

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

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SYSTEM DESCRIPTION

1. GENERAL

1.01 This section describes the major No. 2 ESS and No. 2A ESS system components and explains the functions which these components perform. Call processing fundamentals, per se, will be discussed in Dial Facilities Management Practices, Division H, Section 10c.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 "References" in this section to methods, planning, data requirements, service levels, and equipment quantities are based on American Telephone and Telegraph Company recommendations."

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

2. SYSTEM DESCRIPTION

General

2.01 The No. 2 Electronic Switching System (ESS) performs the functions of a local telephone dial central office under the control of a stored program, which acts through a configuration of data processing facilities, input-output circuitry, and switching equipment. Actions of the system are determined by the sequence of instructions which have been coded and stored in memory. These logic performing programs are grouped into various call processing and maintenance programs.

2.02 The No. 2 ESS is a composite of two primary equipment categories: The control complex and the peripheral units. Fig. 1 illustrates these units in schematic form. Each of these equipment categories will be discussed in relative detail in the ensuing paragraphs of this section.

Control Complex

2.03 The control complex consists of the control unit and the maintenance and administration center. The control complex incorporates high

speed transistor-resistor logic (HSTRL) circuits, so named because of the relatively high operating speeds of these circuits. Fig. 2 shows a typical HSTRL circuit pack. The transistors are mounted on a ceramic chip on which a thin metallic film has been deposited. This metallic film contains the wiring paths for each gate circuit and the required resistors.

2.04 The Control Unit (CU), which is duplicated for reliability, consists of the central processor, the program store, call store, and, when required, the supplementary call store (Fig. 3). The control unit is often referred to as the 'software' or memory unit of the system.

2.05 The Central Processor (CP) contains the program control equipment, input-output control circuitry, call store and capacity for 512 bipolar central pulse distributor points (Fig. 4).

2.06 The Program Control (PC) circuit is the basic system processing circuit. This circuit makes all the major decisions required to administer the operation of the office. The program control circuit obtains a sequence of call processing and maintenance instructions (generic program) from the program store and translates them for use within the program control in order to address peripheral units (Fig. 5). Also, it contains the system clock which generates the command timing pulses required to synchronize the multitude of circuits in the control unit.

2.07 The Input/Output (IO) is a wired logic control circuit which performs the interfacing function between the high speed program control circuit and the relatively low speed peripheral equipment. The input-output circuit is the buffer circuit through which inputs are received into the central processor and from which outputs are transmitted to the peripheral area of the office.

2.08 The peripheral interface consists of the peripheral unit address bus, the scan answer bus, and the central pulse distributor. The peripheral unit address bus is the output bus (from the

input-output control) while the scan answer bus is the input bus (to the input-output control).

2.09 The Central Pulse Distributor (CPD) is an integral part of the central processor frame and is directly controlled by input-output registers and control signals. Each central pulse distributor has a capacity for a maximum of 512 bipolar points. These 512 outputs may be expanded by using one of the outputs to enable a supplementary central pulse distributor. A supplementary central pulse distributor contains 512 bipolar points and a maximum of 8 supplementary central pulse distributor frames may be added to an office.

2.10 For outgoing information (orders sent to the peripheral units) the enable address register in conjunction with the central pulse distributor and the peripheral unit address bus is utilized. Incoming information bits (replies from the peripheral units) return via the scan answer bus. They are stored in the scan answer register and special peripheral unit error detection circuitry until processed.

2.11 Peripheral Decoders (PD) are primarily associated with relays. They provide the high to slow speed interface between the high speed processor and slow acting relays in the peripheral units.

2.12 The central processor contains a large number of information registers in addition to the data processing logic. In general, the content of any one register can be directed to any other register in the system. The transfer of information is done by means of the common bus designated as the program gating bus.

2.13 The Program Store (PS) circuit is a memory unit of semi-permanent, read-only memory. It contains information which is used by, but is unchanged by the normal functioning of the system as it processes calls (Fig. 6).

2.14 The program store uses the permanent magnet twistor memory as the basic storage device. Information is stored in the state of small magnets affixed to aluminum cards. The state of the magnets is sensed by twistor wire (Fig. 7 and 8).

2.15 Each aluminum program store card contains a matrix of 64 rows of 44 magnets per row.

Each magnet is used to store one bit (binary digit) of information. Each of the 64 rows is divided into two 22-bit words for a total of 128 22-bit words per card. 128 memory cards are slotted into a memory module resulting in 16,384 program store words per module.

2.16 Each program store frame has a capacity of four modules and each control unit may have a maximum of four program store frames for a maximum of 16 memory modules.

2.17 Two types of information are stored in program store memory:

- (a) The program instructions (Generic Program) which contain the logical instructions that provide for call processing, maintenance and administration of the system.
- (b) The translation data which contain all of the information for defining the characteristics of the individual office and each customer within the office.

2.18 The generic program is information that details the sequence of instructions which the central processor will follow. As the name implies, there are many programs which control the sequencing of a call. To conserve memory space, certain programs are grouped into subroutines which are used many times by larger, more complex programs in the call processing instruction sequence. There are five categories of programs each controlling a particular function:

- (a) **Monitor programs** watch or observe inputs coming into the machine to determine if some action is required.
- (b) **Input-output programs** direct the machine in the handling of the input information to the machine periphery and outside world.
- (c) **Base level call processing programs** direct the machine to properly handle a particular call.
- (d) **Maintenance programs** are used to detect and diagnose machine failures and to aid in the recovery from and the repair of the failures.

(e) *Administrative programs* keep track of the usage of equipment and any data associated with the equipment.

2.19 Input-output programs must be executed in real time because requests for customer service must be dispatched with the least possible delay. Some programs such as routine maintenance, will be deferred to low traffic periods. All programs, therefore, are woven into a hierarchical order based on their relative importance to call completion.

2.20 The size of the generic program is determined by the features and services offered and does not change with office growth in terms of the number of lines and trunks served.

2.21 The translation area of the program store contains information concerning customer lines, directory numbers, trunk and service circuits, junctors, office codes, charging and routine assignments, classes of service, features and options. Also included are the parameters for the specific office, identifying the limits in size and quantities of equipment.

2.22 The translation area of program store is affected by day to day office changes, and, consequently, methods are available to update this information without immediately changing the translation data in the program store. New information, such as number changes, added new customers, added trunks, etc., is entered into the recent change area of call store via the teletypewriter message from the maintenance, service order, traffic and test desk teletypewriter channels. (Recent change area is discussed in 2.41). Changes concerning customer lines, some changes on trunks and service circuits, and some traffic measurement changes become immediately usable in lieu of the information in program store information on these items. Any new information will be entered into the program store translation area on these new items with an update using the single card writer which is discussed in 2.47.

2.23 The translation modules of program store are custom engineered for each office. A maximum of eleven modules may be ordered for the translation area of program store.

2.24 During the processing of a call by the central processor, the status of the activity on a line or a trunk is recorded in areas of call store

memory and then interpreted by programs which determine the meanings and perform the logic necessary to decide which actions should be taken on a call (Figs. 4 and 9). The following types of information are stored in call store:

- (a) Busy-idle state of lines, trunks, and junctors
- (b) Record of network terminations used for each call in progress
- (c) Digits received from customer lines and incoming trunks
- (d) Digits which should be outpulsed
- (e) Billing information
- (f) Maintenance information
- (g) Recent change information

2.25 Each call store is equivalent to 8192 words or 2 modules of call store of 4096 words each. Four call stores or 8 modules may be the maximum number provided in each office. The first two call stores are in the central processor frame and the second two are in the supplementary call store frame.

2.26 The basic storage element in the cell store is a one inch square ferrite sheet (Fig. 10). Each ferrite sheet has 256 holes arranged in a 16 by 16 array. The ferromagnetic material around each hole can be magnetized in either a clockwise or counterclockwise direction to store a binary information bit. Each word has 16 binary bits. The ferrite sheet is equivalent to an array of 256 miniature magnetic cores. The X and Y select wires, a readout wire, and an inhibit wire are associated with each magnetic core. Reading and writing operations have a read cycle followed by a write cycle. The read cycle is destructive because the core is forced into the 0 (zero) state. During reading operation, the write cycle is used to restore the information just read. During writing operations, the read cycle is used to clear the core and the write cycle is used to store a 1 or 0.

2.27 Areas of call store memory are associated with various call store programs and will be discussed in subsequent paragraphs. A minimum of two call store modules will be provided in the local office generic type office, which is referred

to as the LO1 generic. (See PA2H200, Documentation of Call Store areas.)

2.28 Call store memory area requirements are divided into three categories:

- (a) Fixed requirements (those requirements that never change for a given generic program)
- (b) Equipment requirements
- (c) Traffic dependent requirements

2.29 Fixed requirements are areas of call store memory required for the generic programs and for various registers and buffers that are always supplied in maximum quantities. No traffic engineering is required for the fixed areas of call store.

2.30 Equipment requirements are areas of call store memory that are required for line trunk networks, scanners, and program store translation modules. The amount of call store memory required is dependent on the physical quantity of equipment installed.

2.31 Traffic requirements are engineered items. They are:

- (a) Transient call record blocks
- (b) Originating registers
- (c) Stable timing entries
- (d) Terminal memory record blocks
- (e) Call forwarding entries.

2.32 The logic performing areas of call store are called hoppers, originating registers, peripheral order buffers, terminal memory records, transient call records, and stable timing entries (Fig. 11).

2.33 Once an off-hook from a line is detected by the call processing program, the off-hooks are reported to the off-hook hopper as 1-word entries which contain the terminal equipment number of the line. Once the monitor determines that a supervisory signal has occurred, it attempts to report the signal to a transient call record. Similarly, off-hook state changes from trunks, junctors, and service circuits are reported to the

off-hook hopper as 2-word entries which contain the scan point number and the timing entry.

2.34 An Originating Register (OR) is an 8 word block in call store which is used to store digits during the reception of digits stage and the transmission of digits stage (Fig. 12). Each originating register may store up to 16 digits at a time. When digits are received, the first two words are used by the wired logic scanning program to record the number of dialed pulses [TOUCH-TONE (TT), dial pulse (DP), or multi-frequency (MF)]. Associated input-output interrupt programs detect received digits and store them in the last four words of the originating register where they are accessed by call processing programs to determine call disposition. When the originating register is used for digit transmission, using a DP or MF transmitter, the digits which will be transmitted are placed in the originating register and sent out one at a time by an input-output interrupt program. A maximum of 128 originating registers may be provided in an office.

2.35 A Peripheral Order Buffer (POB) uses 16 call store words to store information concerning disconnect, connect and/or sending peripheral decoder, scan, and network orders (Fig. 13). Each peripheral order buffer contains the information needed to complete one POB action. Information needed to perform a peripheral action is retrieved from the transient call record and/or the terminal memory record and loaded into the peripheral order buffer. This data is then stored in one of two areas within the POB. The data for network orders is stored in the network area of the POB. For other peripheral actions (scan point number and peripheral decoder number), the data is stored in one of the POB circuit areas. Various programs will use the information stored in the peripheral order buffers to complete the needed actions. There are twelve 16-word blocks in the call store area in each machine dedicated to peripheral order buffer activity.

2.36 The terminal memory record (TMR) is a 2-word area in call store which is associated with any circuit which contains a supervisory scan point (Fig. 14). One terminal memory record is assigned to each trunk, junctor, and service circuit. Each circuit may be in one of 3 states: idle, transient, or stable. When a call is in progress, or in a transient state, a Transient Call Record (TCR) with its attendant call processing programs

is used until the call is in a talking or stable state (Fig. 15). The transient call record is an 8 word layout in call store which is used when a call is in progress and when a call is in the disconnect stage. For three-way calling and call waiting service, consecutive transient call records are required. A special subroutine is provided to handle these selections. Terminal memory records are provided in blocks of 128 records each. A maximum of 39 blocks may be provided. Transient call records are provided in blocks of 70 transient call records per block with a maximum of 4 blocks or 280 transient call records per office.

2.37 Stable Timing Entries (STE) are 2-word blocks in call store required for timing coin zone, coin overtime, lines with message registers which must be incremented, and lines with the call waiting feature. Stable timing entries are engineered in blocks of 144 2-word blocks with a maximum of 576 2-word blocks available.

2.38 Call forwarding tables are auxiliary areas of call store which are used to store call forwarding entries for non-centrex lines. A call to a line with an active call forwarding entry will have the forwarded telephone number placed in the originating register for completion of the call. Call forwarding tables are 4 word blocks in call store. A minimum of 32 blocks and a maximum of 123 blocks may be provided.

2.39 The network map is an area in call store which is used to record the busy-idle state of all network connecting links and a record of the path of every established and/or reserved connection. The status bits for each network are grouped into a single block in call store and designated as the network map for that network.

2.40 Some translation data can be changed by teletypewriter messages into the recent change area of call store and will be updated in program store as mentioned earlier. Some data, such as new trunk groups and route index changes cannot be changed without an office data assembly (ODA) run at the Western Electric Regional Office. The restrictions are outlined in No. 2 ESS translation guide, TG 2H.

2.41 Data in the recent change area of call store is accessed through an 18 bit program store address (Fig. 16). The change data table contains the new data bits for each word of program store

which is changed. It also stores the program store address so that changes can be found. The change index table contains a one word entry for each twistor card in a module of program store. This area of call store is searched if the change index table entry indicates a change exists in call store for the program store words. A word can be changed as many times as needed in recent change between updates. A new change always overwrites the old one.

2.42 The plant measurement count of Recent Change Area (RCA) will print the number of entries in each of the various recent change areas of call store. One register is assigned per change data table. Whenever any one of these recent change data tables is approximately 81 percent filled, the system will initiate a printout with this information at the maintenance center teletypewriter. Updating of program store should begin at this time. Whenever a recent change area is at 93 per cent fill, new data will be rejected by the system; therefore, it is advisable that updating of program store begin as soon after the 81 per cent fill message is received.

2.43 Depending on the number of call store modules installed in the engineered requirements, the size of the recent change area will vary. Recent change activity should be closely monitored by the personnel involved in the administration of the office to be sure that recent change updating is not done so frequently that it becomes a hindrance to maintenance of the office. The cost of another call store module may be warranted to overcome this problem.

2.44 Interaction with the No. 2 ESS system is done via teletypewriters (TTY). The traffic, service order, local test desk, and trunk test teletypewriters are limited by the number of messages allowed to these channels as described in the Input Message Manual, IM2H200. The maintenance and administration center teletypewriter has unlimited access to the machine. Use of the traffic channel TTY is described in Dial Facilities Management Practices, Division H, Section 10d (8).

2.45 The maintenance and administration center has four functions:

- (a) As an in-service monitor of the status of the system.

- (b) As a test and control center for routine functions.
- (c) As a back up when preplanned diagnostic procedures fail
- (d) As an emergency control in extreme situations.

2.46 The maintenance center frame provides the equipment which allows the monitoring of the system (Fig. 17). Interrogations are made through a teletypewriter or the display panel controls. The answers are returned on a printout from the teletypewriter and visually on the display panel. The maintenance center circuit provides the means for interrogation of the control unit. The maintenance center gathers information from the system which is displayed visually to the operator. The control unit signals enter the frame via connectors, and through buffer circuits their contents are shown on the display panel. The teletypewriter control circuit provides the logic to communicate with a maximum of 8 teletypewriters. The control equipment consists of a panel which contains keys to disconnect signals from the teletypewriters and a unit which directs signals shared by all teletypewriters to their individual control logic.

2.47 The single card writer is mounted in the maintenance center frame and is used to magnetize permanent magnet twistor memory cards in program store (Fig. 18). The single card writer consists of two basic units: the control and logic circuit and the mechanical card writing unit. The control and logic unit contains circuit packs, controls and a relay panel. The card writing unit consists of a writing head and a means for accurately moving the head over a memory card. The new information which will replace the existing information on the cards is retrieved from the system via a teletypewriter request from the maintenance center. The card writing unit will be driven over a single card changing the previously magnetized information to the new information.

2.48 The trunk test frame is used by the maintenance personnel to make operational and transmission tests on trunks and service circuits (Fig. 19).

Peripheral Units

2.49 The peripheral units are the line trunk networks, the associated scanners and

controllers, peripheral decoders, trunks, junctors, service circuits, and the automatic message accounting frame. These units are often referred to as 'hardware' items of the system.

2.50 The line trunk network is the basic component of the switching network (Fig. 20). One side of the network contains the line trunk switching frames on which lines, trunks and service circuits are terminated (Fig. 21). On the other side of the network is the network control junctor switching frame which is used to interconnect lines to service circuits, lines to trunks, lines to lines, and trunks to trunks (Fig. 22). This is accomplished with junctors, which, through interconnection on the junctor grouping frame, can be linked with each network in the office (Fig. 23). Because of the single-sided arrangement used in the No. 2 ESS switching network, this configuration is called a 'folded' network. This means that 8 stages of switching are required to connect a line to a service circuit, a line to a trunk, a line to a line, and a trunk to a trunk (Fig. 24).

2.51 Each line trunk switching frame is divided into two concentrator groups, each containing 8 concentrators for a total of 16 concentrators (Fig. 22).

2.52 Each concentrator has 8 first stage crosspoint ferreed switches which are 4 by 4 (4 inputs and 4 outputs), and 4 second stage crosspoint ferreed switches which are 8 by 4 (8 inputs and 4 outputs). The first and second stage switches within each concentrator are connected by metallic paths known as A-links. Each concentrator has 32 A-links concentrated to 16 B-links in the second stage of switching. Thus, this is known as a 2:1 concentrator (Fig. 25). Since each line trunk switching frame has 16 concentrators, this means that there are 512 terminals or terminal equipment numbers (TEN), 512 A-links and 256 B-links in each frame.

2.53 Each of the 512 terminals in the line trunk switching frame has a line scanner ferrod associated with it for detecting line organizations. These ferrods are mounted at the top of the line trunk switching frame—16 per row in 2 scanner quadrants of 256 scan points each.

2.54 Ferreed switches are used in the line trunk network to complete network connections. A ferreed switch contains two ferrous metallic

reeds enclosed in a glass envelope which is mounted adjacent to a bipolar electromagnet. These ferreed switches are assembled in the 4 by 4, 8 by 4, and 8 by 8 configurations (Fig. 27 and 28).

2.55 In addition to the ferreed crosspoint, there are polar ferreeds used as line scanner cutoff switches which are bridged across the input terminals. For trunks, service circuits, and tone circuits, the ferreed cutoff switch is disconnected. These polar ferreeds are assembled in a 1 by 8 array (Fig. 25).

2.56 The network control junctor switching frame is arranged into 3 bays, one control bay and two junctor switching bays. The junctor switching bays contain the switches for the third and fourth stages of switching. The control bay contains the control equipment for the duplicated network controllers and the two duplicated line scanner controllers (Fig. 22). The two junctor switching bays in the network control junctor switching frame contain 512 B-links and 512 junctor terminals. Each junctor switching bay contains four grids. Each grid is made of eight third stage crosspoint switches which are 8 by 8, eight fourth stage crosspoint switches which are 8 by 8 and eight polar access switches which are 1 by 8 and which are bridged on the B-links to provide for test vertical access. Each grid, therefore, has 64 B-links with interconnection to 64 junctor terminals. Since each junctor switching bay contains 4 grids, there are 256 B-links and 256 junctor terminals in each bay for a total of 512 B-links and 512 junctor terminals in the two bays (Fig. 26). The C-links are the interconnecting metallic paths between the third and fourth stages of switching.

2.57 There are two network controllers. Each network controller may be in operation at the same time. Each controller may be operating the ferreed switches in the network control junctor switching bays and the ferreed switches in the line trunk switching frame; however, each controller will not be operating in the same grid or concentrator group. If one controller fails, the remaining controller will handle traffic for the entire line trunk network.

2.58 The four scanner controllers are arranged in two controller pairs. The pairing is for reliability. The first scanner controller pair is used to scan the 1024 line scan points in the first two line trunk switching frames. The second controller

pair scans the line scan points in the other two line trunk switching frames.

2.59 One network control junctor switching frame equipped with two line trunk switching frames is a full 2:1 line trunk network. In this type line trunk network, there are 1024 terminals (2 line trunk switching frames with 512 terminals each) which will terminate on 512 B-links (2 junctor switching bays with 256 B-links each) (Fig. 29).

2.60 A fully equipped line trunk network with 4:1 concentration ratio consists of one network control junctor switching frame and four line trunk switching frames. The 4:1 concentration ratio is accomplished by adding two line trunk switching frames (No. 2 and No. 3), for a total of 2048 terminals. These terminals have access to the 512 B-links in the network control junctor switching frame. The additional line trunk switching frame concentrators of frames 2 and 3 are multiplied to the existing B-links on a per concentrator basis. The 64 terminals of the two concentrators share the same 16 B-links. Each concentrator on line trunk switching frame 0 is multiplied to its equivalent concentrator on line trunk switching frame 2 and the concentrators on line trunk switching frame 1 are multiplied to those on line trunk switching frame 3 (Figs. 30 and 31).

2.61 Partial networks of either the 2:1 or 4:1 type may be provided. *However, in the 4:1 type, when fewer than 4 line trunk switching frames are equipped, each line trunk switching frame must be administered as if it were a 4:1 concentration ratio (Fig. 32).*

2.62 Junctors are the paths used to connect line trunk networks to themselves and to other line trunk networks. There are two types of junctors: wire junctors and circuit junctors. A wire junctor consists of a metallic path from a network control junctor switching frame to the junctor grouping frame and back to the same or another network control junctor switching frame. A circuit junctor path is constructed in a similar manner except that a universal circuit called a circuit junctor circuit is inserted into the path. The junctor pattern of paths to be interconnected at the junctor grouping frame is generated by a junctor assignment program at the Western Electric Regional Center.

- 2.63** Wire junctors are used for all line to trunk, trunk to line, trunk to trunk, and line to service circuit connections.
- 2.64** The circuit junctor is required on all line to line (intraoffice), line to tone circuits and line to announcement connections. This circuit is used to provide talking battery, audible ring, and supervision to lines when a trunk circuit is not required in the connection. In addition, a circuit junctor may be used in the bypass state for overflow traffic from the wire junctor group when specifically engineered for this purpose *and when properly designated in translations.*
- 2.65** Junctors, either wire or circuit, are combined into subgroups of 8 junctors in each subgroup. Each end of a subgroup contains junctors from the same numbered switches and levels of all 8 grids on the network control junctor switching frame. The maximum number of junctor subgroups terminating on a line trunk network is 64 (8 switches per network control junctor switching frame multiplied by 8 levels per switch equals 64 subgroups).
- 2.66** The junctor grouping frame, on which all junctors are terminated, is subdivided into 8 horizontal shelves and ten vertical files (Figure 23). Vertical files terminate circuit and wire junctor pairs from the line trunk networks and circuit junctor circuits from the universal trunk and junctor frames. Either the junctor pairs to the line trunk networks or the circuit junctor circuits may be terminated in a single vertical file but the two types may not be combined on a file. Each vertical file consists of 32 plugs and 32 jacks, with each plug or jack considered a subgroup terminal.
- 2.67** A wire junctor subgroup is formed on the junctor grouping frame by connecting the plug ended subgroup terminal of one line trunk network into the jack ended subgroup terminal of the same or another line trunk network. In this way, a maximum of 64 junctor subgroup terminals can be interconnected on one vertical file of the junctor grouping frame.
- 2.68** A circuit junctor subgroup is formed on the junctor grouping frame by connecting a plug ended subgroup terminal of network into the jack ended subgroup terminal of the circuit junctor circuit. The plug ended terminal of the same circuit junctor circuit is connected to the jack ended subgroup terminal of the same or another line trunk network. A maximum of 32 circuit junctor subgroups can be interconnected on one circuit junctor vertical file of the junctor grouping frame.
- 2.69** Depending on the mix of intraoffice, tone, announcement, and interoffice calls, junctors are engineered on CCS requirements for each type call.
- 2.70** As mentioned earlier, customer lines, trunk circuits, and service circuits appear on one side of the switching network, wire and circuit junctors appear on the other side. This relationship is illustrated in Fig. 33.
- 2.71** Trunk circuits are used as the interface between the No. 2 ESS switching network and the transmission facilities from, or to other central offices. The overall facility including the trunk circuit between two switching centers is called a trunk. Basically, trunk circuits provide the through metallic transmission path and battery for talking and for receiving or transmitting call status supervisory signals.
- 2.72** There are three broad equipment categories of trunk circuits which are generally used in the No. 2 ESS:
- (a) Universal trunk circuits
 - (b) Miscellaneous trunk circuits
 - (c) Service circuits
- 2.73** Universal trunk circuits are divided into four different types of circuits:
- (a) Outgoing trunk, both local and tandem
 - (b) Incoming trunk both local and tandem
 - (c) 2-way trunk to a 3CL switchboard
 - (d) Circuit junctors
- 2.74** The common denominator of each of these universal trunks is that they are physically arranged to have four circuits on a 2-inch mounting plate. Each circuit contains two scan points and its complete operation is controlled by three relays.
- 2.75** Miscellaneous trunk circuits and test circuits are more elaborate circuits and require

greater mounting space than do universal trunk circuits. Depending on the type of miscellaneous circuit, the miscellaneous trunks will have a variable number of decoder buffers and scan points per circuit.

2.76 Service circuits perform specialized functions such as digit reception, digit transmission, ringing, coin control operations and provision of various tones, announcements, and certain custom calling features.

2.77 The relays in the various trunks, junctors, and service circuits are wire spring relays. They receive their operating instructions from the central processor via signals through the central pulse distributor. The central pulse distributor sends high speed signals while the wire spring relays are mechanical and comparatively slow operating. The peripheral decoder acts as the interface between the central pulse distributor and the relays. The peripheral decoder is an electronic circuit made primarily of integrated circuits. One peripheral decoder circuit pack contains four peripheral decoder buffers of three peripheral decoder points each for a total of twelve peripheral decoder points. Peripheral decoder buffers are engineered based on the number required per trunk or service circuit.

2.78 Junctors, trunks, and service circuits are mounted on one of 3 types of frames:

- (a) Universal trunk and junctor frame
- (b) Miscellaneous trunk frame
- (c) Miscellaneous frame.

2.79 The universal trunk and junctor frame consists of 3 bays designated 0, 1, and 2. The 0 and 2 bays mount 32 universal trunk or junctor circuits per bay for a total of 64 units. On the center bay, or bay 1, are mounted the audible alarm control panel and peripheral decoder units, each of which provides twelve peripheral decoder points to control the twelve relays in each universal trunk or junctor unit or 4 trunks (Fig. 34). The universal trunk and junctor frame can be arranged for optional home master scanner operation, home operation, or mate operation depending on whether it is equipped with a scanner controller and the type of scanner quadrants the controller serves (Figs. 35, 36, and 37).

2.80 The miscellaneous trunk frame is used to mount miscellaneous trunk test and service circuits. Any circuit, other than a universal trunk circuit, which uses a peripheral decoder point must be mounted in the miscellaneous trunk frame. A peripheral decoder circuit pack unit with a capacity for 16 peripheral decoder packs is provided on each frame for the control of all relays associated with the equipment mounted on the frame (Fig. 38).

2.81 The miscellaneous frame is used to mount any circuit which does not contain any relays, and, therefore, does not require peripheral decoder points.

2.82 Trunk scanners are mounted on the master scanner frame and the universal trunk and junctor frame. Through the scanner controllers, the central processor obtains information on the status of trunks. Orders to the scanner controllers are transmitted on the peripheral unit address bus and enable pairs. The results of the scan are returned to the central processor via the scan answer bus (Fig. 34 and 39).

2.83 Trunks and service circuits and related frames are engineered items. Each office will be custom engineered for these items. For a detailed explanation of the various trunks and service circuits, see the Traffic Facilities Practice, Division D, Section 12c and Section 12d.

2.84 When customers are served by unigauge cable, range extension amplifiers may be used to serve these customers up to a maximum transmission limit of 2500 ohms which is equivalent to 52 kilofeet of 26- and 22-gauge cable. Ordinary limits are 1300 ohm transmission range (15 kilofeet of 26 gauge cable) (Fig. 40).

2.85 Range extension amplifiers may be installed in the switching path on all unigauge loops. The range extension amplifiers are connected to B-links on a total concentrator basis. That is, the entire 16 B-links of a given concentrator must be completely equipped with amplifiers. Range extension amplifier converter packs are mounted on the range extension frame (Fig. 41). Each range extension frame has a total capacity of 144 range extension amplifier converter packs. Range extension frames are provided in pairs to provide service protection for the system. In addition, each range extension concentrator is fed from two different

frames using two power buses and a portion of four peripheral decoders.

2.86 The range extension feature is assigned in translations on a per concentrator basis. This means that the paired concentrators of a 4:1 concentrator ratio office may be individually assigned as range extension concentrators. *Non-range extension subscriber lines may not be assigned in these concentrators. Trunks and service circuits may be assigned, however.*

2.87 No. 2 ESS may have one or two types of billing on tape: CAMA and/or LAMA. CAMA is Centralized Automatic Message Accounting; LAMA is Local Automatic Message Accounting.

2.88 With LAMA each individual or 2-party customer from whom a billable call is placed will be automatically identified by the No. 2 ESS, and billing information will be recorded on AMA tape (Fig. 42). The AMA data then will be placed on magnetic tape (Fig. 42). The calling directory number or billing number is identified along with the destination and duration of the call for billing purposes. The called number is included for detail billed calls. For a message unit (bulk) billed call, the called number may be replaced by a message billing index number. AMA data may also be used for various studies required by the companies.

2.89 Calls forwarded to a CAMA office may be of two types:

(a) Calls on which the local calling directory number for 1- and 2-party lines is automatically identified in the originating office and forwarded to the CAMA office. This is called Automatic Number Identification (ANI).

(b) Calls on which an operator must be brought in on the call to obtain the originating directory or billing number. This is called Operator Number Identification (ONI).

2.90 CAMA billing is required on calls from (1) 4- and 8-party lines; (2) multiline hunting groups and PBXs which require detail billing; and (3) offices which are not equipped with ANI or LAMA.

2.91 Depending on the configuration of the individual offices and the requirements of the wire center, there are various distributing

frames on which line and trunk cable pairs may be terminated.

2.92 The single sided protector frame provides protectors for line cable pairs entering the building from the outside. Heat coils are not required since the line ferroids provide the high current arresting capability (Fig. 43). No plugging up panels are required because lines are routed to trouble intercept via teletypewriter messages from the local test desk and the maintenance center teletypewriters.

2.93 One type of combined distributing frame is used to interconnect trunk, service circuit, and subscriber line cable with terminal equipment numbers of the concentrators on verticals of a single sided frame, a combined distributing frame module consists of 10 vertical files (Fig. 44).

2.94 The standard main frame has protector, connector, or jack mountings on one side (vertical) of the frame and terminal blocks on the other side (horizontal) of the frame (Fig. 45). The trunk, service circuit, and subscriber line cable is terminated on blocks on the vertical side of the frame and the terminal equipment number (concentrators are terminated on blocks on the horizontal side of the frame). The frame may be sectorized (zoned so that short jumpers are used between the vertical and the horizontal side of the frame).

2.95 A specially designed combined distributing frame for the modularized installation (No. 2A ESS) comes equipped with junctor grouping jacks and plugs, terminal strips, and cable connectors (Fig. 46). No other frame can be used in this type installation since the units in the No. 2A ESS are prefabricated to be shipped to and placed at the telephone company site.

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PD-2H137, B-Link Amplifier Test Program

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PD-2H210, Disconnect Program

PD-2H214, Network Path Hunt, Bus, and Idle
Program

PD-2H216, Peripheral Order Buffer Loading Program

PD-2H219, Peripheral Order Buffer Execution
Program

PD-2H220, Recent Change Subroutine Program

PD-2H221, No Test Trace Program

PD-2H222, Call Store Layout Programs

PD-2H224, High and Dry Program

PD-2H228, Translation Data Program

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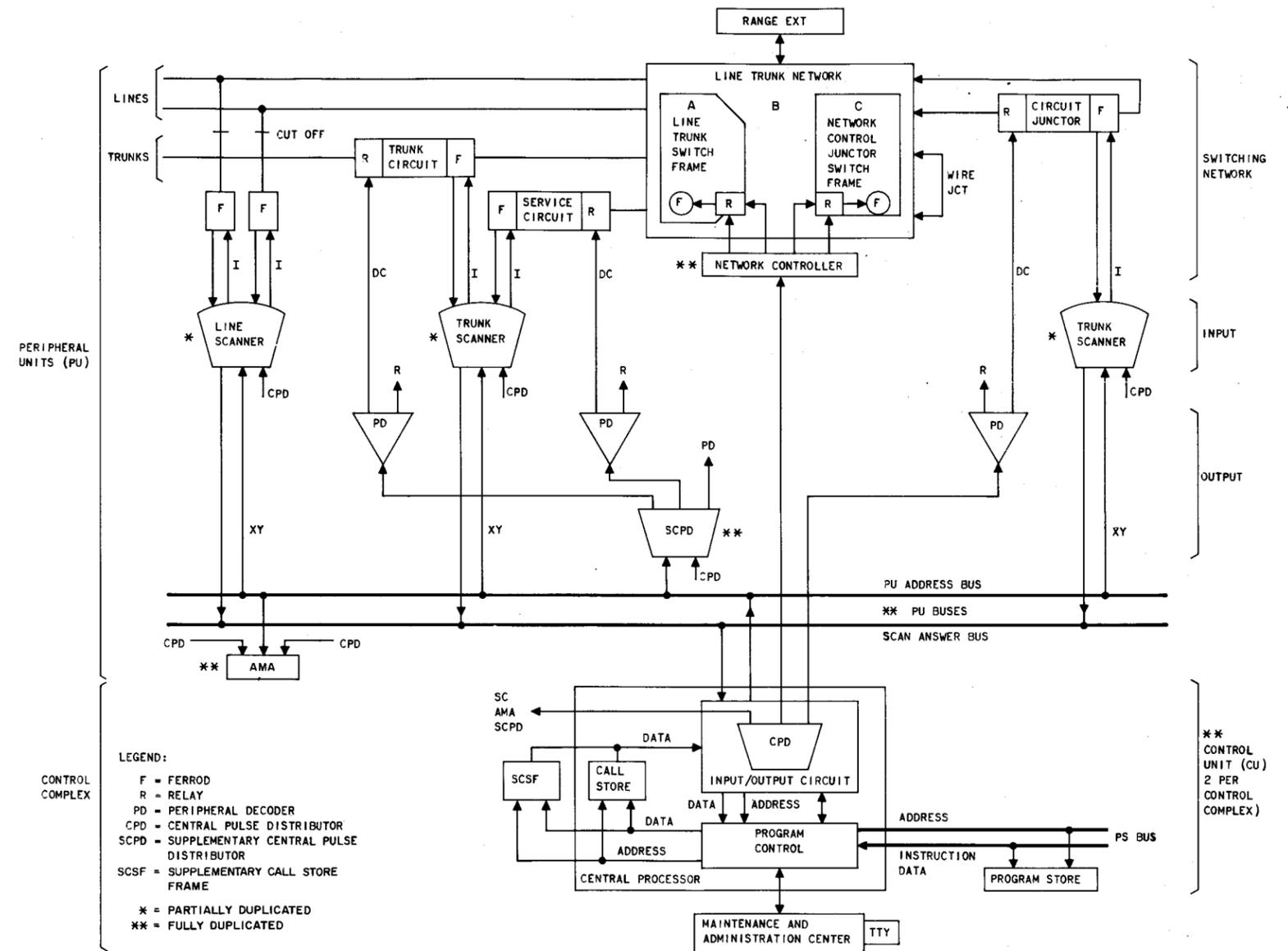


Fig. 1—No. 2 ESS Functional Block Diagram (2.02)

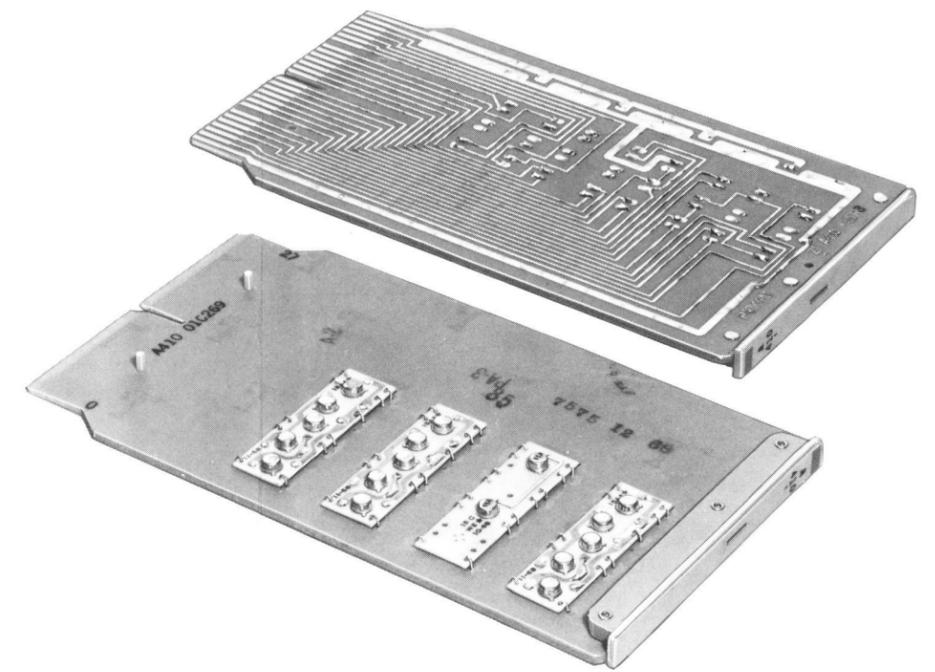


Fig. 2—HSTRL Circuit Packs (2.03)

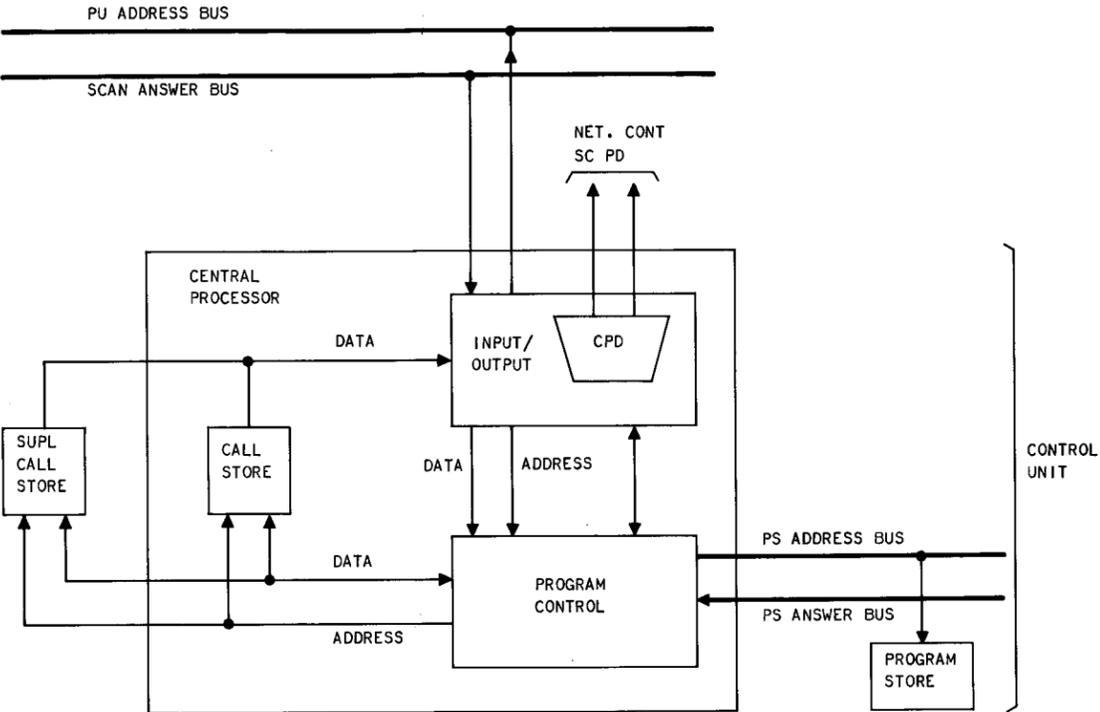


Fig. 3—No. 2 ESS Control Unit (2.04)

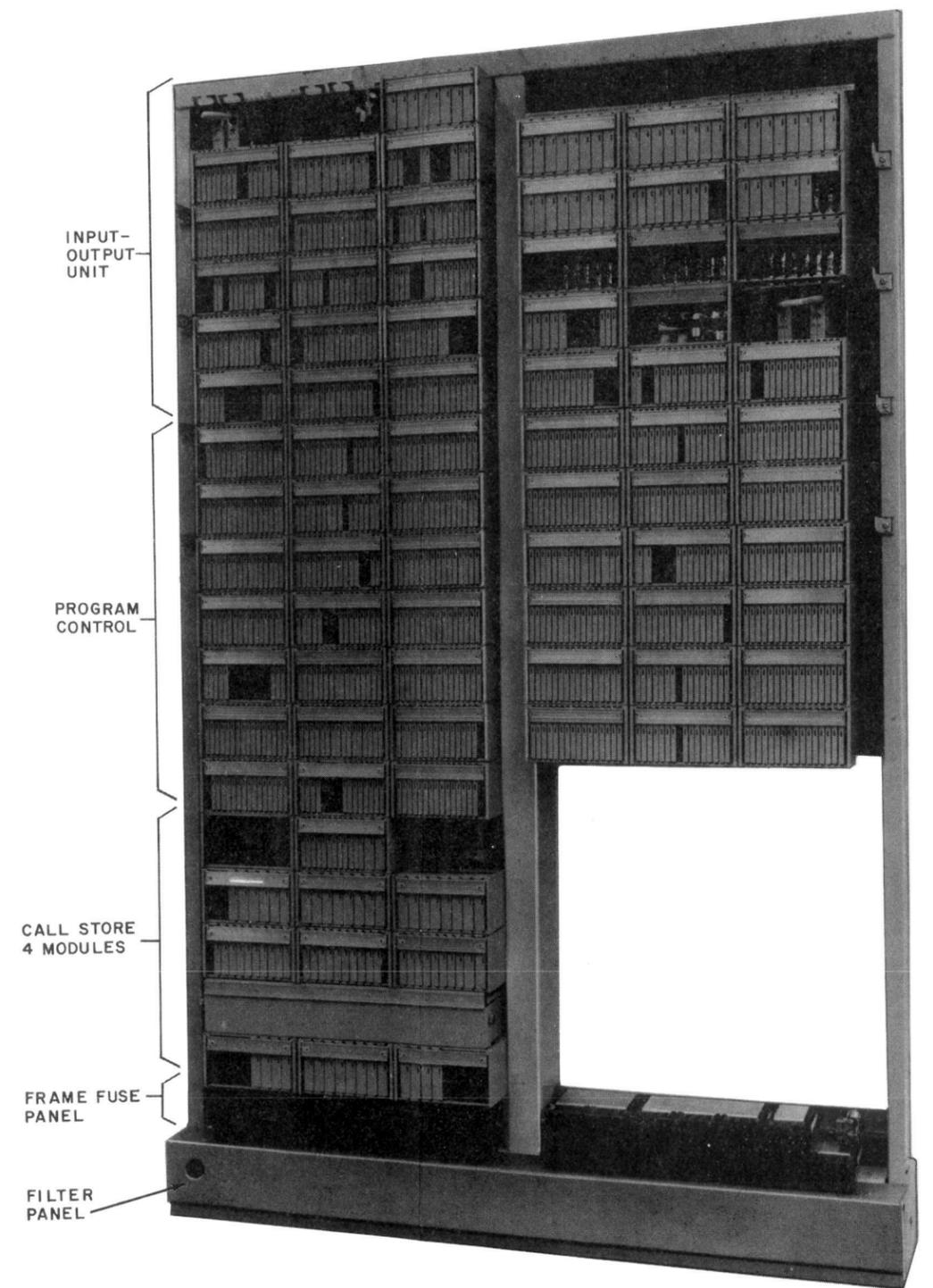


Fig. 4—Central Processor Frame (2.05)

LINE SCANNING

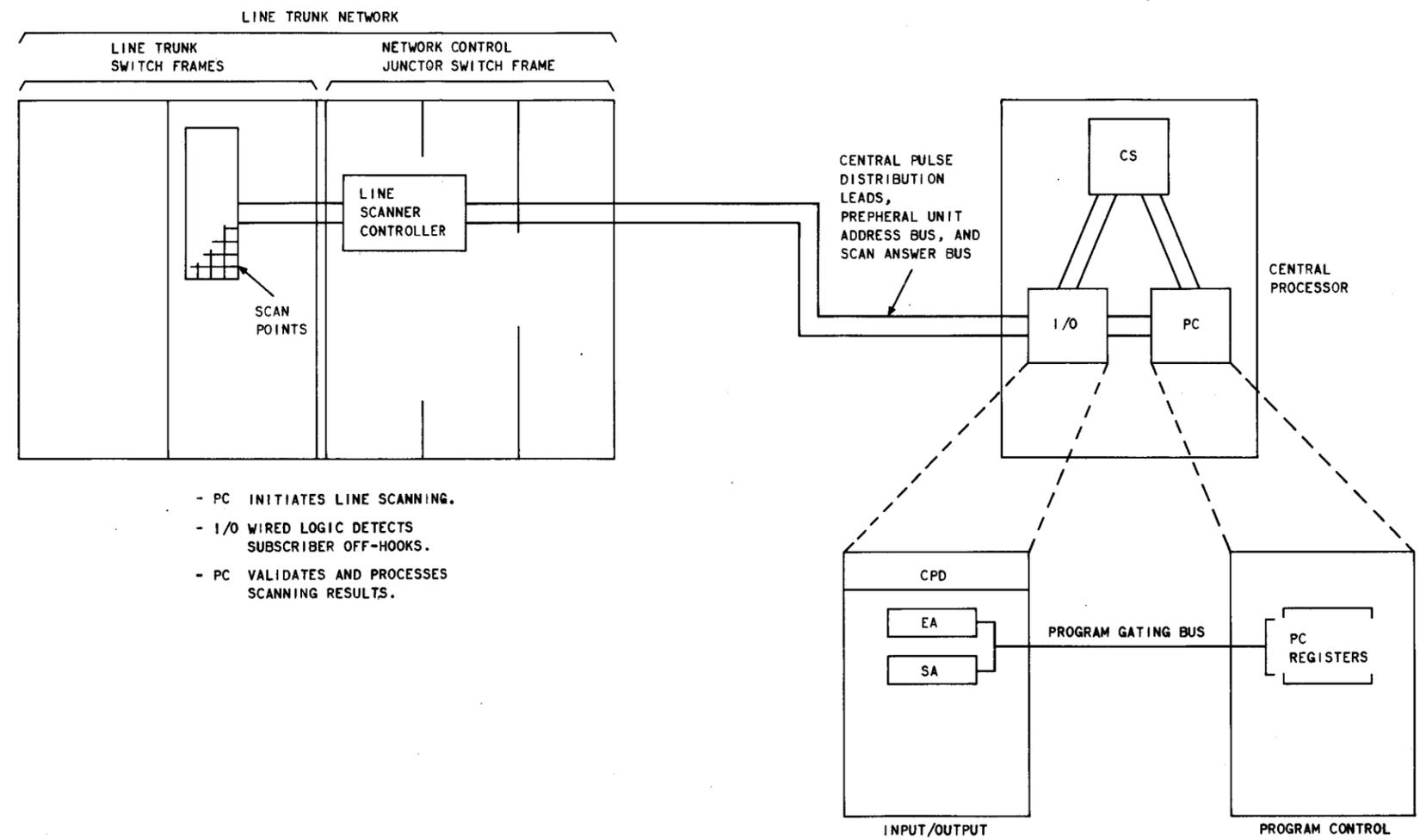


Fig. 5—Program Control (2.06)

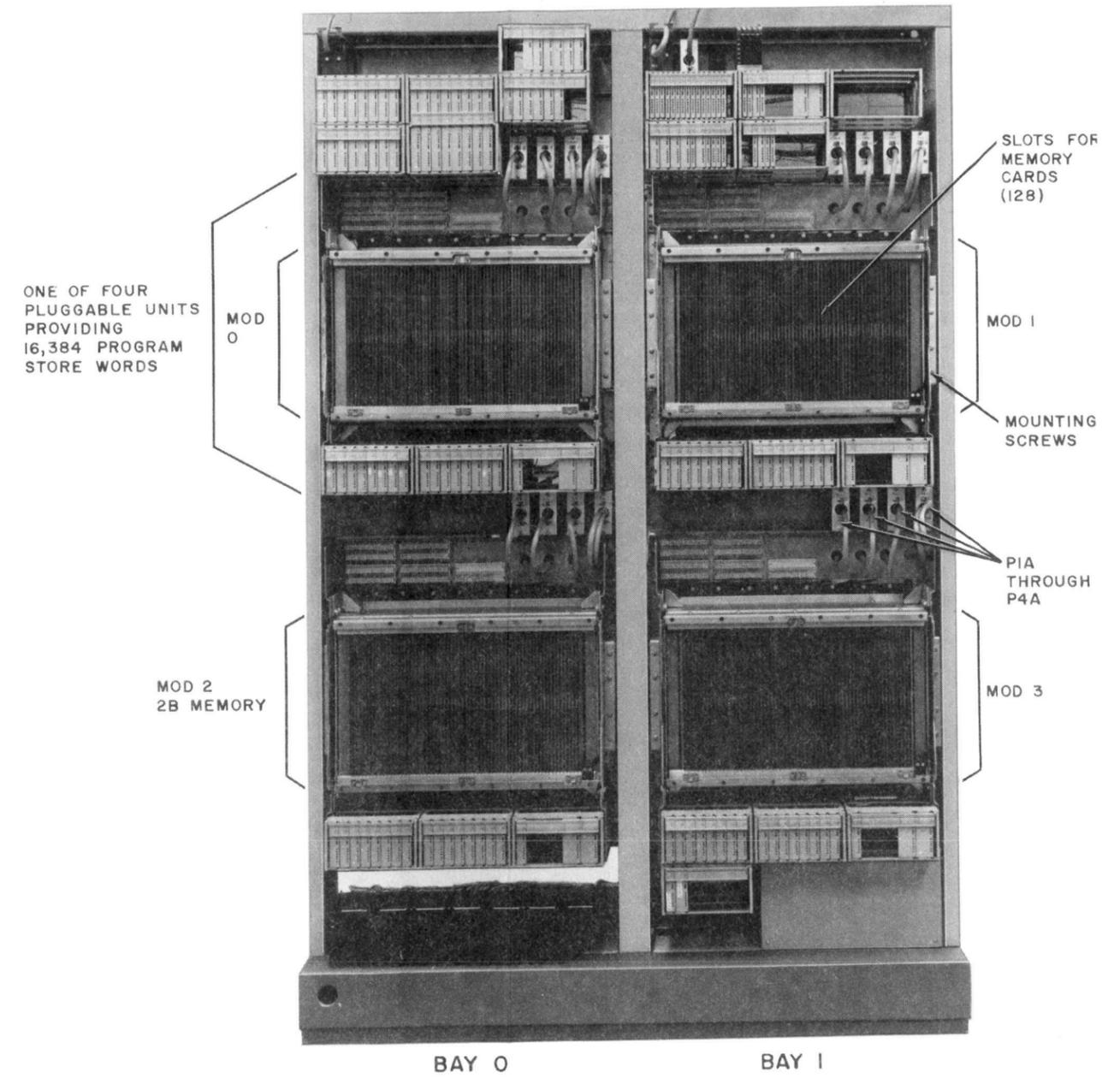


Fig. 6—Program Store Frame (2.13)

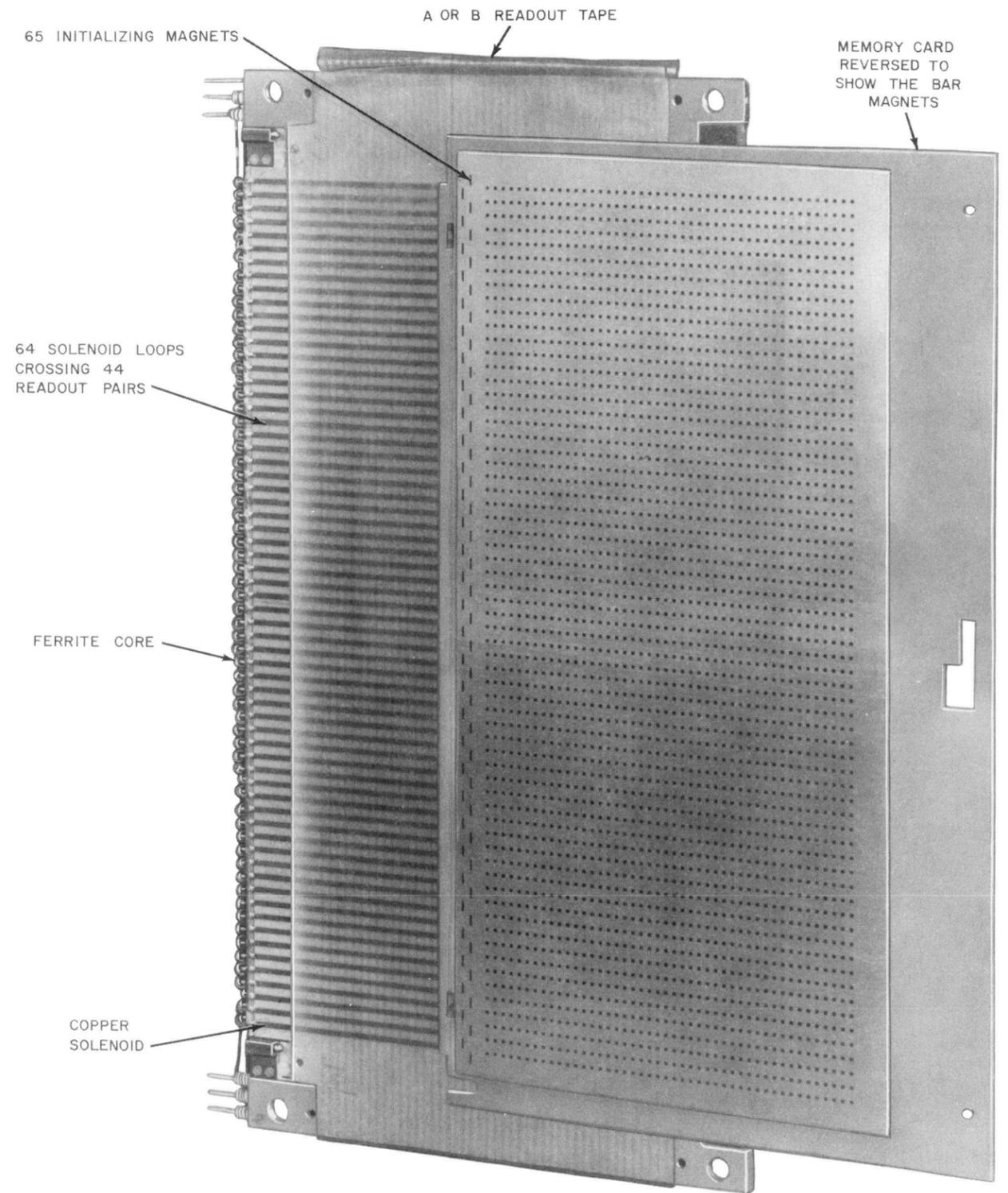


Fig. 7—Program Store Memory Card (2.14)

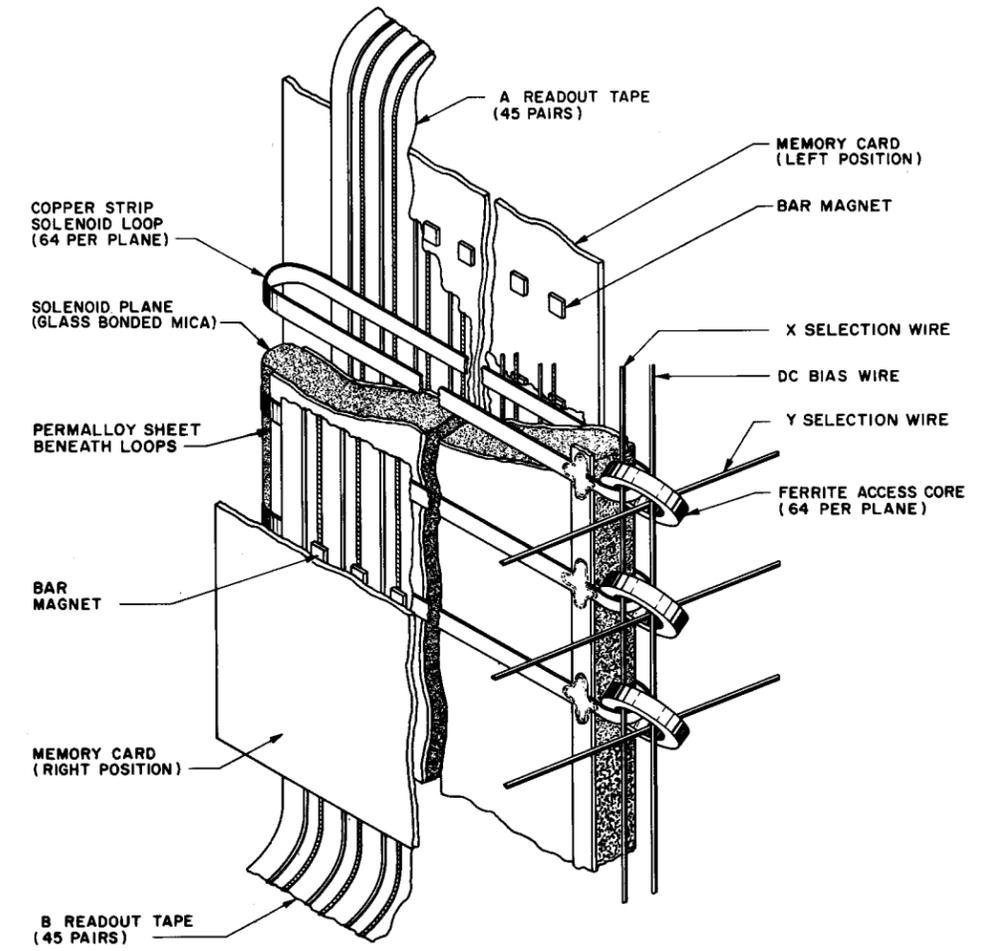


FIG. 11-11 VIEW FROM REAR OF MEMORY MODULE

Fig. 8—Module Section of Memory Card (2.14)

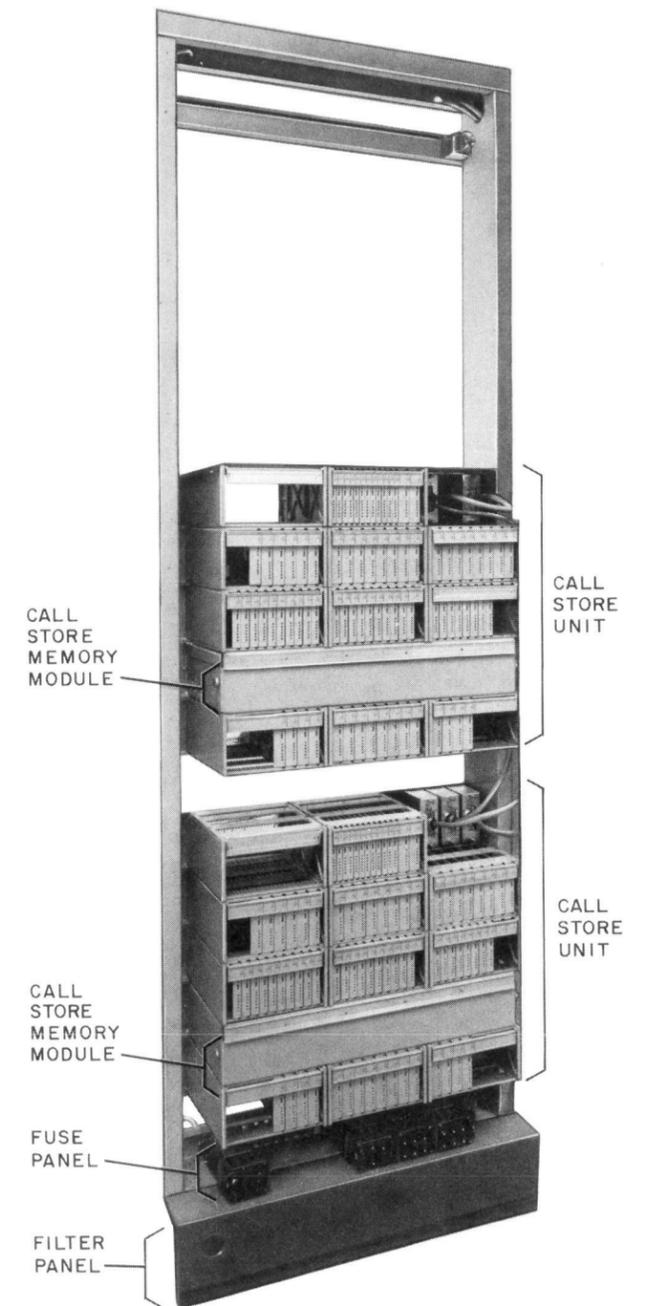


Fig. 9—Supplementary Call Store Frame (2.24)

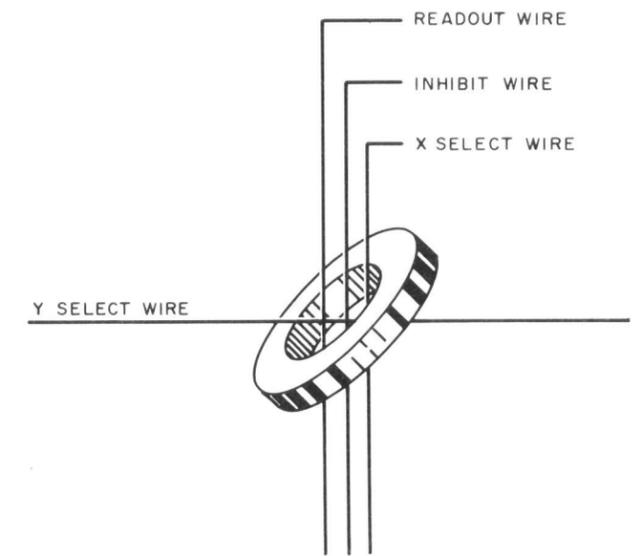
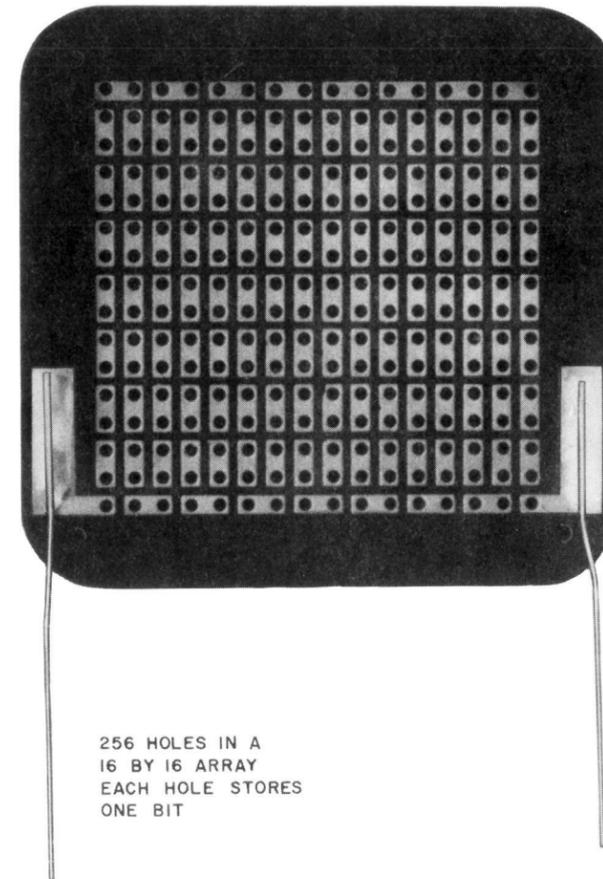


Fig. 10—Ferrite Sheet and Equivalent Magnetic Core (2.26)

MEMORY AREA	FUNCTION	WORD SIZE	QUANTITY	
			1 CS	2 CS
OR	REC. & SEND. DIGITS	8	51	128
POB	ORDERS TO PD, SC & NET CONT	16	12	12
TCR	NON-TALK TIME	8	70	210
TMR	STATUS OF TRK, JCT & SVC CKT	2	2048	4096
HOPPER	STORES PERIPHERY INFO FOR BL PROGRAM	-	-	-

OR — ORIGINATING REGISTER
 POB — PERIPHERAL ORDER BUFFER

 TCR — TRANSIENT CALL RECORD
 TMR — TERMINAL MEMORY RECORD

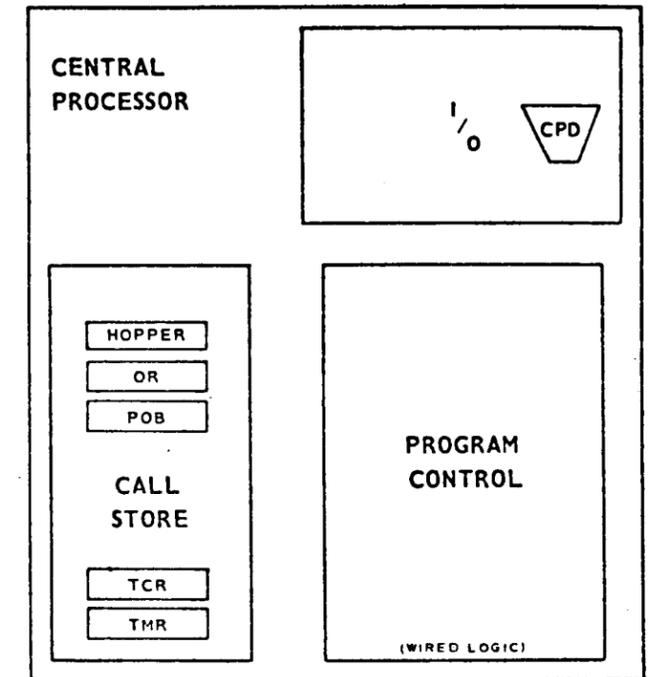
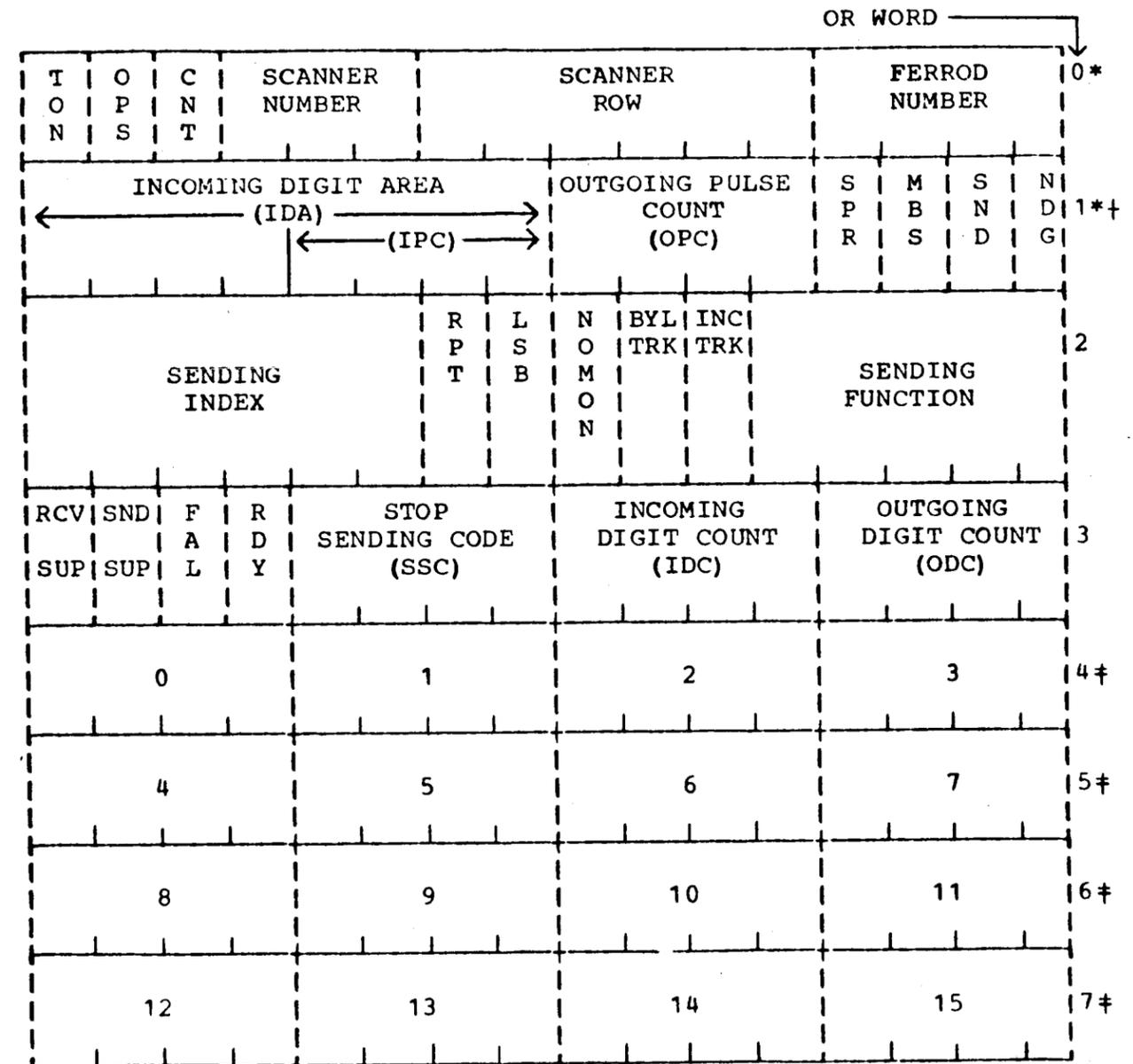
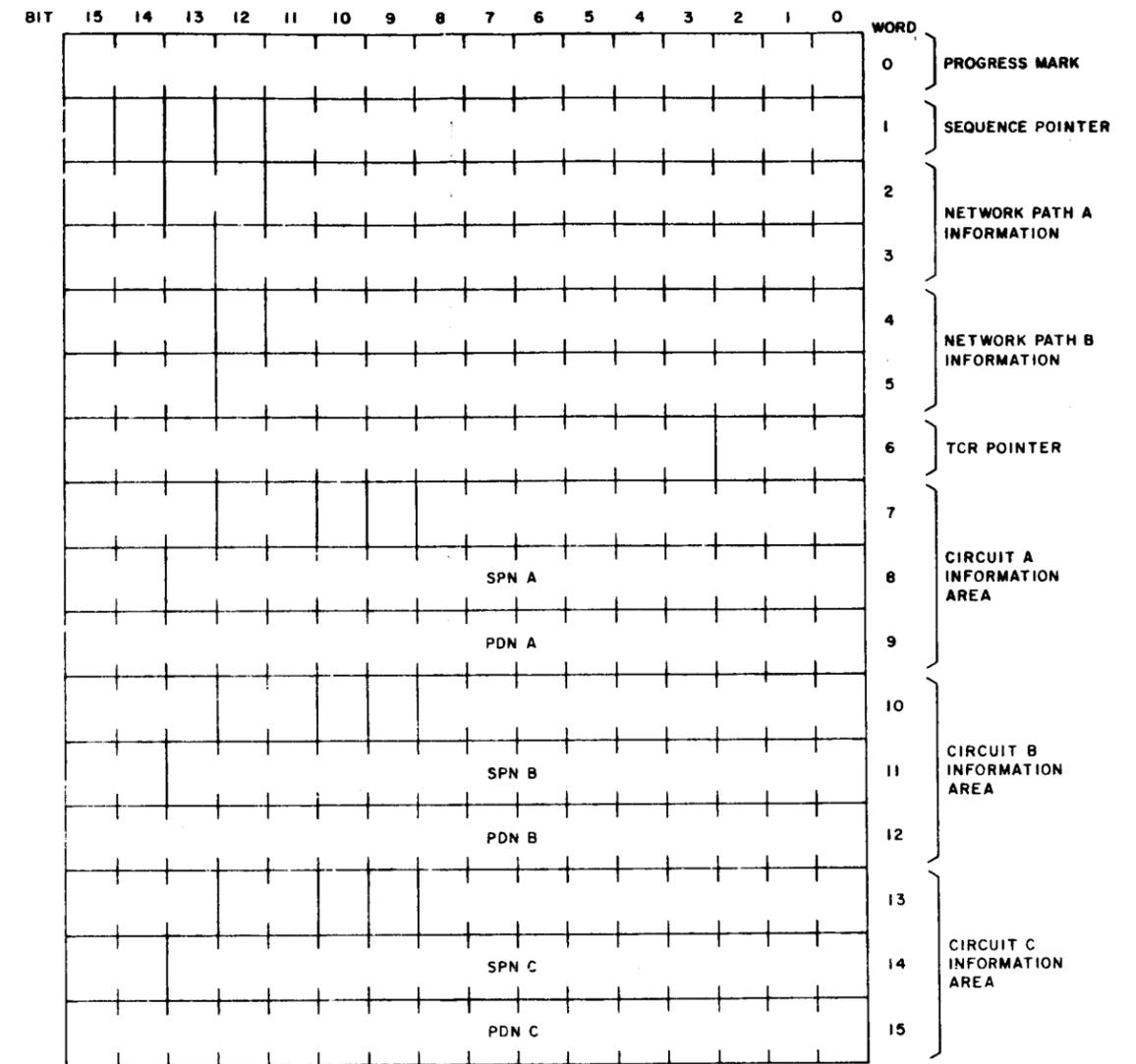


Fig. 11—Call Store Areas (2.32)



* IO wired logic may read.
 † IO wired logic may write.
 ‡ Digit storage.

Fig. 12—Originating Register Layout (2.34)



LEGEND:
 TCR - TRANSIENT CALL RECORD
 PDN - PERIPHERAL DECODER NUMBER
 SPN - SCAN POINT NUMBER

Fig. 13—Typical Peripheral Order Buffer Layout (2.35)

STABLE JUNCTOR TMR

0	X PARTY TERMINAL		
STE	AMA	PATH	Y PARTY TERMINAL

TRANSIENT JUNCTOR TMR

1	TCR POINTER		SUPV
	PATH		

STABLE TRUNK TMR

0	X PARTY TERMINAL				
STE	AMA	PATH	CLG	TDM	WIRE JUNCTOR

TRANSIENT TRUNK OR SERVICE CKT TMR

1	TCR POINTER			SUPV
	PATH		WIRE JUNCTOR	

- SUPV — SUPERVISORY FUNCTION
- STE — STABLE TIMING ENTRY PROVIDED
- AMA — AMA DISCONNECT ENTRY IS NECESSARY
- CLG — INDICATES WHETHER CIRCUIT IS CALLING OR CALLED PARTY
- TDM — TANDEM CALL

Fig. 14—Terminal Memory Record Format (2.36)

PROGRESS MARK (PM)											S U P
L T	"A" PARTY										
L T	"B" PARTY										
PØB	PRTY S P	S T R	C F R	C B V	T F R		F L H	E O T	F S T	TIMER	
ØRIGINATING REGISTER ADDRESS											
DGN	"A" SERVICE CIRCUIT										
"B" SERVICE CIRCUIT											
CIRCUIT JUNCTØR ØR AUXILIARY ADDRESS											

- SUP — SUPERVISØN FLAG
- LT — SET 1 IF PARTY IS A LINE, 0 IF A TRUNK
- PRTY — P SET 1 IF "A" IS 2-PARTY LINE
S SET 1 IF 2-PARTY LINE IS TIP, 0 IF RING
- STR — SECØND TRY IN PROGRESS
- CFR — CØNFERENCE IN PROGRESS
- CBV — CHANGE ABBREVIATED ØPERATIØN
- TFR — TRANSFER CALL
- FLH — DISTINGUISH FLASH SUPERVISØN FROM ØN HØØK
- EØT — ENTER ØN TIME ØUT FLAG (DIGIT INTERPRETATION)
- FST — SECØND TIMEOUT IN PRØGRESS

Fig. 15—Typical Transient Call Record Layout (2.36)

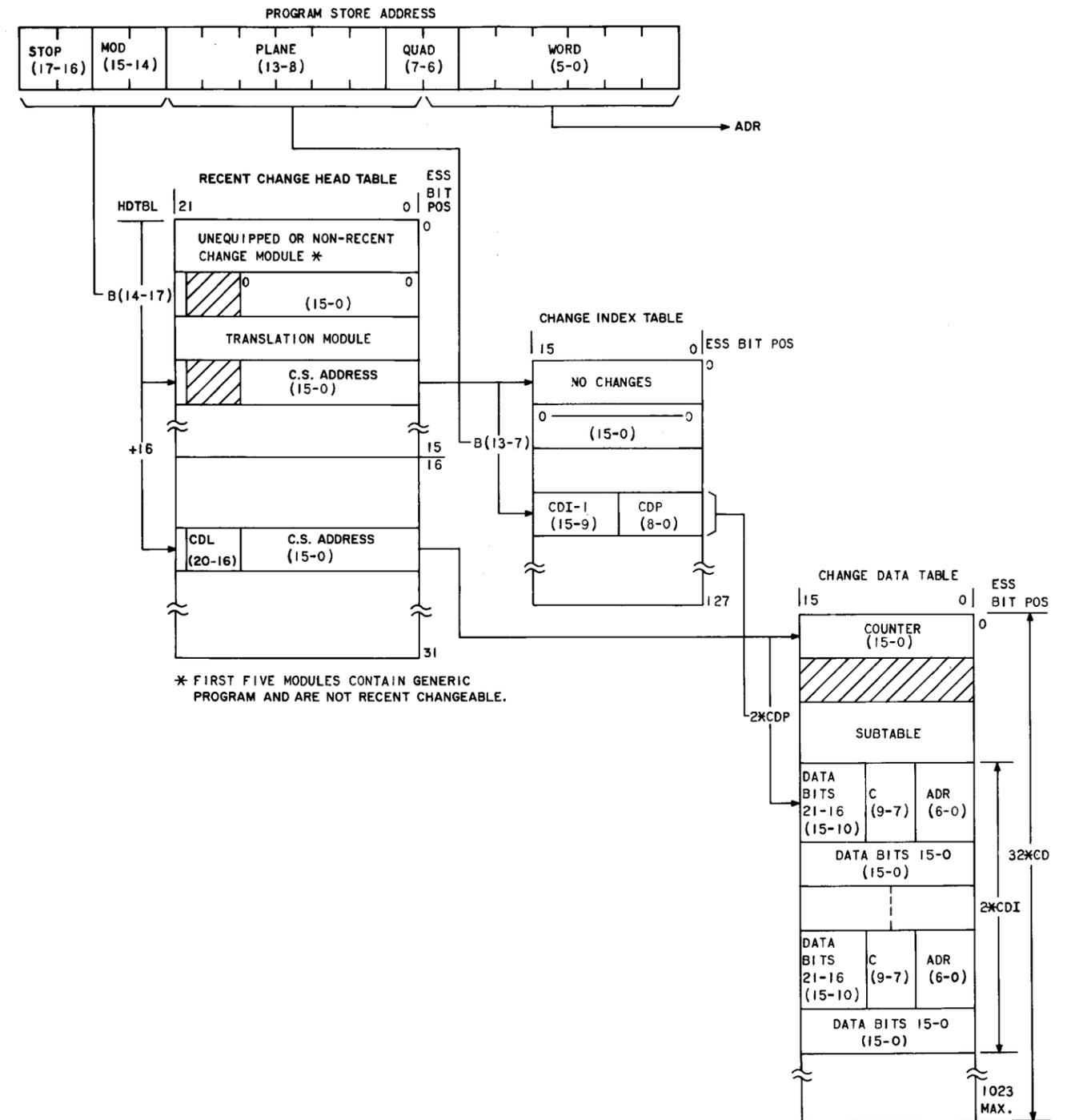


Fig. 16—Data Layout in Recent Change Call Store (2.41)

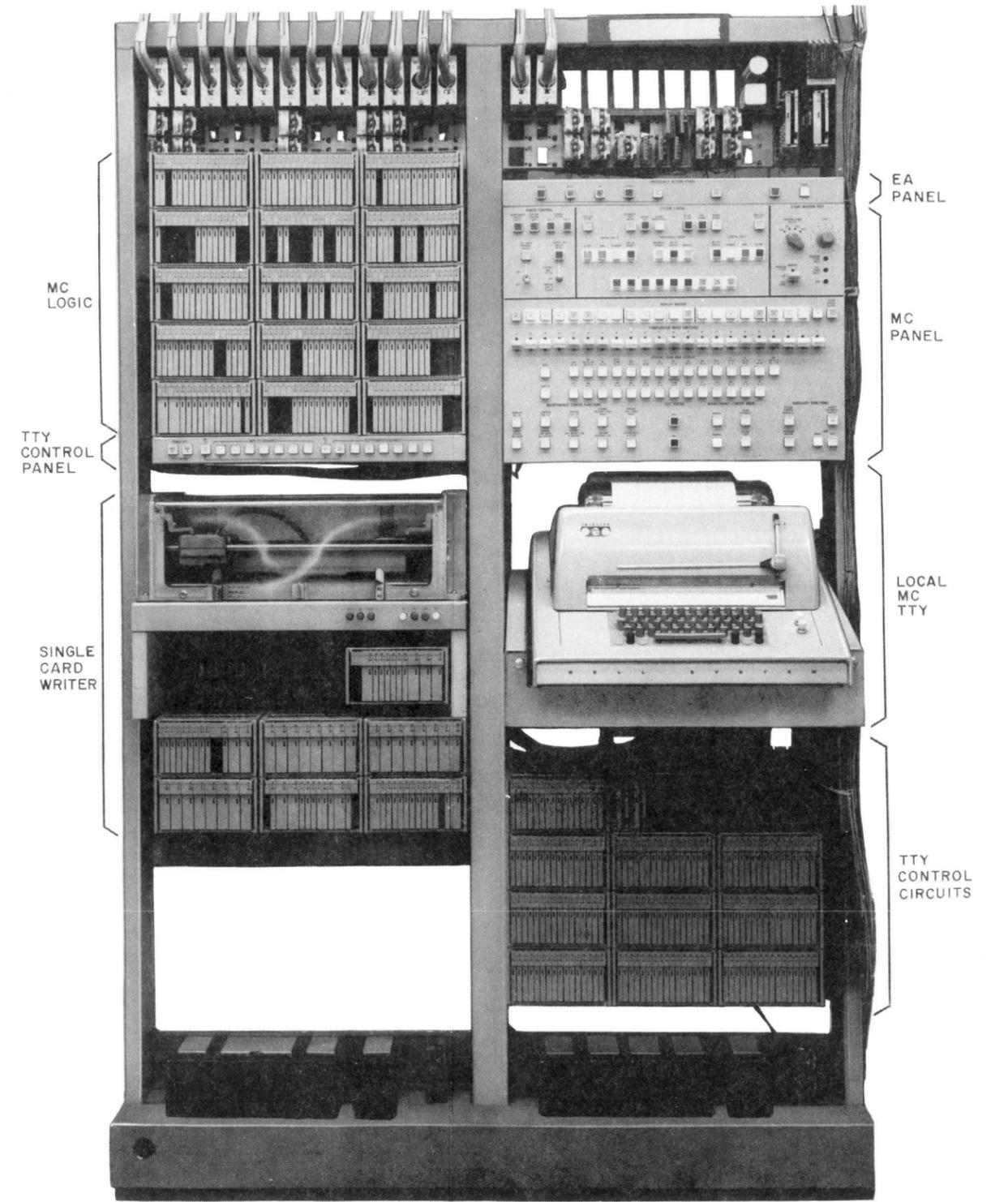


Fig. 17—Maintenance Center Frame (2.46)

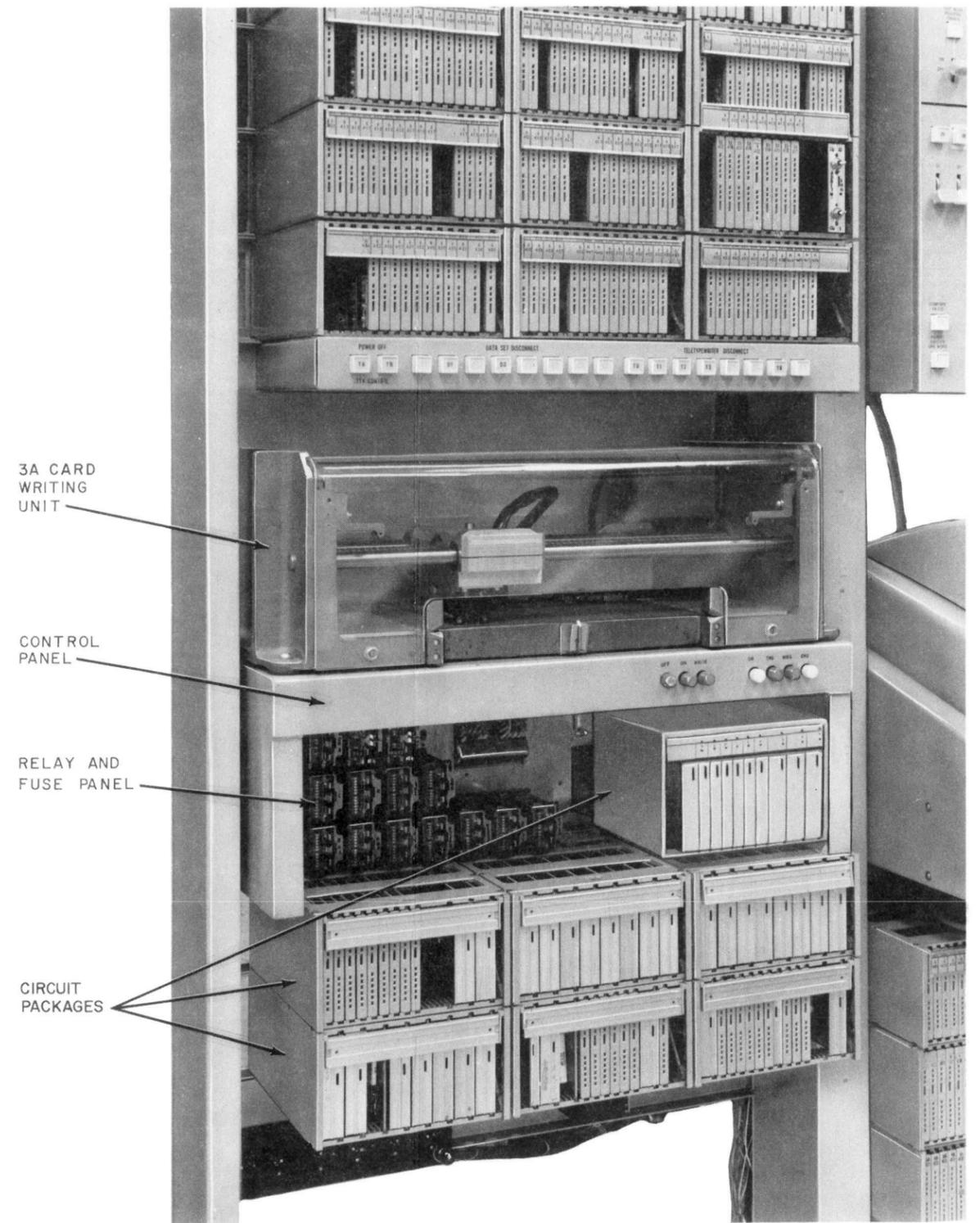


Fig. 18—Left Side of Double Bay Maintenance Center Frame-Partial View (2.47)

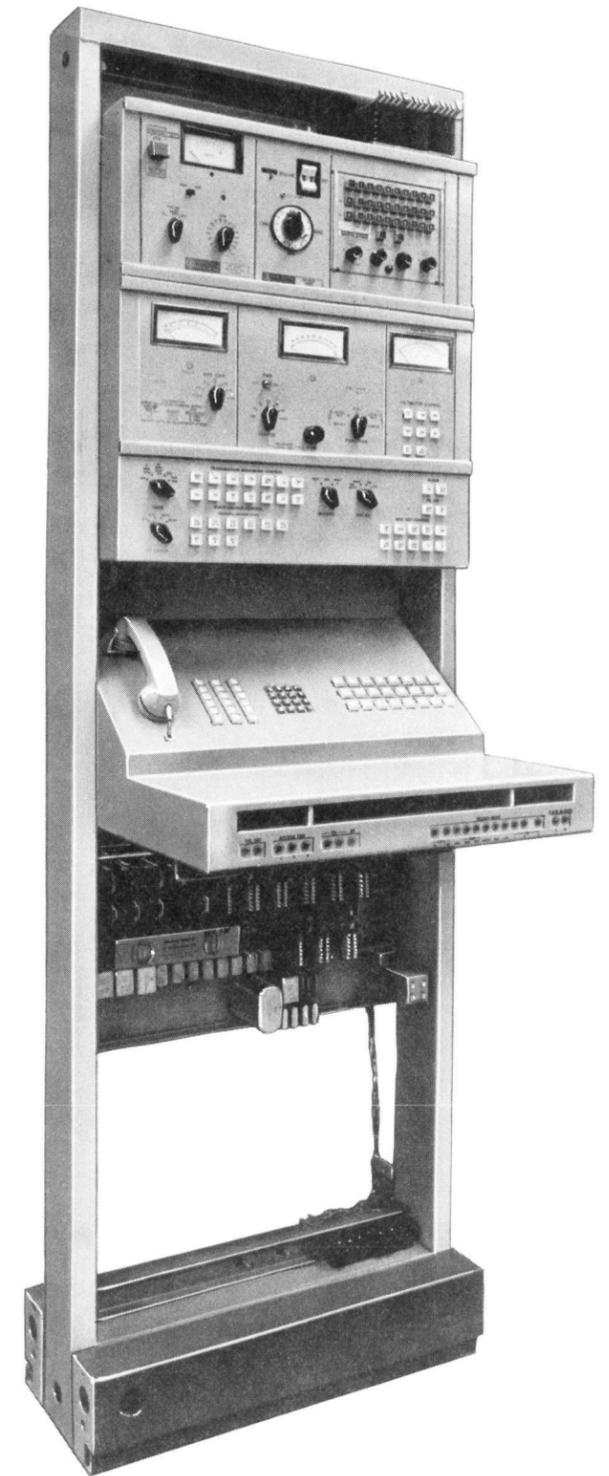


Fig. 19—Trunk Test Frame (2.48)

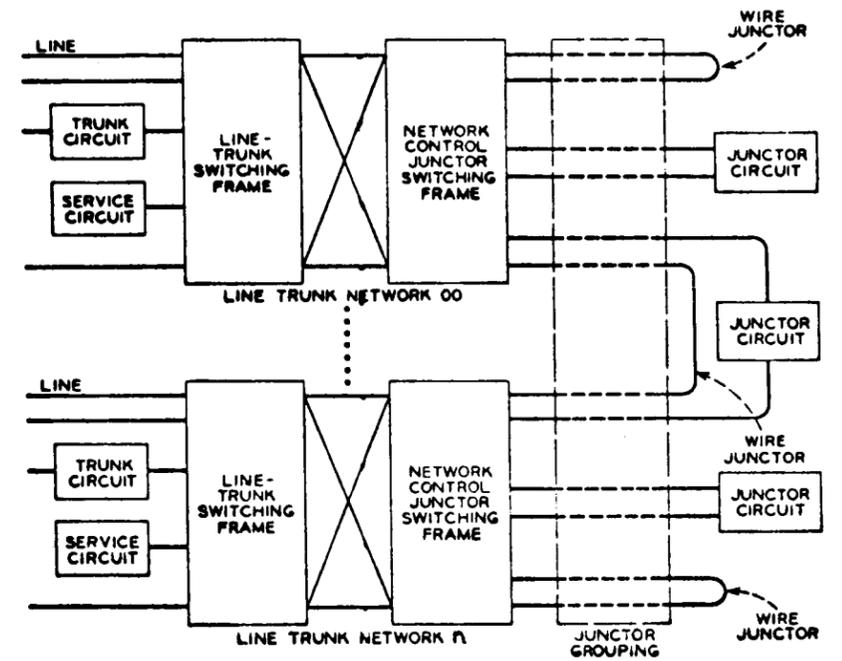


Fig. 20—No. 2 ESS Network Diagram (2.50)

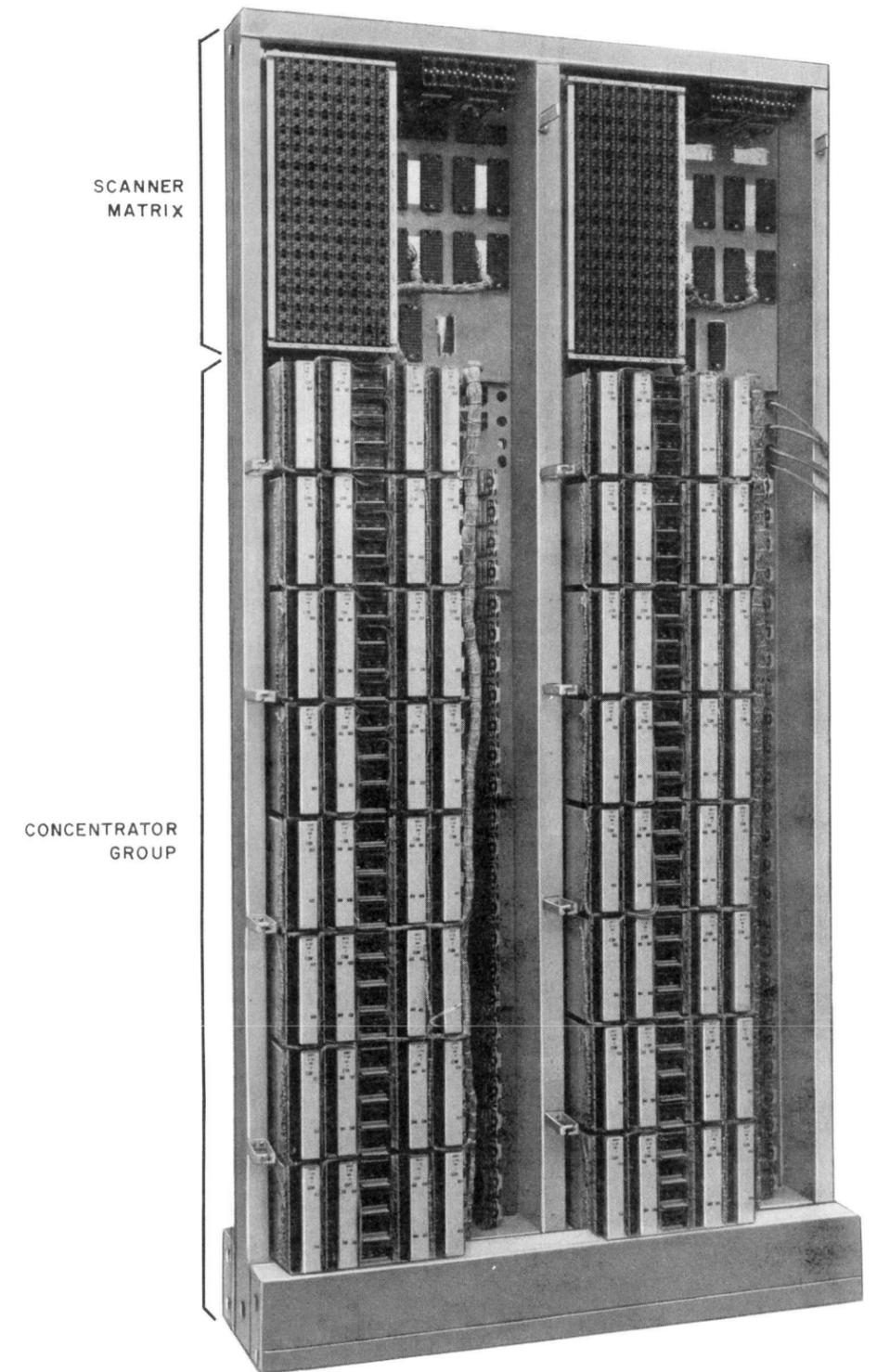


Fig. 21—Line Trunk Switching Frame (2.50)

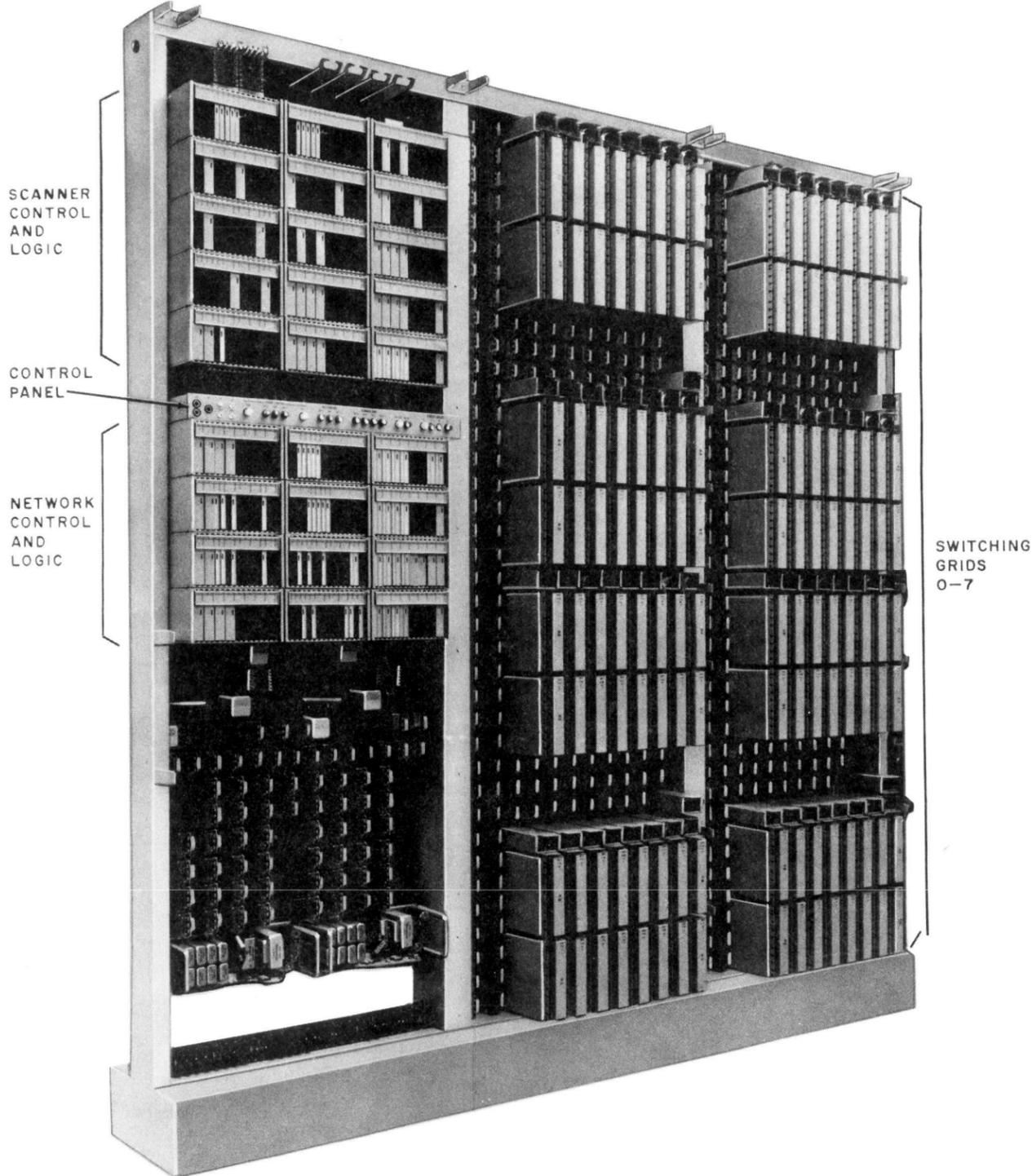


Fig. 22—Line Link Switching Frame (2.50, 2.51, 2.56)

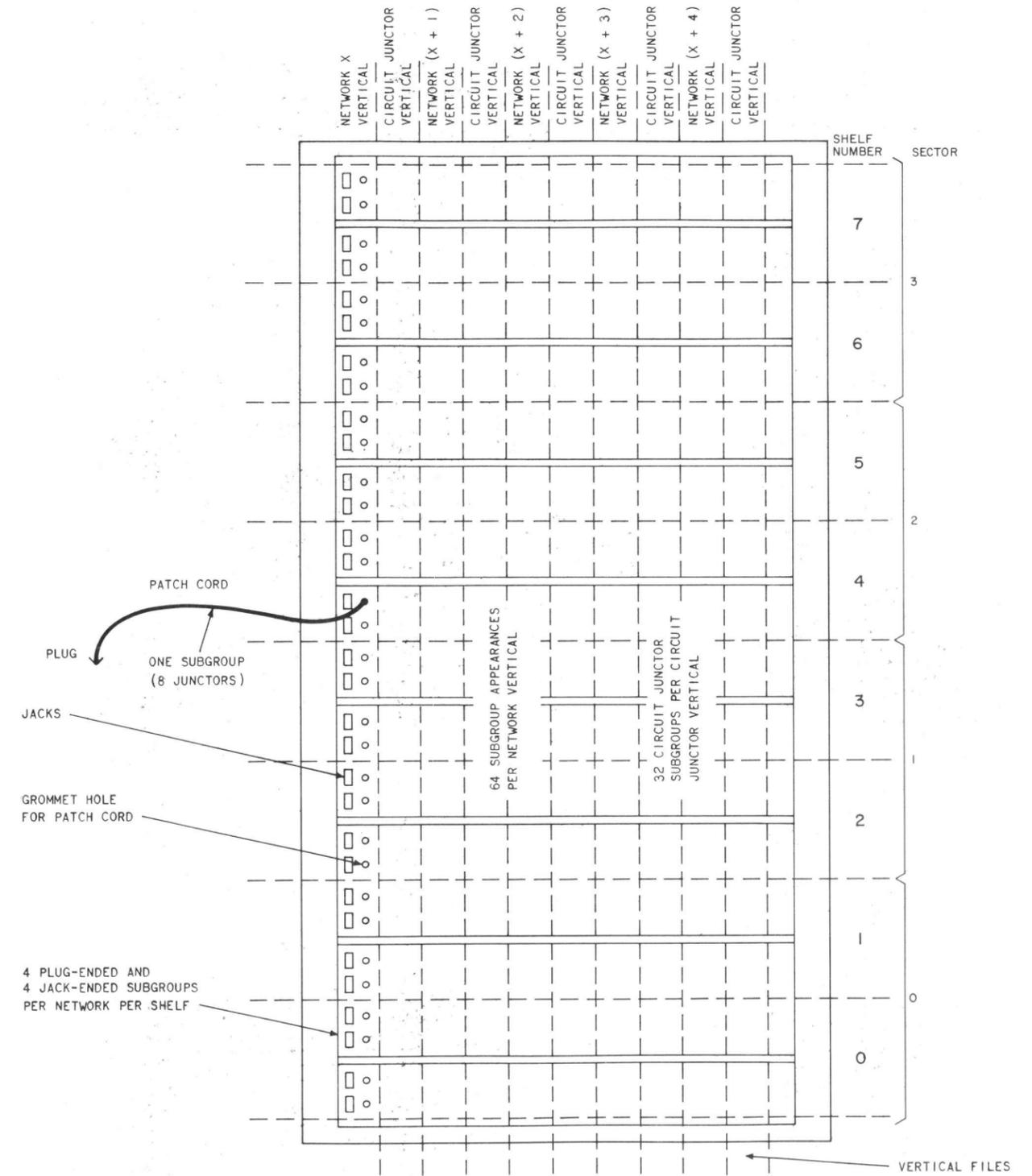
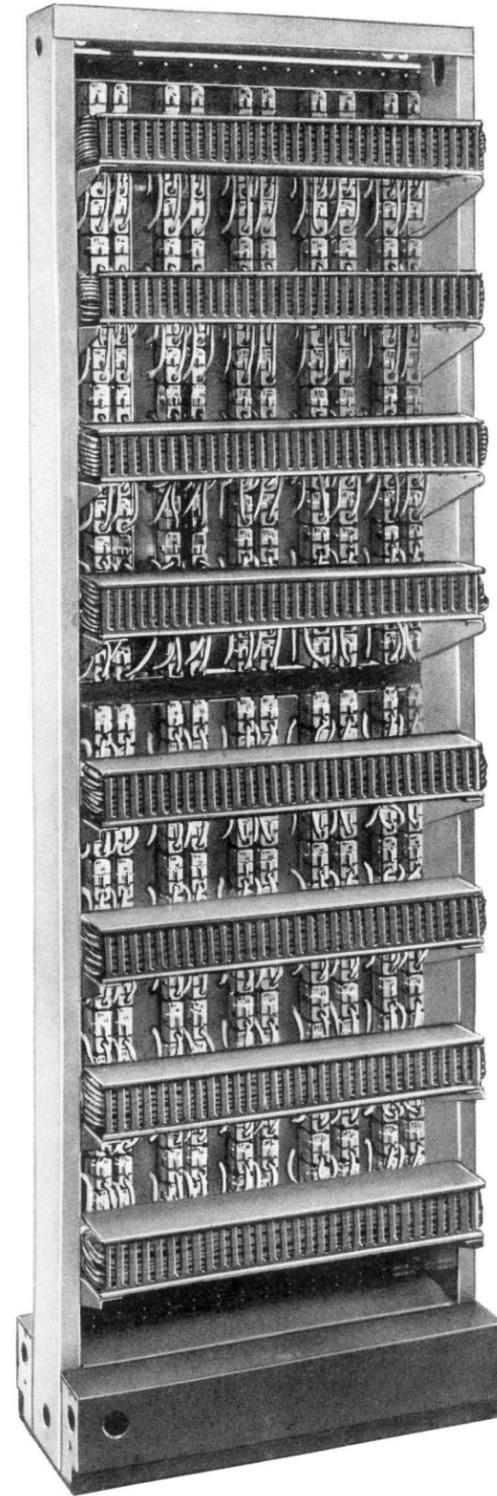


Fig. 23—Junctor Grouping Frame and Physical Diagram of a Junctor Grouping Frame (2.50)

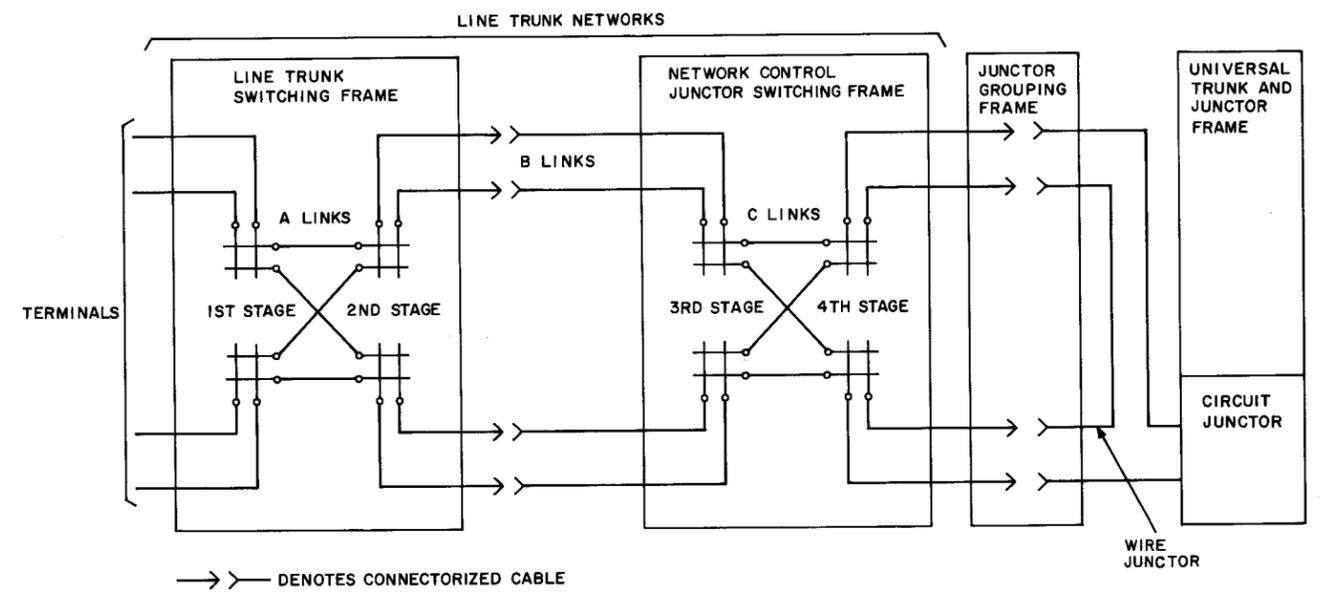


Fig. 24—Junctor Arrangements (2.50)

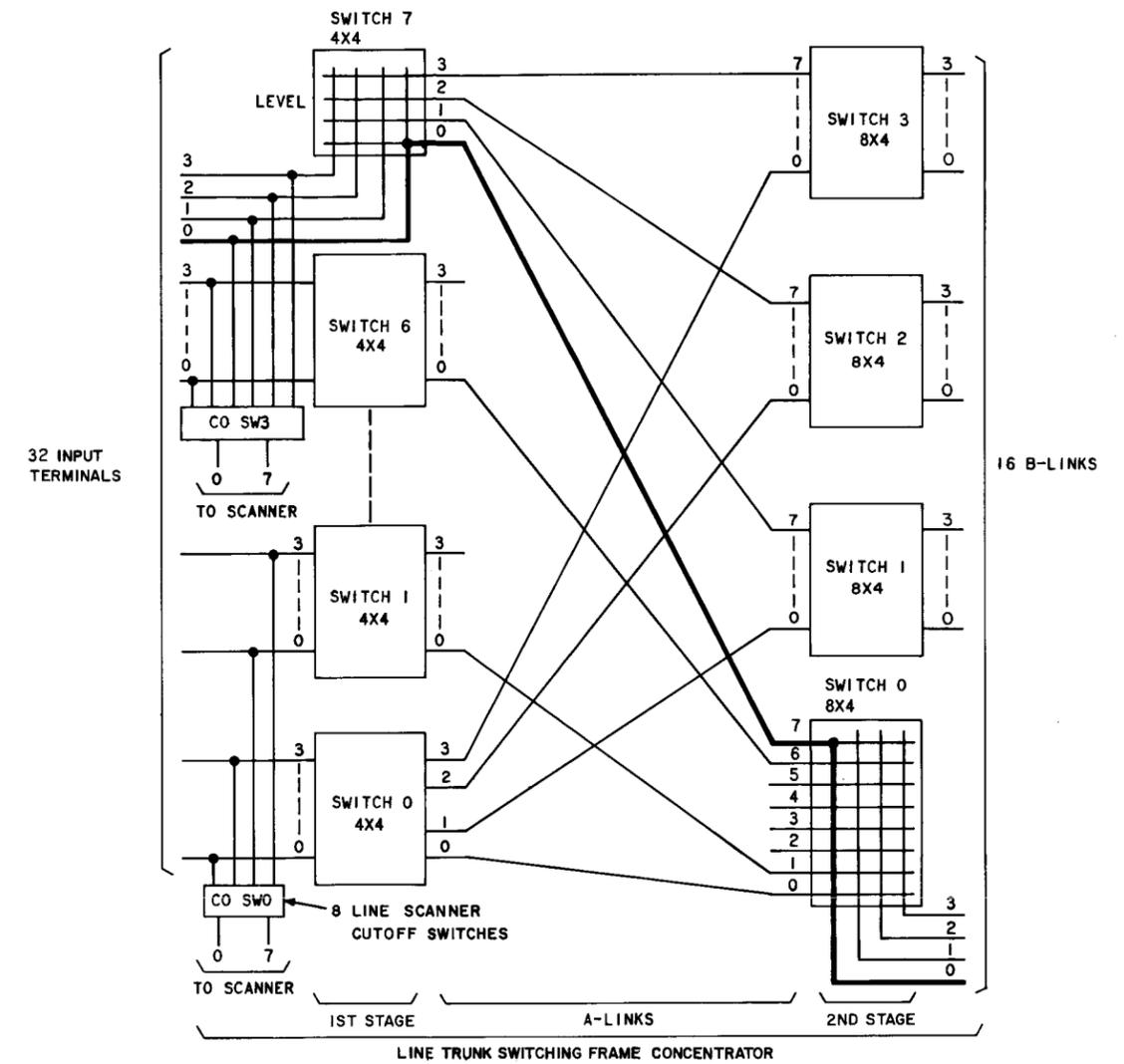


Fig. 25—Block Diagram of Line Trunk Switching Frame Concentrator (2.55)

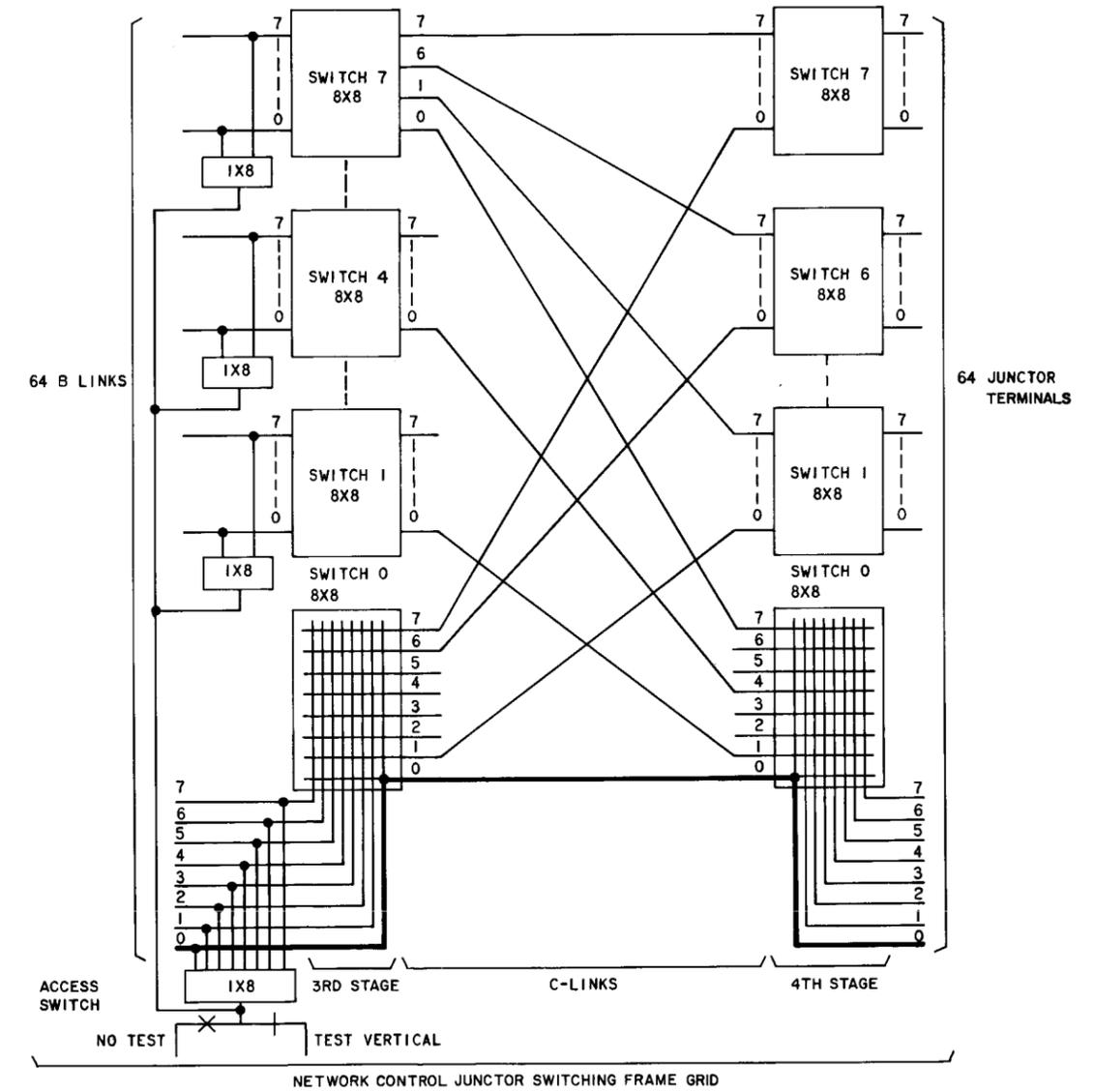


Fig. 26—Block Diagram of Network Control Junctor Switching Frame Grid (2.55)

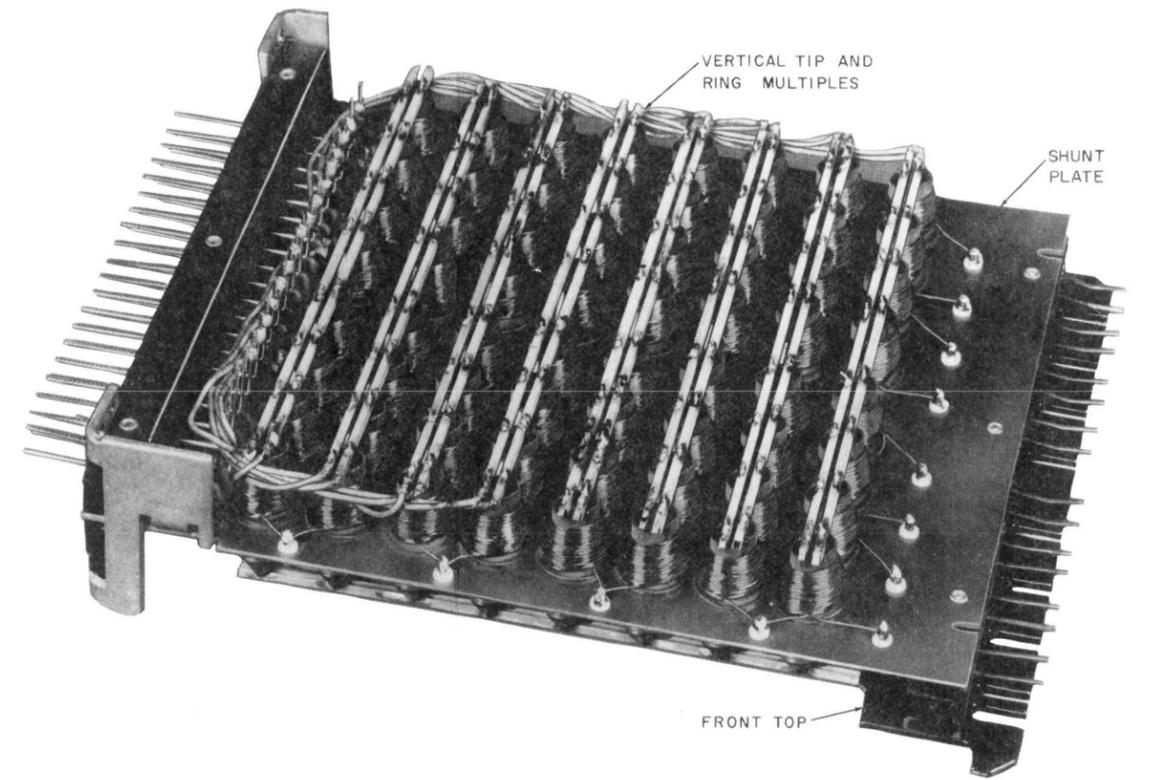
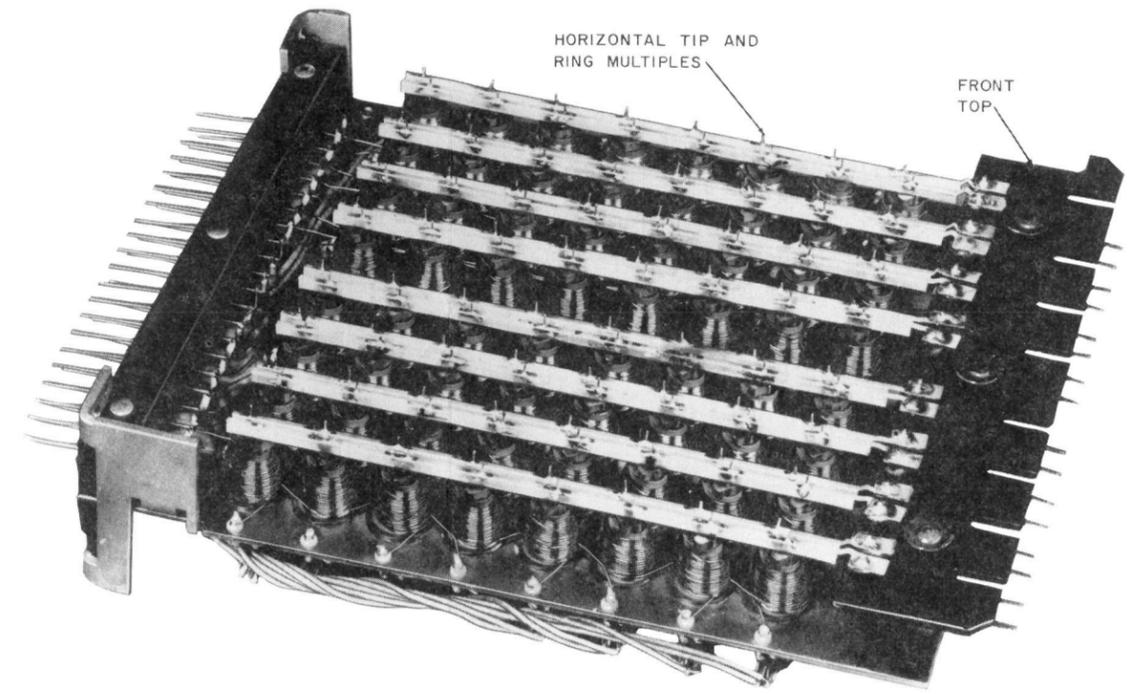


Fig. 27—An 8 by 8, 2-Wire Ferreed Switch (2.54)

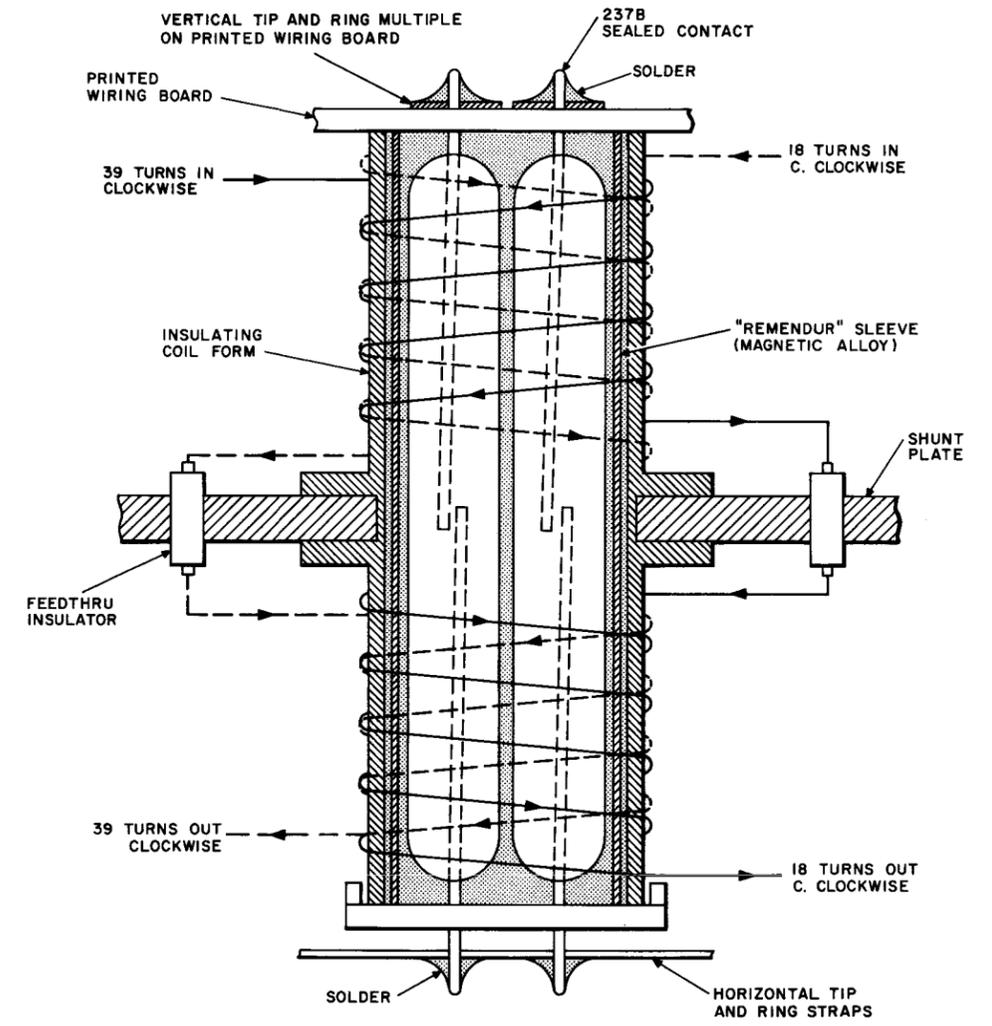


Fig. 28—Ferreed Crosspoint (2.54)

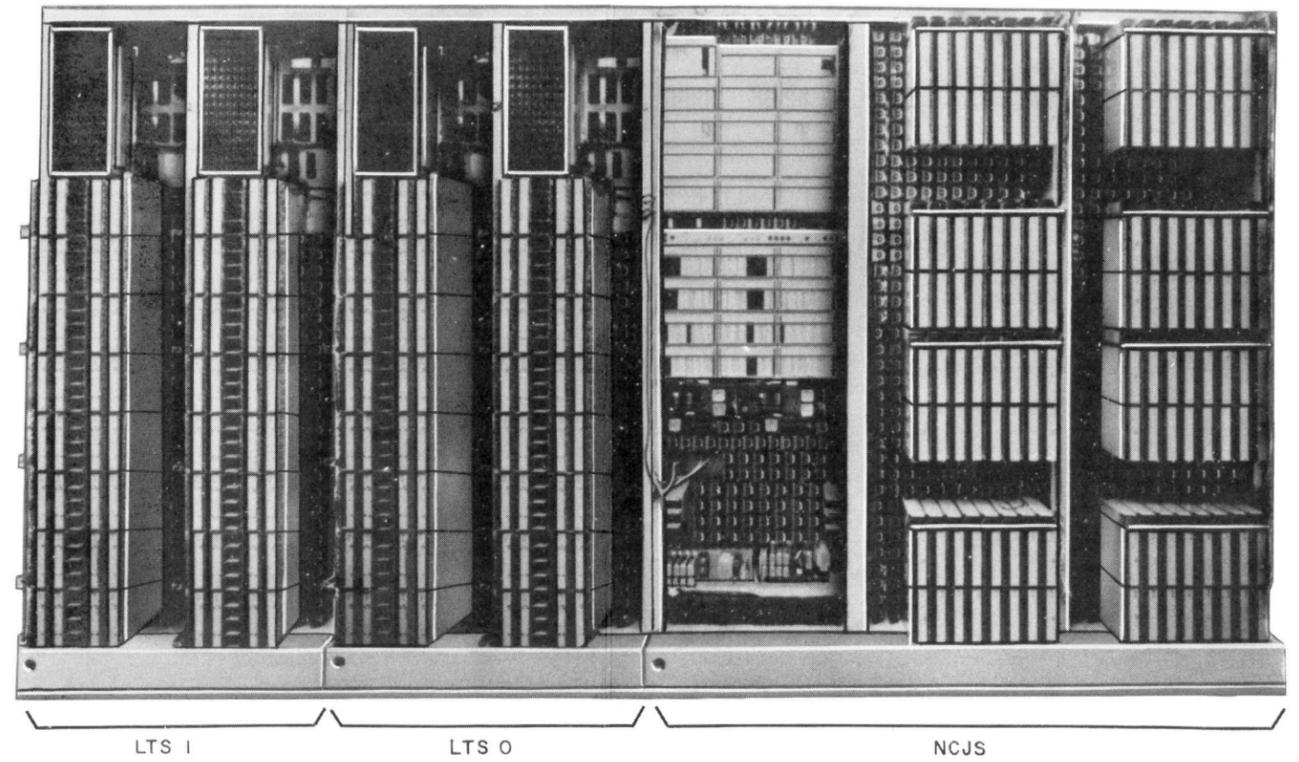


Fig. 29—Fully Equipped Line Trunk Network With
2:1 Concentration Ratio (2.59)

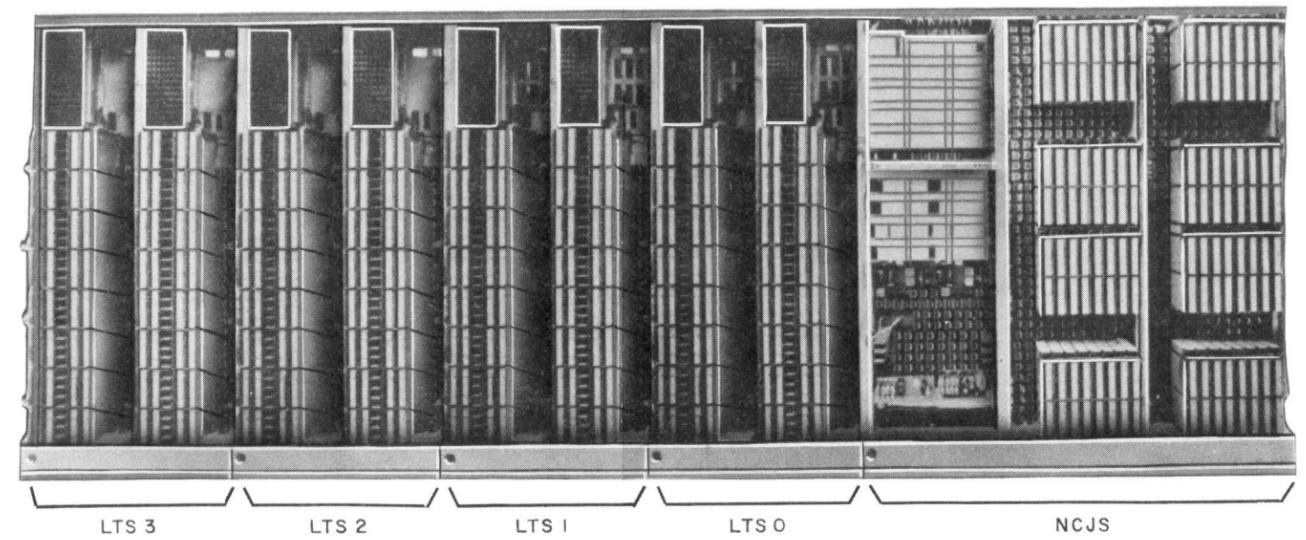
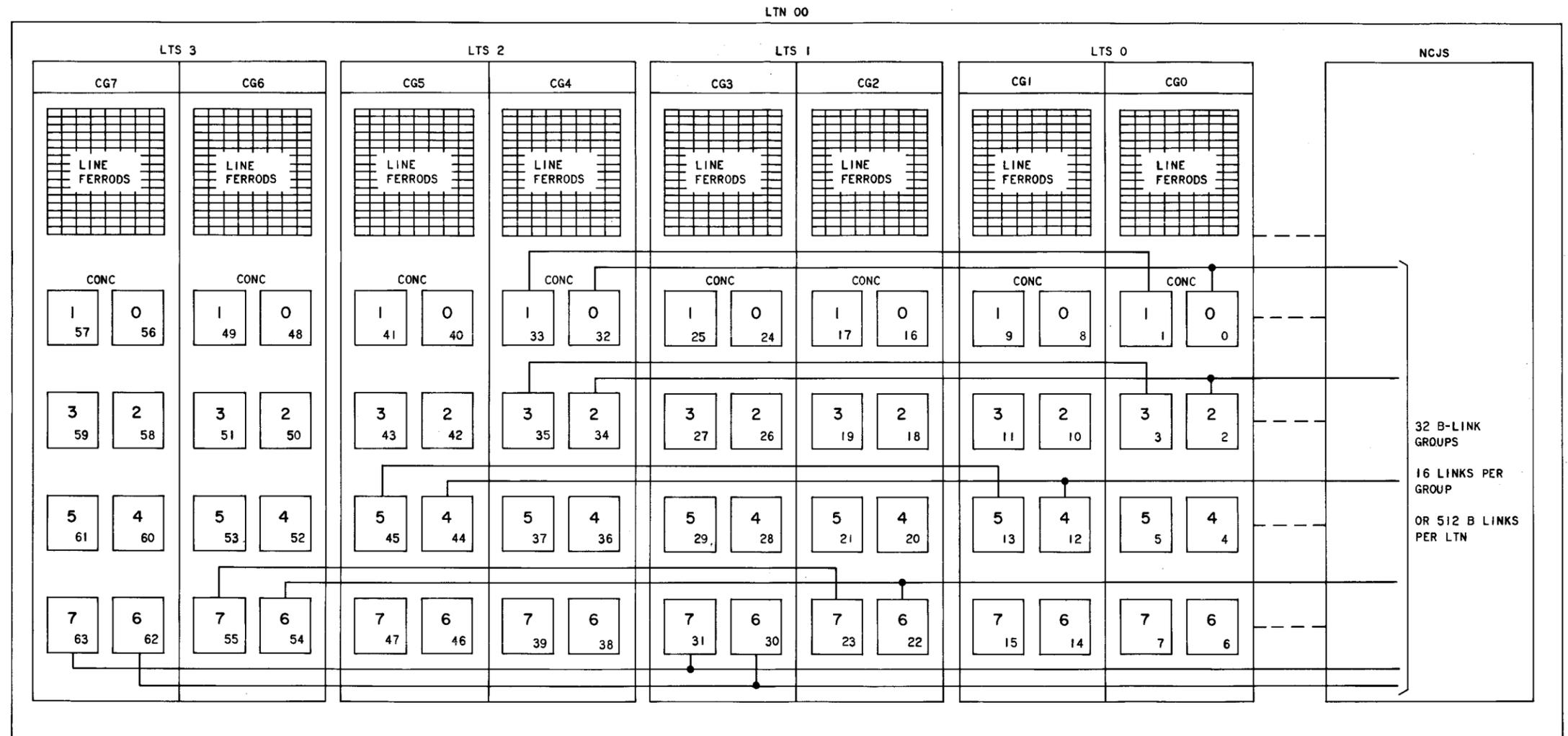


Fig. 30—Fully Equipped Line Trunk Network With 4.1 Concentration Ratio (2.60)

NO. 2 ESS
4:1 LINE TRUNK NETWORK

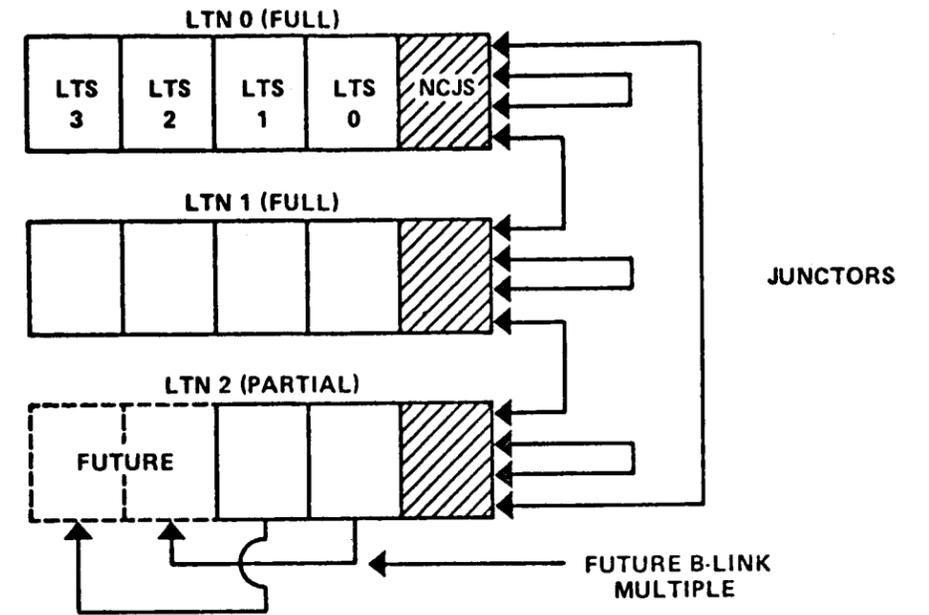


"B" LINK MULTIPLE ON A 4:1 LTN - CONCENTRATOR GROUP (CG) 0&4, 1&5, 2&6, AND 3&7 ARE MULTIPLIED;
WITH THE CONCENTRATORS WITHIN THE GROUPS MULTIPLIED 0 TO 0, 1 TO 1 ETC.

Fig. 31—Block Diagram of 4:1 Line Trunk Network (2.60)

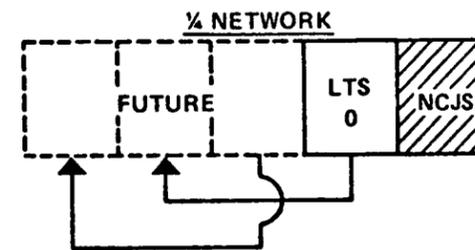
LOADING CONSIDERATIONS FOR PARTIAL LTN'S

4:1 Concentration (Last LTN — 1/2 a Network)

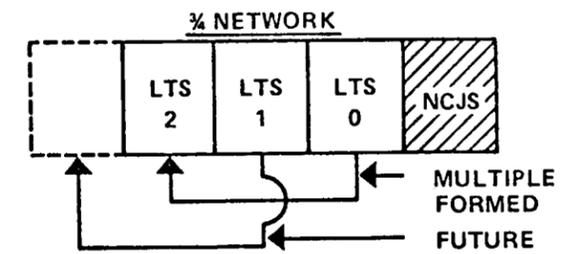


Junctors are engineered assuming CCS is spread evenly across all LTN's and in proportion to whether a full or partial network. Therefore, you can't load the partial LTN to carry the same CCS as LTN 0 & 1. The B-link groups in LTN 0 & 1 (full LTN's) can carry max. 230 CCS (7372 CCS ÷ 32 B-link GPS = 230). The B-link groups associated with LTS 0 & 1 in LTN 2 (partial) can carry 115 CCS since the junctors were engineered assuming it would carry half the load.

OTHER EXAMPLES OF PARTIAL LTN:



B-link groups associated with LTS 0 can carry a Max. of 115 CCS.



B-link groups associated with LTS 0 and 2 could carry a Max. of 230 while B-link groups associated with LTS 1 could carry Max. 115 CCS.

Fig. 32—Loading Considerations for Partial Line Trunk Networks (2.61)

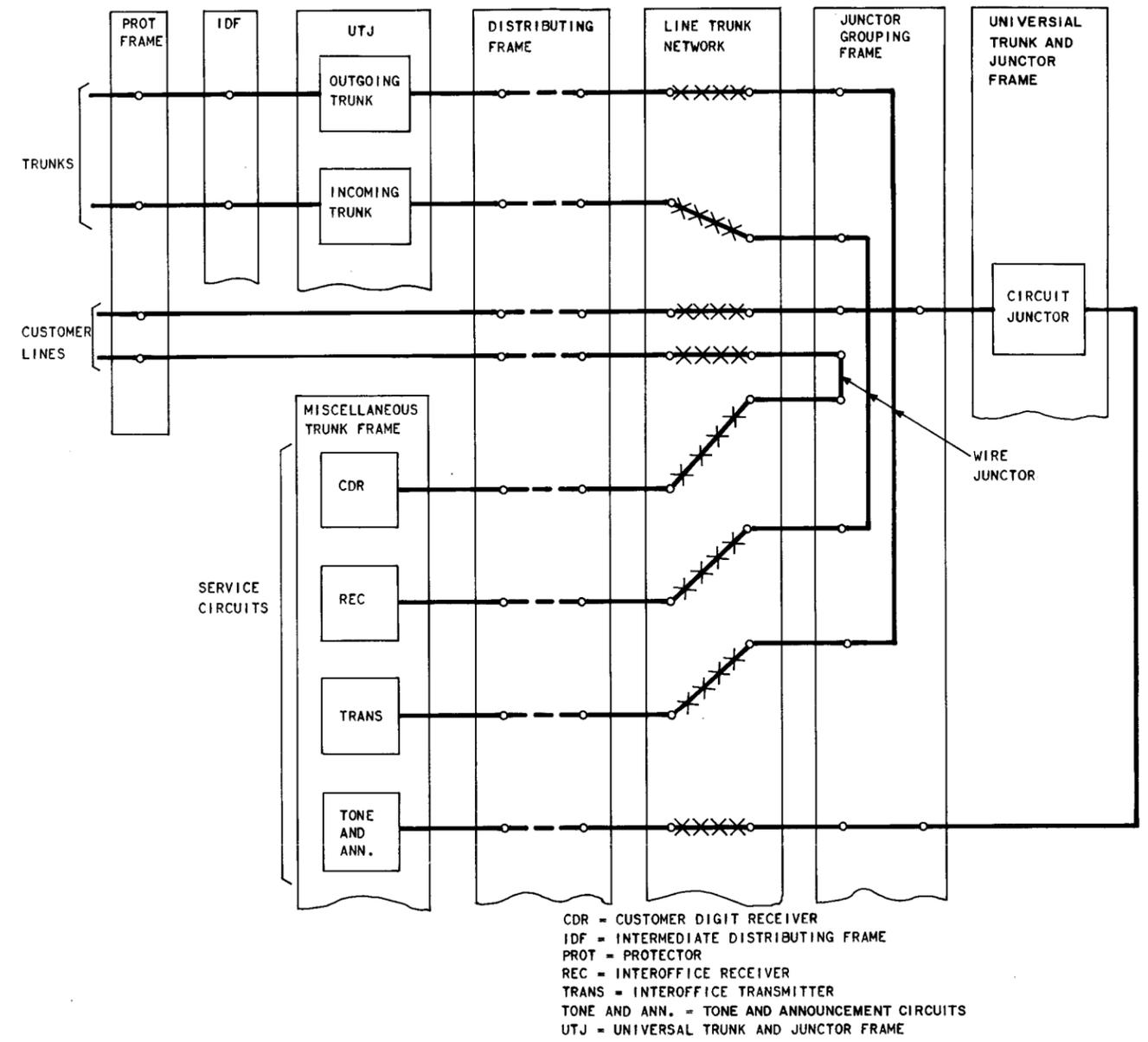


Fig. 33—Relationship of Service Circuits to Lines, Trunks, Junctors and the Switching Network (2.70)

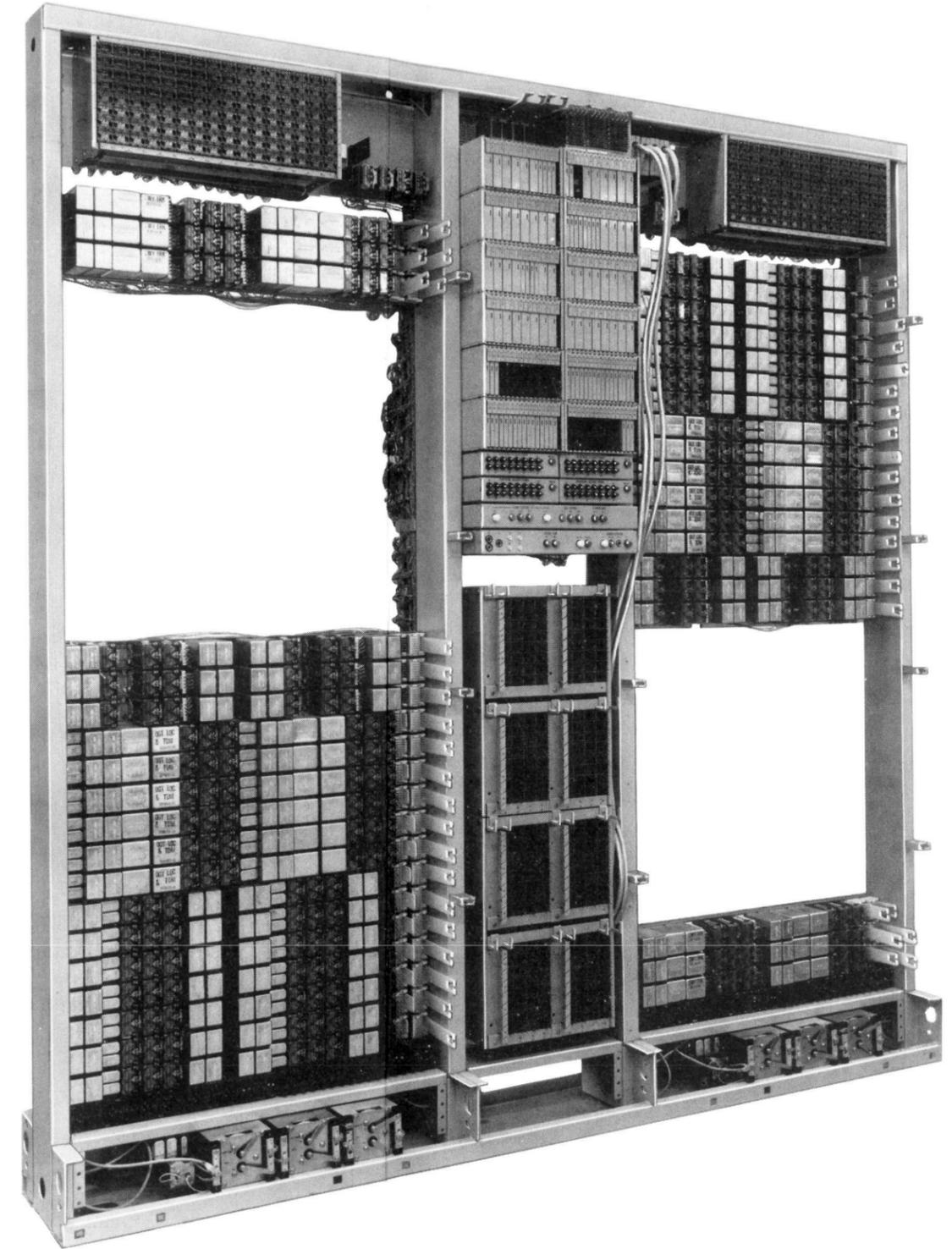


Fig. 34—Universal Trunk and Junctor Trunk (2.79, 2.82)

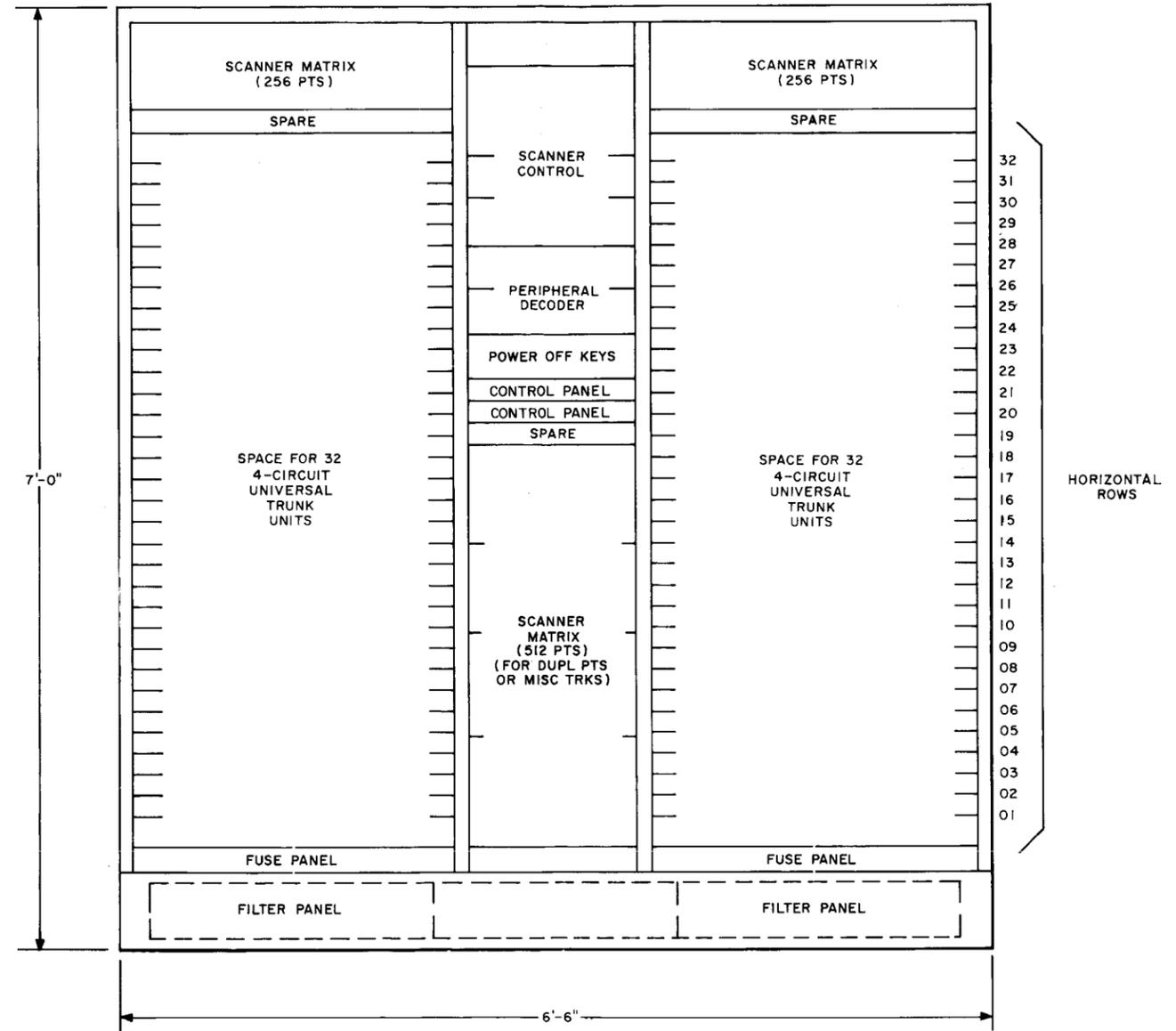


Fig. 35—Diagram of Universal Trunk and Junctor Home Master Scanner Frame (2.79)

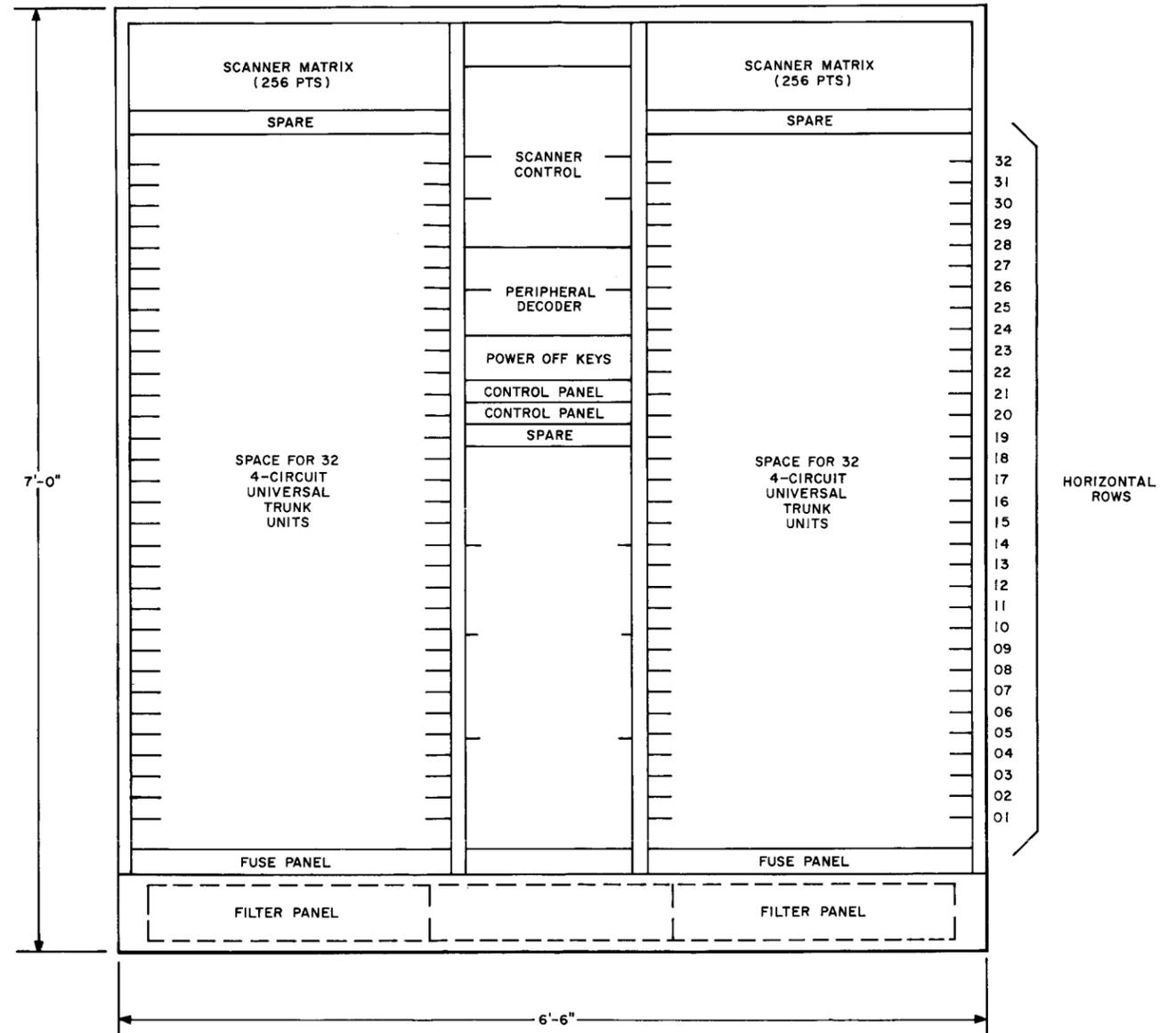


Fig. 36—Diagram of Universal Trunk and Junctor Home Frame (2.79)

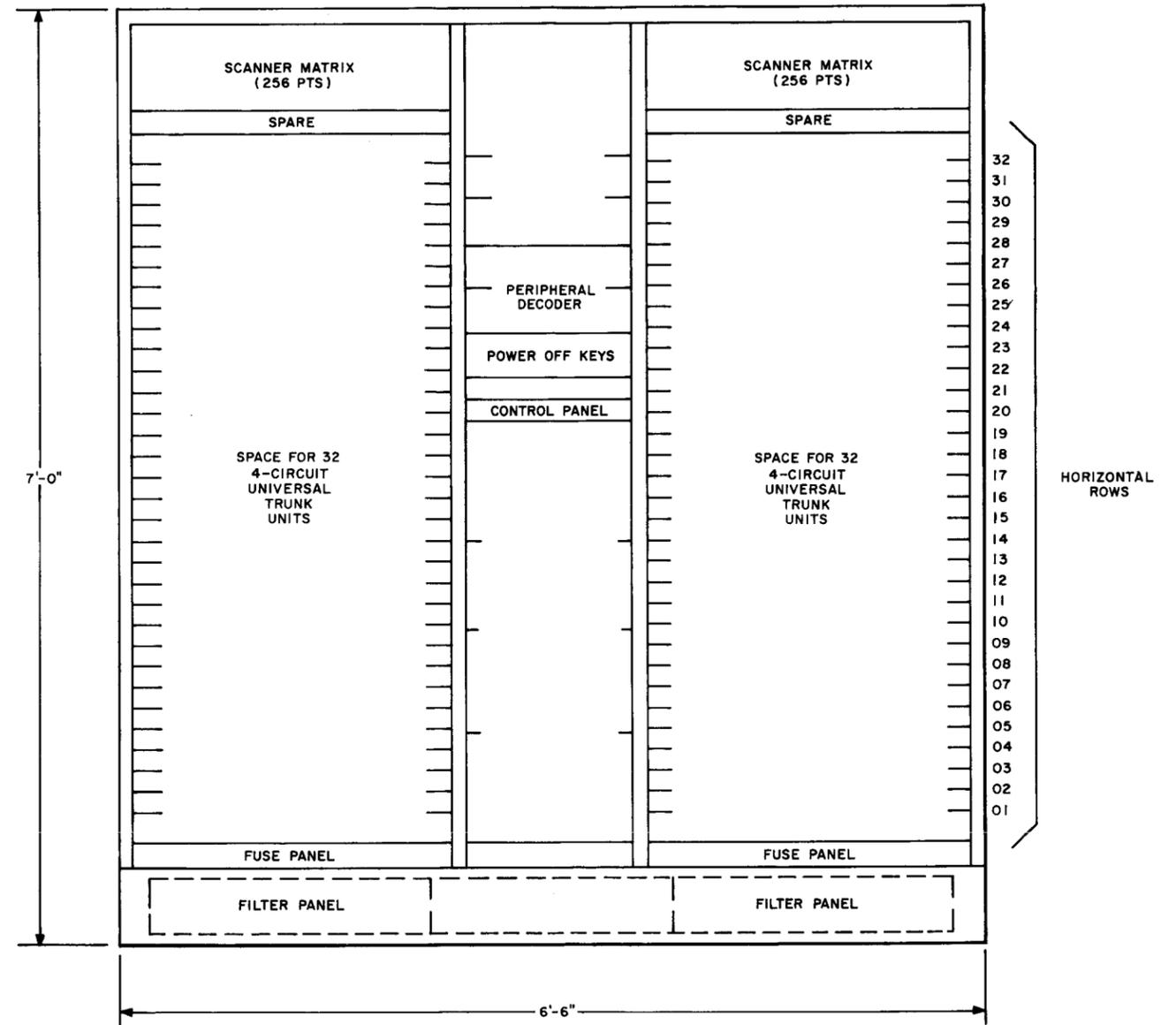


Fig. 37—Diagram of Universal Trunk and Junctor Mate Frame (2.79)

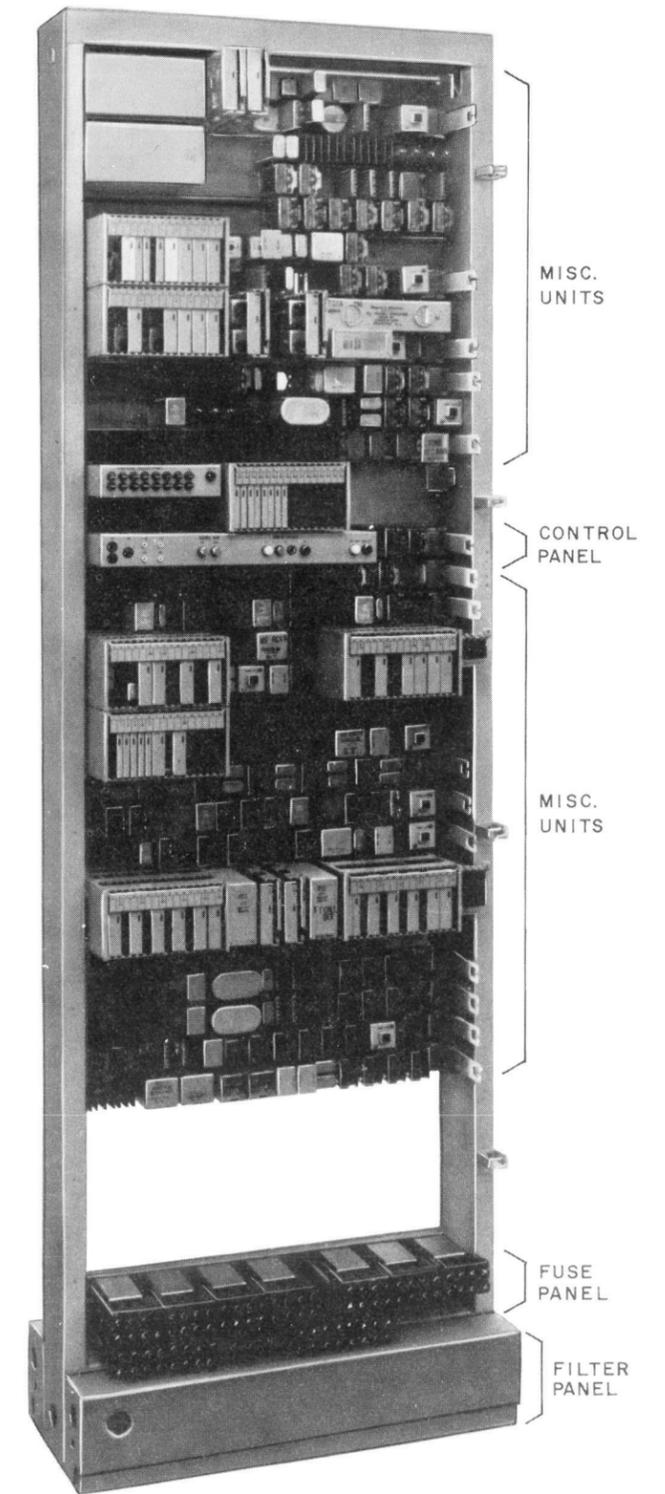


Fig. 38—Miscellaneous Trunk Frame (2.80)

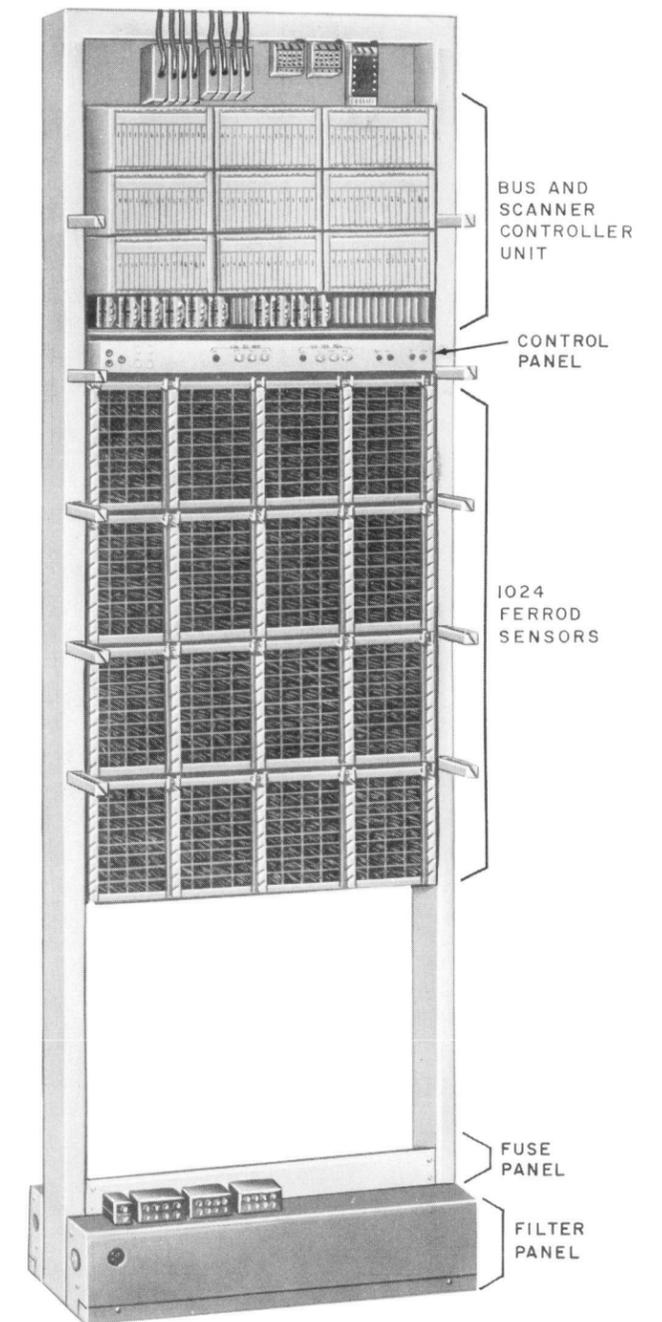


Fig. 39—Master Scanner Frame (2.82)

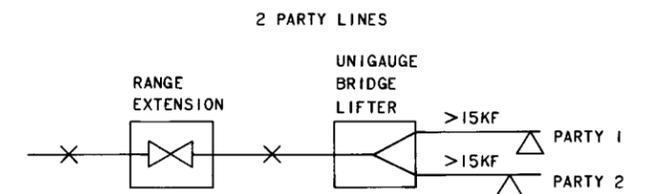
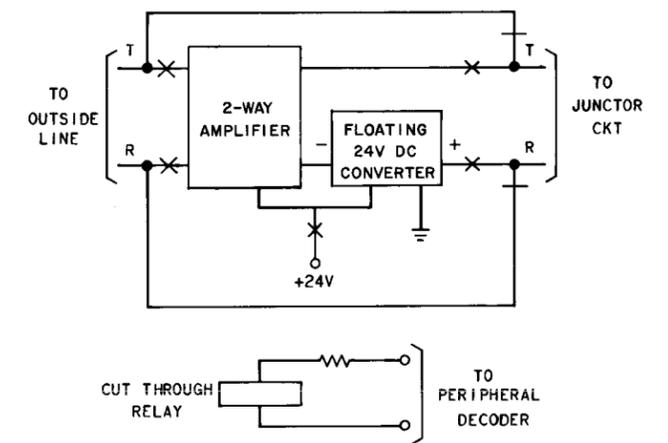
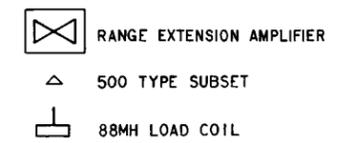
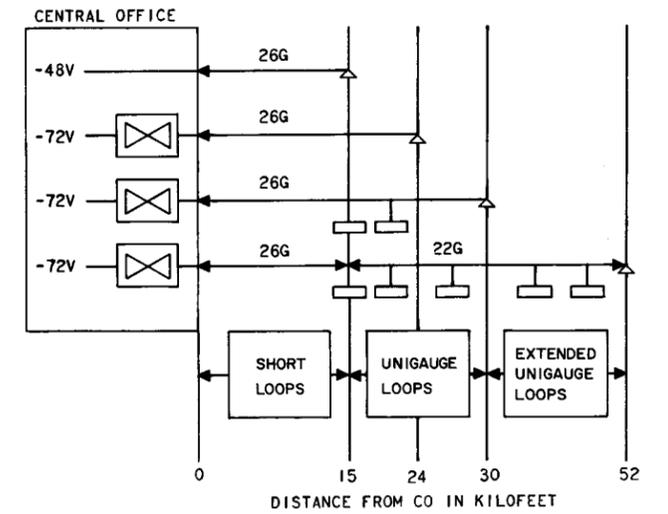


Fig. 40—Uniguage and Range Extension (2.84)

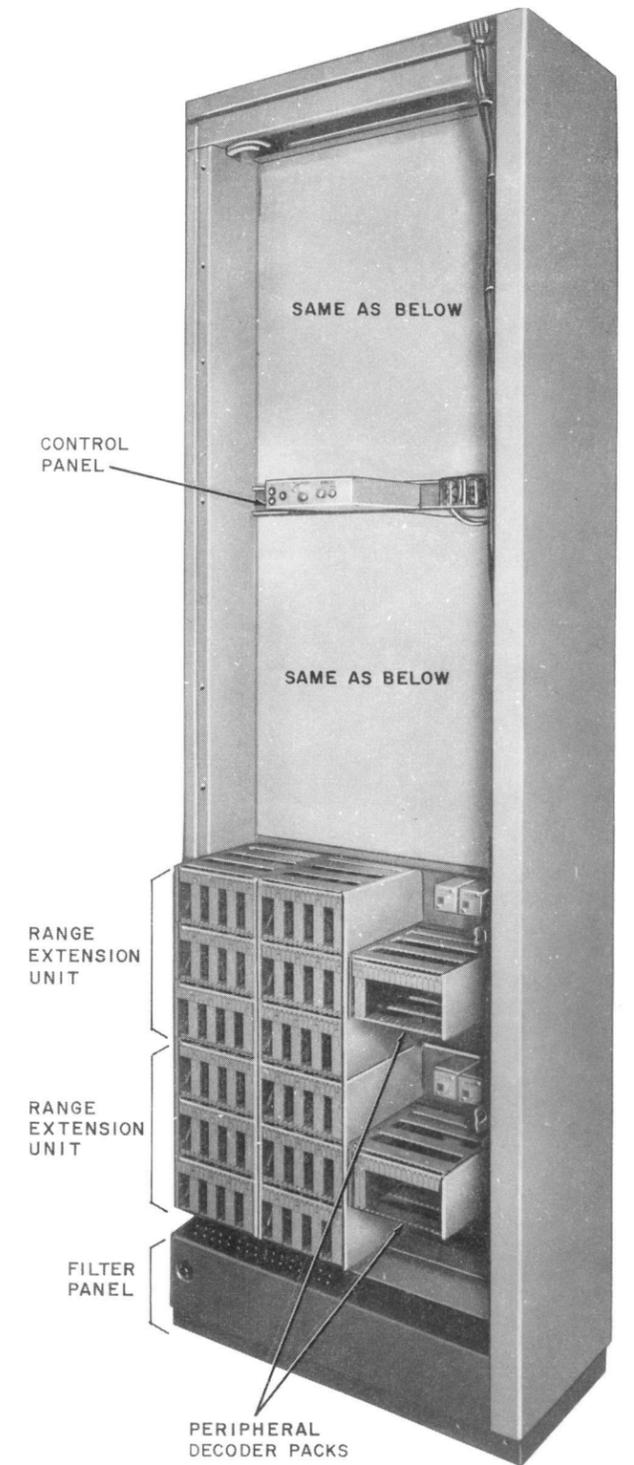
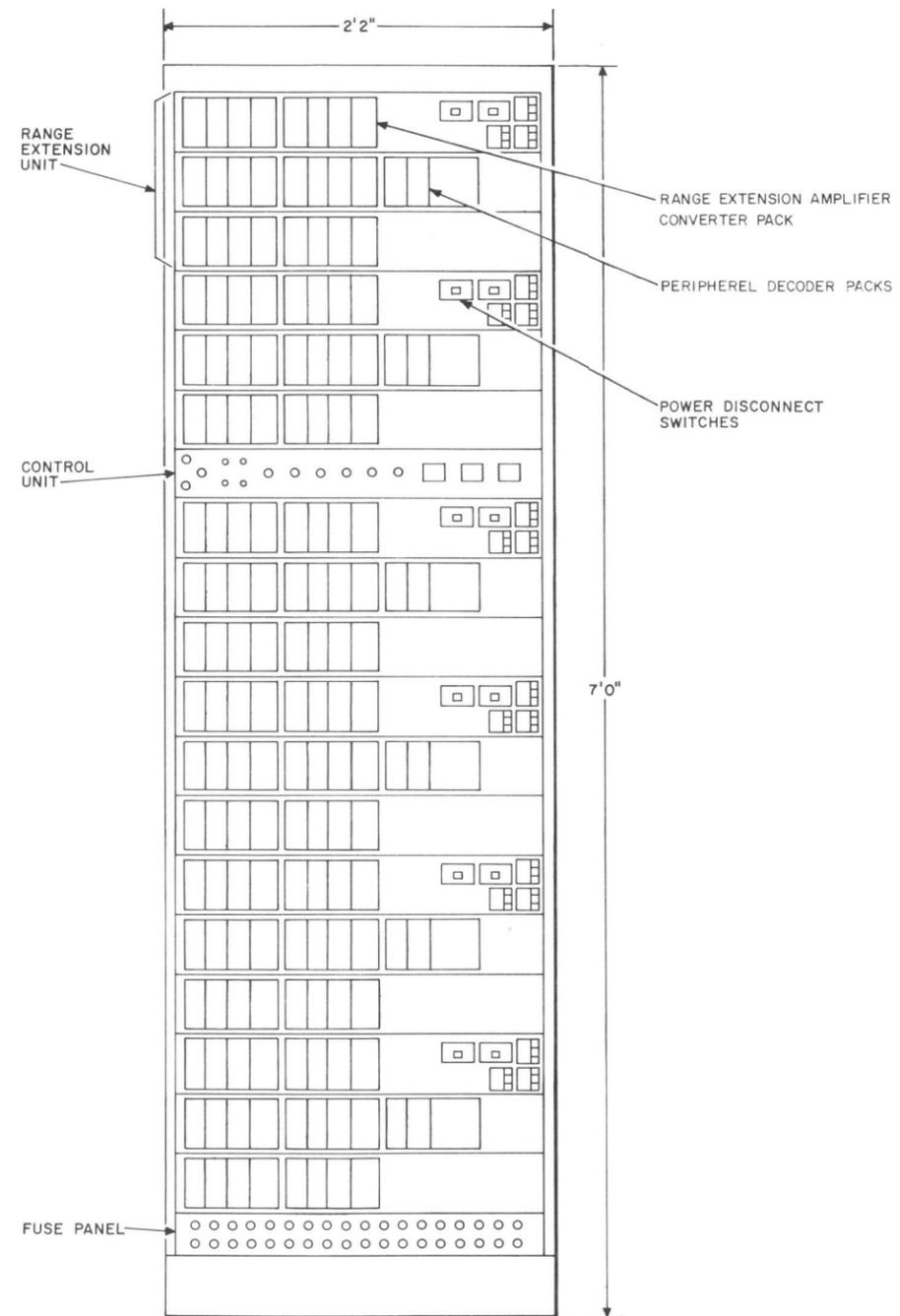


Fig. 41—Range Extension Frame (2.85)

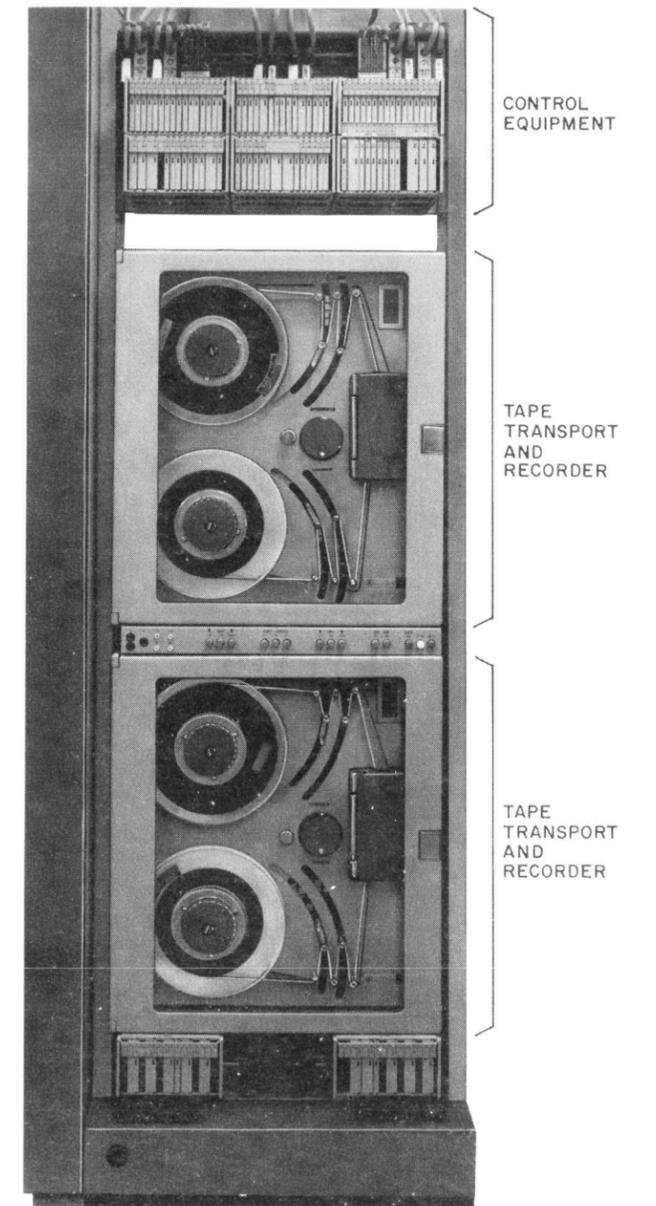


Fig. 42—Automatic Message According Frame (2.88)

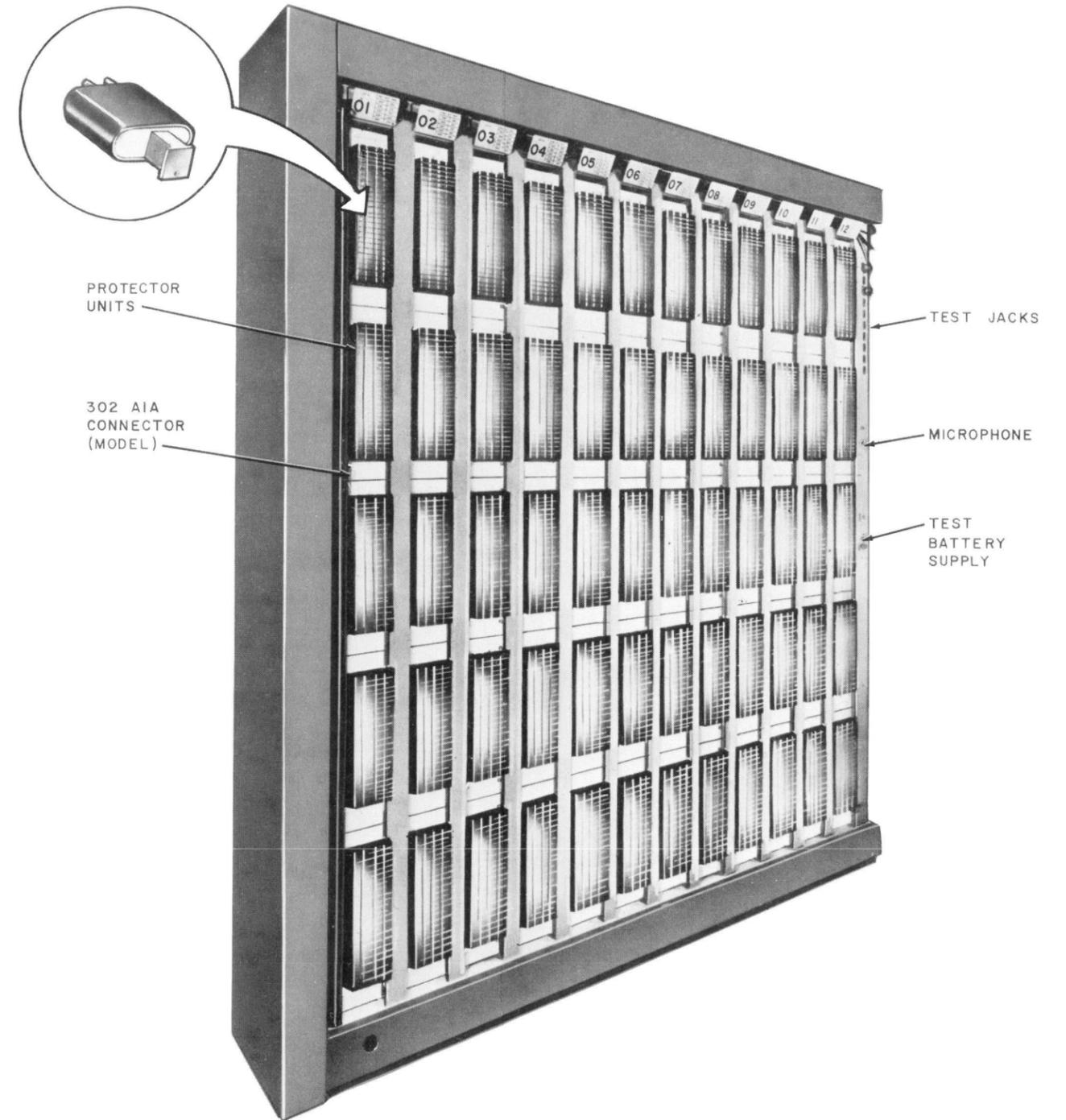


Fig. 43—Single Sided Protector Frame (2.92)

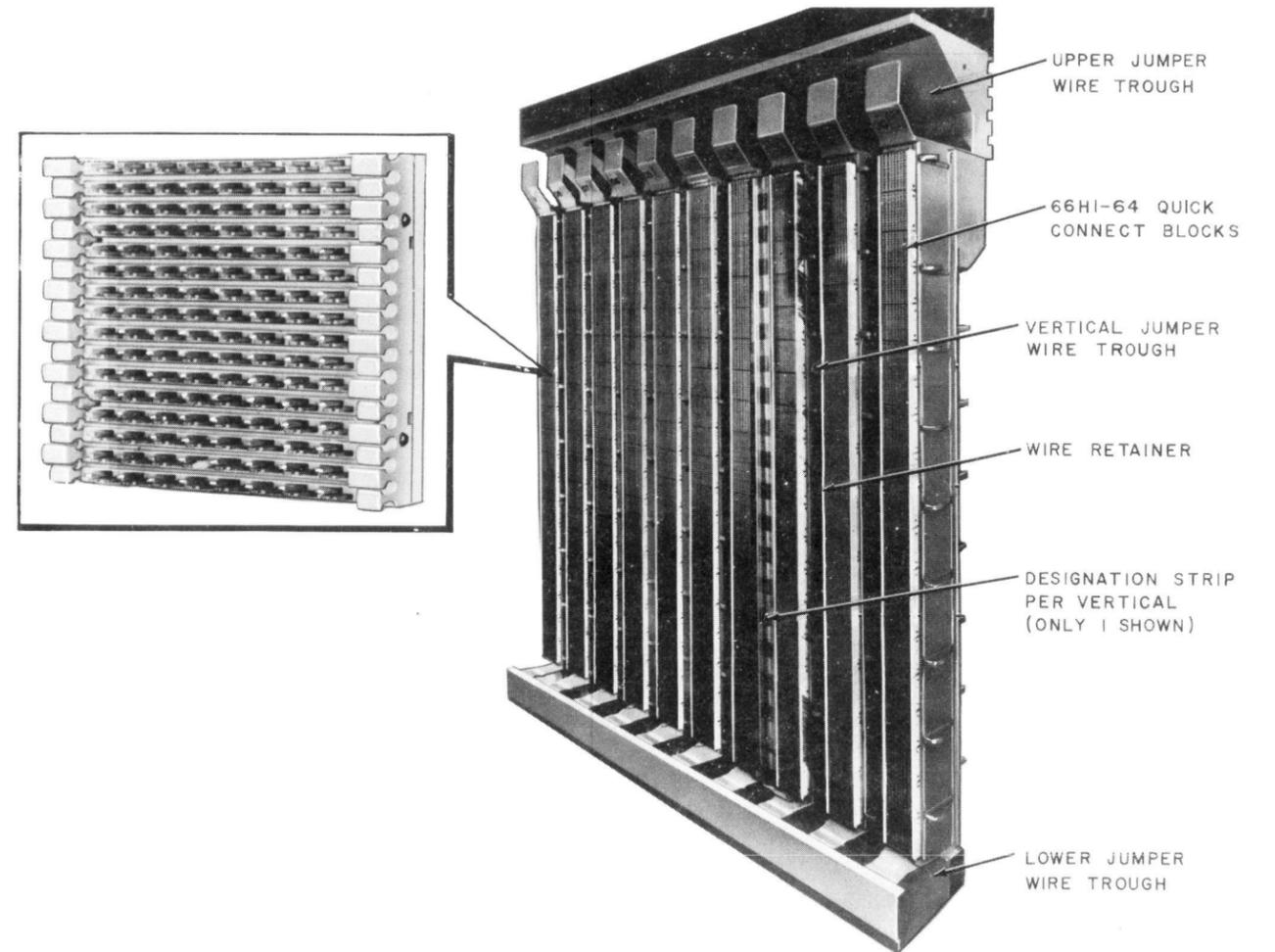


Fig. 44—Combined Distributing Frame (2.93)

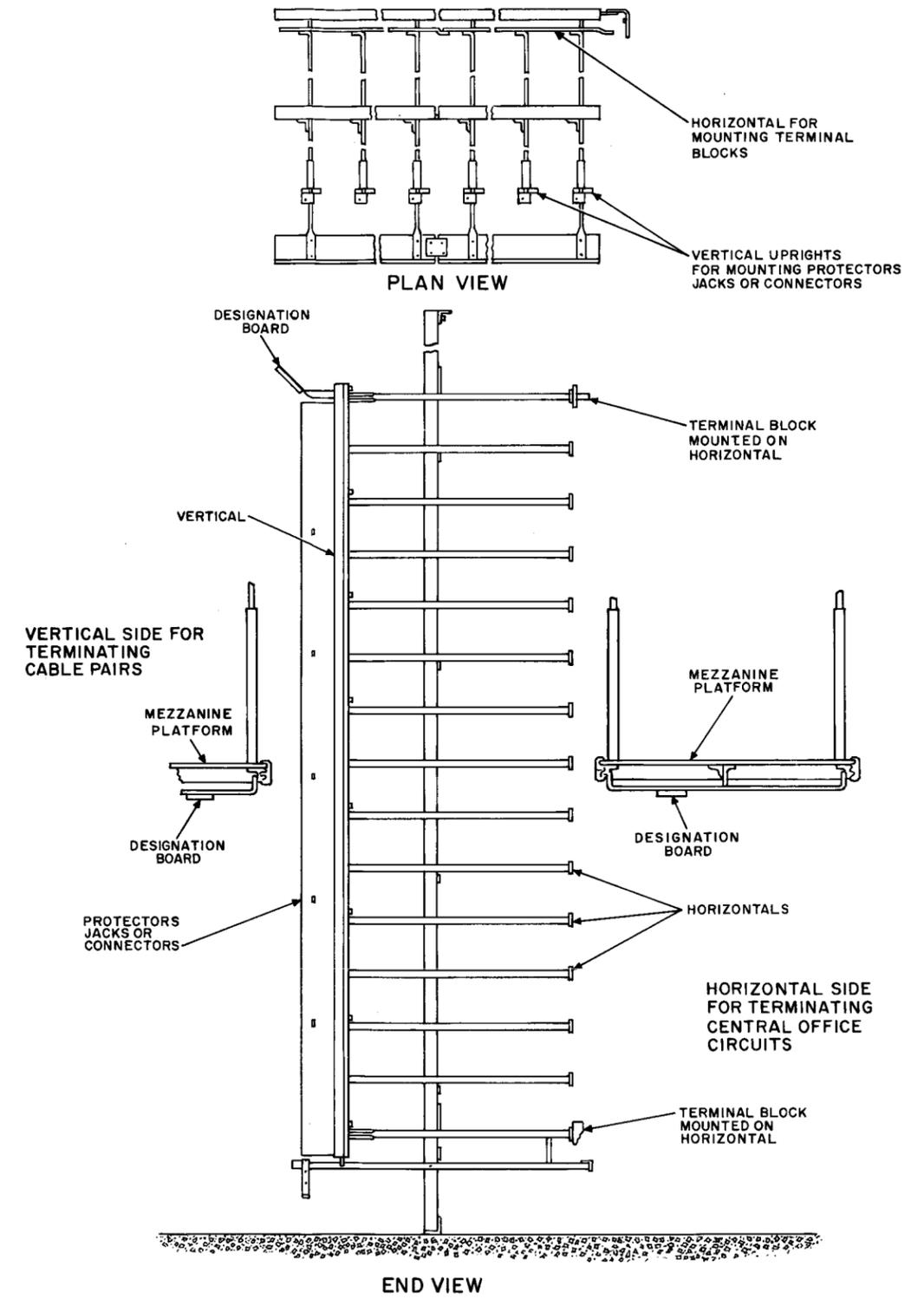


Fig. 45—Diagram of Standard Main Distributing Frame (2.94)

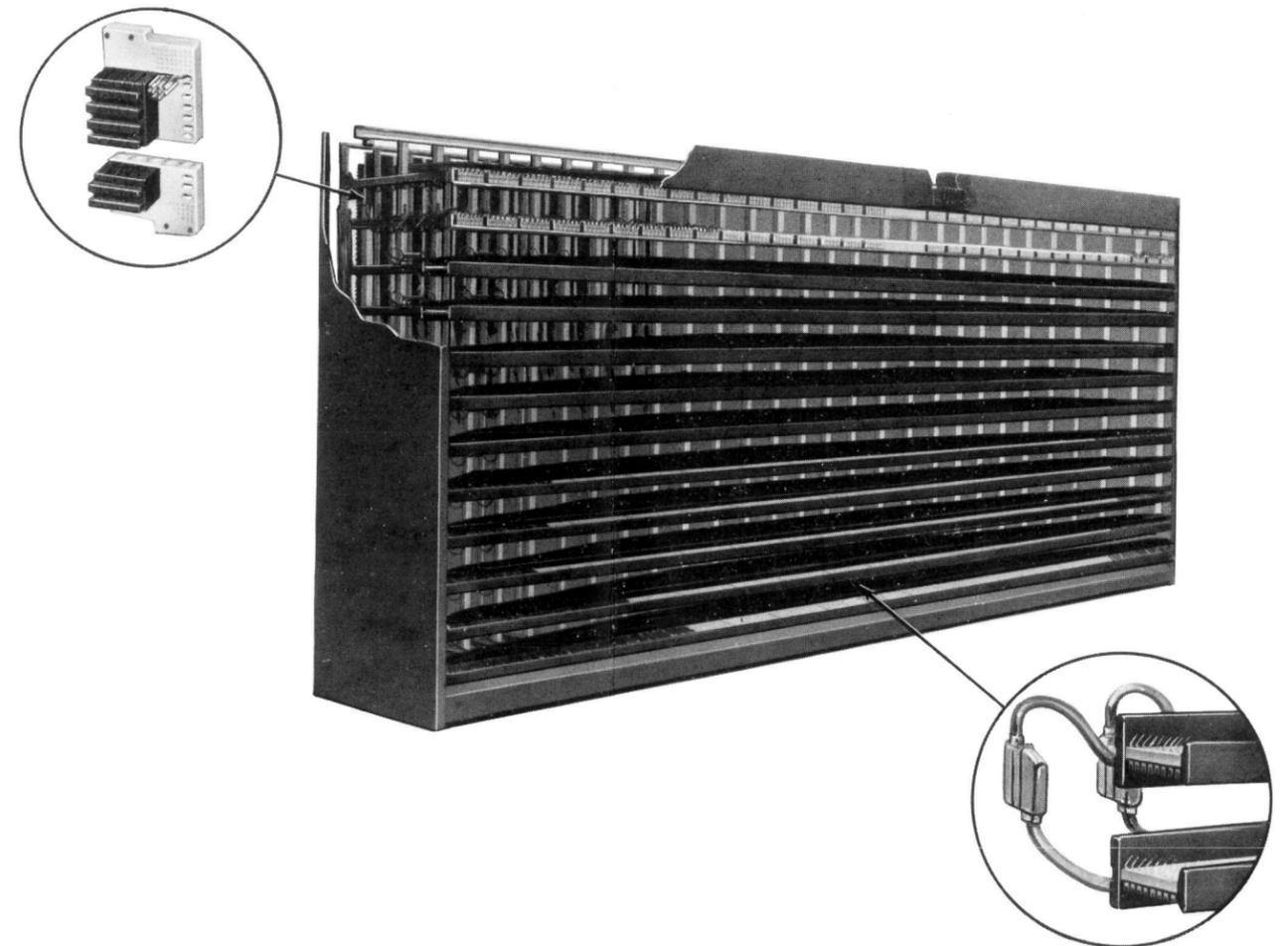


Fig. 46—Combined Distributing Frame for No. 2A ESS
(2.95)