speed calling list. For more detailed information on the speed calling feature, refer to Practice 231-090-401.
- (b) **Three-Way Calling (Add-On):** The three-way calling feature allows a third party to be dialed or keyed into a two party established connection and is available for use with individual noncoin and non-PBX lines. The feature includes both consultation hold and add-on capabilities. The three-way calling customer may hold one party with privacy exclusion while dialing and talking to another party in a three-way connection. For more detailed information on the speed calling feature, refer to Practice 231-090-080.
- (c) **Call Waiting:** The call waiting feature communicates to a talking customer by two-tone bursts that a third party is calling. The customer with the feature may answer the calling third party by flashing the switchhook, which puts the original call on hold. Switchhook flashes may be used by the customer to alternate between the two connections. To terminate the original call, the call waiting customer disconnects. Once the disconnection is made, ringing occurs to the calling waiting customer. When answered, a connection is established to the calling party. For more information on the call waiting feature, refer to Practice 231-090-081.
- (d) **Call Forwarding:** Call forwarding is a group of features that allows a customer to

automatically route all incoming calls to another line. The customer selects which line all incoming calls will be routed to. For more detailed information on all of the service provided by the call forwarding feature, refer to Practice 231-090-073.

## 2. MAJOR SYSTEM FEATURES

### CENTREX SERVICE AND ESSX-1 SERVICE

2.01 The centrex (CTX) feature is a large business service package that provides many individual stations on the customer premises with access to direct-inward-dialing and automatic identified outward dialing (AIOD) capabilities. The CTX feature is available in two different configurations. One is the CTX - central office (CO) and the other one is CTX - customer unit (CU). No switching equipment is located at the customer premises with the CTX-CO configuration. Some switching equipment is located at the customer premises with the CTX-CU configuration. Centrex service is provided through 1E4 generic programs. Effective with 1E5 generic programs, CTX service is replaced with ESSX-1 service. A CTX data link provides 2-way data communications between the 1ESS switch CO and the attendant consoles located at the customer premises. Key signals from these consoles are transmitted to the CO by the data link and are interpreted at the CO as requests for specific action. Refer to Practice 966-102-100 for a complete list and an explanation of other CTX features.

### AUTOMATIC CALL DISTRIBUTION (ACD)

- 2.02 The ACD feature concentrates, queues, and equitably distributes incoming calls to assigned agents with maximum efficiency. This is made possible by the switching, call processing, and translation capabilities of the 1ESS switch.
- 2.03 The phase 1 ACD offering uses compact 20-button consoles (500A type) for call processing by agents and desk-type display units for system control and traffic data reports for supervisors. Phase 1 ACD-ESS switch features are available in all issues of CTX-8 and later generic programs. A detailed description of phase 1 ACD features is contained in feature documents.
- 2.04 Phase 2 ACD uses 600-type consoles for call processing by agents and supervisors plus a sophisticated ACD-ESS switch management infor-

mation system (AEMIS) that utilizes a minicomputer located on the customer's premises. The system can serve up to 1000 agents divided into a maximum of 30 functional groups (sometimes called splits). Reassigning agents to different functional groups, to handle calls or other work situations, can be made by the customer without wiring changes or rearrangements by the telephone company. The phase 2 ACD-ESS switch features are available in 1E4 and later generic programs. A description of phase 2 ACD features is contained in feature documents.

#### HILO 4-WIRE SWITCHING

**2.05** The HILO 4-wire switching available with the 1E4 and later generic programs, permits the 2-wire 1ESS switch to function as a 4-wire, 600-ohm toll office. HILO 4-wire switching provides two electrically independent transmission paths through the

switching network. The HILO 4-wire feature is available for both trunk-only toll offices and combined local/toll offices (Fig. 2 and Fig. 3). Incoming pulsing can be multifrequency (MF) dial pulse (DP), and TOUCH-TONE calling. Outgoing pulsing can be MF, TOUCH-TONE calling, and no pulsing. Revertive and program controlled interrogator (PCI) are not available. Equivalent 4-wire switching is achieved by providing the switched metallic conductors and an unswitched metallic common return path.

**2.06** The HILO 4-wire feature is intended for small to moderately sized toll offices. It is also applicable to those offices in which the local and toll function can be combined, thus using only one processor to serve both functions. Remreed trunk link networks (TLNs) must be used with HILO 4-wire switching. Refer to Practice 231-090-366 for a detailed description of the HILO 4-wire switching features.

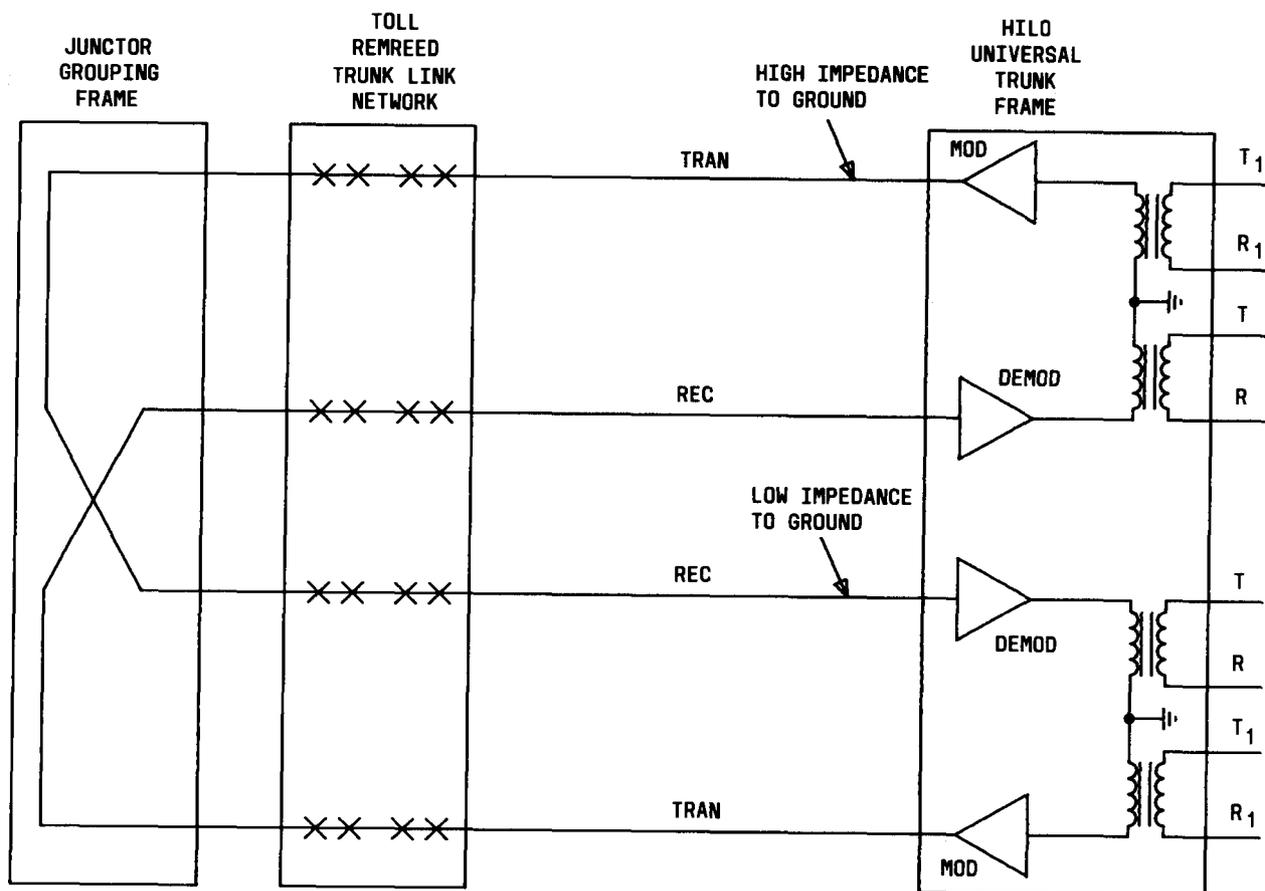


Fig. 2—HILO 4-Wire Trunk-Only Toll Office (Showing MODs and DEMODs)

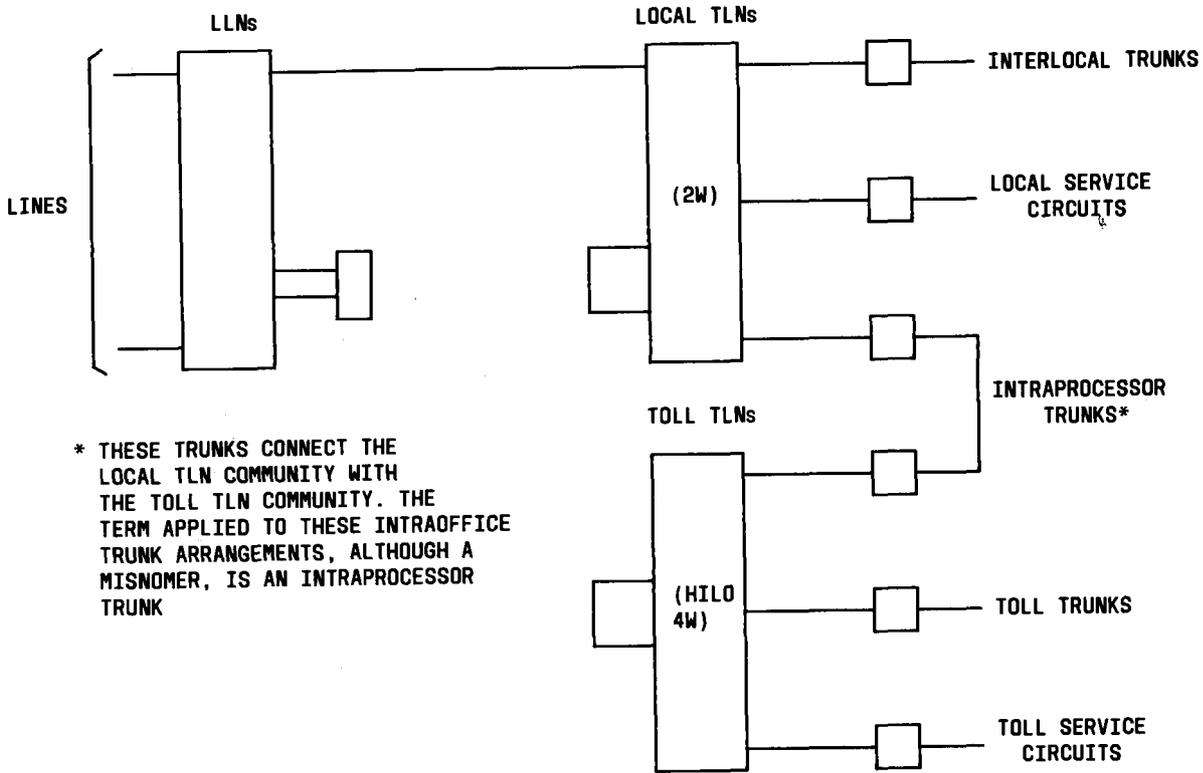


Fig. 3—HILO Combined Local and or Toll Office

**ENHANCED PRIVATE SWITCHED COMMUNICATIONS SERVICE (EPSCS)**

**2.07** The EPSCS is a private switched network of dedicated facilities providing full duplex communication on all connections. It provides the customer with the facilities to exercise, monitor, and control functions relative to the performance of the network. This service is intended for the major corporate and governmental customers which have an extraordinary dependence on business communications. The 1ESS switches are the network switching points for EPSCS available with 1E5 and later generic programs. These offices must be equipped with HILO 4-wire switching networks so that 4-wire transmission can be provided from CTX/PBX to CTX/PBX. This will allow the customer to have a network capable of full duplex voiceband and data on all connections. In addition, features are provided to allow the customer to allocate internally the cost of the network to permit the customer to determine the traffic and maintenance status of the network, and to permit the customer to make network

routing and screening changes directly from a customer network control center (CNCC).

**2.08** A customer service administrative control center (CSACC) is also available to provide the operating company with control and maintenance features for better service to the customer. Refer to feature documents for more details.

**2.09** A 1ESS switch providing EPSCS service uses a peripheral data storage processor (PDSP) as an auxiliary processor to provide a data link connection to the CNCC and the CSACC. The PDSP is a duplicated 3A auxiliary processor.

**ENHANCED PRIVATE SWITCHED COMMUNICATIONS SERVICE PHASE II (EPSCS II)**

**2.10** The EPSCS II feature is available with 1E6 and later generic programs. All services available with EPSCS are available with EPSCS II.

**2.11** The EPSCS II provides an extended and improved version of EPSCS which was available

with the 1E5 generic program. Five new services are available with EPSCS II. They are as follows:

- Automatic calling station identification (ACSI)
- Improved authorization codes (IAC)
- Multiple direct access lines (MDAL)
- Network attendant (NEAT)
- Traveling class marks (TCMs).

**2.12** The service provides automatic station identification (ACSI) on calls originating from a PBX or a CTX. This service allows for station identification information to be forwarded automatically from the 1ESS switch CTX CO to EPSCS switches.

**2.13** The IAC service provides the ability to assign and administer authorization codes (ACs) with efficient use of memory and the ability to change the treatment of a treatment group. An AC translates into a treatment group. A treatment group specifies the privileges available to that AC.

**2.14** The MDAL service allows more than one direct access line (DAL) to be assigned to the same trunk group. The DALs in a trunk group are accessed individually by the use of a 7-digit code. The DALs in the same trunk group can be billed separately by using a unique screening line equipment number (LEN) for each DAL. The MDAL permits series completion among the members of a trunk group. The MDAL service offers improved routing and billing capabilities and the efficient assignment of DALs to trunk groups.

**2.15** The NEAT service permits a network attendant at a PBX or a CTX location to answer and extend a call and then be released from the connection by eliminating the facility between the EPSCS switch and the PBX or CTX. Releasing the attendant from the connection enhances transmission quality and reduces the use of facilities.

**2.16** Traveling class marks (TCMs) are used to provide a distance switching office with the calling privileges of the calling station. When a call requires routing through more than one switching office, traveling class marks are sent to the next switching office.

## DIGITAL CARRIER TRUNK

**2.17** The digital carrier trunk (DCT) feature is an optional feature available with the 1E6 and later generic programs.

**2.18** The DCT feature interfaces T-carrier lines with a 1ESS switch. This feature provides the 1ESS switch with the capability to operate with digital carrier lines. The feature is implemented with duplicated microprocessor controllers and digital carrier trunk banks (DCTBs). The feature replaces existing 1ESS switch trunk circuits and carrier channel units.

## ELECTRONIC TANDEM SWITCHING

**2.19** The electronic tandem switching (ETS) is an optionally loaded feature available to customers with the 1ESS switch CTX system. It can be used in an electronic tandem network with DIMENSION® PBXs.

**2.20** The ETS feature allows a business to have its own private communications network. Stations that are served by any company PBX or CTX tandem locations are referred to as on-network stations. Off-network stations are stations outside the private communications network.

**2.21** A customer with the ETS feature is provided with a group of private network features which improve tandem tie-trunk services. The ETS group of features include:

- Automatic route selection (ARS)
- Facility restriction levels (FRLs)
- Uniform numbering (UN)
- Automatic alternate routing (AAR)
- Queuing
- Authorization codes
- Traveling class marks (TCMs)
- Account codes
- Facility assurance reports

- Station message detail recording (SMDR)
- Traffic data to the customer
- Facilities administration and control.

A more detailed explanation of the ETS features is given in the following paragraphs.

**2.22** The ARS feature is utilized when an off-network call is originated by an on-network station. The call is automatically routed through the most economical and efficient path available. This automatic route selection process changes as the rates for toll calls change for different times of the day.

**2.23** An FRL is a plan used to determine the calling privileges of on-network stations or an incoming tie trunk. Each on-network station is assigned an FRL from 0 to 7.

**2.24** Uniform numbering allows any on-network station to call another on-network station by dialing seven-digits. An on-network station may call any off-network station by dialing ten digits.

**2.25** Automatic alternate routing allows the alternate routing of on-network calls when the first choice route is not available. The most efficient route is automatically selected. When all network circuits are busy the on-network call can be completed through a relatively more expensive off-network route.

**2.26** Queuing increases the utilization of the facilities by allowing the caller to wait for an idle trunk when all trunks are busy. There are two queuing methods used. One method allows the calling station to wait on the line, listening to a recorded announcement or music until a trunk becomes idle. The other method allows the calling station to hang up, and the ETS network rings the caller when a idle trunk becomes available.

**2.27** The customer of the private network may require users of the network to dial an AC for specific calls. By using ACs, the customer can keep track of communication costs and restrict particular users of the system access to specific services.

**2.28** Travel class marks are explained in paragraph 2.16.

**2.29** Account codes are used by on-network stations to identify projects or clients associated with a call. The account code is dialed before the called number and is not used in call processing but is included in the message detail record. Communications costs for a project or clients may be determined by using account codes.

**2.30** Facility assurance reports (FARs) consist of data relating to all trunks not used and defective trunks which are disabled for an individual facility during the preceding 2 hours. Trunks not used could indicate a fault. Facility assurance reports are used to identify possible defective trunks.

**2.31** Station message detail recording provides a record of all call attempts using the ARS process, UN, and AAR features.

**2.32** Traffic data to the customer is an optional feature which permits the customer access to traffic data on selected trunk groups and queues.

**2.33** The facility administration and control feature gives the ETS customers control of ETS features with the ability to make changes and access to traffic data. This feature gives the customer access to selected data elements in the ESS switch which control the ETS network. Access to data elements in the 1ESS switch is by a dial up peripheral unit controller (PUC) data link port. To access a PUC data link port requires a data terminal or a Customer Administration Center System (CACs).

#### REMOTE SWITCHING SYSTEM

**2.34** The Remote Switching System (RSS) feature is an optionally loadable feature available with the 1E6 generic.

**2.35** The RSS feature provides the 1ESS switch with the capability to operate with a remote switching arrangement (Fig. 4). The microprocessor controlled RSS remote terminal operates under the software control of the host 1ESS switch office. A remote switching facility provides modern telephone service to small communities. This feature allows communities that cannot economically support an independent 1ESS switch to have the features and services of the switch. The 10A RSS under control of the host 1ESS switch can serve as few as 150 lines or up to a maximum of 2048 lines.

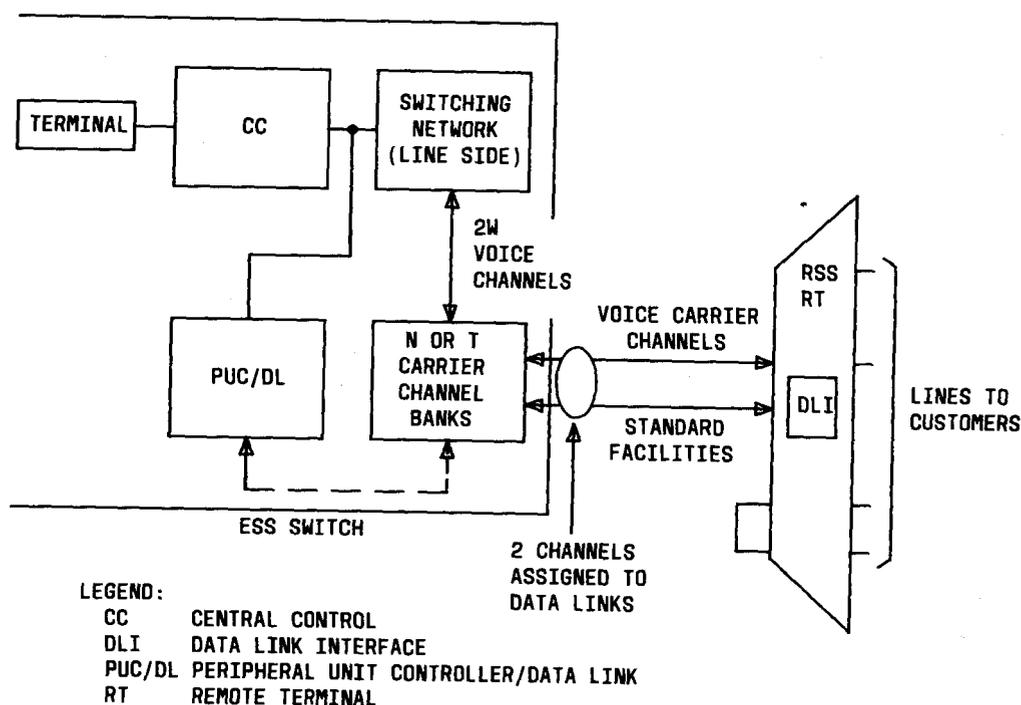


Fig. 4—RSS Block Diagram

**2.36** Communications between the 10A RSS and the host 1ESS switch is by a high speed (2400 baud) data link. Voice carrier channels are used for communications over the data links. For a 1ESS switch to operate with the RSS, the addition of a peripheral unit controller data link (PUC/DL) frame is required. The PUC/DL is located at the host ESS switch and serves as the communications interface between the RSS and the host 1ESS switch.

**2.37** The 10A RSS may be located more than 150 miles away from the host 1ESS switch. The maintenance and testing of 10A RSS is performed at the host 1ESS switch or at a switching control center system (SCCS). Refer to Practice 231-037-022 for a description of the RSS data link.

#### LOOP RANGE EXTENSION

**2.38** Loop range extension (LRE) is an optional feature. A repeater is placed in the B-Links between the line switch circuits (LSCs) and junctor switch circuits (JSCs) of the line link network (LLN). The LRE improves transmission performance and extends the office signaling and supervisory range to 2800 ohms on long customer loops. Location of the LRE feature in the B-links enables several customers to economically share the same repeater. The concentration in the LLN allows a savings in the use of re-

peaters per customer lines which require LRE. A line-to-trunk call with LRE is shown in Fig. 5.

#### ENHANCED 911 EMERGENCY SERVICE

**2.39** The 1ESS switch is the first switching system to provide enhanced 911 (E911) emergency service. This service requires the 1E5 or later generic program. The E911 provides selective routing of 911 calls to a particular emergency service bureau (ESB) based on the directory number (DN) of the calling station with the capability to selectively route transferred calls from primary ESB to a secondary ESB. The capability to display the DN is a feature of E911. Statistical information on 911 calls can also be provided with E911 service. For more information on emergency service, refer to Practice 231-090-287 and Practice 231-367-010.

**2.40** A peripheral data storage processor may be optionally used with the E911 service, particularly with selective routing.

#### COMMON CHANNEL INTEROFFICE SIGNALING

**2.41** Common channel interoffice signaling (CCIS) is a system for exchanging information between processor equipped switching systems over a network of signaling links. All signaling data, includ-

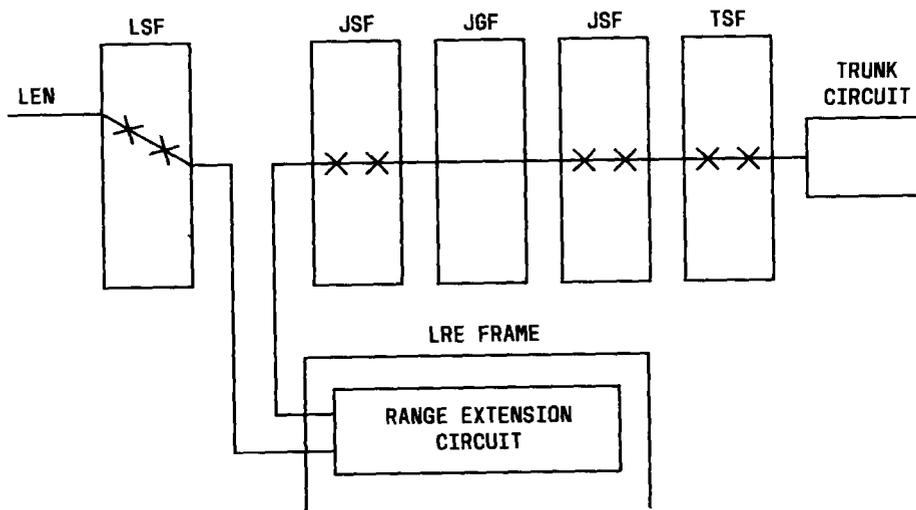


Fig. 5—1ESS Switch Line to Trunk with LRE

ing the supervisory and address signals necessary to control call setup and takedown, as well as network management signals, are exchanged by these systems over the signaling links instead of being sent over the voice path as done using present in-band signaling techniques.

**2.42** The CCIS offers a number of important advantages over present inband signaling techniques. The major advantages are: signaling speed, information capacity, 2-way signaling, separate signaling channel, compatibility with international signaling, reliability, and flexibility in transmitting all types of signaling information for present and future designs. CCIS trunks can only be used in trunk-to-trunk connections and is limited to intertoll trunks on toll and local/toll offices with 1E5 and later generic programs. Refer to feature documents for more details.

#### CARRIER INTERCONNECT

**2.43** The CI feature is available with the 1E8 generic program. This feature provides the local exchange network interconnection for inter-LATA (local access and transport area) carriers and international carriers. The CI feature also provides the telephone customer access to either of the carriers using a uniform dialing plan. For more information on the CI feature, refer to Practice 231-090-120.

### 3. SYSTEM DESCRIPTION

**3.01** The 1ESS switch functional schematic (Fig. 1) shows the system divided into three divisions.

(a) The switching network establishes talking paths and includes:

- Lines
- Junctors
- Trunks
- Service circuits
- Associated network control equipment.

(b) The input/output (I/O) units include:

- Line scanners
- Junctor scanners
- Trunk scanners
- Master scanners
- Signal and trunk distributors
- Central pulse distributors.

(c) The system control equipment includes:

- Central control
- Program store
- Call store
- Signal processor (used in large offices)
- Master control center (MCC).

The MCC is the facility for operating personnel to control and communicate with the system.

## CONTROL UNITS

### A. CENTRAL CONTROL (CC)

**3.02** The CC performs most of the information processing tasks for the 1ESS switch (Fig. 6) and controls the actions of almost all other system units. The CC obtains instructions for call processing from the PS.

**3.03** The CC is capable of performing numerous types of tasks based on PS instructions; the tasks are performed one at a time. Normally, the CC requests an instruction from the PS every 5.5 microseconds, but CC actions required on any call are separated by relatively long periods of time. During the long periods, a particular call may require no action. For maximum use of the allotted time, actions for other calls are interspersed. All call actions occur so rapidly that each individual call appears to have complete CC attention.

**3.04** Two CCs are provided in each system; one is active while the other operates in the standby state. If the active unit should fail, the system automatically switches to the standby unit. The standby unit also performs a maintenance function while in the standby state and processes the same information as the active CC even though no outputs are used for call processing. The standby CC processed results are compared with the results of the active unit. If the matching of the results reveals that they are the same, no maintenance action is taken; if the results do not match, then the CC initiates a transfer to a fault recognition program to determine which unit is at fault. The faulty unit is then switched out of service. Later, the CC uses diagnostic programs to determine the location of the fault within the faulty unit.

### B. Program Store

**3.05** The PS is a semipermanent memory for the 1ESS switch programs (Fig. 7). Binary information is stored on minute magnetized or demagnetized bar magnets bonded to aluminum memory cards (Fig. 8). The PS uses a 44-bit binary word of which 37 bits are for instructions and 7 bits are for error detecting and correcting. The instructions that guide the system in the performance of call-handling, trouble diagnosis, and other routines are stored in the PS. Also stored in the PS are the class of service, type of ringing, and translations on each line and trunk. Line translations convert directory numbers to line locations and line locations to DNs. Trunk translations convert office codes to trunk groups and trunk locations to trunk types. To read information stored on the cards, certain addresses on the cards are specified and the bits stored at these addresses are detected or read.

**3.06** The CC reads and executes a program order from the PS every few microseconds. All telephone switching actions are accomplished as a result of program controlled actions. Many equipment variations are avoided by providing for CO feature differences in the stored program contents.

**3.07** Each PS consists of 16 memory modules, each of which contains 128 memory cards. Each card stores 64 words. Thus, a PS module stores 8192 words and a PS has the capacity to store 131,072 words (44 bits). The PS can store 196,608 translation words (98,304 in each of the G and H halves of PS) because three 23-bit translation words can be stored in two 44-bit PS words. A single right-half translation word may be stored in two left-half PS words.

**3.08** The MCW frame (Fig. 9) is provided to update translation information stored on PS module memory cards. Updating translation PS is controlled by an MCW program. In accordance with system supplied information, the MCW can write individual modules or cards or can be used to write single cards. These modules or cards are used to replace their outdated counterparts in the PS.

**3.09** Certain PS modules (PS0, module 5; PS1, module 15) may be temporarily removed during periods of light traffic and a special maintenance program (eg, fabric testing) may be substituted. There are several of these programs (known as auxiliary test programs) available.

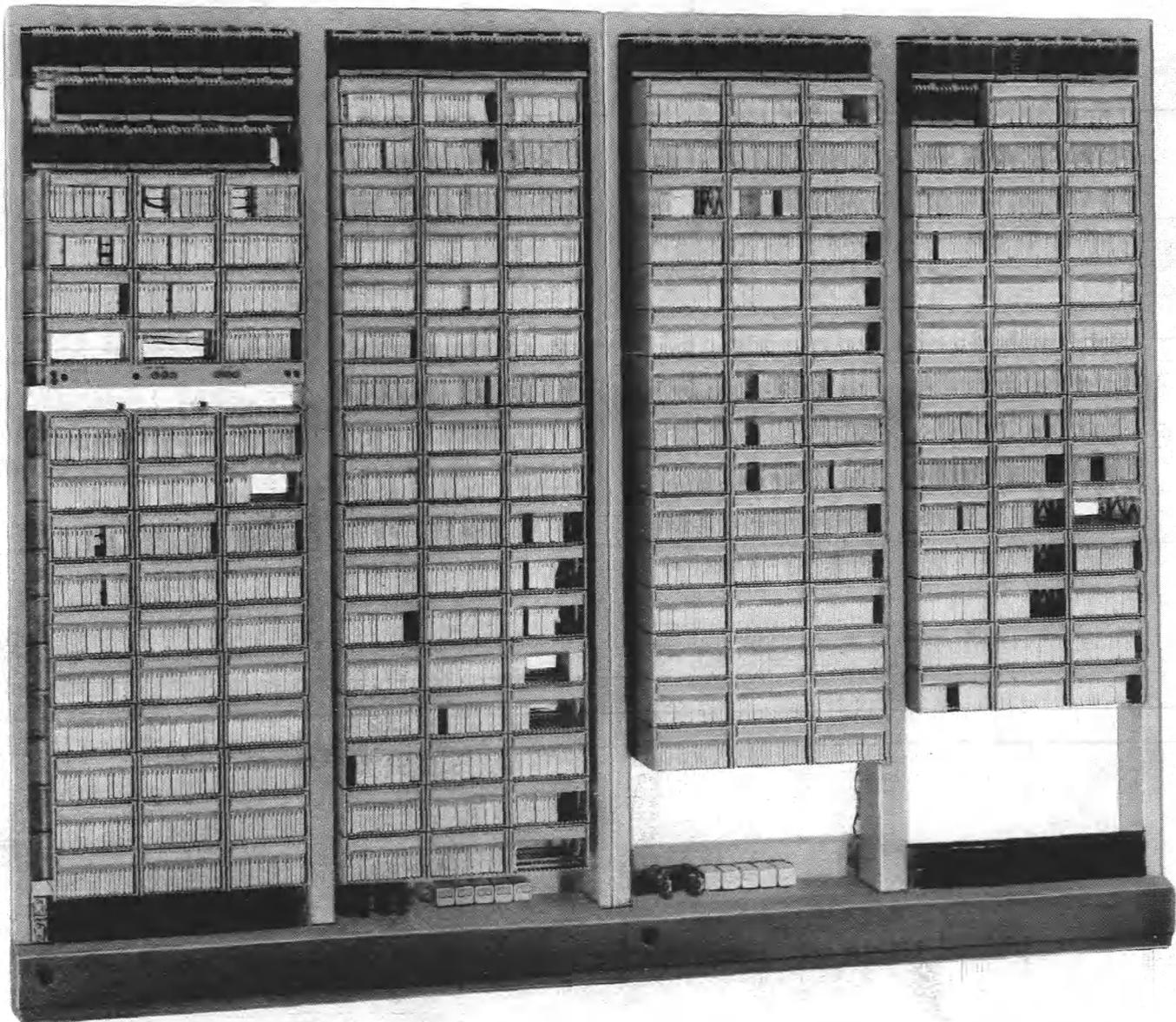


Fig. 6—Central Control

### C. Call Store

#### General

3.10 The CSs are memory units that store information related mainly to the instant-to-instant handling of calls as they are processed. The CS is used for short-term scratch pad storage of events that occur in the 1ESS switch. Certain long-term information is also stored temporarily in the CSs until enough of such information accumulates to render a

card rewriting task worthwhile for relocation of the information into the PS memory cards.

3.11 The CSs are erasable read-write temporary memories used by the CC and signal processor (SP). The information stored in the CSs includes the following:

- Busy-idle status of customer lines, junctors, trunks, and network links

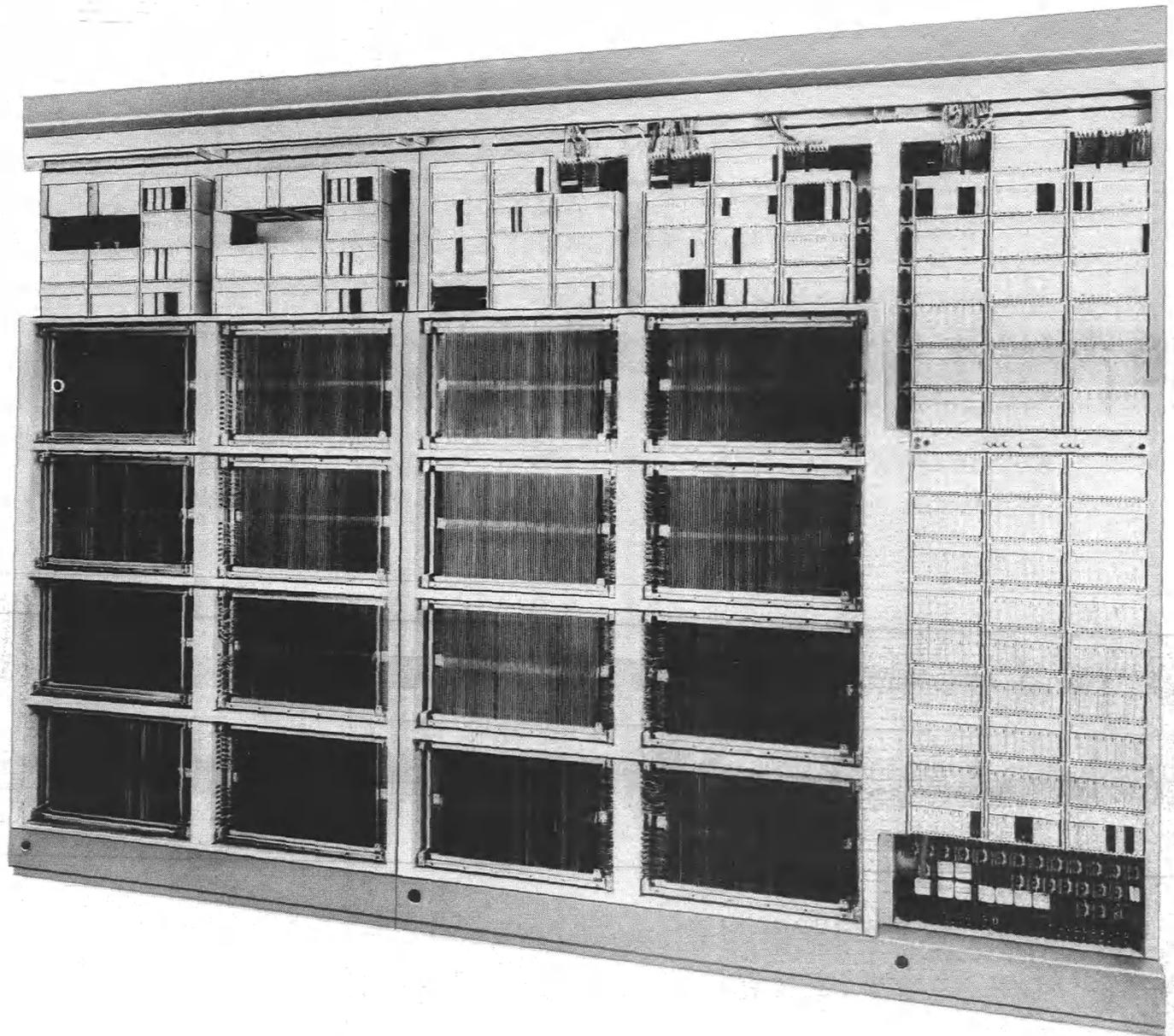


Fig. 7—Program Store

- Records of network terminations in use for each processed call
- Digits received
- Digits to be outpulsed
- Customer billing information prior to recording on the automatic message accounting (AMA) unit
- Recent change information related to customer lines and trunks prior to updating the translation information in the PS

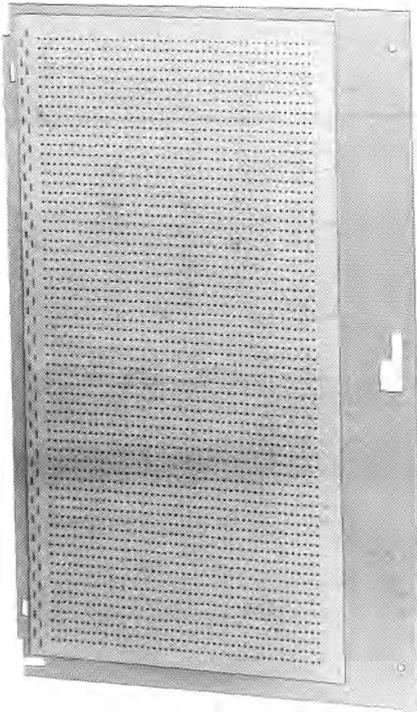


Fig. 8—Aluminum Memory Card

- Temporary changes not to be updated in the PS (eg, call forwarding data)
- Administrative information
- Maintenance information related to program-controlled diagnostic tests.

**3.12** Information stored in the CS is organized into 24-bit words. Twenty-three of these bits are information bits and the remaining bit is a parity bit used for checking purposes. Each CS is divided into two information blocks, 0 and 1. In order to achieve maximum reliability, the information which is stored in the 0 block of a given CS is duplicated in the 1 block of another CS.

#### 8K Call Store

**3.13** The basic storage element in the 8K CS (Fig. 10) is the ferrite sheet (Fig. 11). These sheets are aligned in three stacks of 16 sheets plus an unconnected spare to form a memory submodule with a capacity of 512 twenty-four bit words. Four submodules make up a module (Fig. 12) and four

modules make up the total memory unit. Total storage capacity is 8192 words.

#### 32K Call Store

**3.14** The ferrite core patch is the basic storage element of the 32K CS (Fig. 13). Each patch contains 53,248 cores arranged in a 208 by 256 array. Four such patches constitute a core mat. Four code mats in two core mat assemblies (Fig. 14) compose the entire memory unit. The total storage capacity is 32,768 words.

**3.15** Although a 32K CS provides four times the storage capacity of an 8K CS, the physical size is much less. The volume occupied by three 32K CSs with associated logic is equal to the volume occupied by one 8K CS with associated logic (Fig. 15). Therefore, a single bay with three 32K CSs contains twelve times the storage capacity of a single bay 8K CS. The 32K CSs operate with all existing generic programs. The 1E6 generic program allows the addition of a tenth CS in a 1ESS switch. Both 8K and 32K CS cannot be used in the same office.

#### D. Signal Processor

**3.16** The SP (Fig. 16) is required only in larger COs. The SP performs highly repetitive and time consuming input-output tasks for the CC which severely limit the number of lines which may be served by the CC alone. The SP tasks include the supervisory scanning of lines and trunks for service requests, answers, disconnects, as well as the scanning of service circuits. The SP operates under the control of instructions stored in the SP CSs. The SP operates simultaneously with the CC; however, its operation is generally independent of the CC. When the SP has information for processing by the CC, the SP stores the information in the SP CS. The CC reads this information at appropriate times after momentarily interrupting the SP. When the CC has information to be used by the SP, the CC again interrupts and stores the information in the SP CSs.

#### SWITCHING NETWORKS

**3.17** The switching network (Fig. 17) is used to establish 2-wire metallic paths for voice transmission and signaling through four stages of switching in the LLNs and four stages of switching in the TLNs. Besides connecting lines to lines, lines to trunks, and trunks to trunks, the switching net-

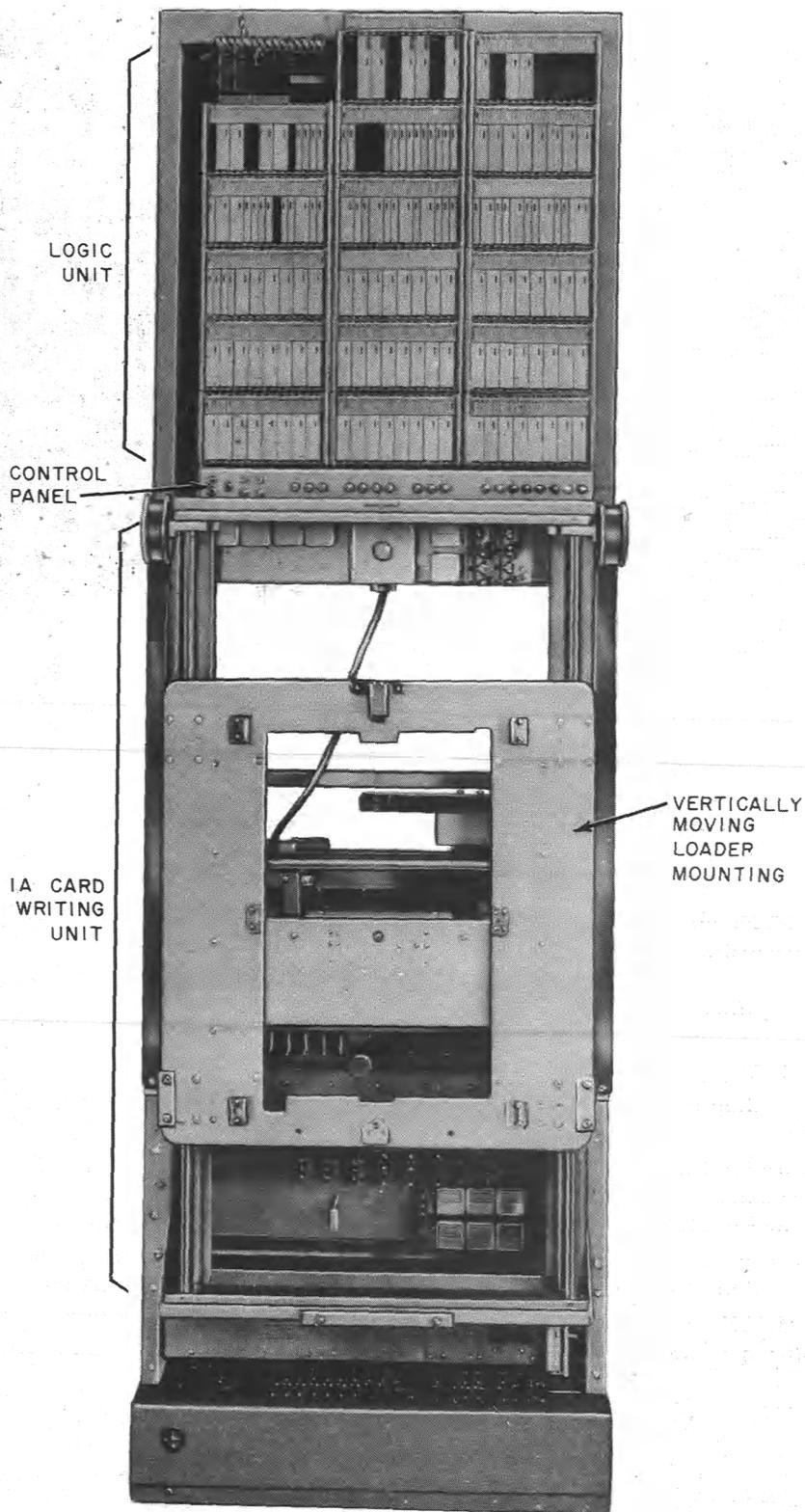


Fig. 9—Memory Card Writer

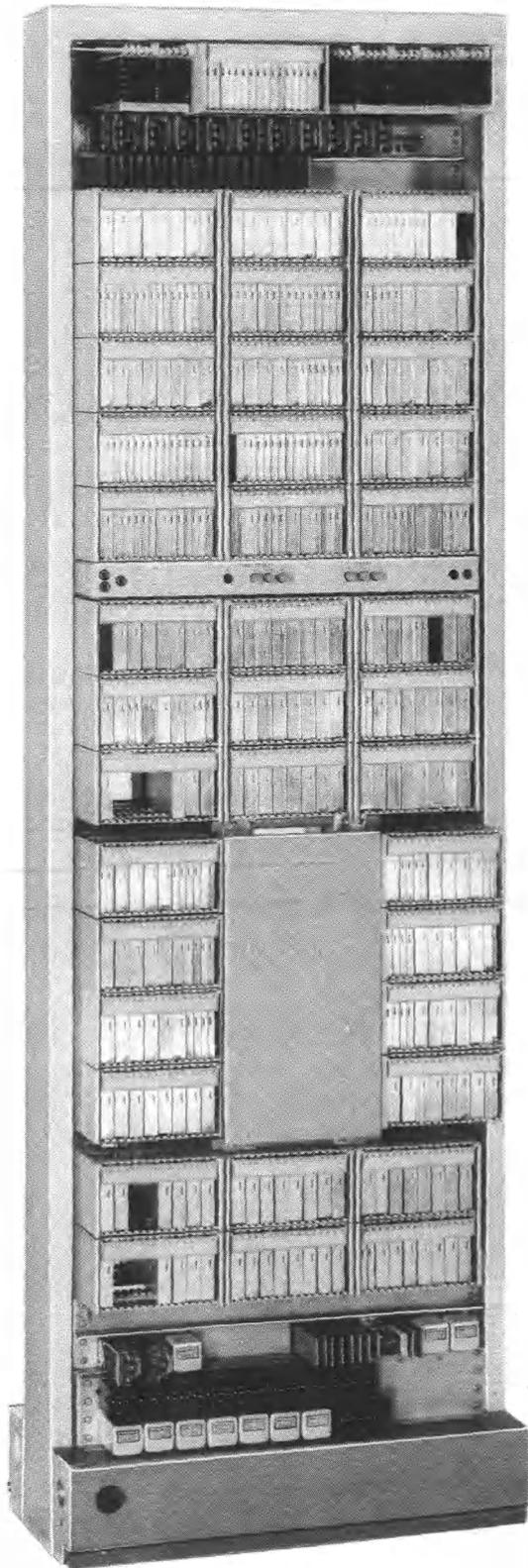


Fig. 10—8K Call Store

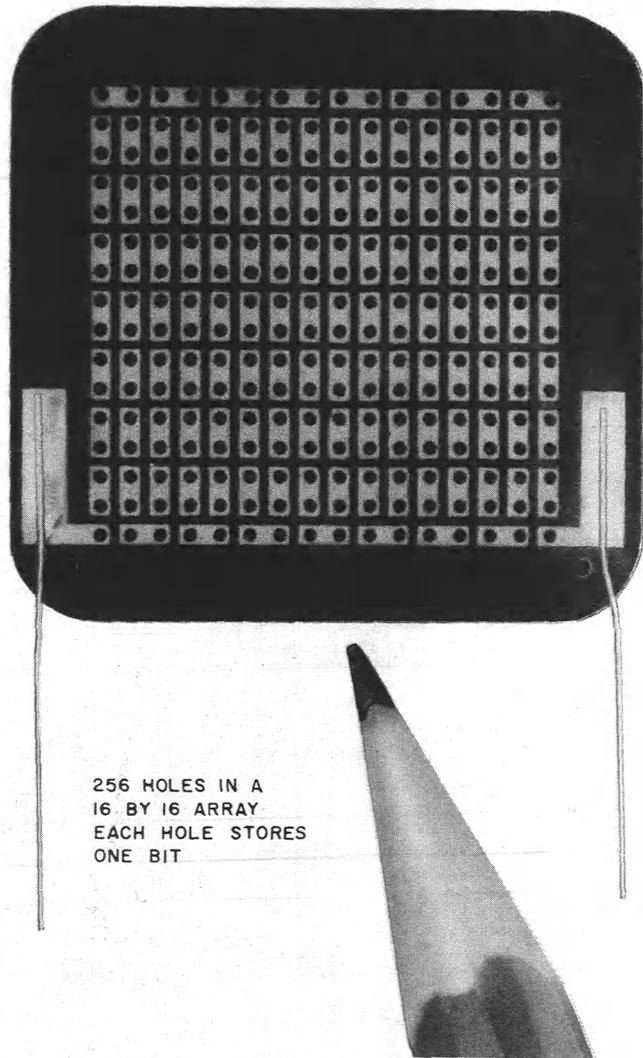


Fig. 11—Ferrite Sheet

work connects lines or trunks to various types of service circuits such as tones, interoffice transmitters, interoffice receivers, coin supervisory circuits, ringing circuits, and maintenance circuits.

**A. Line Link Network**

**3.18** The ferreed LLN contains two types of frames: line switching frames (LSFs) (Fig. 18) and junctor switching frames (JSFs) (Fig. 19). Figure 20 shows another configuration of the frames. The LSFs provide terminations for lines and consist of two stages of switching which perform concentration and distribution functions. The JSFs provide two stages of switching for further distribution and connection

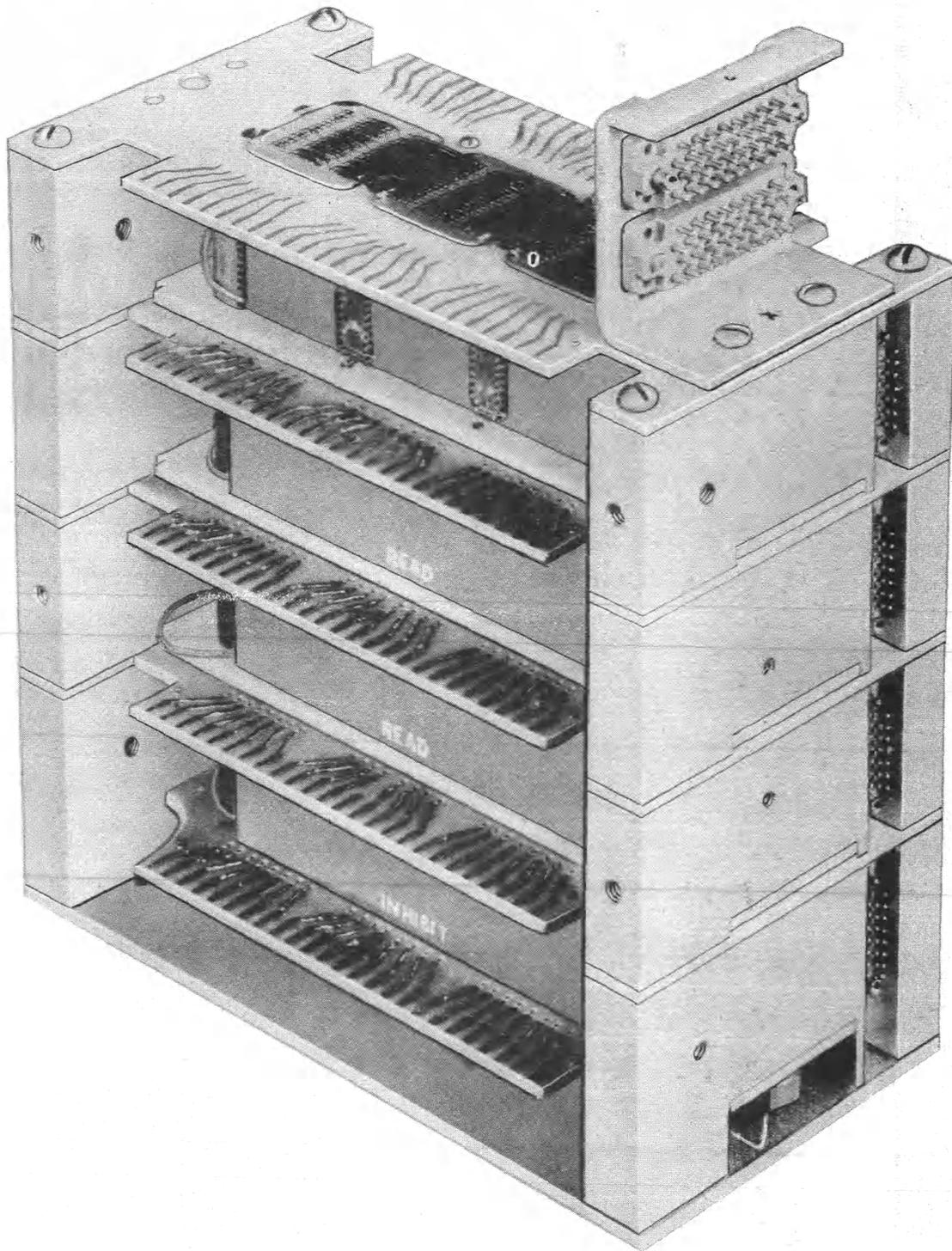


Fig. 12—Ferrite Memory Module

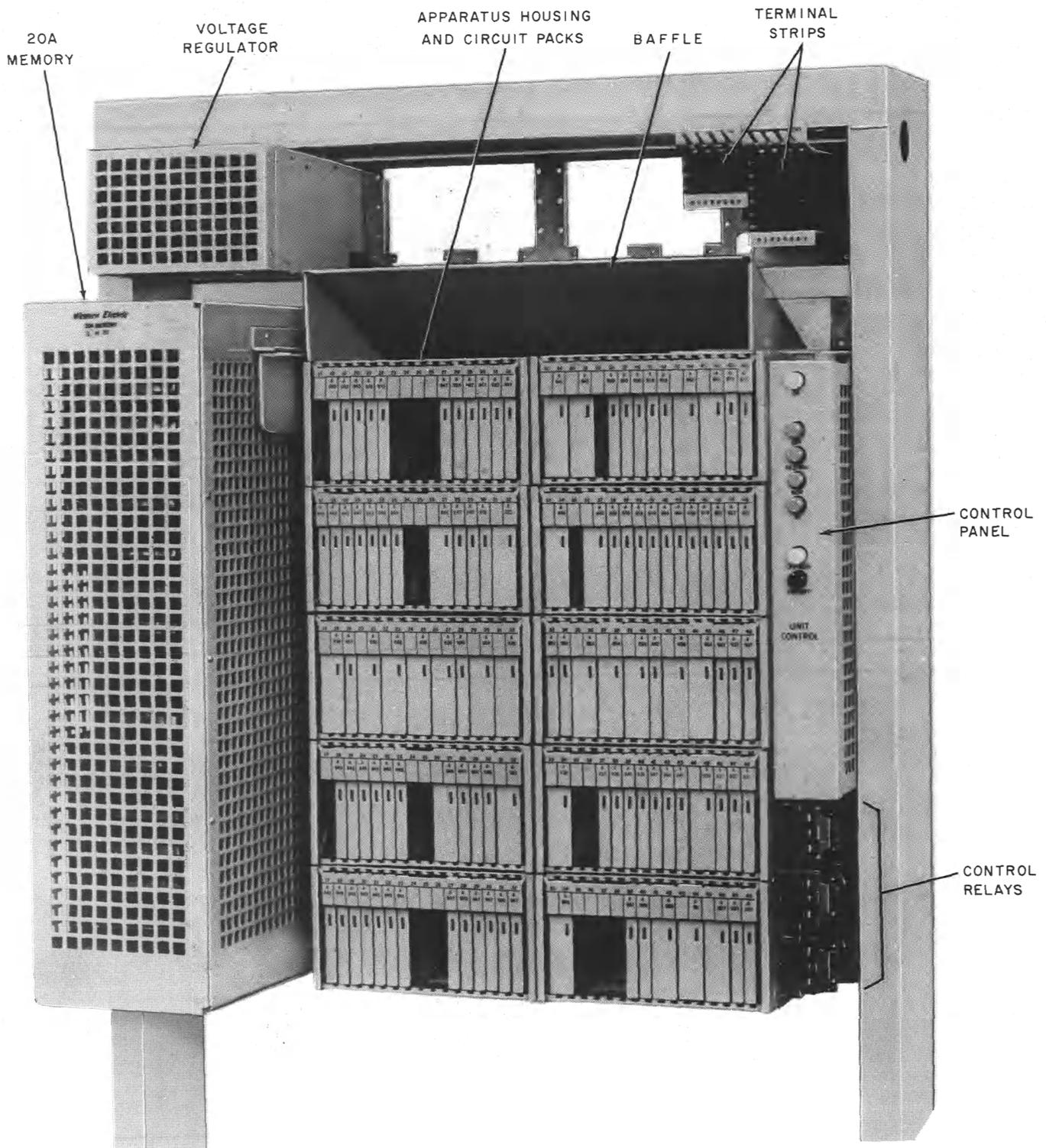


Fig. 13—32K Call Store

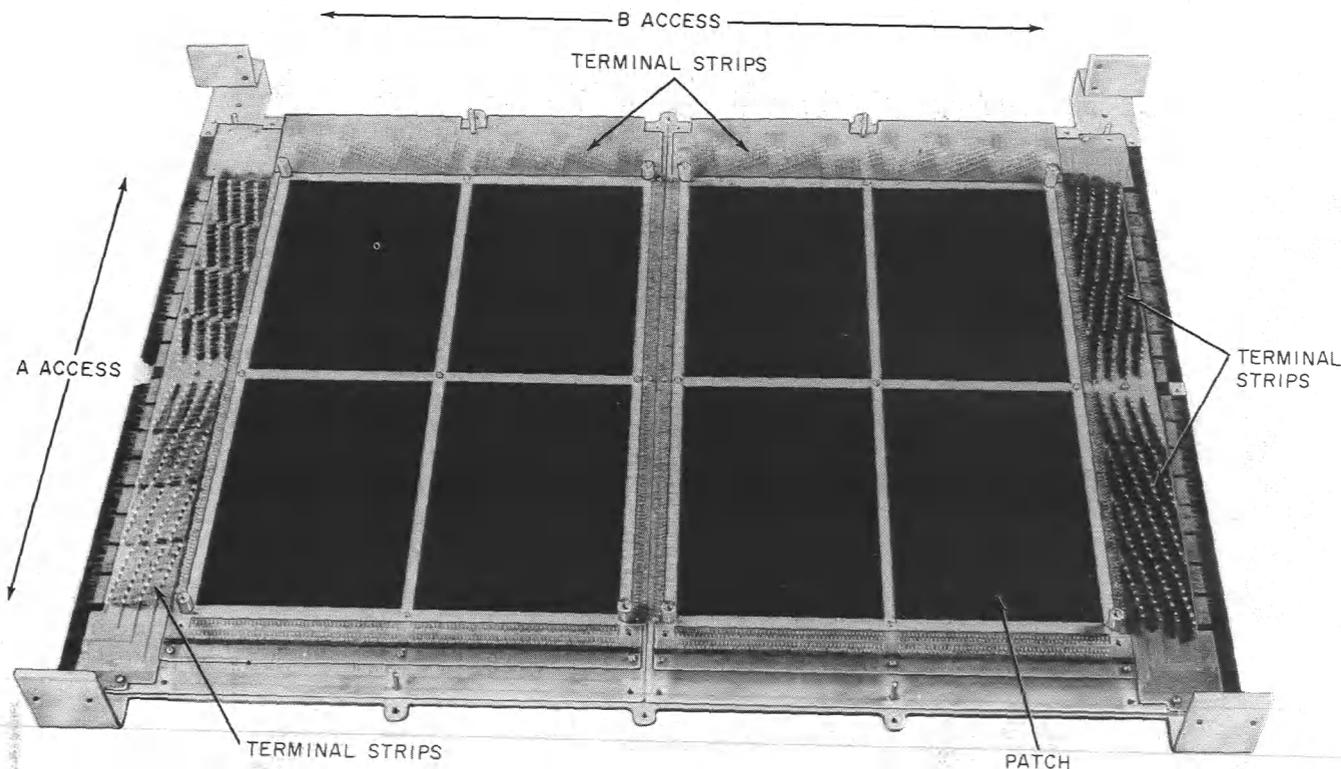
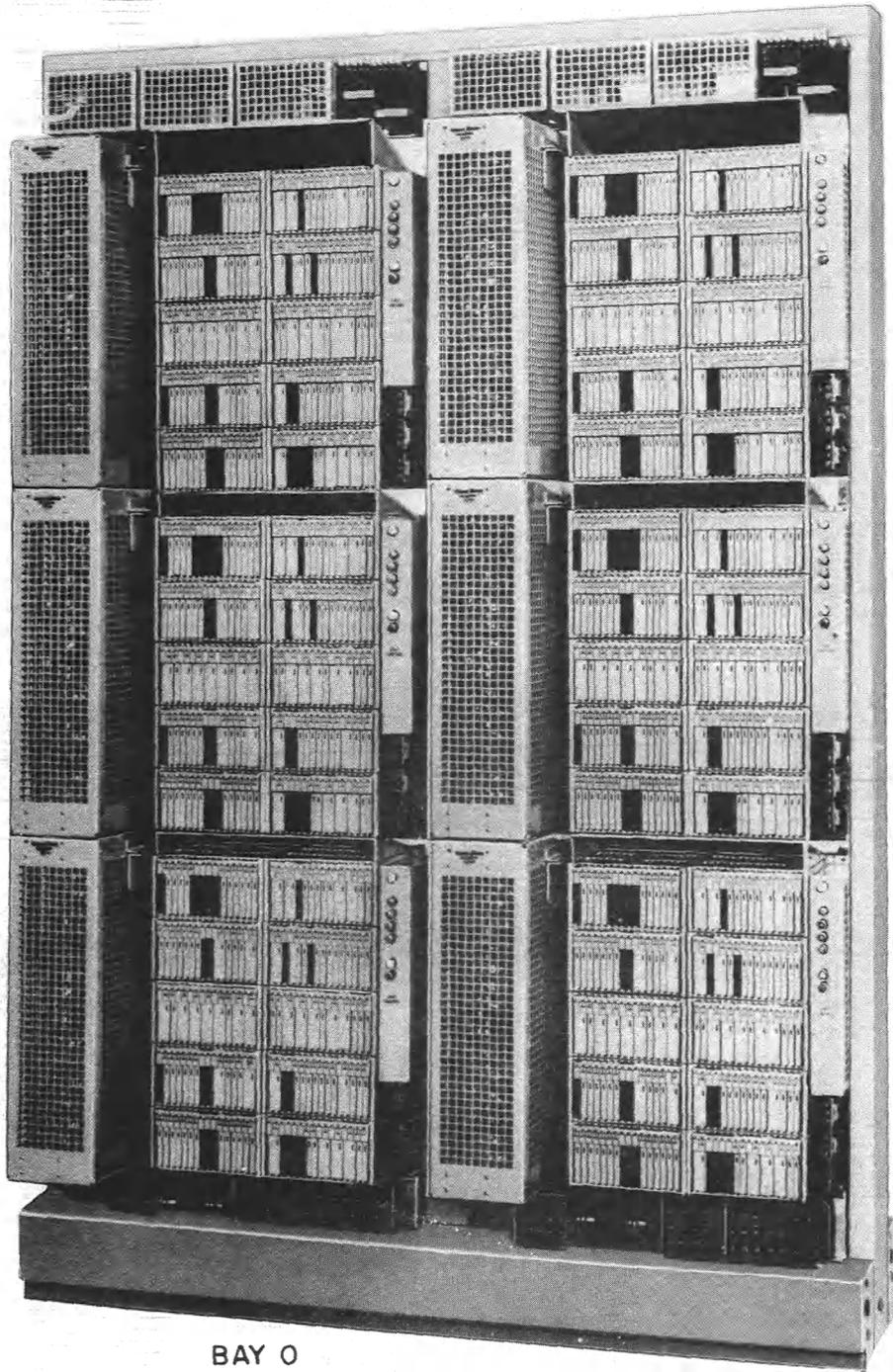


Fig. 14—Core Mat Assembly

to the junctors. There are two designs of LSFs available: one with 2:1 line concentration ratio (LCR) for heavy traffic and the other with a 4:1 LCR for regular or light traffic. Because of the variance between the two designs of LSFs, a mixture of the two designs in an office is not permitted in generic programs earlier than 1E5. However, various ratios of lines to junctors may be used (Table A). The ratio in a particular office must be the same for the entire office. The choice of ratio to be used is traffic-dependent and may be changed only during office growth to meet the needs of changing traffic conditions. Although partially equipped ferreed LLNs (1/4, or 1/2) have been provided in the past, consisting of one, two, or three JSFs, fully equipped LLNs are required with CTX-6 and later generic programs. Fractional equipped LLNs, consisting of fewer than the full number of LSFs for the given concentration ratio, may be provided. Starting with 1E5 generic program, the mixed concentration ratio feature (MCRC) permits a mixture of the two designs of LSFs. This feature allows a heavy LLN concentration ratio to grow using the 4:1 regular network concentration ratio. A 4:1 heavy concentration ratio requires eight 2:1 LSFs whereas a 4:1

regular concentration ratio requires only four 4:1 LSFs. The MCRC feature is used where an office with a heavy LLN concentration ratio (2:1) cannot economically justify to expand using additional heavy LLNs. This feature allows an office of this type to expand more economically by using regular LLNs (4:1). The MCRC software feature allows both 2:1 and 4:1 LLNs to be used in the same office.

**3.19** A 2:1 ferreed LSF may consist of a 2-bay home or mate frame; network control is separately provided for each frame. Two controllers, each of which in turn controls eight concentrators, are associated with each frame. The controllers on each frame operate independently of each other, but each can control the complete frame if the other is out of service. The 4:1 ferreed LSF is arranged with a 2-bay basic frame and a single supplementary bay. Network controllers are located on both the basic frame and the supplementary bay. Like the 2:1 line switching network control, either network controller can control the complete frame if the other controller is out of service. A scanner control unit which operates line scanner matrices on both frames is located on



BAY 0

BAY I

Fig. 15—32K Call Store Frame



Fig. 16—Signal Processor

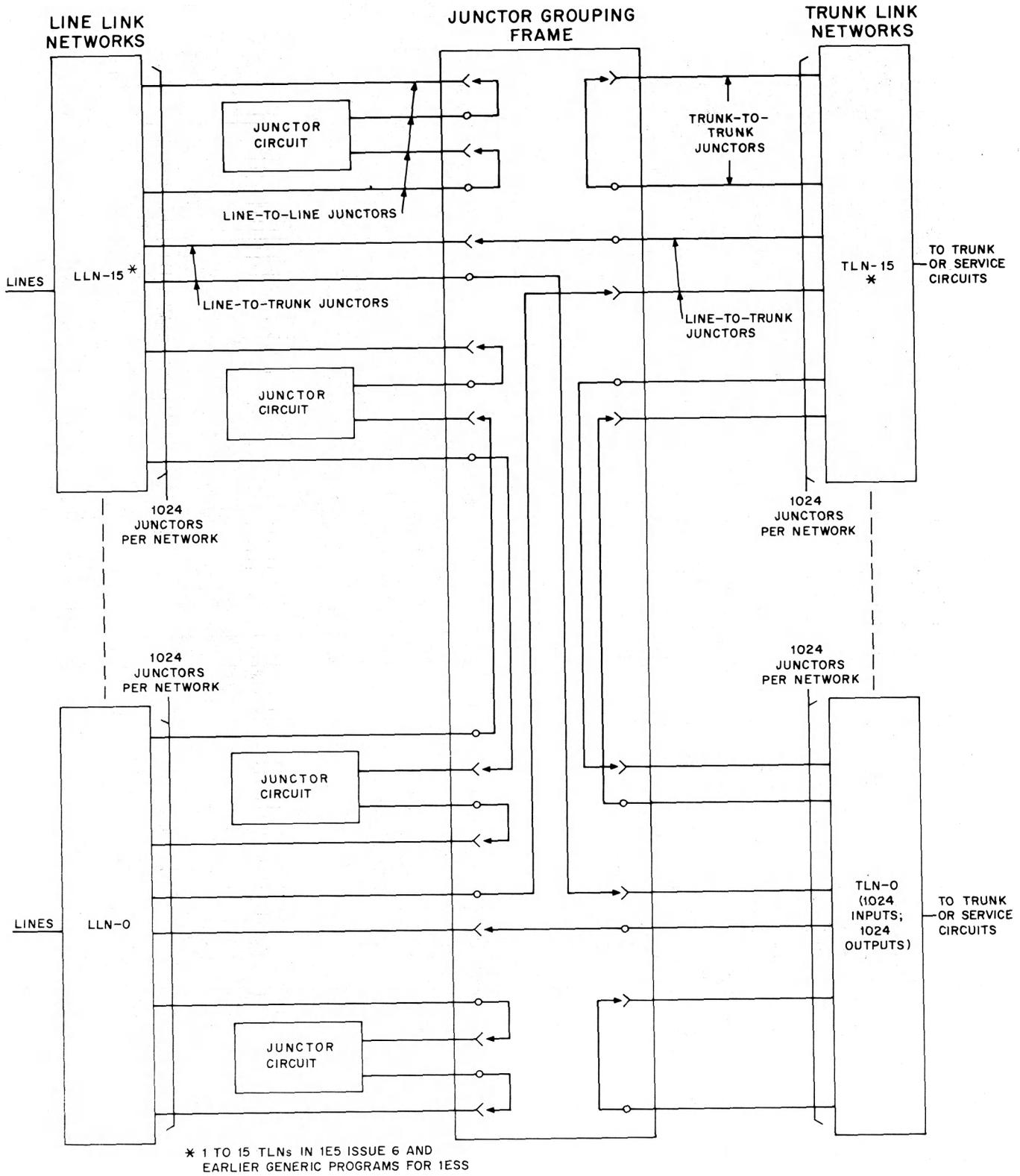


Fig. 17—Local Office Switching Network

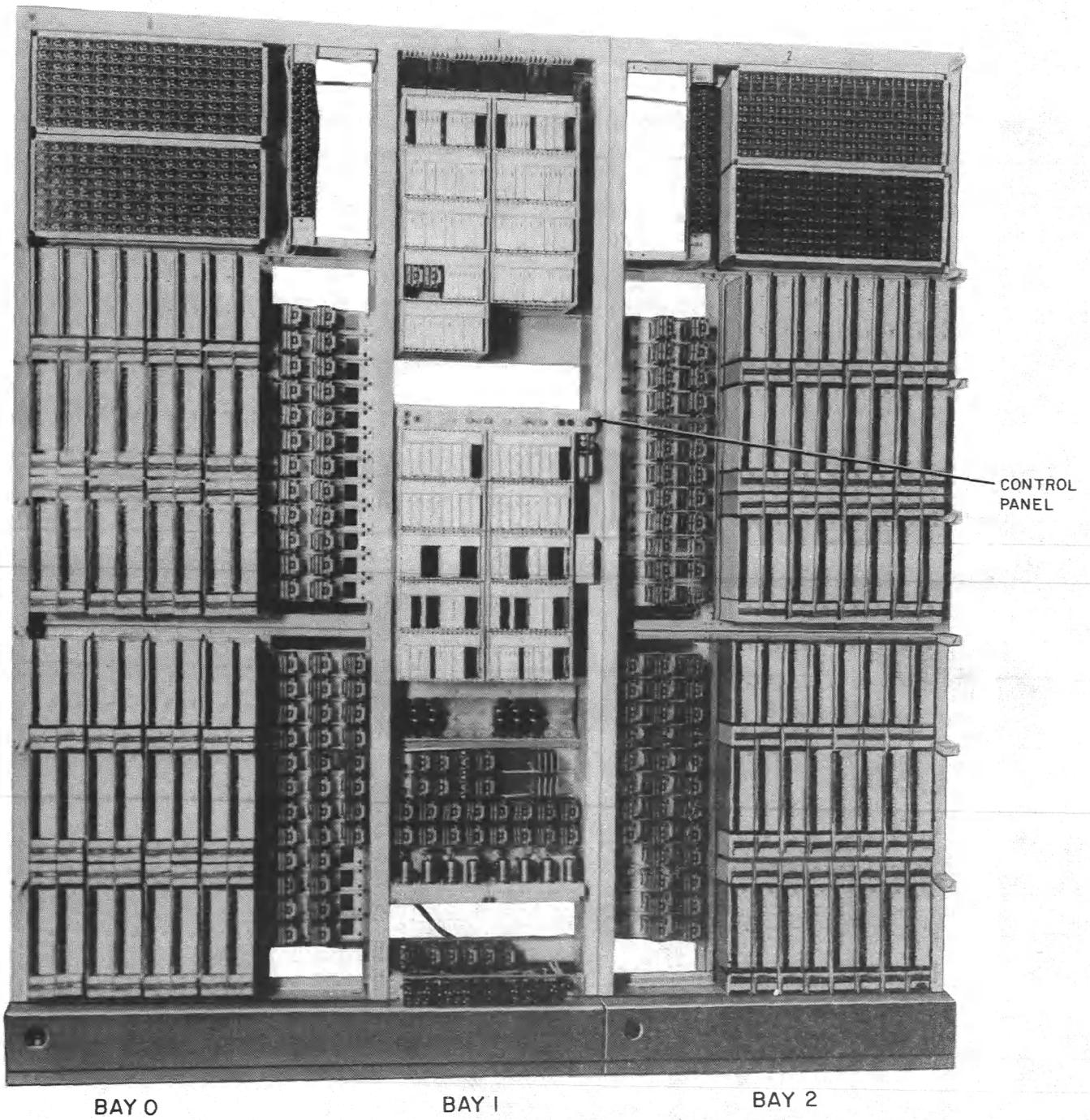


Fig. 18—4:1 Ferreed Line Switch Frame

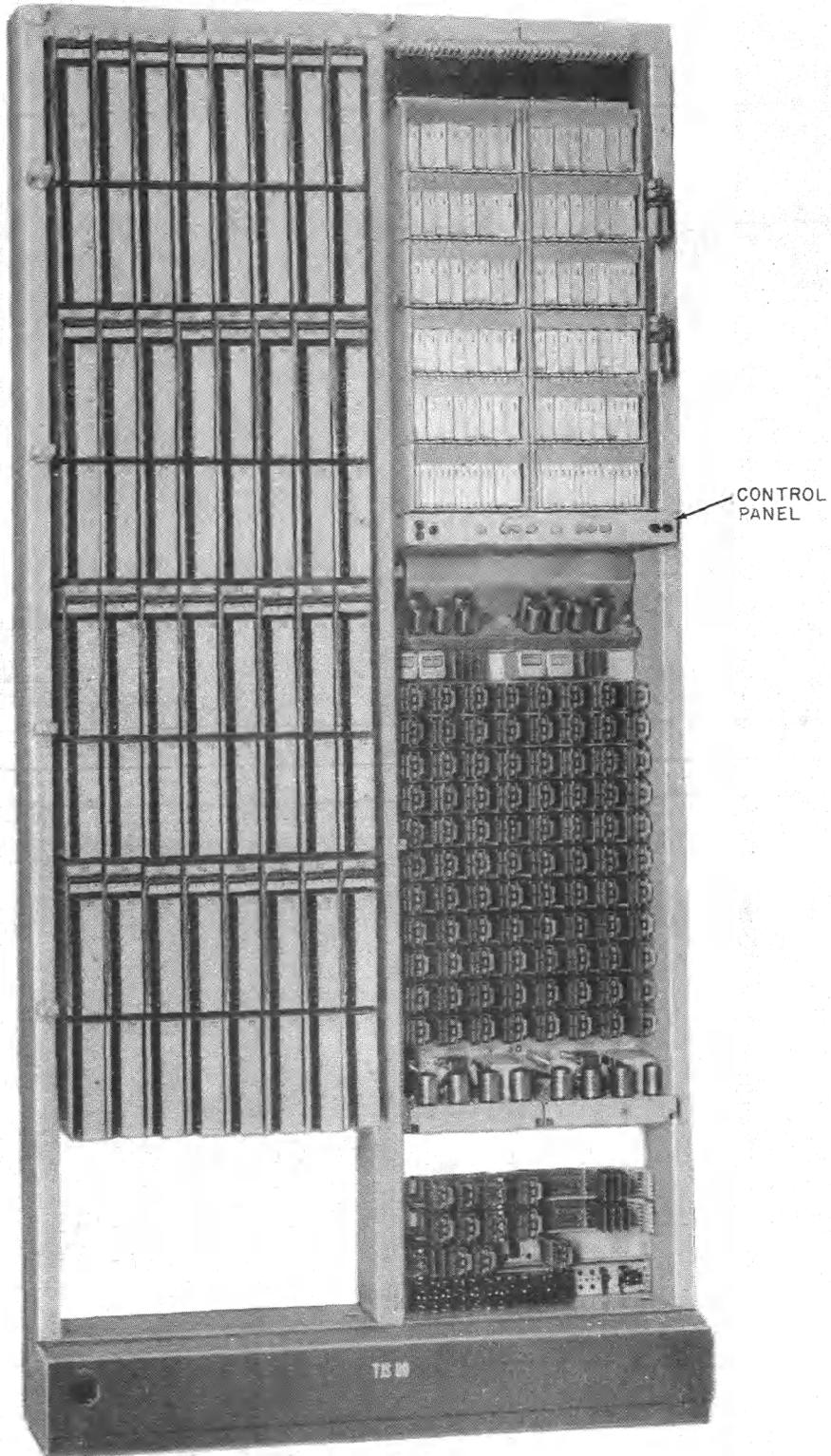
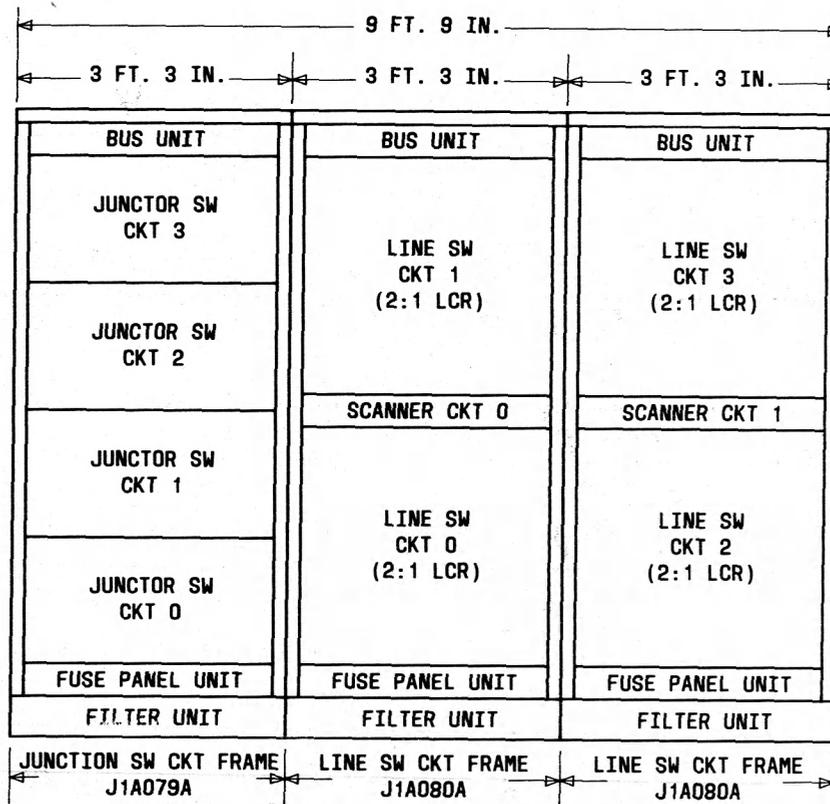
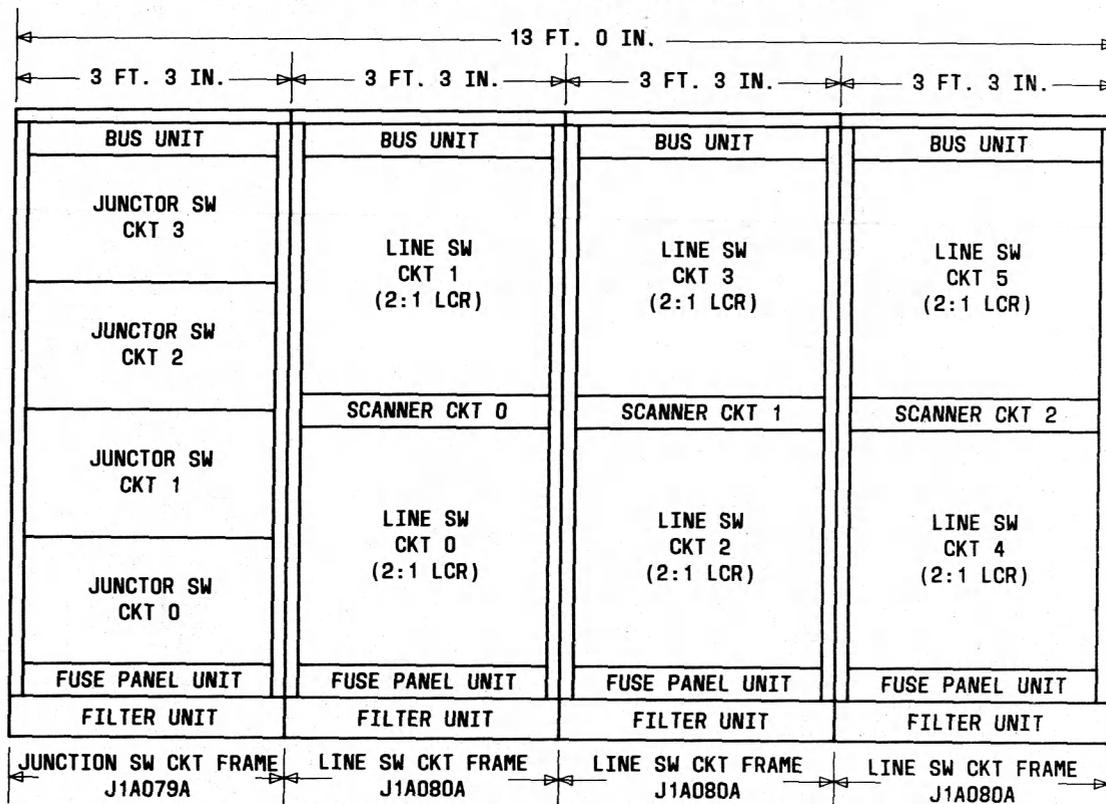


Fig. 19—Ferreed Junctor Switching Frame (Line or Trunk)



**FRONT VIEW LINE LINK NETWORK, 2:1 LCR**



**FRONT VIEW LINE LINK NETWORK, 3:1 LCR**

**Fig. 20—Remreed Line Link Network Frame Configurations**

TABLE A

## LINE LINK NETWORK SIZES

RATIO OF LINE TERMINALS TO JUNCTORS	MAX. NO. OF LINE SWITCH CKTS. PER LLN	MAX. NO. OR CUSTOMER LINES PER LLN	MAX. NO. OF LLNs PER OFFICE	MAX. NO. OF LINES PER OFFICE
FOR HEAVY CUSTOMER USAGE (2:1 CONCENTRATION RATIO)				
2:1	4	2048	16	32,768
3:1	6	3072	16	49,152
FOR REGULAR CUSTMER USAGE (4:1 CONCONETRATION RATIO)				
4:1	6	4096	16	65,536
6:1	6	6144	16	98,304

the home frame for 2:1 and on the basic frame for 4:1 line switching concentrators.

**3.20** The same type of JSF is used in both 4:1 and 2:1 line concentration ratio LLNs. Each frame uses duplicated controllers. One controller can control the entire frame if the other controller is out of service.

**3.21** *Line Link Network (Remreed)*: The 2:1 LCR and 3:1 LCR LLNs are shown in Fig. 20. The 2:1 LCR LLN is the high usage network while the 4:1 LCR LLN is for regular usage. A remreed LLN is completely compatible with ferreed networks. Thus, networks of both types may operate in the same office but remreeds and ferreeds may not be mixed in the same LLN. The remreed network uses B-link local cables in place of B-link switchboard cables.

#### B. Trunk Link Network

**3.22** While customer lines or PBX trunks are associated with LLNs, interoffice trunks and service circuits are associated with TLNs. The TLNs consist of trunk switching circuits (TSCs) that provide termination for trunk and service circuits and junctor switching circuits (JSCs) that provide two additional switching stages.

**3.23** A TSC may consist of either a ferreed trunk switching frame (TSF) (Fig. 21) or part of a remreed TLN frame (Fig. 22). A remreed TLN frame contains four TSCs. Similarly, a JSC may consist of either a ferreed JSF (Fig. 19) or part of a remreed

TLN frame (Fig. 60). A remreed TLN frame contains four JSCs. Remreeds and ferreeds may not be mixed in the same TLN.

**3.24** Both LLN and TLN ferreed JSFs are identical. Ferreed JSFs are similar to ferreed TSFs; remreed JSCs are similar to remreed TSCs.

**3.25** Trunk-to-junctor ratios of 1:1 to 1.5:1 (Table B) may be arranged by increasing the number of TSCs. A 1:1 trunk-to-junctor ratio represents four TSCs and four JSCs. Only one trunk-to-junctor ratio can be used in a single 1ESS switch office. The selection of a specific ratio is traffic dependent and may be changed to meet the needs of office growth. Initially, partial ferreed TLNs arranged to allow additions of trunk and service circuit terminations by small increments were manufactured. Partially equipped junctor switching frame TLNs are no longer recommended since fully equipped TLNs are required to function with CTX-6 and later generic programs. Remreed TLNs are only available equipped with a full complement of JSCs. Trunk switch circuits may be provided on a fractional network basis, with either ferreed or remreed hardware.

**3.26** *1024 Junctor Trunk Link Network*: The 1024 TLN may be used in the office configurations shown in Tables B and C.

A fully equipped 1.5 to 1 TLN contains four trunk JSCs and six TSCs.

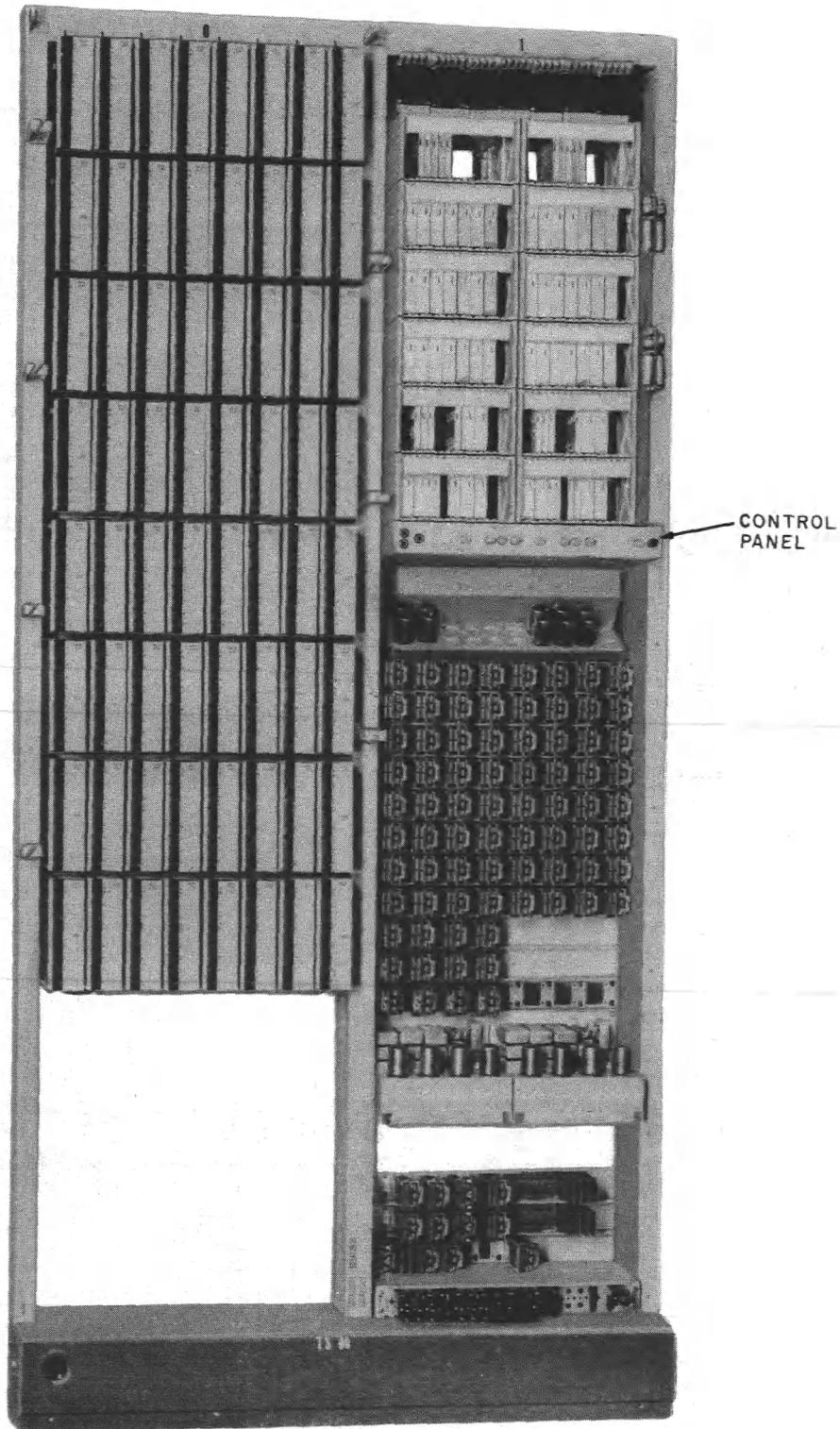


Fig. 21 — Ferreed Trunk Switching Frame

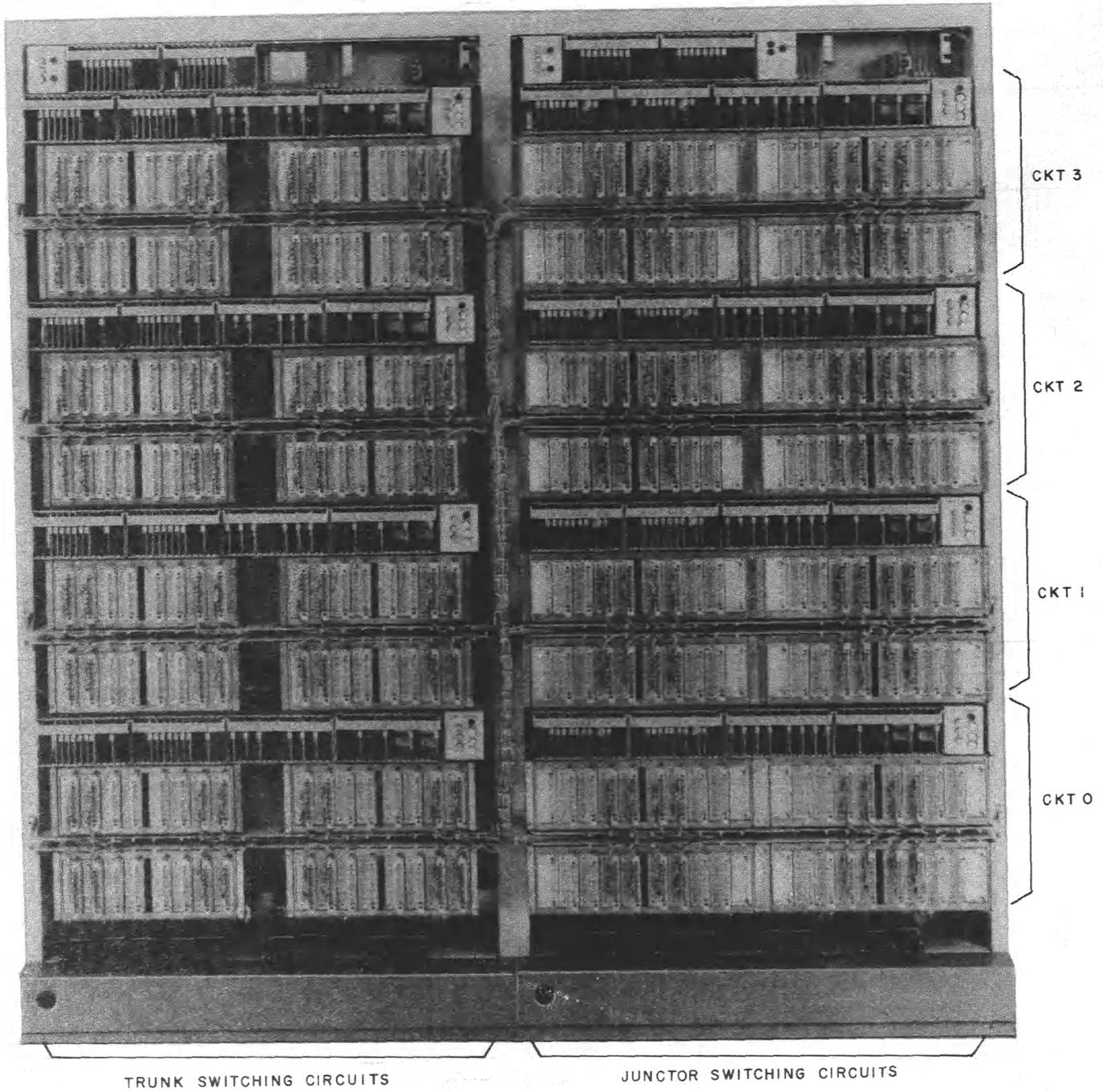


Fig. 22—Remreed Trunk Link Network Frame (1024 Junctor 1:1 Concentration Ratio)

TABLE B

## TRUNK LINK NETWORK SIZES

RATIO OF TRUNK TERMINALS TO JUNCTORS	MAX. NO. OF TSCS PER TLN	MAX. NO. OF TERMINALS PER TLN	MAX. NO. OF JUNCTORS PER TLN	MAX. NO. OF TLNs PER OFFICE	MAX. NO. OF TRUNKS PER OFFICE
1 to 1	4	1024	4	15†	15,360
1.5 to 1	6	1024	4	15†	23,040
1 to 1	8	2048*	8	15†	30,720

\* May be 2-Wire or HILO4-Wire.

† Offices with 1E5, Issue 6, or later generic programs may have from 1 to 16 TLNs.

TABLE C

## POSSIBLE COMBINATIONS OF NETWORK CONCENTRATION RATIOS

GENERIC PROGRAM	LLN CONCENTRATION RATIO	TLN CONCENTRATION RATIO
All	Any in Table A	1024 TL (1:1 or 1.5:1)
CTX-7 and later	No LLNs	2048 TLN (1:1)
1E4 and later	Any in Table A	1024 TLN (1:1 or 1.5:1) or 1024 TLN (1:1) with 2048 TLN (1:1) or 1024 TLN (1:1) with 2048 TLN (1:1 Hilo 4-Wire)
	No LLNs	2048 TLN (1:1) with 2048 TLN (1:1 Hilo 4-Wire) or 2048 TLN (1:1)

**3.27 2048 Junctor Trunk Link Network:** The CTX-7 and later generic programs provide for the 2048 TLN to be used. See Tables B and C. The fully equipped 2048 TLN consists of eight trunk JSCs and eight TSCs with B-link cabling spread between the groups of eight circuits so that each TSC has appearances on each of the JSCs. Only the 1:1 trunk concentration ratio (TCR) is available.

**3.28 Remreed Trunk Link Network:** The remreed TLN is completely compatible with the ferreed TLN; thus, networks of both types may operate in the same office. The remreed 1024 TLN occupies one 2-way frame (Fig. 22) with a total width of 6 feet 6 inches. The remreed TLN is for both 1:1 and 1.5:1 TCR.

**3.29** The remreed TLN contains the equivalent of four ferreed TSFs. Although the remreed hardware is smaller in size, different in appearance and operation, the ferreed and remreed TLN hardware performs the same switching functions. However, the remreed and ferreed grid apparatus units (crosspoint switches) are not interchangeable between the respective TLN frames.

**3.30** The remreed TLN is highly connectorized for ease of maintenance as well as for initial installation. Semiconductors are used in the remreed network for crosspoint switching control (pulse current steering) instead of wire-spring relays, and integrated circuits are used for logic and translation functions.

**3.31** The four separate trunk and JSCs on the remreed TLN (Fig. 22) share the peripheral unit bus (PUB) receivers and the diagnostic bus connections for each bay.

**3.32** Interconnection between LLNs, TLNs, and JSCs is provided by the JGF (Fig. 60 and Fig. 61).

### JUNCTOR, TRUNK, AND SERVICE CIRCUITS

**3.33** Trunk circuits in the 1ESS switch are used mainly to provide transmission and supervision. Unlike electromechanical systems, the tasks of pulsing, charging, timing, ringing, etc, are handled directly by program control or by service circuits which are under program control. Service circuits, in general, are auxiliary circuits connected through the network to lines or trunks, as required. They perform functions which can be handled more economically by providing a few special circuits than by providing additional equipment in each trunk to accommodate the same function.

**3.34** Junctor circuits are switching circuits used to complete intraoffice calls. Junctor circuits also include a transmission circuit which provides ac coupling between the two lines and supplies talking battery to each end. Magnetic latching relays are used in junctor circuits for switching. Junctor circuits are mounted on junctor frames. Junctor frames have the same configuration as universal trunk frames (UTFs) shown in Fig. 23. An explanation of an intraoffice call appears in Part 4.

#### A. Universal Trunk Frame

**3.35** There are two types of UTFs: home and mate (Fig. 24). Each home and mate frame consists of three bays numbered 0, 1, and 2. The 0 and 2 bays are arranged to mount 64 individual plug-in trunk units, each for a total of 128 units for the frame. The number of circuits per plug-in unit is either one or two. The frame will accommodate 256 circuits if all the units are of the 2-circuit type. The frames are 6 feet 6 inches wide.

**3.36** Bay 1 of the home frame contains 512 ferrod sensors and the control equipment necessary for interrogating 1024 ferrods and converting their outputs to signals that can be used by other parts of the system. Bay 1 of the mate frame contains only 512 ferrods; the control equipment for them being located

on bay 1 of the home frame. Bay 1 of each home and mate frame contains a complete 1024-point signal distributor (SD).

**3.37** Bay 1 mounts, in addition to the scanner and the SD, the power control panel, the fuse panels, and the power filters for the scanner and SD units. The 512 scanner matrix points and 768 of the 1024 SD matrix points are wired in a fixed pattern to the connectors on the trunk chassis mountings. The remaining 256 points are used for remote circuits. Four scan and six SD points are reserved for each trunk chassis mounting connector.

#### B. Miniaturized Universal Trunk Frame

**3.38** The miniaturized universal trunk (MUT) frame consists of a pair of 2-foot 2-inch bays arranged in a home-mate configuration that provides plug-in housing for 256 circuit board mounted universal trunk units (Fig. 24). Each trunk unit may contain one or two trunk circuits. The MUT frame also provides power, filters, and fusing for the trunk units. Contained in the MUT frame are two 1024-point TRIAC SDs, a 1024-point scanner, and PUBs.

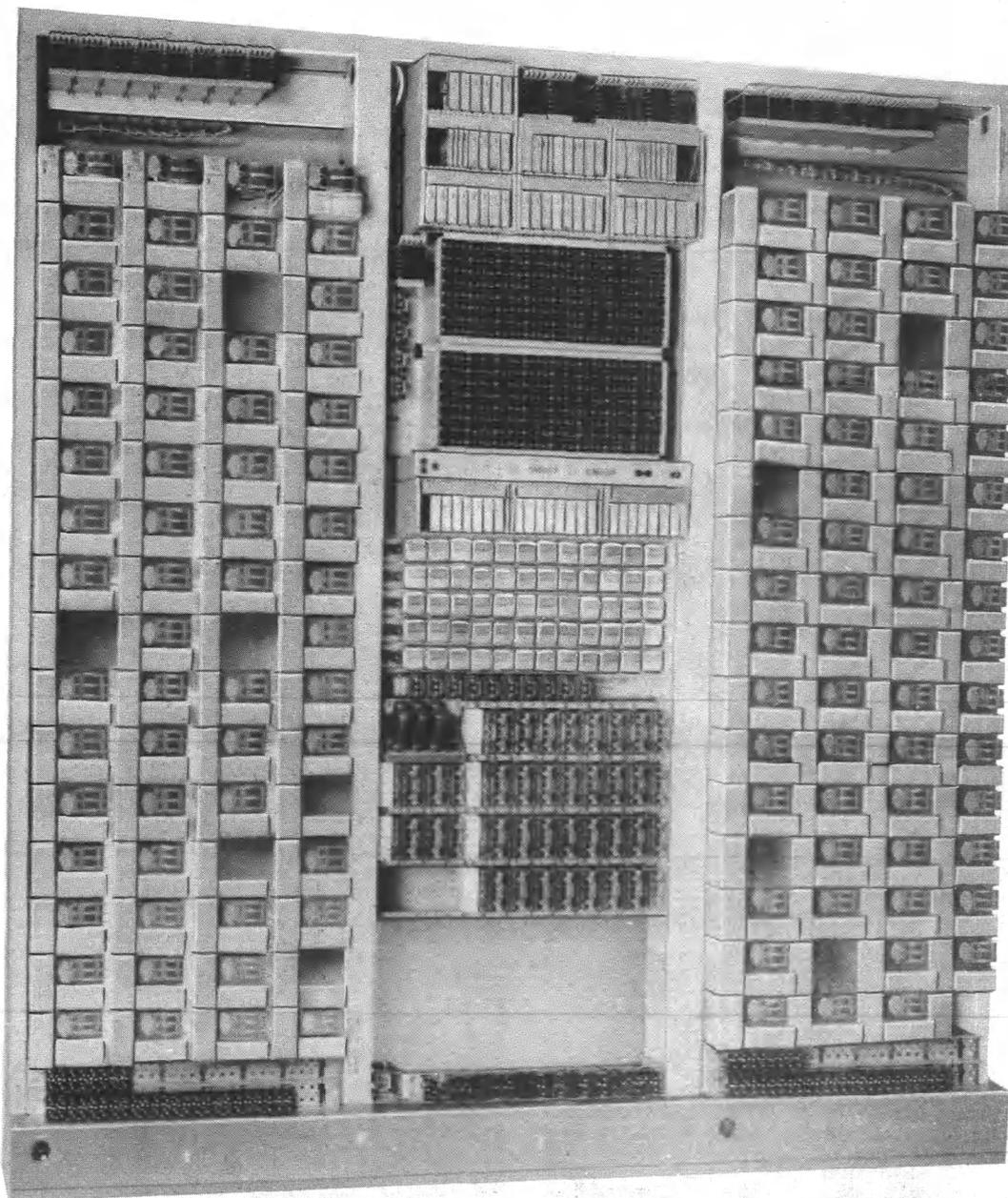
**3.39** The scanner in the MUT supervises only trunk and service circuits mounted in the MUT frame. The home frame has the 0 controller for the 1024-point scanner and the mate frame has the 1 controller for the scanner. The associated matrix is split in half with 512 points on the home frame and 512 points on the mate frame.

**3.40** There is a pair of SD controllers in the home frame and another pair in the mate frame. Therefore, both the home and mate frames have a 1024-point SD.

#### C. Miscellaneous Trunk Frame

**3.41** The miscellaneous trunk (MT) frame is a single bay frame 2 feet 2 inches wide. The frame has thirty-six 2-inch mounting plate spaces used for mounting trunk and service circuits. The MT frame mounts those trunk and service circuits which do not fit the universal pattern required for mounting on the UTF. Those circuits on the MT frame are cabled via unit terminal strips to their associated MS, SD, and distributing frame terminations.

**3.42** The MT frame does not contain a scanner or SD. The MT frame is also used to mount other



**Fig. 23—Universal Trunk Frame**

equipment, such as, a supplementary signal distributor (SSD), IOT, and automatic identifier outward dialing (AIOD).

**D. Combined Miscellaneous Trunk Frame**

**3.43** The combined miscellaneous trunk (CMT) frame is a double bay (3 feet 3 inches per bay)

frame that provides housing for the control circuits and up to 256 circuit board mounted MT circuits.

**3.44** The CMT frame can be provided with up to two SSDs and an MS. Each SSD supplies 960 points capable of operating either full-size or miniature magnetic latching relays. The MS supplies 1024 scan points. The layout of the CMT with one SSD is shown in Fig. 25.

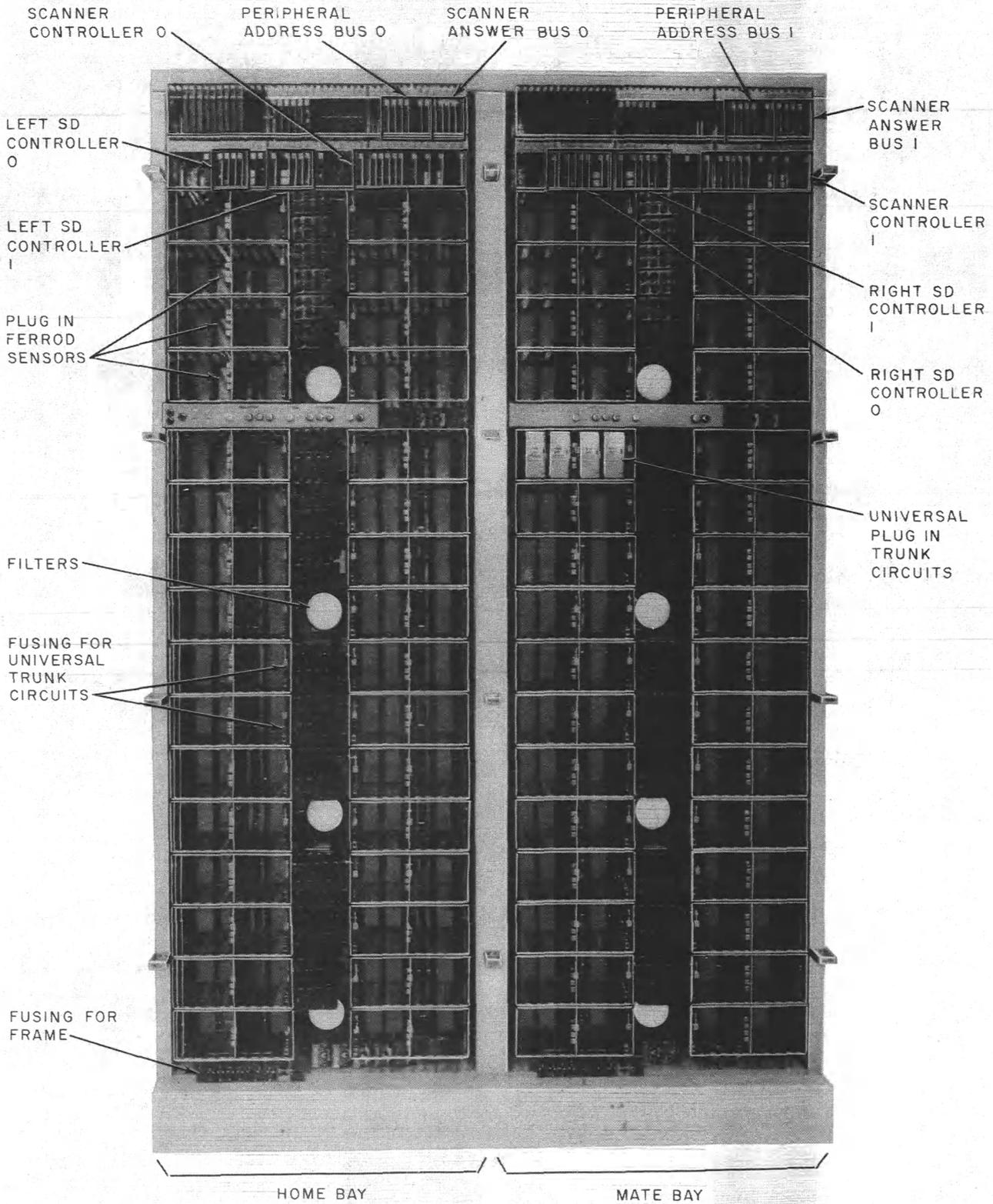


Fig. 24—Miniaturized Universal Trunk Frame

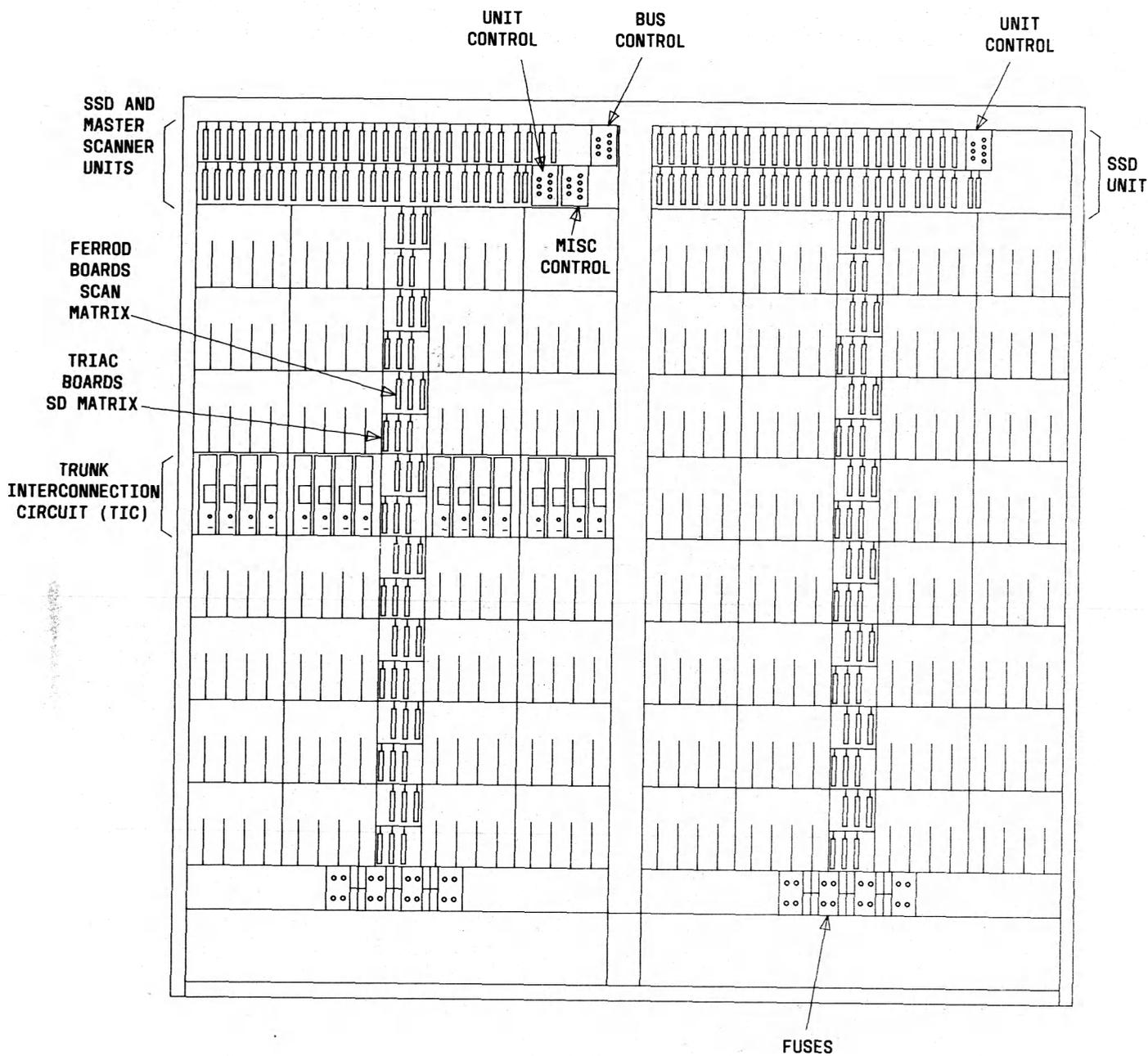


Fig. 25—Layout of CMT Frame with Two SSDs

**3.45** The plug-in MTs are plugged into the trunk interconnection circuit (TIC). The TIC is designed for a specific group of MT circuits and is mounted in the CMT frame. Each TIC houses circuit boards containing miniaturized ferroids for scanner functions and circuit boards containing TRIACs (solid-state switches) for SD functions. A CMT frame can provide housing for 16 TICs. Each TIC can provide housing for 16 MT circuits, plug-in TRIAC matrix circuit boards, and plug-in scanner matrix circuit boards.

**3.46** The MTs are organized into nine groups of trunk circuits. Each group requires a TIC that accepts only trunk circuits from that particular group. A TIC can accept any trunk circuit in the group it is designed for, but cannot accept trunk circuits from any other group.

#### **E. HILO Universal Trunk Frame**

**3.47** The HILO universal trunk (HUT) frame is a standard double bay framework 7 feet 0 inches high by 6 feet 6 inches wide by 1 foot 0 inches deep (Fig. 26). The HUT frame supports 256 plug-in trunks (512 trunk circuits) and the associated power filtering, fusing alarm, bus, scanner, and SD control units. The HUT is equivalent in function to an MUT frame, but houses only HILO 4-wire trunk units.

**3.48** The HILO 4-wire switching feature makes it possible to use the existing 1ESS switch 2-wire remreed switching network to provide an equivalent 4-wire switching function. This function is accomplished by converting the 2-wire bidirectional conductor pair into two independent unidirectional unbalanced paths and using the ground path as the common return.

#### **F. HILO Miscellaneous Trunk Frame**

**3.49** The HILO miscellaneous trunk (HMT) frame (Fig. 27) is a standard double bay framework 7 feet 0 inches high by 6 feet 6 inches wide by 1 foot 0 inches deep and is provided to accommodate most of the trunks that cannot be mounted on the HILO UTF. The HMT frame, arranged for HILO incoming step-by-step trunks may be equipped with up to 256 trunk circuit plug-in units (512 circuits) of which there are two MT pack codes.

**3.50** The HMT frame usually does not contain its own SD circuit but uses the required number

of SD points located on other frames (HILO UTF or miniaturized UTF) within the office. However, there are options for 0-2 SDs on the HMT frame.

**3.51** The scanner in the HMT supervises only trunks and service circuits mounted in HMT frame. Bay 0 of the HMT has the controllers for the 1024-point scanner. The associated matrix is split in half with 512 points in bay 0 and 512 points in bay 1.

### **INPUT-OUTPUT UNITS**

#### **A. Scanners**

**3.52** Scanners furnish input information to the system. Scanners supervise on-hook and off-hook conditions, monitor dial pulses, and observe the electrical state of various points within the CO for administrative, diagnostic, and other purposes. Scanners monitor lines, trunks, and other circuits at discrete time intervals as directed by the system.

**3.53** Each point to be scanned in the system is connected to a current-sensing device called a ferrod sensor. A scanner can select and interrogate any group of 16 ferroids specified by information received from the central control (CC) or the SP. Each of the 16 ferroids interrogated causes a pulse or no pulse output referred to as a 1 or 0 readout, respectively. Whether the readout is a logic 1 or 0 depends on the state of the scanned circuit. In response to signals from a CC or an SP, a scanner produces a 16-bit output word that is transmitted to the CC or SP for interpretation.

**3.54** The following types of scanners are used in the 1ESS switch:

- Ferreed switch line scanners
- Remreed switch line scanners
- Universal trunk scanners (nonminiaturized, miniaturized, and HILO)
- Junctor scanners
- Master scanners
- Combined miscellaneous trunk (master) scanners.

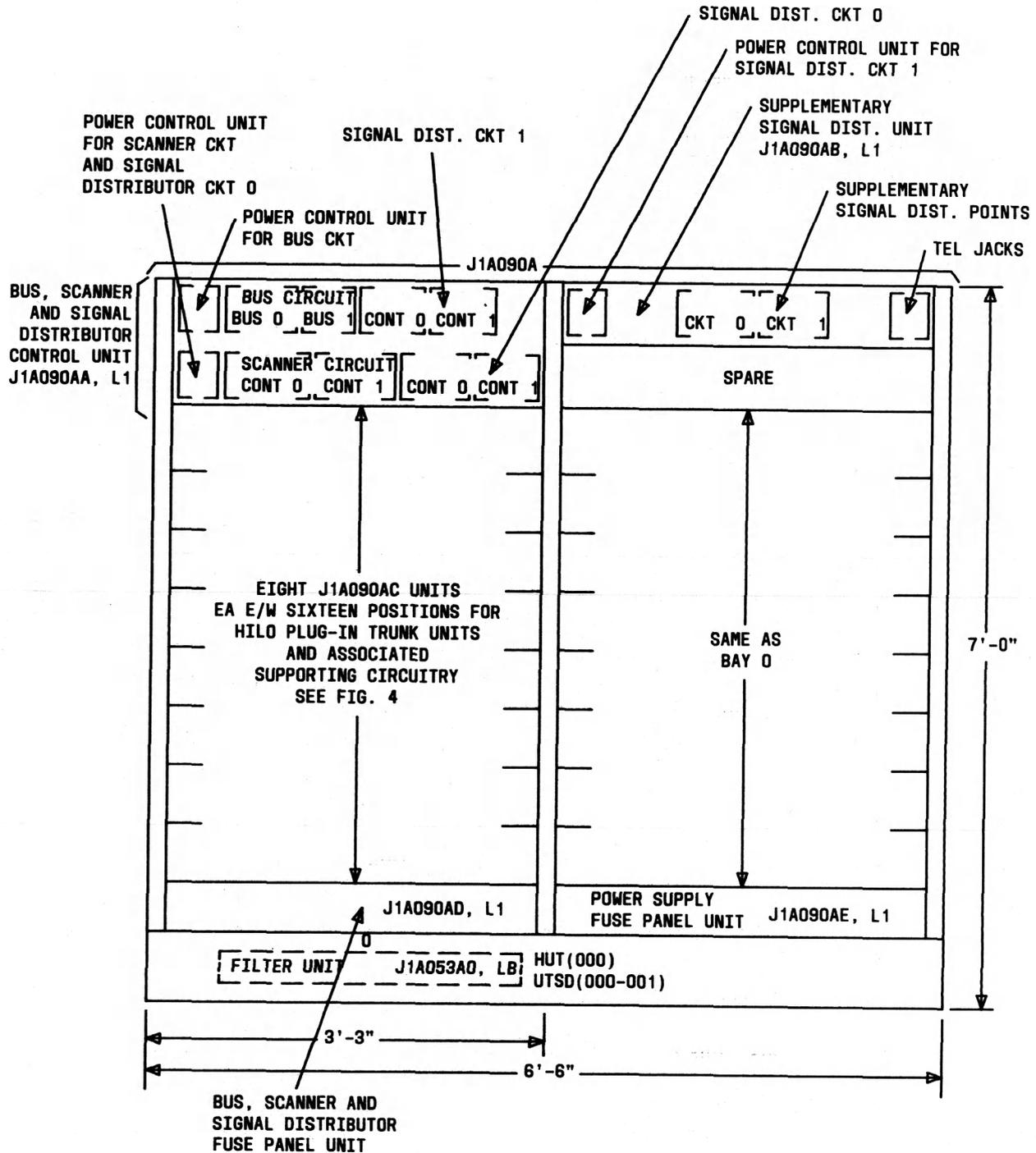
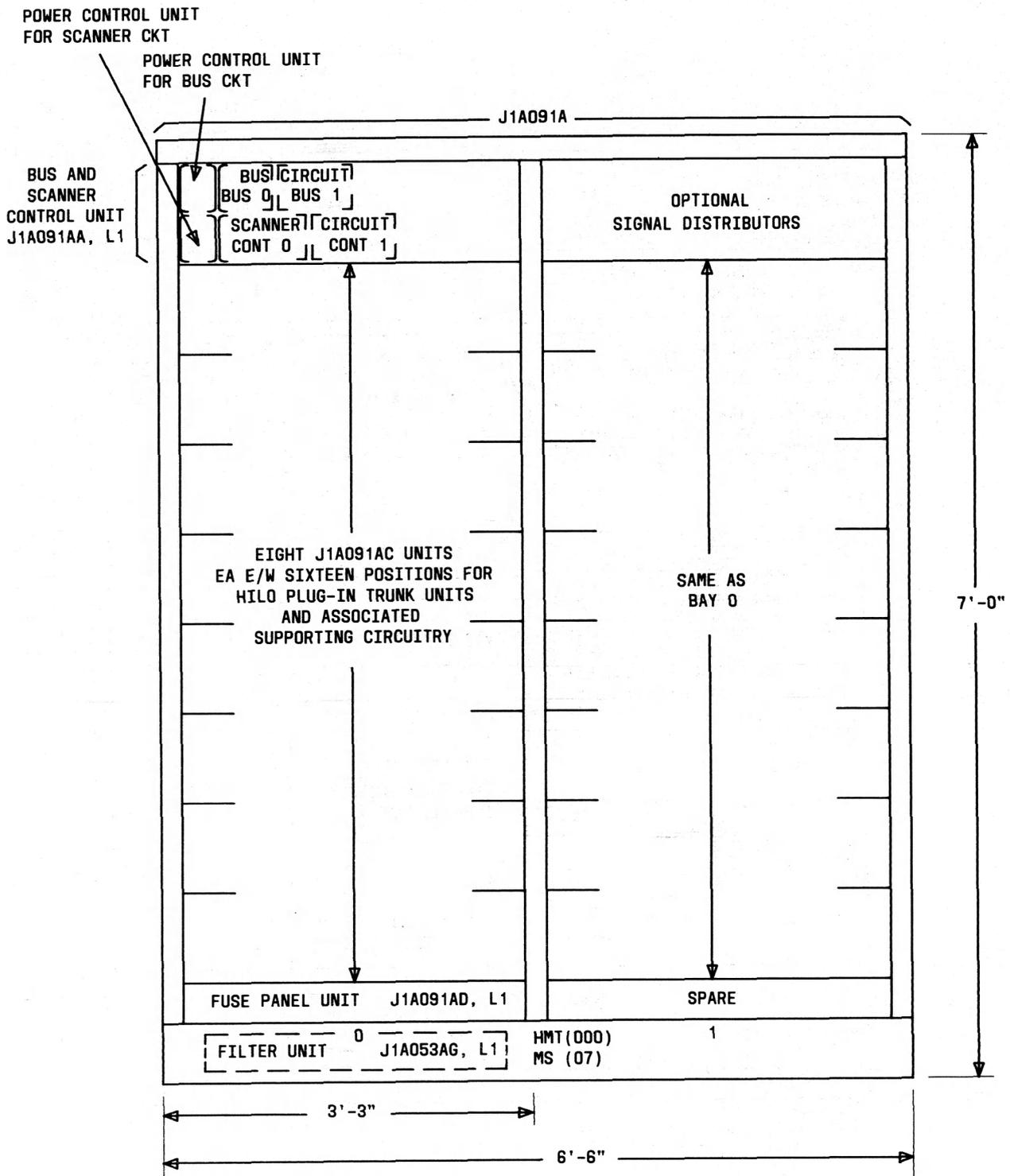


Fig. 26—HILO Universal Trunk Frame



NOTE: FRAME EQUIPPED FOR OPTION Z

Fig. 27 — HILO Miscellaneous Trunk Frame

The scanners differ mainly in function and types of ferroids used; however, the control and operation of all scanners are essentially the same. The total number of scan points required in a typical CO is about one and a half times the number of office lines.

**Master Scanner**

3.55 The MS (Fig. 28) supplements the line, trunk, and junctor scanners to collect additional information at many points in an office. The MS also

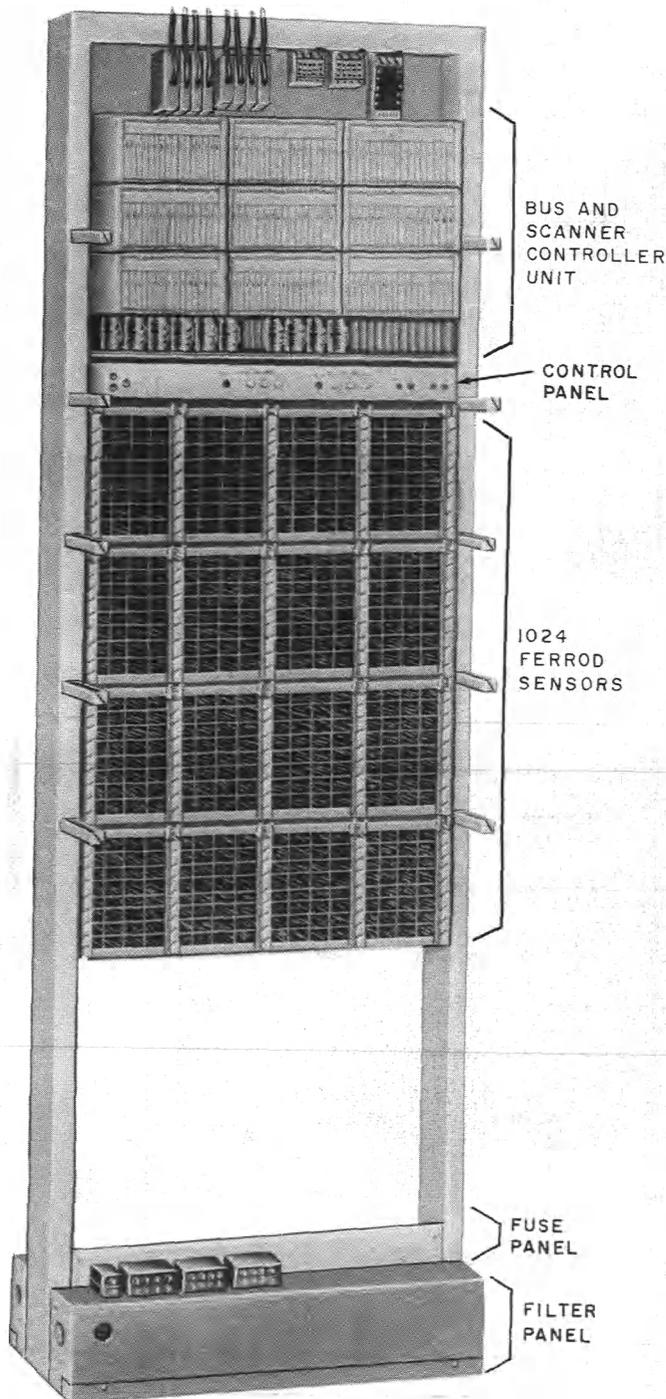


Fig. 28—Master Scanner

supplies the scan points for MT frame circuits. Scans are requested for any of several reasons:

- (a) To perform a diagnostic test

- (b) To verify proper execution of an action previously requested
- (c) To recognize existing conditions in order to take appropriate steps.

### B. Signal Distributors

3.56 The SDs are used to select and control equipment within the 1ESS switch for which operation at electronic speeds is not necessary. The SDs provide the CC with a means for selecting and operating magnetic latching relays in trunk and service circuits, junctor circuits, and certain control circuits. Thus, SDs are the buffers between the microsecond CC requests and the millisecond relay response.

3.57 An SSD unit located on an MT frame is available for use when the SD point arrangement of the junctor frame and UTFs is insufficient. This supplementary unit provides a complete SD for circuits located on MT frames.

### C. Central Pulse Distributors

3.58 The CPDs provide the CC rapid access to many points throughout the CO (Fig. 29).

3.59 Upon receiving an order from the CC, a CPD selects and pulses at electronic speed, one of the outputs specified by the address from the CC. Outputs from the CPD may be either unipolar (pulses of only one polarity) or bipolar (pulses of either polarity). Unipolar pulses are mainly used to enable peripheral units (scanners, SDs, network frame controllers, teletypewriters, and AMA magnetic tape recorders). The verification pulse that results is returned to the CPD, decoded, and then sent to the CC. Bipolar pulses, sent to peripheral and other units, can be used to change the state of flip-flops or to operate a logic circuit. Circuits receiving a bipolar output pulse do not return a verify pulse to the CPD.

### MASTER CONTROL CENTER

3.60 The MCC is used in the 1ESS switch for maintenance and administrative controls. The

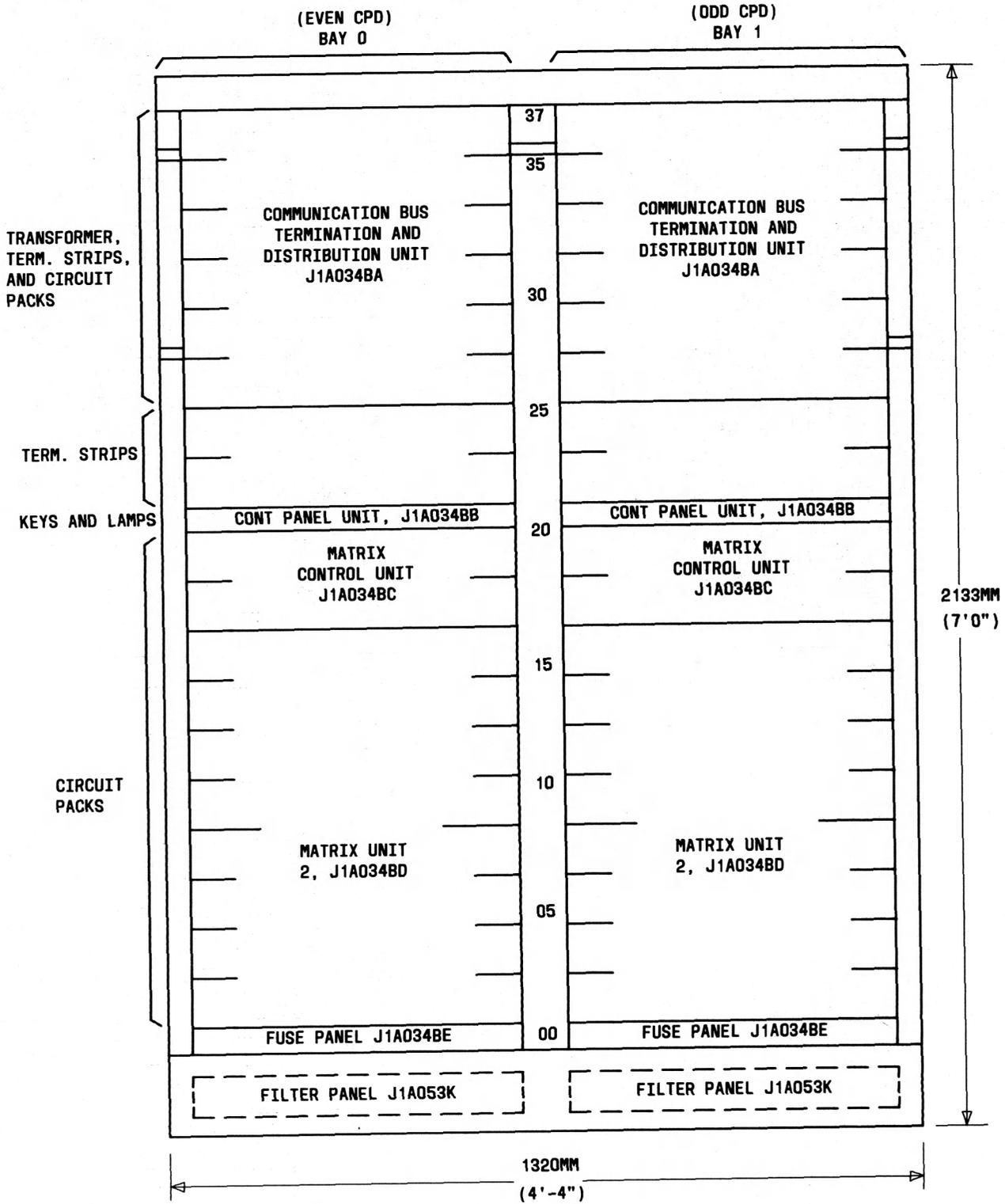


Fig. 29—Central Pulse Distributor

frames comprising the MCC are shown in Fig. 30. The MCC is composed of four separate units:

- Maintenance terminal
- Automatic message accounting
- Trunk and line test panel
- Alarm, display, and control panel.

#### A. Maintenance Terminal

**3.61** The maintenance terminal is one of the main means for communicating with the system. The operator can type in messages to request the system to perform specific actions. The system can provide a printout to report response on the action requested and can also furnish printouts to report on various internal conditions including trouble conditions. In addition to the maintenance terminal at the MCC, a remote maintenance terminal may be provided. The remote terminal function is generally the same as the one at the MCC.

#### B. Automatic Message Accounting

**3.62** The AMA feature is included with all 1ESS switches. Its purpose is to automatically record billing data on calls. Software programs accumulate, format, and transfer the billing data from call store to the AMA unit. An optional feature (starting with the 1E7 generic) is the AMA Teleprocessing System (AMATPS). With the AMATPS feature, the billing data is transferred from call store to an AMA transmitter (AMAT). One implementation of an AMAT is an IBM Series/1 sending unit configuration.

**3.63** The AMA feature (MCC AMA circuit SD-1A273-01) includes two magnetic tape recorders. When a customer originates a charge call, the billing data is stored in specified registers in the CS. This information is later transferred to one of the magnetic tapes. Periodically, the tape is manually removed and shipped to a revenue accounting office (RAO) for processing. For more information on the AMA feature, refer to Practice 231-190-063.

**3.64** The AMATPS feature (MCC AMAT circuit SD-1A620-01) includes two sending units with disk memory in the AMAT. This feature operates on a store and automatic forwarding basis. During the

course of a call, the billing data is handled in the same manner as with the AMA feature, but transferred from CS to the AMAT. The AMAT then formats the data into standard AMA entries and stores them on disk memory. The AMAT is periodically polled by a remote collector located at an RAO. When the AMAT is polled, it retrieves the AMA data from disk memory and teleprocesses it to the collector over dedicated or dial-up data links. For more information on the AMATPS feature, refer to Practice 231-190-068.

#### C. Trunk and Line Test (TLT) Panel

**3.65** The TLT panel provides the system with a facility to manually remove from service and to test outgoing trunks, service circuits, or customer lines.

**3.66** The TLT panel is also used to perform a number of miscellaneous transmission tests.

#### D. Alarm, Display, and Control Panel

**3.67** The alarm, display, and control panel has two functions. First, the panel automatically shows the status of the system units; second, the panel provides manual controls for the system.

#### SUPPLEMENTARY TRUNK TEST PANEL (STTP)

**3.68** The STTP is functionally identical to the TLT panel when performing trunk tests. The major difference is that the STTP is not provided with line test features. With appropriate options, the STTPs may be located up to 1500 cable feet from the test level point or the reference TLN and may be powered from other systems in the building.

**3.69** Between each two STTPs is an auxiliary test frame (AUT) housing a terminal and optional rack-mounted test equipment. The AUT replaces the earlier MT frame equipped with terminal.

#### MANUAL TRUNK TEST (MTT) FRAME

**3.70** The MTT frame (Fig. 31) is used to test HILO 4-wire trunks as well as 2-wire trunks. The MTT offers expanded trunk testing capability which is most useful in a toll or local/toll office. It is required for HILO 4-wire and toll CCIS and is optional in other situations. It may be used in an office with STTPs. Between each two MTTs is an auxiliary man-

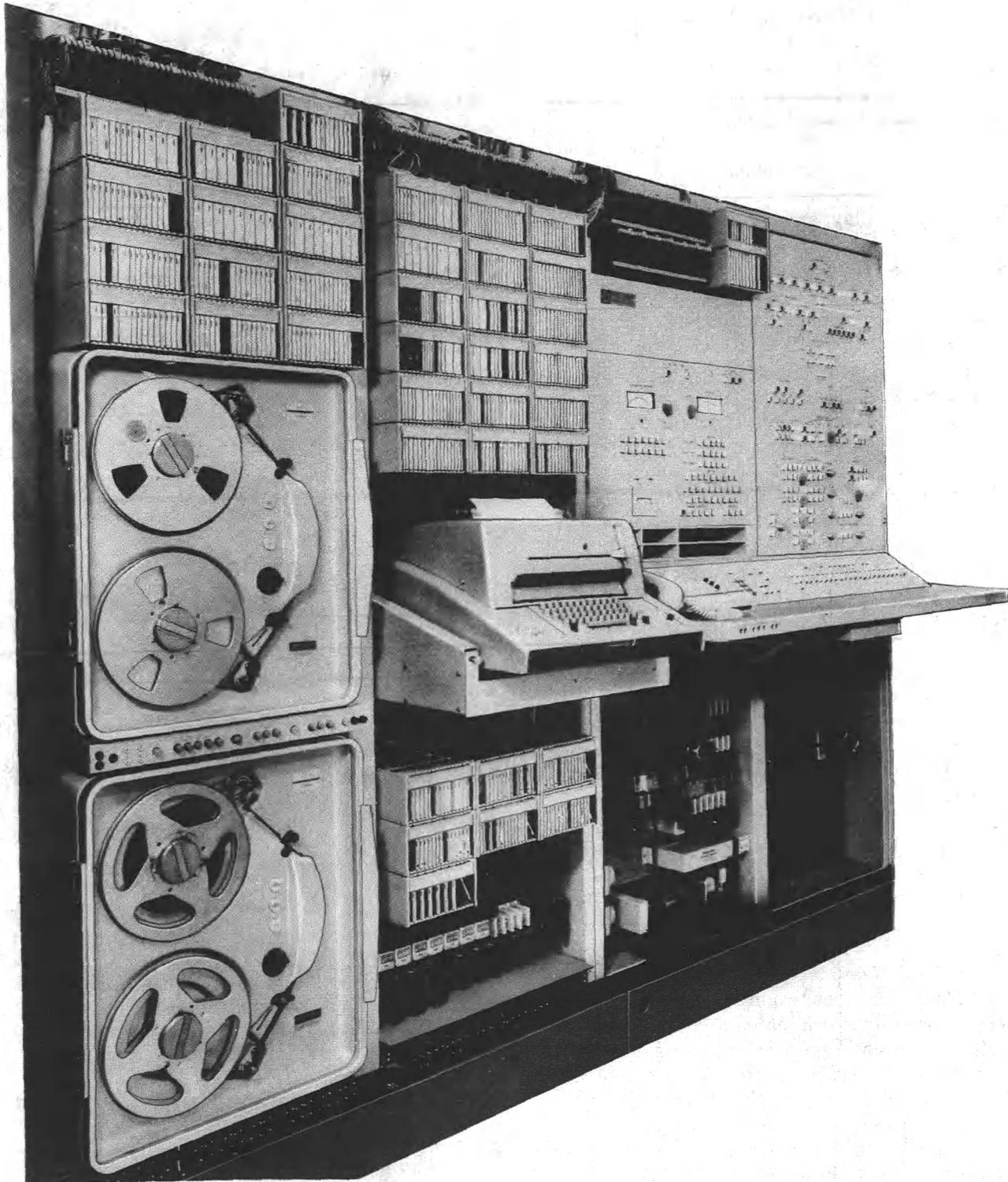


Fig. 30—Master Control Center

ual test (AMT) frame which mounts transmission test sets as well as a terminal. The terminal can be optionally a send/receive channel. Software is available as a separate optional feature package in 1E5 generic program. The MTT and AMT can be located up to 1500 cable feet from the ESS switch. Both the MTT and AMT are standard 2 foot 2 inch frames.

### CENTREX EQUIPMENT UNITS

**3.71** Centrex service (Practice 966-102-100) is a centralized telephone communication exchange service using the data handling capabilities of a nearby 1ESS switch. Centrex service requires the use of three additional specialized equipment units:

- Centrex data link frame (at the 1ESS switch)
- Centrex console control cabinet (at the customer premises)
- Attendant telephone consoles (at the customer premises).

**3.72** A data loop is connected between the data link frame and the console control cabinet to control the states of the lamps and to receive key signals from the remote CTX attendant telephone console.

**3.73** The CO end of a CTX data loop terminates in a CTX data link circuit mounted on a CTX data link frame (Fig. 32) in the 1ESS switch. The CTX data link frame is arranged to mount up to eight data link circuits and their associated equipment. Each data link provides the interface between a data loop and the ESS switch central processor.

**3.74** The remote end of the data loop terminates in a console control circuit contained in the console control cabinet (Fig. 33) at the CTX location. The console control circuit provides the interface between the data loop and the attendant telephone consoles. As many as four attendant telephone consoles can be controlled by a single data loop and a console control cabinet mounting four console control circuits.

**3.75** Attendant telephone consoles (Fig. 34) are used by the CTX customer to provide attendant service. The 1ESS switch can work with the 50A customer premises system (CPS) consoles arranged with attendant direct station selection (ADSS) and

busy lamp field (BLF) for small CTX service or PBX service (Practice 981-300-100). The 50B CPS provides all of the features available with the 50A CPS. A customer with the 50B CPS may have up to 4 attendant positions with BLF/direct station selection (DSS) features or up to 16 attendant positions without BLF/DSS features. The CPS may be engineered to meet traffic capacity and requirements of the CTX customer.

### DISTRIBUTION FRAMES

**3.76** In addition to the units and frames already mentioned, other frames are used which perform noncontrol functions. These frames are primarily distribution frames and are used to interconnect two groups of leads in a unique pattern according to the office assignment. The interconnecting pattern can be easily rearranged when assignments are changed. The additional noncontrol frames are:

- Main distributing frame and protector frame
- Trunk distributing frame
- Intermediate distributing frame
- Power distribution frame
- Power plant frame.

#### A. Main Distributing Frame and Protector Frame

**3.77** All outside cables, from customers and other COs, are terminated at the protector frame on protectors that prevent damage to office equipment from lightning strokes and power crosses on selected special circuits. Cables from the protectors are connected to alternate columns of terminal blocks at the main distributing frame and are distributed vertically. Protector cables are interconnected with cables from LLNs and intermediate distributing frames which are connected to the remaining columns (distributed vertically across the column).

#### B. Trunk Distributing Frame

**3.78** The trunk distributing frame interconnects trunk and service circuits and the TLN appearances. The distribution frame is also a preferred point for cross-connections not requiring direct access to an outside cable pair. The TLN appearances are connected to alternate columns of terminal

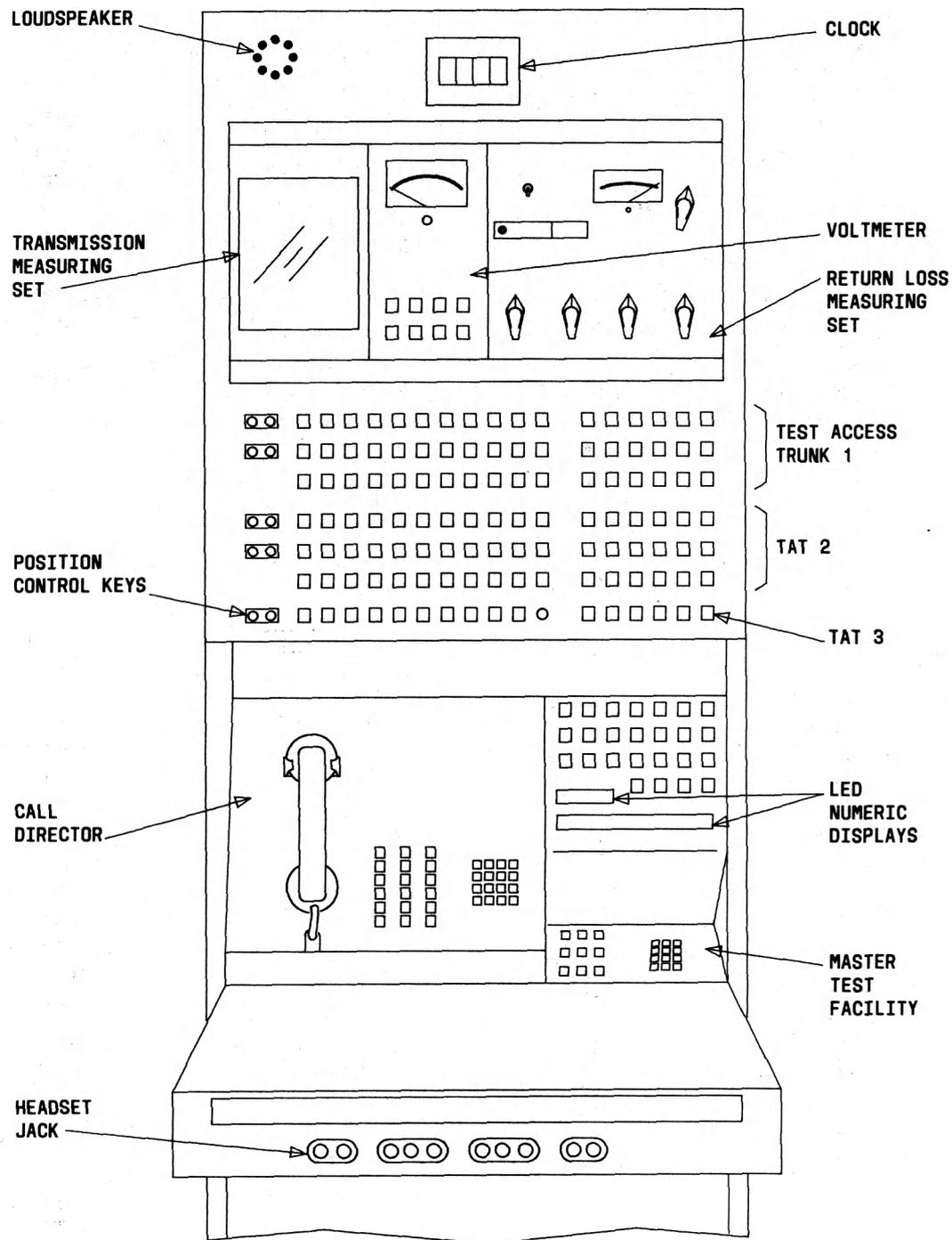


Fig. 31 — Manual Trunk Test Frame

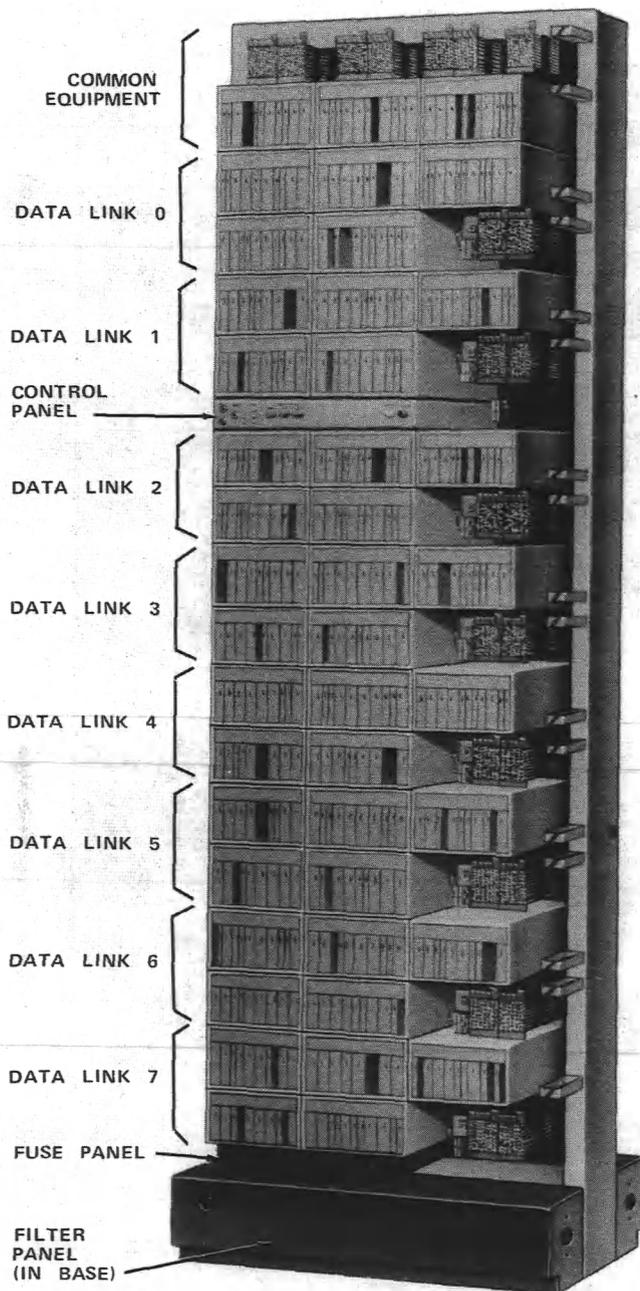


Fig. 32—Centrex Data Link Frame

blocks and the trunk circuits, and service circuits are connected to the remaining columns.

### C. Intermediate Distributing Frame

**3.79** The intermediate distributing frame interconnects the main distributing frame and incoming and outgoing trunk circuits. In appear-

ance, the intermediate distributing frame is the same as the trunk distributing frame. Cable pairs from the main distributing frame are connected to alternate columns of terminal blocks while cable pairs from the trunk circuits are connected to the remaining columns.

### D. Power Distribution Frame and Power Plant Frame

**3.80** Area bus centers and power distribution fuse boards are located near the CO equipment and serve as distribution points for the various voltages.

**3.81** The power distribution system for the 1ESS switch follows standard plant practices. The normal ac power source for the entire office is commercial ac. If commercial ac is lost, engine-driven alternators supply reserve ac power to replace commercial ac. Primary dc power is normally supplied by battery plant rectifiers that convert commercial/reserve ac to primary dc power. When commercial/reserve ac is disrupted, reserve batteries take over for the rectifiers and supply primary dc power to the office. DC voltages other than primary dc required by the office are provided by dc-to-dc converters that convert primary dc to the various dc voltages. Some critical office loads require uninterrupted (protected) ac power which is supplied by a dc-to-ac inverter when commercial ac is lost. Other ac loads that are essential to the office, but can tolerate short interruption of ac power without degrading service, are supplied commercial/reserve (essential) ac power. Those loads that are not essential to the office are supplied from only commercial ac power.

**3.82** Normal and reserve power sources for the 1ESS switch are depicted in Fig. 35. The normal primary sources for the entire system is 208V, 240V, or 480V, 60-Hz, 3-phase commercial ac. If commercial ac power is lost, the gas-turbine alternator reserve power system supplies reserve 480V, 60-Hz, 3-phase primary ac power. Emergency 208/120V ac power can also be provided by the 504B power plant which supplies single or 3-phase ac voltage from the 48-volt office battery during a commercial power failure. Primary dc power for the system is +24V and -48V supplied by the 111A power plants or 326A and 326B power plants. Negative or positive 130 volts are supplied by the 610B or 660C converter plants and delivered to fuse panels on a miscellaneous frame in the switchroom for distribution to the loads.

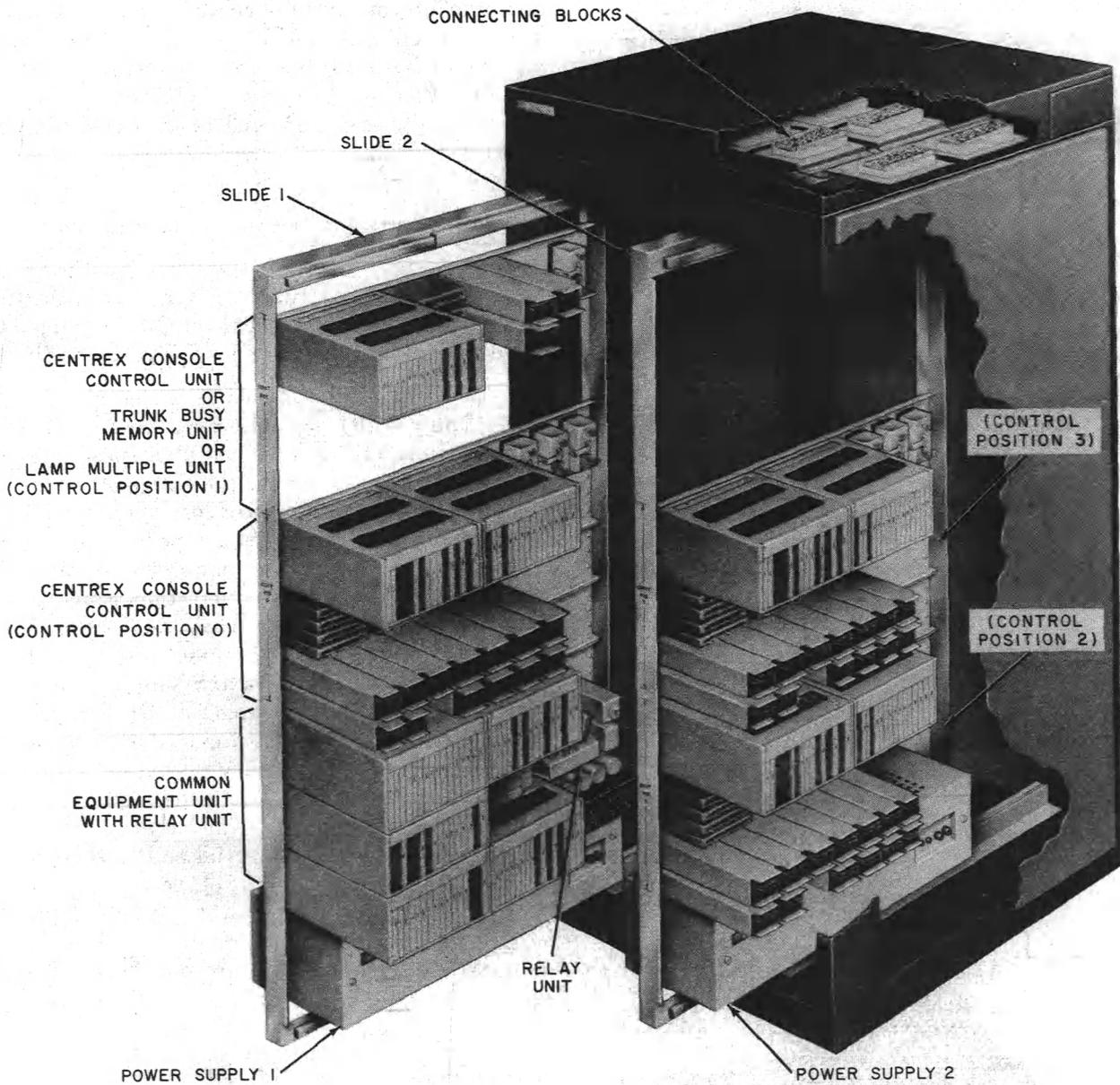


Fig. 33—Centrex Console Control Cabinet

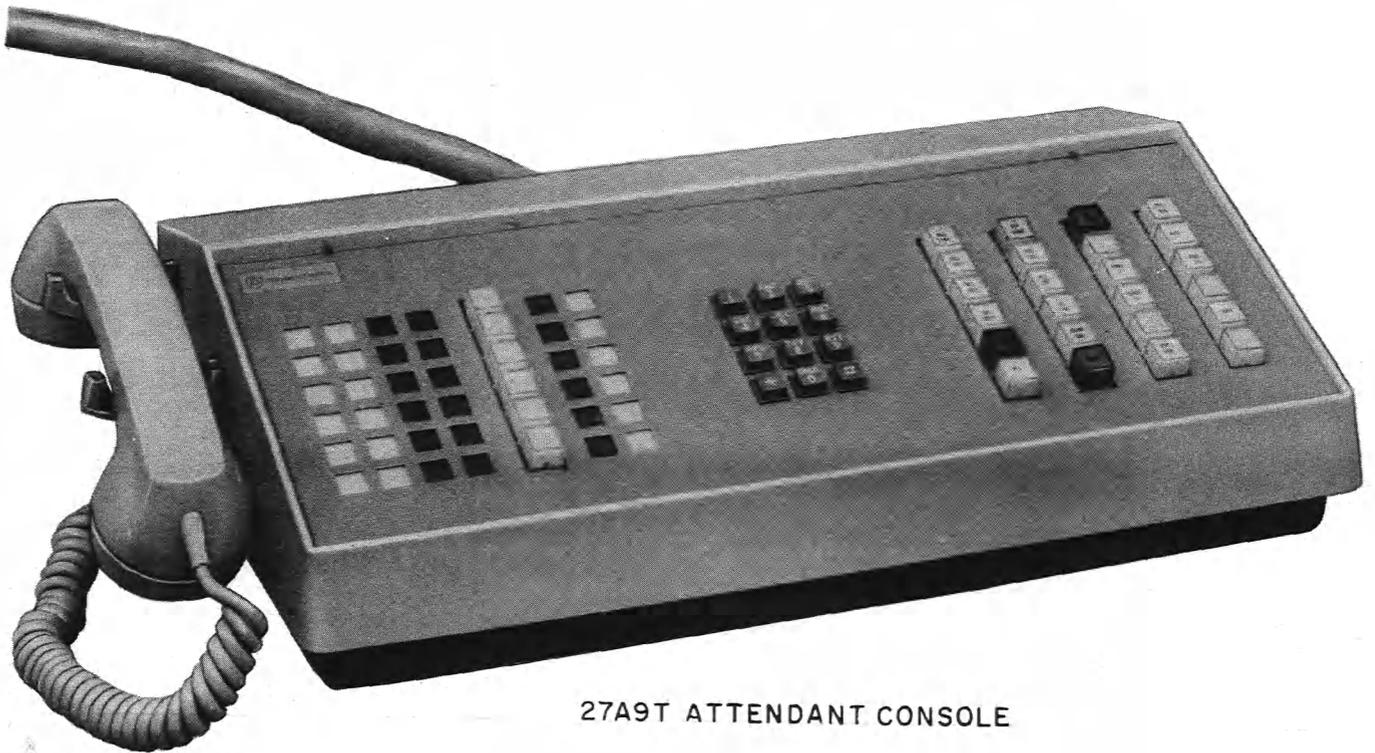
**MEMORY CARD STORAGE FRAME**

**3.83** The memory card storage (MCS) frame is a 1- or 2-bay frame which can accommodate up to four modules of spare PS cards in each bay. Modules of cards are placed in or removed from the MCS by a card loader which is powered from the frame. A summary of equipment capacities for units associated with the 1ESS switch is shown in Table D.

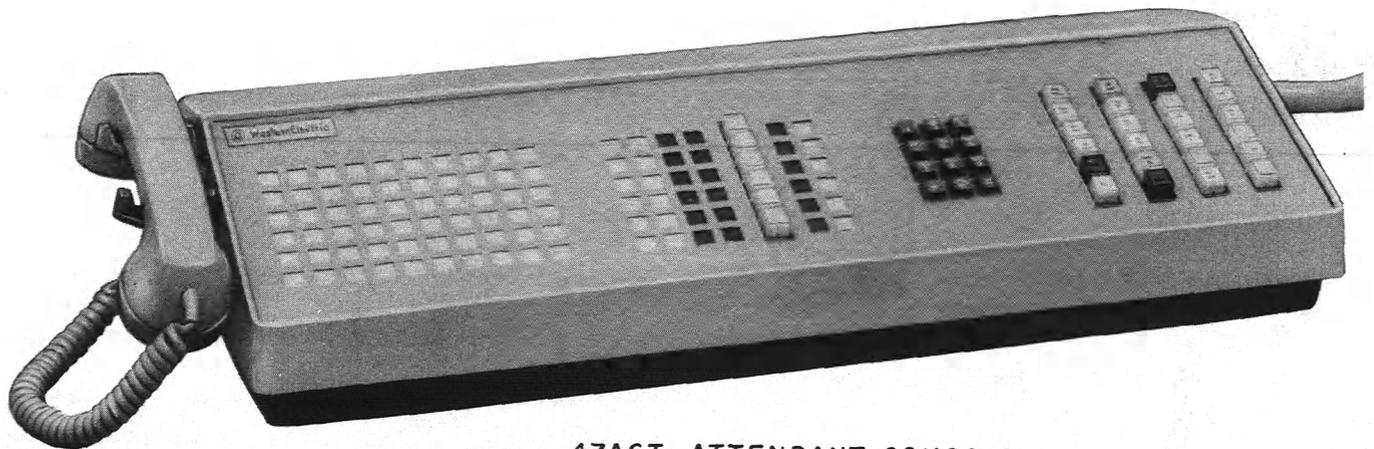
**RING AND TONE FRAMES**

**3.84 812A Power Plant (1.5A):** The 812A power plant is available in two versions for precut offices. The ac-dc ringing and tone power plant version (Fig. 36) provide the following tones.

- Audible ringing tone
- TOUCH-TONE Calling



27A9T ATTENDANT CONSOLE



47A6T ATTENDANT CONSOLE

Fig. 34—Centrex Attendant Telephone Consoles

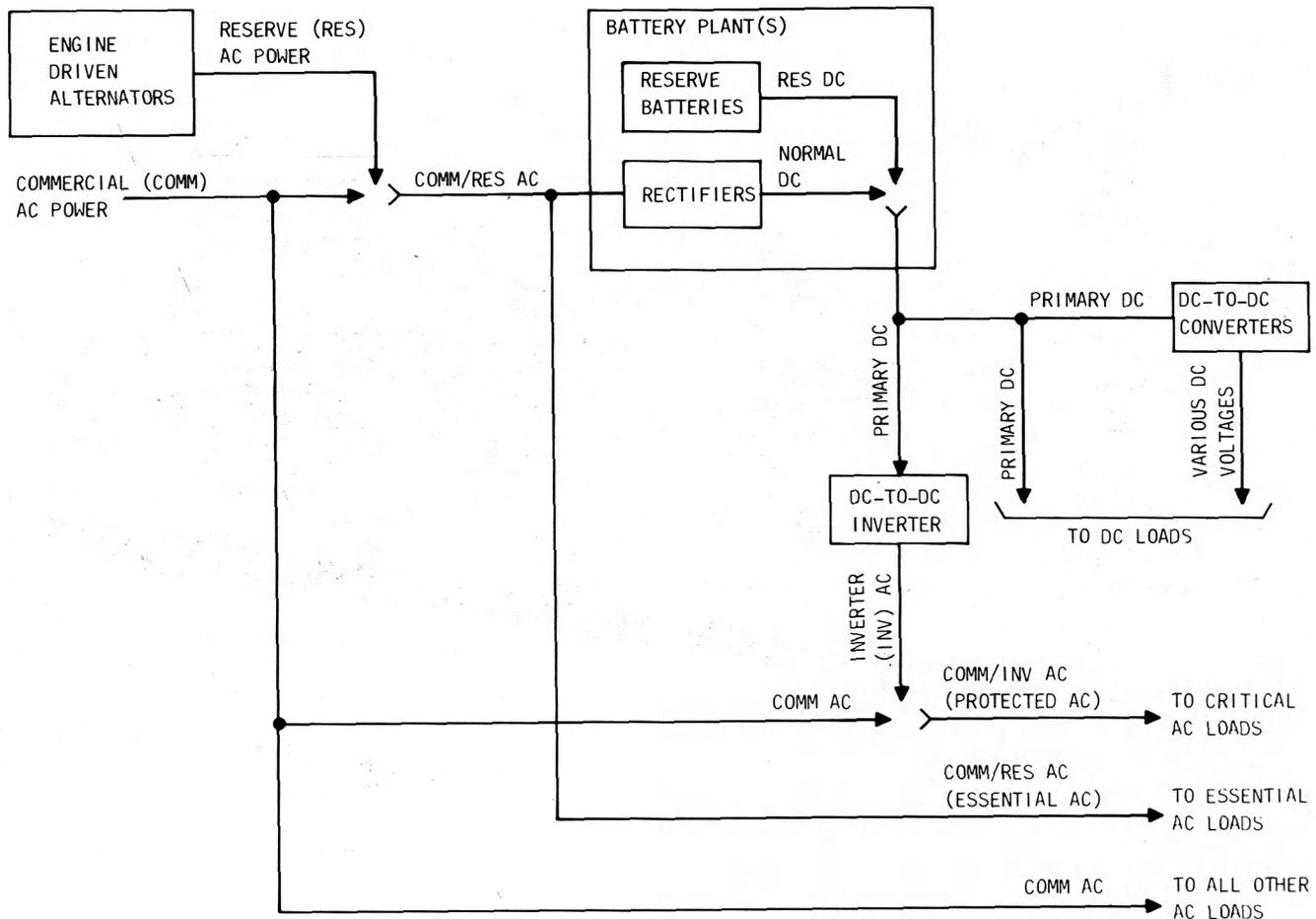


Fig. 35—Telephone Office Power Distribution System

- High tone
- Call waiting tone
- Busy verification tone
- Simulated audible ringing tone
- Preempt tone
- Precedence audible ringing tone.

The superimposed ringing and tone power plant (Fig. 37) version also provides these tones. Similar frames of 1/2-amp capacity on two bays, 6-amp capacity ac-dc on four bays, and 6-amp capacity superimposed on five bays are available.

**RECORDED ANNOUNCEMENT FRAME**

3.85 The recorded announcement frame (Fig. 38) is a single bay frame 2 feet 2 inches wide. Six announcement channels of a fixed 12-second length are provided on the magnetic drum. Each basic announcement channel unit uses distributing resistors to serve up to 20 announcement trunks. If more than 20 announcement trunks for each channel are required, a supplementary unit may be used. Up to 16 frames to provide 96 separate announcements may be installed in a 1ESS switch.

**COMMON SYSTEMS RECORDED ANNOUNCEMENT FRAME**

3.86 The common systems recorded announcement frame (CSRAF) available with 1E4 and later

TABLE D

## SUMMARY OF EQUIPMENT UNIT CAPACITIES

NAME	DESIGNATION	CAPACITY OR REMARKS
Basic ferreed line switching circuit (4 to 1 conc.) bays 0 and 1	LSC (LSF)	512 lines — 128 B-links, network and scanner controllers for 1024 lines
Supplementary lines switching bay (4 to 1 conc.) bay 2	—	512 lines — 128 B-lines (bay 2)
Line switching circuit (frame) (2 to 1 conc.)	LSC (LSF)	512 lines — 256 B-links, network and scanner controllers for 1024 lines
(Line or trunk) junctor switching circuit (frame)	LJSC (LJSF) TJSC (TJSC)	256 B-links — 256 junctors
Trunk switching circuit (frame)	TSC (TSF)	256 B-links — 256 trunks
1024	1024 TLN	4 TJSC and 1 to 6 TSC (1.5:1 max.)
2048	2048 TLN	8 TJSC and 1 to 8 TSC
Line Link Network	LLN	4 LJSC and 1 to 8 LSC
Junctor Home Frame  2-bay basic: Bays 0 and 1 Supplementary: Bay 2	J	64 connectors for plug-in units (2 circuits per plug-in unit)  Scanner controller for both home and mate frame  1024 scan points and SD points (4 scan points and 6 SD points per connector)
Junctor Mate Frame  2-bay basic: Bays 0 and 1 Supplementary: Bay 2		64 connectors for plug-in units (2 circuits per plug-in unit)  SD controllers but no scanner controllers
Universal Trunk Home Frame  2-bay basic: Bays 0 and 1 Supplementary: Bay 2	UT	64 connectors for plug-in (trunk) units (1 or 2 circuits per plug-in unit)  Scanner controllers for both home and mate frames  1024 scan points and SD points (4 scan points and 6 SD points per connectors)
Universal Trunk Mate Frame  2 bay basic: Bays 0 and 1 Supplementary: Bay 2		64 connectors for plug-in (trunk) units (1 or 2 circuits per plug-in unit)  SD controllers but no scanner controllers

TABLE D (Contd)

## SUMMARY OF EQUIPMENT UNIT CAPACITIES

NAME	DESIGNATION	CAPACITY OR REMARKS
Miniaturized Universal Trunk Frame 2-bay basic: Bays 0 and 1	MUT	256 trunk units, 1024 SD points, 1024 scanner points
Miscellaneous Trunk Frame 1 bay	MT	72-inch high mounting space for wired-in circuits
Master Scanner Frame	MS	1024 scan points (max. per office)
Centrex Data Link Frame	CDL	Up to 8 per office; up to 8 data links per frame
Central Pulse Distributor	CPD	768 outputs, 2 or more per office in pairs (max. per office)
8K Call Store	9K CS	8192 word (24-bit) up to 39 stores with CC, up to 8 stores with SP, as required
32K Call Store	32K CS	32,768 words (24 bits) up to 10 stores with CC offices and 12 with SP offices
Combined Miscellaneous Trunk Frame 2-bay basic: Bays 0 and 1	CMT	Two SSDs, each supplying 960 points, 1024 MS scan points
Common Systems Recorded Announcement Frame	CSRAF	48 variable message length channels per CSRAF (max. of 16 CSRAFs per central office)
Recorded Announcement Frame Single Bay Frame	RAF	6 announcement channels per drum 20 announcement trunks per channel (max. of 16 frames to provide 96 separate announcements)
Junctor Grouping Frame	JGF	9-Vertical File 12-Vertical File
13A Announcement System	13A	1 to 8 channels, 1 message per channel, 3 types of messages: 3 to 24 sec. FML, a 12 sec. FML, 3 to 12 sec. VML
Peripheral Unit Controller Digital Carrier Trunk Frame	PUC/DCT Frame	480 T1-channels per DCT frame
Peripheral Unit Controller Data Link Frame	PUC/DL Frame	16 separate data links per PUC/DL frame. A PUC/DL frame can serve up to 8 RSS units.
Common Channel Interoffice Signaling	CCIS	2-way signaling, separate signaling channel, compatibility with international signaling, flexibility

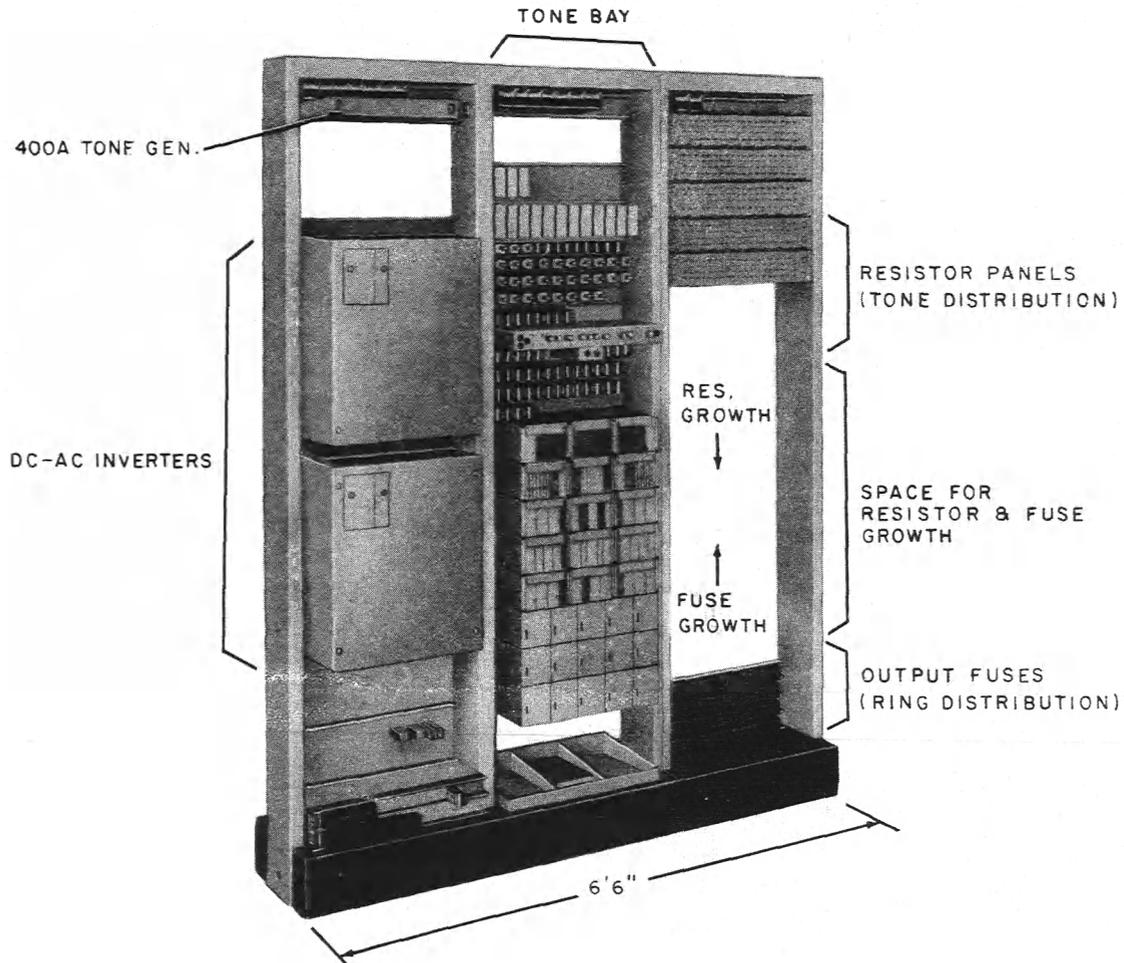


Fig. 36—Ac-Dc Ringing and Tone Plant (812A Power Plant)

generic programs, has two different types of channels:

- (1) Modular message (MM) length
- (2) Variable message length (VML).

The MM channel provides a 4-second announcement for city-of-origin applications. The VML channel can provide a 16-, 32-, or 48-second announcement. One CSRAF can control up to 48 VML channels, depending on the announcement length of the VML channels and the mixture of VML and MM channels on the frame.

**3.87** The CSRAF recordings may be made either remotely on a dial-up basis from the customer premises or from within the CO. As with the recorded announcement frame, CO recordings on CSRAF are made at the frame and through a dedicated CALL DIRECTOR® telephone. The CSRAF feature provides remote access to CSRAF as part of the automatic call distribution (ACD) Phase II feature. It may also be used in other applications, since CSRAF is a multi-purpose frame.

**3.88** Each announcement channel can drive a trunk group of up to 80 trunks. A CO can have up to 16 CSRAFs. Associated with each CSRAF is one to three control and distribution frames.

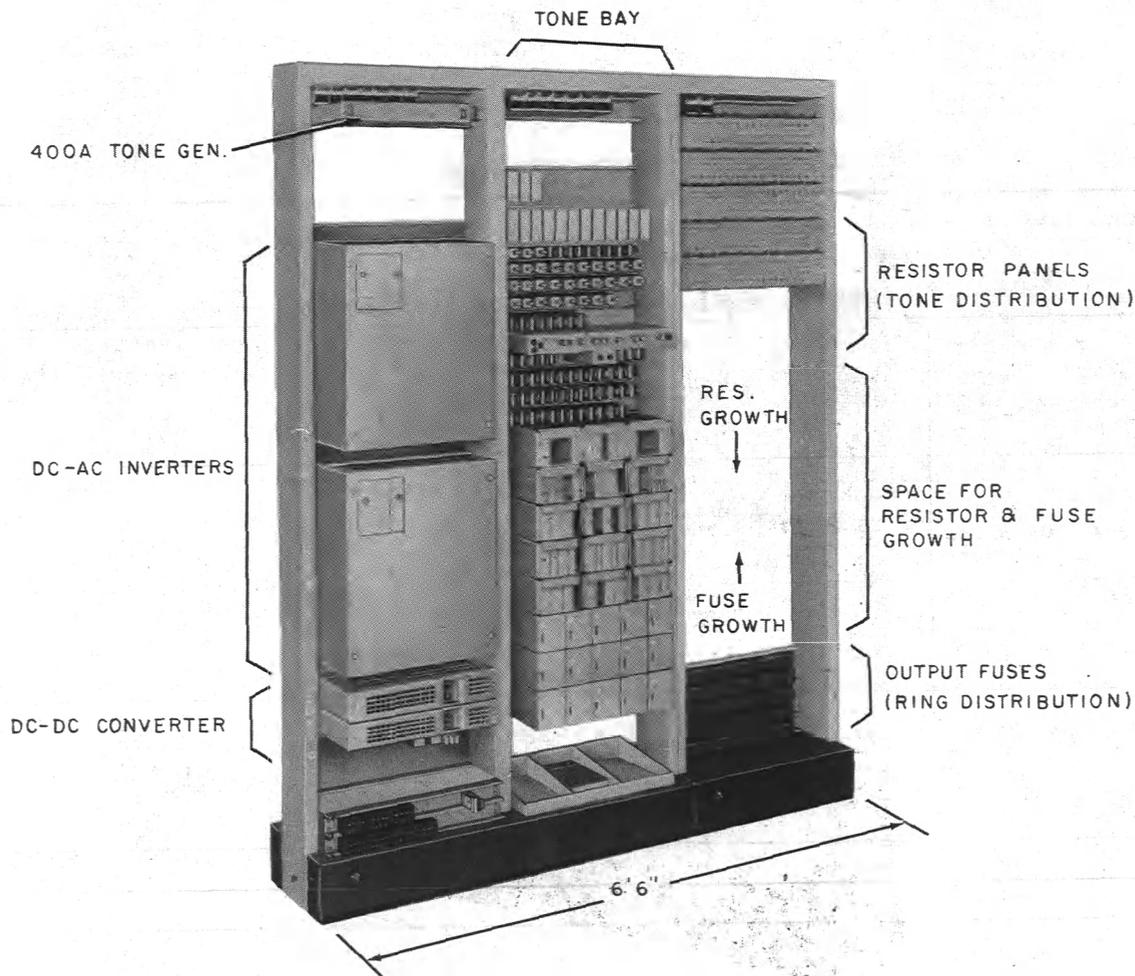


Fig. 37—Superimposed Ringing And Tone Plant (812A Power Plant)

**13A ANNOUNCEMENT SYSTEM**

**3.89** The 13A announcement system is a completely electronic announcement system that utilizes the 29A magnetic bubble memory to store digitized speech.

**3.90** The 13A announcement system is a multichannel system capable of having from one to eight channels. Each channel can supply one prepared announcement. Circuitry for an announcement message is located on circuit packs called message modules. There are three types of message modules: a 12-second fixed message length (FML)-UD5, a 3- to 12-second VML-UD6, and a 3- to 24-second VML-UD4. Each message module can provide an announcement of up to 500 trunk circuits simultaneously. A VML-UD4 message module is shown in

Fig. 39. The message module utilizes the 29A bubble memory packages to store the prepared announcements. During the recording of an announcement, the analog speech is converted to an equivalent digital signal. Once the conversion is made the digital speech is stored.

**3.91** Recording an announcement into the 13A announcement system is by a handset or tape recorder (Fig. 40). Once a message is recorded the stored information will remain even if power is removed from a module.

**CCIS TERMINAL GROUP AND VFL ACCESS FRAME**

**3.92** The data terminal group is a 4-bay complex containing the terminals and modems for up to 16 duplicated signaling links, as well as duplicated

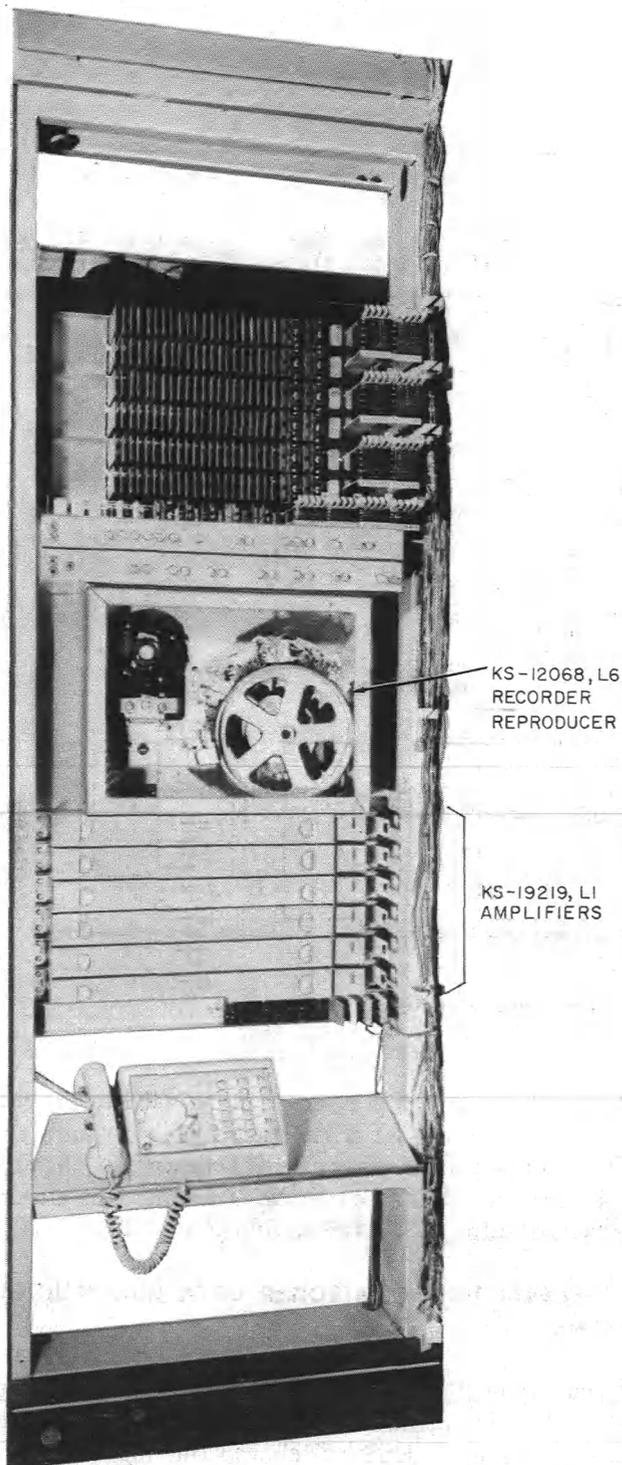


Fig. 38—Recorded Announcement Frame (Typical)

terminal access controllers. The controllers interface the terminals to the PUB system of the processor.

The terminal is a small, special-purpose stored-program processor which maintains data communication over the signaling link and provides buffering between itself and the processor for received and to-be-transmitted data filled information words. In the CCIS system, these words are called signal units. The processor periodically polls the controller to determine which terminals, if any, contain waiting data-filled information words. Synchronization, error detection, retransmission of information words received in error, and acknowledgment of correctly received information words are also handled by the terminal independent of the processor.

**3.93** The data terminal basic frame (Fig. 41) of the terminal group consists of two bays, each 3 feet 3 inches wide and 7 feet high. Contained on this frame are up to eight terminal access controllers, and the associated voice frequency link access (VFLA) circuits. Two supplementary 3 foot 3 inch bays (Fig. 42) may be added, each containing four additional terminal-modem units and eight associated VFLA circuits.

#### PERIPHERAL DATA STORAGE PROCESSOR AND PROCESSOR INTERFACE FRAME

**3.94** The peripheral data storage processor (PDSP) is used in the 1ESS switch as an auxiliary processor. Initial uses are EPSCS and expanded 911 (optionally). Figure 43 is a block diagram of the PDSP as used in 1ESS switch. Interface with the 1ESS switch CC is via the CS bus and the processor interface frame (PIF). Interfaces external to 1ESS switch are via the data link interface circuits. There may be 1 to 16 interface circuits, a duplicated universal data link controller (UDLC), and a duplicated PIU per PIF. One PIF and no PDSP are presently used per 1ESS switch.

**3.95** A typical use of the PDSP is for EPSCS (paragraph 2.07). A PDSP is required in each 1ESS switch that is part of an EPSCS network.

#### LOOP RANGE EXTENSION FRAME

**3.96** The LRE frame is a single bay framework which measures 2 feet 2 inches wide, 2 feet deep, and 7 feet high (Fig. 44). An LRE frame consists of range extension units, a common control panel, and a fuse and distribution unit. Each LRE frame can

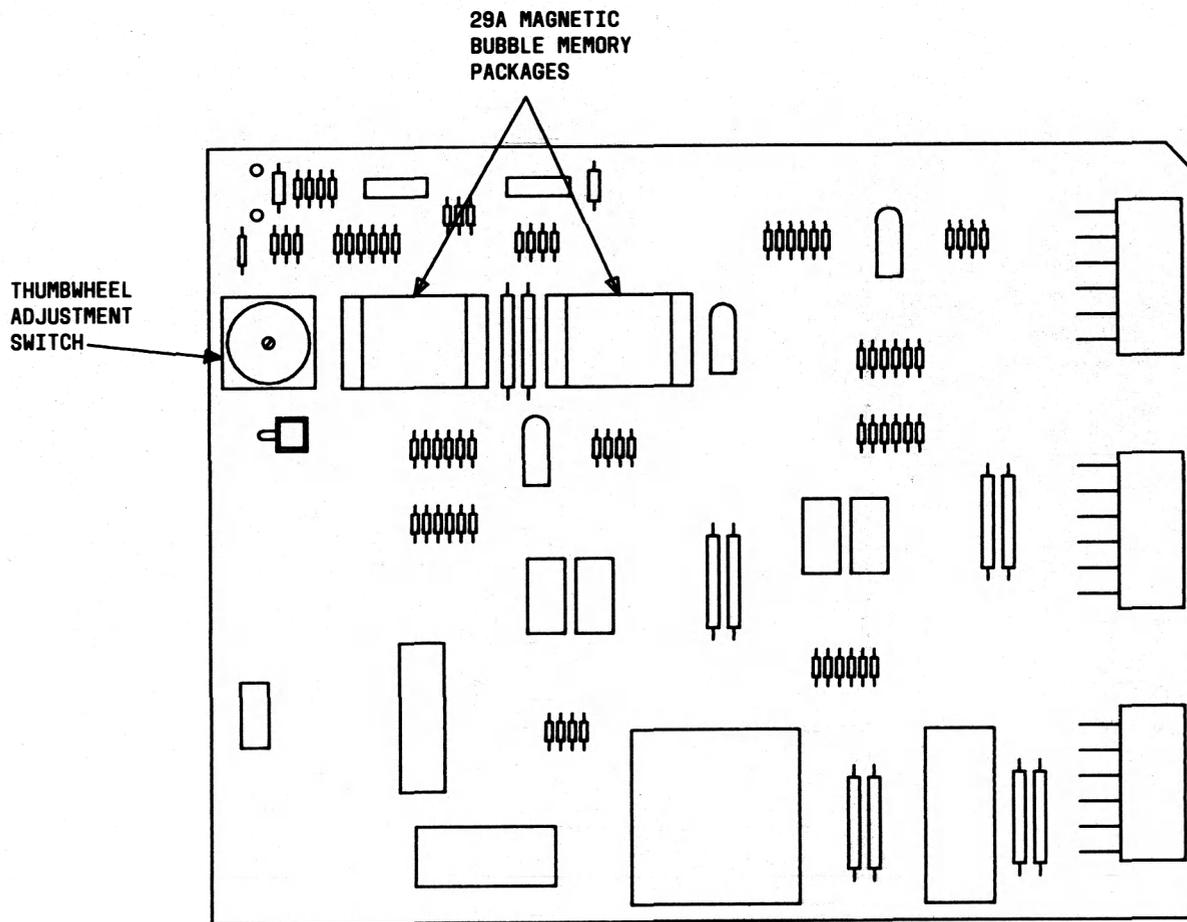


Fig. 39—VML (UD4) Message Module Circuit Pack

have up to four range extension units. The number of LRE frames may vary from 1 to 52 (00 to 51) in a 1ESS switch.

**3.97** A range extension unit contains forty 7A range extender plug-in boards or eighty range extension circuits. Each 7A range extender board contains two range extension circuits. A range extension unit is divided into five groups and two shelves as shown in Fig. 45. A complete LRE frame with four range extension units contains one hundred sixty -7A range extender boards.

**3.98** The range extension test circuit is used to perform a list of tests on the range extension circuits under the direction of maintenance personnel or central control. Some of the tests include forward and reverse gain, battery boost, short loop bypass, ring tripping, pretrip, and dial pulsing. The range extension test circuit is located on the MT frame.

**3.99** The network access circuit is used to provide a test loop from the test LREs through the TLN. The network access circuit is located on the universal trunk (UT) frame or MUT frame. One circuit is required for each LLN equipped with LRE.

**PERIPHERAL UNIT CONTROLLER DATA LINK (PUC/DL) FRAME**

**3.100** The PUC/DL frame is a single bay frame which utilizes the PUC to serve as an interface between the ESS switch and the data link control (Fig. 45). The PUC in the PUC/DL frame consists of duplicated microprocessor controllers. Each controller consists of a PUC interface, a central processing unit (CPU), memory, a PUC-peripheral interface, and line interface units (Fig. 46).

**3.101** Data link messages from the 1ESS switch CC are received by the PUC/DL frame. This data

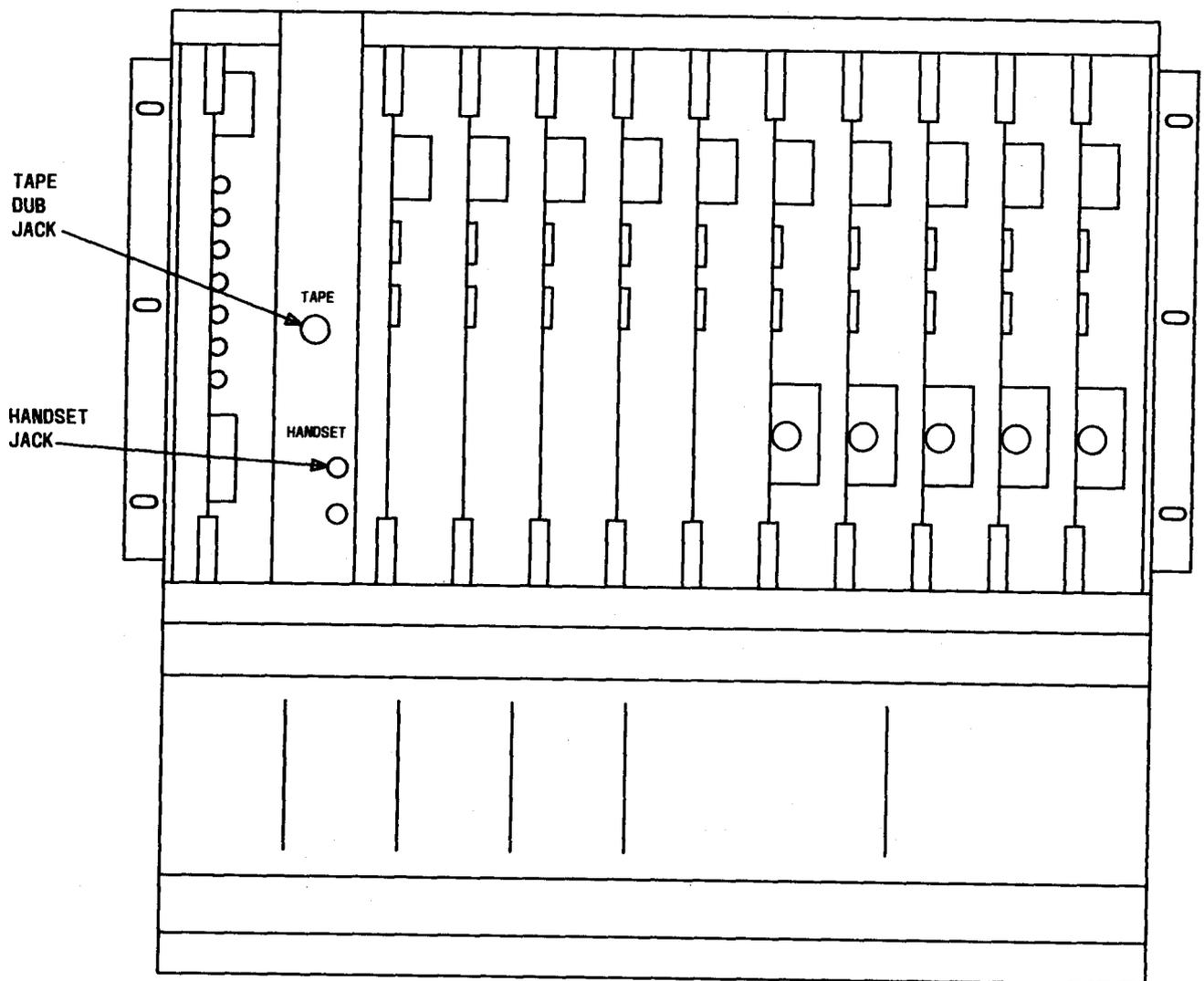


Fig. 40—13A Announcement System (Front Door Open)

is formatted and made ready for data link transmission. The PUC/DL provides error checking, protocol, and generates timing and signaling for the transmission of the data. Incoming messages over the data links are received and checked by the PUC/DL. This information is then sent to the ESS switch CC. The PUC/DL can handle up to 16 separate data links. The PUC/DL is used with the RSS feature and with the ETS feature.

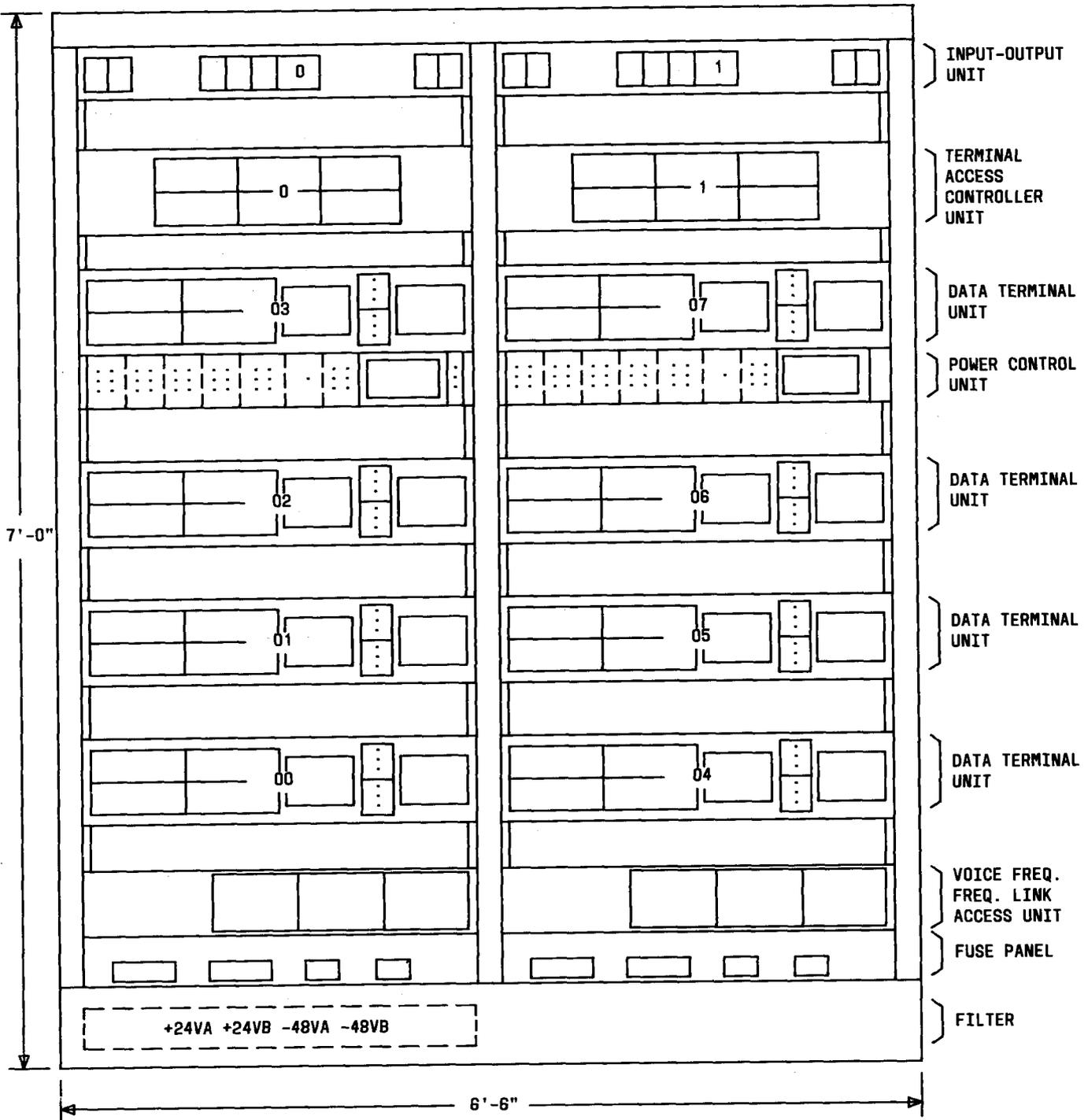
#### PERIPHERAL UNIT CONTROLLER DIGITAL CARRIER TRUNK (PUC/DCT) FRAME

**3.102** The DCT feature is implemented in the PUC/DCT 3-bay frame. The PUC/DCT frame con-

sists of a PUC and DCTBs which are contained in the DCT bay assemblies (Fig. 36).

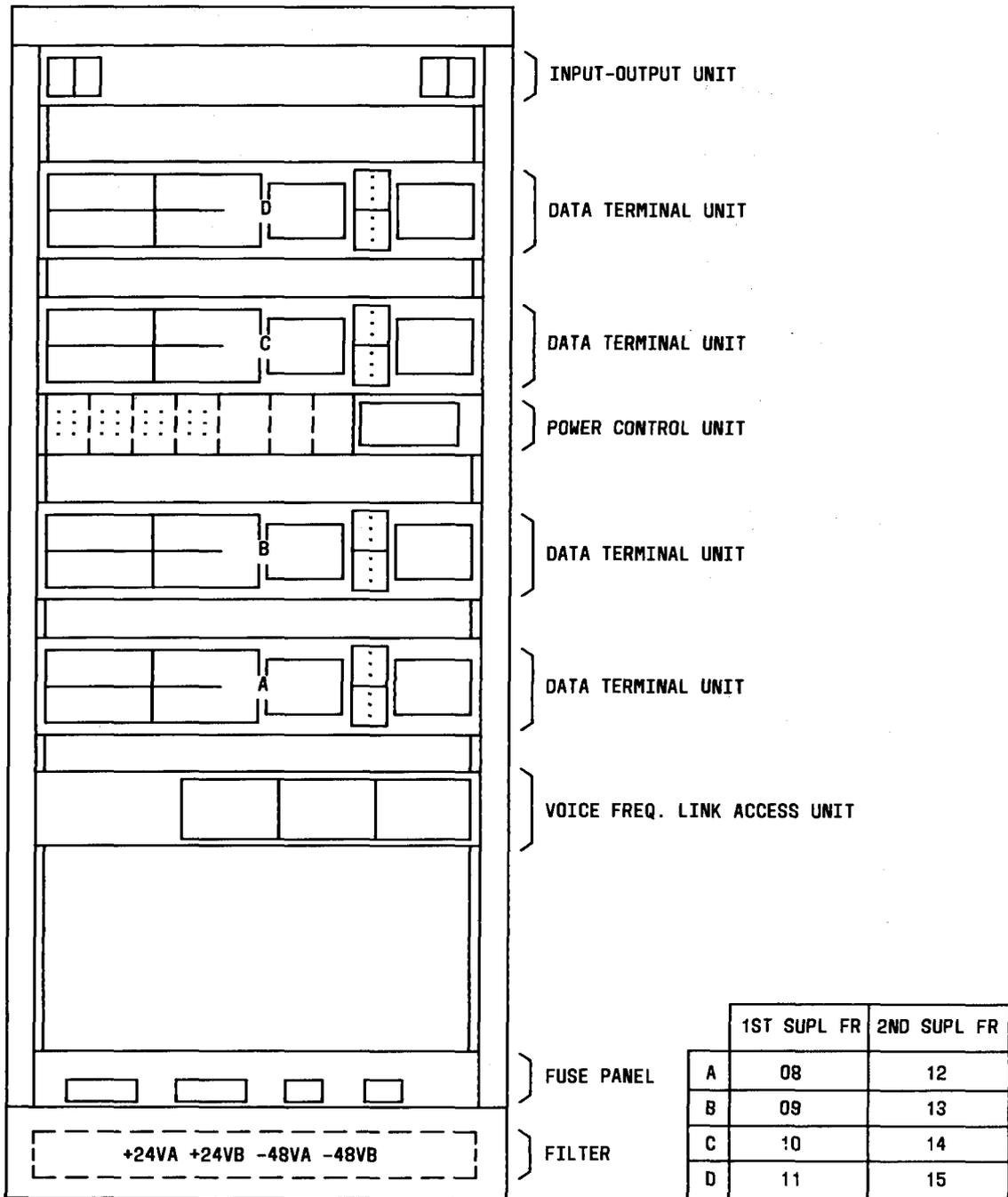
**3.103** The PUC consists of duplicated microprocessor controllers, memory, input/output circuits and hardware which provide capabilities for direct memory access (DMA). Some functions which are performed by the PUC are: trunk supervisory scanning, trunk signaling, maintenance, certain digit reception and transmission tasks, and trunk state control. The PUC serves as an interface between the 1ESS switch CC and the DCTBs.

**3.104** A DCTB is a 48 channel pulse code modulation terminal which provides a transmission interface between T-carrier lines and the trunk dis-



DATA TERMINAL BASIC FRAME

Fig. 41—Data Terminal Basic Frame



DATA TERMINAL SUPPLEMENTARY FRAME

Fig. 42—Data Terminal Supplementary Frame

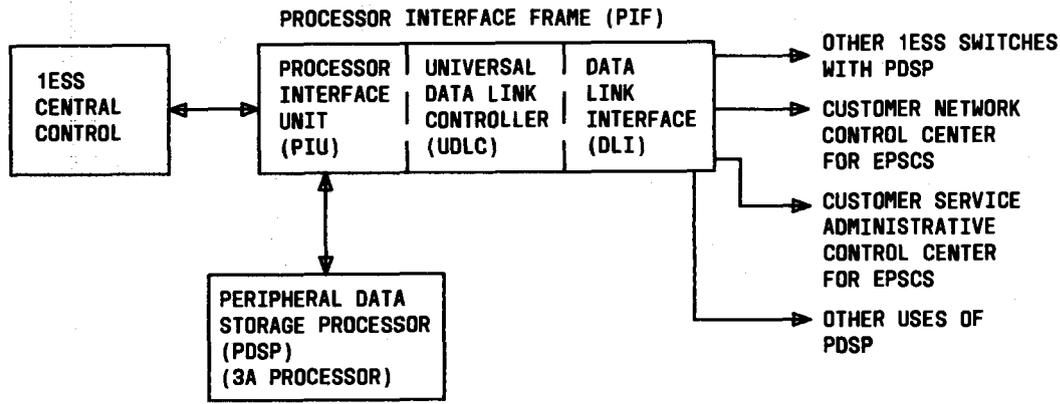


Fig. 43—Peripheral Data Storage Processor and Processor Interface Frame

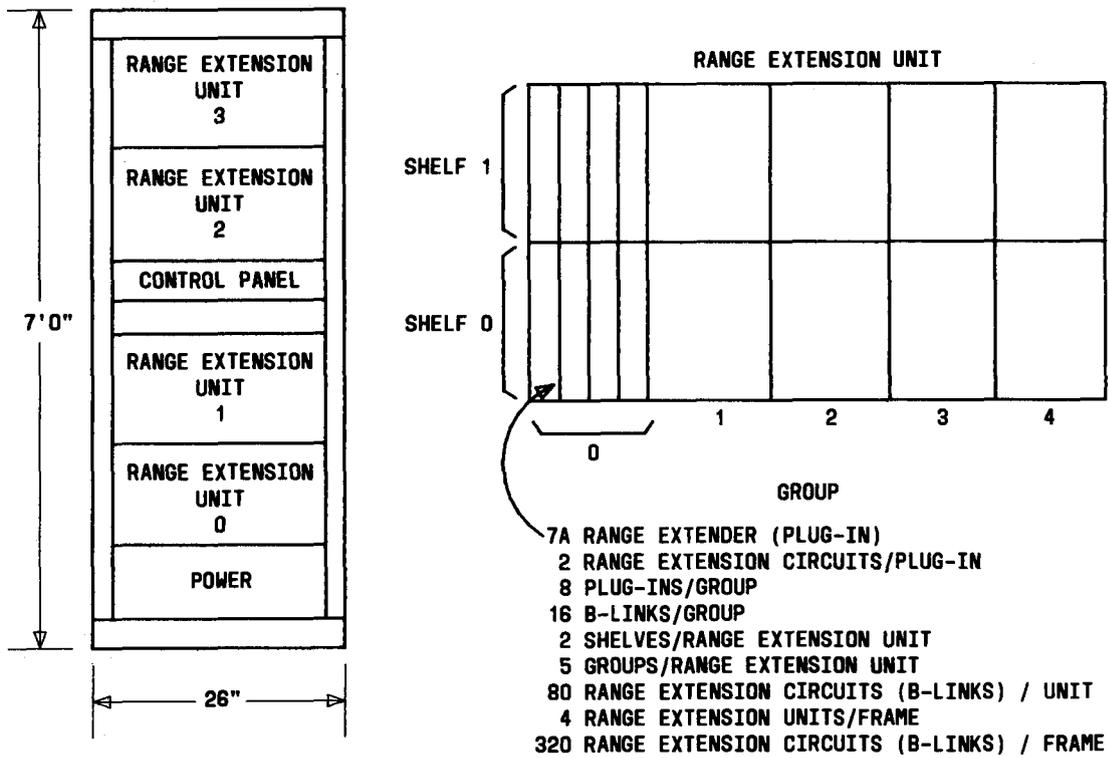


Fig. 44—LRE Frame

tributing frame. There are ten DCTBs for each PUC/DCT frame. A DCTB provides the following:

- Converts multiplex voice frequency and signaling information into a digital line format.
- Interfaces T-carrier lines or compatible multiplexes to the switching system.

- Detects and reports bank and line performance indications to the PUC.

**DUPLICATION**

3.105 All common systems units required to provide continuous service are duplicated. Du-

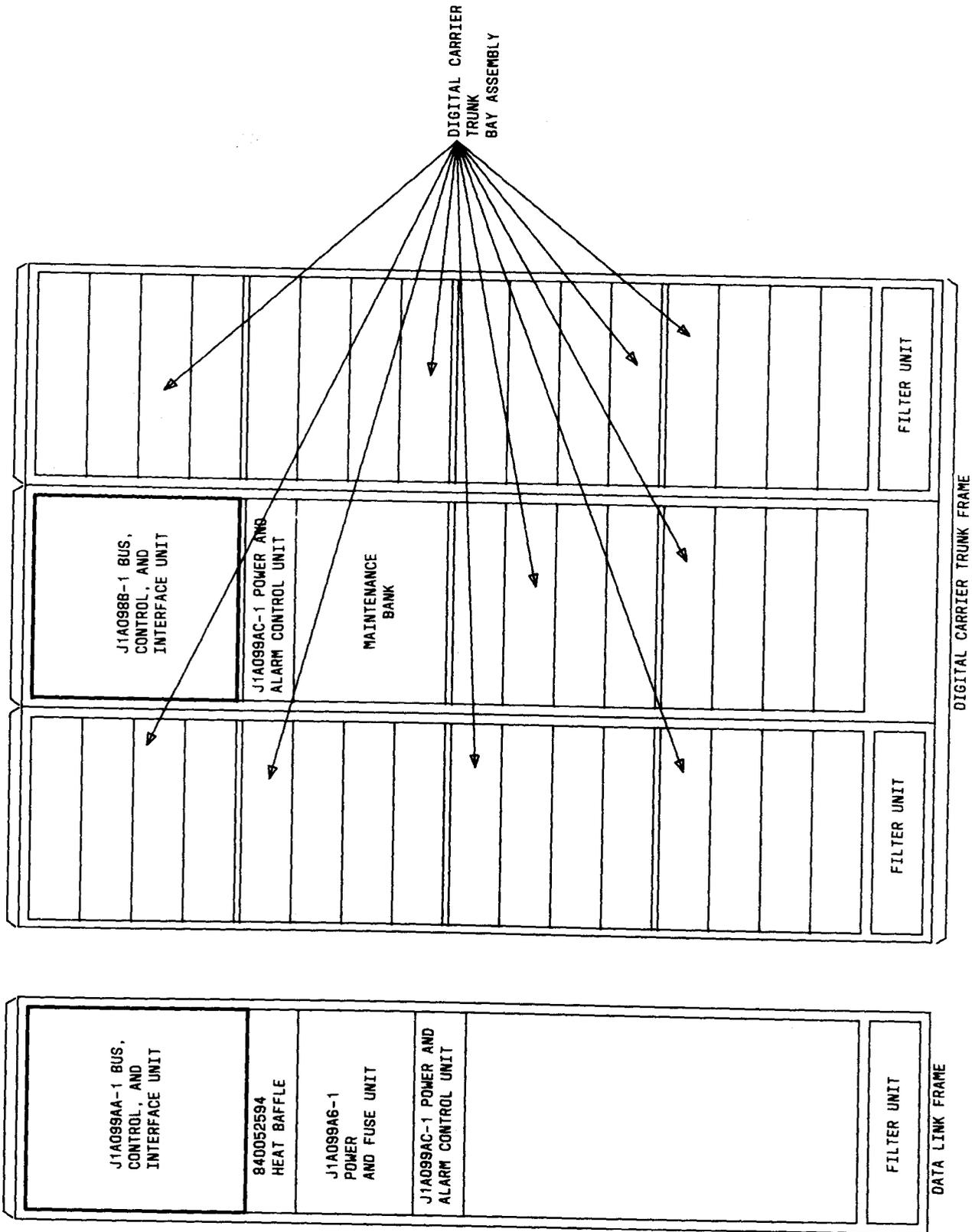


Fig. 45—PUC DL and PUC DCT Frames

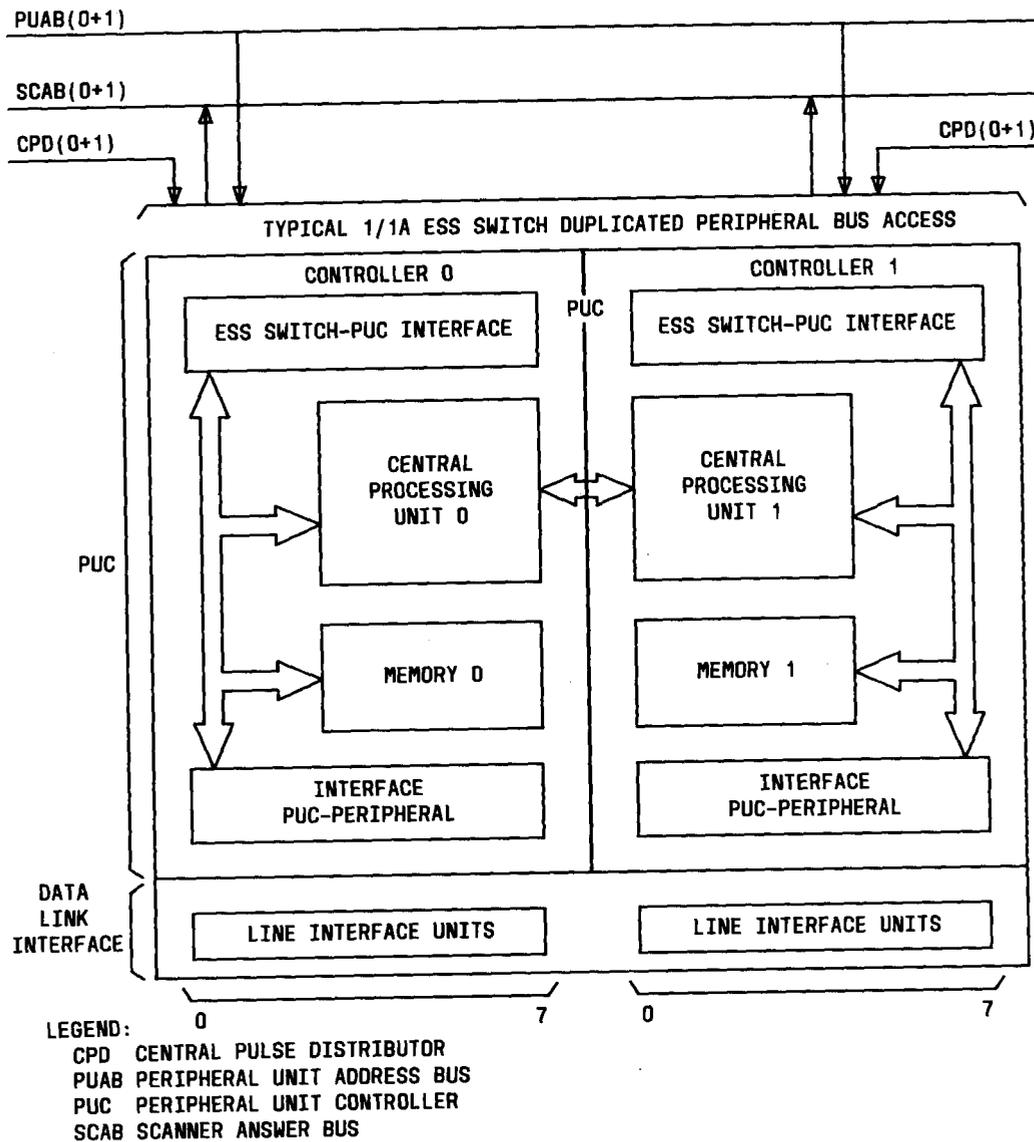


Fig. 46—PUC DL Block Diagram

plicated units in the 1ESS switch (Fig. 62) are as follows:

- Central control
- Signal processor
- Program stores
- Call stores
- Central pulse distributors
- Switch frame controllers
- Signal distributor controllers
- Scanner controllers
- AMA unit
- Interconnection bus system.

**3.106** Under normal conditions both of the duplicated units operate side by side in response to the same information but only one unit operates in active status. By continuously comparing the outputs of duplicated units (and by other means), detection of a system malfunction is possible. The unit at

fault is automatically identified by appropriate programs and is taken out of service. In the case of the stores, duplication is within each store unit so that as system needs increase, stores may be added singularly and not necessarily in pairs.

### INTERCONNECTIONS

**3.107** Two types of interconnections or busing between units are used in the 1ESS switch: (1) a common bus for information broadcast to a group of units of which one or two responds (e.g., CC-CS bus, CC-PS bus, PU bus) see Fig. 63; (2) a private bus for a direct connection between two units (e.g., CPD) to each SD or scanner controller.

**3.108** The peripheral units are connected to the CC (and SP if provided) by a common bus and these units are enabled by the CPD. Gating information is sent from the CPD to the units by interconnecting leads which exist between CPD and the peripheral units.

**3.109** When an office is equipped with SPs, the SPs are connected to the CC-CS buses and treated as CSs. There is also a duplicated bus between SPs and SP-CSs. A simplified diagram of the bus system is shown in Fig. 47. The cables for the bus system and the frames and racks also are shown in Fig. 47. The cables are shielded and divided into different groups in the racks to avoid crosstalk.

### INPUT/OUTPUT TERMINALS

**3.110** The IOTs are the primary means of communication between operating personnel and the 1ESS switch. Operating personnel type on the IOT to request system actions, and the system prints back on the IOT to report on the action taken, or on various system conditions.

**3.111** A 1ESS switch may have many IOT channels. Each channel has a transmit-receive (TR) unit, which is a buffer between the IOT and the central processor.

**3.112** The IOT channels are classified as either maintenance or nonmaintenance channels. Two maintenance channels traditionally connect to the MCC IOT circuit which is located in the double-bay frame with the local maintenance terminal and AMA circuit. The nonmaintenance channels traditionally connect to universal IOT circuits, two of

which circuits may be contained in an MT frame. The following types of IOT channels are used.

(a) **Maintenance Terminal:** A minimum of two maintenance terminals are always on separate 1ESS switch channels. The terminals report the status of the system to maintenance personnel and are used by maintenance personnel to request a variety of system actions. One terminal is always located at the MCC, while the other may be located in the same building or at another location. The terminal located at the MCC is called the local maintenance (LOC) terminal and operates on one channel. All other maintenance terminals are called remote maintenance (REM) terminals and operate on the other channel. A mobile terminal used for belt-line testing may be connected in series with either the LOC or REM terminal. The mobile terminal is plugged into a belt-line jack (wired in parallel on all frames throughout the office) and then patched to a maintenance terminal at the MCC. Thus, a complete input/output unit (IOU) is available at any position in the office.

(b) **Service Order Terminal:** This terminal channel provides an input for service order information. The input information includes changes in customer class or type of service, installation of new service, and inclusion of new features as part of customer service. The service order terminal may also be used to interrogate system memory for verification of translation information. Service order terminals are normally located in an assignment bureau. Generic programs CTX-5 and earlier use special forms to facilitate typing messages on the service order terminal. Centex 6 and later generic programs eliminate the use of special forms. In some locations the service order terminal is located in the 1ESS switch. The service order terminal can be used off-line to produce a punched paper tape for subsequent transmission into the system. Input messages from the service order terminal are received by a service order monitor terminal (receive-only) located in the CO. A service order monitor terminal provides a copy of the information received by the system.

(c) **Dial Service Supervisor Terminal Channels (Traffic Terminals; Administrative and Data):** These terminal channels, also referred to as the traffic channel, reports certain traffic load conditions, overload status, and the traffic data accumulated by the system. The

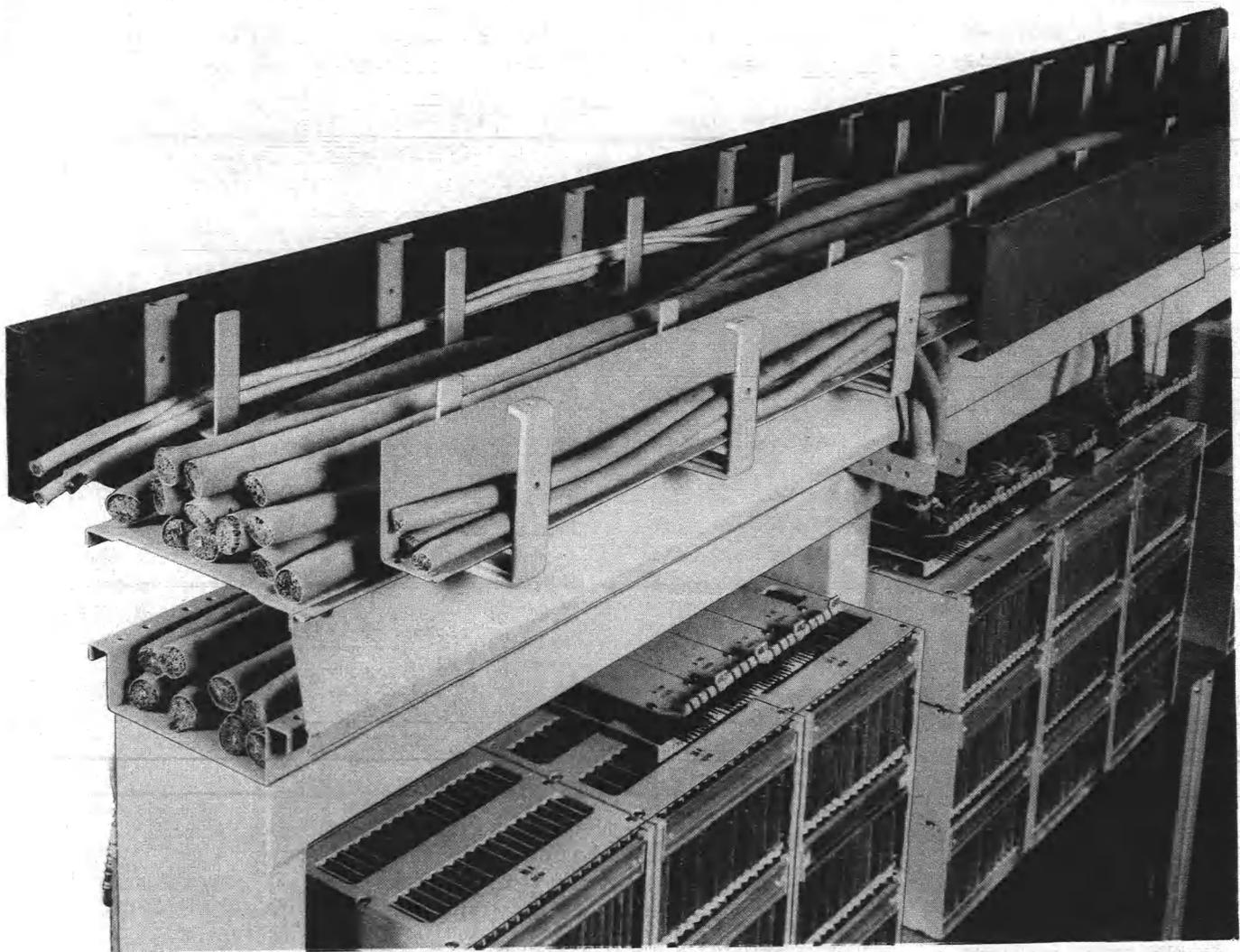


Fig. 47—Cable Rack With Cables in Place

dial service terminal may also be used to implement line load control and toll network protection or to interrogate the memory area. This terminal may be either remotely or locally located and can be used to interrogate the system for the contents of specific traffic registers.

(d) **Supplementary Dial Service Supervisor Terminal Channel:** This is an optional traffic channel and can be used to interrogate system memory, to implement controls, and to back up the network management (NMG) terminal. This channel was designed to alleviate the use of administrative messages and traffic data on one channel.

(e) **Engineering and Administrative Data Acquisition System (EADAS) Interface:** The EADAS is near real time data collection and surveillance system which provides an electronic, software controlled means of collecting traffic data. The EADAS interface transmits traffic measurements from a 1ESS switch (and other type COs) over a data link to a centralized data processor where the data is screened and analyzed. A reverse channel (toward 1ESS switch) transmits network management control signals to a 1ESS switch and selected traffic data from a 1ESS switch to an NMG center. A terminal is also provided from the EADAS to supply real time exception reports to dial administrators. An option for the TR unit to handle even parity is available.

(f) **Automatic Line Insulation Test (ALIT)**

**Terminal Channel:** This terminal channel, also referred to as either the plant service center (PSC) terminal or the local test desk (LTD) terminal, is a nonmaintenance send-receive terminal. It is used by the system for recording information at a local or remote test bureau. This information consists of a list of permanent signals on lines, results of ALITs, and results of tests performed on pressurized cable contactor pairs. The ALIT terminal in later generic programs also may be used to interrogate system memory for verification of translation data.

(g) **Supplementary Trunk Test Position**

**Terminal Channels:** These terminal channels, up to a maximum of four, are used to direct messages to designated sets of STTPs and/or manual trunk test positions (MTTPs). The messages consist of trunk diagnostic results and responses to maintenance personnel actions at the STTP.

(h) **Calling Line Identification (CLID) Terminal Channel:**

This terminal channel records information that has been requested as a result of initiating calling line identification procedures (Practice 231-110-301). This information includes the calling and called DNs and the time that the call was placed.

(i) **Network Management Terminal:** This terminal provides the primary interface between the network manager and the switching system. This terminal may be provided with CTX-6 and later generic programs. Through this terminal, the network manager may activate NMG controls and receive traffic and status information associated with the NMG function. A terminal need not be dedicated for this function; however if it is not, the administrative traffic terminal, by default, serves as the NMG terminal.

(j) **Monitor Terminal Channels:** Three types of monitor terminal channels are provided in a 1ESS switch to monitor various MCC and UNIV terminal channels. Whenever a monitor station is located locally, a direct monitoring channel is provided without the use of data sets. Whenever monitoring by a remote channel is required, the monitor terminal may be connected by using a private (dedicated) line or a switched network and may be equipped with a phone for establishing a monitor channel from the MCC area. A data set

must be used if a monitor channel is located remotely.

**4. EQUIPMENT ELEMENTS**

**4.01** Most 1ESS switch functions are performed by recently developed types of apparatus:

- Ferreed switches for network switching
- Remreed switches for network switching
- Ferrod sensors for scanning
- Magnetic latching wire-spring relays
- Ferrite cores
- Twistor memory and magnetic memory card
- Ferrite sheet memories
- Ferrite core patch memories
- Semiconductor devices.

By unique apparatus combinations used on most frames, an essentially complete functional building block free of options is the result.

**FERREED SWITCHES**

**4.02** The ferreed switch is the basic switching device in the ferreed LLNs and TLNs. Two types of ferreeds are used in the system: crosspoint and bipolar. The crosspoint ferreed (Fig. 48) consists of two miniature glass-enclosed reed switches which determine network paths for tip and ring conductors. The switch contacts are opened and closed while no current flows in the switch.

**4.03** The bipolar ferreed switches (Fig. 49) are used to open and close the current paths for the line ferrod and the no-test verticals.

**4.04** The operation of the two types of ferreeds is different. The crosspoint ferreed is arranged with dual winding and operates only when pulses are applied to both windings simultaneously. A single pulse through either winding causes the ferreed to release. The bipolar ferreed requires a negative pulse for operate and a positive pulse for release. Neither

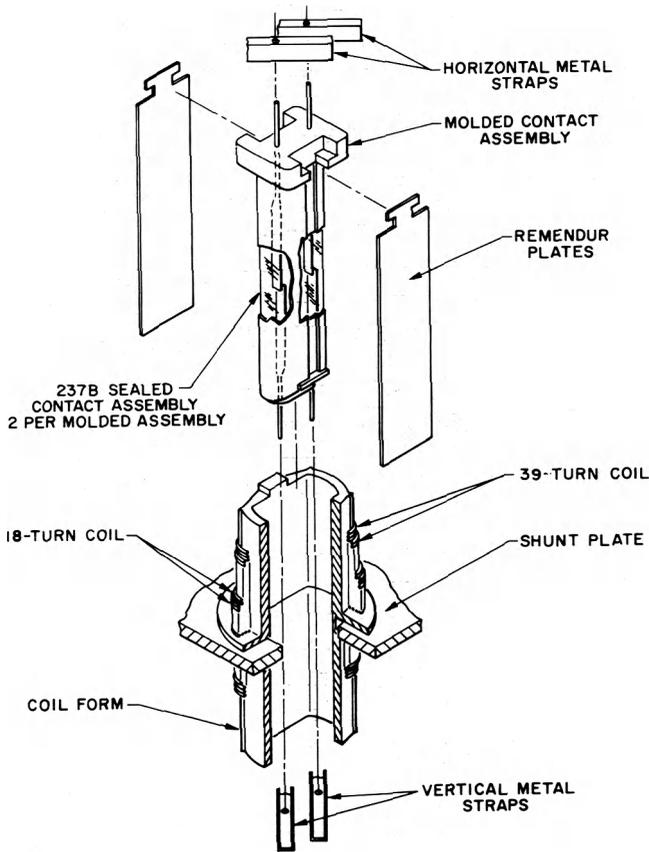


Fig. 48—Ferreed Crosspoint Switch (Exploded View)

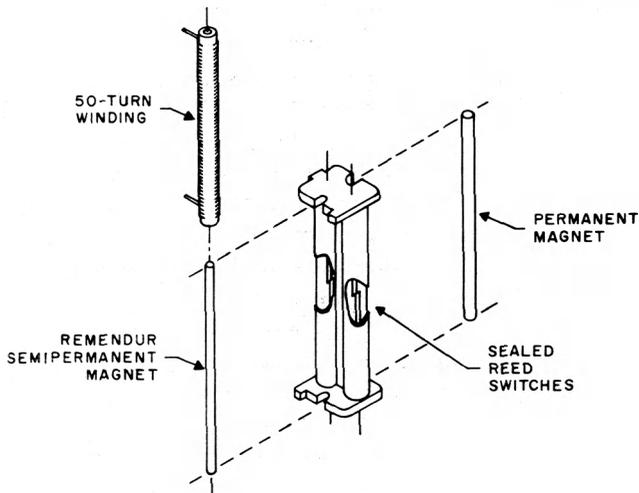


Fig. 49—Bipolar Ferreed Switch (Exploded View)

type ferreed requires a continuous current to maintain an operate or a release state.

REMREED SWITCHES

4.05 The remreed switch (Fig. 50) is the basic switching device used in remreed LLNs and TLNs and is similar to the ferreed switch in many respects. Unlike the ferreed switch, only one type of the basic switch is used to accommodate both the network tip and ring conductor paths and the no-test vertical path functions. Grid apparatus units are packaged in several connectorized configurations: the 10A junctor grid unit, the 11A trunk grid unit, 12B line grid unit, and 13B line grid unit. The 11A trunk grid unit contains two stages of 8-by-8 switches connected in a 64-by-64 configuration. The 10A junctor grid unit contains the same 64-by-64 configuration and, in addition, is arranged with test access switches to each output terminal. The 12B 2-to-1 line grid is comprised of two 296D-3D switch packages and one 296-D-2A switch package. The 296D-3D switch package consists of four 4-by-4, 2-wire remreed matrices. The 296D-2A switch package consists of four 8-by-4 switch matrices. The 13B 4-to-1 line grid is comprised of four 296D-4D switch packages and one 296D-2A switch package. The 296D-4D consists of one 16-by-4/8, 2-wire remreed matrix. The 296D-2A consists of four 8-by-4 switch matrices.

4.06 The remreed switch is arranged with two windings so that part of each winding is both above and below the shunt plate (Fig. 51). Sealed contact operation (close) occurs only by current pulses in both windings simultaneously (coincidence). A single current pulse through either winding causes switch contact release. The remreed sealed contact differs from the ferreed sealed contact in that the remanent magnet material is located in the reeds inside the sealed contact. The remreed switch also does not require continuous current to maintain an operated or released state. Remreed switches are not operated or released while current is applied to the contacts.

FERROD SENSOR

4.07 The ferrod sensor (Fig. 51) used in scanners provides magnetic coupling between the interrogate and readout windings by current applied to the control winding. This current or the absence of current is established by the state of the circuit to be sensed. An example is sensing of an on-hook or off-hook condition of a line. The on-hook condition causes

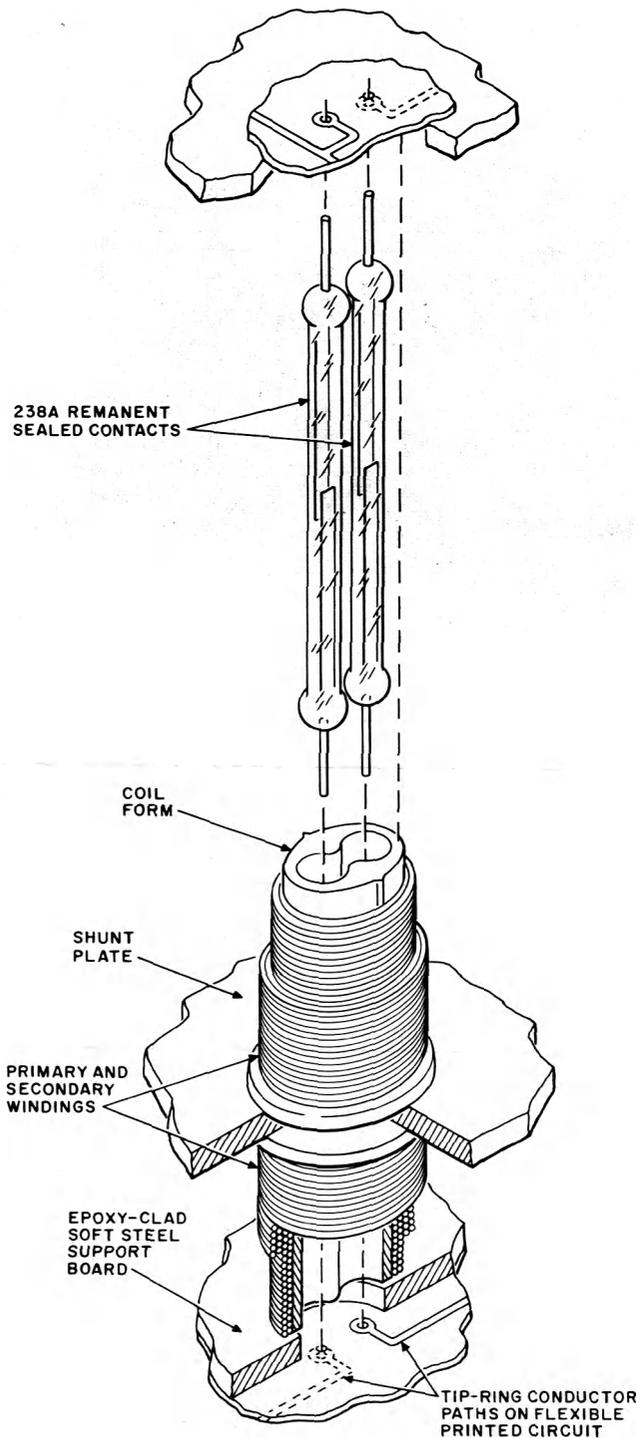


Fig. 50—Remreed Crosspoint Switch (Exploded View)

a binary 1 output and the off-hook condition causes a binary 0 output.

4.08 The types of ferroids used in the 1ESS switch vary in sensitivity. The more sensitive types are used to sense distantly located circuit conditions.

#### MAGNETIC LATCHING RELAYS

4.09 Magnetic latching wire-spring relays appear similar to conventional wire-spring relays. The main characteristic of magnetic latching relays is the remanent core material which retains enough residual magnetism to hold these relays operated after the operating current is disconnected. Actual operation and release are similar to the bipolar ferreed, in that operation is accomplished by a negative pulse and release by a positive pulse. No current is required to maintain an operate or a release state.

4.10 The magnetic latching relays are operated and released by the SDs and provide the final closing of a metallic path in the associated circuit. When the path is closed, a pulse is generated by the relay and, when detected, is verification of the closure. The same type verification occurs when the metallic path is interrupted.

#### TWISTOR MEMORY

4.11 The twistor memory is used in the PS to store the generic program, parameter, and translation information. The memory is a semipermanent read-only type. A basic element of the twistor memory module is a 3-mil copper wire that is spiral-wrapped with a thin magnetic permalloy tape; this combination is called a twistor wire (Fig. 52). A plain wire parallels the twistor wire and serves as a return current path. The twistor wire and plain wire are connected at one end to form a sensing or readout loop. The other end of the pair is connected to readout circuitry outside the memory module unit. The readout loop is perpendicular to a single-turn copper strip solenoid which is driven by a ferrite core (Fig. 53). A bar magnet on the memory card is positioned at the intersection of the solenoid loop and the readout loop. Both the permalloy tape of the twistor wire and the ferrite core that drives the solenoid have hysteresis square-loop magnetic characteristics.

4.12 Twistor memory information is stored in the form of binary digits (zeros or ones) formed by magnetizing or demagnetizing the small bar magnets on the aluminum memory card. An MCW is used to record information on the memory cards before the cards are placed in the PS. A view of the memory card

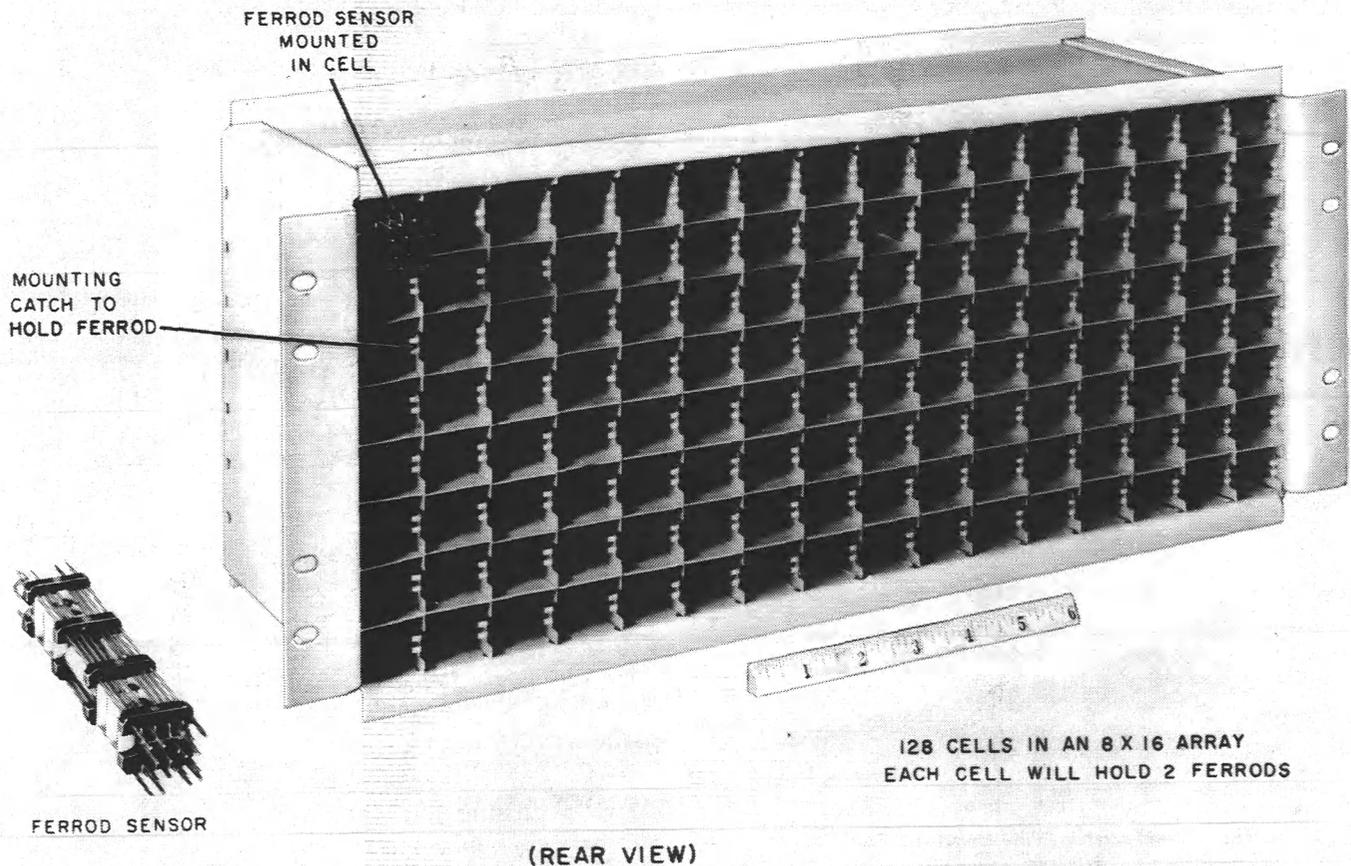


Fig. 51—Ferrod Sensor and Mounting Apparatus

showing the small magnets is shown in Fig. 9. Each aluminum memory card contains 64 words; each word is composed of 45 binary bits of which 44 are used. There are also elements on the card edge which are sensed by the card writing machine.

#### FERRITE MEMORIES

4.13 Ferrite memories are the basic storage component in the CS and provide temporary or

read-write storage. Binary information can be stored, read, altered, or erased by the system.

4.14 Ferrite is composed of magnesium-manganese material. Each ferrite sheet contains 256 holes in a 16-by-16 array (Fig. 12). Each ferrite core patch contains 53,248 holes in a 208-by-256 array (Fig. 15). The ferrite material around each hole stores one binary digit, 0 or 1. Combinations of these zeros and ones form the words in the CS.

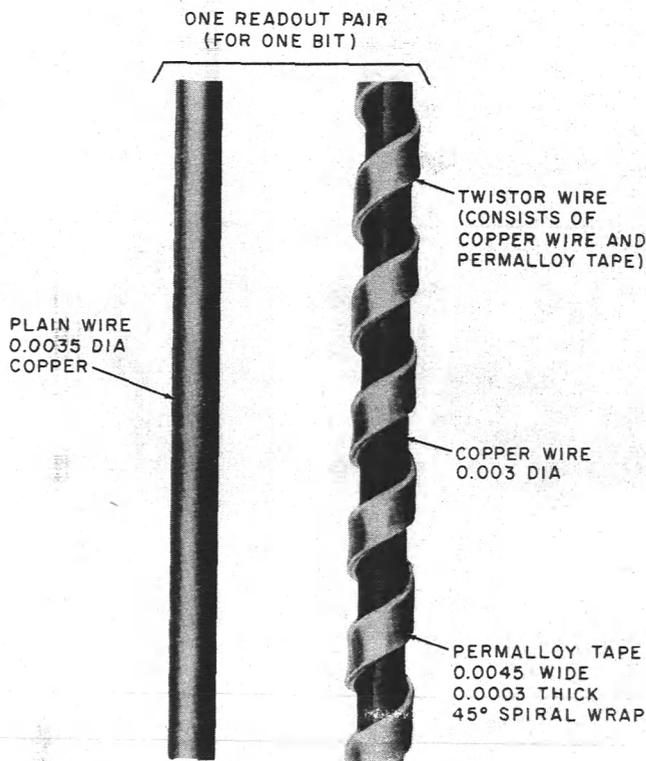


Fig. 52—Twistor Wire Readout Pair

#### FERRITE CORES

**4.15** Ferrite has a hysteresis square-loop magnetic characteristic, and ferrite cores are doughnut-shaped pieces of ferrite material. The direction of current applied to conductors passing through the hole in a ferrite core determines the polarity of magnetization. The two magnetic polarities are used to store binary 0 and binary 1.

#### SEMICONDUCTOR DEVICES

**4.16** Semiconductor devices mounted on plug-in circuit packs are used for most of the logic and controls. The circuit packs and the pack-mounted apparatus are shown in Fig. 54. Semiconductor devices make possible the operating speed and reliability required by the system. The circuit pack provides for rapid replacement of defective circuitry and restoration of the unit to service.

## 5. METHOD OF OPERATION

### TYPICAL INTRAOFFICE CALL

#### A. Call Origination

**5.01** When a customer originates a call by lifting the receiver, a current begins to flow through a sensing element (ferrod sensor) associated with the line but located in the line scanner matrix. On the next line scan (intervals of 200 milliseconds), the CC, or an SP in larger offices, receives no sensor output which indicates that the line is off-hook. Line state (busy-idle) memory in the CS indicates that the line was previously on-hook. The CC now marks busy the busy-idle memory of the line. Next, the originating line, identified by the associated scanned location, has a translation sequence performed which provides class-of-service information necessary for processing the call.

#### B. Dialing Connection

**5.02** The CC selects an idle customer dial pulse receiver (Fig. 55) which is a service circuit capable of returning dial tone and detecting, but not counting, dial pulses. If the customer has a TOUCH-TONE telephone (class-of-service information), an idle customer dial pulse receiver equipped with a TOUCH-TONE calling detector is selected. The CC must then cause the establishment of a path through the LLNs and TLNs to connect the receiver to the originating line. The line scanner is disconnected from the calling line by disconnecting the line cutoff ferreed and the supervision of the line is transferred to a ferrod in the scanner associated with the customer dial pulse receiver. The CC, by using the SD, operates a relay in the customer dial pulse receiver that causes dial tone to be sent to the calling line. The dial tone is removed, again by SD action, as soon as the first pulse of the first digit is received. The calling line is scanned at the receiver every 10 milliseconds to detect changes on the line resulting from the dial pulses.

#### C. Digit Analysis

**5.03** Dial pulses are counted and recorded in the CS register memory by CC. A digit is considered to be completed when the line is off-hook with no changes detected for a period of at least 100 milliseconds. When the first digit is completed, a check is made to see if a digit 0 or 1 has been dialed,

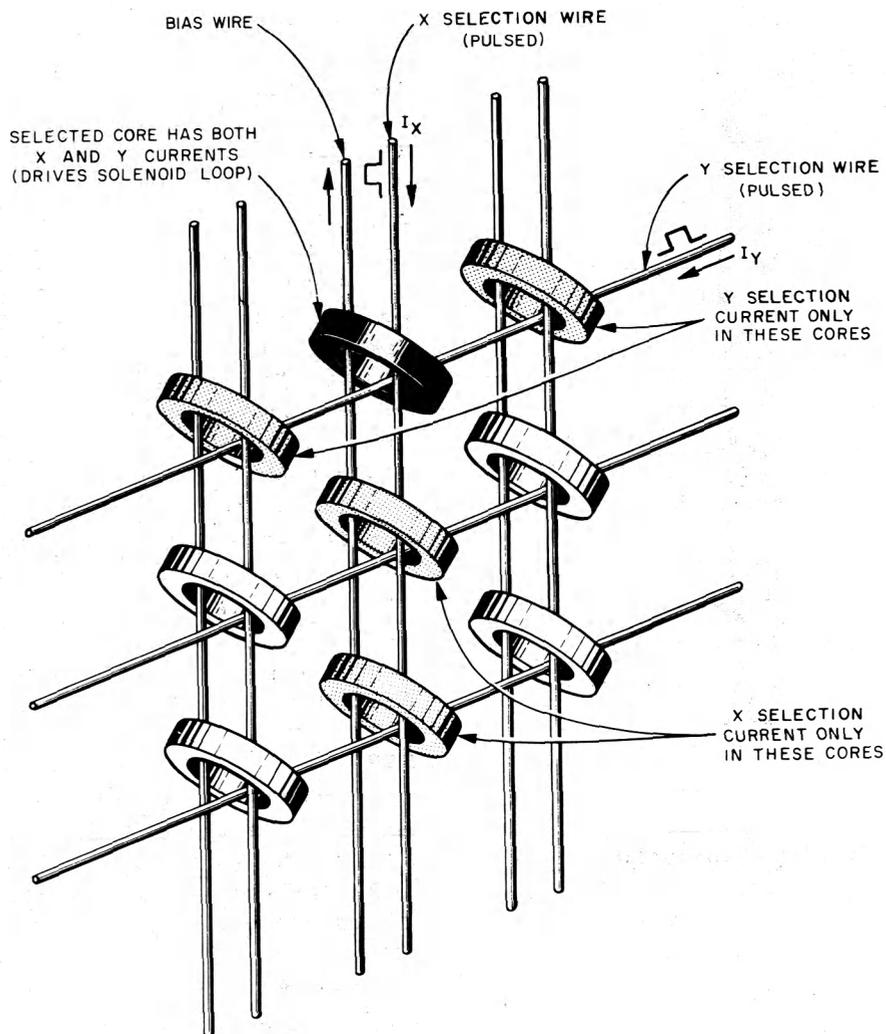


Fig. 53—Selection of Ferrite Access Code

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 1 has not been dialed) provides CC the call type (intraoffice, interoffice, etc) and the number of digits to expect.

#### D. Ringing Connection

5.04 Upon completion of the last dialed digit, CC causes the dialed DN of the called number to be translated into a format which provides the LEN (or location) and terminating class-of-service information. The busy-idle memory of the called line in

the CS is also checked and, if idle, the memory is marked busy. An idle ringing circuit and audible ringing tone circuit are selected. Paths are selected to connect the ringing circuit to the called line and to connect audible ringing to the calling line. Also, a path from the calling and called line, including a junctor circuit, is selected and reserved in the CS memory. The customer dial pulse receiver and associated network paths are released and CS busy-idle indications updated. The appropriate network paths are established for ringing and audible ring tone signals. Every 100 milliseconds, the ringing circuit is scanned for off-hook or answer, and the audible ringing tone circuit is scanned for on-hook or abandonment.

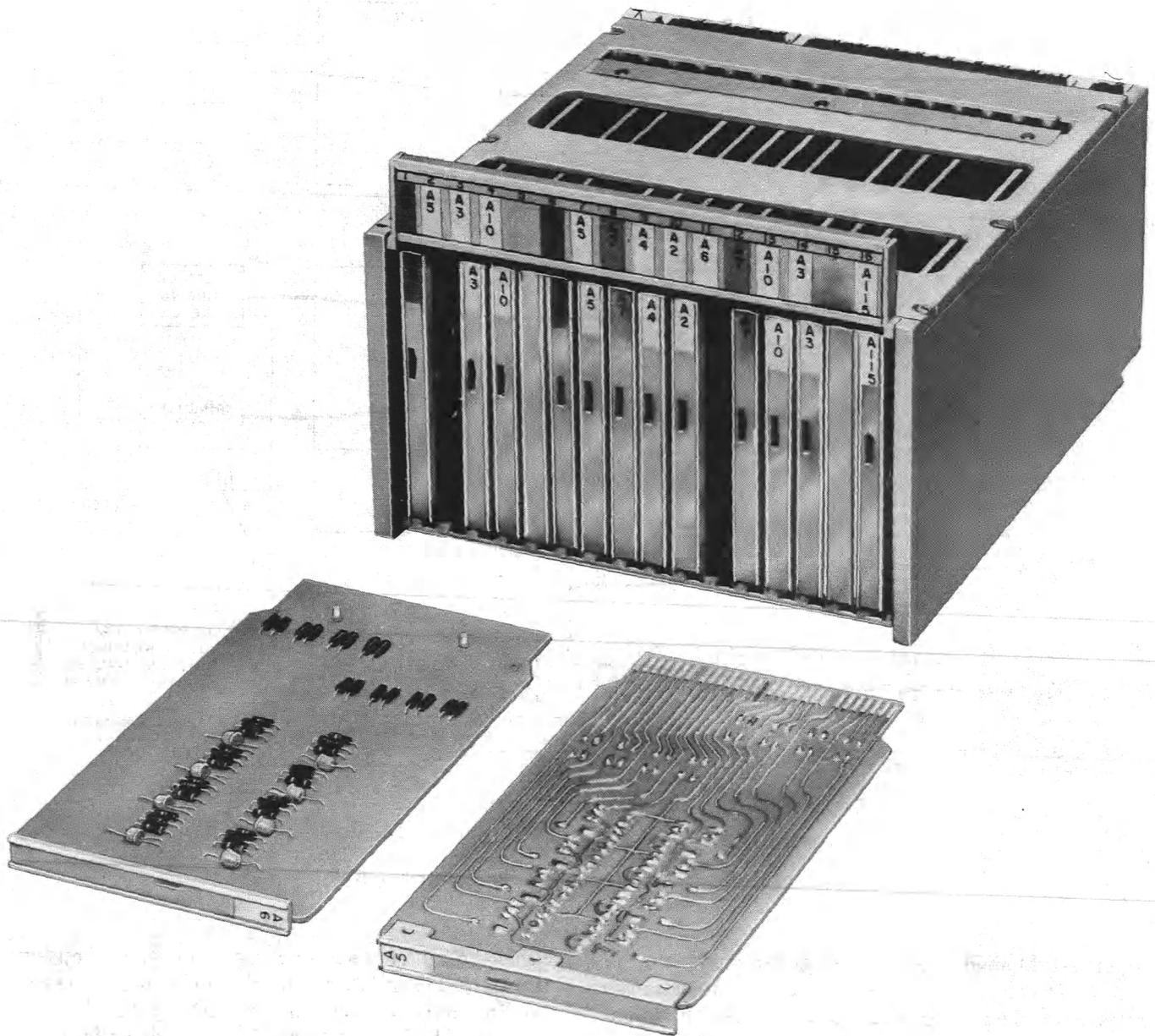


Fig. 54—Circuit Packs and Apparatus Mounting

#### E. Talking Connection

**5.05** When the called line answers, ringing and audible ringing tone circuits are released and the previously reserved talking path is then established. During talking, the junctor circuits are scanned every 100 milliseconds for supervision. When a change to on-hook by either calling or called line is detected, an interval of 200 to 300 milliseconds is timed. This is a safeguard against momentary on-

hook conditions or hits which would cause disconnect actions to be performed prematurely. The call is under calling party control but a timed-release feature is provided which prevents the calling customer from holding the called line out of service indefinitely by failing to hang up the receiver. After the 200- to 300-millisecond time-out following on-hook, the system times an interval of 10 to 11 seconds if the calling party remains off-hook. During this interval, if the called line returns to off-hook, the network path re-

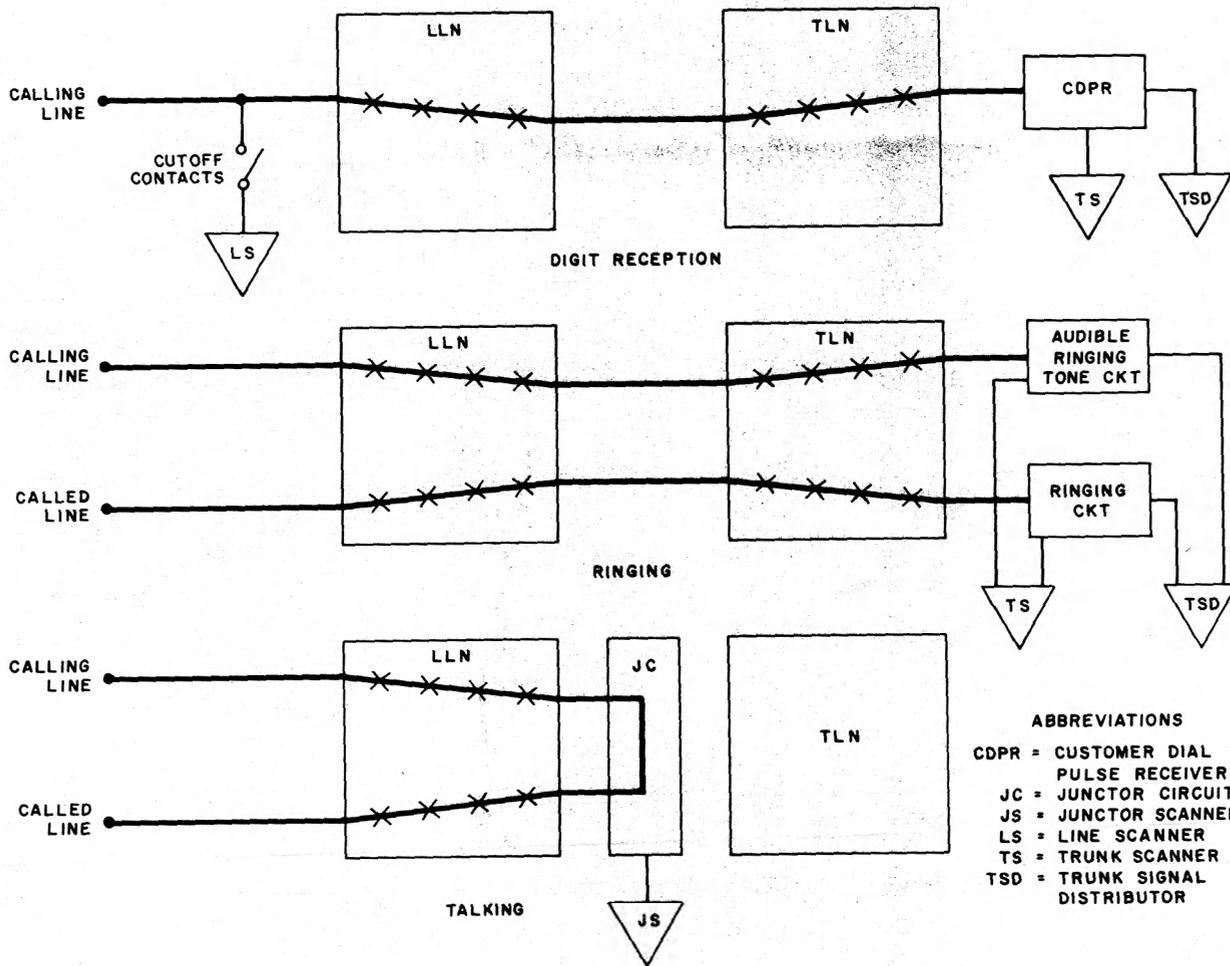


Fig. 55—Typical Connections for an Intraoffice Call

mains established. If an on-hook is detected from the calling line or the time-out occurs, the connection is released. If the calling party hangs up first, the called line is given 10 to 11 seconds to go on-hook before interrupting the connection for a new origination and returning dial tone.

**TYPICAL INTEROFFICE CALL - OUTGOING**

5.06 When translation (see Fig. 64, Sheet 1, for general sequence of translations) of the first three dialed digits (assuming a 0 or 1 has not been dialed) indicates an interoffice call type, the number of digits to expect (7 or 10) and a route index is furnished. The route index information provides the outgoing trunk group number, any digit prefixing and deletion actions which may be required, the type of transmitter to be used, the alternate route index to

be used if all trunks are busy, and any special options if required (Fig. 56). With this information, the calling line continues to be supervised from the dial pulse receiver which is held and CC proceeds as follows:

- (a) Selects an idle outgoing trunk.
- (b) Selects an idle transmitter.
- (c) Establishes a network path between the transmitter and trunk circuit.
- (d) Reserves a network path between the calling line and trunk circuit.
- (e) Dial pulse receiver is released.

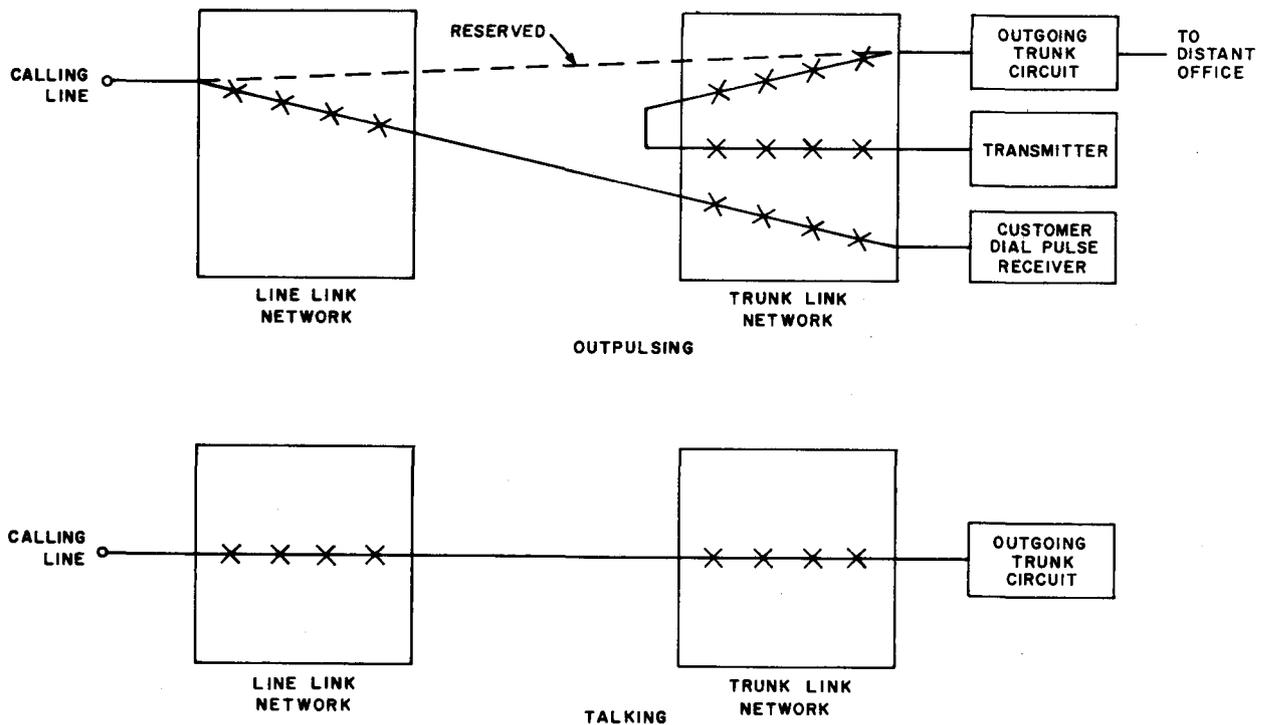


Fig. 56—Switching Sequence From Left to Right (Outgoing Call)

**5.07** The trunk circuit is placed into a bypass state (clear metallic path) and a seizure signal is sent to the distant office from the connected transmitter. The CC proceeds to make a continuity check and, if successful, applies supervisory signals, as required, before commencing to outpulse. At the completion of outpulsing, the transmitter is released by CC and the supervision is turned on in the outgoing trunk circuit. The previously reserved path between the calling line and the trunk circuit is established. Every 100 milliseconds, the trunk ferrod is scanned, by scanners associated with the trunk, for answer (off-hook) and the calling line for possible abandonment (on-hook). When the called line answers, CC recognizes the change in supervision from the distant office, by the trunk ferrod, and the trunk busy-idle memory in the CS is changed to the talking state. A similar disconnect program and timing is used for interoffice calls as described for intraoffice calls, except a guard interval of 800 milliseconds is imposed during which the outgoing trunk circuit cannot be re seized. The guard interval allows time for all associated relays in the distant office to release.

#### TYPICAL INCOMING CALL

**5.08** For this description, it is assumed that the 1ESS switch is processing an incoming call to an individual line. During the 100-millisecond supervisory scan of trunks, when CC reads the row containing the scan point of the incoming trunk circuit CC detects a mismatch between the scanner reading and the associated trunk busy-idle word. The busy-idle word records the previous scanner reading for that row. Among other things, the trunk scan supervises for incoming trunk seizures as well as outgoing trunk answers. Therefore, the CC cannot conclude from the mismatch whether a seizure or an answer has been detected. The trunk scanner number of the trunk causing the mismatch is recorded in the trunk service request hopper because the trunk change is from on-hook to off-hook. Then the trunk scanner number is taken from the hopper and converted to a PS address. The translation information, stored in the PS address, indicates that the trunk is incoming (which means that a seizure has been detected). Also

the translation information specifies the trunk network number which identifies the network location of the trunk (Fig. 64, Sheet 2, for general sequence of translations).

**5.09** An incoming register is hunted and seized; the trunk network number is recorded in the incoming register; and this number is converted into the PS address of the translation information for the trunk. This translation information is used to determine the type of digit receiver (MF, dial pulsing, etc) to be connected to the trunk, the number of digits to be received, and the type of supervision required. The translation information is recorded in the incoming register. (An exception to this procedure exists for the step-by-step immediate dial incoming trunk. In this case, a special directed scan detects dial pulses

via a ferrod in the incoming trunk circuit. This same ferrod also indicates the origination of the call.)

**5.10** When the type of digit receiver is determined, an idle digit receiver is seized and the network map is searched for a path between the incoming trunk and the digit receiver (Fig. 57). A peripheral order bus (POB) is loaded with the orders for the network controllers, SD, and scanner to make and check the connection. The path information is recorded in the junior incoming register.

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

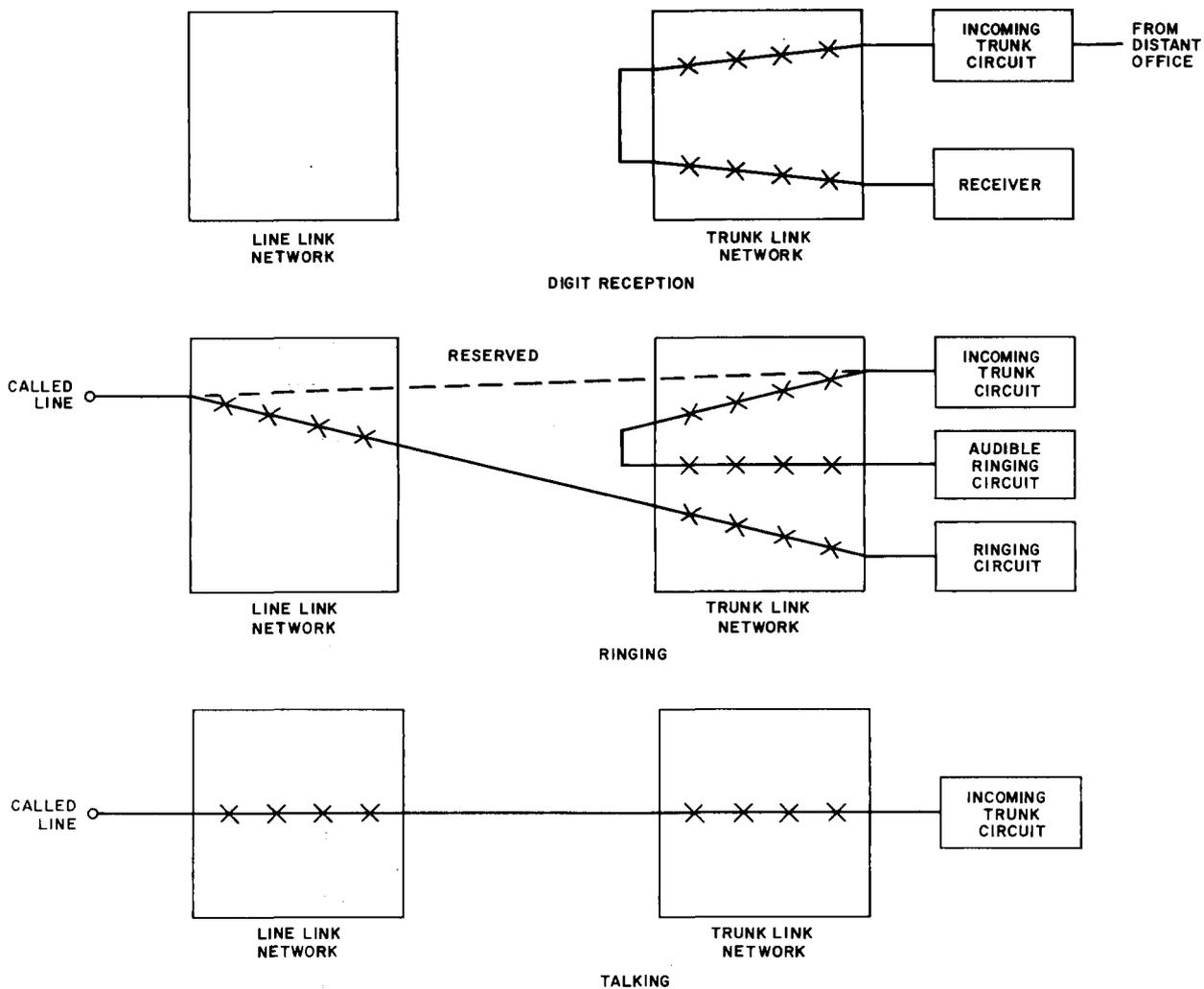


Fig. 57—Switching Sequence from Left to Right (Incoming Call)

**5.12** Upon completion of each digit, the pulse count is taken from the junior incoming register and, via a digit hopper, is recorded in the incoming register that is administering the call. When the last digit is completed, the digits received are converted to the PS address of the directory number translation for the called line. A part of the directory number translation is the LEN for the called line. This LEN is converted to the location of the line busy-idle bit in the CS. This bit indicates that the called line is idle.

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

**5.14** Every 100 milliseconds, the ringing circuit is scanned for an answer. The incoming trunk is scanned for a possible abandonment.

**5.15** When the called customer answers, ringing is automatically tripped by the ringing circuit. The ringing connections and the ringing register are released. Answer supervision is returned to the originating office. The previously reserved talking path is established and the temporary memory is brought up to date. The connection is now supervised via the trunk scanner for disconnect.

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

**5.17** After the hit timing period, a disconnect register is seized. If the distant end is disconnected first, the incoming trunk is made available for reseizure and a timed release period of 10 to 11 seconds is started. During this time, the 1ESS switch customer is being scanned at the trunk every 100 milliseconds for disconnect. The connection is released when the ESS switch customer disconnects or the timed release period ends. If the trunk is reseized in the meantime, the connection is released immedi-

ately and the line is supervised via the line scanner. If the ESS switch customer remains off-hook, beyond the timed release period, the call is treated as a new origination.

**5.18** If the 1ESS switch customer is disconnected first, when hit timing is completed, the distant office is notified of the disconnect. The ESS switch starts a timing period of 35 to 45 seconds when waiting for the disconnect signal from the distant office. When the ESS switch receives the disconnect signal or when the timing period ends, the connection is released.

#### TYPICAL TRUNK-TO-TRUNK CALL

**5.19** The position of equipment for a typical call in a 1ESS switch trunk-to-trunk connection is indicated in Fig. 58. An intermediate distribution frame (IDF) serves as the boundary between switching and transmission equipment while the TLNs constitute the switching matrix. Four stages of switching are encountered in each pass through a TLN; therefore, a trunk-to-trunk connection encounters eight switching stages. From a transmission point of view, the only difference between the ferreed TLN and the remreed TLN is that the remreed TLN is one-fourth the size of the ferreed TLN. This factor affects parameters which are dependent upon the switched path length, with the remreed TLNs offering an improvement.

#### COMMON CHANNEL INTEROFFICE SIGNALING

**5.20** The CCIS system is described in Part 2 of this practice. For more information on CCIS operation and call processing, refer to Practice 231-090-416.

#### 6. PROGRAM ORGANIZATION

**6.01** The organization of the 1ESS switch generic program has been influenced by the following factors:

- (a) To accommodate a large number of calls (up to about 110,000 intraoffice calls or the equivalent incoming and outgoing interoffice calls during the peak busy hour of the busy season)
- (b) To provide sufficient flexibility for office growth and addition of recently developed service features

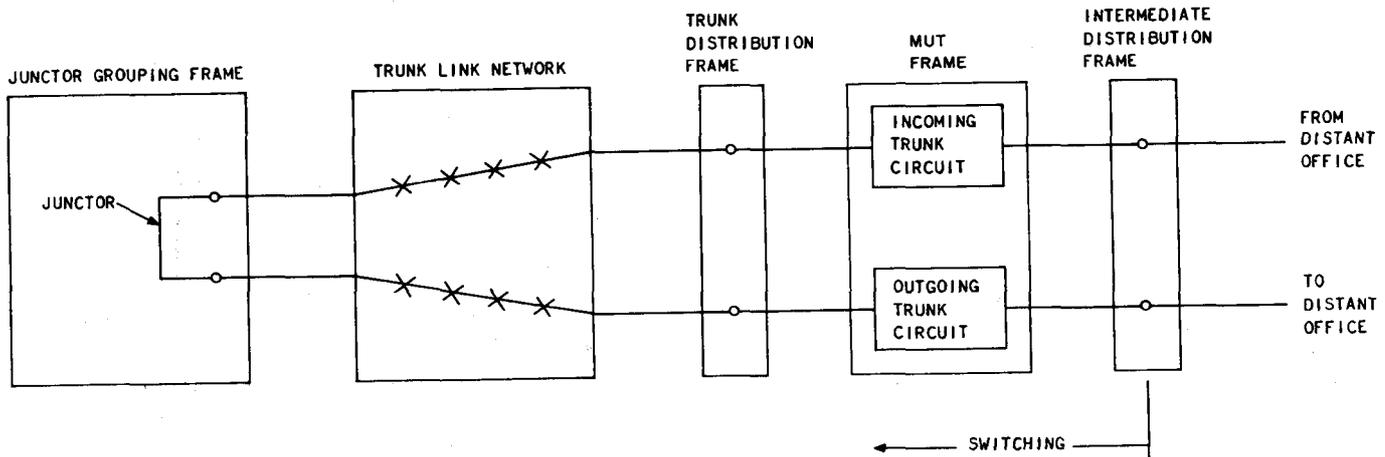


Fig. 58—Trunk-To-Trunk Connections

- (c) To accommodate an SP if required by the initial size of the office or by growth
- (d) To provide automatic detection and diagnosis of trouble conditions.

**6.02** The size of the generic program may vary from approximately 288,000 instructions to a maximum dependent on the optional feature groups installed. Of the total, approximately one-half are devoted to call processing and related functions while the other half is devoted to automatic maintenance.

**6.03** The 1ESS switch generic program can be divided into a number of major functions. These functions are associated with programs designed to perform a particular system operation. The following are some of the general categories of nonmaintenance programs:

- (a) Input/output programs which specialize in collecting a particular type of input information to be processed (for example: dial pulses) or in transmitting to peripheral equipment such information that has resulted from processing.
- (b) Call processing programs which specialize in the processing of information associated with a particular type of call or a phase of a call.
- (c) Service routine programs which specialize in processing functions not exclusively related to one type of call or to one phase of a call. These routines are called upon, when needed, by the various

call processing programs and are referred to as clients of the service routine program. As an example: any program can request a translation service routine to determine the equipment number corresponding to a given DN.

- (d) An executive control program which schedules the task of the I/O and call processing programs.

**6.04** The organization of the program is also related with the organization of the information stored in the temporary memory of the CS. In general, each program functions with one or more CS areas. The contents of these areas are modified to reflect the occurrence of events or the results of processing. Information recorded by one program may later be used by the same program and/or by others.

**6.05** Each CS area consists of one or more words. The size and layout of the area vary from case to case. A CS word may be used completely to store some item of information or may be divided into parts of one or more bits. Each word or part of a word has a precisely defined assignment. A whole word may be used, for example: to store the identity of the TLN terminal connected to the CDPR used for a particular call. Groups of four bits may be used to store the various digits dialed by an originating customer. A single bit may be used to indicate whether dialing has been completed or not.

**6.06** The organization of the generic program is strongly influenced by the fact that the sys-

tem must operate in real time; that is, the system must respond promptly to actions that occur at times not under the control of the system. A single time-shared high-speed CC must keep up with the flow of information from subscribers and from distant COs. Consequently, the establishment of a hierarchy of priorities is necessary. Some system functions are of a nondeferrable nature and must be performed under tightly controlled schedules. Other functions are of a deferrable nature and occasionally can be delayed without significantly adverse effects. For example, monitoring originations is a deferrable type function and when postponed for a number of milliseconds there is no noticeable effect on service. Detecting dial pulses is a nondeferrable type function, and if postponed for even 5 milliseconds pulses may be missed, thus mutilating digits.

**6.07** Nondeferrable type operation is carried out on schedule by a clock interrupt or a maintenance interrupt. Program execution is immediately interrupted and a transfer made to another program associated with the source of the interrupt signal. When the interrupt program has completed its functions, the program that was interrupted resumes operation as though no interrupt had occurred.

## **7. MAINTENANCE**

### **MAINTENANCE PLAN**

**7.01** Maintenance provisions for the 1ESS switch consist of the following:

- (a) Maintenance circuits and programs provide for detection and diagnosis of failures automatically or by manual requests.
- (b) An MCC provides a centralized control point for communicating, controlling, testing, and recording requirements of the system.
- (c) An office alarm system provides for both system-detected and locally-detected failures.

**7.02** The maintenance plan is supported by the following:

- (a) Circuits are made reliable by using long-life components and by providing liberal margins between component ratings and actual operating conditions.

- (b) Circuits are made rapidly repairable by the use of plug-in units.

- (c) Duplication of equipment is provided throughout the system, except where a failure would affect only a small number of subscribers.

- (d) High-speed facilities are used to switch duplicated equipment in or out of service and to combine system units in various configurations.

- (e) Various types of redundancy (parity bits, one-out-of-N codes, etc) are used in the information transmitted between units in order to detect errors.

### **FAULT RECOGNITION PROGRAM**

**7.03** When a malfunction is detected, call processing is momentarily interrupted by the CC interrupt sequencer which transfers the program control to an appropriate fault recognition program. The occurrence of a malfunction is detected mainly by means of circuits which perform matching, parity checking, or by scan points which monitor circuit conditions. The fault recognition program performs two functions:

- (a) Reestablishes an operational configuration of the office.
- (b) Determines which system unit failed and removes the unit from service. Then, the fault recognition program requests an appropriate diagnostic program initiation at some later time and returns control to the call processing programs. Normally, the interruption of call processing does not last long enough to result in the loss of any dial pulses.

### **DIAGNOSTIC PROGRAM**

**7.04** A diagnostic program provides a systematic sequence of tests for localizing a fault to a small number of plug-in circuit packs. The diagnostic program operation does not interrupt normal telephone service because the diagnostic actions are segmented and interweaved with the processing of calls. In turn, the diagnostic results are printed out by a maintenance terminal. With the aid of a trouble locating manual, these printed results are translated by maintenance personnel into the location and type of circuit pack(s) that require replacement.

**A. Exercise Program**

**7.05** The exercise program is a low-priority scheduled routine which includes line-to-line test calls, trunk transmission and noise tests, and network map verifications.

**B. Audit Program**

**7.06** The audit program is a form of exercise program which provides continuous checks for errors in stored data, reconstructing data found in error, and retrieving "lost" information.

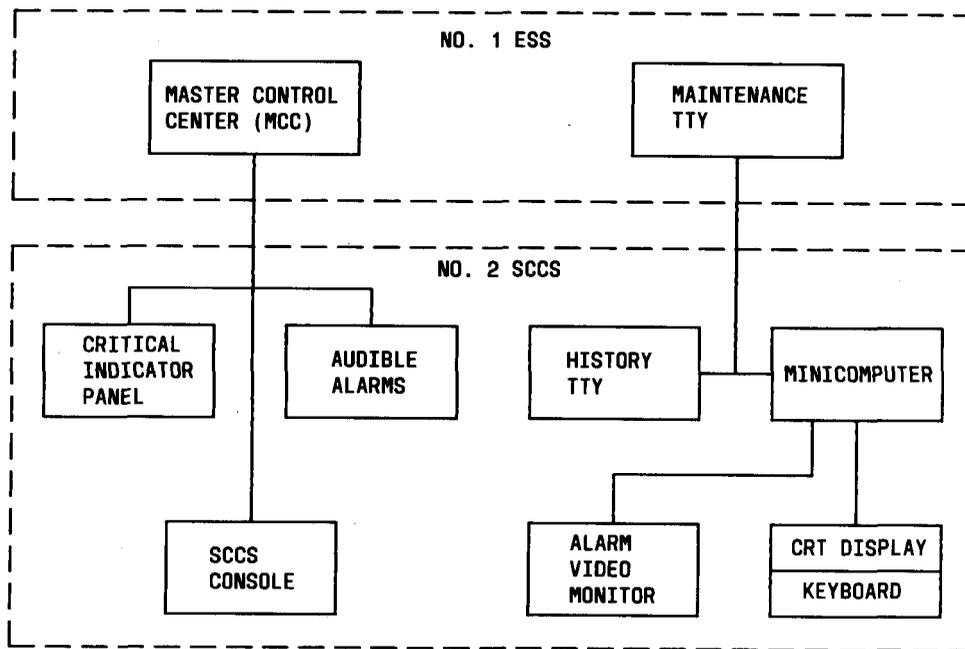
**8. INTERFACE WITH NO. 2 SWITCHING CONTROL CENTER SYSTEM (SCCS)**

**8.01** An SCCS is a centrally located facility capable of handling administrative, operational, and maintenance functions for 16 COs (Fig. 59). The SCCS provides sufficient display, control, and alerting capabilities to enable the COs to be remotely operated. Operationally, the primary responsibility for the associated CO resides at the switching control center (SCC). Work scheduling, dispatching, trouble analysis, and administrative functions are performed at the SCC.

The centralization concept of the SCC has four primary objectives:

- To improve service quality over an unattended operation by economically providing around the clock surveillance and control.
- To gain personnel efficiency by pooling existing expertise and allowing the pooled force to work on the problems of several offices.
- To improve proficiency and training by exposing the SCC force to more systems and the associated problems, making it easier for the SCC force to develop and retain their skills.
- To improve work conditions by providing a pleasant, attractive, and spacious place to work.

By utilizing these concepts, many types of switching machines can be served from the same center. The SCC also has the capability of shifting the primary CO responsibilities between the SCC and the associated CO.



**Fig. 59— IESS Switch Interface With No. 2 Switching Control Center System (SCCS)**

## MASTER CONTROL CENTER INTERFACE

**8.02** Most MCC interface control and display functions have been remotely located at the SCC. An interface circuit at the MCC and telemetry are used to transfer these functions to the SCC. There are some additional indicators available at the SCC that are not found at the MCC. These are system state-of-health indicators intended to provide additional information to help analyze system problems.

## TERMINAL INTERFACE

**8.03** Each 1ESS switch is connected to the SCC location by at least one dedicated terminal channel, an extension of the first maintenance channel. Other terminal channels may also be provided to the SCC on a dedicated or dial-up basis. The first maintenance channel is connected to the SCCS minicomputer where the terminal messages are logged and analyzed by the minicomputer.

## 9. EQUIPMENT ADDITIONS (OFFICE GROWTH)

**9.01** Office growth is necessary whenever an operating office must add equipment or equipment frames to increase call handling capacity. (More detailed description of growth procedures may be found in Practice 231-019-101.)

**9.02** In the 1ESS switch, frames can be added to an operating system using relatively few wired connections. Parameter and translation changes in program store instead of wired logic modifications provide most of the information required by the office for added frames.

**9.03** Major objectives during office growth are to minimize the possibility of interruption or impairment to customer service, to minimize changes required in normal operating procedures of the telephone company, and to permit allowable margins and overlap of installation effort to provide efficient job schedules and utilization of personnel. These objectives can best be implemented by providing a safe and well defined environment in which growth frames can be tested without interference to the operating system. The intervals where simplex operation (no duplication) of equipment is required are minimized. Installation procedures are sequenced to allow growth frames to be integrated into the system in small steps that can be easily verified. Several safe stopping points are provided in the growth proce-

dures to allow for unforeseen difficulties that may arise. The procedures are kept simple and explicit and use computer generated data where applicable. When new equipment or equipment frames are added to an ESS switch, they must be added without an interruption in telephone service. Continuous service is possible primarily due to the duplicate design of the 1ESS switch which permits numerous operating configurations among the duplicated system units. Another aspect that allows growth to be accomplished in a smooth and orderly sequence is the way parameter and translation data defines the equipment. After the added equipment is wired into the system, selected parameter and translation updates can be performed to allow the system diagnostic and fault recognition programs to test the equipment. Testing occurs without interference to call processing, and call processing programs are unaware of the added equipment due to the parameter and translation updates that have not yet been accomplished.

**9.04** System evaluation tests (Practice 231-164-005) must be performed prior to and after office growth to ensure that the office is in excellent operating condition. These tests consist of testing the emergency action portion of the MCC to ensure that the system can operate without trouble in all possible configurations of the CCs, CSs, and PSs. Also, the system tests verify that power can be removed and restored to either one of the duplicate buses or equipment units without equipment troubles or adverse system action. An optional test is to execute a manual phase of reinitialization to make sure this function is operational.

**9.05** Restrictions which must be considered in any office growth are imposed by dc power requirements, frame interdependencies (point assignments), frame line-up pattern, special wire-length limitations, and other similar items. The dc power problem is easily solved, but other restrictions create tasks which are different and unique. Each task raises problems which must be solved individually.

**9.06** Besides the addition of growth frames, there are other changes which must be accomplished. Translation changes may be performed before the system testing interval, just prior to diagnostic testing, or after testing to complete growth and merge added equipment into service. Parameter changes may be performed just prior to or after testing. Junctor redistribution is required when JSFs are added or when junctor occupancy changes.

9.07 If there are a number of frames to be installed, they must be added to the existing machine in a certain sequence. There are also certain procedures which are followed for all frames and other procedures which are executed for only a given class of frames.

## 10. GLOSSARY

10.01 The following is a glossary defining some terms used in the 1ESS switch.

### Address

A combination of bits that identifies a location in a storage device or equipment unit.

### Bipolar Pulse

A pulse that may have either a positive or negative polarity.

### Bit (Binary Digit)

A binary unit of information. It is represented by one of two possible conditions, such as, the character 0 or 1, on or off, high potential or low potential, conducting or not conducting, magnetized or demagnetized.

### Buffer

(a) An isolating circuit used between two other circuits. The isolation may be between high-speed and low-speed circuits or between high-impedance and low-impedance circuits. (b) A CS register used to store information until it can be used by the system.

### Bus

A group of leads providing time-shared communication paths over which information is transmitted from any one of several sources to any of several destinations as governed by gates.

### Cut-Through Relay

Relay that is used to complete a talking path only after all ferreed switches have been closed.

### Decode

To translate input information into a form recognizable by the unit receiving the information.

### Enable Pulse

A pulse that permits a unit or circuit to become operative.

### Encode

To code information into a form suitable for transmission from one unit to another.

### Error

A malfunction, the symptoms of which *cannot be reproduced under program control*.

### Fault

A malfunction, the symptoms of which can be reproduced under program control.

### Indexing

The process of adding the contents of a specified index register to that part of an instruction which specifies an address or some data to be operated on.

### Instruction

A binary word which directs CC to perform a particular function.

### Memory

A unit into which information can be placed to be extracted at a later time. The ability to retain information for later use.

### Memory Circuit

A circuit which, having been put in some state by an input signal, will remain in that state after the removal of the input.

**Parameter Information**

Information contained in the PS pertaining to office equipment and certain hardware and software options.

**Parity Bit**

A bit attached to a word to make the total number of ones, including the parity bit, odd or even.

**Parity Check**

A check on the validity of a binary word by determining whether the number of ones in the word is odd or even.

**Program**

An organized set of instructions used to control system functions.

**Read**

To retrieve information from a memory device.

**Real Time**

Actual time of occurrence of an event. A real time control system is one in which information related to a physical process is converted by the control equipment quickly enough so that the outputs obtained are useful in controlling that process.

**Redundancy**

The use of additional equipment and facilities to make possible continuity of service in the presence of troubles.

**Semipermanent Memory**

A read-only memory which contains information that cannot be changed by the internal circuitry of the system but can be changed by external circuitry.

**Subroutine**

A sequence of programmed instructions to perform a particular function which is common to several programs.

**Temporary Memory**

A read and write memory which contains information that can be changed by the internal circuitry of the system.

**Time-Shared Circuit**

A common circuit whose services are used by a number of circuits during separate time intervals.

**Translation Information**

Information contained in the PS or CS pertaining to the individual lines or trunks. It may be used, for instance, to convert a DN into an equipment location, to derive the class of service, etc.

**Translator**

A circuit or program table used to change information from one form of representation to another.

**Trouble**

A fault that causes a deviation from normal system operation.

**Unipolar Pulses**

A pulse of one polarity only.

**Word**

A set of characters associated to express system information. (The term word may be prefixed by an adjective describing the nature of the characters, such as binary word.)

**Write**

To insert information into a memory device.

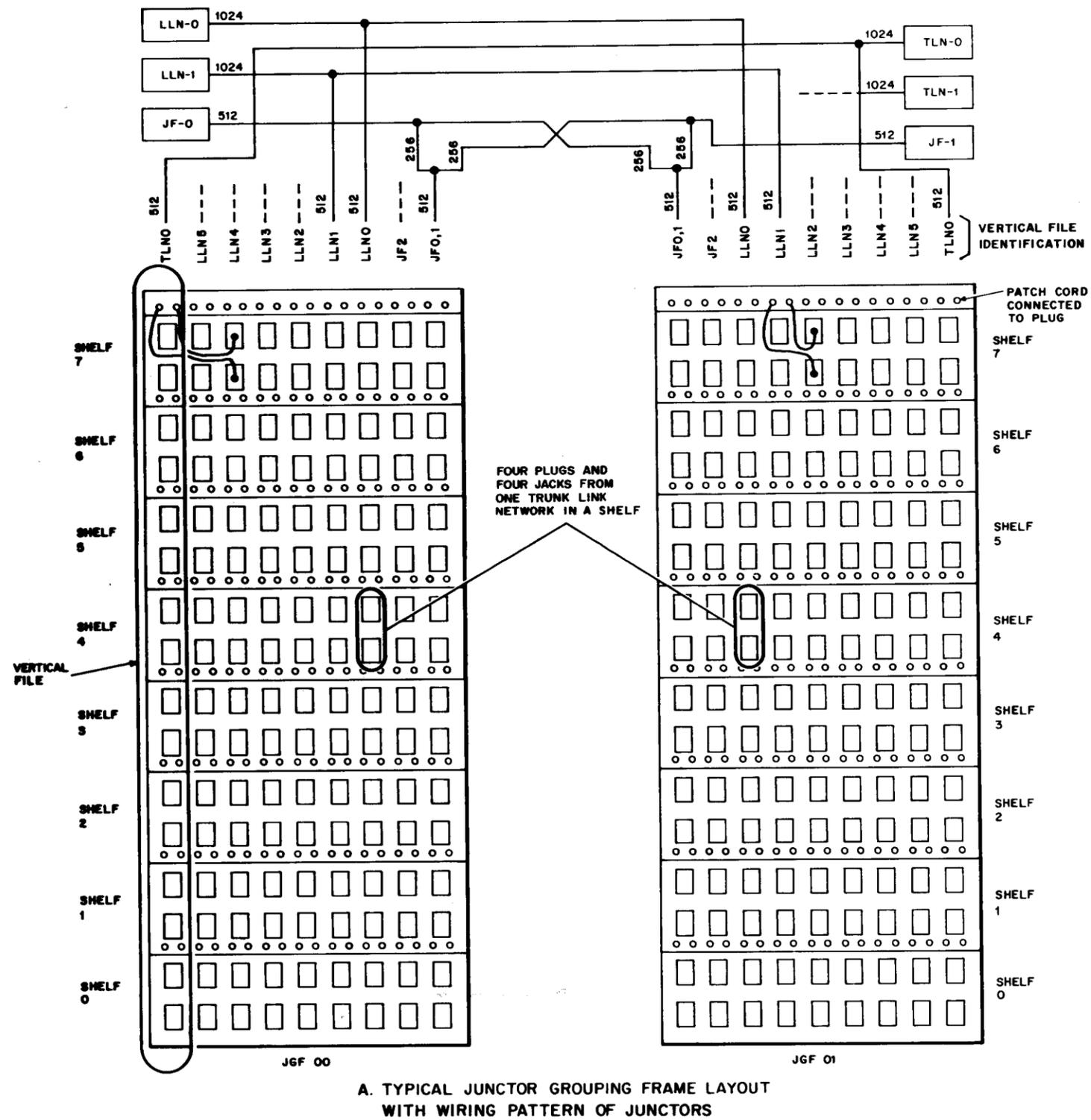
## 11. ABBREVIATIONS AND ACRONYMS

11.01 The following are abbreviations and acronyms used in this practice.

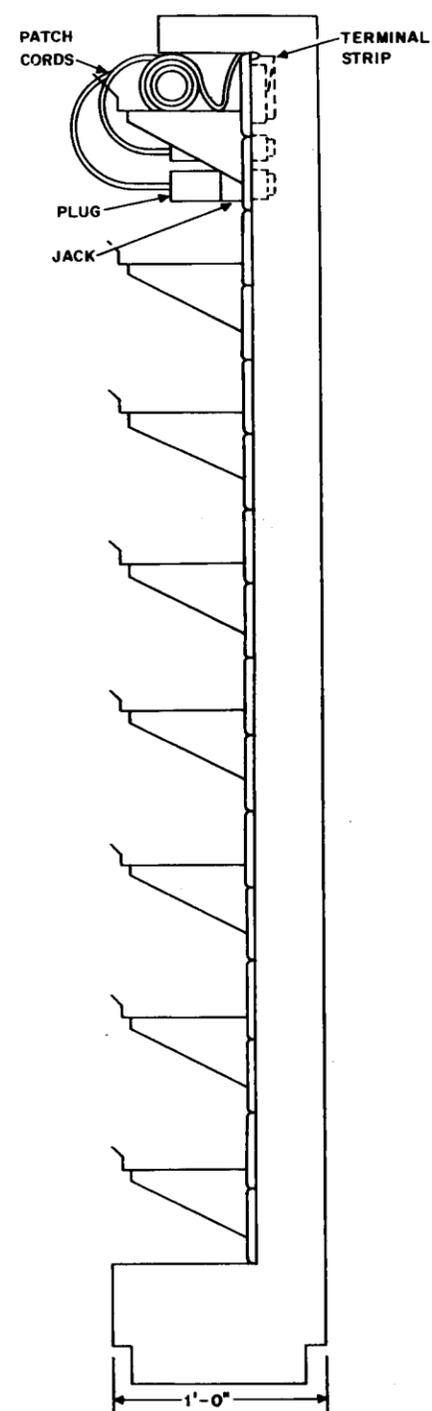
AAR	Automatic Alternate Routing	CC	Central Control
AC	Authorization Code	CCIS	Common Channel Interoffice Signaling
ACD	Automatic Call Distribution	CD	Control and Display Panel
ACSI	Automatic Calling Station Identification	CDL	Centrex Data Link
ADS	Auxiliary Data System	CLID	Calling Line Identification
ADSS	Attendant Direct Station	CLT	Calling Line Identification
AEMIS	ACD-ESS Switch Management Information System	CMT	Combined Miscellaneous Trunk
AIOD	Automatic Identified Outward Dialing	CNCC	Customer Network Control Center
ALIT	Automatic Line Insulation Test	CO	Central Office
AMA	Automatic Message Accounting	CPD	Central Pulse Distributor
AMAT	AMA Transmitter	CPS	Customer Premises System
AMATPS	AMA Teleprocessing System	CPU	Central Processing Unit
AMT	Auxiliary Manual Test	CS	Call Store
ARS	Automatic Route Selection	CSACC	Customer Service Administrative Control Center
ASW	All-Seems-Well	CSRAF	Common System Recorded Announcement Frame
AU	Auxiliary Unit	DAL	Direct Access Line
AUB	Auxiliary Unit Bus	DCS	Duplicated Call Store
AUT	Auxiliary Test Frame	DCT	Digital Carrier Trunk
BLF	Busy Lamp Field	DCTB	Digital Carrier Trunk Bank
BLT	Beltline Maintenance	DN	Directory Number
CACS	Customer Administration Center System	DOC	Dynamic Overload Control
CAROT	Centralized Automatic Reporting on Trunks	DP	Dial Pulse
		DSS	Direct Station Selection
		DUC	Data Unit Controller
		DUS	Data Unit Selector

EADAS	Engineering and Administrative Data Acquisition System	LOC	Local Maintenance
EPSCS	Enhanced Private Switched Communications Service	LRE	Loop Range Extension
ESB	Emergency Service Bureau	LSC	Line Switch Circuit
ETS	Electronic Tandem Switching	LSF	Line Switch Frame
FAR	Facility Assurance Reports	LTD	Local Test Desk
FCG	False Cross and Ground	MCC	Master Control Center
FML	Fixed Message Length	MCS	Memory Card Store
FRL	Facility Restriction Level	MCRC	Mixed Concentration Ratio Change
FS	File Store	MCW	Memory Card Writer
FSC	File Store Controller	MDAL	Multiple Direct Access Lines
HMT	HILO Miscellaneous Trunk	MF	Multifrequency
HUT	HILO Universal Trunk	MM	Message Module
IAC	Improved Authorization Code	MOS	Metal Oxide Semiconductor
IDF	Intermediate Distribution Frame	MS	Master Scanner
I/O	Input/Output	MT	Miscellaneous Trunk
IOC	Input/Output Channel	MTT	Manual Trunk Test
IOT	Input/Output Terminal	MTTP	Manual Trunk Test Position
IOU	Input/Output Unit	MUT	Miniaturized Universal Trunk
IOUC	Input/Output Unit Controller	NEAT	Network Attendant
IOUS	Input/Output Unit Selector	NMG	Network Management
JGF	Junctor Grouping Frame	PBX	Private Branch Exchange
JSC	Junctor Switch Circuit	PCDF	Power Conversion and Distribution Frame
JSF	Junctor Switch Frame	PCI	Program Controlled Interrogator
LCR	Line Concentration Ratio	PDSP	Peripheral Data Storage Processor
LEN	Line Equipment Number	POB	Peripheral Order Bus
LLN	Line Link Network		

PPI	Processor Peripheral Interface	SSD	Supplementary Signal Distributor
PS	Program Store	STT	Supplementary Trunk Test
PSC	Plant Service Center	STTP	Supplementary Trunk Test Panel
PUB	Peripheral Unit Bus	TCM	Traveling Class Mark
PUC	Peripheral Unit Controller	TCR	Trunk Concentration Ratio
PUC/DL	Peripheral Unit Controller/Data Link	TIC	Trunk Interconnection Circuit
RAO	Revenue Accounting Office	TLN	Trunk Link Network
RC	Recent Change	TLT	Trunk and Line Test
RCS	Recent Change Service Order	TR	Transmit-Receive
REM	Remote Maintenance	TSC	Trunk Switch Circuit
ROTL	Remote Office Test Line	TSF	Trunk Switch Frame
RSS	Remote Switching System	UCS	Unduplicated Call Store
SCCS	Switching Control Center System	UDLC	Universal Data Link Controller
SD	Signal Distributor	UN	Uniform Numbering
SMDR	Station Message Detail Recording	UTF	Universal Trunk Frame
SP	Signal Processor	VFLA	Voice Frequency Link Access.
SRM	Supplementary Remote Maintenance		

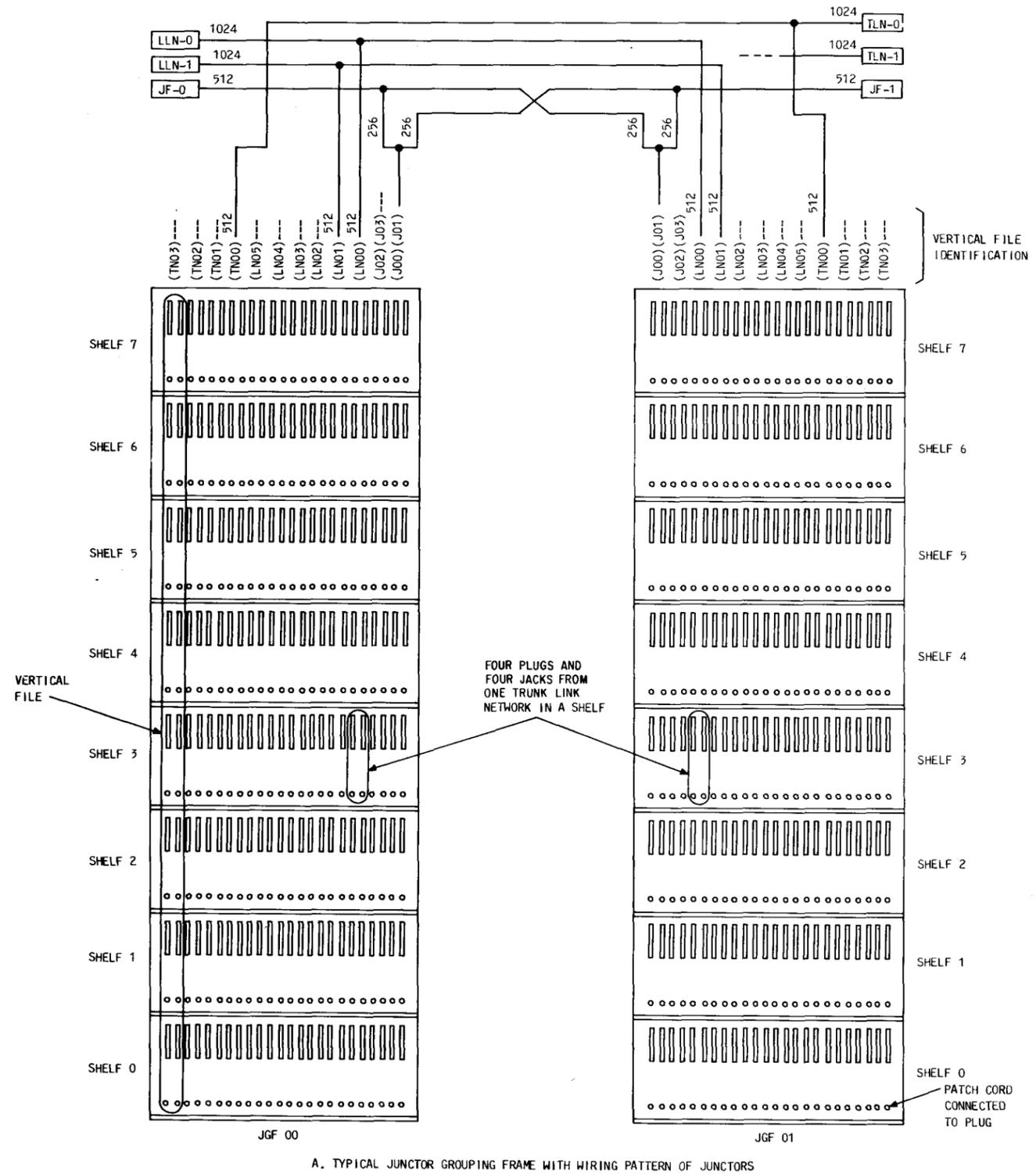


A. TYPICAL JUNCTOR GROUPING FRAME LAYOUT WITH WIRING PATTERN OF JUNCTORS

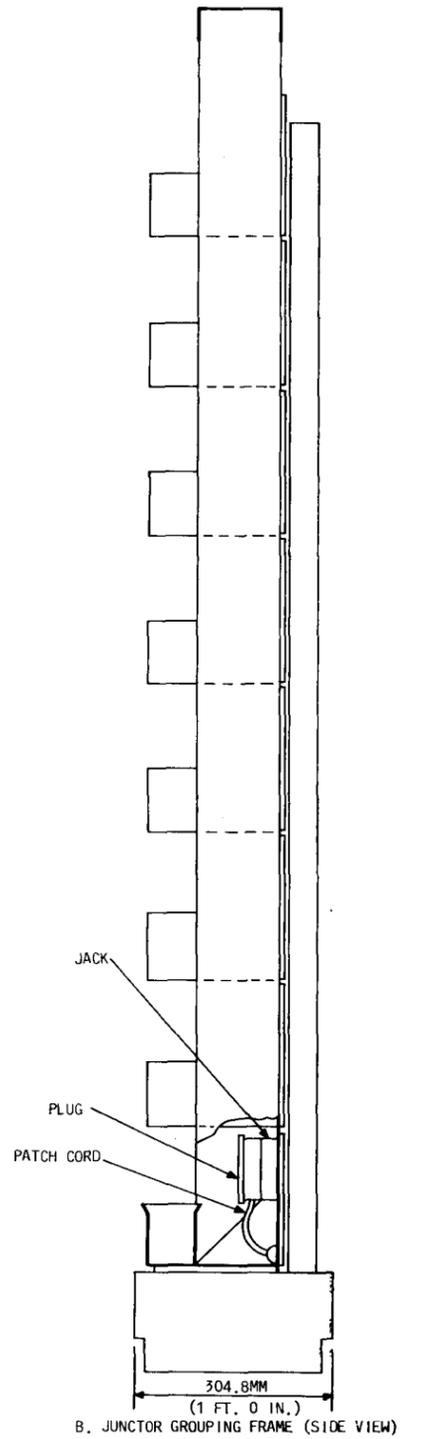


B. JUNCTOR GROUPING FRAME (SIDE VIEW)

Fig. 60—Junctor Grouping Frame Layout 9, Vertical File



A. TYPICAL JUNCTOR GROUPING FRAME WITH WIRING PATTERN OF JUNCTORS



B. JUNCTOR GROUPING FRAME (SIDE VIEW)

Fig. 61—Junctor Grouping Frame Layout 12, Vertical File

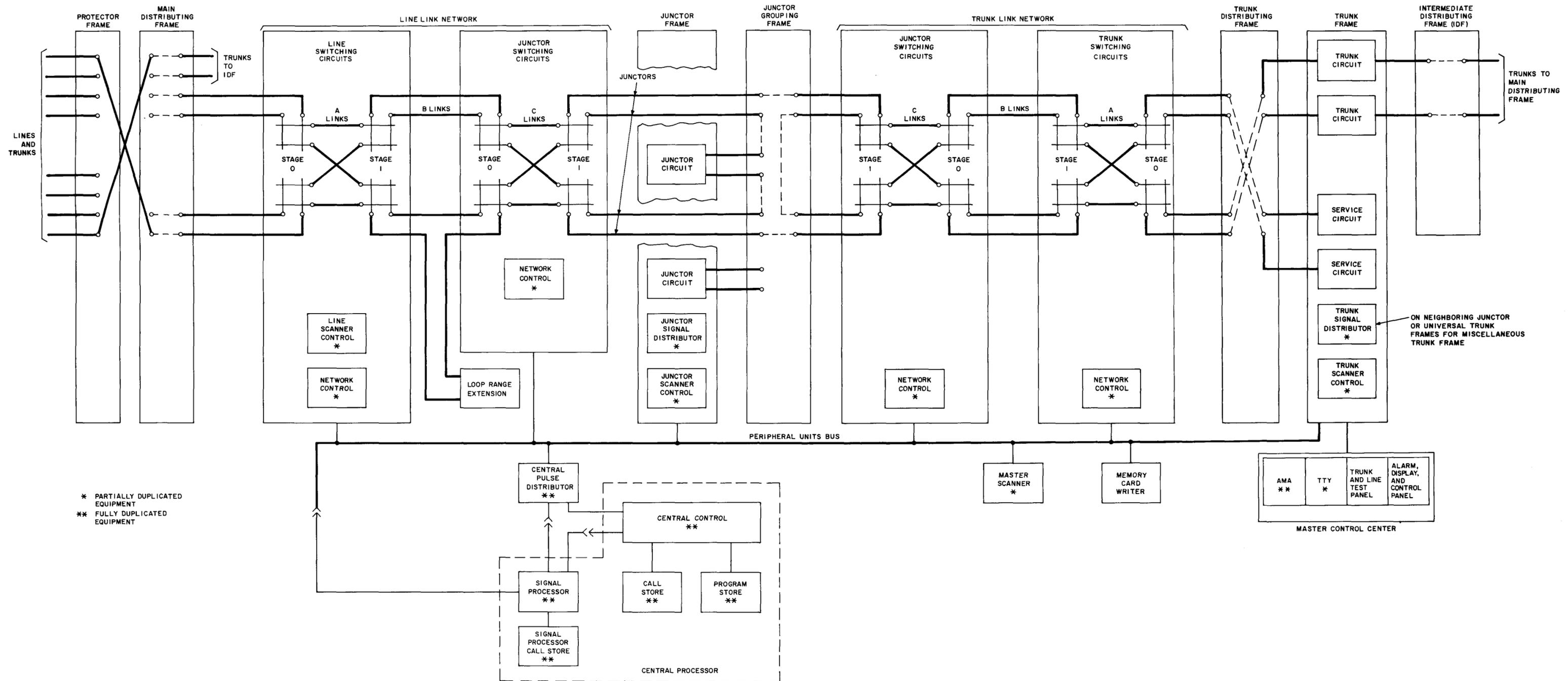


Fig. 62—1ESS Switch Block Diagram

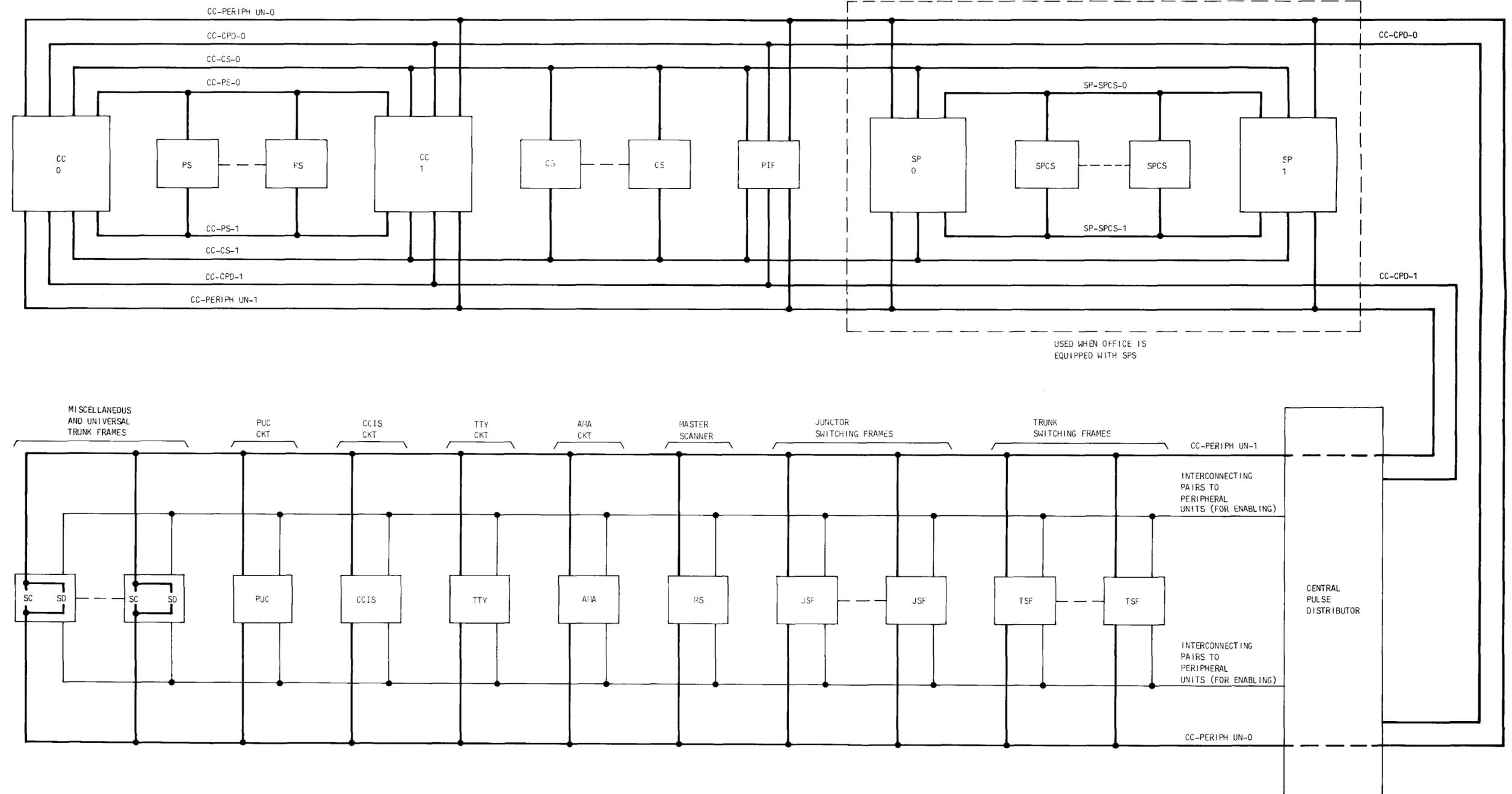
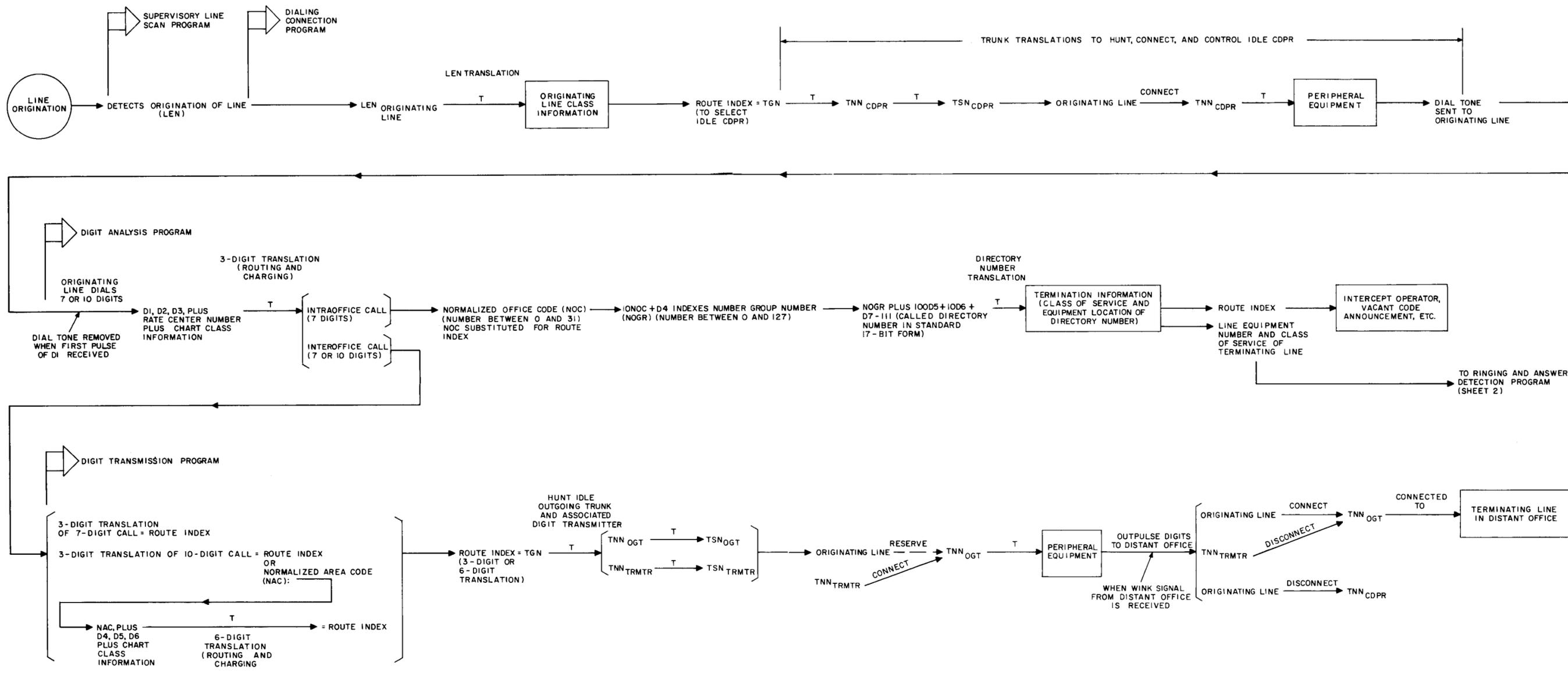


Fig. 63—Bus System and Interconnections - Simplified Diagram



- LEGEND:
- ARTC - AUDIBLE RINGING TONE CIRCUIT
  - BTC - BUSY TONE CIRCUIT
  - CDPR - CUSTOMER DIAL PULSE RECEIVER
  - LEN - LINE EQUIPMENT NUMBER
  - NAC - NORMALIZED AREA CODE
  - NOGR - NUMBER GROUP NUMBER
  - NOC - NORMALIZED OFFICE CODE
  - OGT - OUTGOING TRUNK
  - RC - RINGING CIRCUIT
  - T - TRANSLATION
  - TGN - TRUNK GROUP NUMBER
  - TNN - TRUNK NETWORK NUMBER
  - TRMTR - DIGIT TRANSMITTER
  - TSN - TRUNK SCANNER NUMBER

Fig. 64—General Translation Sequence During Outgoing Call (Sheet 1 of 2)

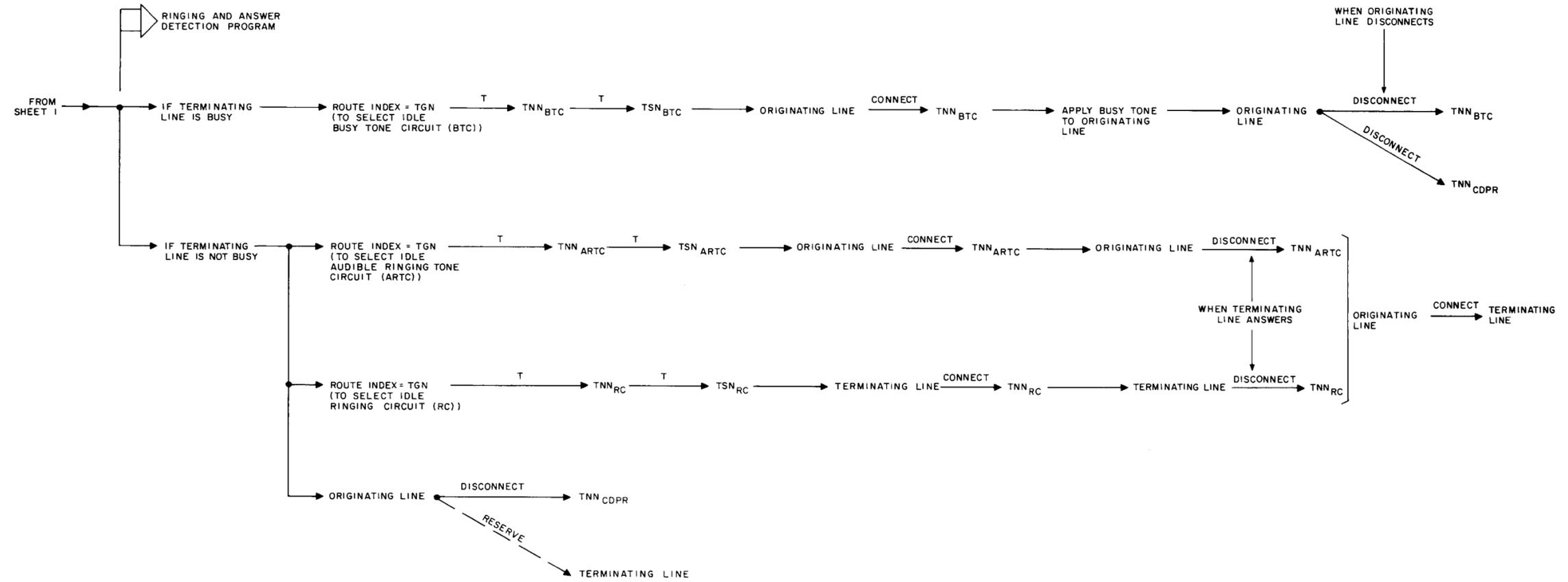


Fig. 64—General Translation Sequence During Outgoing Call (Sheet 2 of 2)