SWITCHING SYSTEMS MANAGEMENT
NO. 1 ELECTRONIC SWITCHING SYSTEM (2-WIRE)
GENERAL DESCRIPTION

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1. GENERAL

1.01 This section describes the operation and major characteristics of the No. 1 Electronic Switching System (ESS) up through the CTX-7 generic program issue.

1.02 When this section is reissued, this paragraph will contain the reason for reissue.

1.03 This section is arranged into six major categories as follows:

(a) System techniques and features

(b) Machine logic and operating programs

(c) Equipment elements and components

(d) Teletypewriters (TTYs)

(e) Equipment additions

(f) Call processing

The System description provided within this section is intended as a starting point for network (dial) administrators who require some technical information. Any detailed investigations of machine functions should be pursued via the Bell System Practices and Bell Telephone Laboratories program descriptions (1A series).

1.04 The No. 1 ESS is an electronic telephone switching system with numerous features which provide system arrangements for a wide range of uses. The 2-wire No. 1 ESS is compatible with all existing equipment; it 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 range of use for No. 1 ESS is local, tandem, and toll switching.

1.05 The No. 1 ESS is a common control type switching system directed by a program and capable of serving a maximum of 98,304 (6:1 concentration ratio) customer lines and a maximum of 32,720 trunks, including service circuits (see note). The No. 1 ESS 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 semipermanent and temporary memories. Variations and changes are accomplished primarily by changing the stored program rather than by changing apparatus and wired logic.

> ***Note:*** Both line and trunk figures given above refer to the total terminations on line and trunk link networks. A minimum of 5 percent of the terminations must be used for administrative reasons so that the actual maximum ***working*** lines and trunks would be at least 5 percent less.

1.06 The title of each figure in this section includes a number(s) in parentheses which identifies the paragraph(s) in which the figure is referenced.

2. TECHNIQUES AND FEATURES

BASIC SYSTEM TECHNIQUES

2.01 Some basic system techniques used in the No. 1 ESS are:

- Stored program control
- Functional concentration
- Time-shared control
- Modular design
- Plug-in equipment units
- Duplication
- Automatic fault location and system reconfiguration

- Built-in traffic measurements.

2.02 ***Stored Program Control:*** The functions performed by the system are specified by programs consisting of 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.

2.03 ***Functional Concentration:*** The system equipment is concentrated in a small number of efficient units, each specialized in some broad system function such as control, input, output, memory, etc. The result is a simple overall No. 1 ESS equipment organization.

2.04 ***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 much higher speeds 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 tasks 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.

2.05 ***Modular Design:*** Traffic-dependent units are provided in modular blocks so that growth is accommodated economically and conveniently. If improvements are made in the design of a module (such as optional 32K call store, redesigned 3-bay line switch frames, the 1A processor, etc) other modules need not be redesigned or replaced unless floor space considerations dictate otherwise.

2.06 ***Plug-in Equipment Units:*** In a major portion of the equipment, circuit components (such as transistors, resistors, etc) are mounted on circuit packs as plug-in units with printed wiring. Faulty circuit packs can be quickly replaced.

2.07 ***Duplication:*** To ensure continuity of service, duplication of equipment is provided for those units whose failure would affect a large number of customers. When an equipment failure occurs, the faulty unit is automatically identified by appropriate programs and immediately taken out of service. The system continues to provide telephone service via the duplicate piece of equipment while the appropriate diagnostic programs submit the faulty unit to a thorough sequence of tests aimed at pinpointing the trouble within one or more plug-in circuits. The results of the tests are printed out by the system via the maintenance TTY.

2.08 ***Automatic Fault Location and System Reconfiguration:*** The No. 1 ESS performs a large portion of its own checking for system troubles. The self-checking scheme provides a system capability to detect a malfunction, automatically identify the malfunctioning unit, remove the unit from service, diagnose the unit, notify maintenance personnel that a malfunction has occurred, and provide results of the diagnostic test.

2.09 ***Built-In Traffic Measurements:*** The ESS machine is always measuring its own performance. Adequate memory must be engineered to store the counts of these measurements. The measurements will always be made automatically by the machine. However, printouts of the measurements must be scheduled appropriately by use of the traffic map. When trunks are added to an existing trunk group, peg count and usage measurements will be automatically set up for the added trunks without separate administrative or maintenance action.

POTS CUSTOM CALLING SERVICES

2.10 The plain old telephone service (POTS) custom calling services provided by the No. 1 ESS are discussed in 2.11 through 2.14.

> ***Note:*** Some centrex features are included in 2.11 through 2.22 but only if they are not significantly different from the POTS feature. See the appropriate 231-series Feature Documents for more details on the features discussed in 2.11 through 2.22, especially for centrex features.

2.11 ***Speed Calling (Abbreviated Dialing):*** Speed calling is the use of codes assigned to frequently called telephone numbers (not usable for tandem tie trunk calls). Speed calling code list sizes of 8 and 30 are available. Centrex stations may be provided only with an individual list containing six codes. Size 30 speed calling lists for centrex are provided on a centrex group basis only.

(a) ***CTX-6 and Earlier Generic Programs:*** Revisions of a code list are made by customer contact with the local telephone company business office and by submitting a revised code list. Code lists require programming on a service order basis. The speed calling customer uses a code by dialing the prefix 11 followed by a one-digit speed calling code (1 through 8) for the small list feature or 11 followed by a 2-digit speed calling code (20 through 49) for the large list feature. Centrex stations dial the prefix 1 followed by a one-digit speed calling code (2 through 7) for the 6-code list feature. For centrex group speed calling, a 11 plus a 2-digit code accesses the size 30 list accessible to that station. For speed calling customers who have 12-button TOUCH-TONE® telephone sets, the * (eleventh) button may be keyed instead of the 11 (or 1) digits.

(b) ***CTX-7 and Later Generic Programs:*** Using the customer changeable speed calling feature, revisions of an abbreviated code list are customer performed by dialing the activating code 74 for the 8-code list or 75 for the 30-code list. A 4-second time-out period is allowed after the activating code is dialed; then a second dial tone is heard. The abbreviated code (2 through 9 are the abbreviated speed calling codes for CTX-7 size 8 code lists) followed by the revised 7- or 10-digit telephone number is accepted from the customer. The use of the prefix 11 or the * button with speed calling codes is no longer required for CTX-7 and later generic programs although it will be accepted. CTX-7 also permits POTS individual lines (not 2-party or multiline hunt) to be arranged with both one-digit and 2-digit speed calling features simultaneously. With the dialing of any speed calling code, a 4-second time-out period occurs. Customers provided with 12-button TOUCH-TONE telephone sets may avoid the 4-second time-out periods by keying the # (twelfth; ie, end-of-dial) button.

2.12 ***Three-Way Calling:*** The 3-way calling feature allows a third party to be dialed or keyed into a 2-party established connection and is available for use with individual noncoin and non-PBX lines. The customer operation of the feature differs in accordance with the generic program installed in the ESS. The feature includes both consultation hold and add-on capabilities. By using consultation hold the 3-way calling customer may hold one party with privacy exclusion while talking to another party. Add-on enables all three parties to be connected simultaneously in a 3-way conversation.

(a) ***Prior to CTX-5 (Flash Interpretation Method):*** These centrex feature generics use the consultation hold or privacy exclusion variation for the 3-way calling feature. The generics also operate without control digits. Three-way calling is performed by the customer (the first party) making a regular call to the first of the two other parties. A switchhook flash is used to place the second party on hold after the call is answered. Three spurts of tone followed by a steady tone are heard to indicate that the third party may be dialed. When the third party answers, a connection is established to the calling party only. A switchhook flash by the calling party establishes a 3-way connection and reconnection of the held party. The last connected (called) party may be diconnected using another switchhook flash by the 3-way call originating party.

(b) ***CTX-5 and Later Generic Programs:*** CTX-5 provides changes to establish standards as follows.

- Code 110 is used for recalling an associated operator.
- Switchhook flashes are recognized any time after outpulsing is complete.
- Transmission requirements are relaxed.

2.13 ***Call Waiting:*** The call waiting feature is provided by a CC-CTX-2, SP-CTX-3, or later generic program. The feature informs a talking customer by two spurts of tone at 10-second intervals that a third party is calling. On the original connection, the tone spurts are heard only by the call waiting customer and the calling party hears an audible ringing signal (any other incoming calls will receive a busy tone). A switchhook flash is used to answer the call and, at the same time, to place the connected party on hold. Switchhook flashes are also used to alternate connections between the parties. To terminate the original call and answer the incoming call, the call waiting customer disconnects and power ring follows. When answered, connection is established with the calling party. No other incoming call can preempt the original incoming call. Call-waiting-terminating is the standard feature; however, centrex stations may arrange for call-waiting-intragroup for intracentrex group calls and/or call-waiting-originating for applying the feature to any called line within a centrex group.

2.14 ***Call Forwarding:*** The POTS call forwarding feature allows an individual line customer to automatically route all incoming calls to another line (with certain restrictions; eg, cannot call forward to 411 directory assistance) which the customer selects. The customer may activate or deactivate the call forwarding feature by dialing the appropriate code. Activation of the feature does not affect a station's capability to originate and deactivation may also be accomplished by the central office maintenance teletypewriter (TTY). Calls are forwarded without regard to the state (idle or busy) of the call forwarding station. Prior to CTX-7, multiple forwarding (see note following 2.14[c]) within the same No. 1 ESS is not permitted and only one call at a time may be forwarded out to another office. The forwarded leg of an incoming call is charged to the customer with the call forwarding service and not to the calling party. Where the call forwarding or automatic message accounting registers are not available, the calling party is routed to overflow. The call forwarding feature is not available for coin, hotel-motel, manual, multiline hunt (except for the listed directory number for the group), party lines, denied termination lines, or master control center lines. The call forwarding feature does not restrict a station from other individual line features; however, call waiting does not operate while call forwarding is activated. There are two methods of call forwarding operation that differ with particular generic programs applied to the central office.

(a) ***SP-1 to CTX-4 Generic Programs (Nonstandard):*** The feature is used by the customer dialing the prefix 11 followed by call forwarding activate code 91. (Prior to CTX-4, the prefix and activate codes had to be translated on the 1300A form.) A second dial tone is then heard and the telephone number (or speed calling code) of the station to which calls are to be forwarded may be dialed. Two tone spurts are heard which indicate that call forwarding has been recorded. When the called party answers the signaling that follows, the feature is activated. The customer can activate the feature without a called-party answer by going on-hook and then repeating the procedure within 2 minutes. Without a called-party answer (busy or idle), two tone spurts are heard to confirm that the feature has been activated. To deactivate the feature, the prefix 11 is dialed followed by the deactivate code 93. Two tone spurts are heard to indicate that the call forwarding feature has been canceled. Customers who have 12-button TOUCH-TONE telephone sets may depress the * (eleventh) button instead of keying the prefix 11.

(b) ***CTX-5 and Later Generic Programs (Standard):*** Simultaneous availability of activate codes 91 (nonstandard) and 72 (standard) and deactivate codes 93 (nonstandard) and 73 (standard) is permitted with CTX-5 and later generic programs. The feature is used by the customer dialing activate code 72, waiting for 4-second time-out and return of dial tone, and then dialing the telephone number (or speed calling code) of the station to which calls are to be forwarded. When the called party answers, the feature is activated after 4 seconds of connection. The customer can activate the feature without a called-party answer (busy or idle) by going on-hook and repeating the procedure within 2 minutes. Without a called-party answer, two tone spurts are heard to confirm that the feature is activated. A short burst of ringing occurs at the call forwarding station for each call that is forwarded. To deactivate the feature, deactivate code 73 is dialed. Two tone spurts are heard to indicate that call forwarding is canceled. Customers who have 12-button TOUCH-TONE telephone sets may avoid the 4-second time-out period by depressing the # (twelfth) button.

(c) ***CTX-7 and Later Generic Programs:*** As a central office optional feature, all individual lines (customers) can be provided with the capability to call forward without specifically purchasing call forwarding as a customer calling feature. This option is set on the 1500D form. Billing is dependent only on activation usage. Remote call forwarding is also provided by CTX-7 for use by a business subscriber who advertises a local directory number for customers. The local directory number is permanently forwarded to the business subscriber's remote location. The total number of activated forwarded calls in an office is limited by a predetermined number in parameters. Call forwarding requests in excess of this number are routed to Route Index 0115 (call forward denied announcement).

> ***Note:*** Multiple call forwarding within the same No. 1 ESS switcher is provided with CTX-7 and later generic programs. A maximum of five forwarded legs may be established. Each forwarded station is charged for its portion of the forwarded leg.

OTHER CALLING FEATURES

2.15 ***International Direct Distance Dialing (IDDD):*** The IDDD feature is provided by CTX-4 and later generic programs. The feature provides station-to-station overseas calls when prefixed by the access code 011. The access code may be followed by from 7 to 12 digits consisting of a country code (from one to three digits) and the national number. Charge recording is performed by local automatic message accounting facilities.

2.16 ***E-Digit Unblocking:*** The feature is provided by CTX-5 and later generic programs and retrofitted in Issue 4 of CTX-2 through CTX-4 programs. The feature permits the E digit (fifth digit) of a 10-digit direct distance dialing call to be 0 or 1. The feature also allows the use of NXX (N=2 through 9, X=0 through 9) office codes for areas where NNX codes are exhausted and with directory numbers of form N 1/0 x-xxxx.

2.17 ***Party Line Service:*** Party line service is provided with full selective ringing to 2-party line customers, semiselective ringing to 4-party line customers, and semiselective ringing to 8-party line customers. Four- and eight-party customers are customers normally located in rural areas where the cost of wire to each single customer is uneconomical. A set of customers then shares a common line from the central office. The service is provided by SP-CTX-4 and later generic programs.

2.18 ***Manual Originating Line Service:*** Manual service can be provided to customers who require operator assistance for all originating calls. When a manual customer goes off-hook, the line translation indicates that the service request is from a manual station. A digit receiver is connected to the line but dial tone is not applied. Transfer of supervision is then checked and false cross and ground tests along with power cross tests are made. The digit receiver is then released. By using an operator trunk, a connection is established to an operator as though the customer dialed 0. The operator completes the call as requested by the customer.

2.19 ***Station Hunting:*** The station hunting feature routes an incoming call to an idle station line of a prearranged group when the called station is busy with CTX-5 and earlier generic programs. Station hunting may be accomplished by either of two methods:

(1) Series completion

(2) Multiline hunting.

Newer generic programs have four additional hunting features with multiline hunting:

(1) Circle multiline hunt (CTX-6 and later)

(2) Uniform call distribution (CTX-6 and later)

(3) Preferential multiline hunt (CTX-6 and later)

(4) Multiple position hunt (CTX-7 and later).

The series completion method is used only for small groups that never contain more than 16 lines. The multiline hunting method is used for larger hunting groups.

(a) ***Series Completion:*** Series completion station hunting is accomplished by using the directory numbers of each line in the prearranged group where only lines with assigned directory numbers are allowed to be members of the group. When a series completion group station directory number is dialed and the station is found busy, the next station directory number of the group list is tested. Using the series completion hunting method, one of two methods can be used to determine the next directory number location. When using the ***consecutive series completion*** method, the system causes an octal 1 to be added to the busy directory number. When using the ***nonconsecutive series completion*** method, the system uses the next directory number associated with the directory number found busy. The potential of infinite looping is prevented by the system limiting the number of repeated hunts. Hunting ceases when an idle line is detected or a stop hunt terminal is reached. Consecutive series completion will use fewer translation words in program store than nonconsecutive series completion will use.

Note: No. 1 ESS generic programs are arranged with a one to zero unit numbering sequence. Therefore, a consecutive series would be, for example, 21 through 20, or 91 through 90. Assigning the first line with a directory number ending in zero (or group of zeros) would not constitute consecutive series completion.

(b) ***Multiline Hunting:*** Multiline hunting is performed by using line equipment numbers where each line in the group has a line equipment number but not necessarily an assigned directory number. Only one directory number (listed directory number) is associated with the lines in a multiline hunting group. Each group line is represented by a terminal number. The hunting list line equipment numbers are scanned starting with terminal 1 since terminal 0 is not assigned in the arrangement. Each terminal in the group is hunted until an idle line equipment number or a stop hunt indication is detected. When an idle line equipment number is located, the station line is then connected to the incoming call.

(1) ***Circuit Multiline Hunt:*** This feature will allow the program to perform a regular hunt starting at the group terminal number of the called number to the end of the group, then returning to group terminal number 0001, and hunting to the terminal number preceding the one associated with the dialed number. This feature may be used in place of regular hunt or may be used optionally with preferential hunt. It must be applied to uniform call distribution.

(2) ***Preferential Multiline Hunt:*** This feature allows the individual group terminal numbers of the hunt list to have a separate "preferential" list consisting of any terminal numbers in the hunt group in any sequence. This list will be sequentially hunted for an idle line if the called terminal number is found busy. The last terminal in the preferential list will be considered the start hunt terminal number for a regular or circle hunt (see [1] above) if all the terminal numbers in the preferential list are found busy. A maximum of 18 terminals can be assigned in each preferential list. Preferential multiline hunt is available with either large (0000 to 0063) or small (0064 to 2047) multiline hunt groups. However, only group terminal numbers 0001 to 0063 are valid entries for the members.

(3) ***Uniform Call Distribution:*** This feature provides for equal distribution of incoming traffic to the terminal numbers in the multiline hunt group. A start hunt pointer, located in the call store activity block, will be used as the start hunt terminal number whenever the multiline hunt group receives an incoming call. When an idle terminal is found, another search will be made for the next idle line. This second idle line will become the next start hunt terminal number for the next incoming call. Circle hunt is mandatory when uniform call distribution is specified.

(4) The multiple position hunt feature is a new type of multiline hunting arrangement (CTX-7) that distributes incoming calls to attendant positions according to the type of call (eg, "dial 0", list directory number, etc). A maximum of 16 positions is allowed. Each position must be equipped with a release key and is allowed to have a maximum of 32 key-operated loops, except for the first position which can have only 31 loops. The multiple position hunt feature provides for the distribution of a maximum of six types of calls. Each call type is referred to as a subgroup and can have a maximum of five or six terminals per position. At least one start hunt directory number and an associated terminal are required for each subgroup that is to be established. Additional start hunt directory numbers are possible by associating them with terminals of an established subgroup on a one-for-one basis (one directory number, one terminal) at the expense of sharing the subgroup.

2.20 ***Automatic Queuing of Trunks and Lines (AQTL):*** With CTX-6 and higher generic programs, an automatic queuing of trunks and lines has been made available for application to multiline hunt groups. This feature allows the incoming calls to be placed in a queue (on a ringing register) when all terminal numbers are busy.

2.21 This queue will function on a first-in-first-out basis; that is, the call that has been in the queue the longest will be connected to the first terminal that becomes idle. The number of calls that will be allowed into queue will be equal to one-half the number of lines in the multiline hunt group.

2.22 This feature (queuing) has the ultimate effect of providing the customer with more lines than are actually being purchased. This queuing could, therefore, tie up all the ringing registers on calls waiting in queue for one particular multiline hunt group. Hence, some discretion is necessary in the use of this feature in the CTX-6 generic.

> ***Note:*** With CTX-7 and higher generic programs, a number of improvements were made in the queuing feature. The number of calls that will be allowed in queue has been made variable. Also, calls in queue are placed on a special queue register, thereby alleviating the previous problems of congestion.

OFFICE OPERATIONAL FEATURES

2.23 Some major office operational features provided by the No. 1 ESS are discussed in 2.24 through 2.32.

2.24 ***Tandem Operation:*** This feature is provided by CTX-6 and later generic programs. The feature provides for a No. 1 ESS office to be arranged for operation as a combined local (class 5) and class 4 toll center. This center is capable of accommodating toll, operator, and/or plant test codes coming in on intertoll, secondary intertoll, and/or direct distance dialing access trunks. Operations as a class 2 or class 3 toll office are restricted to special cases.

2.25 ***2048-Junctor Trunk Link Network (TLN) (Phase 1):*** CTX-7 and later generic programs provide the No. 1 ESS with a maximum capacity of 32,768 termination in a 1:1 concentration ratio. The 1:1 2048-size TLN is for tandem and class 4 toll/tandem offices. Line link networks (LLNs), service link networks, and 1:1 1024-size TLNs cannot be used with these offices.

2.26 ***No LLN:*** The CTX-7 feature permits an office to function without any LLNs.

2.27 ***Maintenance of Tandem and Toll Trunks:*** CTX-7 and later generic programs provide additional maintenance features to the existing 100, 101, and 105 test lines. (See Feature Document 231-190-299.)

2.28 ***Operation With Automatic Intercept System (AIS):*** The AIS feature allows No. 1 ESS local offices to route regular and trouble intercept calls to an automatic intercept center (AIC) 1A. The No. 1 ESS office multifrequency-outpulses an information digit, along with the 7-digit called number, indicating an intercept treatment class. The AIC will return an announcement or connect to an operator, depending on this indication and the calling customer's action (held or disconnected).

2.29 ***Network Management:*** The first phase of the network management feature is available with CTX-6 and later generic programs. The capabilities provided for network management with the first phase include code blocking and preprogrammed trunk group control. In addition, the capability to receive the origination of dynamic overload control signals is provided. The second phase of the network management feature is available with CTX-7 and later generic programs. This phase of the feature expands on existing capabilities by providing flexible trunk group controls. In addition, the capability of controlling subtending offices is provided through the detection of overload and dynamic overload control signals. In order that the network manager might be more aware, on a near real-time basis, of the conditions of the switching system and network, an interface for a status display board is provided. The receiver attachment delay report feature, also available with CC- or SP-CTX-7 and later generic programs, provides the network manager with additional information on the status of the switching system. the TTY is the primary interface between the network manager and the switching system.

2.30 ***Trilevel System Alarms:*** CTX-7 and later generic programs provide for a critical alarm in addition to the existing alarms. The alarm sounds when the system encounters or is about to encounter a catastrophic failure. Minor alarms sound for 6 seconds or continuously under the maintenance TTY control. The three alarms are:

(1) Critical alarm

(2) Major alarm and major power alarm

(3) Minor alarm and minor power alarm.

2.31 ***Service Observing (Multiline):*** Service observing on lines and PBX trunks (dial line) is a service using an observing desk (or a No. 6 service observing set) over multiline circuits to jack panels at the main distribution frame. The jack panels are distributed over the main distribution frame in a pattern which provides acess by patching cord to any line or PBX trunk when required for service observing. The distribution pattern permits flexibility in the number of observing circuits that can be provided in any large or small office. The quantity of service observing attachments is determined in conjunction with the service observing organization.

2.32 ***Calling Line Identification Interoffice (Without Trace Tone):*** Calling line identification interoffice (without trace tone) provides the feature for tracing certain types of calls in No. 1 ESS.

2.33 ***Centralized Automatic Message Accounting (CAMA) Tandem Automatic Number Identification-Operator Number Identification:*** This feature is available with CTX-6 and later generic programs. CAMA tandem provides automatic message accounting for other class 5 offices. Refer to Bell System Practices Section 231-201-101 for a description.

2.34 ***Compatibility With MJ Radio and 1A Line Concentrator:*** This feature allows No. 1 ESS telephone customers to be served via the MJ/MK mobile radio telephone system or the 1A line concentrator system.

PROGRAM INFORMATION

2.35 The functions performed by the ESS 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) ***A Generic Program For Controlling All System Operations:*** A generic program is constructed in such a manner 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 errors or "bugs" and the capability of every office to provide any feature and service associated with the generic program. The two types of generic programs produced are the CC-CTX generic and the SP-CTX generic. The SP-CTX generic is designed for offices with heavy calling traffic which places a heavy load on the central control.

(b) ***Translation Data:*** Translation data provide the generic program with information about individual lines, trunk, and service circuits which may require frequent revisions.

(c) ***Parameter Data:*** Parameter data are engineering information which contains details about office equipment and certain hardware and software options in the office which are infrequently modified.

CENTREX SERVICE

2.36 Centrex service is divided into two classes: CTX-CO and CTX-CU. The main office provides all switching arrangements for CTX-CO. Switching equipment is located on the customer premises for CTX-CU. The CTX-CU with the No. 1 ESS can provide direct inward dialing and automatically identified outward dialing. Refer to Bell System Practices Section 966-102-100 and/or Translation Guide TG-1A for a complete list and an explanation of other centrex features.

3. MACHINE LOGIC AND OPERATING PROGRAMS

MACHINE LOGIC OVERVIEW

3.01 No. 1 ESS has the same functional components as a digital computer; this type of computer performs mathematical operations of addition, subtraction, multiplication, and division very quickly.

3.02 For a computer to solve any problem, two kinds of information are required: first, the ***data*** to be manipulated and, secondly, the instructions (or ***program***) on what to do. A program is a step-by-step instruction on what to do with the data and the order in which it is to be done. A digital computer or an ESS machine requires all of the following information:

(a) ***Input:*** A means of entering data for processing.

(b) ***Memory:*** A place to store data until they are needed.

(c) ***Program:*** Instructions which direct operation.

(d) ***Control:*** A unit to manipulate the data as directed by a program. This unit is called a central control.

(e) ***Output:*** A unit to transmit the results obtained from control.

(f) ***Bus System:*** An internal communications path between units.

(g) The combination of memory, programs, and the control unit is known as the central processor. The central processor always contains a central control.

3.03 ***Data:*** Data, stored in machine memory, are represented by use of the ***binary*** numbering system. Since most machine conditions are either functionally on/off (busy/idle) or require yes/no answers to machine logic inquiries, the binary system is best suited for data storage. All that is required is to let a zero represent one state and let a one represent the other. In ESS, a one normally indicates a yes (or active) condition and a zero indicates a no (or inactive) condition.

3.04 ***Data Services:*** Data inputs to an ESS are either external or internal in origin. ***External*** inputs would typically be received from a TTY. The network administration group, for example, may input a schedule for the collection of traffic data, or the maintenance group could input information on a customer's telephone service. ***Internal*** inputs originate within the ESS machine itself. Sensors are associated with lines, trunks, and service circuits to provide input. The busy or idle status of all lines and trunks within an ESS is a continuous source of internal inputs.

3.05 ***Data Memory:*** Memory stores data magnetically. It receives data from input units and magnetically stores this information until it is needed. One area of memory, designated call store, magnetically stores information on thousands of small ferrite rings called cores. Each memory core can be magnetized in either a clockwise or in a counterclockwise direction in order to represent a zero or a one. Another area of memory, called program store, utilizes small bar magnets attached to a metal sheet called a card. Bar magnets are magnetized or demagnetized to represent a zero or a one. A more complete physical description of call store and program store is given in Part 5 of this section.

3.06 ***Data Outputs:*** Outputs may be either internal or external. Internal output typically consists of the commands between units of equipment that require some action to be performed. Internal output either completes telephone calls or maintains system operation. External output is the data transmitted to either central office maintenance, dial administration, or a plant service center and indicates system status.

PROGRAM ORGANIZATION

3.07 Programs include all of the instructions for machine operation. The organization of the No. 1 ESS generic program has been influenced by the following factors:

(a) To accommodate a large number of calls (up to approximately 120,000 equivalent incoming and outgoing interoffice calls during the peak busy hour of the busy season for CTX-7 generic programs)

(b) To provide sufficient flexibility for office growth and addition of recently developed service features

(c) To accommodate a signal processor if required by the initial size of the office or by growth

(d) To provide automatic detection and diagnosis of trouble conditions.

3.08 The entire program consists of from 160,000 to 260,000 instructions. Of these, approximately one-half are devoted to call processing and related functions while the other half is devoted to automatic maintenance.

3.09 Various versions of the generic programs have been instituted since the installation of the first No. 1 ESS. The coding for these versions is based on whether the office is equipped with a signal processor or not. A prefix code of either CC (for central control), for offices without signal processors, or SP, for offices with signal processors, identifies the type of office to which a particular generic applies. A numeral follows the prefix code (eg, CC-1 or SP-1) to indicate the version of the program. If centrex service is applicable within the program, then CTX will follow the prefix (eg, CC-CTX-1 or SP-CTX-1). SP or CC, Issue 4, and later generic programs, all have the centrex capability but the option is not used in some offices.

3.10 Four terms are used to describe generic program changes. They are as follows:

(a) ***Retrofit:*** Means to change from one generic program to another; eg, converting an office from an SP-CTX-4 to an SP-CTX-6.

(b) ***Restart:*** Means to change to a higher program issue; eg, to change from CC- or SP-CTX-6, Issue 4, to CC- or SP-CTX-6, Issue 7.

(c) ***Point Issue Change:*** Means to change from one generic program issue to another in the same issue series; eg, to change from CC- or SP-CTX-5, Issue 2.1, to CC- or SP-CTX-5, Issue 2.3. Note that the issue series is the same.

(d) ***Overwrite:*** Means to change a specific item within a generic or parameter area. The basic generic issue or series remains the same. The decision to make this type of change is made by Bell Telephone Laboratories only. The translation and parameter areas of program store can also be changed by transferring information from call store with a memory card writer. TTY additions and revisions are held in call store.

3.11 Programs contained within the generic program are divided into six functional groups. Figure 1 illustrates the generic program and it is suggested that this figure be used for reference throughout this part. Programs are functionally grouped as follows:

(a) ***Executive Control Program:*** Schedules the order in which input, output, and call processing programs are used.

(b) ***Input Programs:*** Direct input hardware to scan the switching network. The resulting information is reported to call processing programs.

(c) ***Output Programs:*** Process parts of a call at the direction of call processing programs.

(d) ***Call Processing Programs:*** Control aspects of call processing.

(e) ***Service Routine Programs:*** Assist the ESS in the translation of information. These programs are shared by input, output, and call processing programs.

(f) ***Maintenance Programs:*** Provide direction for the detection and diagnosis of system failures. These programs locate, remove from service, and isolate faulty equipment.

These program functional groups are discussed in detail in 3.16 through 3.21.

3.12 The organization of the program is related to the organization of the information stored in the temporary memory of the call store. In general, each program functions with one or more call store 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.

3.13 Each call store area consists of one or more words. The size and layout of the area vary from case to case. A call store 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 customer digit receiver 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.

3.14 The organization of the No. 1 ESS program is strongly influenced by the fact that the system must operate in real time; that is, the No. 1 ESS system must respond promptly to actions that occur at times not under the control of the system. A single time-shared, high-speed central control must keep up with the flow of information from subscribers and from distant central offices. 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 of function and when it is postponed for a number of milliseconds there is no noticeable effect on service. Detecting dial pulses is a nondeferrable type of function; if it is postponed for even 5 milliseconds, pulses may be missed and digits may therefore be mutilated.

3.15 Nondeferrable type operation is carried out on schedule by a clock interrupt or a maintenance interrupt. Program execution is interrupted immediately and a transfer is 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.

3.16 ***Input Programs:*** Input programs detect inputs and report changes or events to call processing programs which analyze the report and perform any required action. Input programs are as follows.

(a) ***Supervisory Line Scan Program:*** This program looks at every customer's line equipment five times per second to detect a request for service.

(b) ***Dial Pulse Scan Program:*** This program detects and counts dial pulses generated by a customer dialing. To ensure that the dial pulses are counted properly, the customer dial pulse receiver is scanned every 10 milliseconds or 100 times per second. This program performs permanent signal and partial dial timing, measures intervals to determine when pulses have ended, and reports when the first digit dialed is detected (to have dial tone removed).

(c) ***TOUCH-TONE Digit Detection Program:*** This program controls the monitoring of a customer TOUCH-TONE receiver. In all other areas, this program provides the same information as does the dial pulse scan program.

(d) ***Multifrequency (MF) Digit Detection Program:*** This program controls the monitoring MF incoming receivers. MF pulsing from an incoming trunk is scanned 100 times per second.

(e) ***Ringing Trip Scan Program:*** This program controls the scanning of a line ten times per second to detect an answer by the called customer. This is necessary in order that ringing may be removed from the line at the appropriate time.

(f) ***Supervisory Trunk Scan Program:*** This program directs the monitoring of incoming and outgoing trunks. It can only detect a change in the state of a trunk. This information is sent to a call processing program or to the hit timing input program for evaluation.

(g) ***Supervisory Junctor Scan Program:*** This program detects changes in the junctor from off-hook (busy) to on-hook (idle). This program reports changes in the supervisory state of a junctor to the hit timing program.

(h) ***Hit Timing Program:*** This program receives inputs from the supervisory trunk or junctor scan programs. It times the duration of the on-hook condition to determine if a true disconnect has occurred. This program inputs information into a call processing program.

3.17 ***Call Processing Programs:*** The functions of the call processing programs are as follows.

(a) ***Dialing Connection Program:*** This program is used to set up a dialing connection. A report that a line has requested service is the input to this program. To serve the request, the program performs several functions. First, it stores the data regarding the calling line and the number that the customer is dialing. Secondly, it acquires information about the calling line: for instance, is it dial pulse or TOUCH-TONE; is the line one-party or 2-party; is it a PBX trunk or a coin line; or has the line been denied service for some reason? When the answers to these questions have been obtained, the program selects the appropriate call processing program or service routine program to assist and selects the proper equipment to process the call. There are various tests that this program makes on the customer's line before it actually returns the control to the executive control program.

(b) ***Digit Analysis Program:*** This program is used to record and analyze the digits dialed and to determine the destination of the call. The program is responsible for recording, counting, and interpreting the customer's digits as digits are dialed to determine the routing of the call. It also determines whether a charge is to be made for the call. On an originating call, the digit analysis program selects an outgoing trunk to the distant office, selects the proper type of digit transmitter, and establishes a connection between the outgoing trunk and the digit transmitter. The program then passes control to an outpulsing program and finally returns control to the executive program.

(c) ***Ringing and Answer Detection Program:*** This program is used to establish the ringing connection, to detect the called customer's answer by activating the ring trip scan program, and to establish the talking connection. The program connects ringing to the called line, connects audible ringing tone to the calling line or trunk, establishes a talking connection if the call is answered, and removes all connections if the call is abandoned before answer. Control is returned to the executive control program.

(d) ***Disconnect Program:*** This program is used to control the disconnect of the call and to restore the lines to the idle state. Unless a special service call or a coin call is in progress, no other call processing program is called upon until one of the customers disconnects. Functions of the disconnect program are:

(1) To detect switchhook flashing by those lines permitted to request special services

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

(3) To signal disconnects to a distant office over the incoming or outgoing trunk

(4) To remove a talking connection at disconnect

(5) To restore to idle any lines or trunks used in a call

(6) To restore control to the executive control program.

(e) ***Outpulsing Program:*** Since each form of output signaling (dial, revertive, panel call indicator, and MF pulsing) has a different transmitter circuit, this program causes the outgoing trunk and the transmitter to be set in the proper states to test the continuity and polarity of the pair of leads to the distant office, to send a seizure signal, to detect a start pulsing signal from another central office, and to then cause the called number to be transmitted. The outpulsing program does this with the cooperation of output programs capable of generating the outgoing pulses and returns control to the executive control program.

(f) ***Operator Program:*** Calls to the operator are passed to this program. The actions required are different from those required for other types of calls. For example, calls to assistance and toll operators provide for joint holding and these operators are permitted to ring back an off-hook or on-hook line. Operators can also collect and return coins. In addition to assistance and toll operators, there are directory assistance, intercept, and repair service operators, all with their own functions and signaling arrangements. Control is returned to the executive control program.

(g) ***Permanent Signal and Partial Dial Program:*** This program handles call attempts which become permanent signal or partial dials. The program switches the call to an announcement requesting that the customer hang up and then to a distinctive receiver off-hook tone for a timed interval. If these actions do not succeed, the program connects the line to the high-and-wet list. Control is returned to the executive control program.

3.18 ***Service Routine Programs:*** These programs are activated by a variety of programs. They are as follows.

(a) ***Translation Program:*** This program gains access to the translation tables in the program store. Translation tables contain translations from line equipment numbers to calling line class and directory numbers; from office code to routing information and charge class; from directory number to line location and class. Control is returned to the program which activated the translation program. A program which passes control to a service routine program is termed the ***client*** program.

(b) ***Network Control Program:*** The primary function of the network control program is to hunt for idle network paths, to administer the network map and path memory, and to load instructions in memory used to operate network paths. This program has the capability to find an idle trunk in a group, make a second trial if all paths to the first selected trunk are busy, and consult the translation program to find an alternate route if all trunks are found busy in the first choice trunk. It can reserve a path from one terminal to another terminal for expected use at a later stage of the call. The network control program records pertinent information about a path at the time a connection is made or removed and returns control to the client program.

(c) ***Change-In-Circuits Program:*** When a call processing program determines that there is a change of state in a trunk or service circuit and a test is required, it calls upon the services of the circuit control program. This program will load an area of memory with the operations necessary to implement the changes and actions needed to check whether the operation was performed successfully. Control is returned to the client program.

(d) ***Coin Control Program:*** The coin control program tests for the presence of coins and controls the function of coin circuits for the collection and return of coins. Control is returned to the client program.

3.19 ***Output Programs:*** These programs provide the direction for the control of various output equipment units. They are listed as follows.

(a) ***Peripheral Order Buffer Execution Program:*** Orders for peripheral units are distributed via the No. 1 ESS Peripheral Bus System. The Bus System connects central control with peripheral equipment units. The order data, consisting of addresses and control information, are stored in temporary memory areas called peripheral order buffer. This program controls the rate and transmission of the order data and is responsible for seeing that the correct addresses and instructions are sent. The program checks whether the proper action was taken in response to the instructions, reporting the success or failure of the requested action back to the call processing program.

(b) ***Digit Transmission Program:*** A call directed to another central office requires that the transmitted called number be in acceptable form. There are several types of signaling: dial pulsing, revertive pulsing, panel call indicator, and MF pulsing. Each type of signaling requires a particular transmitter circuit. The digit transmission program controls the appropriate transmitter circuit and reports to a call processing program.

(c) ***Call Charge Reporting Program:*** This program controls the processing of call charge information, automatic message accounting, and reports to a call processing program.

3.20 ***Maintenance Programs:*** These programs provide for detection and diagnosis of failure either automatically or by manual request. If a unit in the system becomes faulty, it is most important that the faulty unit be identified and isolated as quickly as possible. After the faulty unit has been removed from service, diagnosis of the problem is a deferrable task that can be completed when traffic load permits. Nondeferrable maintenance programs have the highest priority and deferrable maintenance programs have the lowest priority.

3.21 Three types of maintenance programs provide the instructions needed to maintain the call processing capability of the ESS and to isolate faulty equipment. They are as follows.

(a) ***Fault Recognition Programs:*** The first type of maintenance program is the fault recognition program which is nondeferrable. The purpose of the fault recognition program is to restore the call processing capability of the system when a trouble is detected. It does this by first determining whether the trouble detected is an ***error*** or a ***fault***.

(1) ***An error is a malfunction that cannot be reproduced.*** Central control may detect a mismatch which is not present upon verification.

(2) ***A fault is a reproducible malfunction that can be diagnosed.*** In the case of a fault, the program will identify the faulty unit and remove it from service. It then records a request for a diagnosis of the faulty unit and records all pertinent information. The system is then returned to normal call processing.

(b) ***Diagnostic Programs:*** The second type of maintenance program is the diagnostic program. Its purpose is to localize a fault to a small number of plug-in circuit packs within a unit that has been taken out of service. Typically, a diagnostic program carries out a fixed sequence of tests. These tests are performed by observing either the normal outputs of a unit or special test points strategically located within the unit. The program records tests that pass or fail. Unlike the fault recognition programs, diagnostic programs are deferrable.

(c) ***Routine Exercise Programs:*** The third type of maintenance program is the routine exercise program which is deferrable. The purpose of these programs is to:

(1) Supplement the trouble detection facilities. For example, test calls are initiated occasionally to detect troubles that might escape circuit detection.

(2) Search for uncorrected errors. For example, some programs check the validity of information contained in the call stores.

(3) Check the trouble detection circuits. Mismatches, for instance, are intentionally induced to check the response of the system.

(d) ***Traffic and Overload Control Programs:*** There are various traffic and overload control programs in No. 1 ESS which provide for:

(1) Making and printing traffic measurements

(2) Performing efficiency tests (eg, dial tone speed tests)

(3) Instituting manual or automatic overload control recovery procedures caused by:

- Machine phases or interrupts
- Abnormally high originations (line load control)
- Abnormally high backlog of through-switched traffic (dynamic overload control)

(4) Reporting on the general conditions/status of an office and network blockage and delay.

These programs can generate messages, based on requests, on a scheduled basis or in times of emergency.

4. EQUIPMENT ELEMENTS

4.01 Most No. 1 ESS functions are performed by the following basic types of apparatus and elements:

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

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.

(a) The crosspoint ferreed (Fig. 2) 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.

(b) The bipolar ferreed switches (Fig. 3) are used to open and close the current paths for the line ferrod and the ***no test*** verticals.

4.03 The operation of the crosspoint ferreeds is different from that of the bipolar ferreed. 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 type of ferreed requires a continuous current to maintain an operated or a released state.

REMREED SWITCHES

4.04 The remreed switch (Fig. 4) is the basic switching device used in remreed LLNs and TLNs and it 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 two connectorized configurations: the junctor grid unit and the trunk grid unit. The trunk grid unit contains two stages of 8-by-8 switches connected in a 64-by-64 configuration. The junctor grid unit contains the same 64-by-64 configuration and, in addition, is arranged with test access switches to each output terminal.

4.05 The remreed switch is arranged with two windings so that part of each winding is both above and below the shunt plate (Fig. 4). Sealed contact operation (close) occurs only as a result of 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 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

4.06 The ferrod sensor (Fig. 5) used in scanners provides magnetic coupling between the interrogate and readout windings by means of 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 the sensing of an on-hook or off-hook condition of a line. The on-hook condition causes a binary 1 output and the off-hook condition causes a binary 0 output.

4.07 Four types of ferrods are used in the No. 1 ESS and they vary only in sensitivity. The more sensitive types are used to sense distantly located circuit conditions.

MAGNETIC LATCHING RELAYS

4.08 Magnetic latching wire-spring relays appear similar to conventional wire-spring relays. The main characteristic of magnetic latching relays is the 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 is accomplished by a positive pulse. No current is required to maintain an operated or a released state.

4.09 The magnetic latching relays are operated and released by the signal distributors 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 of verification occurs when the metallic path is interrupted.

TWISTOR MEMORY

4.10 The twistor memory is used in the program store 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. 6). 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. 7). 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.

4.11 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. A memory card writer is used to record information on the memory cards before the cards are placed in the program store. A view of the memory card showing the small magnets is shown in Figure 8. Each aluminum memory card contains 64 words; each word is composed of 45 bits, 44 of which are used for data. There are also elements on the card edge which are sensed by the card writing machine.

FERRITE SHEET MEMORIES

4.12 Ferrite sheet memories are the basic storage component in the 8K call store and provide temporary or read-write storage. Binary information can be stored, read, altered, or erased by the system.

4.13 Ferrite is composed of magnesium-manganese material. Each ferrite sheet contains 256 holes in a 16-by-16 array (Fig. 9). Since the ferromagnetic material surrounding each hole of the ferrite sheet can be magnetized the holes can be used for storage of binary data.

FERRITE CORE MEMORY

4.14 Each 32K call store unit contains a 20A memory (Fig. 10) which in turn contains two ferrite core mat assemblies (Fig. 11). Each core mat assembly contains 425,984 ferrite cores in a 512 by 832 matrix.

4.15 Ferrite cores are doughnut-shaped pieces of ferrite material which has magnetic properties. The direction of current applied to conductors passing through the hole in a ferrite core determines the polarity of magnetization. The two magnetic polarities represent the storage of a binary 0 or a 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 Figure 12. Semiconductor devices make possible the operation 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. COMPONENT DESCRIPTION

5.01 The No. 1 ESS is a relatively simple switching system. Customer lines are connected on an LLN; trunks and service circuits are connected on TLNs. The LLNs and TLNs are interconnected by junctors through the use of a junctor grouping frame(s). A high-speed central control performs the main call processing of ESS calls.

5.02 Figure 13 is a block diagram which identifies the equipment components that comprise the organization of an ESS office. The elements may be functionally separated into four categories: switching network, input signal scanners, output signal distributors, and control section. A brief description of each is given in 5.03 through 5.102.

SWITCHING NETWORK

A. General

5.03 The switching network is used to establish 2-wire metallic paths for voice transmission and signaling through eight stages of switching. In addition to connecting lines to lines, trunks to trunks, and lines to trunks, the network also connects lines or trunks to various service circuits (eg, tones, transmitters, receivers, coin supervision, and ringing circuits).

5.04 The network consists of a number of LLNs and TLNs interconnected through the junctor grouping frame (Fig. 14). Each path shown represents 2-wire, tip, and ring. The number of LLNs and TLNs required depends on the traffic characteristics of the office. At present, this number may vary from one to 16 for LLNs and from one to 15 for TLNs.

5.05 The junctor grouping frame provides the means for terminating the wire junctors used to interconnect the LLNs and TLNs. It also provides terminations for the junctor circuits used for intraoffice calls through the LLNs. Plug-ended patch cords and connectors are used to interconnect the junctors in a pattern suited to the size and traffic characteristics of the switching network.

5.06 Presently, two types of LLNs and TLNs are available: ferreed and remreed. Remreed networks are newer than the ferreed neworks and offer a significant reduction in floor space requirements over the older ferreed networks. Both types of networks are completely compatible and may be operated simultaneously in the same office. However, CTX-6 and later generic programs are required to test the remreed frames.

5.07 The elements of the various remreed and ferreed LLNs, TLNs, and the junctor grouping frame will be described separately in the following paragraphs.

5.08 ***Ferreed LLN:*** A ferreed LLN is used to connect customer lines to junctors and consists of two types of switching frames: a ferreed line switch frame (Fig. 15) to which the customer lines are connected and a ferreed line junctor switch frame (Fig. 16) to which the junctors are connected. The frames are equipped with a network control circuit to establish connections through the frame. An LLN terminates from 2048 to 6144 lines depending on the concentrator ratio and the number of line switch frames in an LLN. Each line switch frame has terminations for 512 or 1024 lines. A maximum of six line switch frames and four line junctor switch frames may be used in an LLN, with a current maximum of 16 LLNs per office. Various arrangements of line switch frames and line junctor switch frames within an LLN are based on office characteristics.

5.09 ***Ferreed Line Switch Frame:*** A ferreed line switch frame (a maximum of six per LLN) is divided into two bays of concentrators. Each bay has eight concentrators and each concentrator consists of ferreed switches. Subscriber lines appear on the ferreed switches in the concentrators. There are two stages of switching in the line switch frame: stage 0 and 1. Each stage of switching is accomplished by ferreed switches.

5.10 Ferreed switch arrangements allow customer lines (inputs) to access a lesser number of switching paths (outputs) (see Fig. 17). A ratio of inputs to outputs is therefore created. This is known as concentration and the degree of constriction is called the concentration ratio. Concentrators in the line switch frames have either a 4:1 or a 2:1 concentrator ratio. Concentrators with 4:1 concentrator ratios are termed ***regular*** usage concentrators and concentrators with 2:1 ratios are termed ***heavy*** usage concentrators.

5.11 Concentrators with a 4:1 concentrator ratio have four inputs to every output (Fig. 18). Stage 0 has 64 inputs and 32 outputs. These outputs are called "A-links." Stage 0 has four 16-by-4/8 (sixteen by four of eight) ferreed switches. The 32 A-links are further restricted to 16 outputs in stage 1 switching by using four 8-by-4 ferreed switches. The 16 outputs are called "B-links." The 64 inputs per concentrator are limited to 16 B-links; this is a 4:1 ratio. Regular (4:1) concentrators are used where normal customer telephone usage is expected. Line switch frames with 4:1 concentrators have three bays: bays 0 and 2 contain concentrators and bay 1 contains two network controllers. Network controllers assist the control portion of the ESS in establishing network connections.

5.12 Line switch frames with 2:1 concentrators have two bays with each bay containing a network controller and eight concentrators (Fig. 19). There are two stages of switching connected by A- and B-links. Stage 0 has eight 4/4 ferreed switches and stage 1 has four 8/4 ferreed switches. Note that no concentration occurs in stage 0. The ratio of lines to B-links, from the line switch frame, is 2:1. This concentration ratio, as stated previously, is termed heavy. An ESS office may have only one type of concentrator; it cannot have both 2:1 and 4:1 type concentrators.

5.13 ***Line Equipment Number-Ferreed:*** A customer's line is physically located on an input level of a ferreed switch; this location has a line equipment number associated with it. A line equipment number pinpoints the location of a customer's line.

5.14 The following defines the makeup of the 8-digit line equipment number.

Digit/Range	Equipment
1st, 2nd (00-15)	LLN
3rd (0-7)	Line switch frame
4th (0 or 2, 0 or 1*)	Bay
5th (0-7)	Concentrator
6th (0-3, 0-7*)	Switch

7th, 8th (00-15, 00-03*) Level

* Depending on the line switch frame concentrator ratio (the first item is for 4:1; the second is for 2:1)

5.15 Figures 20A, B, and C indicate how line equipment number 00-101-102 would be located in a 2:1 concentrator. The 8-digit line equipment number indicates the following:

00 = LLN

101 = Line switch frame 1, bay 0, concentrator 1

102 = Switch 1, level 02.

5.16 ***Blockage:*** The 64 line equipment numbers in a regular (4:1) concentrator have access to 32 A-links from stage 0 and 16 B-links from stage 1. If all 64 line equipment numbers have customers assigned to them and all 64 customers attempt to use their telephones at the same time only 16 could reach a B-link. Thirty-two customers would be blocked in stage 0 and 16 more would be blocked in stage 1. At the same time, since all links are busy incoming calls to customers on the concentrator cannot be completed, thereby causing a high degree of incoming matching loss.

5.17 A switching network which has more customer lines than paths through the network is more economical than a network with a path for each line. Since all 64 customers do not normally use their telephones at the same time, the degree of originating or terminating blockage is quite small. When the demand for service exceeds the network paths available, a high degree of blockage or dial tone delay can occur.

5.18 A heavy (2:1) concentrator has 32 total inputs to 16 B-link outputs. Fifty percent of these customers can use their telephones simultaneously as opposed to 25 percent of the customers in a 4:1 concentrator.

5.19 The 2:1 and 4:1 line switch frames are connected to line junctor switch frames by B-links. An LLN can have a maximum of four line junctor switch frames. Each line junctor switch frame is divided into four grids, each of which can terminate 64 junctors. An LLN, therefore, can have 1024 junctors (4 line junctor switch frames times 4 grids times 64 junctors).

5.20 Line junctor switch frames, like the line switch frames, have two stages of switching: stage 0 and 1. Each LLN therefore has four stages of switching: two in the line switch frame and two in the line junctor switch frame. The line junctor switch frame provides switching versatility to connect any line equipment number to any TLN. Calls are distributed, not concentrated, in the line junctor switch frame. Figure 21 shows how one concentrator can be connected by B-links to one grid of one line junctor switch frame. Switching stages 0 and 1 are connected by C-links. The outputs of stage 1 are wired to junctors.

5.21 The line concentration ratio (ie, line-to-junctor ratio) refers to the number of equipped lines on the line switch frame versus the number of junctors; it ***does not*** refer to the type of concentrators used in the line switch frame. As was stated previously, a 4:1 concentrator has 64 line equipments and 16 B-links. Each line switch frame, with 4:1 concentrators, has two bays with eight concentrators each. There is a total of 1024 line equipments per 4:1 line switch frame. (2 bays times 8 concentrators times 64 line equipments equals 1024 line equipments). An LLN with 4 regular line switch frames will have 4096 line equipments and 1024 junctors. This is a 4:1 ***line*** concentration ratio; that is, there are four lines for every B-link leaving the line switch frame.

5.22 An LLN may have a maximum of six line switch frames. The B-links from line switch frames four and five are wired to B-links from line switch frames zero through three. (See Fig. 21.) Six line switch frames, with a 4:1 concentration ratio, would have 6144 line equipments and 1024 junctors. Thus, the ***line*** concentration ratio or line-to-junctor ratio (for the entire LLN) would be 6:1. Figure 22 indicates the various line concentration ratios (line to junctor) available.

5.23 There are 3072 line equipments and 1024 junctors in an LLN with 2:1 concentrators and 6 line switch frames. This is termed a 3:1 heavy LLN; the heavy indicates the use of 2:1 concentrators (there is a 2:1 ratio between line equipments accessing a concentrator and the B-links leaving that same concentrator). The 3:1 indicates a 3:1 ratio between line equipments accessing the LLN and junctors leaving the LLN. Figure 21 illustrates the manner in which B-links are multipled to create different concentration ratios in an LLN with 2:1 concentrators.

5.24 Either a partial or a fractional ferreed LLN may be encountered in a No. 1 ESS office. A partial LLN has less than a full complement of line switch frames and line junctor switch frames. The configuration of B-links in a partial network must be changed when the LLN is expanded to full size. Partial networks are no longer installed in a new office. Fractional networks have the maximum of four line switch junctor frames with a lesser number of line switch frames. The fractional network's B-link wiring pattern is installed in its final configuration. Fractional and partial networks, when installed, provide fewer lines than available in a full LLN. Economic considerations determine if less than a full-size LLN will be installed.

5.25 ***Remreed LLN:*** A remreed LLN contains line switch circuits and junctor switch circuits. A path through a remreed network is made up of links connected by switches. A typical switch consists of eight vertical paths and eight horizontal paths with a crosspoint provided at each intersection. Each crosspoint consists of two miniature sealed reed switches and a pair of control windings. The simultaneous pulsing of the vertical control winding and the horizontal control winding results in the closure of the contacts, thus connecting the horizontal and vertical paths at that particular intersection. At the same time, any previously closed contacts on the selected horizontal and vertical paths will be released. The system program and path memory have provisions to prevent the pulsing of control windings associated with busy paths. The switch is capable of selecting any one of 64 crosspoints. However, since one vertical path and one horizontal path are involved in closure of the contacts at either crosspoint, a maximum of eight calls can be handled by the switch at the same time.

5.26 ***2:1 LLN:*** The organization of a fully equipped LLN with a concentration ratio of 2:1 (standard) is shown in Figure 23. The fully equipped LLN has four line switch circuits, four junctor switch circuits, two associated 1024-point scanners, and two network controllers per line switch circuit. The basic 2:1 network arrangement is shown in Figure 24.

5.27 The line switch circuit is comprised of 16 grids. Each grid gives 32 lines access to 16 B-links. Each line switch circuit gives 512 lines access to 256 B-links for a total of 2048 lines to 1024 B-links per LLN.

5.28 Each 2:1 line switch circuit contains 512 ferrods located within the stage 0 switch packages.

5.29 Concentration ratios of 2:1 and 3:1 (Fig. 24) are achieved by using four or six 2:1 line switch circuits and by cross-connecting the B-links to four junctor switch circuits. Although line switch circuits are designated for either 4:1 or 2:1 concentration ratios, in a particular office only one type is used and all LLNs have the same concentration ratio.

5.30 The junctor switch circuit is comprised of four junctor grids. Each junctor grid contains two stages of 8-by-8 switches connected in a 64-by-64 configuration and one stage of 1-by-8 switches which function as test vertical contacts that are connected to no-test and restore-verify circuits.

5.31 ***4:1 Remreed LLN:*** The organization of a fully equipped LLN with a 4:1 concentration ratio is shown in Figure 25. The fully equipped LLN has four line switch circuits, four junctor switch circuits, four associated 1024-point scanner control equipments, and two network controllers per line switch circuit. The basic 4:1 network arrangement is shown in Figure 26.

5.32 The line switch circuit is comprised of 16 grids. Each grid gives 64 lines access to 256 B-links for a total of 4096 lines to 1024 B-links per LLN.

5.33 Each 4:1 line switch circuit contains 1024 ferrods located within the stage 0 switch packages.

5.34 Concentration ratios of 4:1 and 6:1 (Fig. 27) are achieved by using four or six 4:1 line switch circuits and by cross-connecting the B-links to four junctor switch circuits.

5.35 ***Line Equipment Number—Remreed:*** A line equipment number is an 8-digit number that describes the line equipment location in the network as follows:

Digit	Equipment
1st, 2nd (00-15)	LLN
3rd (0-7)	Line switch frame

4th, 5th (00-07) (10-7)	Concentrator grid
6th (0-3 or 0-7*)	Switch
7th, 8th (00-15) 02 (00-03*)	Level

* Depending on LLN concentration ratio

5.36 ***Ferreed/Remreed Line Equipment Number Analogy:*** An analogy can be made between the ferreed and remreed line equipment numbers. The LLN numbers can be directly equated. The ferreed line switch frame is analagous to the remreed line switch circuit. The first digit of the remreed concentrator grid is analagous to the ferreed bay while the second digit of the remreed concentrator grid is analagous to the ferreed concentrator. The switches and levels of both are directly analagous.

5.37 ***Ferreed TLN:*** A ferreed TLN is made up of two types of frames: a trunk switch frame (Fig. 28) where the trunks and service circuits are connected and a trunk junctor switch frame (Fig. 16) where the junctors are connected. A network control circuit is associated with each frame. Each ferreed TLN terminates from 1024 to 2048 trunks and service circuits depending on the network concentration. Each trunk switch frame has 256 terminations, with a minimum of four and a maximum of eight trunk switch frames.

5.38 The minimum of four trunk switch frames allows a 1:1 concentration ratio of trunks to junctors. Trunks are assigned to stage 0 of the four grids that physically make up one trunk switch frame. This physical location is called a trunk network number; the breakdown of a trunk network number parallels that of a line equipment number in the LLN. The assignments are designated as follows:

Digit/Range	Equipment
1st, 2nd (00-15)	TLN
3rd (0-7)	Trunk switch frame
4th (0-3)	Grid
5th (0-7)	Switch
6th (0-7)	Level

5.39 Trunk switch frames and trunk junctor switch frames can be provided in various combinations producing ratios of trunk terminations to junctor terminations. Figure 29 illustrates the standard 1:1 ratio of trunks to junctors. Additional trunk switch frames will result in new ratios of trunks to junctors.

5.40 With CTX-6 and later generic programs there are always four trunk junctor switch frames per TLN. (A few offices have partial TLNs with one or two trunk junctor switch frames. These are now MD rated.) The number of trunk junctor switch frames will not vary with the installation of additional trunk switch frames.

5.41 Various trunk concentration ratios in a ferreed TLN are accomplished by multipling the B-links of trunk switch frames 4 through 7 with the four trunk junctor switch frames. Figure 30 illustrates the different trunk concentration ratios for ferreed TLNs.

5.42 The ferreed TLN consists of two frames which are identical in appearance to the line junctor switch frame. These two frames are the trunk junctor switch frame and the trunk switch frame. As in the LLN, the crosspoint ferreed switch is used as the basic switching device. Switching stages 1 and 0 of the trunk junctor switch frame and the trunk switch frame contain (8-by-8) ferreed switches.

5.43 Figure 29 illustrates the discussion on the TLN. A TLN has a maximum of four trunk junctor switch frames. Each trunk junctor switch frame has four grids with each grid comprised of eight (8-by-8) ferreed switches in both stage 0 and stage 1 switching. The trunk junctor switch frame is identical to the line junctor switch frame. There are 64 junctor inputs to stage 1 and 64 C-link outputs to stage 0; this provides 64 junctors per grid, equaling 256 junctors per trunk junctor switch frame. A fully equipped TLN of four trunk junctor switch frames can terminate 1024 junctors. A network control circuit is associated with each frame which assists the control portion of the ESS in crosspoint operation trunk junctor switch frames.

5.44 Stages 1 and 0 are interconnected by C-links. The output of stage 1 to the input of stage 0 is a 1:1 concentration ratio; all 1024 junctors can access B-links to the trunk switch frame. No concentration occurs in the trunk junctor switch frame.

5.45 The TLN can be equipped with from four to eight trunk switch frames. The trunk switch frame is identical in makeup to the trunk junctor switch frame and the line junctor switch frame in that an 8-by-8 ferreed switch is used in four grids to make up each trunk switch. There are two stages of switching in the trunk switch frame: stage 1 and stage 0. Stage 1 terminates the 1024 junctors from the trunk junctor switch frame via the B-links. Stages 1 and 0 interconnect via A-links. These links again terminate the same 1024 junctors from the inputs of stage 1 to the inputs of stage 0.

5.46 ***Remreed TLN:*** The remreed TLN is a recent development and was designed to replace the ferreed TLN. The remreed TLN performs the same function as the older type TLN. The remreed TLN offers the following advantages:

(a) A ferreed TLN with a 1:1 trunk-to-junctor rate requires 26 feet of floor space whereas the remreed uses only 6-1/2 feet. The remreed TLN is available with a 1:1 or 1.5:1 ratio only.

(b) Power requirements for the remreed TLN are less than those for the ferreed TLN.

(c) The time required for installation has been greatly reduced.

(d) Remreed TLNs are entirely compatible with current No. 1 ESS equipment. It is possible to have both ferreed and remreed TLNs in the same office.

5.47 ***1:1 and 1.5:1 Remreed TLN:*** The organization of a fully equipped TLN with a 1:1 trunk-to-junctor ratio is shown in Figure 31. There are four trunk switch circuits and four junctor switch circuits for a 1024 TLN. A TLN must be fully equipped for offices with CTX-6 and later generic programs. The network arrangement is shown in Figure 32.

5.48 The trunk switch circuit contains four trunk grids. The trunk grid unit contains two stages of 8-by-8 switches connected in a 64-by-64 configuration. The junctor switch circuit contains four junctor grids. The junctor grid unit contains two stages of 8-by-8 switches connected in a 64-by-64 configuration and one stage of 1-by-8 switches which function as test vertical contacts.

5.49 The 1024 trunks are given unifrom access to 1024 junctors over 1024 B-links by four grids per circuit and four circuits per frame bay. A concentration ratio of 1.5:1 is also available. This is accomplished by using six trunk switch circuits and four junctor switch circuits. Figure 32 also shows two 1.5:1 TLNs.

5.50 A remreed trunk network number is a 6-digit number that describes the trunk equipment location in the network as follows:

Digit/Range	Equipment
1st, 2nd (00-15)	TLN
3rd (0-3 or 0-7*)	Trunk switch circuit
4th (0-3)	Grid
5th (0-7)	Switch
6th (0-7)	Level

* Depending on TLN concentration ratio.

5.51 The remreed trunk network number is directly analagous to the ferreed trunk network number if the remreed trunk switch circuit is equated to the ferreed trunk switch frame.

5.52 ***2048 TLN:*** The 2048-junctor TLN is a trunk switching network which terminates 2048 junctors. A fully equipped 2048 TLN consists of eight junctor switch circuits and eight trunk switch circuit (Fig. 33). The 2048 TLN is two 1024-junctor TLNs with a different B-link pattern. The 2048 TLN provides an increase in both terminal (30,720 maximum trunks) and network traffic capacities.

5.53 The 2048 TLN requires the CTX-7 or later generic program and is intended for use in large toll/tandem No. 1 ESS offices. An office may have from one to 15 fully equipped 2048 TLNs. An office with 2048 TLNs may not have LLNs, service link networks, or 1024 TLNs. The only available option is a 1:1 concentration ratio. Partially equipped networks are not permitted.

5.54 The 2048 TLN primarily affects the network hardware configuration and traffic capacity and does not affect trunk translation, trunk recent change message, or steps in the processing of a call.

5.55 ***Miscellaneous Trunk Frame:*** Those trunks and service circuits associated with the TLN and requiring permanent wiring are mounted in the miscellaneous trunk frame. The miscellaneous trunk frame is used for trunks which cannot be mounted on the universal trunk frame. Trunks on this frame are wired in place. The miscellaneous trunk frame contains a variety of trunks and service circuits. Therefore, it is uneconomical to provide universal scanners and signal distributors to satisfy all calling conditions. Instead, the scanning function for these trunks is performed by the master scanner while the signal distributing function is performed by signal distributors on nearby universal trunk and junctor frames.

5.56 ***Combined Miscellaneous Trunk Frame:*** The new combined miscellaneous trunk frame is a replacement for and an improvement over the miscellaneous trunk frame. The combined miscellaneous trunk frame contains a maximum of two supplemental signal distributors and a master scanner which are factory wired to plug-in positions on the frame. The miscellaneous trunks are plug-in trunk units on printed wiring boards as opposed to the hard-wired trunks on the miscellaneous trunk frame. The combined miscellaneous trunk frame reduces office wiring and engineering effort for miscellaneous trunks plus it offers a space savings over the miscellaneous trunk frame. No software changes are required for using combined miscellaneous trunk frames. Combined miscellaneous trunk and miscellaneous trunk frames can appear in the same office. (See Feature Document 231-190-368 for additional information on the combined miscellaneous trunk frame.)

5.57 ***Bylink:*** A second miscellaneous trunk frame is provided to mount all bylink trunks incoming from step-by-step offices. Nonbylink trunks are not mounted on this frame. Additional information on the trunk types that may be mounted on the miscellaneous trunk frame is contained in the translation guide, TG-1A.

5.58 ***Universal Trunk Frame:*** The universal trunk frame (Fig. 34) may be wired so that plug-in trunk units may be inserted in any position. Each trunk unit may have one or two circuits per mounting plate. The universal trunk frame terminates trunks and service circuits that have less than four scan points and/or six signal distributor points. Signal distributor and scanner control are located between the two bays served. Universal trunk frames may be designated as either ***home*** or ***mate*** frames. Scanner and signal distributor equipments are duplicated for reliability.

5.59 ***Miniaturized Universal Trunk Frame:*** The new miniaturized universal trunk frame has been designed to replace the universal trunk frame home-and-mate-frame combination. It offers a space reduction of one-third compared to the universal trunk frame. No software changes are required for its use. The miniaturized universal trunk frame has better transmission characteristics than the universal trunk frame. Both the miniaturized universal trunk frame and the universal trunk frame can appear in the same office. (See Feature Document 231-190-367 for additional information on the miniaturized universal trunk frame.)

5.60 ***Service Link Network:*** The service link network (if provided) may be used to gain a small increase in the call processing capability of the central control. This is accomplished by simplifying the ringing and incoming receiver connections (via the service link network in lieu of the TLN), thus reducing the amount of real time required by the central control to perform these functions. The service link network is made up of service link frames. Each service link frame is composed of two identical 512-input, 64-output switching bays. Each bay has its own controller which may be used to control both bays if a trouble condition exists. For offices with generics CTX-5 or above, the usefulness of the service link network has been reduced such that service link networks are no longer recommended. The service link network is used for intraoffice and incoming calls but not for outgoing calls.

5.61 ***Junctors:*** Junctors provide the connection between the LLN and the TLN. Three basic types of junctors are used in the No. 1 ESS:

(1) Line-to-line

(2) Line-to-trunk

(3) Trunk-to-trunk.

5.62 The three types of junctors are described as follows.

(a) The line-to-line junctors interconnect customers in the same ESS office for intraoffice calls. Line-to-line junctors have both ends connected to LLNs. It is not necessary that both ends connect to the same LLN where more than one LLN is installed. Junctor circuits are associated with line-to-line junctors and connect or disconnect an intraoffice telephone call (ie, junctor circuits provide both transmission and supervision for intraoffice calls).

(b) The line-to-trunk junctors connect the LLN to the TLN. The line-to-trunk junctor is a pair of wires and does not require a junctor circuit. They are used for intraoffice calls using intraoffice trunks and for interoffice calls. These junctors provide neither supervision nor transmission.

(c) Trunk-to-trunk junctors connect two TLN appearances. For example, the interconnection of an incoming trunk requires a trunk-to-trunk junctor. This junctor is not associated with a junctor circuit. These junctors provide neither supervision nor transmission.

5.63 ***Junctor Grouping Frame:*** All junctors appear on a junctor grouping frame. The pattern of interconnection between the line junctor switch frames and the trunk junctor switch frames is determined by the size of the office. Junctors are divided into subgroups of 16 junctors each. Junctor subgroups appear on the junctor grouping frame. Junctor grouping frames must be installed in pairs with a maximum of eight frames (four pairs). Each pair has a capacity of 9216 junctors.

5.64 ***Trunks:*** Trunks are mounted on universal or miscellaneous trunk frames. The functions of the trunk circuits in the No. 1 ESS are limited mainly to transmission and supervision. All other functions associated with conventional trunks of electromechanical switching systems such as pulsing, charging, timing, etc, are handled by stored program control or by service circuits which are under stored program control. Service circuits (located on miscellaneous trunk frames) are auxiliary circuits which are terminated on the TLN and are switched through the networks to lines and trunks to perform a specific function. Service circuits include customer digit receivers, interoffice transmitters and receivers, ringing circuits, tone circuits, etc.

INPUT SECTION

5.65 ***Scanners:*** Every telephone switching system embodies some mechanism for detecting service requests and supervising calls in progress. Input information of this nature is furnished in ESS by a unique sensing device which gathers current information about the status of the switching system. This device is called a scanner. Scanners are used as the sensing devices for all system operations.

5.66 There is no intelligence built into a scanner; therefore, all decision-making is performed by central control. In larger ESS offices equipped with a signal processor, the signal processor would perform some of these functions instead of central control.

5.67 Scanners also perform the following functions:

(a) Receive address information from central control via the peripheral bus system

(b) Transmit answer-type information to central control via the peripheral bus system

(c) Supervise all intraoffice calls

(d) Supervise the state of miscellaneous trunks and service circuits located in the trunk frames (universal and miscellaneous)

(e) Administratively supervise the system

(f) Provide special supervision for manually (key) controlled operations at remote locations.

5.68 ***Types of Scanners:*** There are four basic types of scanners used in the switching network:

(1) Line scanner

(2) Junctor scanner

(3) Universal trunk scanner

(4) Master scanner.

See Figure 35.

5.69 ***Line Scanner:*** The line scanner is physically located on the line switch frame. The main function of this scanner is to detect off-hook conditions of subscriber lines. For example, when a customer removes the receiver to originate a call, the state of the associated ferrod sensor will change from an on-hook to an off-hook condition. Every line equipment in an office has a ferrod sensor. These line ferrods are scanned every 200 milliseconds for call originations. When the customer's line ferrod changes from an on-hook (demagnetized state) to an off-hook (magnetized state) condition, it will be observed by the line scanner. The line scanner will report this status information to the supervisory line scan program. The line scan program then checks the busy-idle bit associated with the customer's line in call store. Once it is determined that this is a new service request, the appropriate actions will be taken to provide dial tone.

5.70 ***Junctor Scanner:*** The junctor scanner is physically located on the junctor frame. A ferrod sensor is associated with each junctor circuit on the frame. (Junctor circuits are only required on intraoffice calls.) The junctor scanner scans both sides of the junctor circuit every 100 milliseconds, looking for a disconnect. Once a change is detected the junctor scanner will report this information to the supervisory junctor scan program. The supervisory junctor scan program reports the change to the hit timing program which will decide the appropriate actions to be taken.

5.71 ***Universal Trunk Scanner:*** The universal trunk scanner is located on the universal trunk frame. It serves the function of supervising interoffice calls. When the universal trunk scanner detects a change in a trunk located on this frame, this information is forwarded to the supervisory trunk scan program. The supervisory trunk scan program reports this information to the hit timing program. The hit timing program decides the next appropriate action to be taken.

5.72 ***Master Scanner:*** The master scanner is located on the master scanner frame. Figure 36 illustrates the master scanner frame. The master scanner is used to monitor various administrative and diagnostic points throughout the system. Some of these points monitor stop hunt, position make busy, random make busy, and trunk make busy keys; they also monitor carrier group alarms. This scanner consists of a 1024-point ferrod sensor matrix and duplicated control equipments. They alternate on a periodic basis in controlling the interrogate and readout pulses of the matrix. The matrix is divided into 64 groups, each consisting of 16 scan points which are scanned simultaneously. These groups are divided into two general categories, one containing supervisory scan points which are scanned every 100 milliseconds and the other containing directed scan points which are scanned as required by direction of a program. With the exception of certain fixed points, which are the same for all offices and always appear in the same matrix location on the master scanner, scan points are assigned as required on an office basis. The master scanner provides observations of various supervisory scan points in the system to provide supervision of the overall office operation. Another function of the master scanner is to monitor dial pulses and MF pulses.

OUTPUT SECTION

5.73 The main function of the central pulse distributor is to "enable" the peripheral units; that is, the central pulse distributor has a private set of wires to each peripheral unit which enables the unit to receive an order over the peripheral unit bus. An order from the central control goes to all peripheral units on the peripheral unit bus but only the unit enabled by the central pulse distributor acts on the order. The central pulse distributor also performs other high-speed actions such as the control of outpulsing. The central pulse distributor acts in microseconds (millionths of seconds) whereas the signal distributor operates in milliseconds (thousanths of seconds).

5.74 The central pulse distributor (Fig. 37) is provided in pairs (the maximum is eight pairs). Each unit operates independently and is capable of 768 outputs which are connected to the peripheral units for enabling these outputs; normally, 512 are unipolar and 256 are bipolar. Unipolar outputs (pulses of one polarity, negative or positive) are mainly used to enable peripheral units. Bipolar outputs (pulses of either polarity) are sent to peripheral and other units to change the state of a circuit or operate a circuit.

5.75 ***Bus System:*** Information is exchanged between various units within the ESS system by means of bus systems. A bus is a group of leads which provide a common route between many functional units. Through the use of a gating technique, each bus is time-shared by the different units it serves. This arrangement eliminates the need for many individual unit-to-unit interconnections.

5.76 The following four major bus systems exist:

- Central control to call store
- Central control to program store
- Central control to central pulse distributor
- Central control to peripheral units.

5.77 In order to provide continuous service, all common system units are duplicated and this duplication extends to the bus system. Interconnecting leads to peripheral units exist over which information to individual units is relayed. These leads are also duplicated.

5.78 Figure 38 is a simplified diagram of the system which illustrates the interconnection of the buses. Also shown are duplicated units (call store and program store) which may communicate with either central control over either one of the two buses provided for this communication.

5.79 ***Signal Distributor:*** A signal distributor is used to transmit signals from central control to the various circuits throughout the office. The signal distributor controls the operation or release of relays (with limited speed requirements) associated with trunks and junctor circuits or other circuits within the ESS office requiring the opening or closing of a metallic path. Signal distributor points are also required or lines needing open switching interval protection, remote reigisters, certain dial long lines equipment, PBX terminating service observing sets, and inward wide area telephone service timers. The central control instructs the signal distributor to operate or release a particular relay. The signal distributor, acting as a buffer, executes the instruction by selecting the proper lead and sending the appropriate pulse, at reduced speeds, to the required equipment.

5.80 Each basic junctor frame and universal trunk frame is equipped with a signal distributor which provides a total of 1024 outputs per frame. A total of 768 outputs or 384 per controller is for use within the universal trunk frame. These signal distributor outputs are wired for use by the plug-in trunk circuit contained in the basic and supplementary bay. The remaining 256 outputs, or 128 per controller, are wired to terminal strips at the top of the frame for assignments to trunk and service circuits located on neighboring miscellaneous trunk frames.

CENTRAL PROCESSOR

5.81 ***General Description:*** The central processor portion of the No. 1 ESS consists of the three units which work together to convert input data to output commands. These units are as follows:

(a) ***Central Control:*** A data-processing unit for interpretation and execution of instructions which control the actions of all other system units.

(b) ***Program Store:*** A stored program which is a semipermanent memory containing the call-processing instructions. These instructions direct the equipment to service the subscriber.

(c) ***Call Store:*** A temporary memory for the storage of transient information about calls and the present state of all lines and trunks in the office.

A. Central Control

5.82 The central control (Fig. 39) is the heart of the system and the main control unit. Under the direction of the generic, or call-handling program, the central control performs the major information processing of ESS and controls the actions of all system units. The central control interprets and executes instructions one at a time (once every 5.5 microseconds) and processes data from the program store. It receives input information from lines and trunks via the scanner, performs logic operations, establishes connections in the network, and controls trunks via the signal distributor and the central pulse distributor to signal distant offices. By means of the maintenance and diagnostic programs, the central control analyzes trouble and causes the results to be printed out.

5.83 In offices requiring high call processing capacity, an additional piece of equipment known as a ***signal processor*** (Fig. 40) may be used to relieve the central control of most input and output functions. The signal processor is a data-processing unit similar to the central control which operates under the control of programmed instructions stored in its associated call store. By relieving the central control of this work, the overall traffic handling capacity of the system is greatly increased.

5.84 Some program instructions result in actions entirely confined within central control; other instructions cause central control to command some other unit to perform some action. A central control command to call store, for example, may require a read or write operation at the address specified. If a reading operation is performed the readout word is sent back via a bus system to central control.

5.85 Central control is the hub of the system; all commands originate from and all answers return to central control. Central control, memory, and the signal processor (if installed) are collectively known as the ***central processor.***

5.86 Central control consists of four bays of equipment: two frames with two bays each. There are always two central controls in an office: an active and a standby.

5.87 ***Central Control Operation:*** One of the duplicated central controls is always actively exercising control of the No. 1 ESS. The other unit is in a standby status and ready to be switched into operation should the active unit fail. Even though one unit is on standby and not controlling peripheral units, it processes the same information as the active unit. The outputs of the standby unit are compared with those of the active central control to ensure that outputs are the same. This matching of outputs provides a continuous check on central control operation.

5.88 The standby unit is capable of performing maintenance functions while it is in the standby state. If the matching of the results reveals that they are the same, no maintenance action is taken; if the results do not match, central control 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 central control uses diagnostic programs to determine the location of the fault within the faulty unit.

5.89 There are two major categories of memory used by central control. One is the semipermanent memory associated with the program store and the other is the temporary memory associated with the call store.

B. Program Store

5.90 The program store is a semipermanent memory in which sets of instructions are stored on magnetic twistor cards (Fig. 41). Each No. 1 ESS central office may be provided with a maximum of 12 program stores. The information in program store is fully duplicated in that the H-half of one program store and the G-half of another program store contain identical information.

5.91 A request to read in a normal mode is satisfied by a store in which the name of either the H-half or the G-half matched the name code received. In normal operations, such a request is carried out simultaneously by two program stores. One program store reads from its G-half. During the execution of a nonmaintenance program, a request for a particular item of information may be satisfied by either or both of the two program stores.

5.92 The program store memory can be divided into three main areas.

(a) ***Generic Area:*** This area contains the program which controls the operation of the system. It controls actions such as line or trunk scanning, obtaining line equipment and directory number information, setting up connections between line and trunk circuits, making automatic message accounting entries, etc. The program store module requirements in the generic area are fixed by the generic program and features used and are not dependent on office characteristics. A given generic program can serve any office within its generic class. The differences between any two offices in a generic class are reflected only in the parameter and translation areas of the program store. Each generic program contains a particular combination of features, not all of which need be used in a particular office. There are presently two classes of generic programs: central control type with centrex (CC-CTX) and signal processor with centrex (SP-CTX). Generic programs without centrex features included are no longer available; however, no centrex hardware need be provided in offices that do not plan to serve centrex customers. Programs are numbered to indicate the latest issue; for example, SP-CTX-4, CC-CTX-1. In the past, signal processor and central control generics were developed independently. Beginning in 1971, central control programs were issued as a result of the signal processor programs and are numbered the same. For example, SP-CTX-4 and CC-CTX-4 were issued at approximately the same time. Letters describing the features and availability dates of the various generics are issued periodically by the American Telephone and Telegraph Company. These letters should be consulted during the engineering period to determine the latest program and features that will be available at the time of installation.

(b) ***Parameter Area:*** This area contains office-dependent data of a general nature which do not need to be changed for day-to-day administration. Such information as the total number of peripheral frames, call stores, and starting addresses of all components stored in the call store memory are included in this area. The program store module requirements in the parameter area are fixed by the generic program and office configuration and are not dependent on office characteristics.

(c) ***Translation Area:*** The translation area contains data which furnish specific information about lines, directory numbers, service circuits, office codes, trunks, and routing information for a particular system. The data are grouped in program areas called subtranslators. The data may be changed as required via TTY message into the recent change area of the call store. The program store is periodically updated with the recent change information in call store by a process known as card writing.

C. Call Store

5.93 The call store, as its name implies, provides the temporary memory storage for information relating to the progress of calls and the status of various equipment components. This information includes the following:

(a) Busy-idle status of customer lines, junctors, trunks, and network links. This is referred to as the ***network map.***

(b) Records of network termination being used for each call in progress.

(c) Digits received.

(d) Digits to be outpulsed.

(e) Data received. For example, data used in call processing are stored temporarily in this area. Traffic counts are also stored here before they print out.

(f) Customer billing information prior to the recording on the automatic message accounting tape.

(g) Recent change information related to customer lines and trunks prior to updating the translation information in program store.

(h) Maintenance information related to program-controlled diagnostic tests.

5.94 Call store contains a ***temporary,*** read/write memory. In the process of reading information from call store the information is destroyed. This is known as destructive readout. The control unit must ***write*** the information back into call store if it is still needed by the system.

5.95 ***8K Call Stores:*** The information contained in each 8K call store (Fig. 42) is organized in words of 24 bits. One of the 24 bits of each word is used for parity checking. Each word occupies one location in the memory unit of the call store and is identified by a unique address. Inputs from a central control or signal processor specify the operation (reading or writing), call store address, and data (writing only). The call store carries out the order and, in the case of reading, sends the word read to the central control or signal processor.

5.96 The memory unit of each call store consists of four memory modules. Two of these modules are connected to make the left half (designated G) of the memory unit. The other two modules are connected to make the right half (designated H) of the memory unit. Each half has a storage capacity of 4096 words (24 bits each) and each call store memory unit has 8192 storage addresses providing a total capacity of 196,608 bits. In order to achieve maximum reliability, all information stored in the H-half of one call store is duplicated in the G-half of another call store and vice versa.

5.97 The number of 8K call stores needed for a No. 1 ESS depends on the office size. For example, in a 2-wire No. 1 ESS office, a maximum of thirty-nine 8K call stores (76 store halves) can be used with the pair of central controls and a maximum of eight 8K call stores (16 store halves) can be used with each duplicated pair of signal processors.

5.98 ***32K Call Stores:*** The information contained in each 32K call store (Fig. 43) is also organized in words of 24 bits. Each word occupies a location uniquely identified by an address. Inputs from a central control or a signal processor specify the operation (reading or writing), the call store address, and in the case of writing, the word to be written. The 32K call store carries out the order, and in the case or reading, sends the word that it read to the central control or signal processor.

5.99 The memory of each 32K call store unit consists of an F (fixed) half and a V (variable) half. Each half contains 16,384 words for a total of 32,768 words. In order to achieve maximum reliability, all information stored in the F-half of one 32K call store is duplicated in the V-half of another 32K call store.

5.100 The number of 32K call store units needed in a No. 1 ESS depends on the office size. In a 2-Wire No. 1 ESS office, a maximum of two 32K call store units is required (CCCS0 and CCCS1). A maximum of nine central control call stores and two signal processor call stores can be used.

5.101 A 2-bay frame (bay 0 and bay 1), 4 feet 4 inches wide and 7 feet high, has been designed for the No. 1 ESS offices to accommodate the 32K call stores (Fig. 6). This 2-bay frame can be equipped with a maximum of five 32K call store units associated with the central control and one 32K call store unit associated with the signal processor. Two call store frames may be required for each No. 1 ESS office, a maximum of nine 32K call store units are associated with central control, and two 32K call store units are associated with the signal processor. These two frames along with their 32K call store units meet the call store requirements for all No. 1 ESS offices.

5.102 ***Master Control Center:*** The master control center represents the maintenance and administration center of the office. Facilities are provided to communicate with, and exercise control of, the system. The major components of the master control center are as follows.

(a) ***Automatic Message Accounting Recorders:*** Automatic message accounting billing information is stored in call store until call completion. Upon call completion, billing information will be transferred to magnetic tape as a single assembled entry for each call. Two recorders are provided for service protection and continuity of service.

(b) ***Master Control Center TTY:*** The master control center TTY is the primary means of communications between the plant operating personnel and the ESS. It can request system action and provide the channel for the system to report on various operations.

(c) ***Alarm Display and Control:*** The alarm display and control is the centralized control point of the No. 1 ESS. It contains activity and trouble lamps to display the status of various units and keys to control the operation of the system. When trouble occurs, audible alarms are sounded and the general location of the trouble is visually indicated on the panel. Control keys are provided to activate the traffic control programs.

(d) ***Memory Card Writer:*** The memory card writer is used to periodically update the translation information in the semipermanent memory of the program store. This is accomplished by transferring the appropriate information from the recent change area of the call store to the twistor cards of the program store.

(e) ***Line and Trunk Test Panel:*** The line and trunk test panel contains facilities to test and remove from service any outgoing trunk, service circuit, or customer line. From this panel, a master test line can be connected to any point in the system for testing purposes.

(f) ***Supplementary Trunk Test Frames:*** These frames duplicate trunk test features of the line and trunk test panel. Supplementary trunk test frames are provided on a maintenance-usage basis and quantities are specified by the maintenance engineer. Each supplementary trunk test frame has its own associated TTY. The traffic engineer needs to know the quantity of supplementary trunk test frames for engineering call store quantities.

DISTRIBUTING FRAMES

5.103 The distributing frames developed for No. 1 ESS are specially designed 7- or 8-foot, single-sided frames provided in the following types:

(a) Main distributing frame

(b) Protector frame

(c) Trunk distributing frame

(d) Intermediate distributing frame.

5.104 ***Main Distributing Frame:*** The purpose of a main distributing frame is to provide a location where a cable pair can be connected to a customer's line equipment. The cross-connections on the main distributing frame are installed, removed, or changed by assignments from various departments. An ESS office can be equipped with either a conventional main distributing frame (as currently used in step-by-step and crossbar offices), an ESS modular main distributing frame, or the common system main interconnecting (COSMIC) type main distributing frame.

5.105 ***Modular Main Distributing Frame:*** A modular main distributing frame was designed for use with an ESS office. Enough modules are added together to meet the requirements of each office. Every module has ten verticals with cable pairs wired to the odd verticals and line equipment wired to the even verticals. Restrictive line assignment techniques are required due to the limited capacity of the jumper troughs.

5.106 ***The COSMIC Frame:*** The COSMIC frame is a modular frame designed for use with any type of switching equipment. It is intended to operate with computer system for main frame operations (COSMOS) installations. The COSMIC frame is the latest main distributing frame available and may be installed without a COSMOS computer.

5.107 The major physical characteristics are:

(a) ***Low-Profile Design:*** The COSMIC frame employs separate modules for exchange cables and line equipments.

(b) ***Optimum Distribution of Terminals:*** Separate computer programs and engineering assistance are available to assist in frame layout considering ultimate size of the operating center.

(c) ***Connect and Disconnect Simplicity:*** Design of the main distributing frame terminals, and the cross-point jumper wire used, facilitate speed of jumper changes.

5.108 The major administrative advantages are as follows.

(a) Line equipment and exchange cable appearances are arranged to encourage jumper length control.

(b) Intermodular cross-connections, beyond adjacent modules, are minimized resulting in no frame jumper congestion.

(c) Load balance considerations and techniques are readily applied to the COSMIC main distributing frame.

(d) ***Economies of Operation:*** Initial jumper runs are inexpensive, based on labor and copper costs, and these economies are evident when making subsequent changes to the same services.

5.109 ***Conventional Main Frame:*** For information concerning conventional main frames, refer to the available Bell System Practices.

5.110 ***Protector Frame:*** A protector frame may be associated with each type of frame and terminates all outside cables from customers and other central offices. The protector frame protects central office equipment from excessive voltages. From the protector frame the cable pairs are connected to the main distributing frame. A comprehensive discussion of protector frames can be found in Bell System Practices Section 201-201-101.

5.111 ***Trunk Distributing Frame:*** The trunk distributing frame permits cross-connections between the TLN appearance and the miscellaneous or universal trunk frame mounted equipment.

5.112 ***Intermediate Distributing Frame:*** The intermediate distributing frame may be used in conjunction with the main distributing frame to provide a flexible cross-connecting point between the trunk and cable pairs.

6. EQUIPMENT ADDITIONS (OFFICE GROWTH)

6.01 Office growth is necessary whenever an operating office must add equipment to increase call-handling capacity to improve efficiencies of the ESS or provide additional terminations for new subscribers. (Additional information on growth procedures may be found in the appropriate Bell System Practices, Dial Facilities Management Practices, or Traffic Facilities Practices.)

6.02 In the No. 1 ESS, 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 No. 1 ESS for added frames.

6.03 The 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 manpower. These objectives can best be implemented by providing a safe and well-defined environment in which growth frames can be tested without interference with 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 procedures to allow for unforeseen difficulties that may arise. The procedures are kept simple and explicit and use computer-generated data where applicable.

6.04 When new equipment or equipment frames are added to an ESS office, they must be added without an interruption in telephone service. Continuous service is possible primarily due to the duplicate design of the No. 1 ESS which permits numerous operation configurations among the duplicated system units. Another aspect of the No. 1 ESS which allows growth to be accomplished in a smooth and orderly sequence is the way parameter and translation data define 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.

6.05 System evaluation tests must be performed before 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 master control center to ensure that the system can operate without trouble in all possible configurations of the central controls, call stores, and program stores. 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.

6.06 Restrictions must be considered in any office growth. These restrictions create problems which are unique. Each problem must be solved individually.

6.07 Besides the addition of growth frames, other changes which must be accomplished relate to translations/parameter memory areas and to the junctor distribution. Translation changes may be performed before the system testing interval, just before diagnostic testing, or after testing to complete growth and merge added equipment into service. Parameter changes may be performed just before or after testing. Junctor redistribution is required when junctor switch frames are added.

6.08 If a number of frames are 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 others which are executed for only a given class of frames.

7. CALL PROCESSING

7.01 The following call sequences are brief descriptions of call processing in No. 1 ESS. A more detailed discussion of call processing is provided in Dial Facilities Management Practices, Division H, Section 6c.

INTRAOFFICE CALLS

7.02 During a call processing operation, a typical call goes through the following six basic stages:

(a) Detecting service request

(b) Dialing connection

(c) Digit analysis

(d) Ringing connection and answer detection

(e) Talking connection

(f) Call Disconnect.

To illustrate the call processing operation, the handling of a typical call in an office without a signal processor is described briefly in 7.03 through 7.09. An intraoffice call from an individual line (with a rotary dial and no special services) to another individual line is assumed. Link, trunk, and junctor scanners monitor the call processing operations (Fig. 44A).

7.03 ***Detecting Service Request:*** In order to detect a service request, the ESS attempts to scan each customer line every 200 milliseconds via the line scanner (Fig. 44B). When a call is originated, current flows through a ferrod sensor of the line scanner associated with the customer line. To determine whether the off-hook condition was detected previously, the central control examines the line status information recorded in the call store for each line. If the status information indicates that the line was previously on-hook, the central control concludes that an origination has occurred and updates the status information for the line.

7.04 ***Dialing Connection:*** The central control uses the scanner address of the calling line to derive an address in the translation area of the program store. In the translation area, the central control finds the information it needs to know about the line. The following are some examples of information which the central control needs to know.

(a) Is the line permitted to originate calls?

(b) What class of calling line is it (individual, party, etc)?

(c) Does the calling line transmit dial pulses or TOUCH-TONE signals?

(d) Are there any special services for the calling line?

7.05 The central control selects an idle customer dial pulse receiver to receive the dial pulses transmitted by the calling line. (If the calling line can transmit TOUCH-TONE signals, the central control would have selected a customer dial pulse receiver equipped with a TOUCH-TONE calling detector.) The customer dial pulse receiver supplies dial tone to the calling line through the TLN and the LLN (Fig. 44C). The central control consults the network map (an area in call store for recording the status of all network links) to select a path for connecting the customer dial pulse receiver. The central control sends orders over a bus to the network controllers to establish the selected path. The orders to close crosspoints go to all network controllers; however, the desired controller only acts on the order after being enabled by the central pulse distributor. In this manner, the central control builds the path, one set of crosspoints at a time, from the line to the customer dial pulse receiver. The crosspoints are closed dry (no battery) to prevent damage to the ferreed or remreed switches. The line scanner is disconnected from the calling line by opening cut-off contacts to the line ferrod. Then central control requests the trunk signal distributor to operate a customer dial pulse receiver relay that causes dial tone to be sent to the calling line. The dial tone is removed by releasing a relay in the customer dial pulse receiver, via trunk signal distributor action, as soon as the first dial pulse is received.

7.06 ***Digit Analysis:*** The ESS, via the trunk scanner, starts scanning the calling line at the customer dial pulse receiver every 10 milliseconds. Every time the calling line is scanned, the present scanner reading is compared with the previous scanner reading recorded in the call store. Whenever a difference is found between the present and previous scanner readings, the central control adds one to a pulse count kept in the call store for the particular calling line. When no pulse count changes have been detected for a period of at least 120 milliseconds, a dialed digit is considered completed. The ESS analyzes the first three digits received in order to determine the type of call (interoffice or intraoffice, long distance, operator, etc). The first three digits in this case indicates an intraoffice call.

7.07 ***Ringing Connection and Answer Detection:*** When the last four dialed digits are received, the ESS performs a translation on the dialed number. During the translation process, a check is made to determine whether the called line is busy by looking at its busy-idle bit. If the called line is busy, a tone circuit is connected through the switching network to the calling line and busy tone is sent to the calling line. If the called line is idle the ESS:

(a) Releases the customer dial pulse receiver from the calling line.

(b) Searches through the network map for a path (including an idle junctor circuit) to be used later for a talking connection and reserves the path by marking the path busy in the network map (Fig. 44D).

(c) Selects an idle ringing circuit and an idle audible ringing circuit.

(d) Sets up a connection through the switching network between the calling line and an audible ringing tone circuit for returning an audible ringing tone to the calling line.

(e) Sets up a connection between the called line and a ringing circuit.

The audible ringing tone circuit is scanned every 100 milliseconds to check for a possible abandonment by the calling line. At the same time, the ringing circuit is scanned waiting for the called line to answer.

7.08 ***Talking Connection:*** When the called line answers, the ringing circuit connection is released and the LLN, after receiving appropriate instructions from central control, connects the called line to the junctor circuit in the previously reserved talking path (Fig. 44E). The audible ringing tone circuit is released and the LLN connects the calling line to the other side of the same junctor circuit.

7.09 ***Call Disconnect:*** The junctor scanner scans both sides of the junctor circuit every 100 milliseconds looking for a disconnect. If both the called and calling lines disconnect, these lines are restored to normal. When either party does not disconnect, the connection is released after from 10 to 12 seconds and dial tone is returned to the party that is still off-hook.

INTEROFFICE (OUTGOING) CALLS

7.10 This description covers a local call from a No. 1 ESS customer to a line (or trunk in a tandem) in a distant office. The calling customer is assumed to have an individual line that transmits dial pulses. The pulsing between the No. 1 ESS and the distant office is assumed to be MF pulsing.

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

7.12 The office code translation indicates that an outgoing call is being dialed and that outpulsing starts after all seven digits are received. (This is true because of the assumed MF signaling. In the case of dial pulse or revertive pulse signaling, outpulsing is normally started after the fifth digit is received.) The office code translation provides a route index number which is stored in the originating register and is used to derive routing, alternate routing, and signaling information.

7.13 When the last digit is received, an outpulsing register is hunted and seized. Another hunt seizes an outgoing trunk. The identity of this outgoing trunk, the type of supervision, and the number of digits to be transmitted are recorded in the outpulsing register. An MF transmitter is seized and the identity of the transmitter is recorded in the outpulsing register. This outpulsing register contains the identity of the originating register that holds the digits to be outpulsed.

7.14 The calling line is still being supervised at the customer dial pulse receiver via the trunk scanner.

7.15 A peripheral order buffer is loaded with the orders to establish a path between the outgoing trunk circuit and the MF transmitter (Fig. 45A). The information which identifies a reserved network path between the calling line and the outgoing trunk circuit is stored in the outpulsing register. The outgoing trunk circuit is put in a bypass state and a seizure signal is sent to the distant office. Trunk continuity to the distant office is checked by the MF transmitter. If the check is successful, a wink (or start dial) signal is returned from the distant office. The digits in the originating register are transferred to the junior outpulsing register associated with the MF transmitter. Then the called line number is outpulsed to the distant office by bursts of tone. The central pulse distributor is used to operate and release relays that control the tone signals.

7.16 At the completion of outpulsing, the transmitter is released. The supervision of the outgoing trunk is transferred from the transmitter to the outgoing trunk circuit. The previously reserved network path between the calling line and the outgoing trunk circuit is established and checked (Fig. 45B).

7.17 The customer dial pulse receiver, the originating register, the junior originating register, and the outpulsing register are all released. Every 100 milliseconds, via the trunk scanner, the outgoing trunk circuit is scanned for an answer (off-hook) and the calling line is scanned for a possible abandonment (on-hook). When the called customer answers, the trunk is marked in call store memory to the talking state.

7.18 When the 100-millisecond trunk supervisory scan detects a change to on-hook on the outgoing trunk circuits, a timing interval of from 200 to 300 milliseconds is started as a safeguard against a hit. When hit timing is completed and an on-hook condition still exists, a disconnect register is seized. If the calling line went on-hook first, the connection is released and disconnect supervision is sent to the called line end. The outgoing trunk is not idled until the distant office returns on-hook supervision. If the called line went on-hook first, a timed-release period of from 10 to 12 seconds is initiated. If the calling line goes on-hook during the 10- to 12-second interval, or if a time-out occurs, the connection is released.

7.19 The disconnect register is released after a guard timing interval of 750 milliseconds during which the outgoing trunk cannot be reseized. This interval allows enough time for all the relays in the distant office to release.

INCOMING CALLS

7.20 For this description, it is assumed that the ESS is processing an incoming call to an individual line. During the 100-millisecond supervisory scan of trunks, when central control reads the row containing the scan point of the incoming trunk circuit (Fig. 46A) central control 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 central control 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 program store address. The translation information, stored in the program store 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.

7.21 An incoming register is hunted and seized, the trunk network number is recorded in the incoming register, and this number is converted into the program store address of the translation information for the trunk. This translation information is used to determine the type of digit receiver (multifrequency, 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 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.)

7.22 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. A peripheral order buffer is loaded with the orders for the network controllers, signal distributor, and scanner to make and check the connection. The path information is recorded in the junior incoming register.

7.23 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 required number of digits of the called line directory number.

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

7.25 The ringing phase of the call starts as a ringing register and a peripheral order buffer are seized; then the incoming register is released. A search of the network map results in the selection of a reserved path from the incoming trunk to an audible ringing tone circuit and from a power ringing circuit to the called line. Also, a ***talking path*** between the incoming trunk and the called line is reserved (Fig. 46B). The information for all these paths is stored in the ringing register. The orders for both of the ringing connections are loaded into a peripheral order buffer with the signal distributor and scanner orders of power cross, pretrip, and continuity tests.

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

7.27 When the called customer answers, ringing is automatically tripped by the ringing circuit. The power and audible ringing connections and the ringing register are released. Answer supervision is returned to the originating office. The previously reserved talking path is established (Fig. 46C) and the temporary memory is brought up-to-date. The connection is now supervised via the trunk scanner for disconnect.

7.28 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 (from 200 to 300 milliseconds) is started.

7.29 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 from 10 to 12 seconds is started. During this time, the No. 1 ESS customer is being scanned at the trunk every 100 milliseconds for disconnect. The connection is released when the ESS customer disconnects or the timed-release period ends. If the trunk is reseized in the meantime, the connection is released immediately and the line is supervised via the line scanner. If the ESS customer remains off-hook beyond the timed-release period, the call is treated as a new origination.

7.30 If the ESS customer disconnects first, the distant office is notified of the disconnect when hit timing is completed. The ESS starts a timing period of from 35 to 45 seconds when waiting for the disconnect signal from the distant office. When the ESS receives the disconnect signal or when the timing period ends, the line and trunk connections are released.

REVERTING CALLS

7.31 A reverting call is a call between two customers who share the same line; therefore, both customers have the same line equipment number. The call is processed as a regular intraoffice call until all seven digits are detected and recorded in the call store.

7.32 The directory number translation indicates that the calling and called line equipment numbers are the same and that a reverting call is in progress. The reverting call is handled in one of the following ways:

(a) Operator assistance (message or flat-rate customers)

(b) Machine handled

(1) Two-party selective, 4-party semiselective, and divided code ringing (flat-rate customers)

(2) Two-party selective, 4-party full selective, and 8-party semiselective ringing (flat-rate customers).

Note: Offices serving message-rate party lines must use the operator assistance option as the ESS is unable to charge on machine-handled message-rate reverting calls.

7.33 ***Operator Assistance:*** For flat- or message-rate customers, the call is routed to an operator over a recording-completing trunk (Fig. 47A). The operator recognizes that assistance is needed in the completion of a reverting call, either from the trunk having the call or from the reception of an identification tone. The operator requests the called number (and the calling number for message-rate calls) from the calling customer and instructs the customer to hang up, to wait long enough for the called party to answer, and to go off-hook again. In the meantime, the operator dials the called number over a local toll switching trunk (Fig. 47B). When the connection is set up, ringing is applied under control of the operator (Fig. 47C). The operator makes sure that the call is terminated properly before making out the message-rate ticket or leaving the call. Throughout the conversation, the call is supervised via the toll switching trunk (Fig. 47D). After both parties disconnect, the connection is taken down by the operator and the trunk is released.

7.34 ***Two-Party Selective, 4-Party Semiselective, and Divided Code Ringing:*** The ESS returns busy tone until the calling customer hangs up. The busy tone is removed and reverting ringing is connected (Fig. 48A). When any customer on the party line removes the receiver from the switchhook, ringing is removed and a talking connection is established to a holding trunk (Fig. 48B). When both customers hang up and the disconnect is detected at the holding trunk, disconnect timing is completed and the connection is released.

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

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

7.37 ***Two-Party Selective, 4-Party Full Selective, and 8-Party Semiselective Ringing:*** The ESS returns special high tone to the calling customer as a request to dial an additional digit that identifies the customer station and ringing code.

7.38 When the eighth digit is received, the ESS removes the high tone and returns busy tone to the calling customer. When the calling customer hangs up, the ESS removes the busy tone and connects ringing to the calling and called stations. If the calling and called stations are on the same side of the line and have the same polarity, only the called line ringing code is applied. In other cases, reverting ringing is returned to the calling station.

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

4.40 For any of the reverting call arrangements described previously, the network connections are released if:

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

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

(c) Neither the called nor the calling party removes the receiver after ringing has been applied for 3 minutes.

ASSISTANCE, SERVICE CODE, AND DIRECT DISTANCE DIALING CALLS

7.41 Assistance, service code, and direct distance dialing calls are handled like outgoing calls. A translation of the dialed digit or digits indicates:

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

(b) The type of supervision the trunk requires

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

7.42 ***Assistance Calls:*** After the first digit is translated and the customer has dialed a 0, an operator trunk is seized. Audible ringing tone is sent to the customer until the operator answers. When the operator answers, a talking connection is established. Both the operator and the customer must disconnect before the connection is released.

7.43 ***Service Code Calls:*** Calls to service code operators (long distance, repair service, etc) follow a pattern similar to that of assistance calls. A translation of the dialed digits indicates how to terminate the call. Audible ringing tone is sent to the customer and a lamp signal is sent to the operator. The audible ringing connection is released and the talking connection is established when the operator answers. The talking connection is released when the customer disconnects.

7.44 ***Direct Distance Dialing Calls:*** A translation of the area code digits plus the office code, if necessary, indicates how to terminate the call. Then central control selects the proper trunk and outpulses the proper digits.

MANUAL CALLS

7.45 A dial office can serve manual customers who require the assistance of an operator on all originating calls. When a manual customer goes off-hook, the line equipment number translation indicates that this is a manual service line. A digit receiver is connected to the line, but dial tone is not applied. The transfer of supervision is checked and the false cross and ground and the power cross tests are made in the usual manner. Then the digit receiver is released. A connection, via an operator trunk, is established to an operator as though the customer dialed 0. The operator completes the call as requested by the customer.

8. TELETYPEWRITERS

8.01 Each TTY channel consists of a TTY which operates at a speed of 100 words per minute, a transmit-receive unit which serves as a buffer, and a conversion unit between the TTY and the system. There are several call store memory areas which serve as storage for TTY messages and controls. The following types of TTY channels are used.

(a) ***Maintenance TTYs:*** A minimum of two maintenance TTYs is always on separate No. 1 ESS office associated channels. The TTYs report the status of the system to maintenance personnel and are used by maintenance personnel to request a variety of system actions. One TTY is always located at the master control center, while the other TTYs may be located in the same building or at another location. The TTY located at the master control center is called the local maintenance TTY (maintenance control center TTY) and operates on one channel. All other maintenance TTYs are called remote maintenance TTYs and operate on the other channel. A mobile TTY used for belt-line testing may be connected in series with either the local or remote maintenance TTY. The mobile TTY is plugged into a belt-line jack (wired in parallel on all frames throughout the office) and then patched to a maintenance TTY at the master control center. Thus, a complete input/output unit is available at any position in the office.

(b) ***Service Order TTY:*** The TTY provides a channel for service order and translation information. The service order TTY is typically located in a plant assignment bureau. The TTY uses specially formatted paper forms to facilitate the typing of messages and also can be used off-line to produce a punched tape that contains information for subsequent transmission into the system.

(c) ***Network Administration TTY Channel (Administrative and Data):*** This TTY channel, formerly referred to as the traffic channel, reports network load conditions, overload status, and the network data accumulated by the system. This TTY channel may also be used to implement line load control and toll network protection available with CTX-4 and later generics or to interrogate the memory area with CTX-3 and later generics. This TTY may be either remotely or locally located. If the office does not have a network management TTY (see 8.01[h]), this channel serves the network management function.

(d) ***Supplementary Network Administration TTY Channel:*** This TTY channel is optionally available with CTX-7 generic programs. This channel, a network channel, can be used to interrogate the system memory, implement controls, and can also be used as a backup for the network management TTY. This channel was designed to elevate the use of administrative messages and network data on one channel. This channel should be equipped with a Model 35 TTY equipped with idle motor control. This feature provides the capability of having the TTY motor turned on before a message is printed and then turned off after a time-out period has occurred for the last character printed. This feature will reduce motor wear and, consequently, reduce maintenance on the TTY.

(e) ***Automatic Line Insulation Test TTY Channel:*** This TTY channel, also referred to as either the plant service center TTY or the local test desk TTY, is a nonmaintenance send-receive TTY. 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 automatic line insulation tests, and results of tests performed on pressurized cable contractor pairs. The automatic line insulation test TTY in later generic programs may also be used to interrogate system memory for verification of translation data.

(f) ***Supplementary Trunk Test Position TTY Channels:*** These TTY channels, up to a maximum of four, are used to direct messages to designated sets of supplementary trunk test panels. The messages consist of trunk diagnostic results and responses to maintenance personnel actions at the supplementary trunk test panel.

(g) ***Calling Line Identification TTY Channel:*** The TTY channel records information that has been requested as a result of initiating calling line identification procedures (see Bell System Practices Section 231-110-301). This information includes the calling and called directory numbers and the time that the call was placed.

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

(i) ***Monitor TTY Channels:*** Three types of monitor TTY channels are provided in a No. 1 ESS office to monitor various master control center and universal TTY 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 TTY 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 master control center area. A data set must be used if a monitor channel is located remotely.

9. REFERENCES

9.01 The following is a list of Bell System Practices which contain additional descriptive information pertaining to the No. 1 ESS.

SECTION	TITLE
231-001-101	Central Control Description
230-140-101	Teletypewriter Facility Description
231-005-101	Program Store Description
231-006-101	8K Call Store Description
231-009-101	Duplication and Bus System Description
231-010-101	Scanner Description
231-011-101	Program Organization Description
231-025-101	32K Call Store Description
820-001-170	Central Office Engineering General Information - No. 1 ESS
966-100-100	2-Wire No. 1 ESS General Description
966-102-100	2-Wire No. 1 ESS Centrex Service General Description

10. GLOSSARY OF TERMS

10.01 The following glossary contains terms which have been used throughout this section.

A-Links Connect stage 0 and stage 1 switching in the line switch frame and in the trunk switch frame.

Address A combination of bits which identifies an area in memory or unit of equipment.

Automatically identified outward dialing (AIOD) Allows detailed billing for centrex-CU and PBX customer.

Alarm A visual or audible indication of a malfunction.

Audible ringing The ringing sound returned to the billing subscriber.

Automatic message accounting (AMA) Provides the means by which customers are billed for their telephone calls.

Auxiliary block An area of memory used to store information.

B-links Connect the line switch frame to the line junctor switch frame in the line link network. They also connect the trunk switch frame to the trunk junctor switch frame in the trunk link network.

Base level programs The bulk of call processing and maintenance programs in a No. 1 ESS.

Binary number system A numbering system which uses two characters (usually 0 and 1), with a base of two.

Bipolar ferreed A component consisting of two sealed reed switches, a permanent magnet, and a winding with a semipermanent magnet. When the winding is pulsed in one direction the contacts close; when the winding is pulsed in the opposite direction the reed switches open.

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, magnetized or demagnetized.

Buffer Stores address and control information until transmitted to peripheral units.

Bus A group of leads which are shared by various ESS equipment units. Bus systems are used for intermachine communications.

C-link Connect stage 0 and stage 1 switching in the line junctor switch frame and in the trunk junctor switch frame.

Call store (CS) The equipment unit of a No. 1 ESS which provides memory storage of information pertaining to call processing and maintenance.

Central control (CC) The equipment unit of the No. 1 ESS which controls the operation of other equipment units in accordance with instructions received from program store.

Central processor The combination of central control, call store, program store, and the signal processor when installed.

Central pulse distributor (CPD) The equipment used by central control to transmit signals to various units for high-speed control action.

Concentrator A device used to reduce a number of inputs to a smaller number of outputs.

Concentration ratio The ratio between inputs and outputs.

Core A circular device used to store a bit magnetically.

Crosspoint ferreed switch A matrix comprised of individual ferreed switches (see ferreed).

Customer dial pulse receiver A service circuit which, when attached to a customer's line, can detect the digit dialed.

Customer TOUCH-TONE receiver A service circuit used to detect TOUCH-TONE pulsing when attached to a customer's line.

Dial tone speed test Measures the grade of dial tone service being given by the ESS. The test is done automatically.

Directory number (DN) The customer's telephone number.

E-to-E cycle rate The rate at which a No. 1 ESS completes base level programs. The greater the volume of telephone calls the lower the E-to-E cycle rate.

Enable The sending of a pulse of current to an equipment unit so that it becomes operative.

Error A malfunction which cannot be reproduced by the system.

Execute One of the three operational phases in processing an instruction.

Fault A malfunction which can be reproduced by the system.

Ferreed A component containing two reed switches which are operated or released by controlling the magnetic value of two adjacent plates.

Ferrite sheet The basic memory storage device used in the No. 1 ESS call store.

Ferrod sensor Detects the change in the electrical state of a circuit. Ferrod sensors are the primary monitoring device used in the ESS.

Fetch One of the three operational phases involved in processing each instruction.

Generic program The sum total of all programs in an ESS. Offices with the same generic program have the same features.

Hardware The physical equipment is the No. 1 ESS.

Hopper Stores information from input/output programs until used by call processing programs.

Incoming receiver A service circuit used to detect digits sent from another central office.

Index One of the three operational phases involved in processing a program instruction.

Input Information received by the ESS from a TTY or from sensors.

Intermediate distributing frame (IDF) A frame which allows trunk and service circuits to be connected to cables to other central offices.

Junctors Paired wire, voice transmission circuits used to connect the line link network and the trunk link network.

Junctor circuit A circuit used for supervision on a line-to-line junctor.

Junctor grouping frame A frame where junctors are distributed between networks.

Line concentration ratio The ratio between line equipment numbers and junctors (also called the line-to-junctor ratio).

Line equipment number (LEN) An 8-digit identification of the physical location of a customer's line in the line link network.

Line junctor switch frame (LJSF) The part of a line link network which connects B-links to junctors.

Line link network (LLN) The part of the switching network which connects lines to junctors.

Line switch frame (LSF) The part of the line link network which connects lines to B-links.

Logic circuit The process of producing an output only when predetermined inputs are present.

Main distributing frame (MDF) A frame where cables can be connected to line equipment number and trunk.

Master control center (MCC) The maintenance administration center of a No. 1 ESS.

Master head table An area of memory which provides information needed for translation.

Master scanner A scanner used to observe events which occur at a high speed.

Memory A unit into which information can be stored until needed by the system.

Memory card A thin aluminum card with small bar magnets used to retain binary information in program store.

Memory core A circular ferrite ring which stores binary information in call store.

Memory card writer (MCW) The equipment unit used to update information in program store.

Microsecond A unit of time equal to one 1-millionth of a second (usec).

Millisecond A unit of time equal to one 1-thousanth of a second (msec).

Module A unit of equipment capable of being combined with others to form a larger unit.

Network controller Establishes connections in the line link network, trunk link network, and service link network.

Octal numbering system A numbering system with a base of eight and with eight characters, 0 through 7. Octal is used in conversions between decimal and binary numbers.

Originating register An area of call store memory used to store digits dialed by a customer.

Outpulsing register An area of call store memory used to store digits until they are to be transmitted to another office.

Output Information sent at the direction of central control. Output may be either external or internal.

Overwrite Means used to change a specific item within a generic program or within an office parameter.

Parameter Refers to the limits within which the ESS must operate.

Parity bit A bit attached to a word which is changed back and forth from zero to one to make the number of bit ones an odd number.

Parity check A validation check to ensure that the total number of bit ones in a word is an odd number.

Peripheral units (PU) The part of the ESS units that consist of scanners, signal distributors, and the master control center.

Phase action Internal corrective action taken by the ESS to correct a trouble which interferes with call processing.

Point issue change The change from one generic program issue to another issue in the same series.

Power ringing AC voltage applied to the called customer's line for purposes of ringing the bells.

Program An organized set of instructions used to control system functions.

Program store (PS) The equipment unit which stores the program and the translation information.

Protection frame A frame on which all outside cables are terminated. Protective devices prevent voltages from outside from harming central office equipment.

Queue An area of call store memory used to record lists of waiting calls, lines, etc. Call processing programs load and unload queues.

Real time A control system in which operations are performed in time with a physical process so that the outputs obtained are useful in controlling that process.

Register A general storage area located in call store memory.

Restart A change from one generic progam issue to a higher-issue generic program.

Retrofit A change from one generic to a higher generic.

Ring The designation for one side of a 2-wire circuit in a common control office.

Scanner The equipment unit that provides central control with access to lines, junctors, and trunks so that the busy or idle state may be determined.

Semipermanent memory The read-only memory located in program store.

Sensors See ferrod sensor.

Service circuit An auxiliary circuit connected to lines and trunks as required to perform specialized functions such as detecting dial pulses.

Service link network (SLN) A supplementary network which increases the call carrying capacity of the No. 1 ESS.

Signal distributor (SD) An equipment unit which slows down electronic commands to electromechanical speeds.

Signal processor (SP) An equipment unit which is added to large No. 1 ESS offices to increase call carrying capacity.

Switching network The line link network, trunk link network, and service link network (when installed) are collectively called the switching network.

Temporary memory The read-write memory located in call store.

Translations (1)The process of accessing information contained in program store memory. Translations must be done on every call which originates or terminates in the ESS. (2) The memory containing information on routing and charging, directory number conversion, etc.

Transmitter A service circuit used to send information to another central office.

Trunk A circuit used for conversation between or within central offices. Trunks also provide customer access to switchboards of various types.

Trunk concentration ratio The ratio between the number of trunk network numbers and the number of junctors.

Trunk distributing frame (TDF) A frame which allows trunks access to cable and pairs via flexible cross-connects.

Trunk junctor switch frame (TJSF) A portion of the trunk link network which distributes B-links to junctors through two stages of switching.

Trunk link network (TLN) A part of the switching network which connects junctors to trunks.

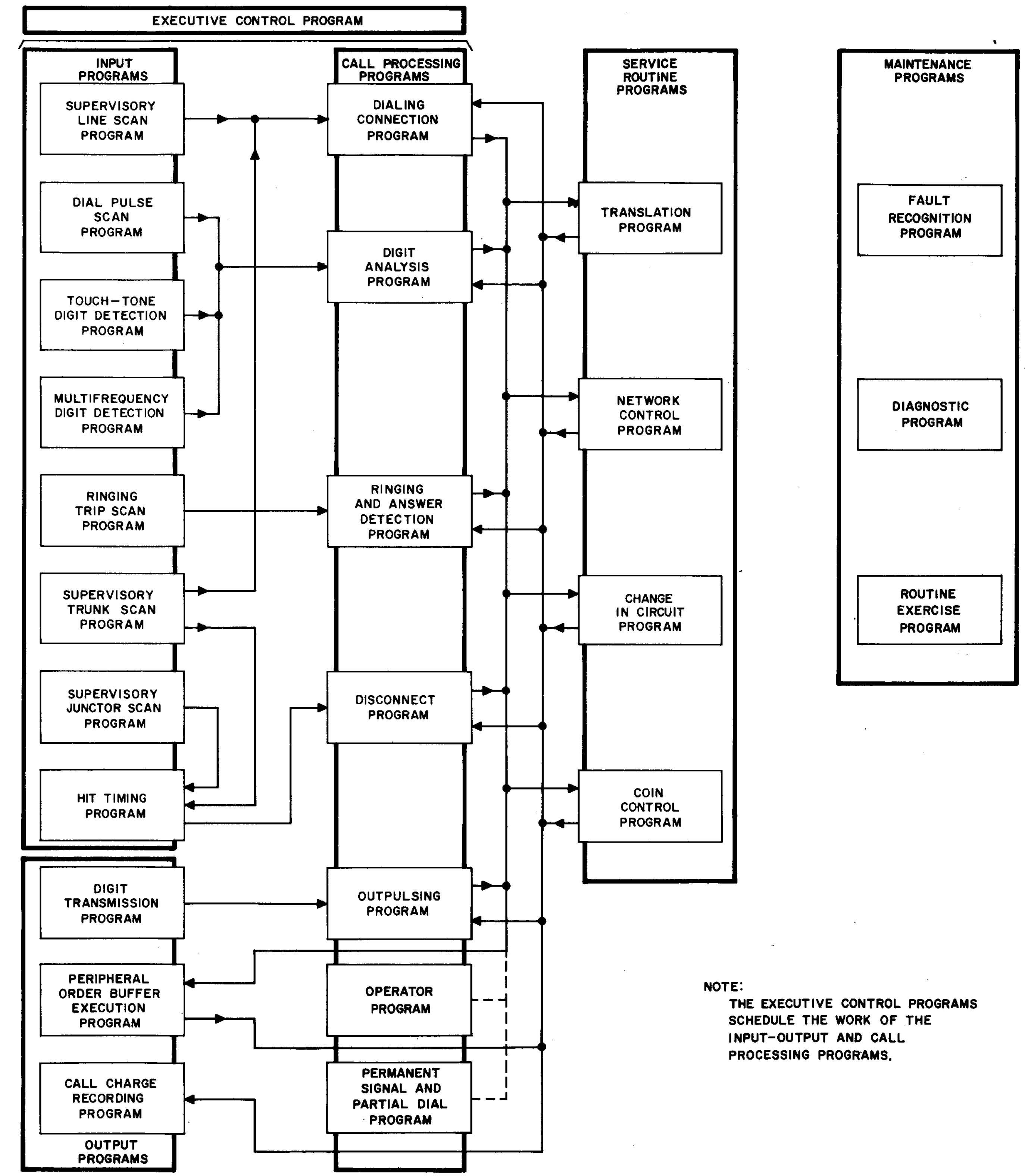
Trunk network number (TNN) A physical location, on the trunk link network, to which trunks and service circuits are assigned.

Trunk switch frame (TSF) The part of a trunk link network which connects trunks to B-links through two stages of switching.

Universal trunk frame (UTF) A frame used for plug-in type trunk circuits.

Word A set of bits used to store information required by the system.

Write The process of inserting information into memory.



NOTE:
THE EXECUTIVE CONTROL PROGRAMS SCHEDULE THE WORK OF THE INPUT-OUTPUT AND CALL PROCESSING PROGRAMS.

Fig. 1—Generic Program (3.11)

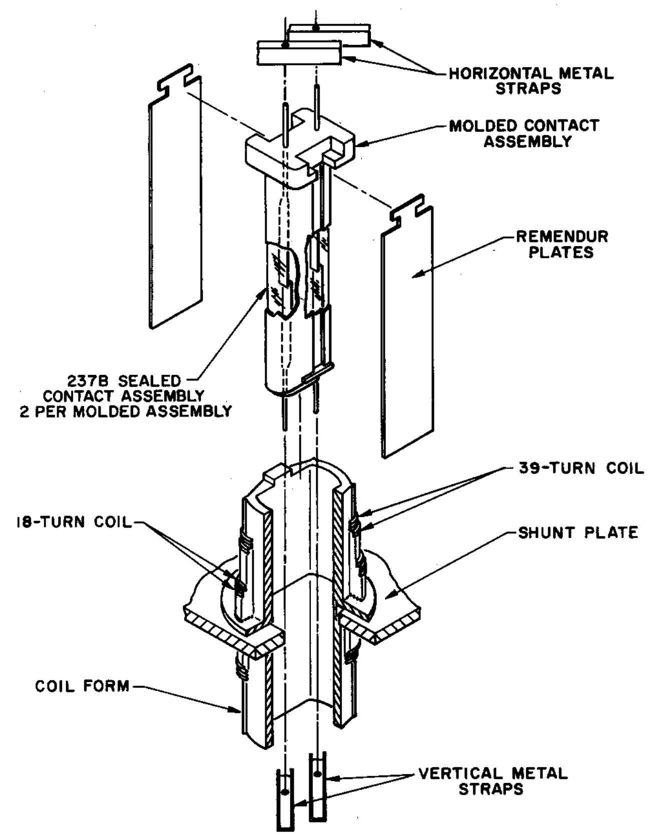


Fig. 2—Exploded View of Ferreed Crosspoint (4.02)

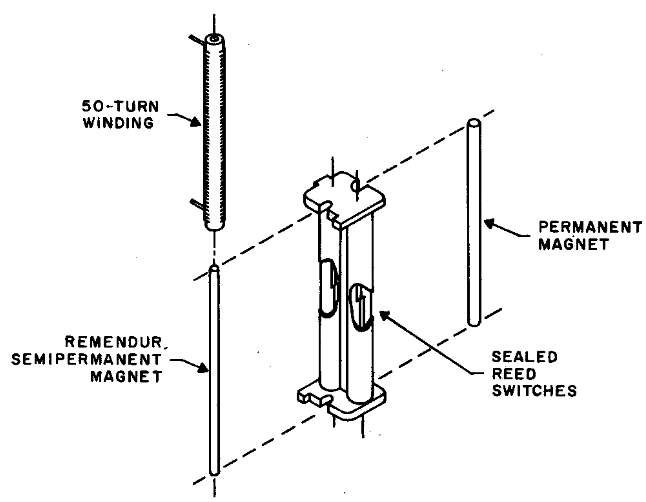


Fig. 3—Exploded View of Bipolar Fereed (4.03)

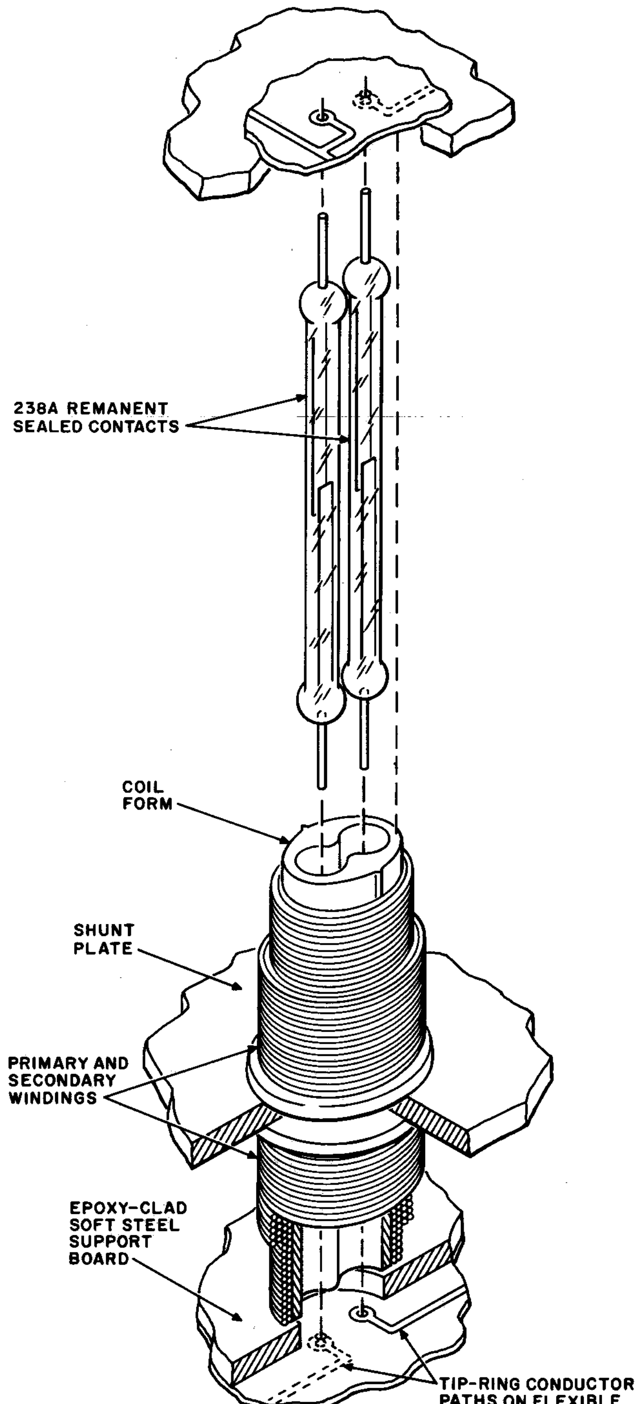


Fig. 4—Exploded View of Remreed Crosspoint (4.04, 4.05)

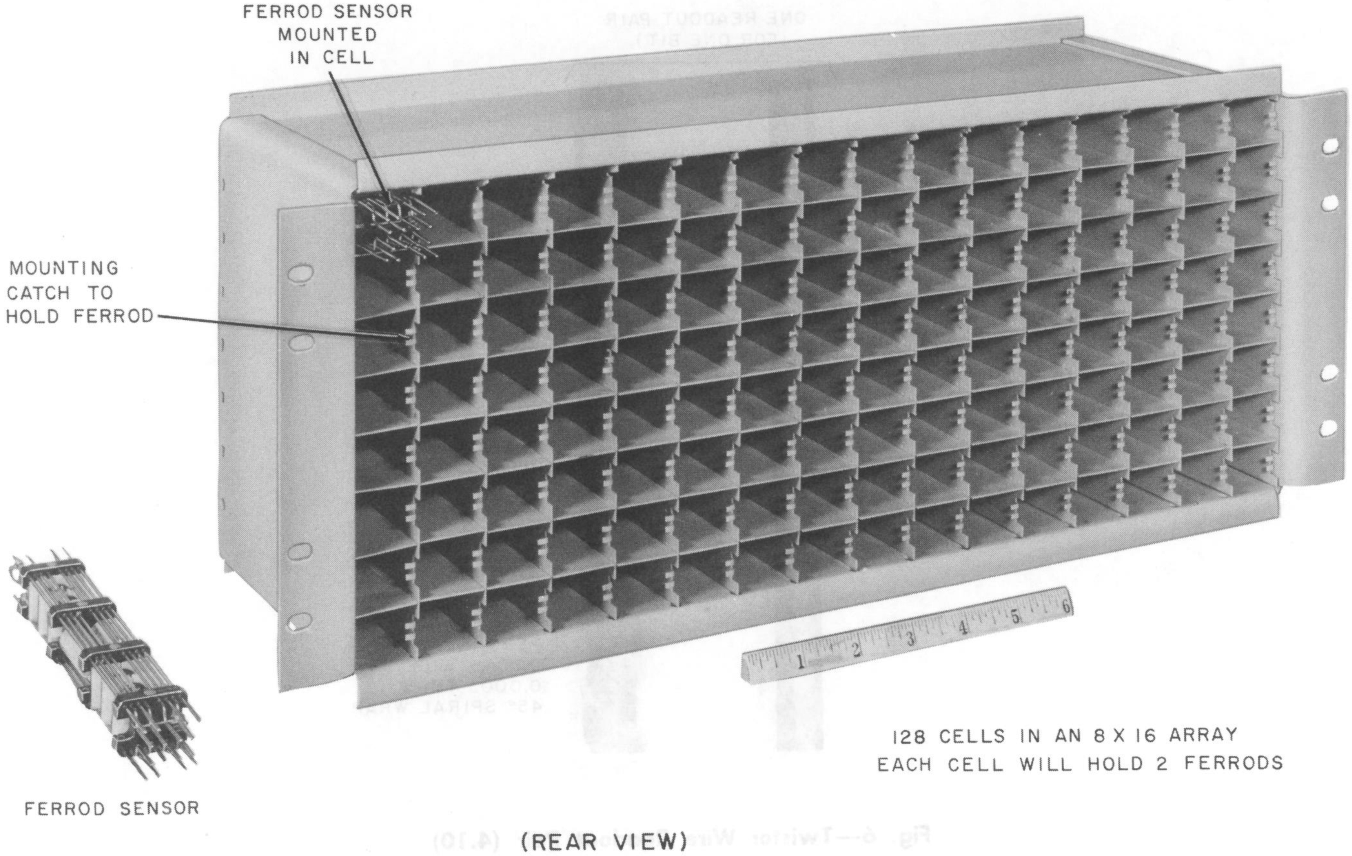


Fig. 5—Ferrod Sensor and Apparatus Mounting (4.06)

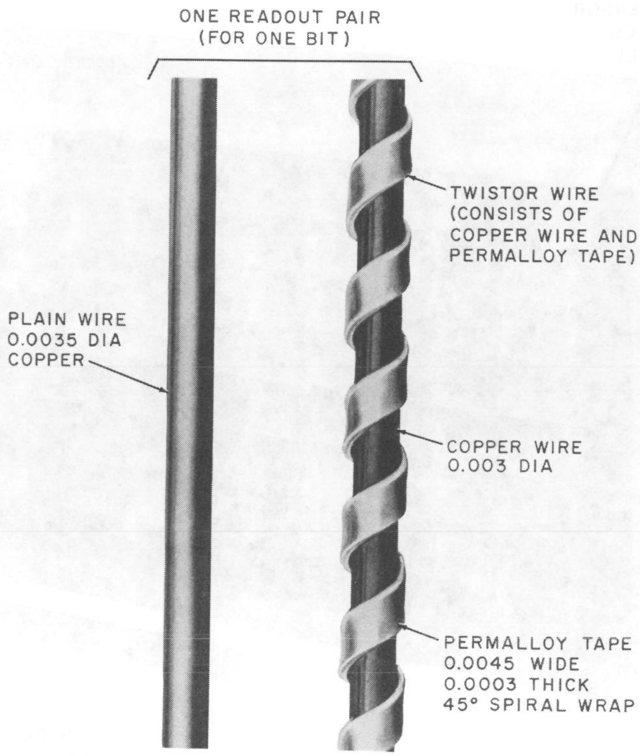


Fig. 6—Twistor Wire Readout Pair (4.10)

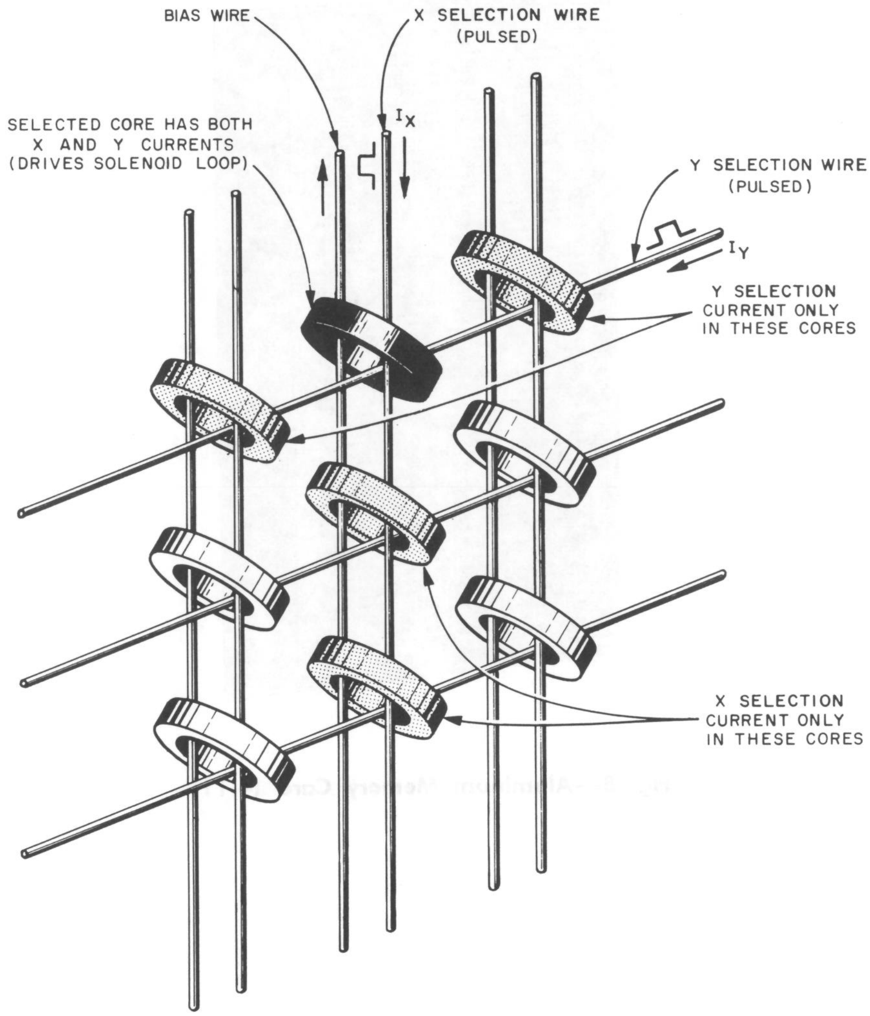


Fig. 7—Selection of a Ferrite Access Core (4.10)

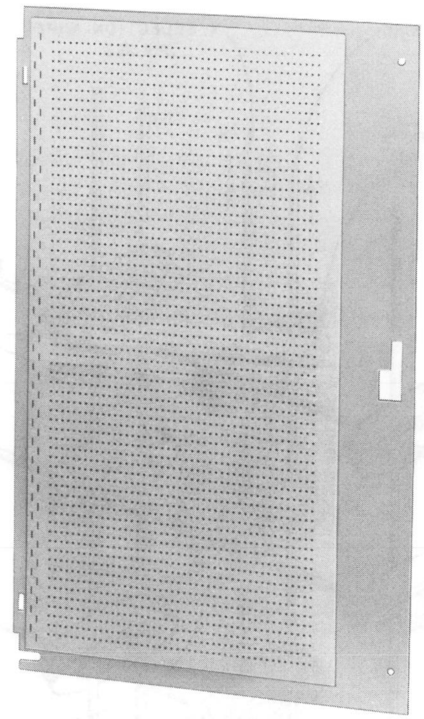


Fig. 8—Aluminum Memory Card (4.11)

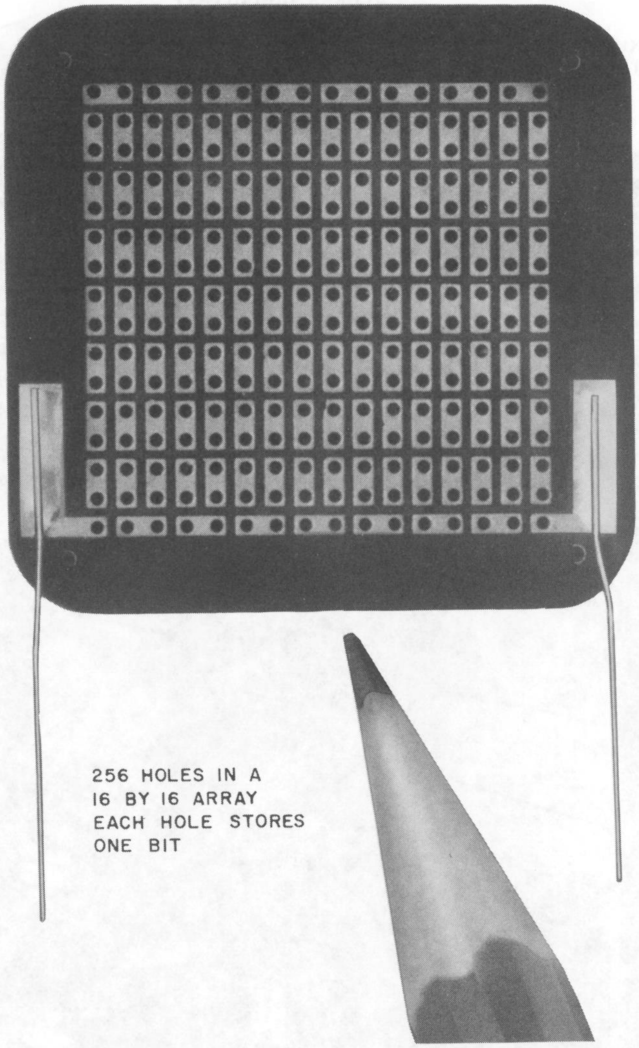
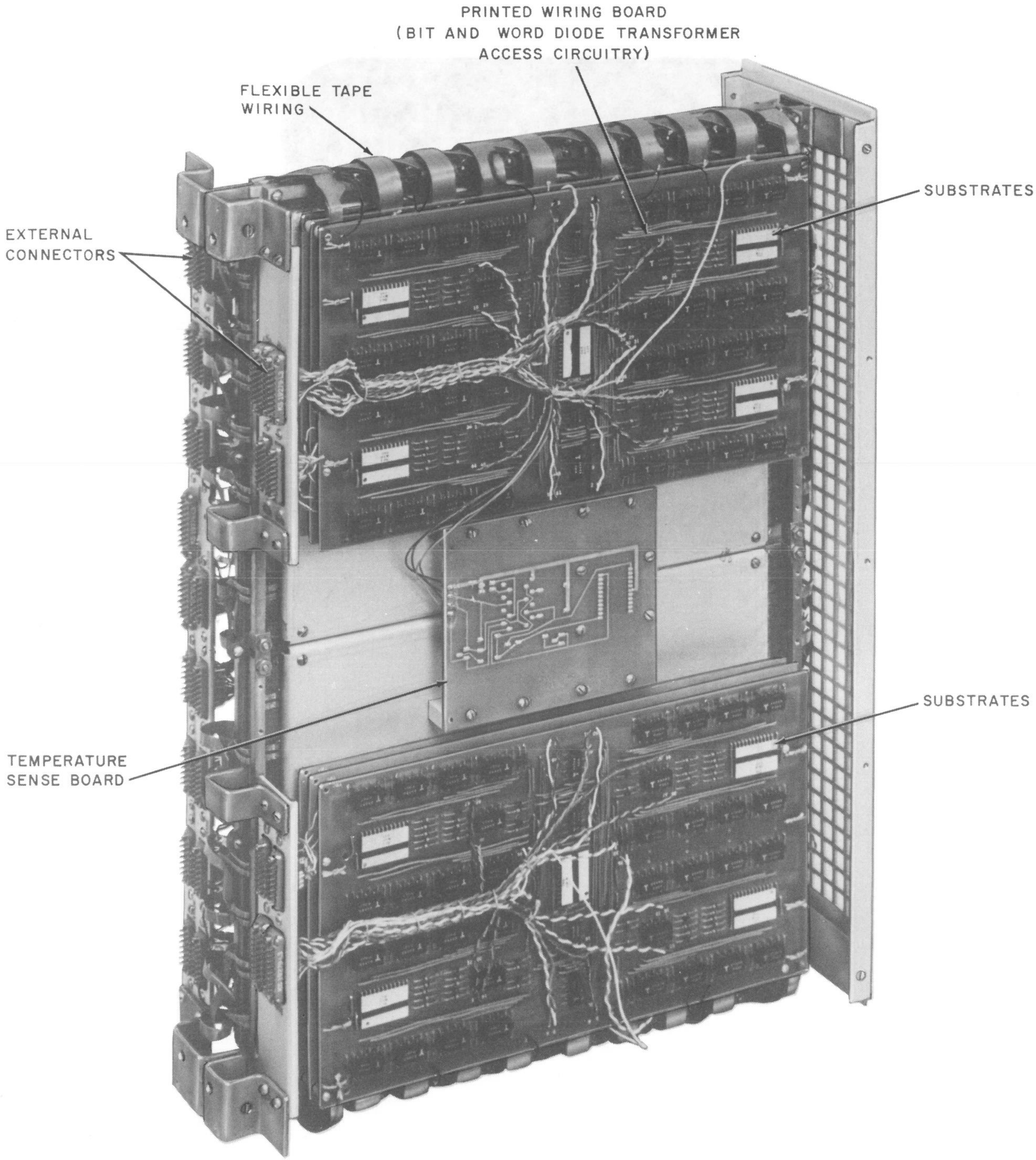


Fig. 9—Ferrite Sheet (4.13)



NOTE:
TWO IDENTICAL CORE ASSEMBLIES MOUNTED BACK TO BACK ON THE STRUCTURAL FRAME WORK ARE LOCATED INSIDE THE 20A MEMORY WHICH CAN NOT BE SEEN HERE.

Fig. 10—20A Memory (4.14)

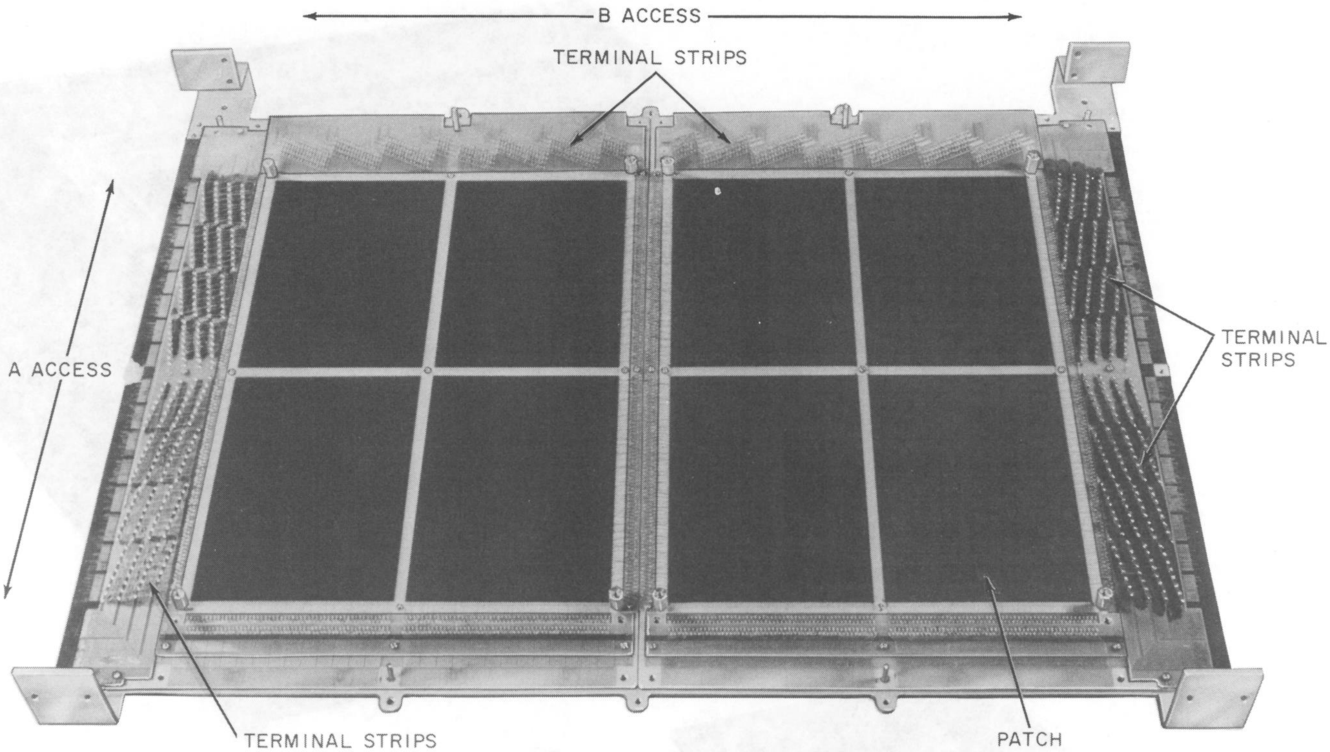


Fig. 11—Ferrite Core Mat Assembly (4.14)

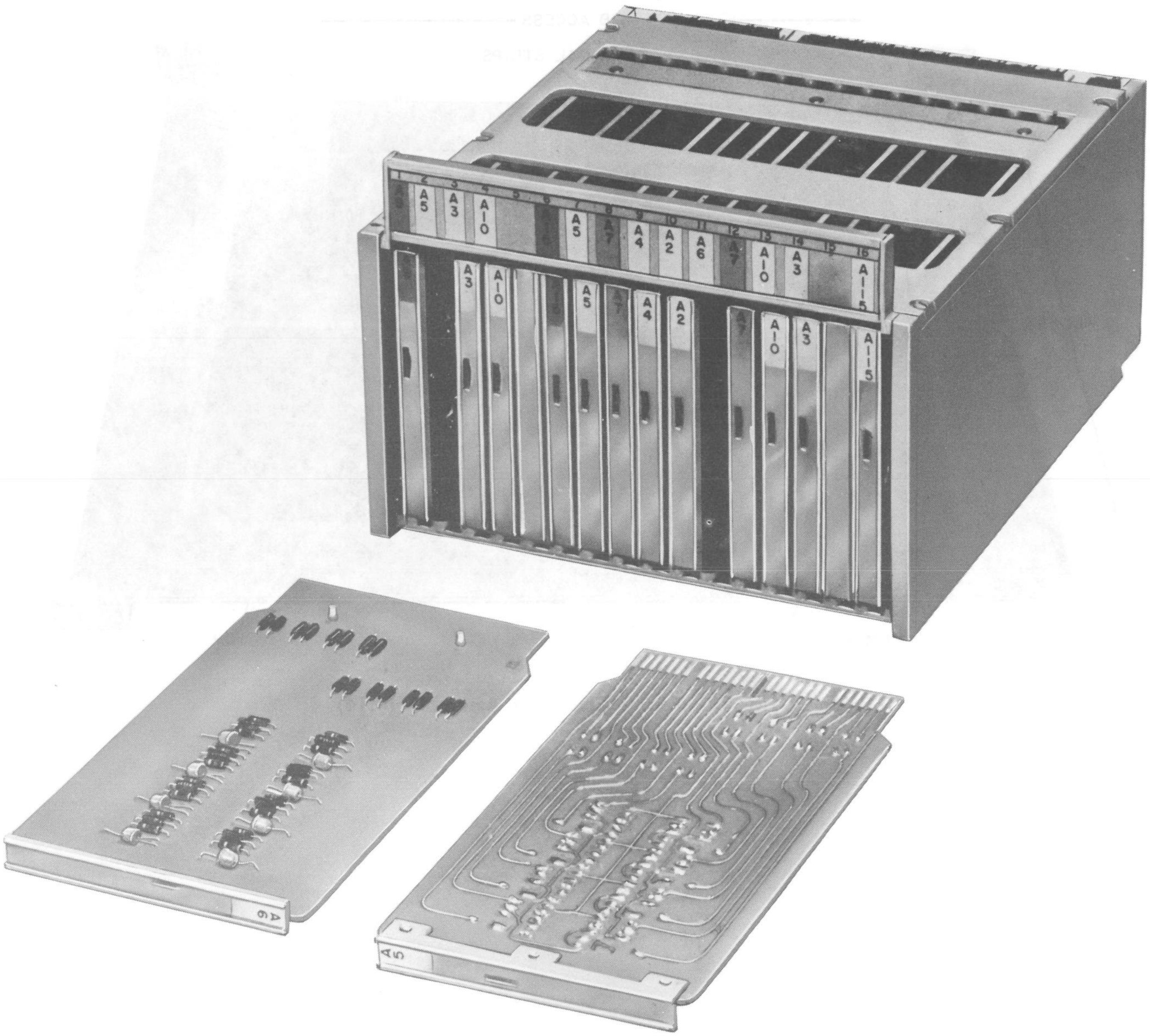


Fig. 12—Circuit Packs and Apparatus Mounting (4.16)

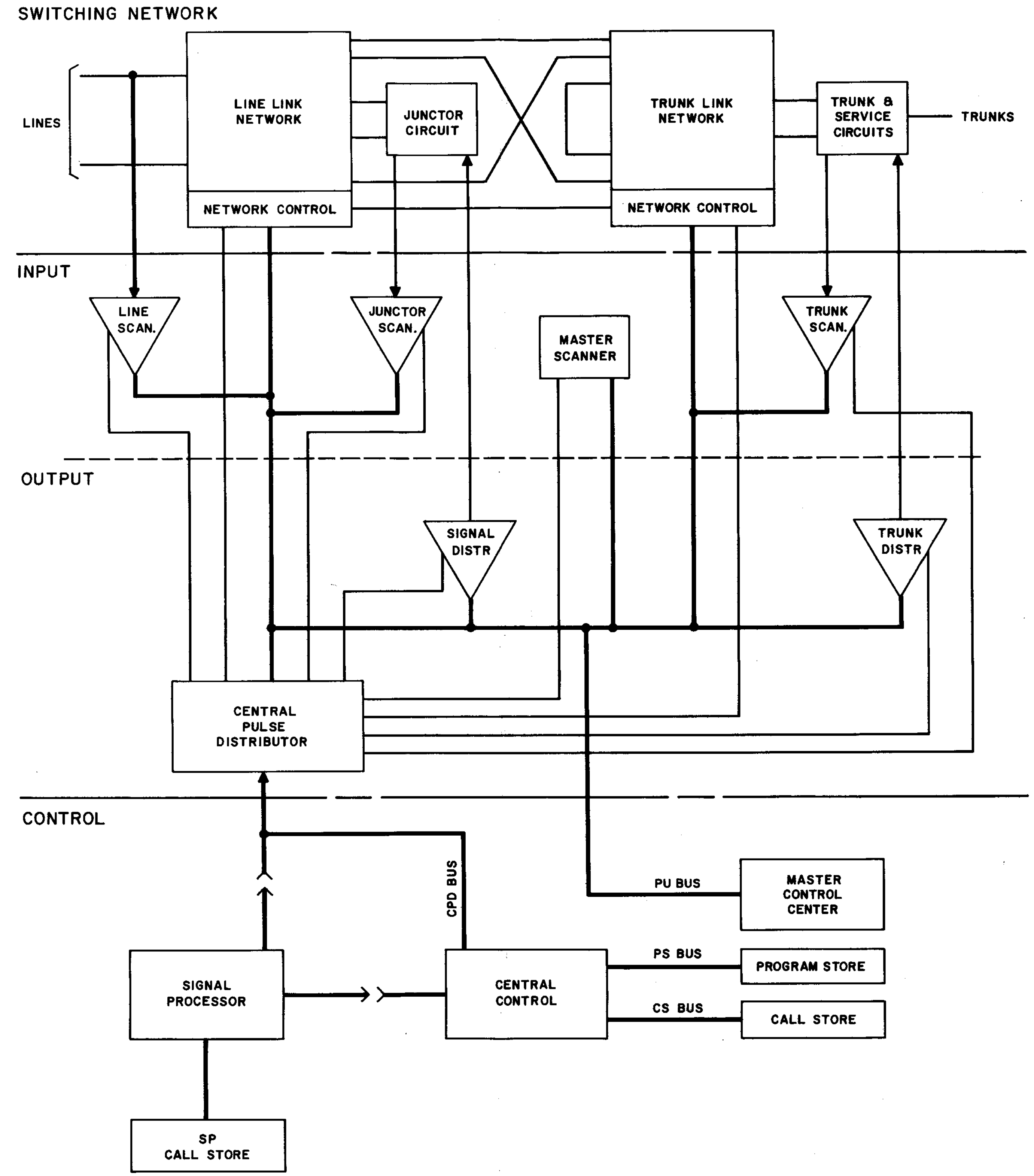


Fig. 13—No. 1 ESS Block Diagram (5.02)

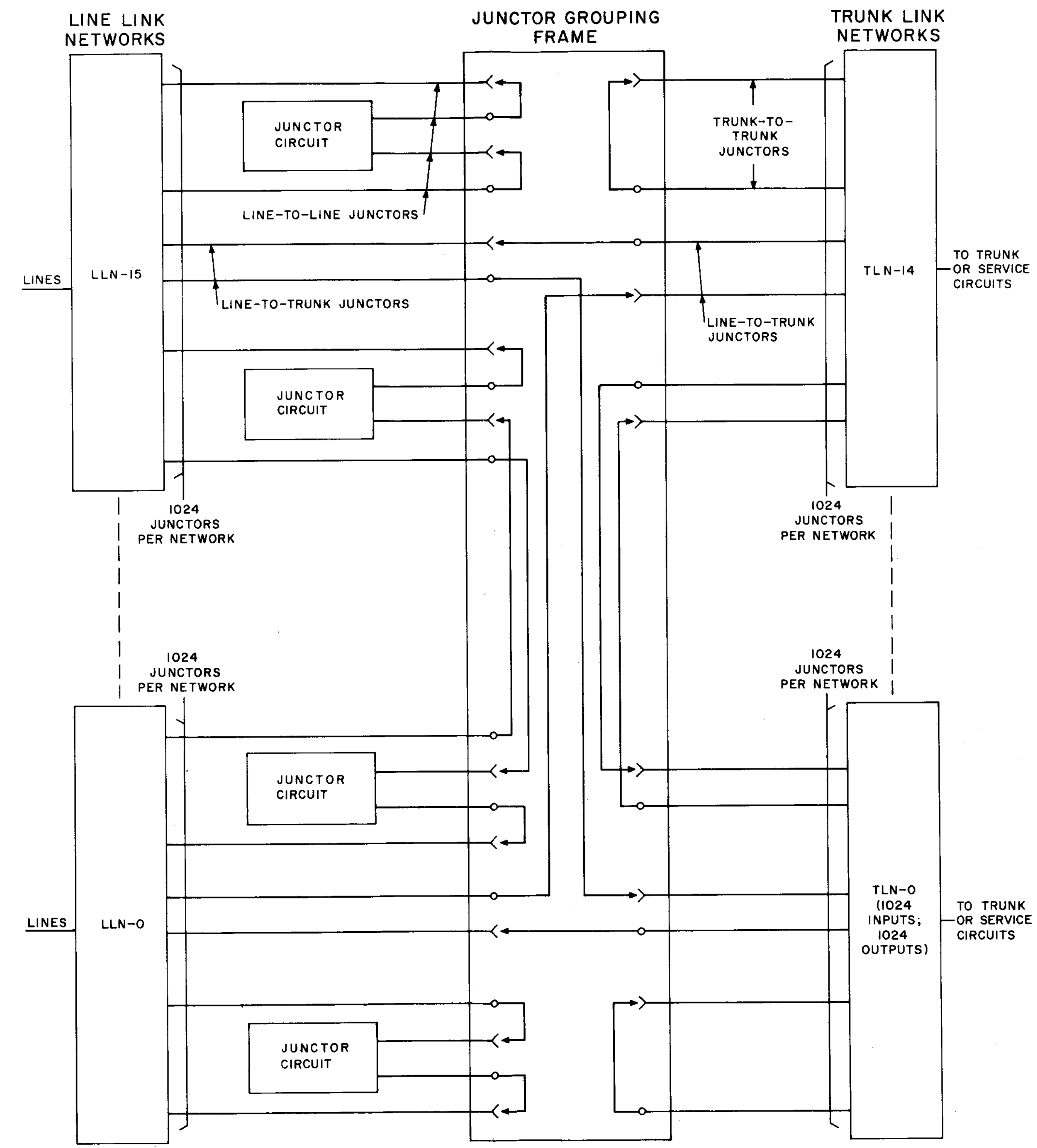


Fig. 14—Switching Network (5.04)

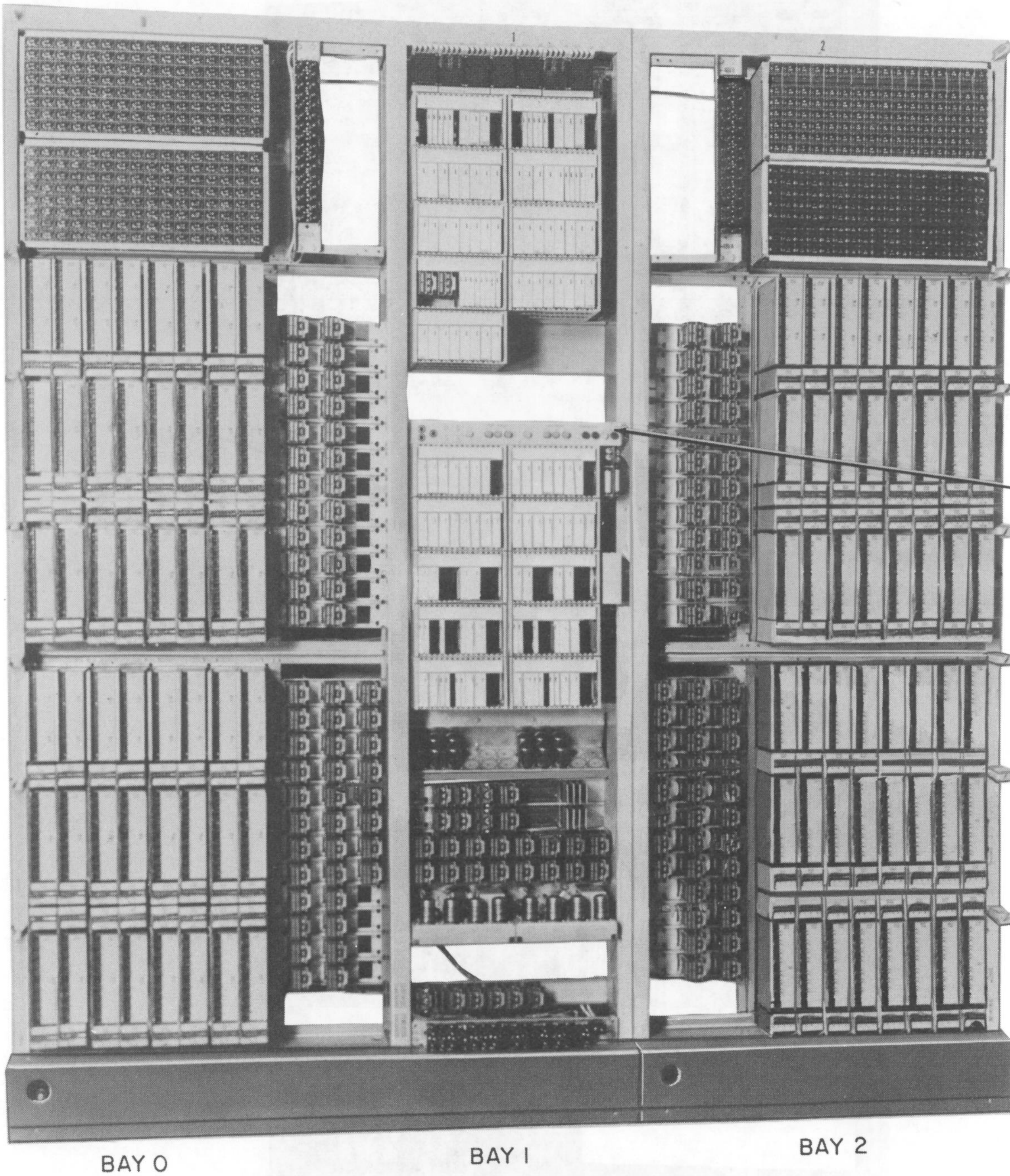


Fig. 15—Ferreed Line Switch Frame (5.08)

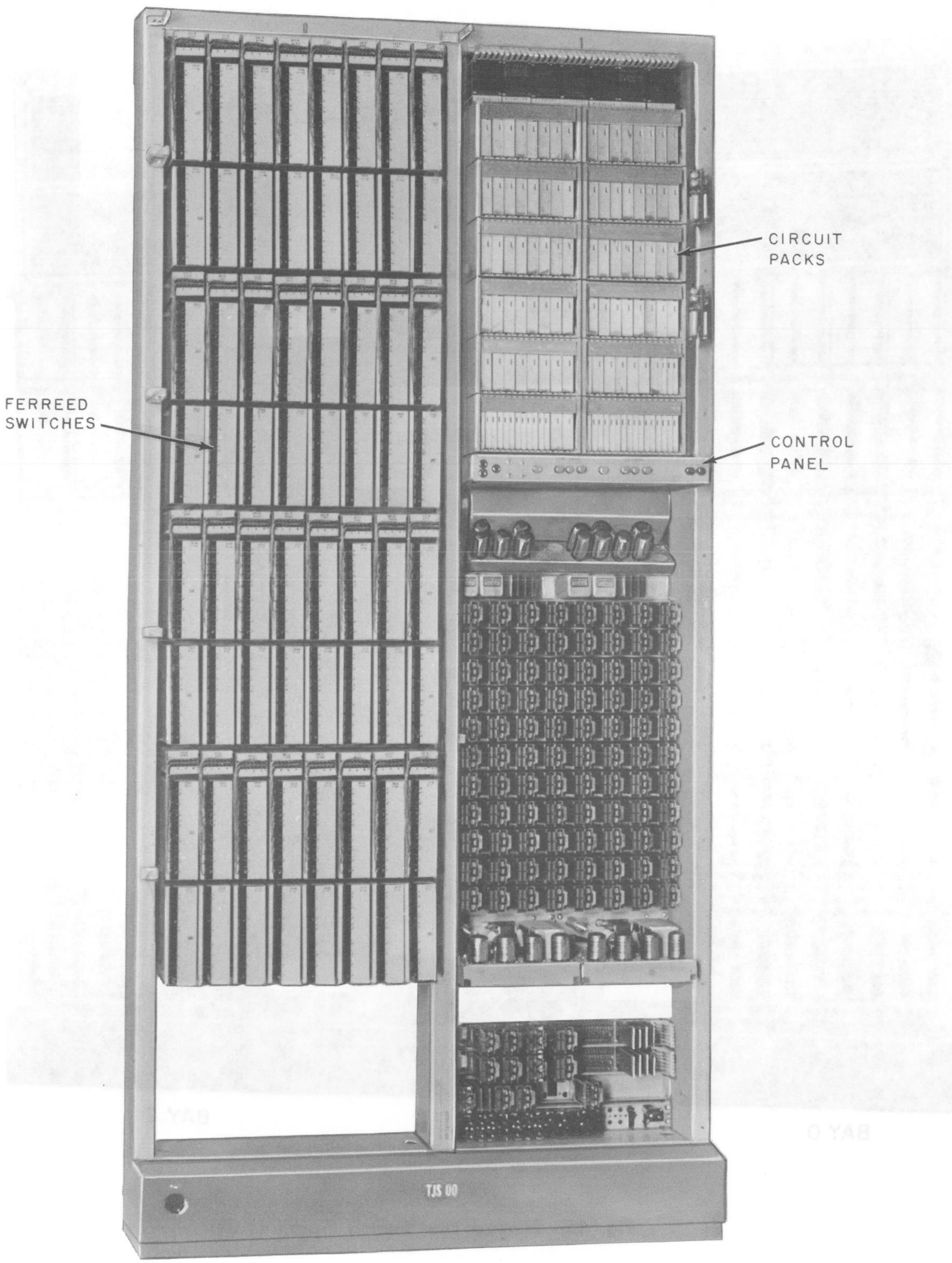


Fig. 16—Line or Trunk Junctor Switch Frame (5.08, 5.37)

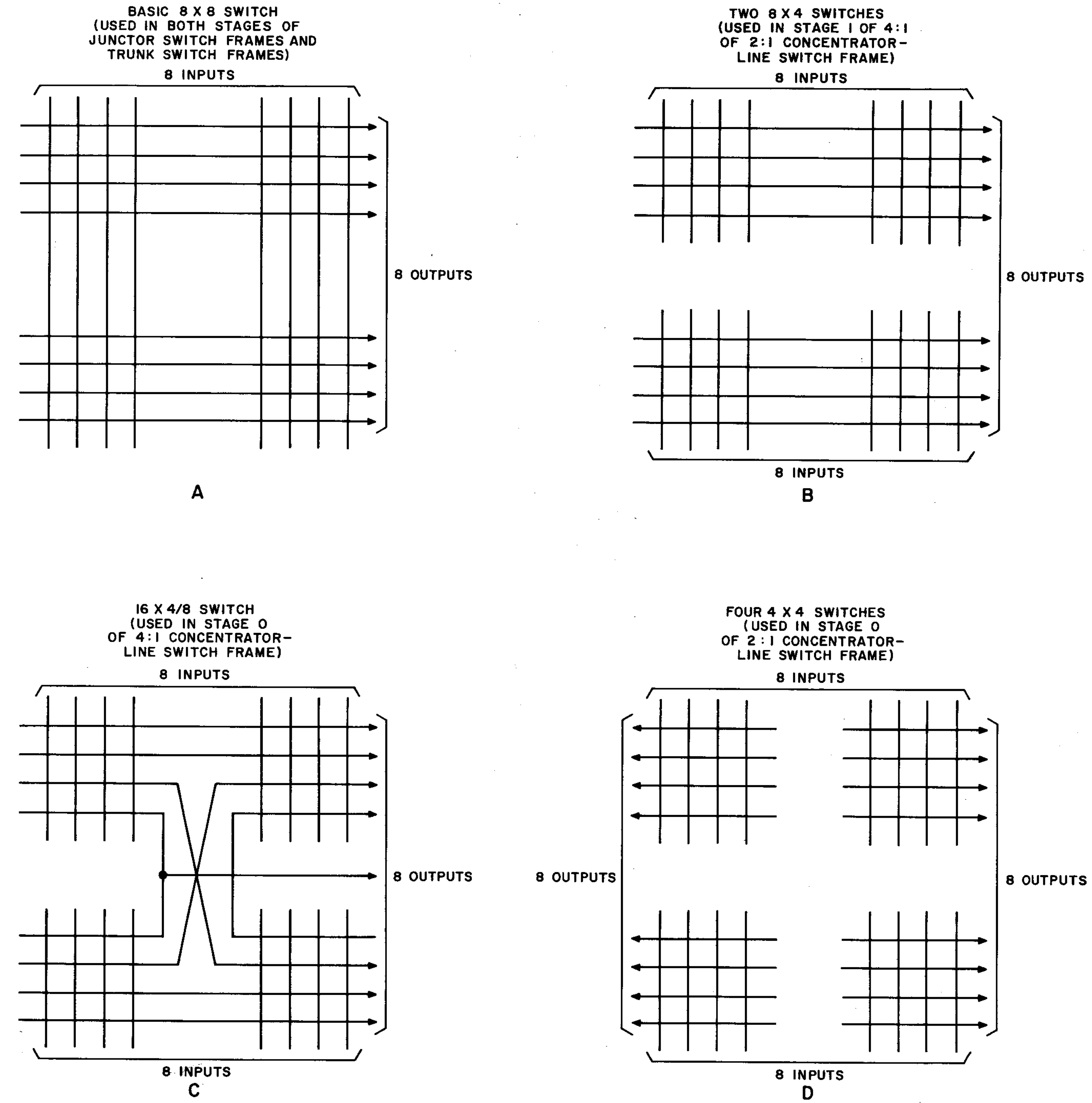


Fig. 17—Ferreed Switch Arrangement (5.10)

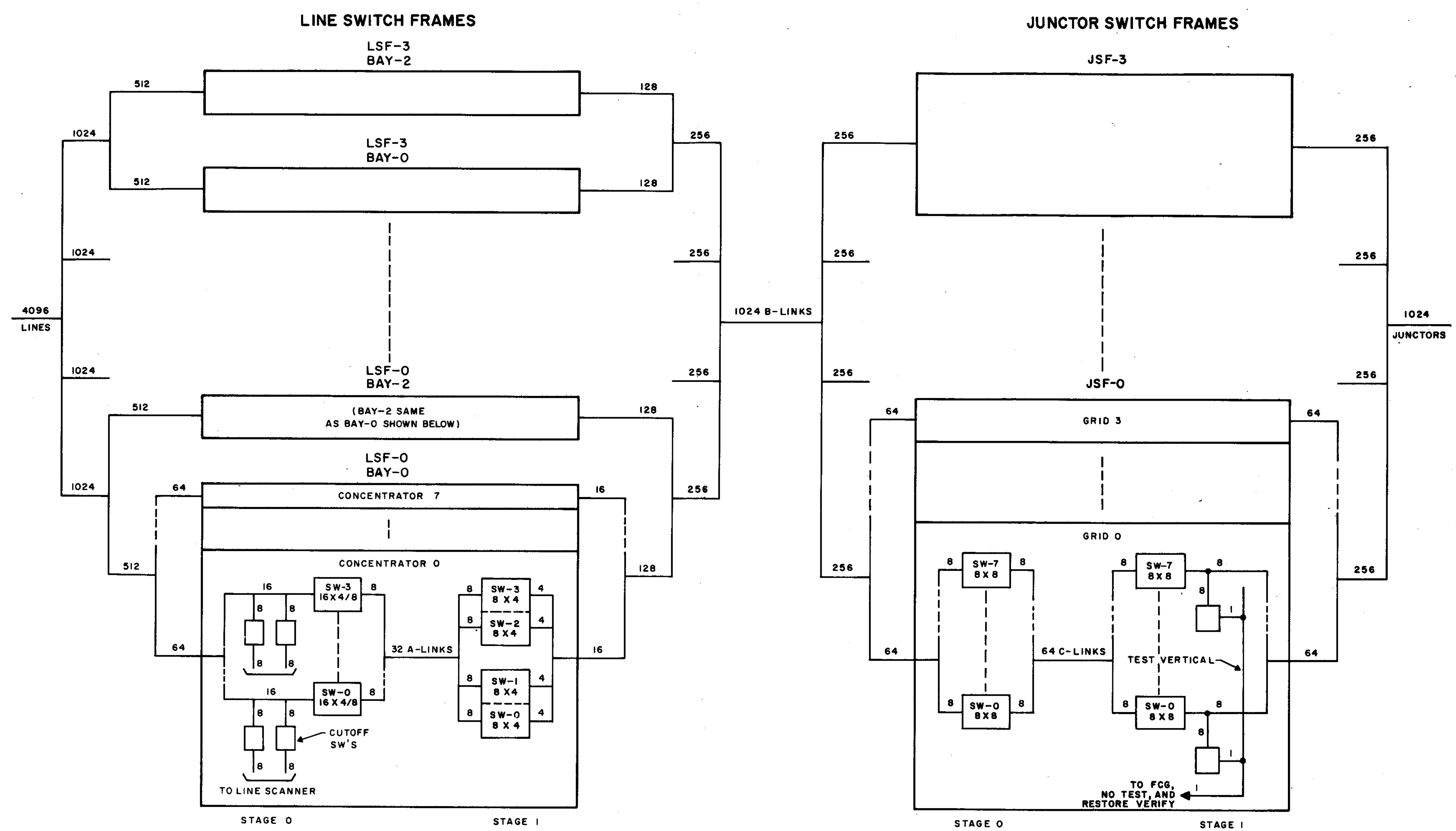


Fig. 18—Organization of Ferreed LLN With 4:1 Concentration Ratio (5.11)

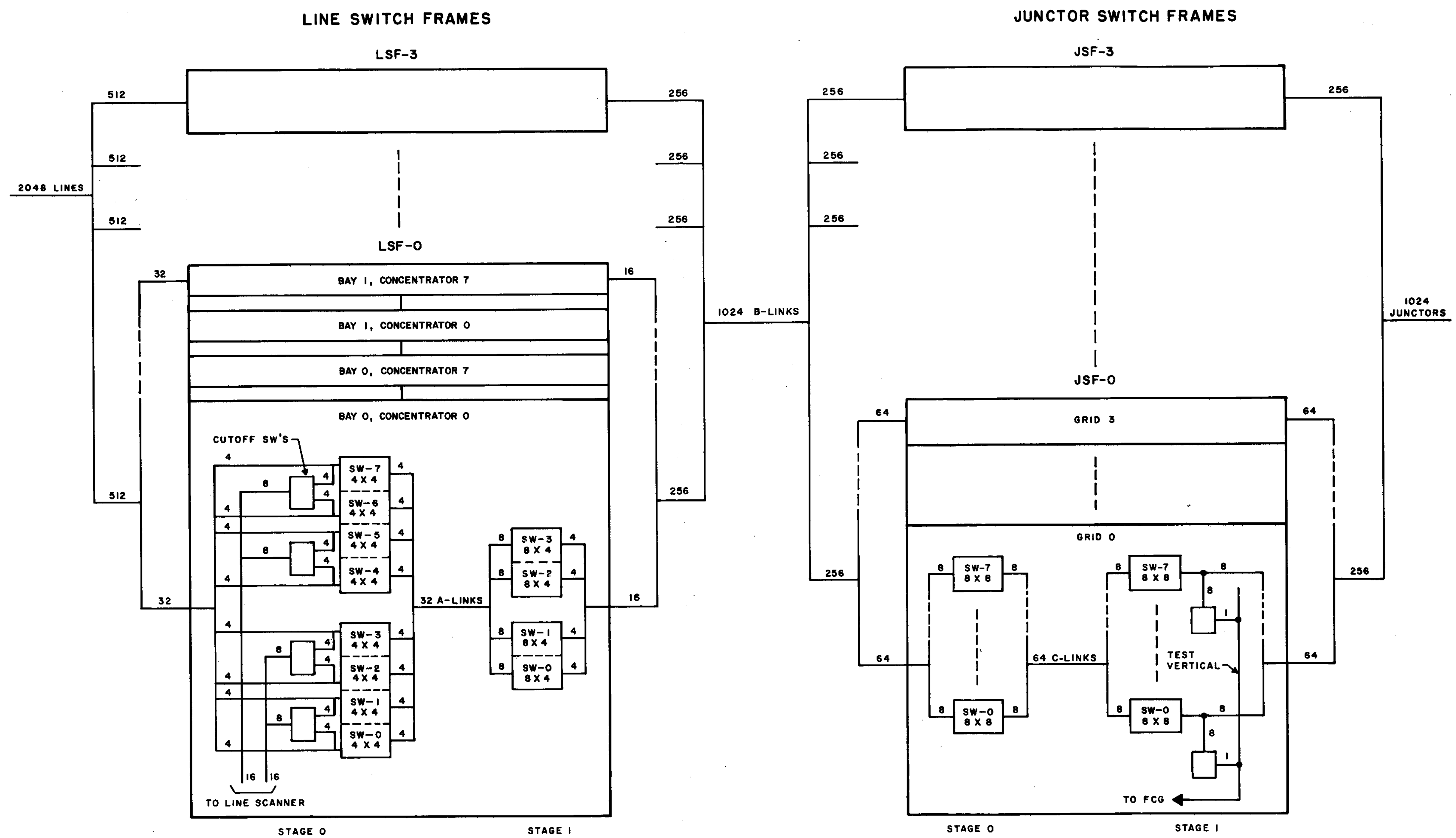


Fig. 19—Organization of Ferreed LLN With 2:1 Concentration Ratio (5.12)

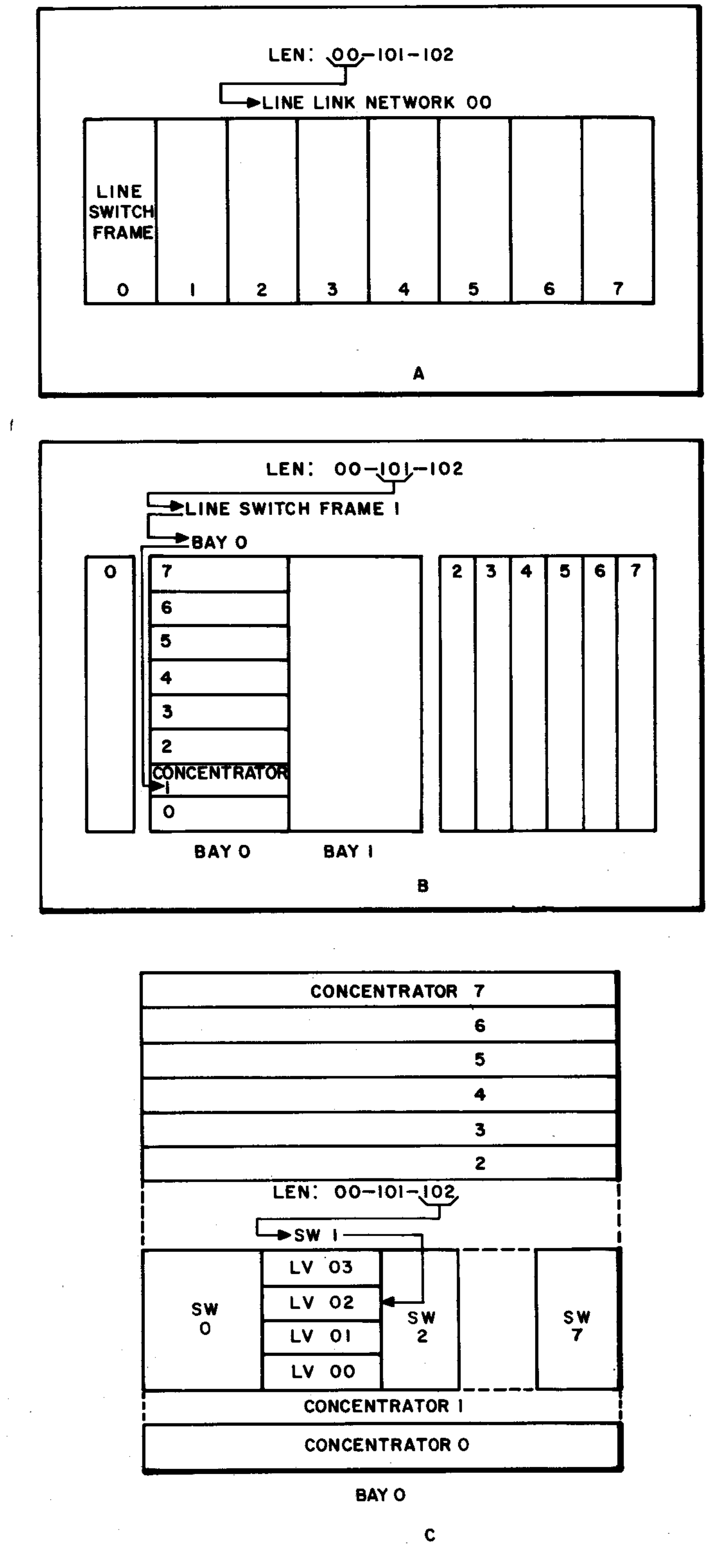
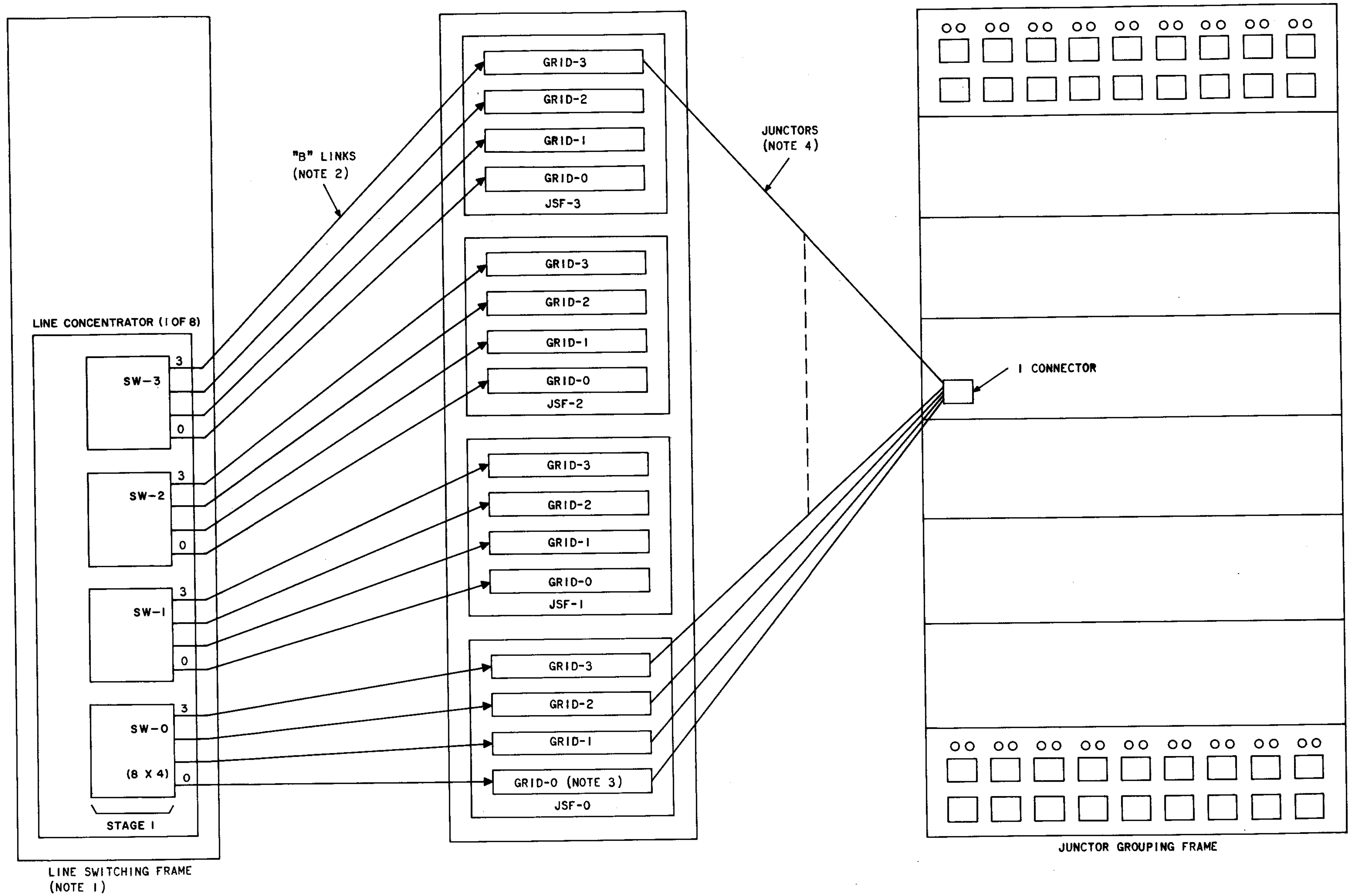


Fig. 20—Locating a Ferreed Line Equipment Number in a 2:1 Concentrator (5.15)



NOTES:

1.
128	OUTPUTS PER LSF BAY
X 2	BAYS PER LSF
256	
X 4	LSFs
1024	OUTPUTS

2. THE LINKS SHOWN ARE 1 OF 64 INPUTS PER GRID.
3. THERE ARE 8 - 8 X 8 INPUT SWITCHES AND 8 - 8 X 8 OUTPUT SWITCHES PER GRID.

64	INPUTS/OUTPUTS PER GRID
X 16	GRIDS
1024	INPUTS/OUTPUTS

4. THE JUNCTORS SHOWN ARE 1 OF 64 OUTPUTS PER GRID. SIXTEEN JUNCTORS EQUAL ONE JUNCTOR SUBGROUP.

Fig. 21—Ferreed Concentrator-to-Grid Connection (5.20, 5.22, 5.23)

LSF CONC RATIO	MAX. NO. LSFs PER LLN	RATIO OF LINE TERMINALS TO JUNCTORS	CUSTOMER LINES PER LLN	MAX. NO. LLNs PER OFFICE	MAX. NO. LINES PER OFFICE
FOR HEAVY CUSTOMER USAGE					
2 to 1	4	2 to 1 (Std.)	2048	16	32,768
2 to 1	5	5 to 2 (A&M)	2560	16	40,960
2 to 1	6	3 to 1 (Std.)	3072	16	49,152
2 to 1	7	7 to 2 (A&M)	3584	16	57,344
2 to 1	8	4 to 1 (A&M)	4096	16	65,536
FOR REGULAR CUSTOMER USAGE*					
4 to 1	4	4 to 1 (Std.)	4096	16	65,536
4 to 1	5	5 to 1 (A&M)	5120	16	81,920
4 to 1	6	6 to 1 (Std.)	6144	16	98,304
4 to 1	7	7 to 1 (MD)	7168	16	114,688
4 to 1	8	8 to 1 (MD)	8192	16	131,072

*Line switch frames (LSFs) for a 4:1 concentration ratio are made up of one home frame and one mate frame.

Fig. 22—Ferreed LLN Sizes (5.22)

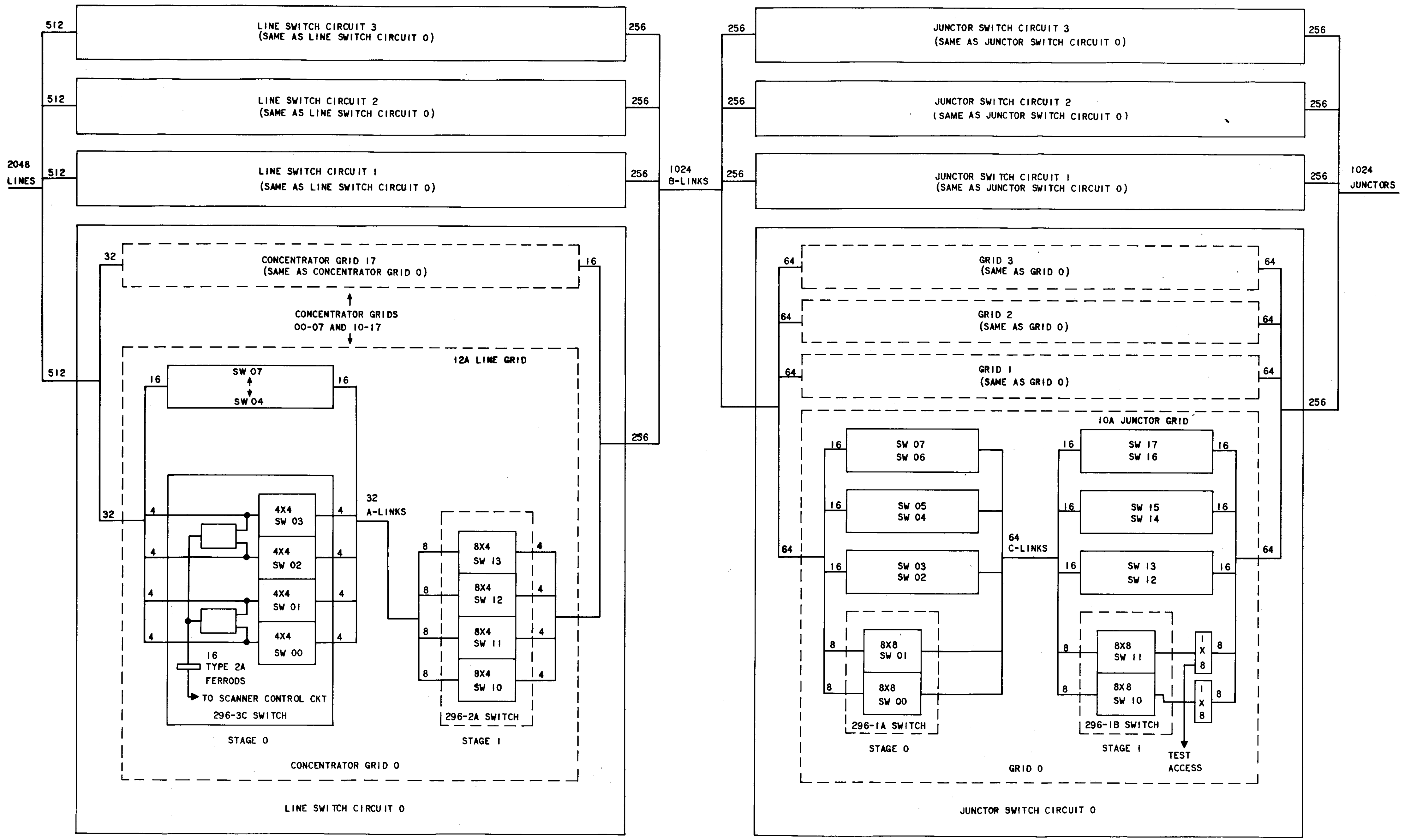
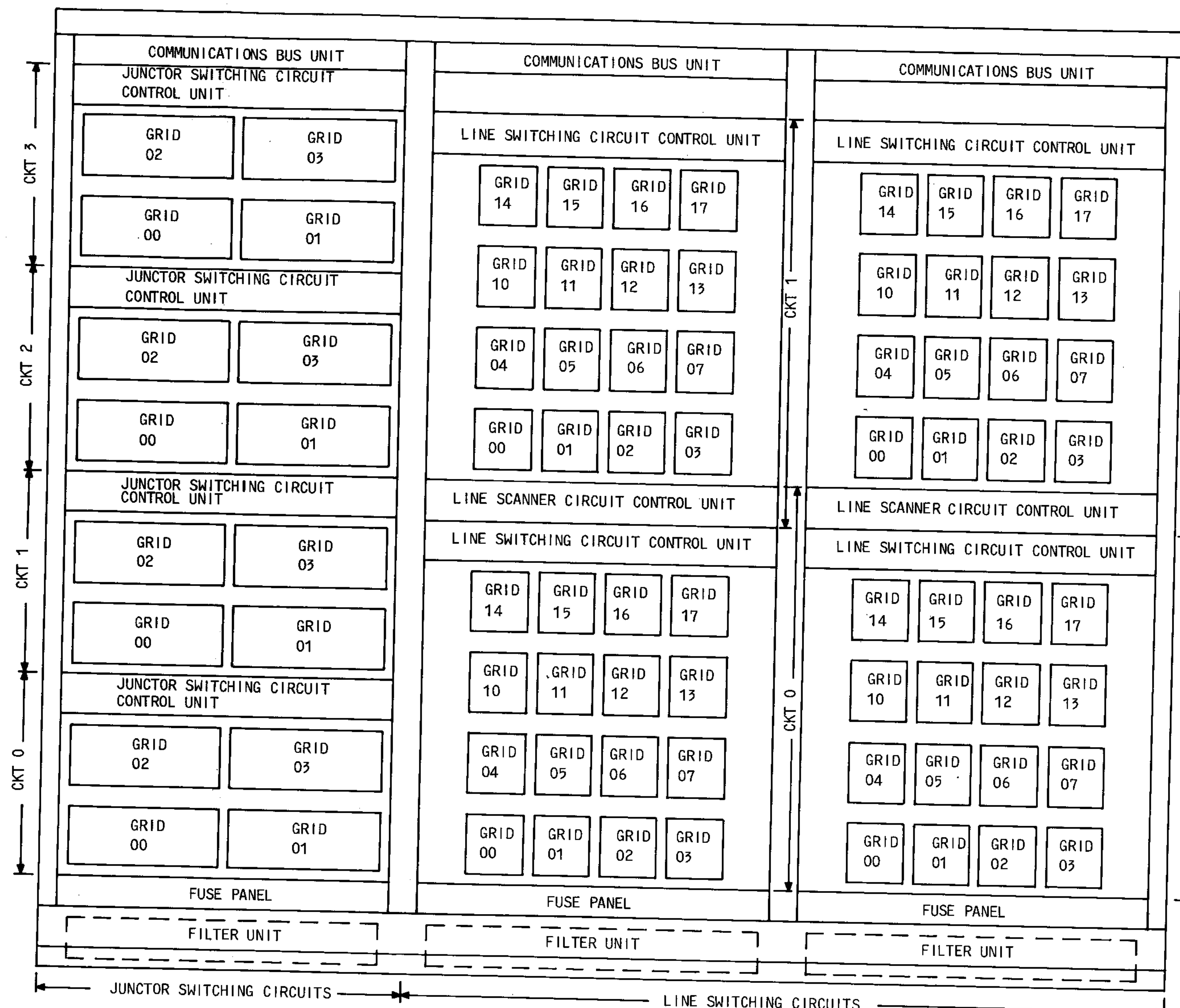
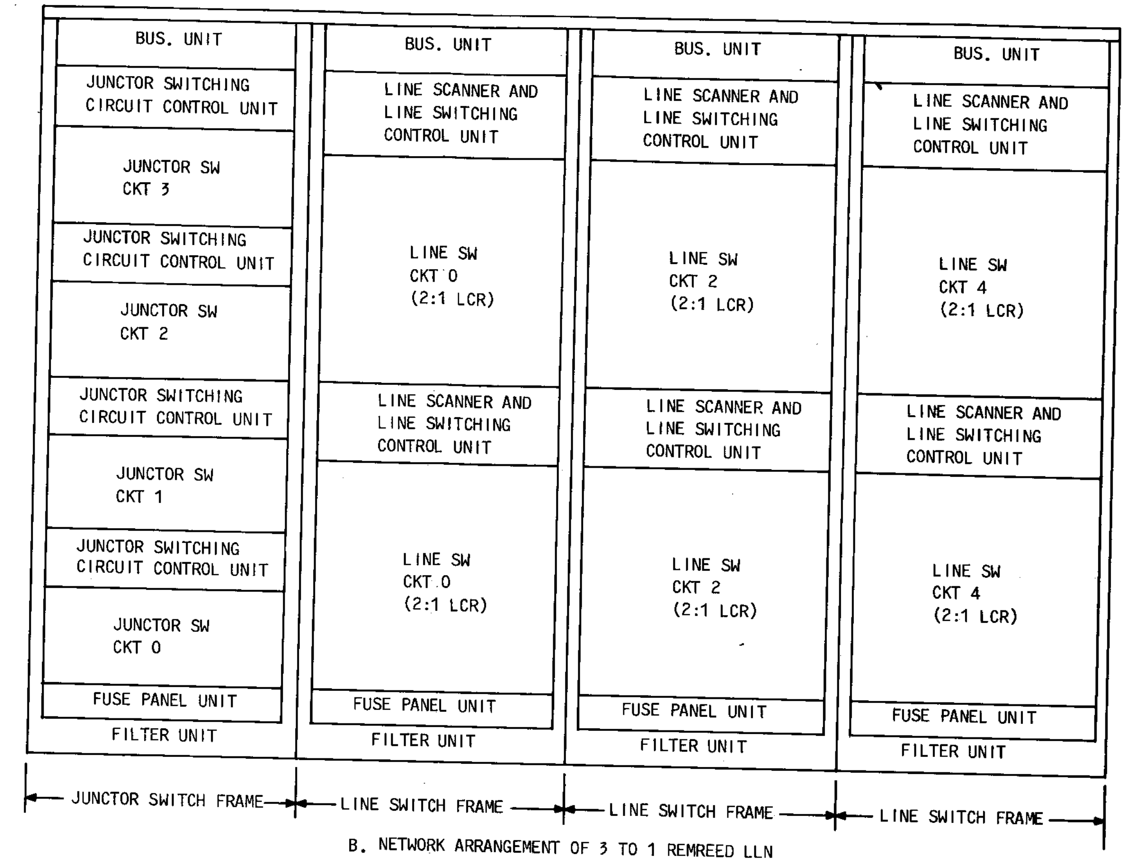


Fig. 23—Organization of 2:1 Remreed LLN (5.26)



A. NETWORK ARRANGEMENT OF 2 TO 1 REMREED LLN



B. NETWORK ARRANGEMENT OF 3 TO 1 REMREED LLN

C. REMREED LINE LINK NETWORK SIZES

LINE SW CKT	MAX NO. LINE SW CKT PER LLN	RATIO OF LINE TERMINALS TO JUNCTORS	MAX NO. CUSTOMER LINES PER LLN	MAX NO. LLNs PER OFFICE	MAX NO. LINES PER OFFICE
FOR HEAVY CUSTOMER USAGE					
2 TO 1	4	2 TO 1	2048	16	32,768
2 TO 1	6	3 TO 1	2560	16	40,960
FOR REGULAR CUSTOMER USAGE					
4 TO 1	4	4 TO 1	4096	16	65,536
4 TO 1	6	6 TO 1	6144	16	98,304

Fig. 24—Network Arrangements—Remreed LLN (5.26, 5.29)

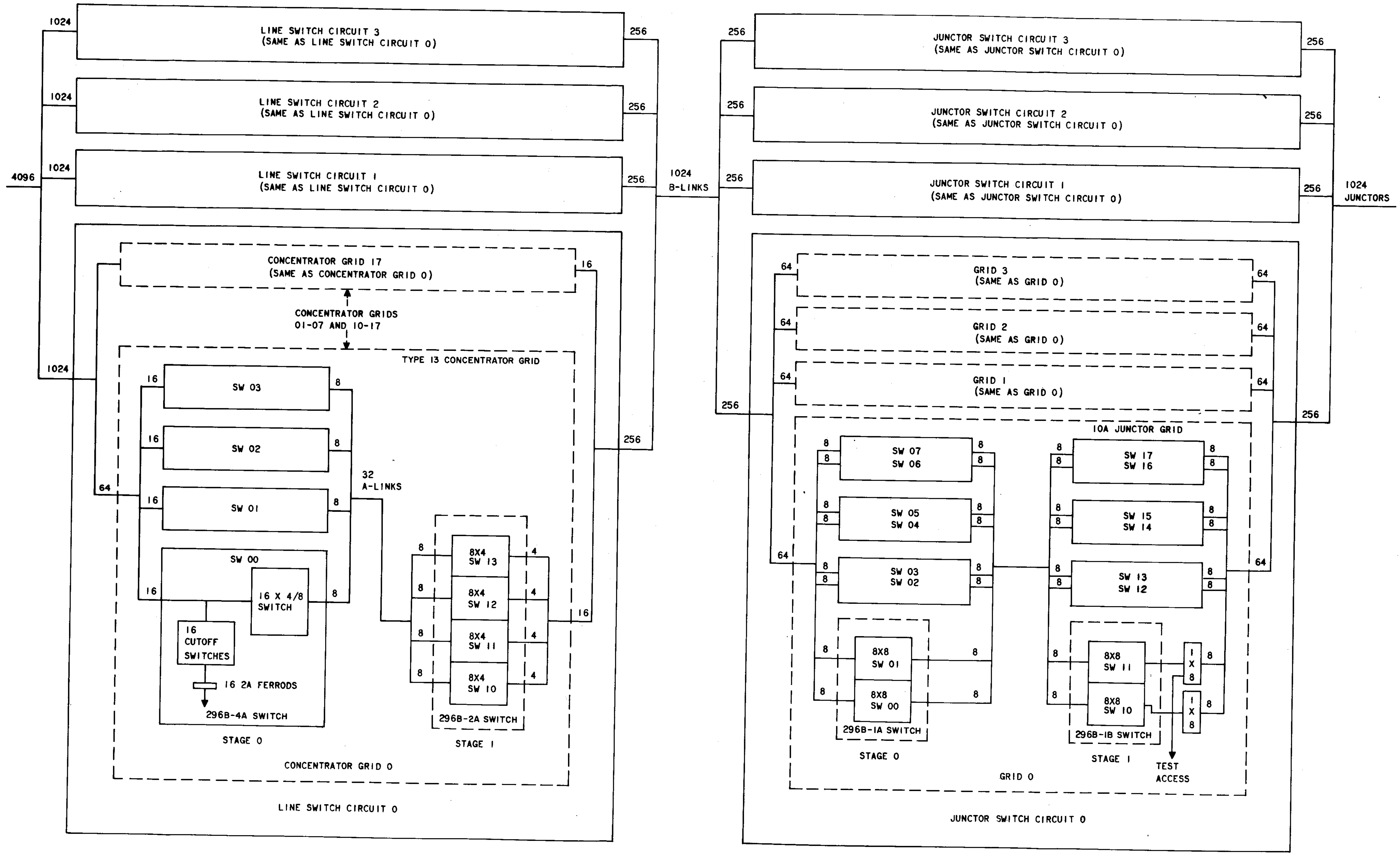


Fig. 25—Organization of 4:1 Remreed LLN (5.31)

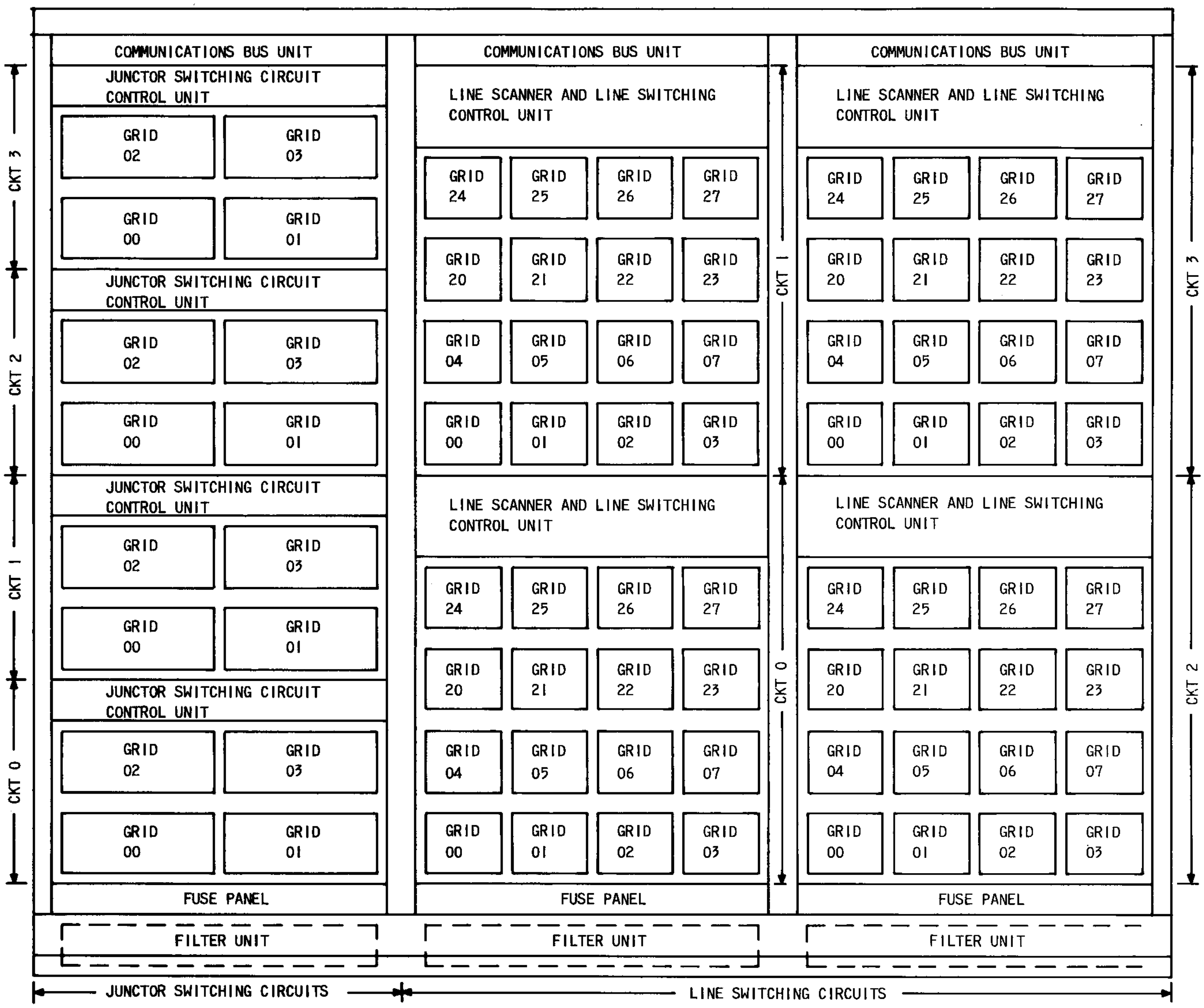


Fig. 26—Network Arrangement of 4:1 LLN (5.31)

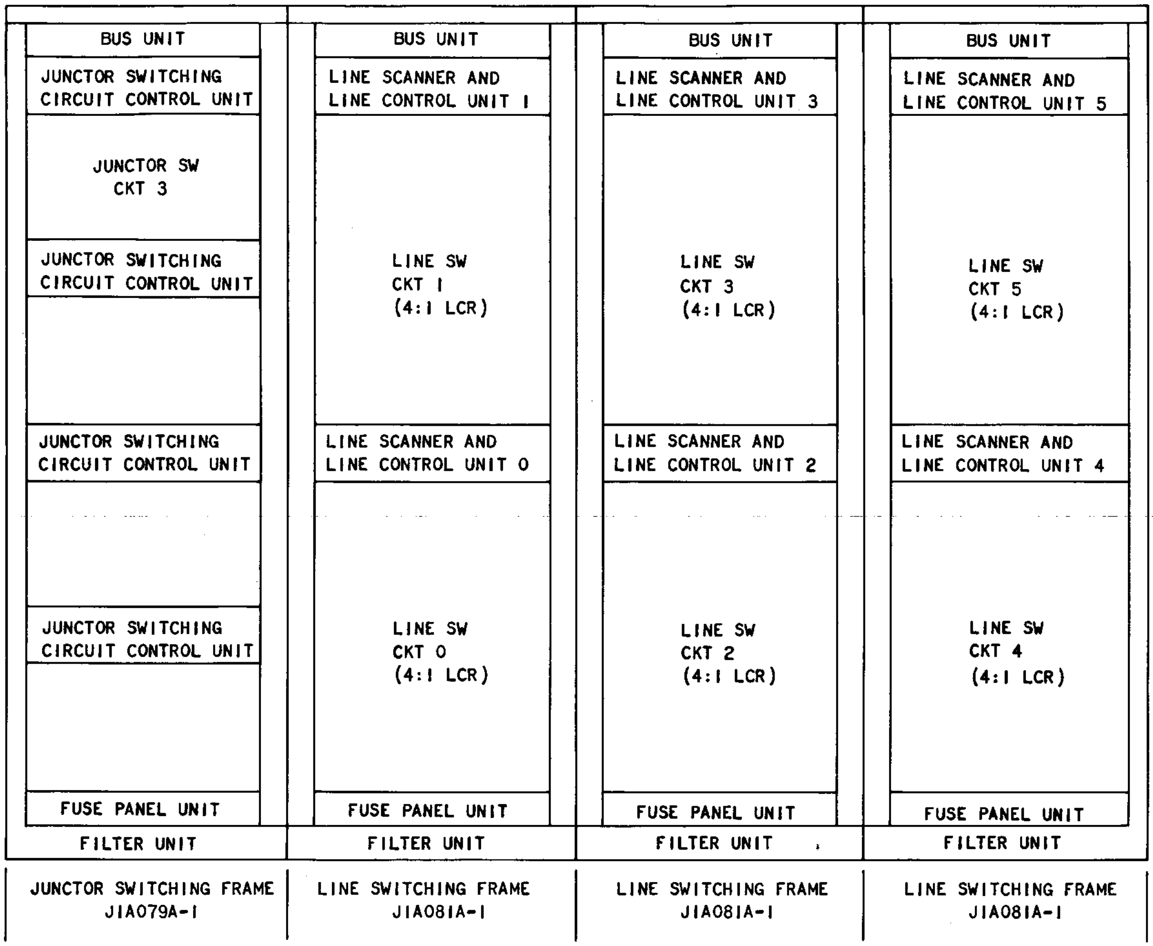


Fig. 27—Network Arrangement of 6:1 LLN (5.34)

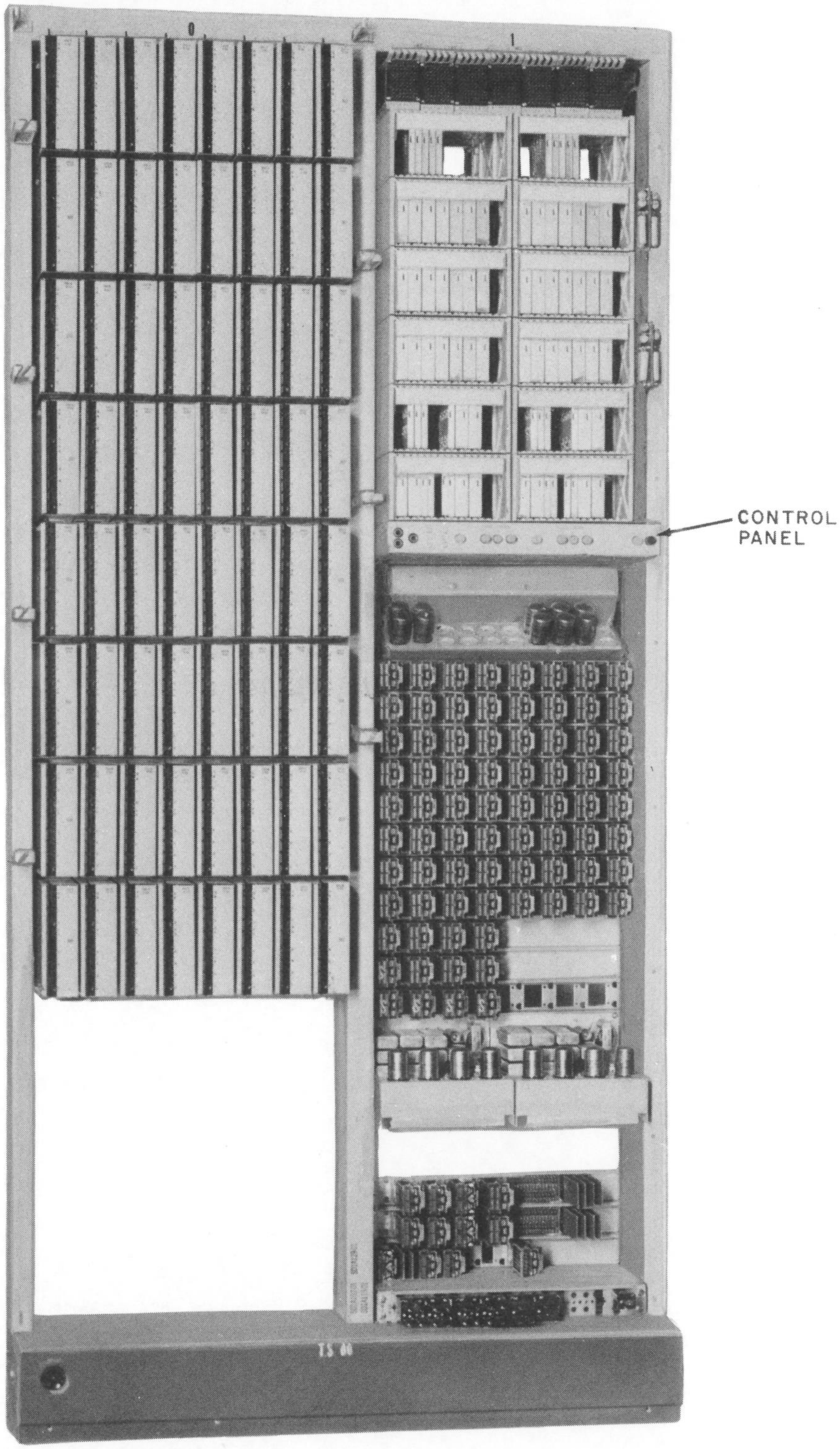


Fig. 28—Ferreed Trunk Switch Frame (5.37)

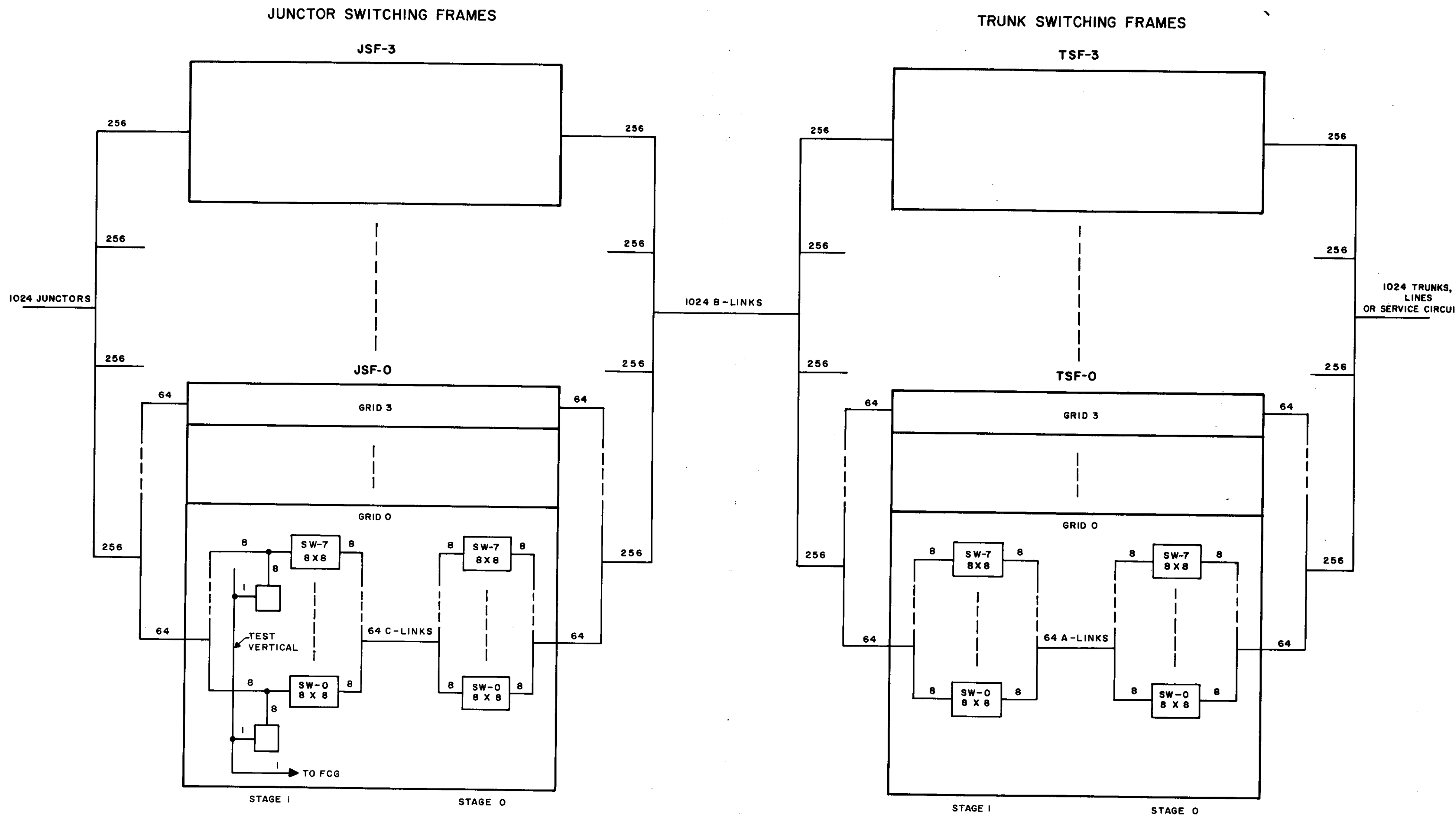


Fig. 29—Organization of Ferreed TLN (5.39, 5.43)

RATIO OF TRUNK TERMINALS TO JUNCTORS	MAX. NO. PER TLN	MAX. NO. TERMINALS PER TLN	NO. JUNCTORS PER TLN	MAX. NO. TLNs PER PER TLN	MAX. NO. TRUNKS
1 to 1 (Std)	4	1024	1024	15	15,360
5 to 4 (A&M)	5	1280	1024	15	19,200
3 to 2 (Std)	6	1536	1024	15	23,040
7 to 4 (A&M)	7	1792	1024	15	26,880
2 to 1 (A&M)	8	2048	1024	15	30,720

*16th TLN reserved for service link network in offices with SP-CTX programs beginning with SP-CTX-3.

Fig. 30—Ferreed TLN Sizes (5.41)

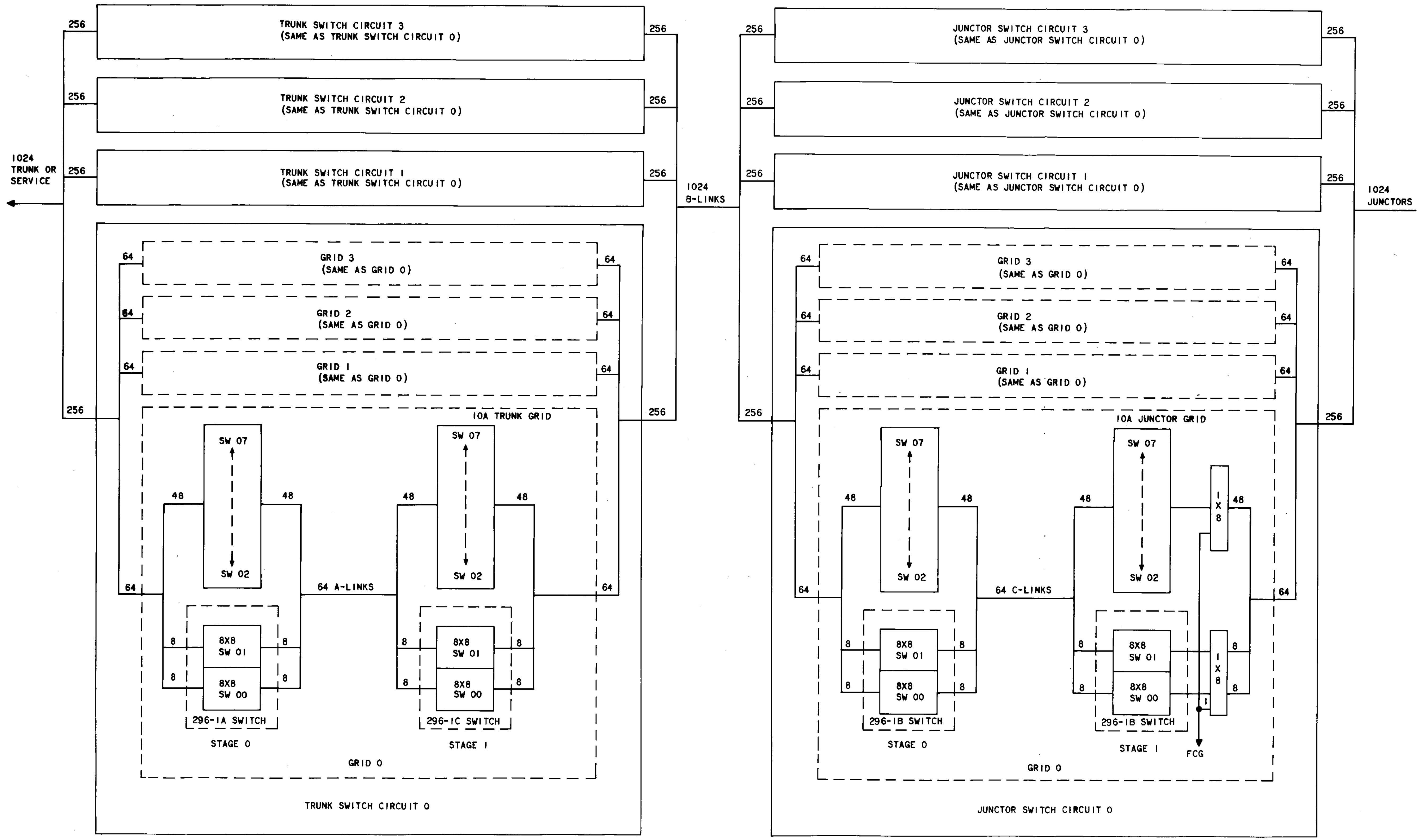
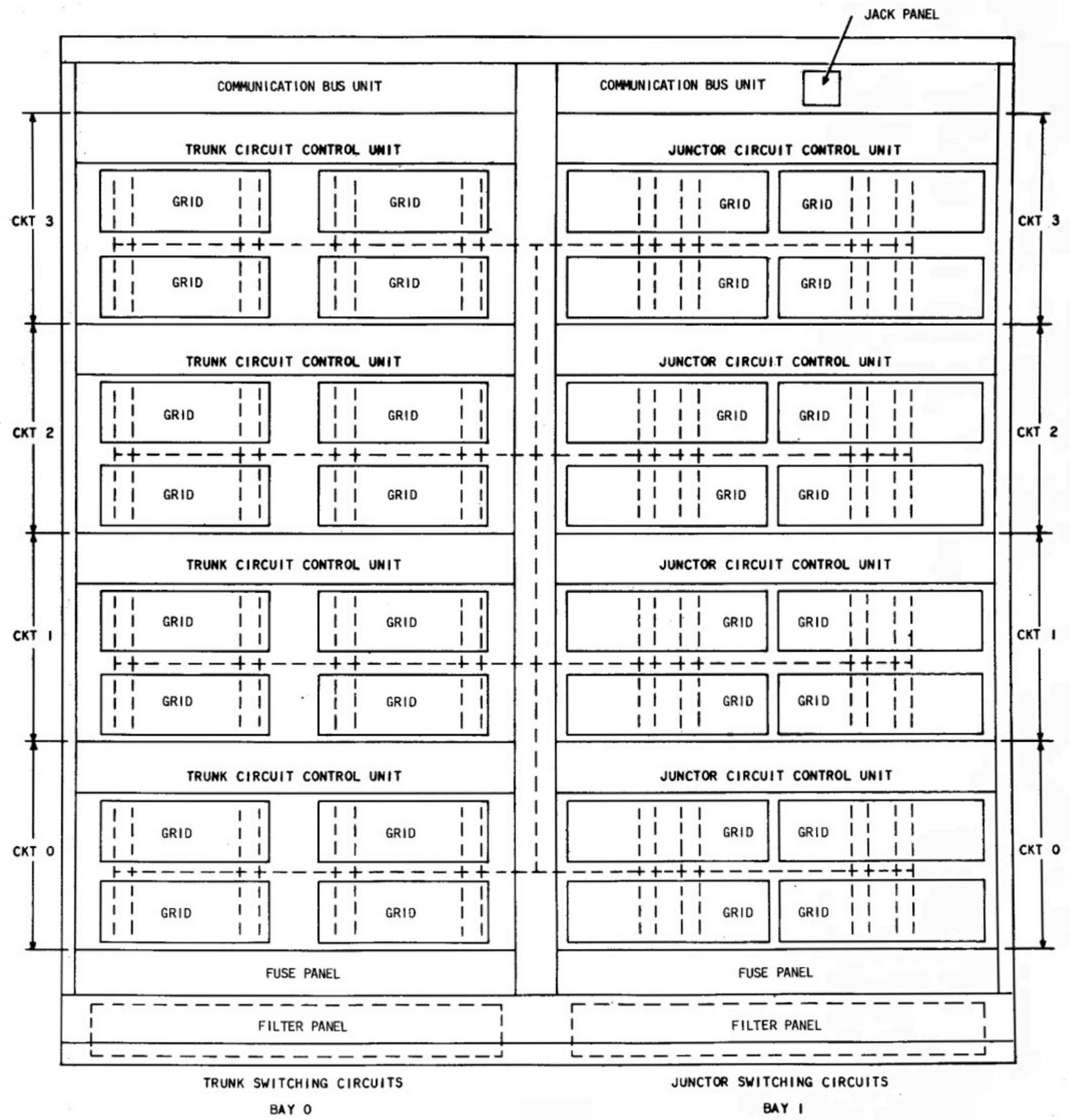
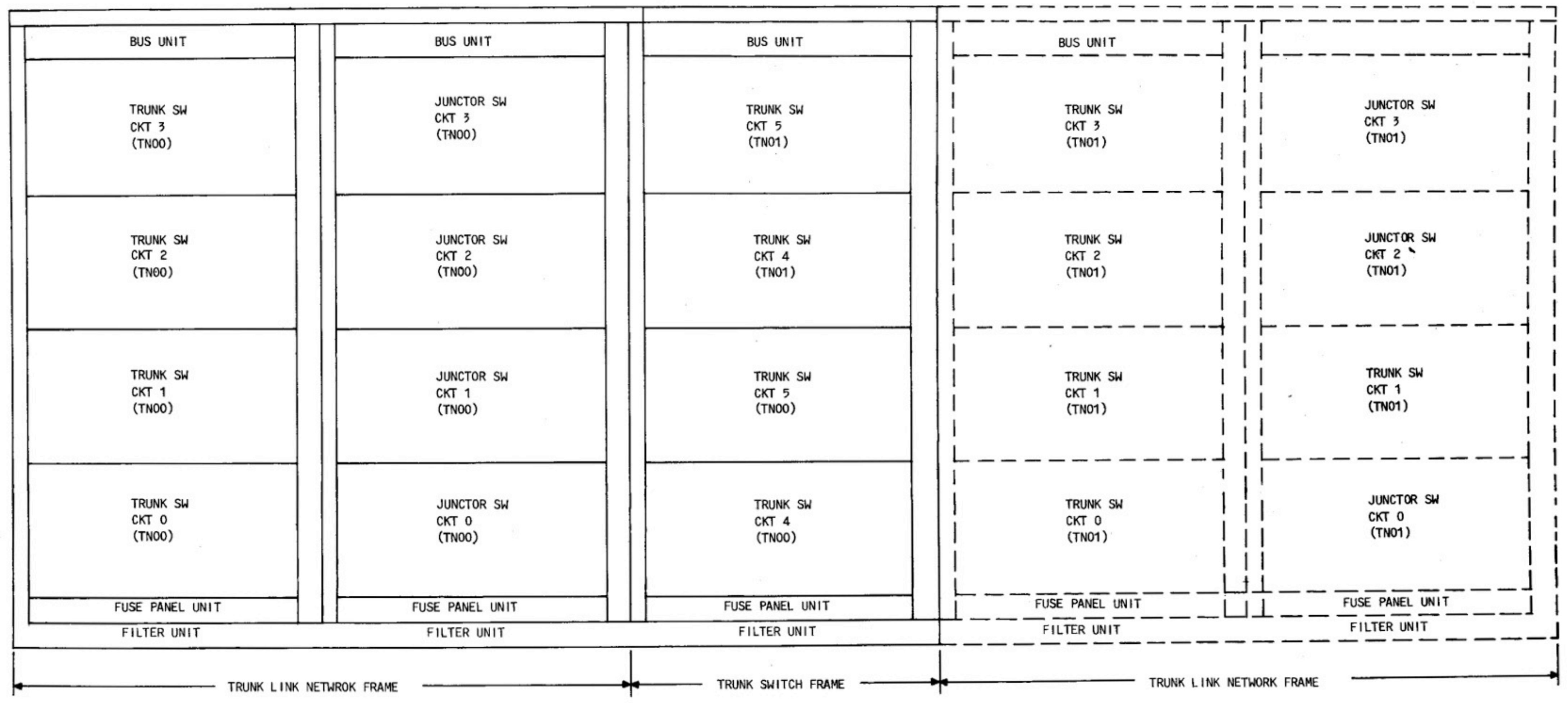


Fig. 31—Organization of 1:1 Remreed TLN (5.47)



A. NETWORK ARRANGEMENT OF 1 TO 1 REMREED TLN



B. NETWORK ARRANGEMENT OF 1.5 TO 1 REMREED TLN

Fig. 32—Network Arrangement of 1:1 and 1.5:1 Remreed TLN (5.41, 5.49)

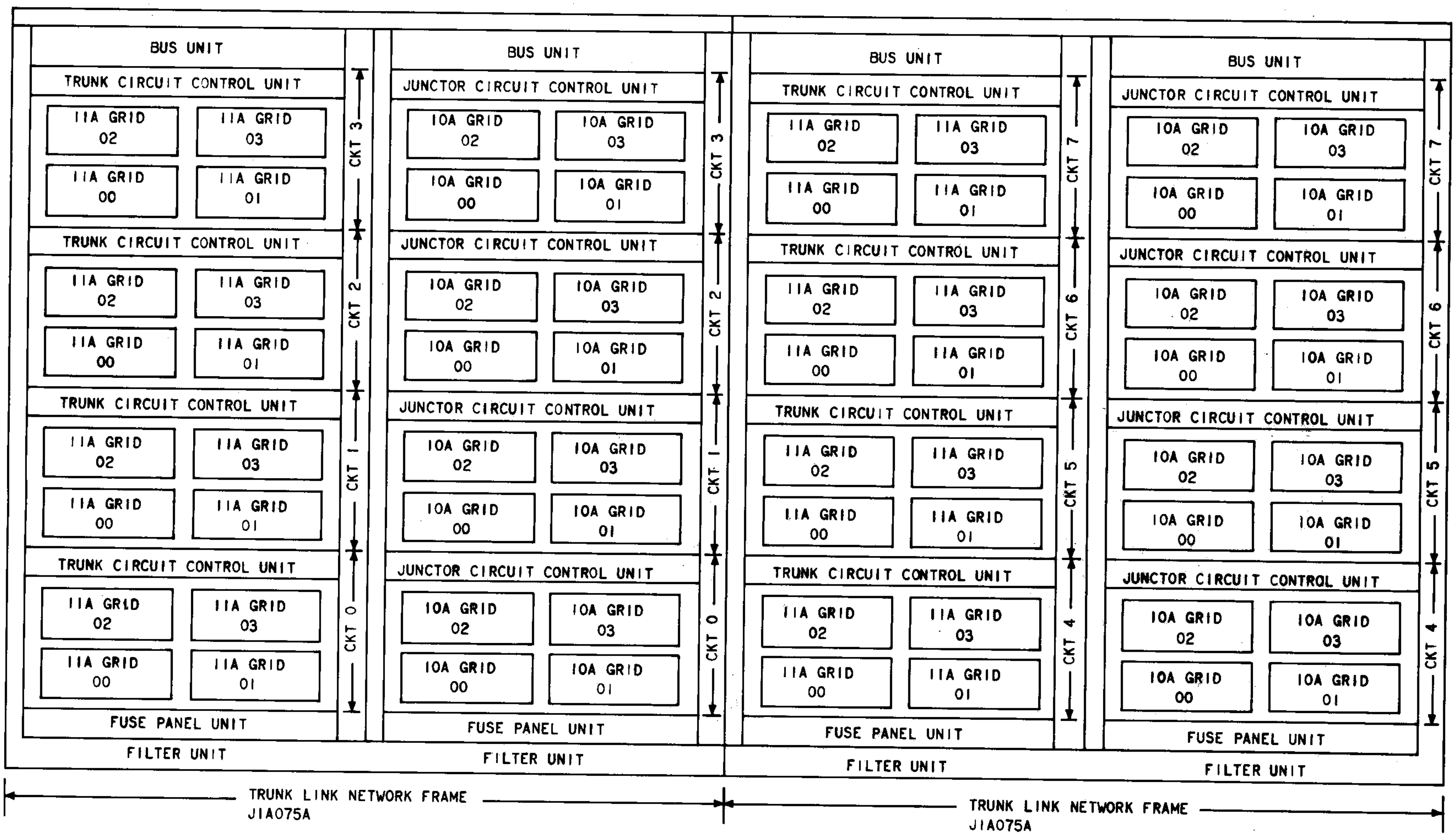


Fig. 33—Network Arrangement of 1:1 2048 TLN (5.52)

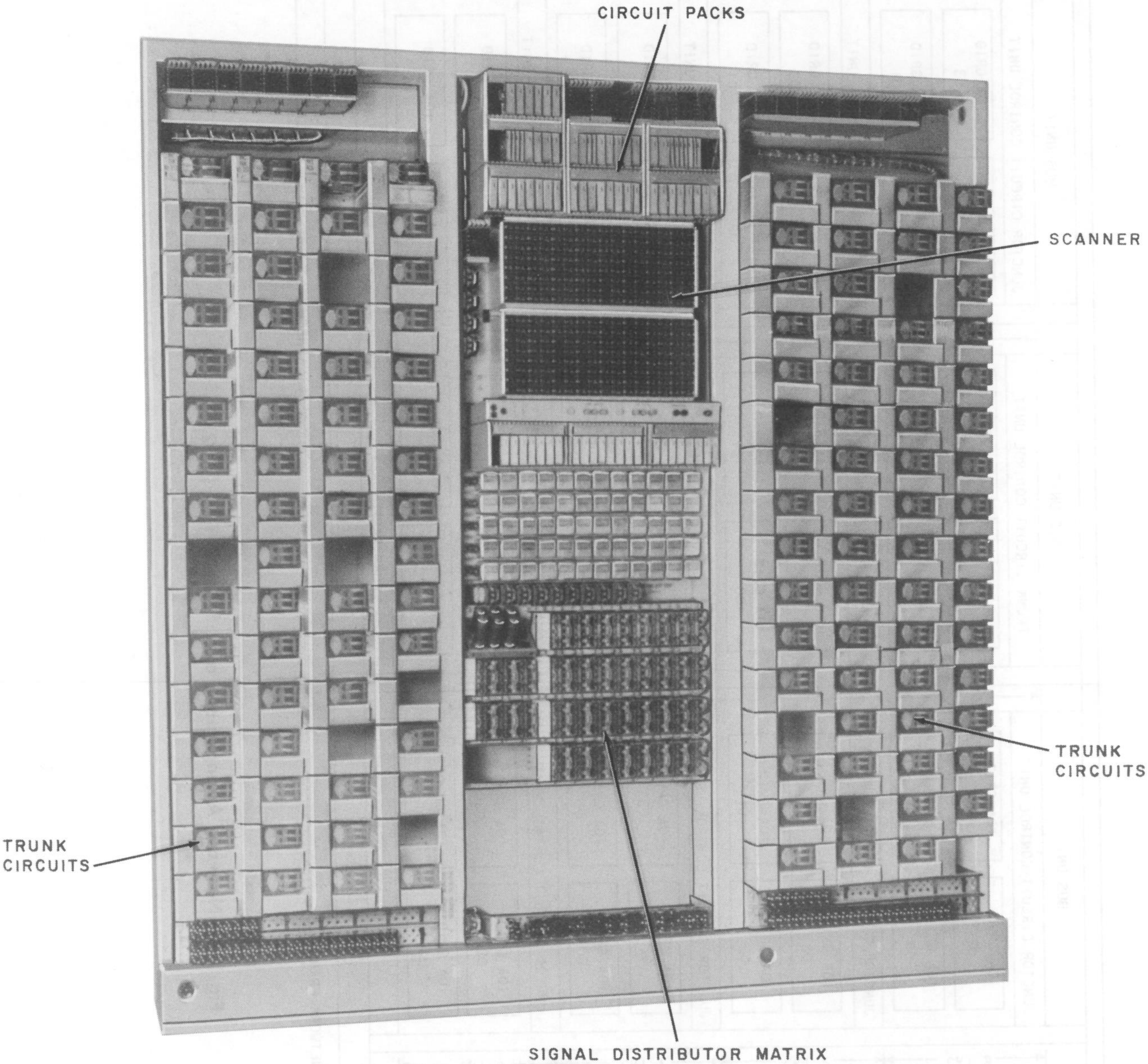


Fig. 34—Universal Trunk Frame (5.58)

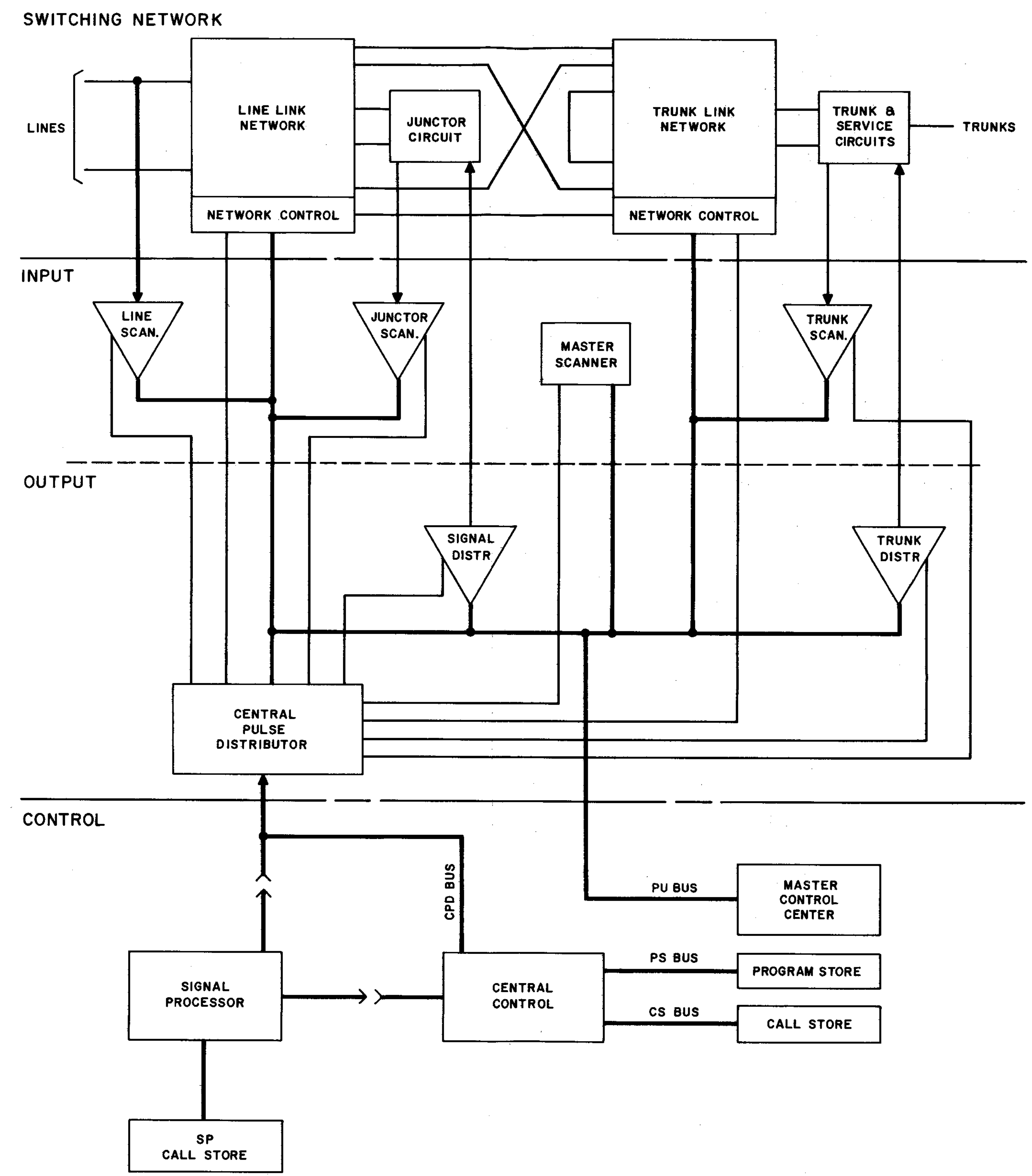


Fig. 35—Scanners in the Switching Network (5.68)

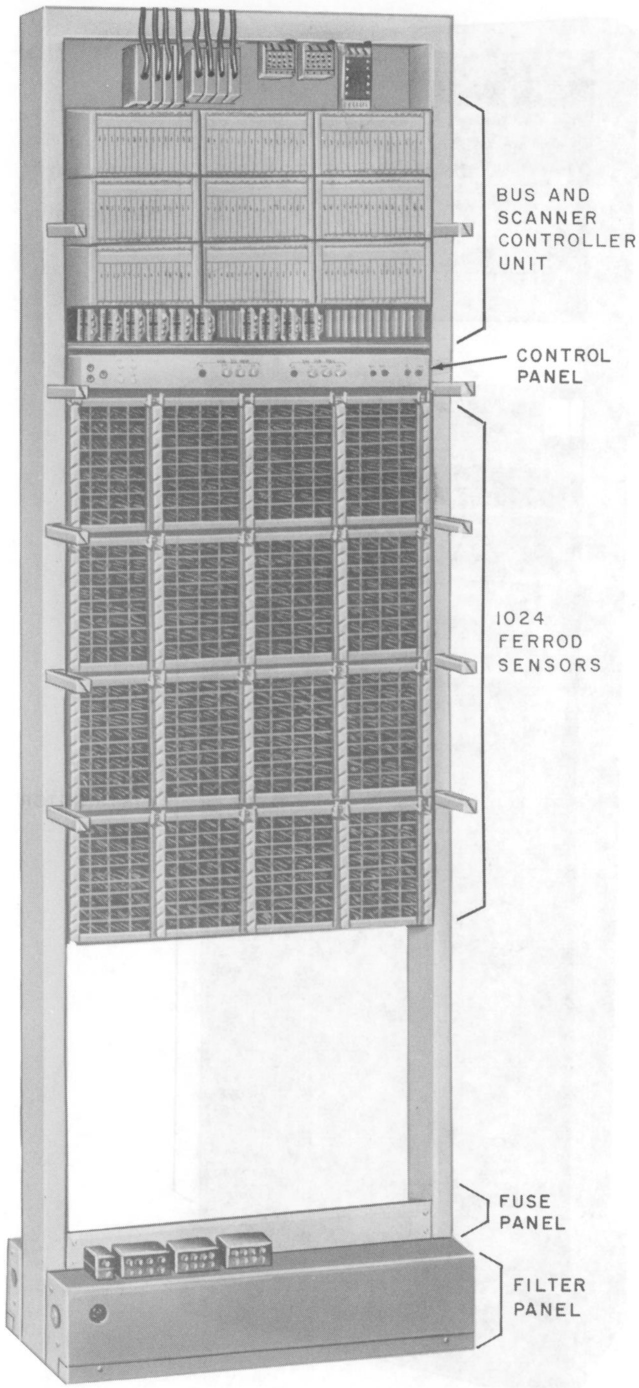


Fig. 36—Master Scanner (5.72)

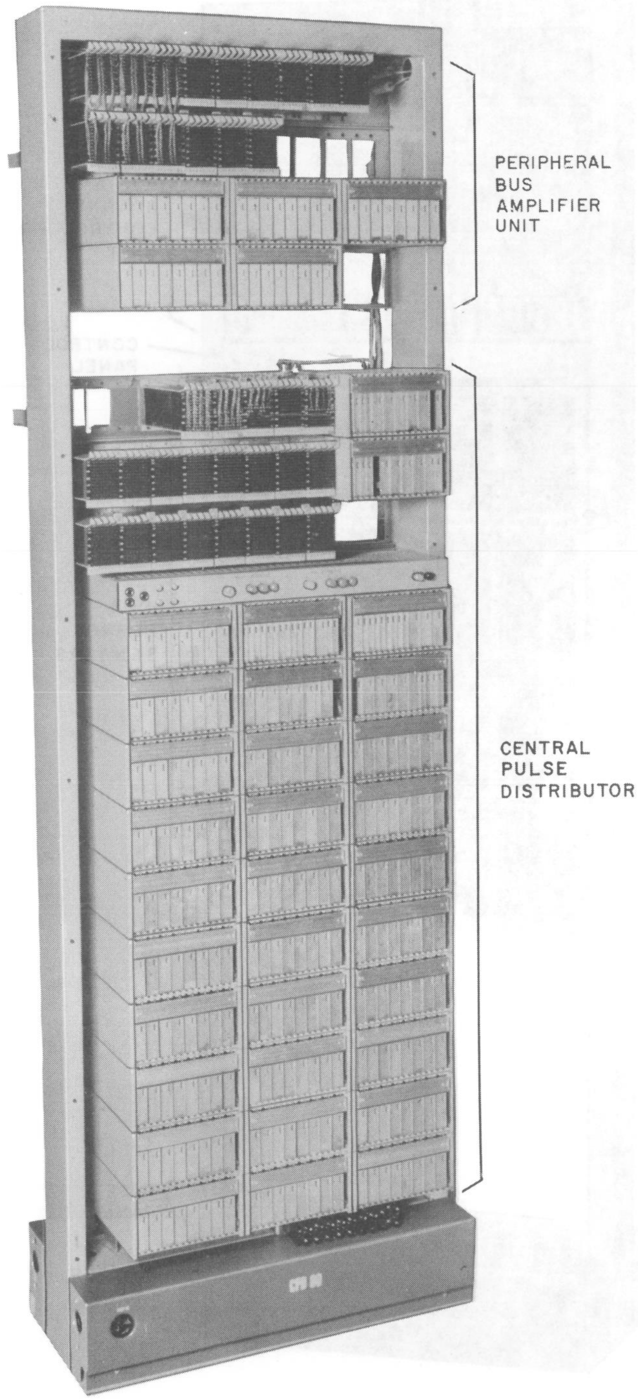


Fig. 37—Central Pulse Distributor (5.56)

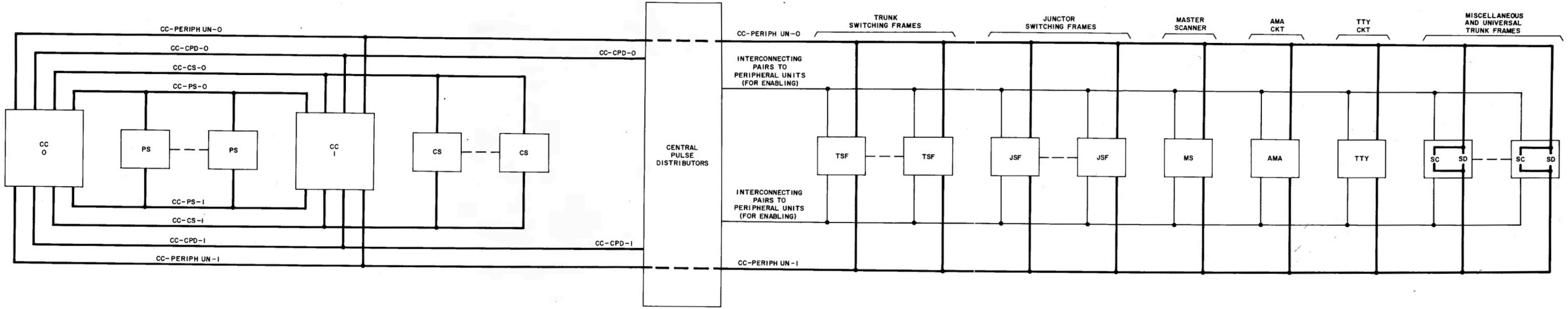


Fig. 38—Bus System Block Diagram (5.78)

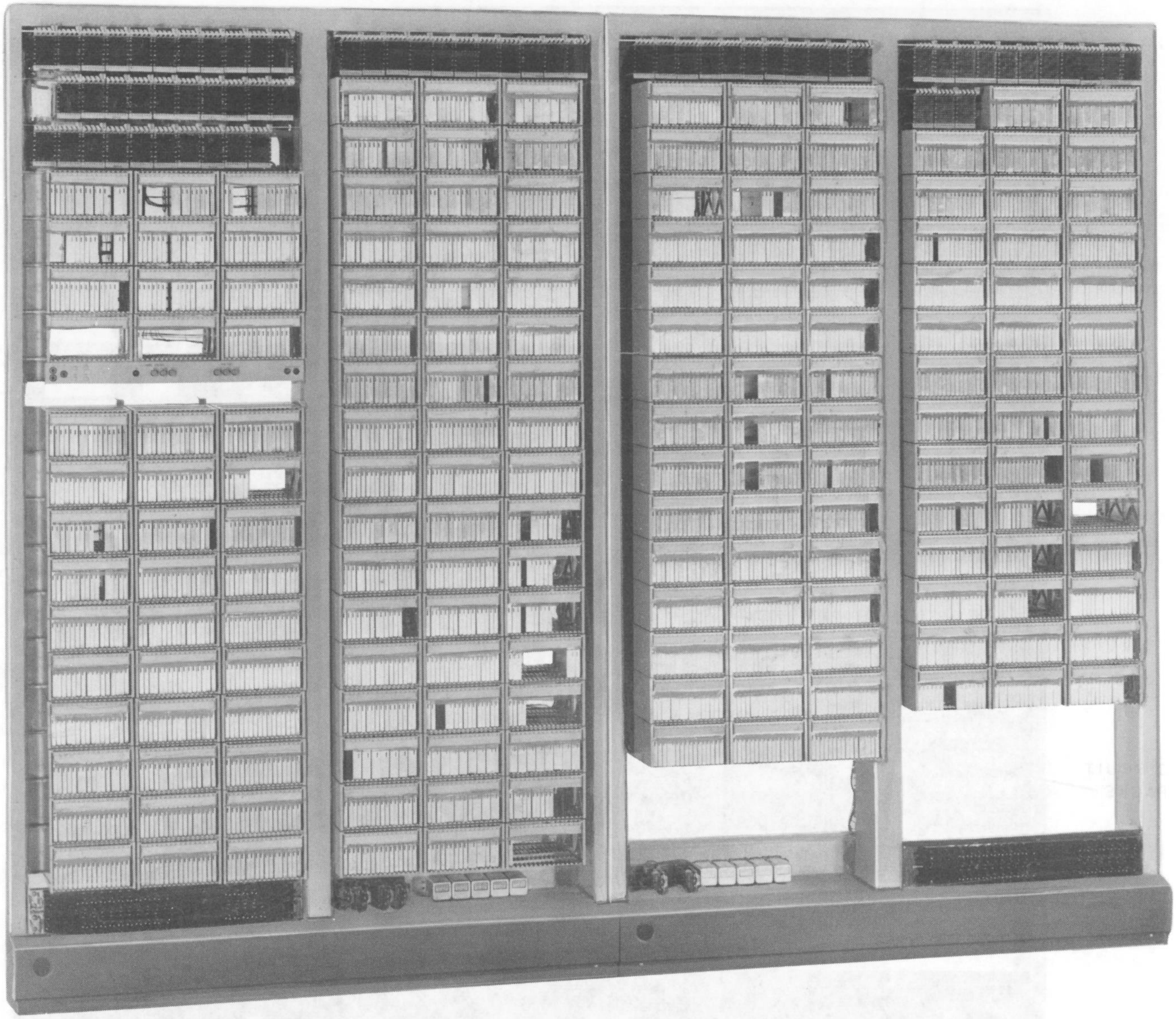


Fig. 39—Central Control (5.82)

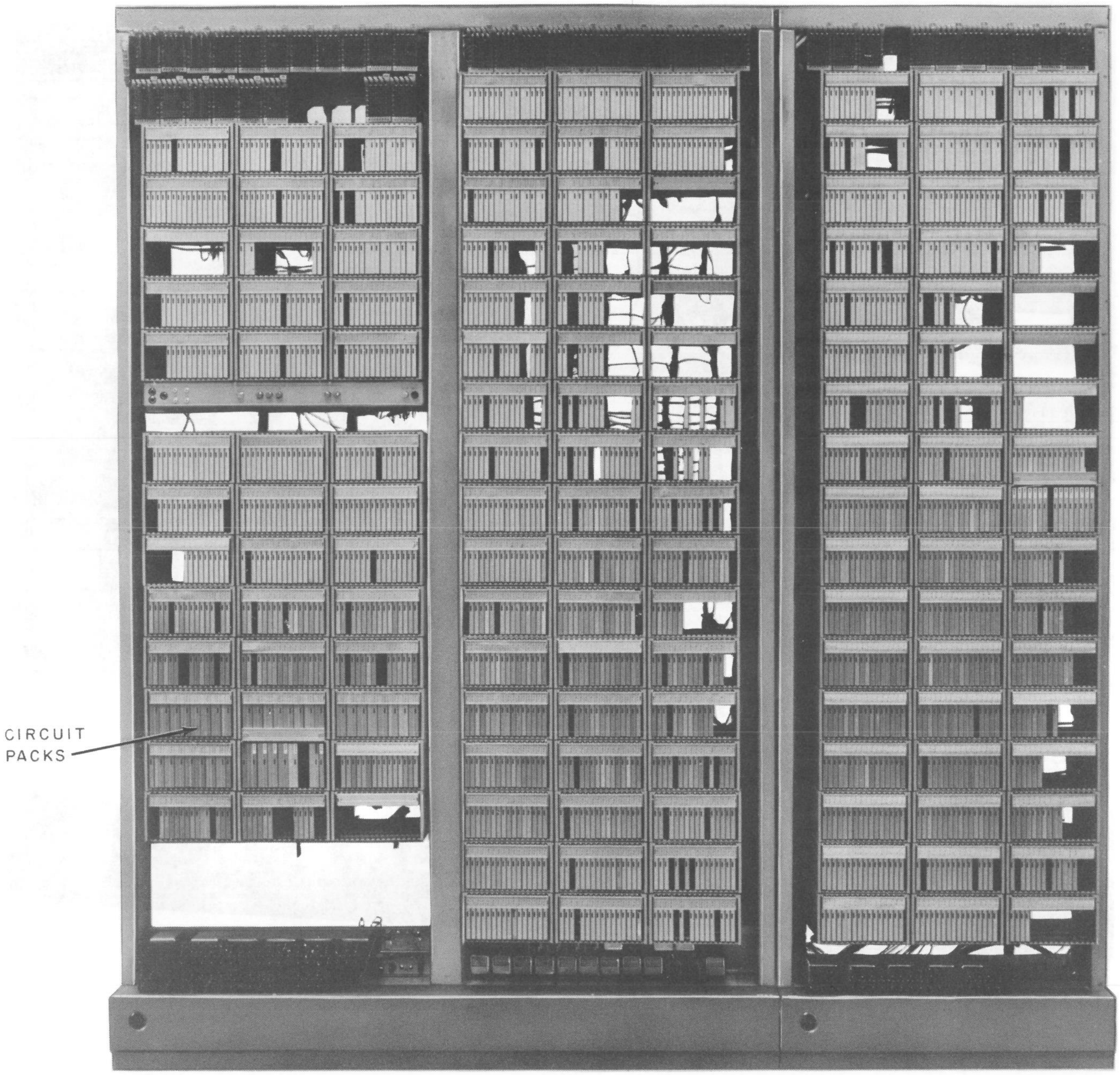


Fig. 40—Signal Processor (5.83)

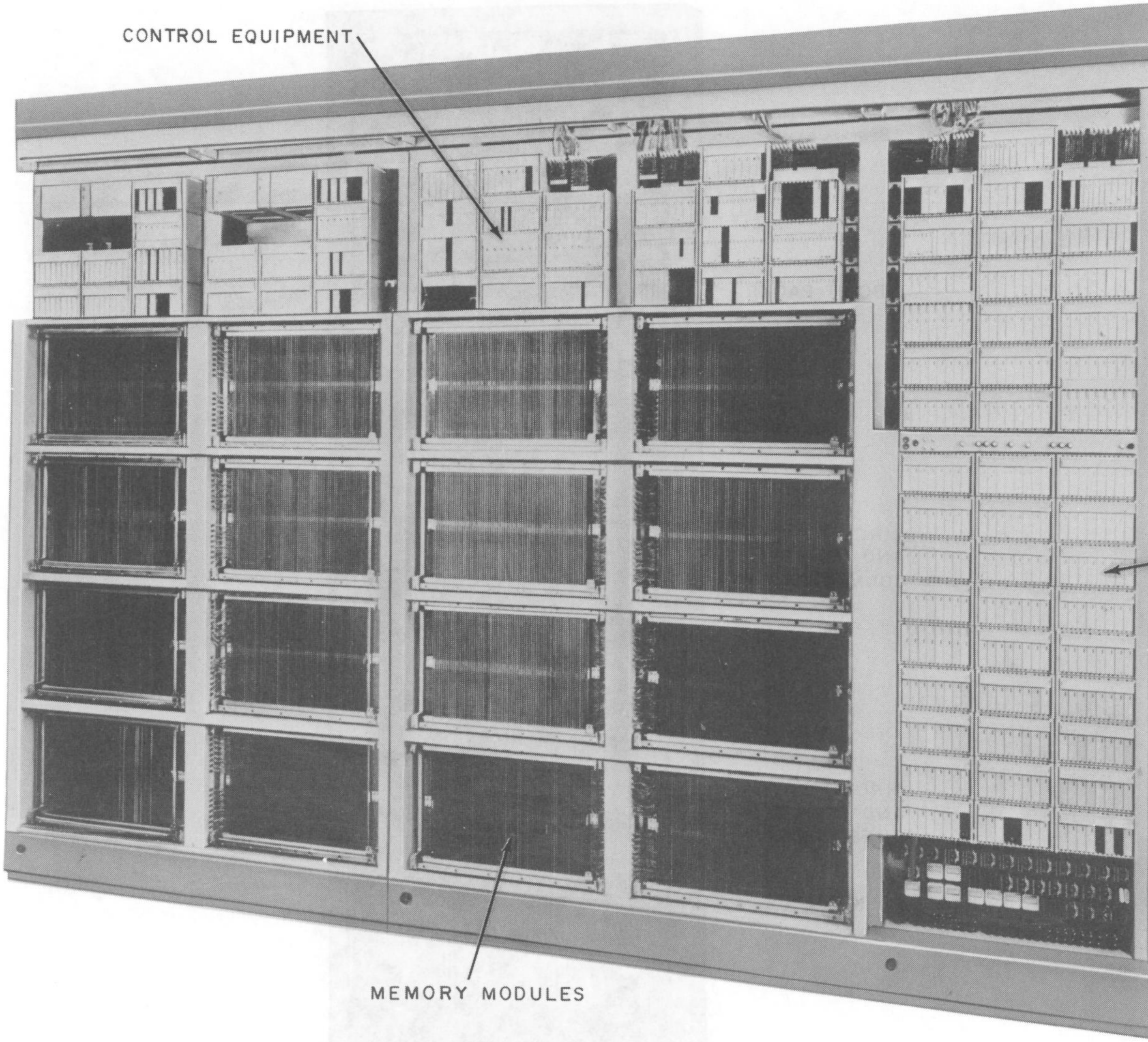


Fig. 41—Program Store (5.90)

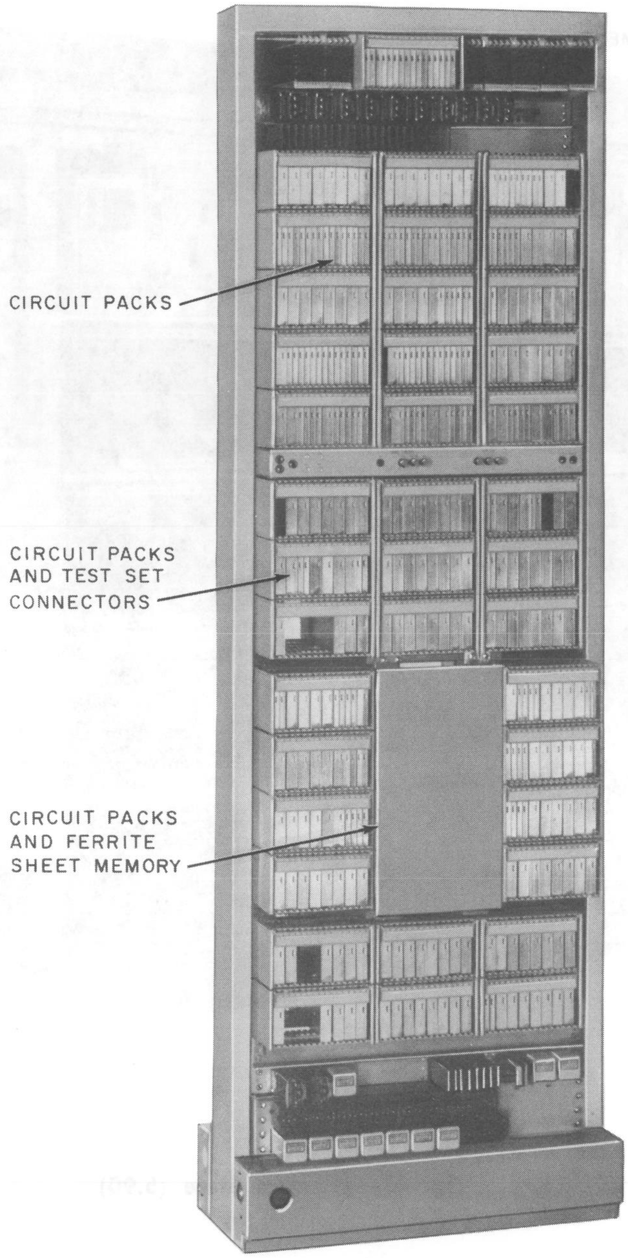


Fig. 42—8K Call Store (5.95)

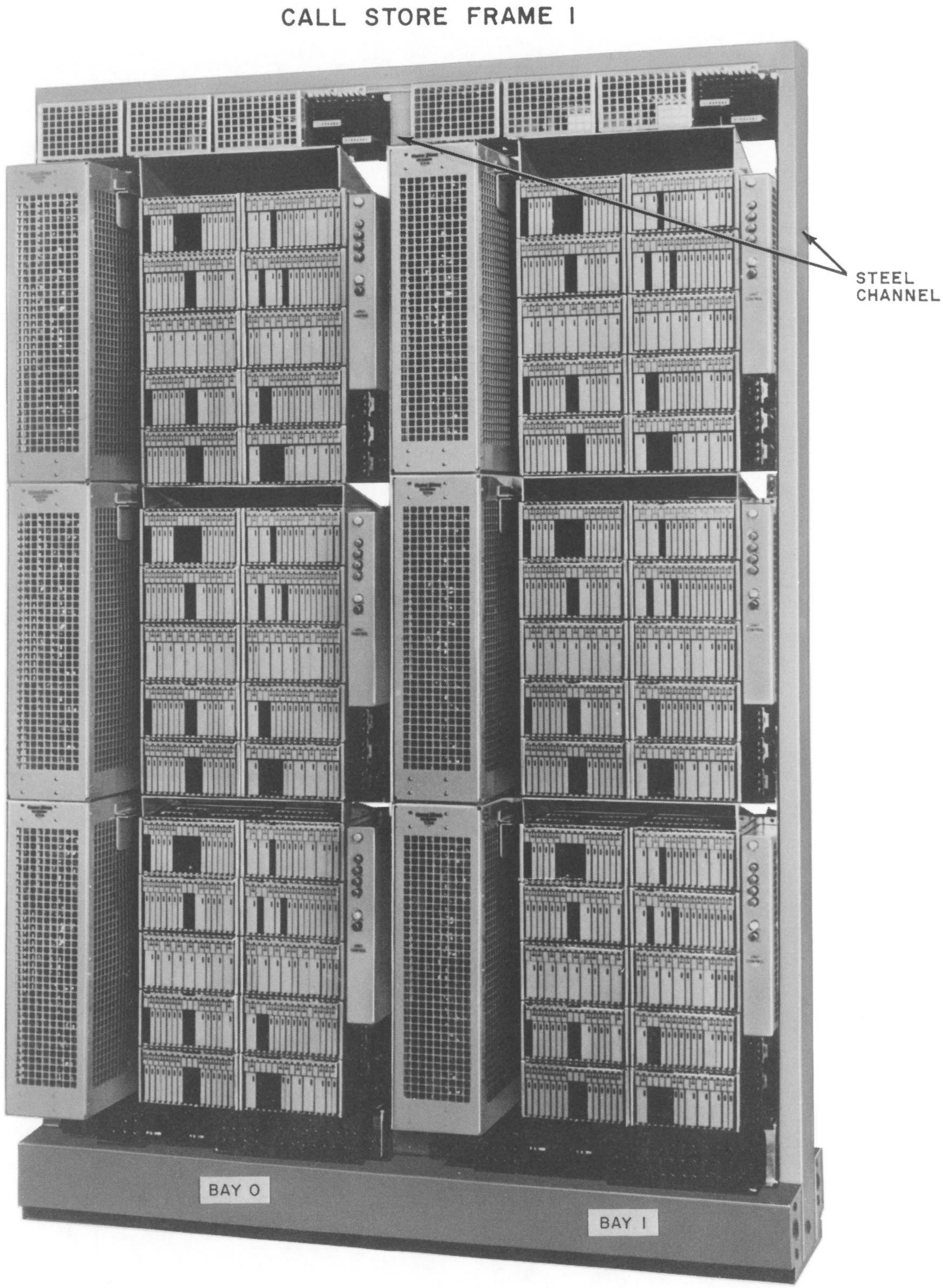


Fig. 43—32K Call Store (5.98)

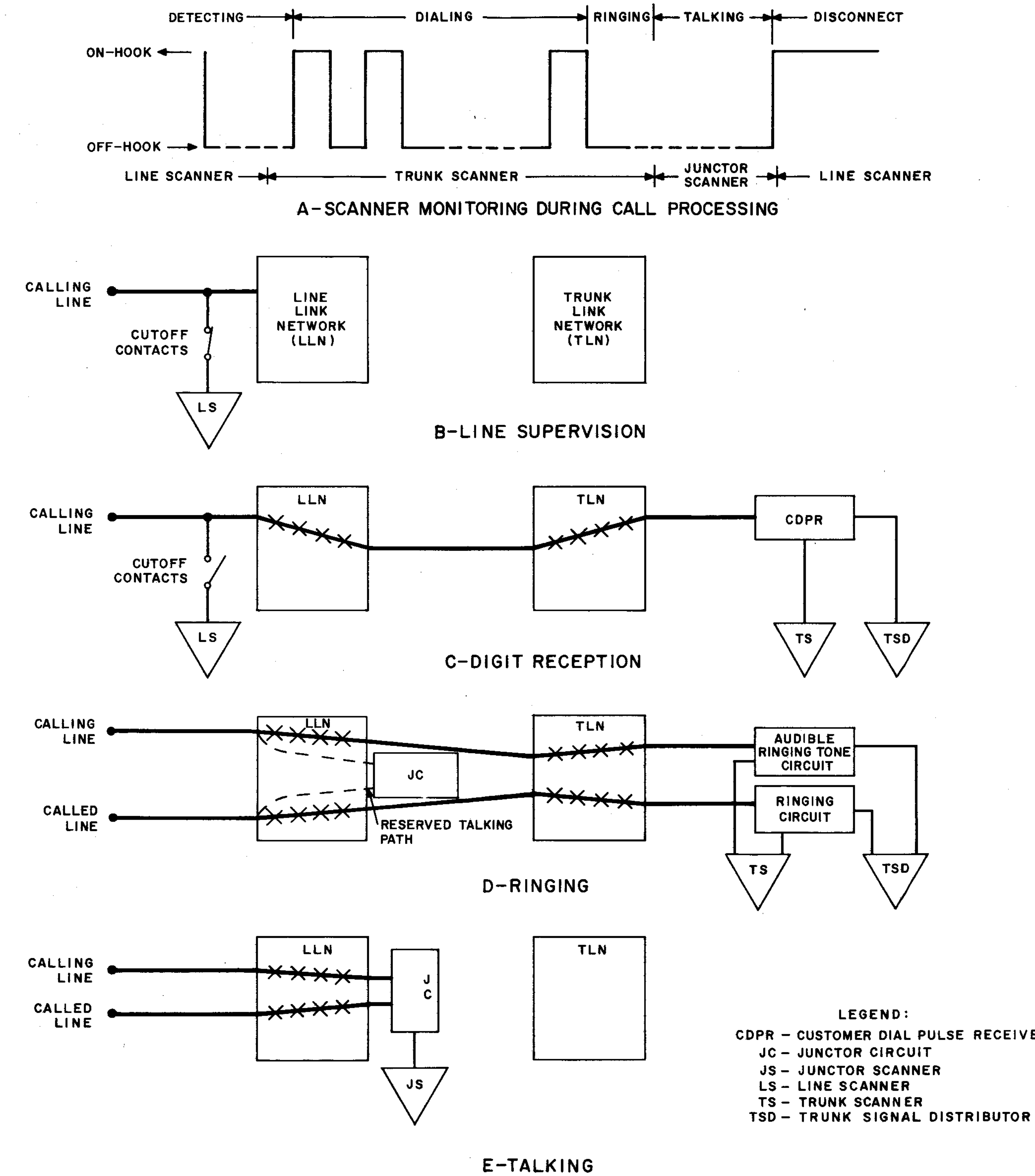


Fig. 44—Typical Connection for an Intraoffice Call (7.02, 7.03, 7.05, 7.07, 7.08)

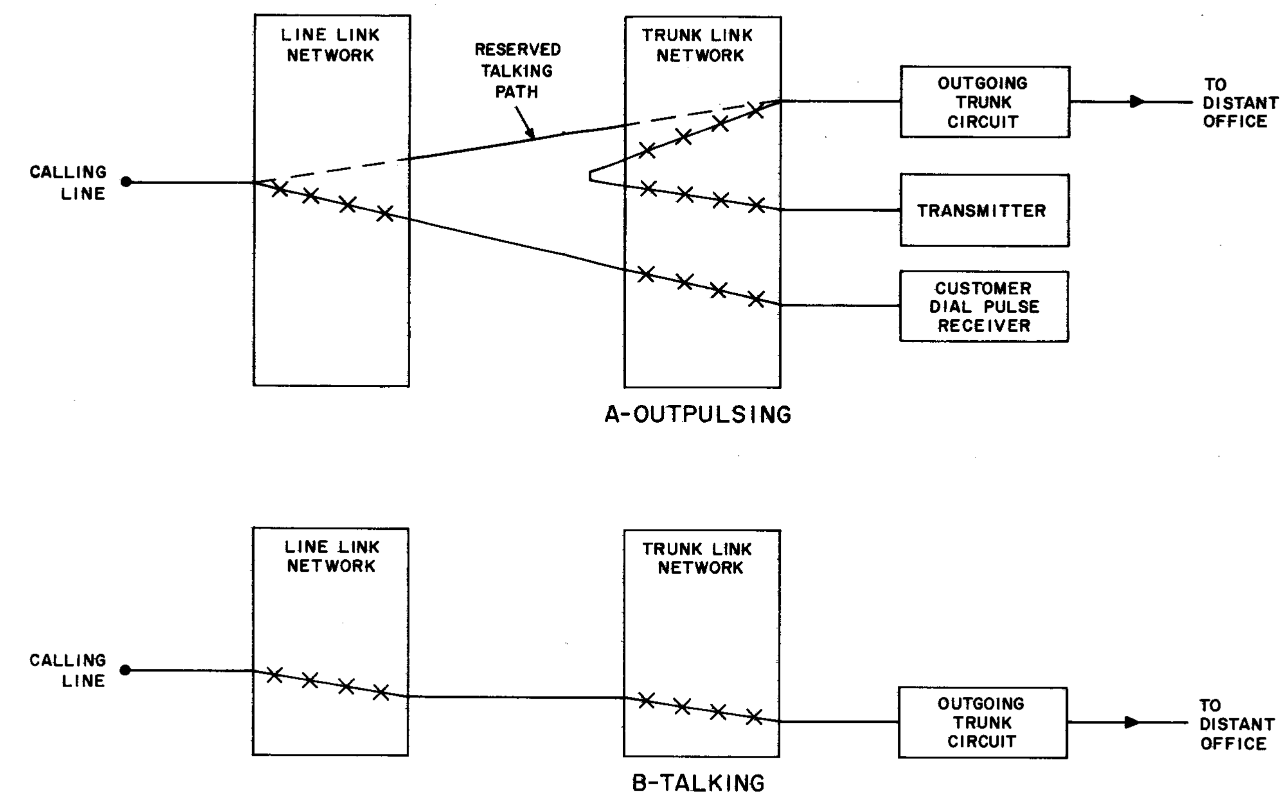


Fig. 45—Typical Connections for an Interoffice (Outgoing) Call (7.15, 7.16)

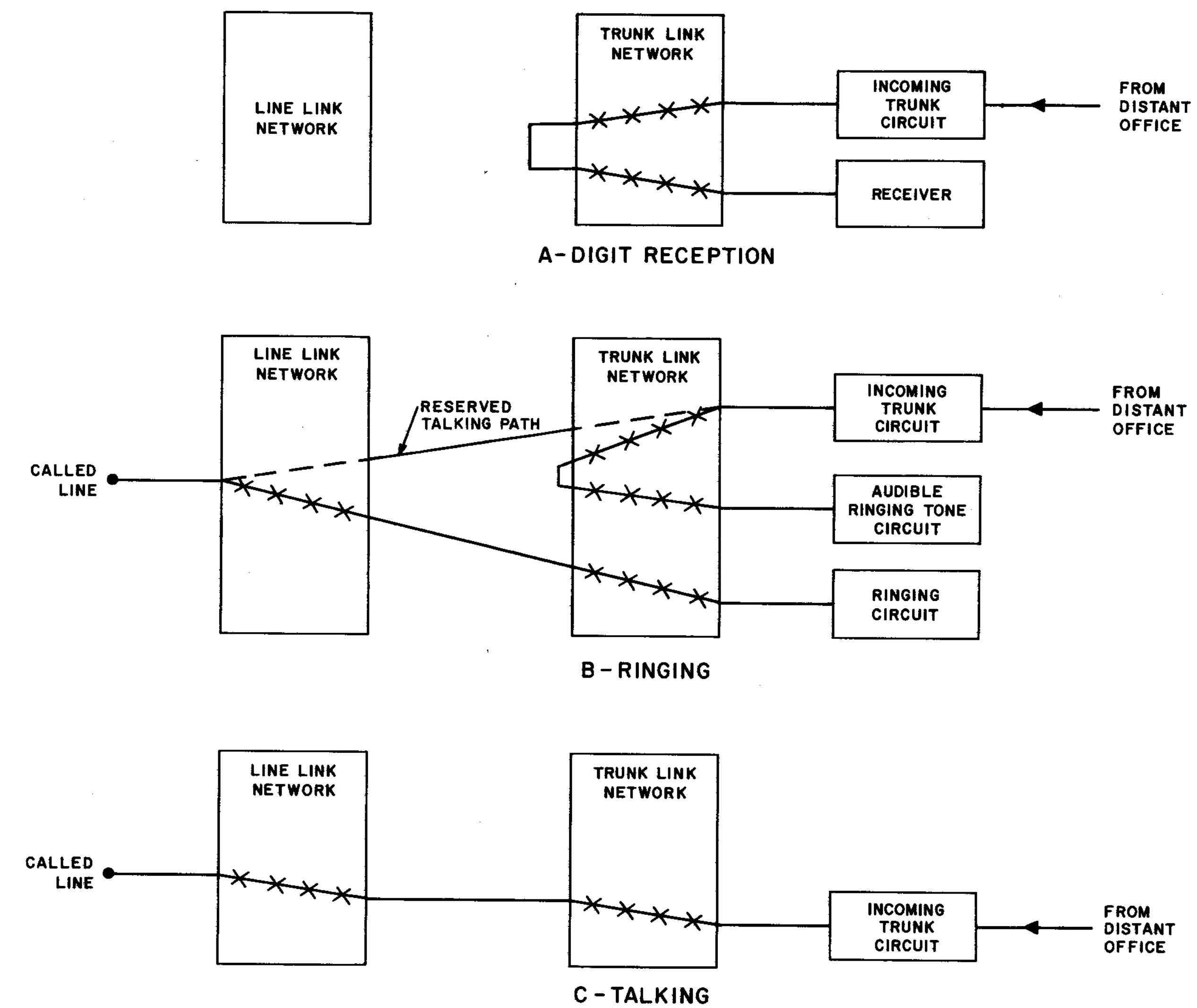


Fig. 46—Incoming Call Connections (7.20, 7.25, 7.27)

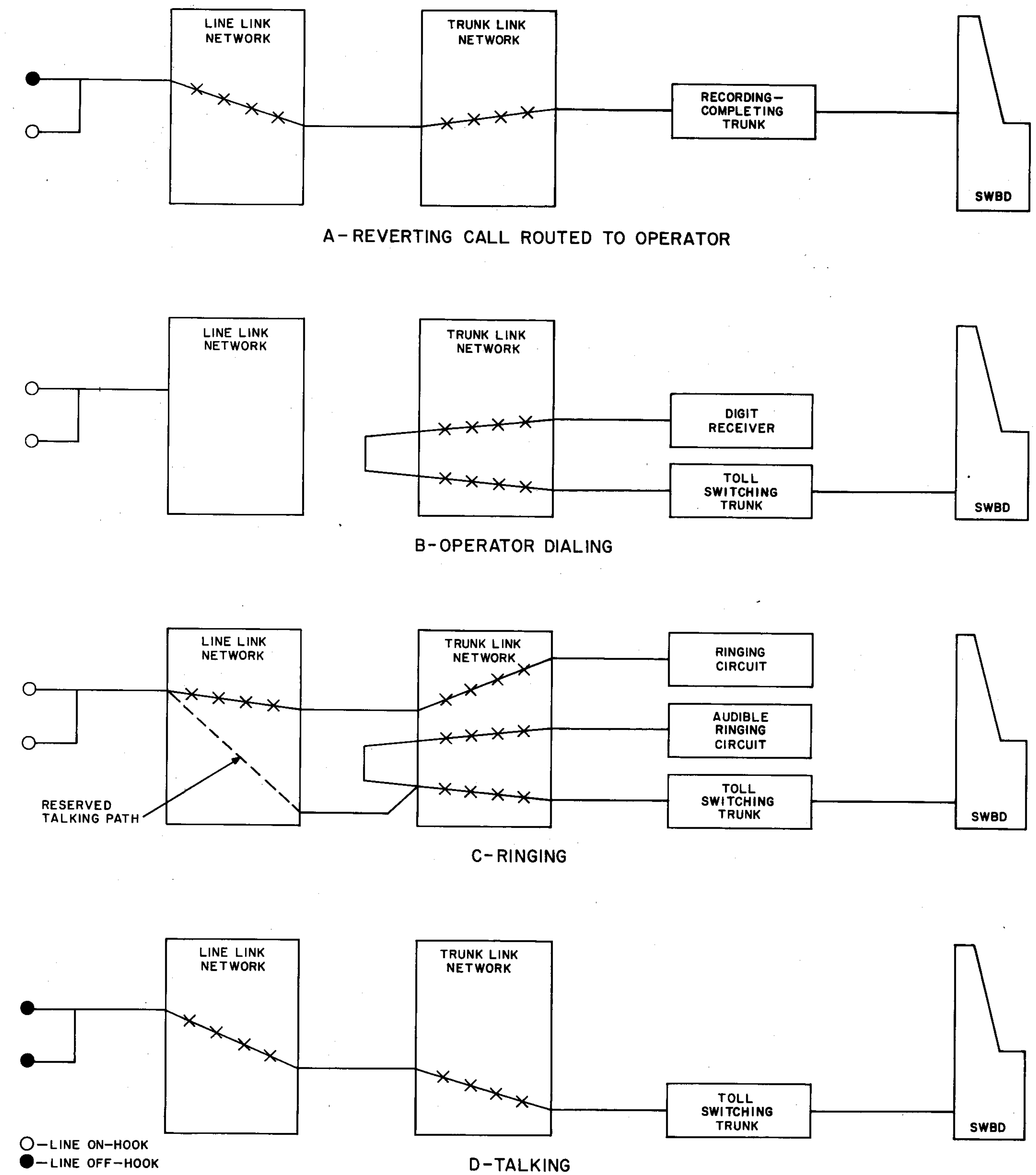


Fig. 47—Reverting Call—Operator Completed (7.33)

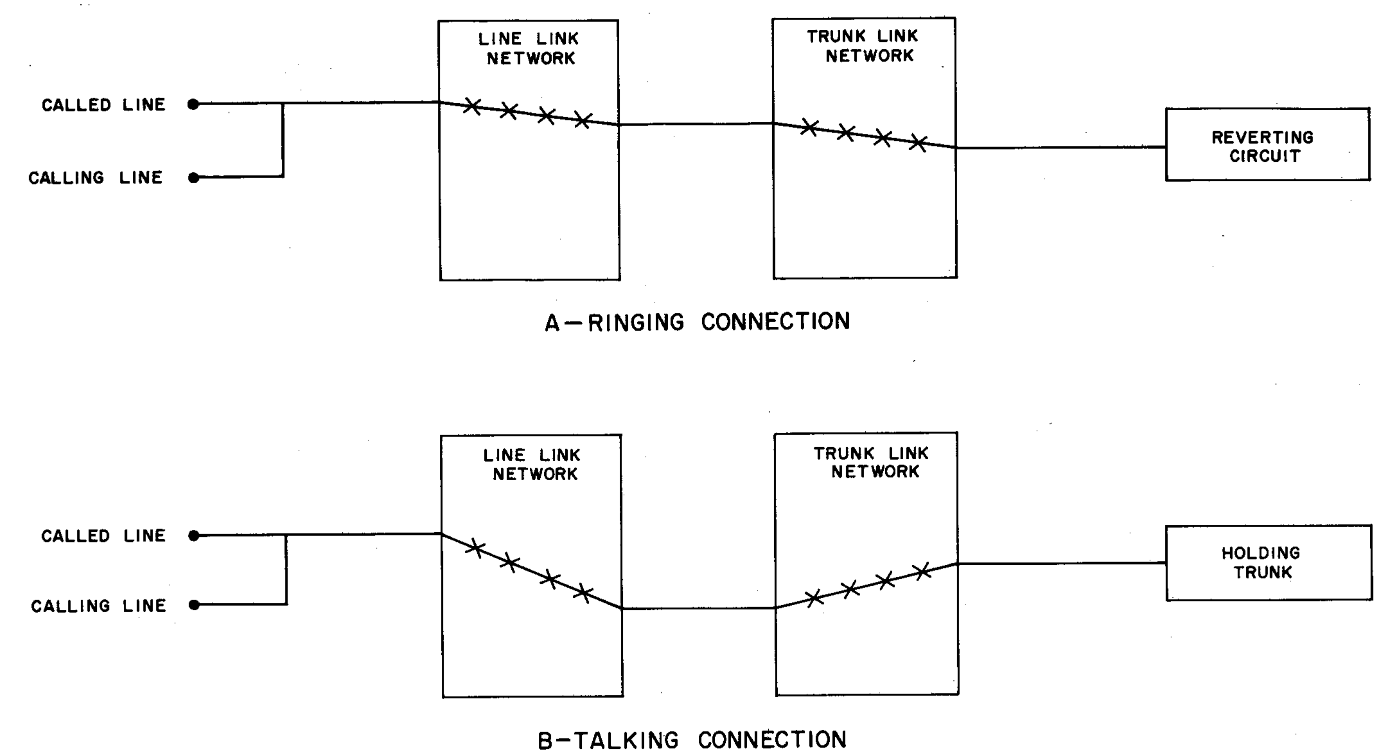


Fig. 48—Connections on a Reverting Call (7.34)