4-WIRE NO. 1 ELECTRONIC SWITCHING SYSTEM

GENERAL DESCRIPTION

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1. GENERAL

1.01 This section contains a general description of the 4-Wire No. 1 Electronic Switching System (ESS) having generic program AV-5, and AV-176-5.

1.02 This section is reissued to include a system configuration using PG-2A010 (AV-5) and PG-2A011 (AV-176-5) generic programs.

1.03 The 4-wire No. 1 ESS is an automatic common control type switching system directed by a stored program. It differs greatly from electromechanical switching systems in the devices that are employed as well as in the call handling techniques that are used. This system makes extensive use of solid-state devices with fast operating speeds which permit a relatively small amount of equipment to perform the control functions. System intelligence, control, and actions are determined by a program stored in a semipermanent memory and in a temporary memory. Variations and changes are normally accomplished by changing the stored program rather than by changing the apparatus and the wired logic.

1.04 The stored program information varies to accommodate the quantities and types of equipment in a particular switching center; however, the basic ESS equipment remains unchanged.

1.05 The basic switching system is used at switching centers in a 4-wire communication network, with capability of interconnection with 2-wire and/or 4-wire communication networks. The 4-wire ESS is capable of switching voice mode services including teletypewriter (TTY) and data up to 2400 bits per second.

1.06 The switching system is capable of terminating approximately 16,000 lines and/or trunks.

1.07 The 4-wire ESS office is capable of receiving and originating the standard dial pulse, TOUCH-TONE®, single frequency, and multifrequency signals used for signaling in the Bell System.

SYSTEM TECHNIQUES

1.08 Some of the basic system techniques in the ESS are as follows:

- Stored program control

- Functional concentration

- Time-shared control

- Modular design

- Plug-in equipment units

- Duplication

- Automatic fault location and system reconfiguration.

1.09 *Stored Program Control:* The functions to be performed by the system are specified by programs consisting of appropriate combinations of precisely defined instructions. Examples of such program instructions are as follows: observe the state of a specified group of lines, add two specified quantities, and observe the sign of a specified quantity and decide accordingly which of the two alternatives to follow. The program instructions are stored in a memory unit 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 any circuit modifications.

1.10 *Functional Concentration:* The system equipment is concentrated in a small number of highly efficient units, each specialized in a broad system function such as control, input, output, and memory. The result is an overall equipment organization that is simple in concept.

1.11 *Time-Shared Control:* A single control unit directs the operation of all other system units in accordance with the program instructions. Using electronic devices this control unit can operate

at speeds much faster than the rate at which events associated with a single call occur. Consequently, the control equipment is time shared by all calls handled by the system. This is accomplished by subdividing the work required to process a call into small segments and by interweaving these segments with those associated with other calls. In addition, certain operations can be performed concurrently on behalf of a number of calls.

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

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

1.14 *Duplication:* Both halves of the duplicated system process the same data simultaneously. If a malfunction is detected, the faulty unit is switched out of service.

1.15 *Automatic Fault Location and System Reconfiguration:* The ESS performs a large number of checks looking for system troubles (diagnostics). It is possible with a checking scheme for the system to detect the existence of a malfunction, to identify (automatically) the malfunctioning unit, to take the unit out of service, to diagnose it, and to provide notification that a malfunction has occurred by printing the results of the diagnostic test. The ESS is programmed for automatic transmission measuring (ATMS).

SYSTEM FEATURES

1.16 The following features are available in the 4-wire No. 1 ESS:

- 2-digit speed calling
- Off-hook service
- Series completion
- List hunt
- Add-on flash
- Voice recorder add-on

- Public address system
- 2-digit intercom
- Multiline hunting
- Compressed dialing code
- Multihomed station
- Traffic measurements
- Automatic traffic overload protection
- Manual line load control
- Automatic transmission measuring (ATMS)
- Operator functions (dial zero)
- Echo suppressor control
- Dialable grade
- Nonbarge-in announcement
- Precedence and preemption
- Broadcast call
- Customer trouble reporting
- Polygrid routing
- 4-digit Centrex
- Multiaddress call
- Direct station selection.

1.17 *2-Digit Speed Calling:* A customer who has a class of service specifying the 2-digit speed calling feature is allowed to reach a list with a maximum of 80 seven- or ten-digit directory numbers (DNs) by keying a two-digit code followed by the special TOUCH-TONE punctuation digit A. This feature is independent of, and in addition to, the normal dialing privileges. There may be many such lists in an office, any one of which may be assigned to a particular station or shared among stations. Each entry in each list is made up of a DN (seven or ten digits), a preset precedence digit (to be used only when none is dialed by the station), a preset grade indication (to be used only when

none is dialed by the stations), and a preset crossover code (Federal Telecommunication System, direct distance dialing, or voice recorder for those offices having these capabilities).

1.18 *Off-Hook Service:* This feature involves two stations: a master station and a slave station. When either station goes off-hook, it is automatically switched to the other station through the ESS office.

1.19 *Series Completion:* This feature is a list of consecutive DNs that are hunted in sequence by the ESS when the terminating DN is found busy. This list cannot exceed nine numbers.

1.20 *List Hunt:* The DNs in a list hunt list are hunted by the ESS in the order that they are listed. There is not a minimum or maximum number of DNs in a list hunt list; however, all of the DNs except the last DN in the list must home on the same office. The last member of the list may have a 7- or a 10-digit DN.

1.21 *Add-On Flash:* This feature allows a station user to add another station to an existing incoming call for a 3-party conference without attendant assistance.

1.22 *Voice Recorder Add-On:* This feature can be preassigned to a line (a recorder connected for each call originated) or a dialed service (a prefixed digit 14 code dialed to clamp a recorder on the line).

1.23 *Public Address System:* This feature allows access by authorized stations to a public address system.

1.24 *2-Digit Intercom:* This special feature is a type of expanded abbreviated dial list that can be used within a 4-wire office to give a 2-digit dialing capability to a maximum of 80 lines. 80 lines are included in the list even though they may not all be assigned. They can not originate calls to or receive calls from outside their group. No operator service is provided. Lines in this group cannot be equipped with any other system features.

1.25 *Multiline Hunting:* A multiline hunting list is used to list all multiline customers. Multiline hunting groups (MLHGs) are characterized by having one DN associated with many lines. Beginning with the next number in the group, a call to the DN hunts through the lines until an idle line is found. These lines can be terminated at a switchboard, such as a manual PBX or telephone sets. Lines in an MLHG can also have nonhunting DNs assigned to them.

1.26 *Compressed Dialing Code:* A station with a high-speed send/receive set (HSSR) can place calls to a group of stations similarly equipped by dialing an abbreviated code. This feature is used with automatic data calls only.

1.27 *Multihomed Station:* This is a station which has a line appearance in two or more switching centers via a dual access switch.

1.28 *Traffic Measurements:* The ESS stores and prints out many traffic counts, such as the number of originating calls, the number of incoming calls, the trunk switch frame grid usage counts, etc. The traffic information is printed out on a routine schedule; however, the information can be requested with TTY input messages.

1.29 *Automatic Traffic Overload Protection:* Automatic traffic overload protection (ATOP) is accomplished by limiting the number of originations processed in a given interval. As the program cycle time grows beyond a certain threshold, the number of originations that the program processes is decreased. A TTY message and a lamp (ATOP) at the master control center (MCC) provide the information that this number has been decreased. As the program cycle time decreases, the number of origination is correspondingly increased. When, in a given interval, more customers than can be processed originate, dial tone is delayed to one or more of the stations. The program gives preferential treatment to stations with higher line load control classes so that any dial tone delay would occur for stations with lower line load control classes.

1.30 *Manual Line Load Control:* Line load control denies originating service to particular classes of lines. Lines are divided into five line load control classes. Line load control is activated and deactivated in increasing and decreasing steps by a set of keys at the MCC or by remote inputs. Lamps at the MCC indicate which class of line load control is active and how it was activated (local or remote control). TTY messages indicate each change in line load control. When a line is under line load control, the line is denied originating service but calls may still terminate to it.

1.31 *Automatic Transmission Measuring System:*
The Automatic Transmission Measuring System (ATMS) provides automatic or manual loss and noise testing of 2-way code 105 marked interoffice trunks. The ATMS feature includes the program and translations required to select a trunk for testing, activate ATMS hardware, and print test results. Failing trunk group members will be removed from service as determined by office parameters.

1.32 *Operator Functions (Dial Zero):* The ESS program provides for outpulsing and receiving 0 on intercenter trunks for dial 0 calls routed to a remote operator. It also provides for operator tandem rering for dial 0 calls when the station switchhook is flashed.

1.33 *Echo Suppressor Control:* The ESS program is capable of controlling echo suppressors which may be line associated or trunk associated in any given office. When a 2-wire line or PBX is connected to an intercenter trunk or to any other circuit capable of extending the call to an intercenter trunk (such as an operator or a conference bridge port), an echo suppressor is enabled. The program leaves echo suppressors disabled for special grade calls.

1.34 *Dialable Grade:* Any station who is normally special grade can dial voice grade by prefixing the address digits with 10. This overrides the fact that the station is normally special grade and overrides any prestored grade indication in the speed calling list. Also any station who is normally voice grade and is authorized may get special grade by prefixing the address digits with 11.

1.35 *Nonbarge-In Announcement:* The system provides nonbarge-in announcements. A station who is routed to a recorded announcement trunk receives audible ring until the announcement channel reaches the beginning of the recording. Then the announcement is cut through to the station.

1.36 *Precedence and Preemption:* Five classes of priority (0 through 4) are given to lines so that they can originate a call, when all lines and trunks are busy, by preempting a lower class of call. The ESS program provides for preemption of a call originator or terminator or an intercenter trunk while in the alerting state or the talking state.

1.37 *Broadcast Call:* This is an automatic call from a specified originator to a preset list of stations. The call may be established at any precedence level. These stations are all equipped with high-speed send/receive (HSSR) equipment.

1.38 *Customer Trouble Reporting:* Troubles can be reported by dialing 990-6161. Upon receiving this number, the ESS program routes the call to a fixed route index. Any trunk group, such as an operator trunk or a code 101 trunk, can be assigned to this route index.

1.39 *Polygrid Routing:* The polygrid switching network provides a trunk interconnection pattern for 4-wire switching centers. The switching centers are equal in rank, which means they are not hierarchically connected. The interconnection pattern provides multiple paths between each pair of centers. Routing over the trunk paths is controlled by route control digits.

1.40 *4-Digit Centrex:* Centrex line groups with 4-digit dialing are available in some 4-wire offices.

1.41 *Multiaddress Call:* The HSSR stations can originate a voice call to 50 other HSSR stations. These multiaddress calls can be placed at any precedence.

1.42 *Direct Station Selection:* Direct station selection (DSS) allows a subscriber line to reach any member of a prespecified list of sixteen 7- or 10- digit directory numbers by keying a single TOUCH-TONE digit. A DSS line can make no other calls.

2. SYSTEM DESCRIPTION

2.01 The functional blocks (Fig. 1) of the No. 1 ESS can be grouped into three divisions.

(a) System control equipment includes the central control, call store, and program store. Also included is the MCC which permits the operating personnel to communicate with and to control the system.

(b) The switching network for establishing talking paths includes the junctor grouping frame, junctor switching frame, trunk switching frame, and associated frame controls.

(c) Input-output units include the universal trunk frame, miscellaneous trunk frames (scanners and signal distributors), master scanner, and central pulse distributor.

CONTROL UNITS

A. Central Control

2.02 The central control (CC) performs most of the processing tasks for the No. 1 ESS (Fig. 2). It controls the actions of most system units and obtains instructions for call processing from the program store.

2.03 The CC is capable of performing many tasks based on the instructions from the program store; these tasks are performed one at a time. Normally the CC requests an instruction from the program store every 5.5 microseconds. The actions required by CC on any call are separated by relatively long periods of time. During these periods a particular call may require no action; therefore, actions for other calls are interspersed.

2.04 Two CCs are provided in each system: one is active while the other is standby. If the active unit fails, the system automatically switches to the standby unit. The standby unit performs a maintenance function while in the standby state. It also processes the same information as the active CC even through it does not control any outputs. The results of this processing are compared with the results of the active unit. If the matching of the results reveals that they are the same, no maintenance action is taken. If the results do not match, then the CC initiates a transfer to a fault recognition program to determine which unit is at fault. The faulty unit is then switched out of service, and the CC uses diagnostic programs to determine the location of the fault.

B. Program Store

2.05 The program store (PS) is a semipermanent memory for the ESS programs (Fig. 3). Binary information is stored on minute magnetized or demagnetized bar magnets on aluminium memory cards (Fig. 4). The PS uses a 44-bit binary word of which 37 bits are instruction and 7 bits are for error detecting and correcting. The instructions that guide the system in the performance of call-handling, trouble diagnosis, and other routines are stored in the PS. Also stored in the PS are the class of service, type of ringing, and other data on each line and trunk. To read information stored on the cards, certain addresses on the cards are specified and the bits stored at these addresses are detected or read.

2.06 The CC reads and executes a program order from the PS every few microseconds. All telephone switching actions are accomplished as a result of program-controlled actions. Many variations in equipment are avoided by having the differences in features of central offices in the stored program.

2.07 Each PS consists of 16 memory modules, each of which contains 128 memory cards. Each card stores 64 words; thus, a PS has the capacity to store 131,074 words.

2.08 Associated with the PS is the memory card writer (Fig. 5) which updates the data on memory cards used in the memory modules of the PS. The updating of the PS is controlled by a memory card writer program (a part of the complete program). In accordance with information stored in the recent change area of the call store, the memory card writer updates individual modules of PS memory cards. These modules are used to replace outdated modules in the PS.

C. Call Store

2.09 The call store (CS) provides the temporary memory for storage of information needed for calls in process (Fig. 6).

2.10 The basic storage element in the CS is the ferrite sheet (Fig. 7). These sheets are stacked in groups to form a memory module (Fig. 8). Information is stored on the ferrite sheets as follows:

- Busy-idle status of station lines, trunks, and network links

- Records of network terminations being used for each call in progress

- Digits received

- Digits to be outpulsed

- Recent change information related to station lines and trunks prior to card writing the information in the PS

● Maintenance information related to program-controlled maintenance programs.

2.11 The CS information is organized in words of 24 binary bits. A single CS has 8192 word locations, providing a total storage capacity of 196,608 binary bits.

SWITCHING NETWORK

A. Network Controllers

2.12 The network controllers give CC access to the control windings of ferreed (crosspoints) switches in the trunk and junctor switching frame (Fig. 1). A relay tree used for selecting a path through the control windings is set by CC. Then a pulser in the controller applies a pulse to the control winding.

2.13 The basic arrangement of a typical frame controller is shown in Fig. 9. The controller is enabled from a private enable bus. The enabled controller then receives an instruction from CC. This information is used by the controller to operate the path selector relays.

B. Trunk Link Network

2.14 A fully equipped trunk link network contains four junctor switching frames and four trunk switching frames. Both of these frames are divided into four blocks, each with 2-stage numbers (0 and 1). There are four paths between any given trunk and any given junctor (Fig. 10).

2.15 The CC determines the complete network path required through eight stages of switching for the processing of a call. The information for establishing the selected path is then sent to the appropriate switching frames.

C. Service Circuits

2.16 Service circuits are terminated on universal couplers (Fig. 1). A switch path is established between the circuit requesting service and the service circuit before call address transmission can begin. Service circuits include the following:

● TOUCH-TONE receivers

● TOUCH-TONE transmitters

● 2600-Hz dial pulse/wink transmitter

● Multifrequency receivers

● Multifrequency transmitters

● Dial pulse receivers

● Ringing and tone power plant

● Recorded announcement circuit.

2.17 *TOUCH-TONE Receivers:* These receivers are used to receive call processing information in the form of TOUCH-TONE signals from customer telephone sets, operator key sets, and certain data sets. This information is passed along to CC by converting the signaling frequencies into dc signals for operation of scan points. The dial and preempt notification tones are also routed through this unit. The switching of these tones is under program control.

2.18 *TOUCH-TONE Transmitters:* These are used in conjunction with the TOUCH-TONE receiver. This transmitter can outpulse in two ways: TOUCH-TONE or 2600-Hz single frequency signaling. The operation of this circuit is under program control. A TOUCH-TONE transmitter can be cross-connected to a TOUCH-TONE receiver to form a transceiver.

2.19 *2600-Hz Dial Pulse/Wink Transmitter:* This is used to outpulse information at some locations such as inward-dialing to a PBX.

2.20 *Multifrequency Receivers:* These are used in an ESS office to recognize signals from a distant office. This circuit converts the multifrequencies into dc signals for operation of scan points. A total of 15 valid frequency combinations can be received and used as digits for input data to CC to identify the customer DNs or other signals.

2.21 *Multifrequency Transmitters:* These are used to transmit call address information to a distant switching center. The CC connects a multifrequency transmitter, via the universal coupler and the 4-wire trunk link network, to the outgoing trunk. The CC then operates the frequency selecting relay to send signals.
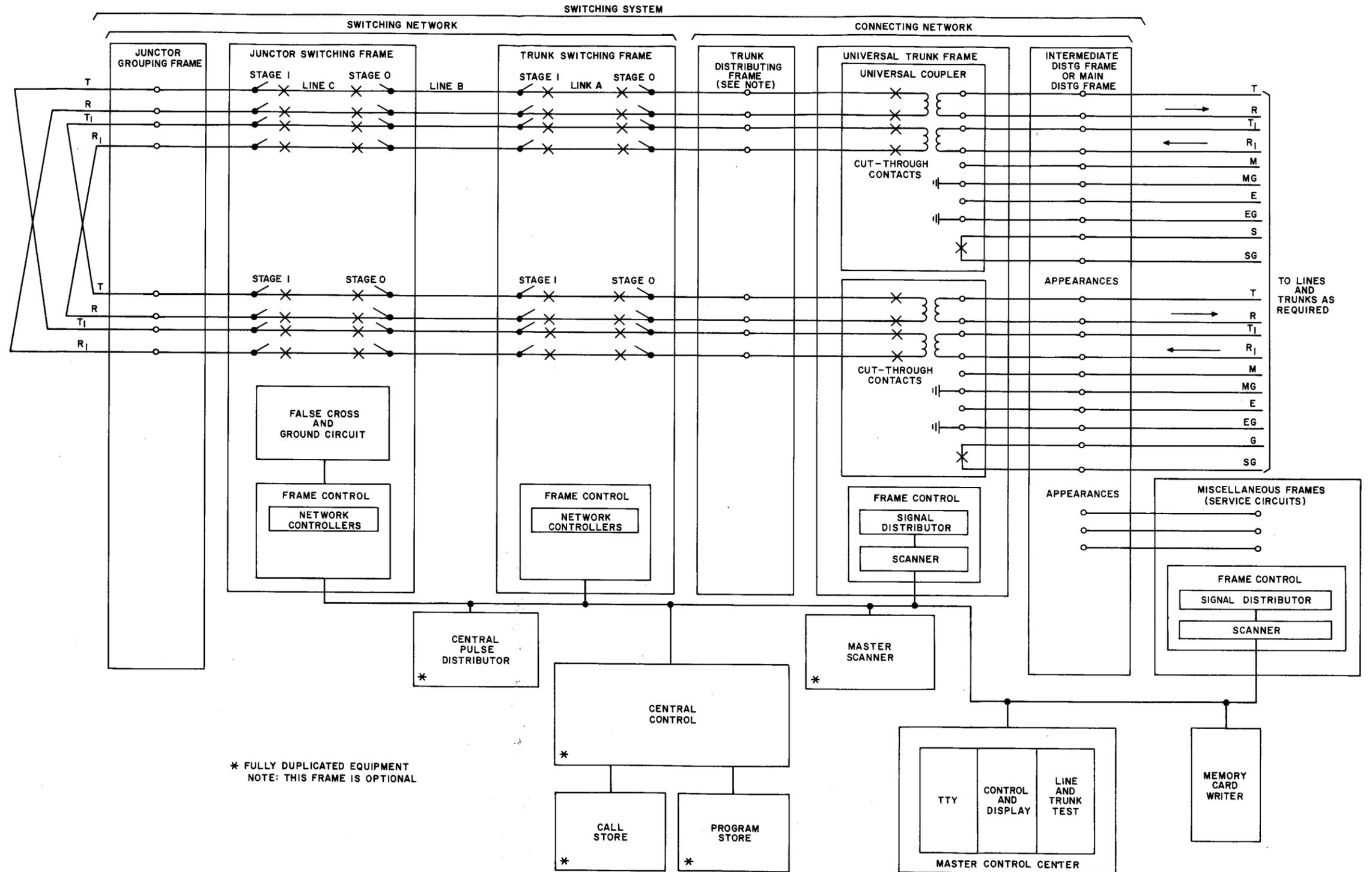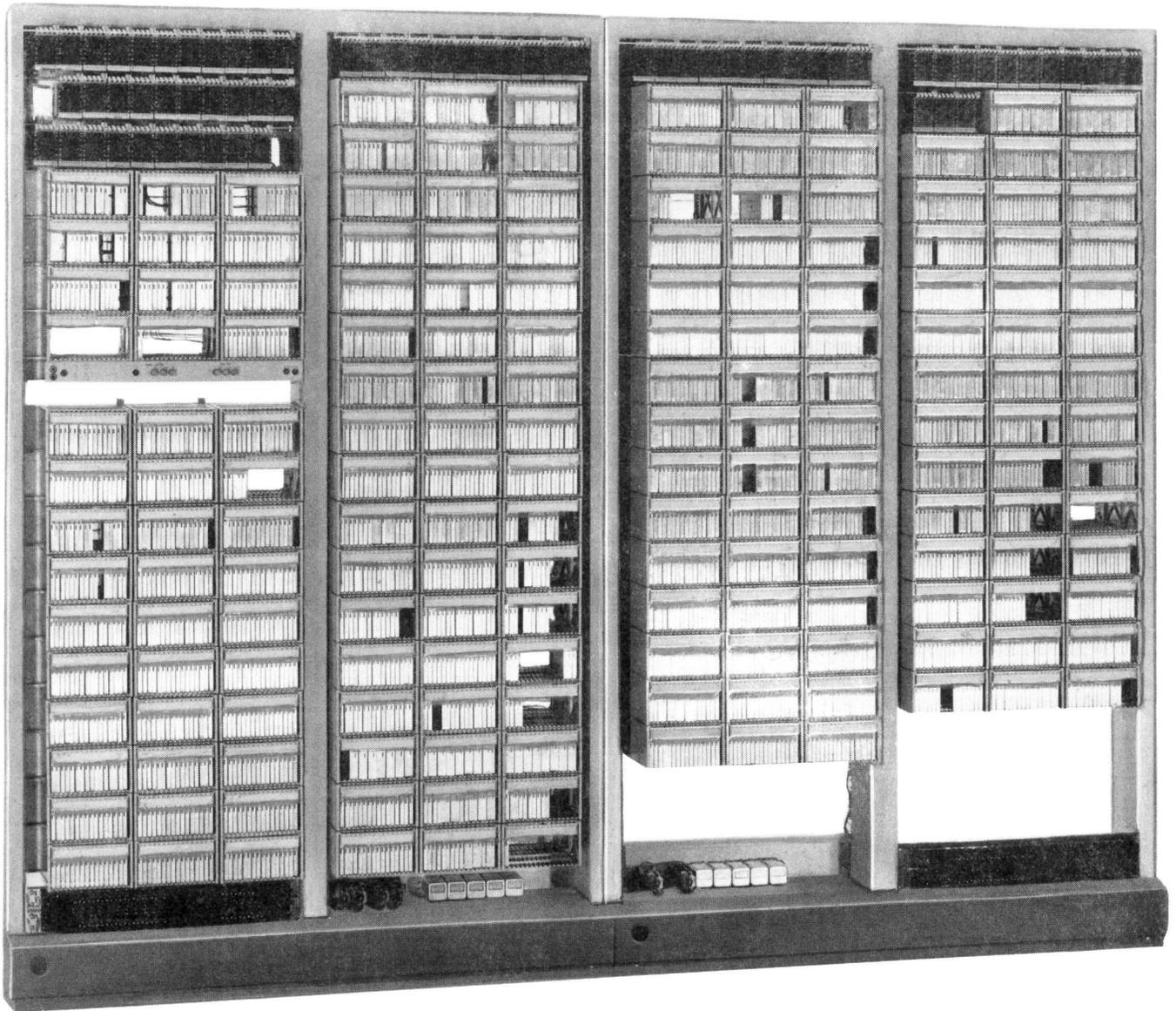
Fig. 1—System Block Diagram

Fig. 2—Central Control

2.22 *Dial Pulse Receivers (Optional Feature):*
This optional feature provides increased call processing capacity by reducing the time required in scanning for dial pulses. The new dial pulse receiver circuits are connected to existing TOUCH-TONE receiver circuits and the resultant combined circuit is used to detect either TOUCH-TONE or dial pulse signals.

2.23 *Ringing and Tone Power Plant:* The 806H plant is used to provide machine-interrupted and continuous ringing; interruption rates available are at 30, 60, and 120 per minute. This plant also provides the preempt tone, dial tone, audible ringing tone, low tone, high tone, and receiver off-hook (ROH) tone. The switching of these tones to the connecting circuits is under program control. The CC monitors and controls the starting and transfer of the load. Optional equipment arrangements at the switching center determine if these tones are switched directly to the universal coupler circuit or through other equipment to the universal coupler
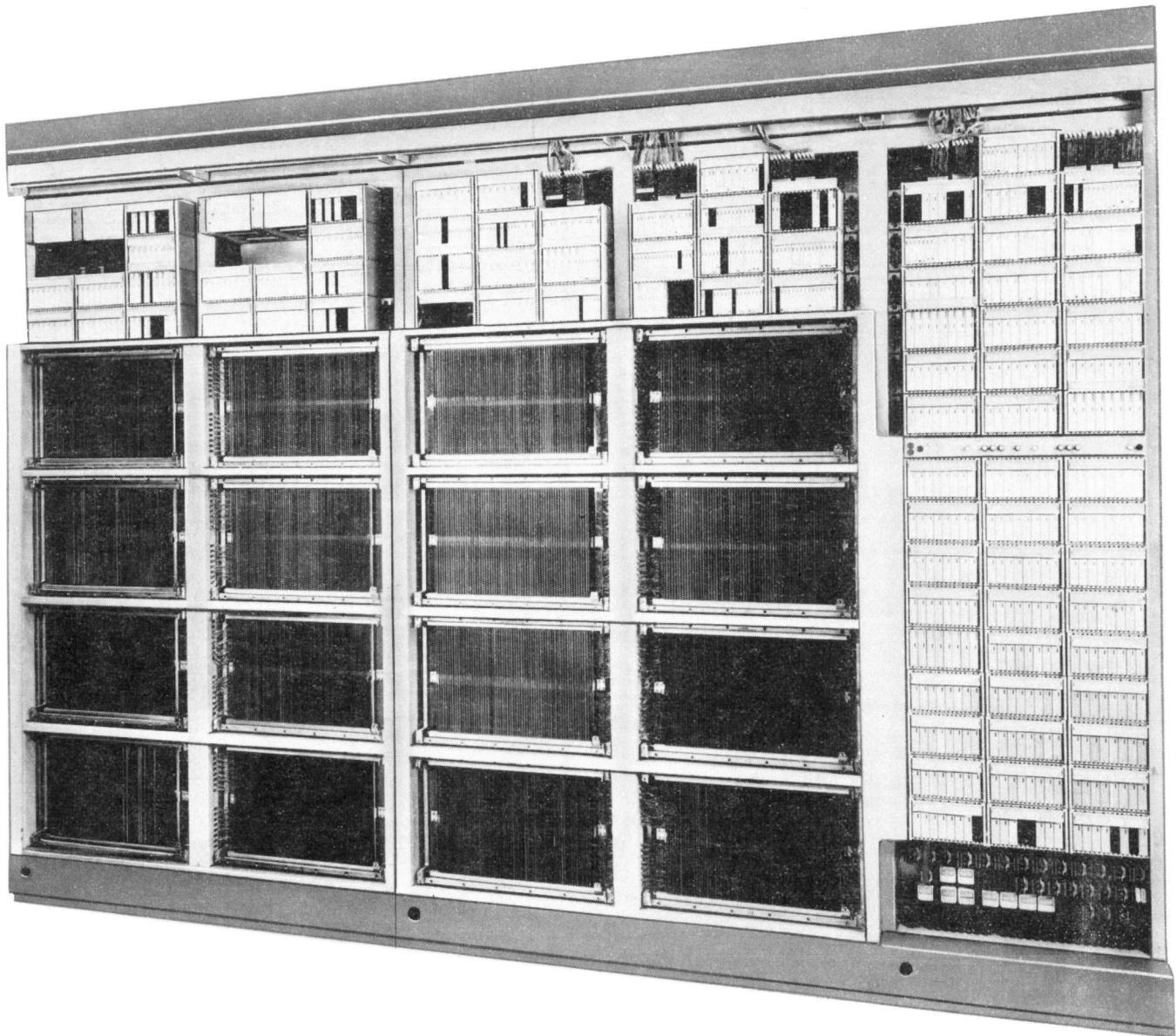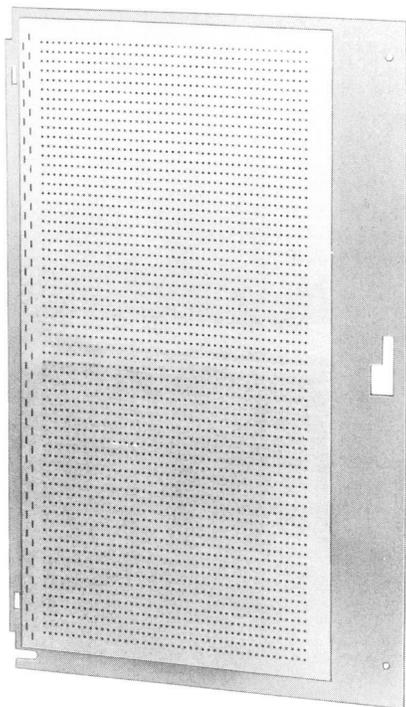
Fig. 3—Program Store

(TOUCH-TONE receivers or dial pulse/wink transmitters).

2.24 A recorded announcement circuit provides facilities for the magnetic recording and reproducing of voice announcements.

D. Switching Frames

2.25 The three switching frames used in the switching network are as follows:

- Trunk switching frame

Fig. 4—Aluminum Memory Card

- Junctor switching frame

- Junctor grouping frame.

2.26 *Trunk Switching Frame:* This frame (Fig. 11) contains a frame controller and 64 units of 8 by 8 crosspoint ferreed switches.

2.27 *Junctor Switching Frame:* This frame (Fig. 12) contains a frame controller, 64 units of 8 by 8 crosspoint ferreed switches, and 32 units of 4 by 8 bipolar ferreed switches. The bipolar switches are used for no-test connections and for making false cross-and-ground tests in the switching network.

2.28 *Junctor Grouping Frame:* This frame (Fig. 13) contains crossover connection for junctor-to-junctor wiring. These connections terminate on plugs and jacks.

INPUT-OUTPUT UNITS

A. Scanners

2.29 Scanners furnish input information to the CC. Scanners supervise on-hook and off-hook

conditions, monitor dial pulses, TOUCH-TONE and multifrequency signals, and observe the electrical state of points within the central office or points within the central office for administrative, diagnostic, and other purposes. The scanners monitor lines, trunks, and other circuits at discrete intervals of time as directed by the system.

2.30 Each point to be scanned in the system is connected to a current-sensing device called a ferrod sensor. A scanner can select and interrogate any group of 16 ferrods specified by information received from the CC. Each of the 16 ferrods interrogated will cause a pulse or no-pulse output referred to as a 1 or 0 readout, respectively. Whether the readout is a 1 or 0 depends on the state of the circuit being scanned. In response to signals from a CC, a scanner produces a 16-bit output word that is transmitted to CC where it is interpreted.

2.31 There are three types of scanners used in the system:

- Universal trunk scanner

- Miscellaneous trunk scanner

- Master scanner.

The scanners differ mainly in function; however, the control and operation of all scanners is essentially the same.

2.32 The master scanner supplements the other scanners to collect additional information at many points in an office (Fig. 14). The master scanner also supplies the scan points for the switching network frame. Such scans are requested for the following reasons:

- To perform a diagnostic test

- To verify the proper execution of an action previously requested

- To recognize existing conditions in order to take appropriate steps.

B. Signal Distributor

2.33 The signal distributors (SDs) provide the CC with access to points in the system which do not operate at electronic speeds (Fig. 15). The SDs located in the universal trunk or miscellaneous
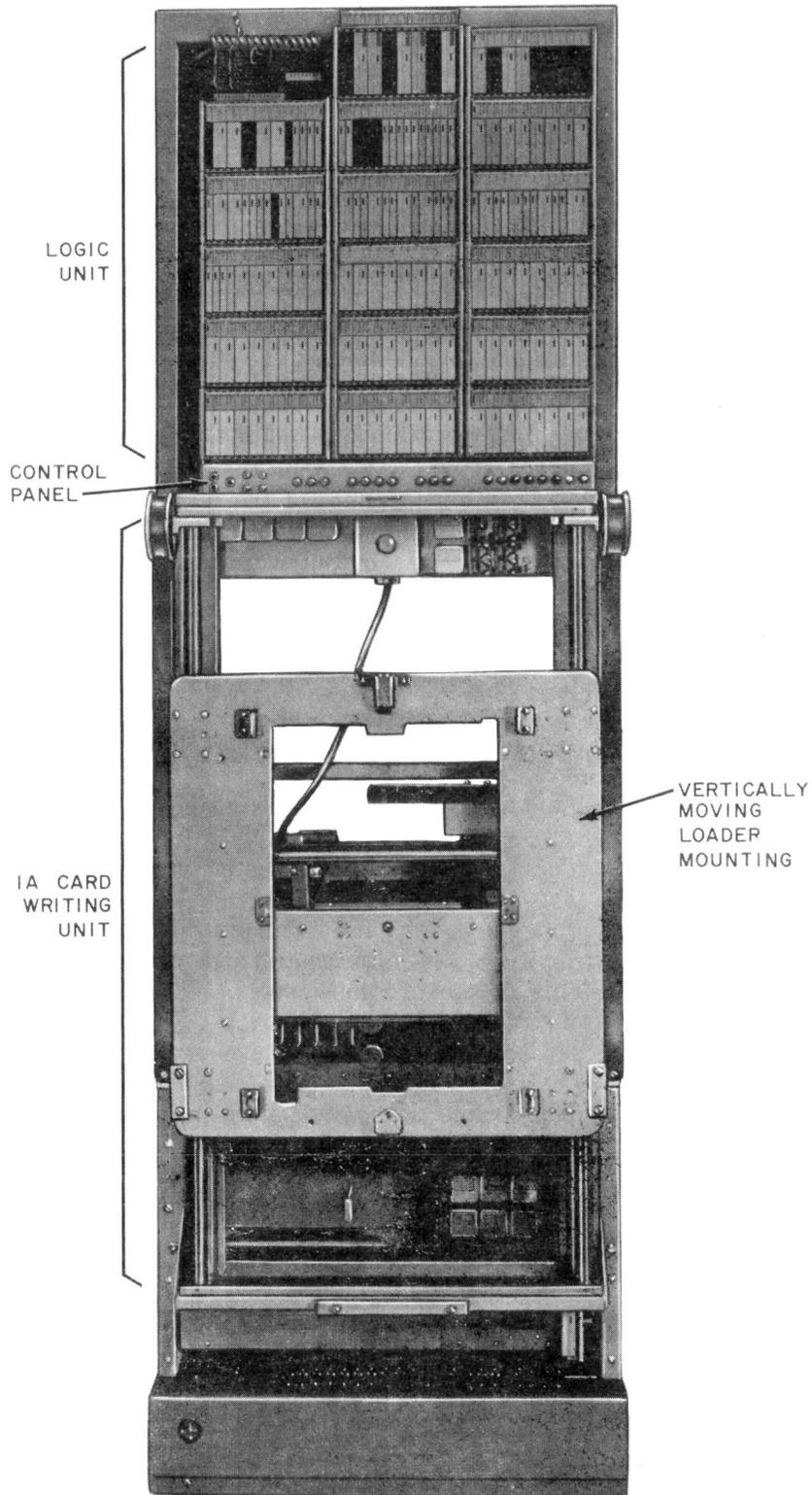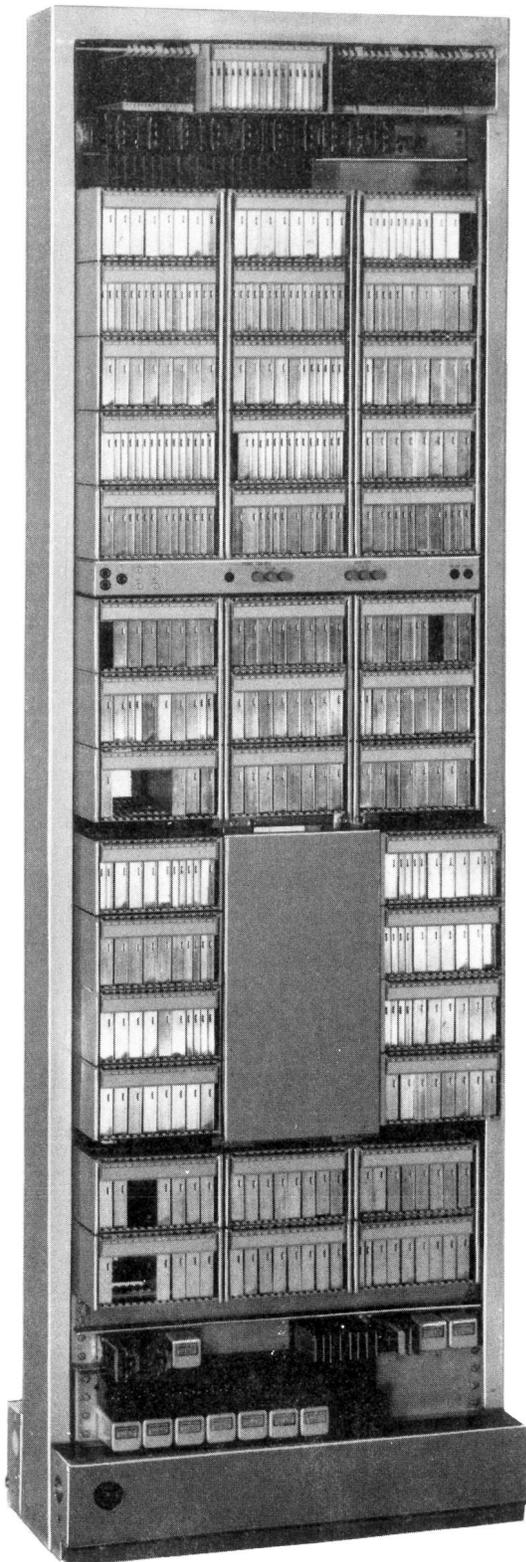
LOGIC
UNIT

CONTROL
PANEL

IA CARD
WRITING
UNIT

VERTICALLY
MOVING
LOADER
MOUNTING

Fig. 5—Memory Card Writer

Fig. 6—Call Store
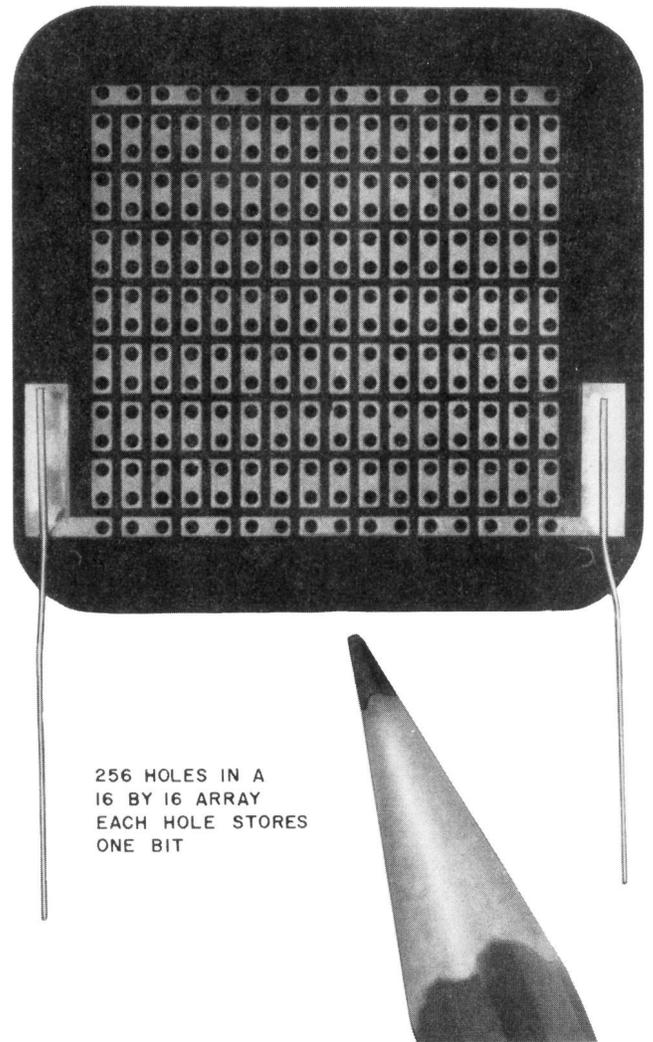
256 HOLES IN A
16 BY 16 ARRAY
EACH HOLE STORES
ONE BIT

Fig. 7—Ferrite Sheet

trunk frames operate or release relays used to complete or break circuits.

2.34 In operation, the CC sends an order to an SD to operate or release a particular relay. The SD selects the appropriate lead to reach the specified relay and sends a -48 volt operate pulse or a $+24$ volt release pulse to the magnetic latching relay which closes or opens an electrical path.

C. Central Pulse Distributor

2.35 The central pulse distributors (CPDs) provide CC with fast access to many points through the central office (Fig. 16).

Fig. 8—Ferrite Memory Module
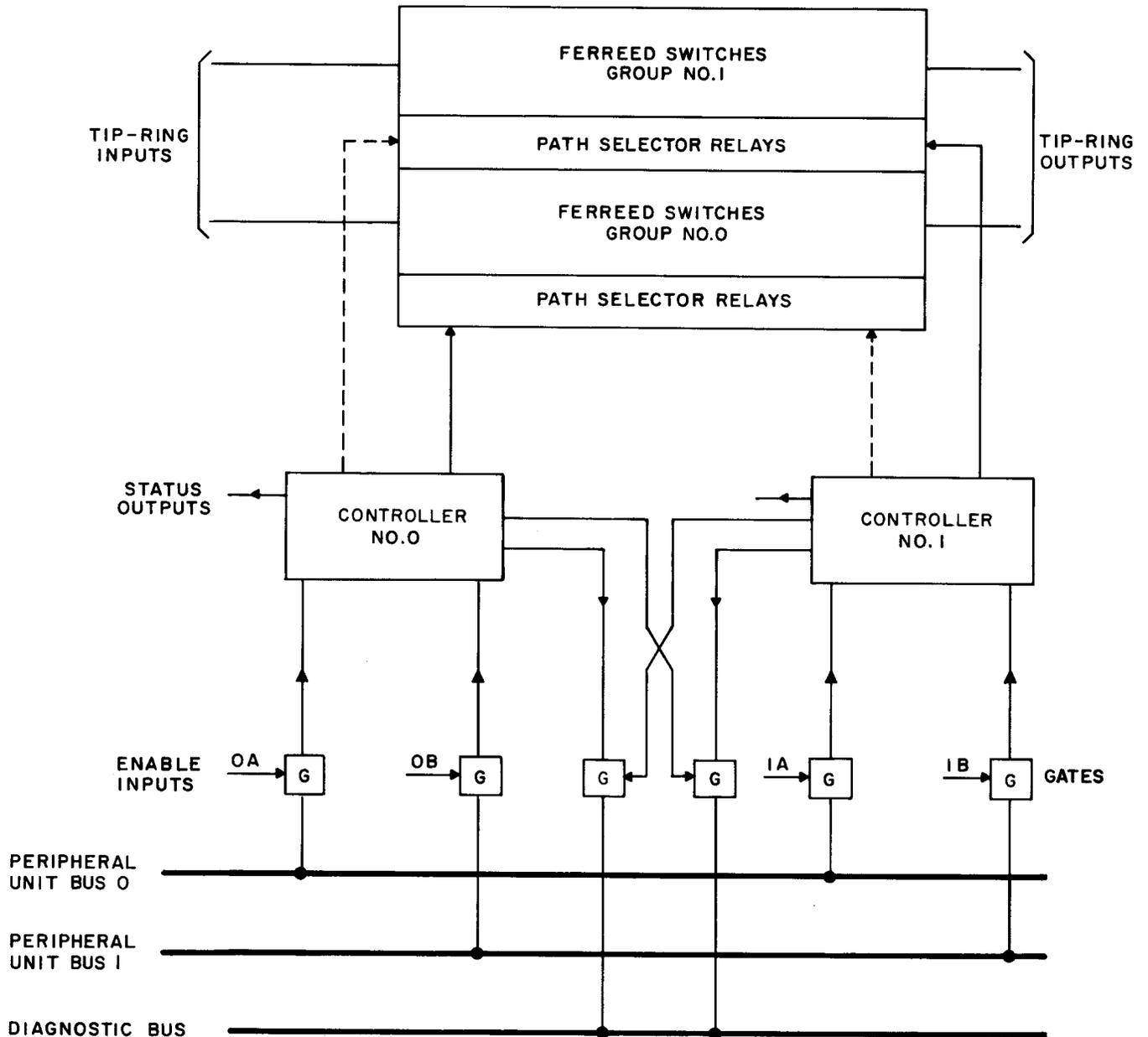
Fig. 9—Network Controllers

2.36 Upon receiving an order from CC, a CPD selects and pulses one of the outputs specified by the address from CC. These outputs may be unipolar pulses (of one polarity) or bipolar pulses (of either polarity). The primary function of the pulses, conveyed by the CPD, is to enable peripheral units. Peripheral units enabled by unipolar CPD pulses return to the CPD a verify pulse which is decoded and sent to the CC. The decoded pulse acknowledges that the peripheral unit received the proper pulse. Circuits receiving bipolar output pulses do not return a verify pulse.

2.37 The CPDs also send signals to control relays in the master control center and various maintenance test points.

MASTER CONTROL CENTER

2.38 The master control center (MCC) is used in the 4-wire No. 1 ESS for maintenance and administrative control. The frames of the MCC are shown in Fig. 17. The MCC is composed of three separate units:

- Maintenance teletypewriter

- Line and trunk test panel

- Alarm, display, and control panel.

A. Maintenance Teletypewriter

2.39 The maintenance TTY is one of the main means for communicating with the system. Messages can be typed in to request the system to perform specific actions. The system can give a printout to report back on the action requested and can give printouts to report on internal conditions including trouble conditions. In addition to the maintenance TTY at the MCC, a remote maintenance TTY is provided. Its function is the same as the one at the MCC.

B. Line and Trunk Test Panel

2.40 The line and trunk test panel provides the system with a facility to manually remove from service and to test outgoing trunks, service circuits, or customer lines.

2.41 The line and trunk test panel is also used to perform miscellaneous transmission tests.

C. Alarm, Display, and Control Panel

2.42 The alarm, display, and control panel has the following two functions. It automatically shows the status of the system units, and it provides manual controls for the system.

OTHER EQUIPMENT

2.43 In addition to the units and frames already mentioned, other frames are as follows:

- Universal trunk frame

- Line applique frame

- Multiaddress frame

- Miscellaneous frame

- Power frames

- Main or intermediate distributing frame

- Trunk distributing frame

- Office status display frame

- 2B line concentrator.

A. Universal Trunk Frame

2.44 The universal trunk frame (Fig. 18) contains 128 universal couplers, a frame scanner circuit, and a signal distributor circuit. The scanner and signal distributor also control 128 universal couplers in a supplementary universal trunk frame (Fig. 19). The universal coupler circuit is used as a connecting circuit between the 4-wire switching network and various transmission facilities such as lines, trunks, and service circuits.

2.45 Transformer isolation (in the universal coupler) between the lines and the switching network prevents direct current from the flowing between the two circuits; thus, the line can be wet or dry. However, when a 4-wire circuit using loop signaling on the line is to be switched by an ESS, an applique circuit is required.

B. Line Applique Frame

2.46 The line applique frame (Fig. 20) contains 54 line applique circuits. An applique circuit permits a 4-wire circuit, using loop signaling, to be connected to a 4-wire network terminal on the ESS via the universal coupler. Its purpose is to convert loop signaling received from the line circuit to E and M signaling required by the coupler circuit. In addition, it supplies ringing current to the subscriber line.

C. Multiaddress Frame

2.47 The multiaddress frame contains four multiaddress bridge modules. Each module is made up of 20 port circuits (Fig. 21). The bridge frame is used for multiaddress calls and broadcast calls.
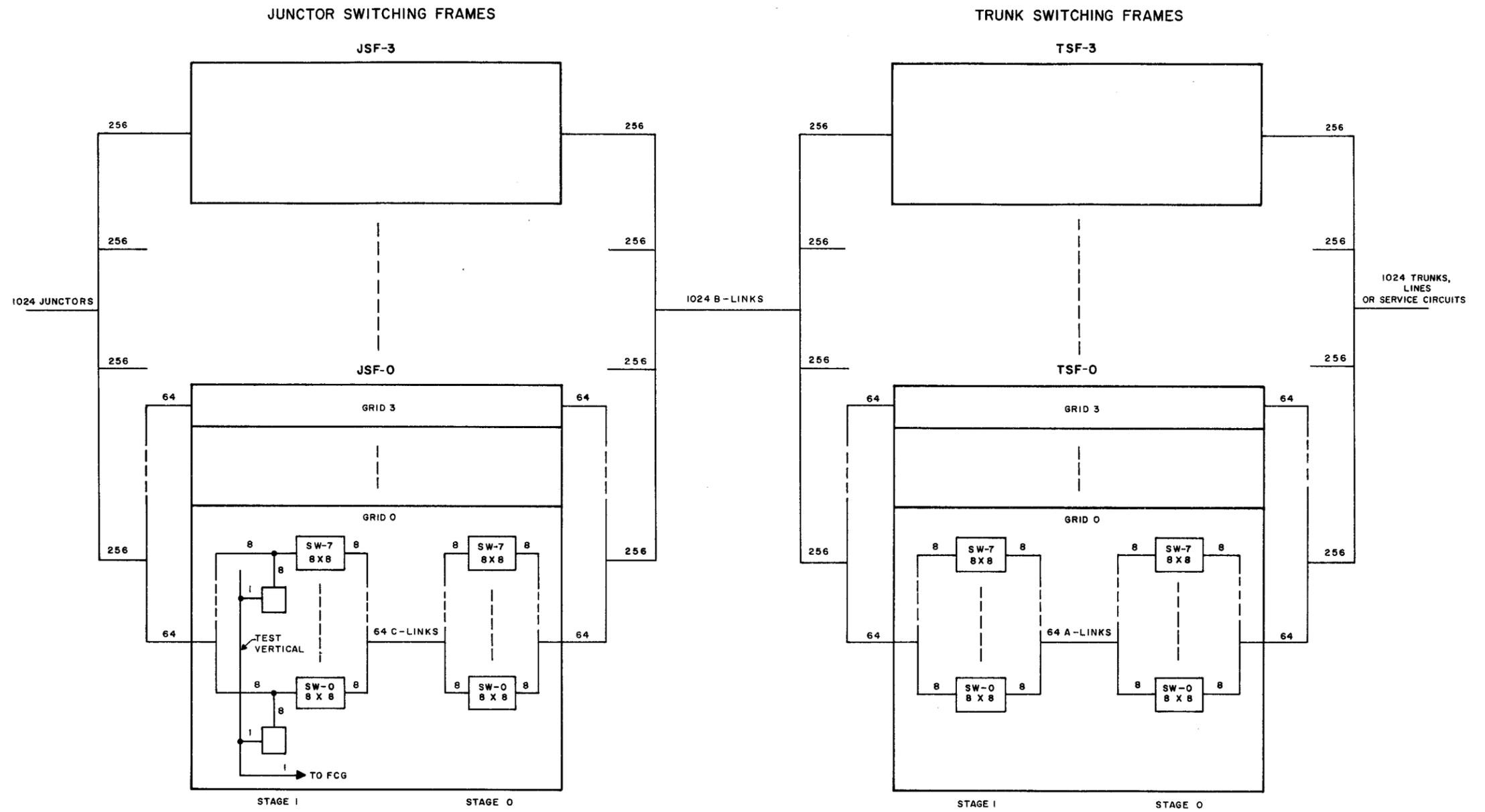
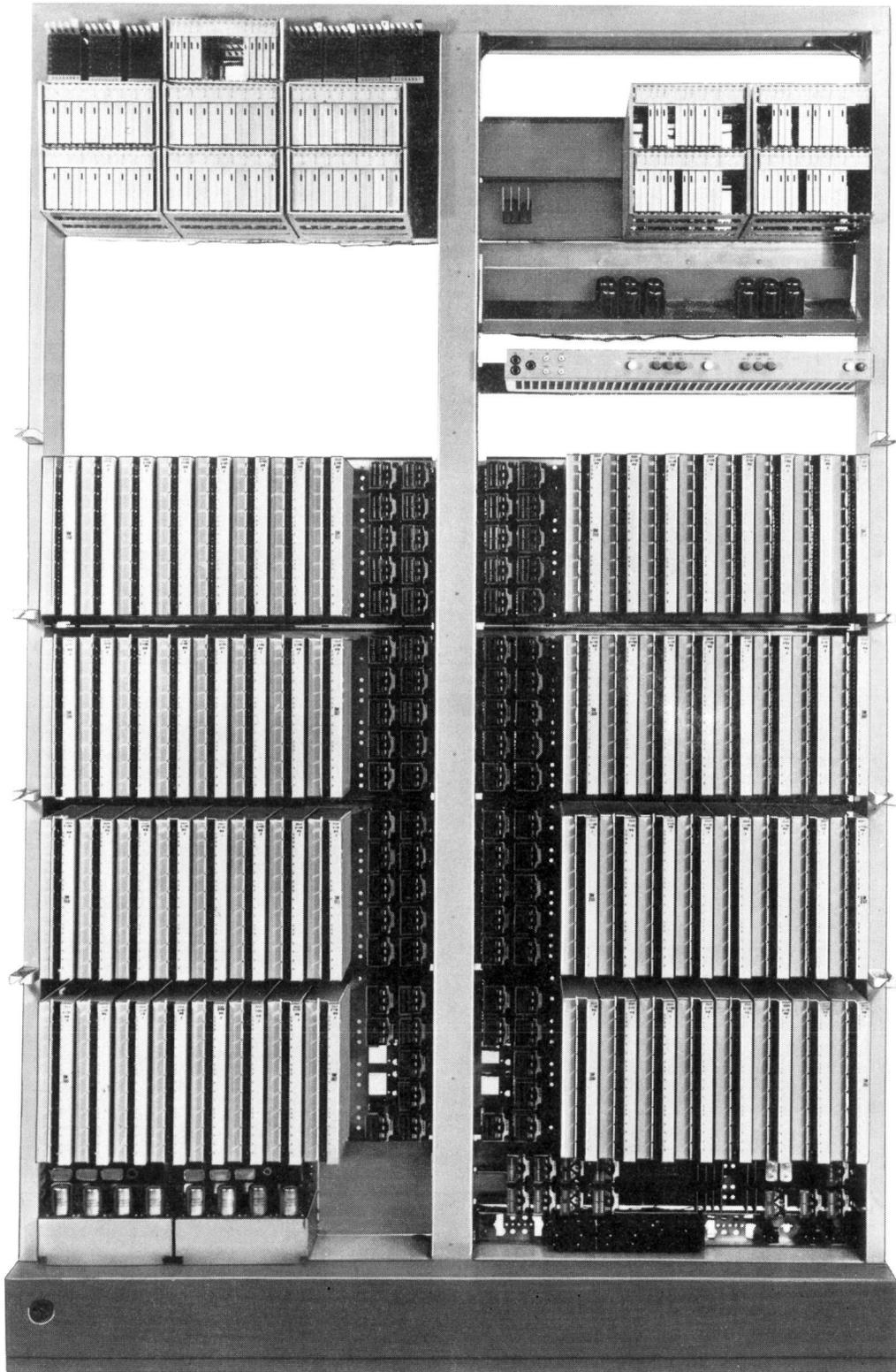Fig. 10—Organization of Trunk Link Network

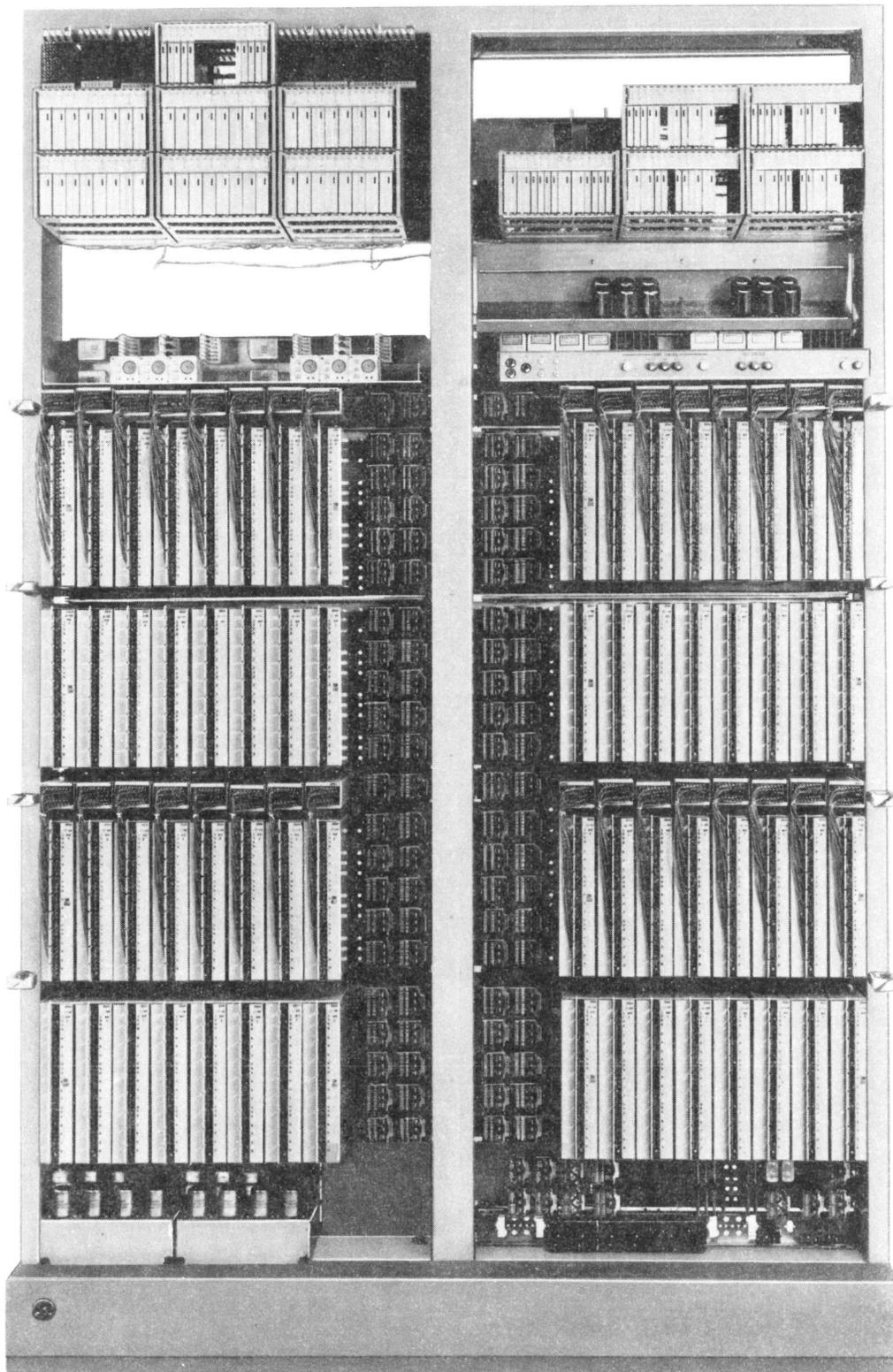Fig. 11—Trunk Switching Frame

Fig. 12—Junctor Switching Frame

Fig. 13—Junctor Grouping Frame

BUS AND
SCANNER
CONTROLLER
UNIT

CONTROL
PANEL

1024
FERROD
SENSORS

FUSE
PANEL

FILTER
PANEL
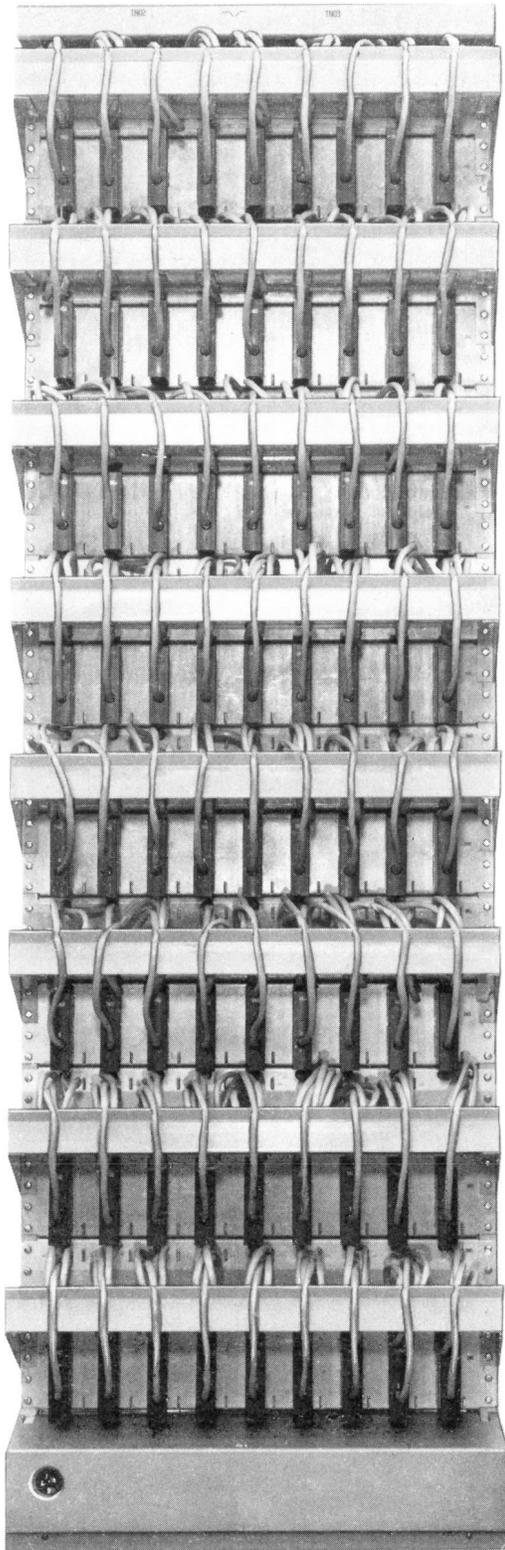
Fig. 14—Master Scanner

Fig. 15—Signal Distributor
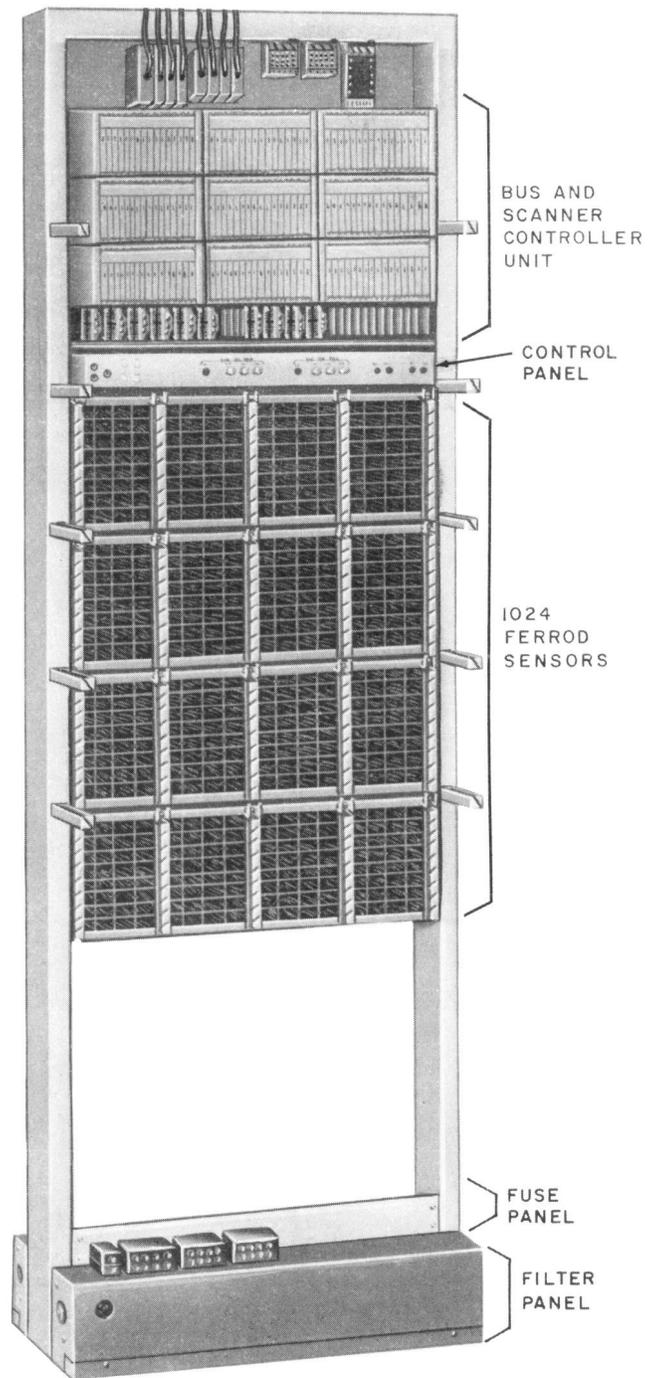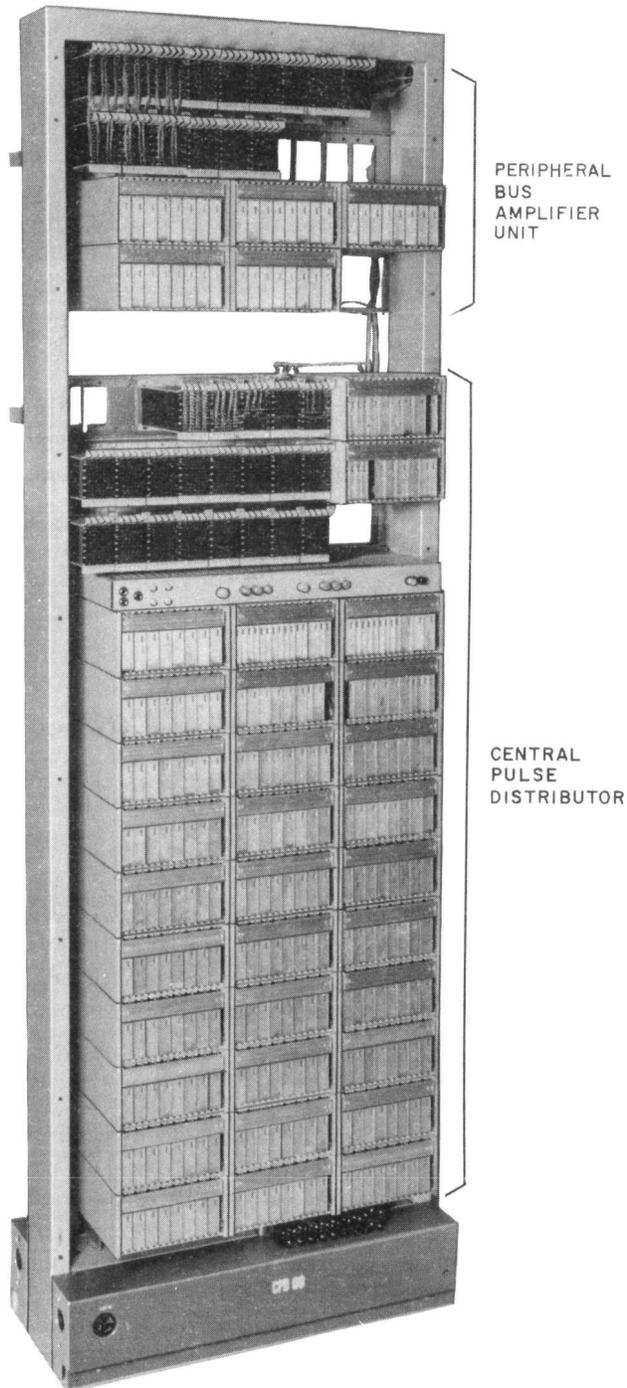
Fig. 16—Central Pulse Distributor

D. Miscellaneous Trunk Frame

2.48 The miscellaneous trunk frame (Fig. 22) contains a scanner, a signal distributor, signal distributor applique circuits, and TOUCH-TONE

receivers. These control units also control the equipment in the supplementary miscellaneous trunk frame.

2.49 The supplementary miscellaneous trunk frame (Fig. 23) contains multifrequency transmitters and miscellaneous equipment.

E. Power Frames

2.50 Power feeders are run from the +24 volt and −48 volt power plants to the two (or more if required) power distributing frames (Fig. 24) in the switchroom. These feeders are composed of battery and ground-return leads. At the power distributing frame each battery lead is filtered by a capacitor shunt to ground and is branched through the banks of fuses that feed the various system units.

2.51 The distribution of power is arranged so that no two duplicate circuits are fed from the same power distributing frame.

2.52 At each functional frame each battery lead from a power distributing frame terminates on a filter which feeds the fuse panel supply bus. The ground-return lead is connected to the terminal provided by the ground-return system on the frame. The fuse panel branches the dc power to the circuitry within the functional frame.

F. Main or Intermediate Distributing Frame

2.53 All outside cables, from stations and other central offices, are terminated at the main or intermediate distributing frame (Fig. 1 and 25), where they are interconnected with cables from the universal trunk frame.

G. Trunk Distributing Frame

2.54 The trunk distributing frame interconnects the universal trunk frame and the trunk link network on the trunk switching frame (Fig. 1 and 26).

H. Office Status Display Frame

2.55 The circuit in this frame (Fig. 27) monitors the alarm and traffic status of the ESS office, displays this status locally, and drives the Status Assembly System (SAS) which transmits this status information to a remote control center

for network management purposes. Most of the status information from the ESS is program controlled but some is hardware controlled.

I. 2B Line Concentrator

2.56 When station lines are connected to a 4-wire ESS as shown in Fig. 28, the station is provided with access to more than one switching center by use of the dual access circuit and the 2B line concentrator system. The station equipment, dual access circuit, and 2B line concentrator are covered in the plant series 981, 480, and 951 divisions, respectively.

DUPLICATION AND INTERCONNECTIONS

2.57 All common system units required to provide continuous service are duplicated. This applies to the following units:

- Central control
- Program store
- Call store
- Central pulse distributor
- Switch frame controller
- Signal distributor controller
- Scanner controller
- Intercommunication bus system.

2.58 Under normal conditions both units of a duplicated pair operate side by side in response to the same information, but only one of the two units is given active status. By continuously comparing the outputs of duplicate units (and by other means), it is possible to detect the existence of a malfunction within the system. The unit at fault is automatically identified by appropriate programs and is taken out of service.

2.59 Two systems of interconnection or bussing between units are used in the 4-wire No. 1 ESS: the connection to the stores, and the connection to the peripheral units via the CPD. The CC requests a particular address within a particular store for a read or a write operation. The particular store involved then recognizes its

address and enables the particular memory location desired.

2.60 The peripheral units are connected to CC via a common bus, and access to these units is controlled by the CPD. Gating information is sent from the CPD to the units by interconnecting leads which exist between the CPD and the peripheral units. A simplified diagram of the bus system and interconnecting leads is shown in Fig. 29.

3. EQUIPMENT ELEMENTS

3.01 Most of the functions in the No. 1 ESS are performed by the following types of apparatus:

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

These components, combined as required, are arranged on a limited variety of frames in ways which make each frame, as nearly as practicable, a complete functional building block free of options.

FERREED SWITCHES

3.02 The ferreed switch is the basic switching device in the trunk link networks. Two types of ferreeds are used in the system: crosspoint and bipolar. The crosspoint ferreed consists of four miniature, glass-enclosed, reed switches which determine the network paths for the tip and ring connectors (Fig. 30). The contacts of these switches are opened and closed dry (no current flowing). The bipolar ferreed swtiches are used to test verticals (Fig. 31).

3.03 The operation of the two types of ferreeds is different. The crosspoint ferreed has a 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 operation and a positive pulse for release.
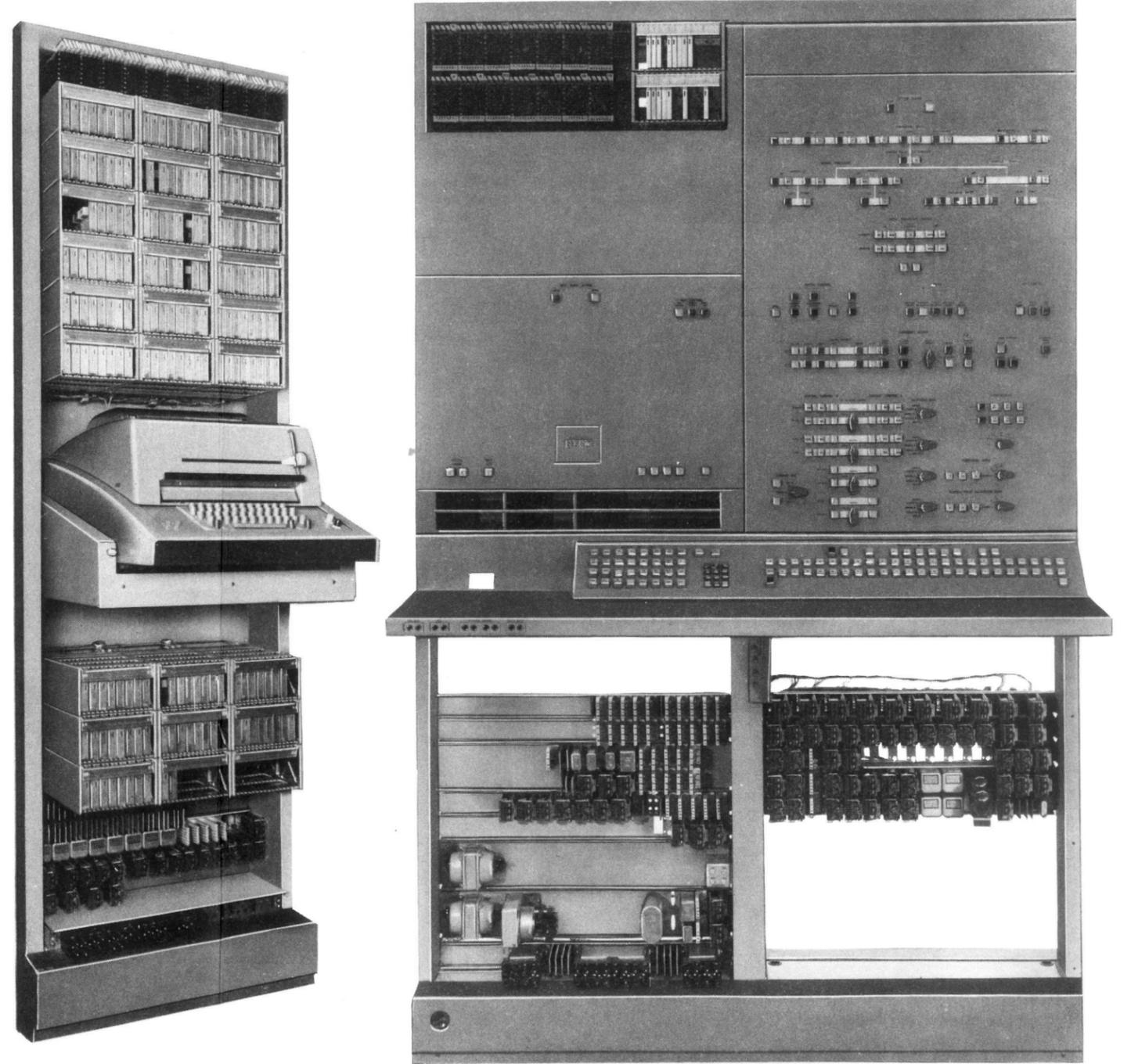
Fig. 17—Master Control Center
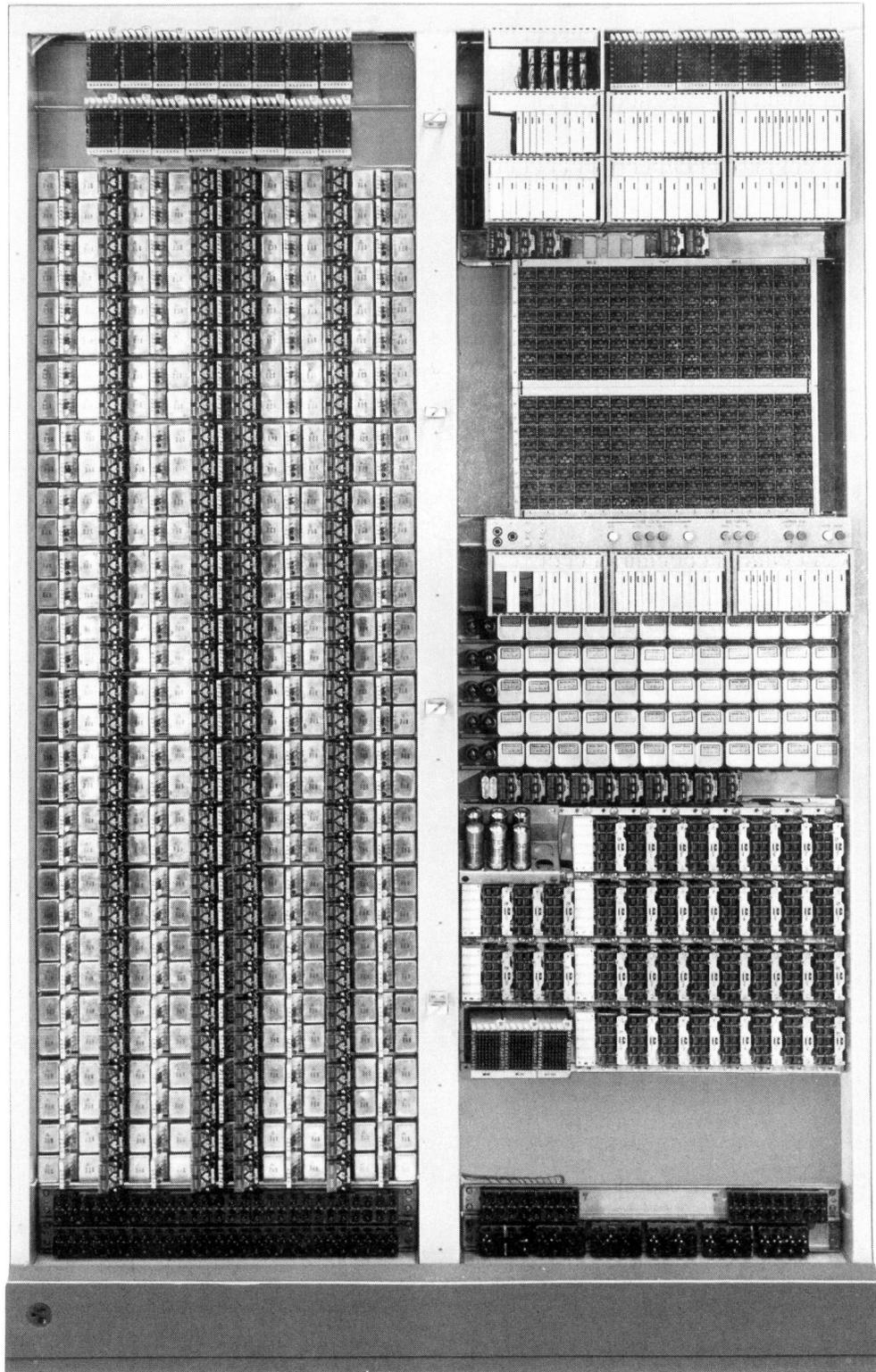
Fig. 18—Basic Universal Trunk Frame

Fig. 19—Supplementary Universal Trunk Frame

Fig. 20—Line Applique Frame

Neither type ferreed requires a continuous current to maintain an operate or a release state.

FERROD SENSOR

3.04 The ferrod sensors used in the scanners are devices in which the magnetic coupling
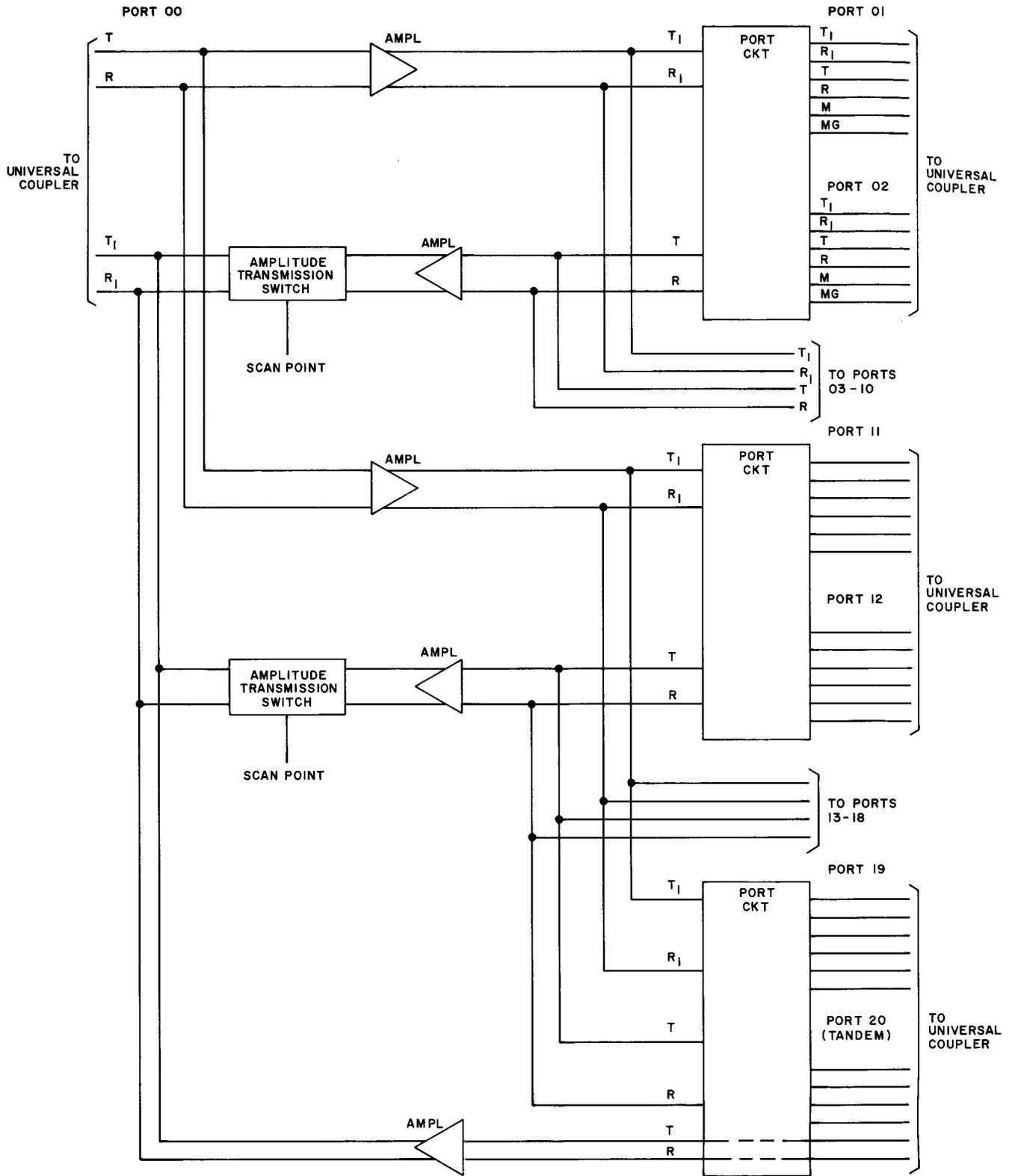
Fig. 21—Bridge Module

Fig. 22—Miscellaneous Trunk Frame

Fig. 23—Supplementary Miscellaneous Trunk Frame
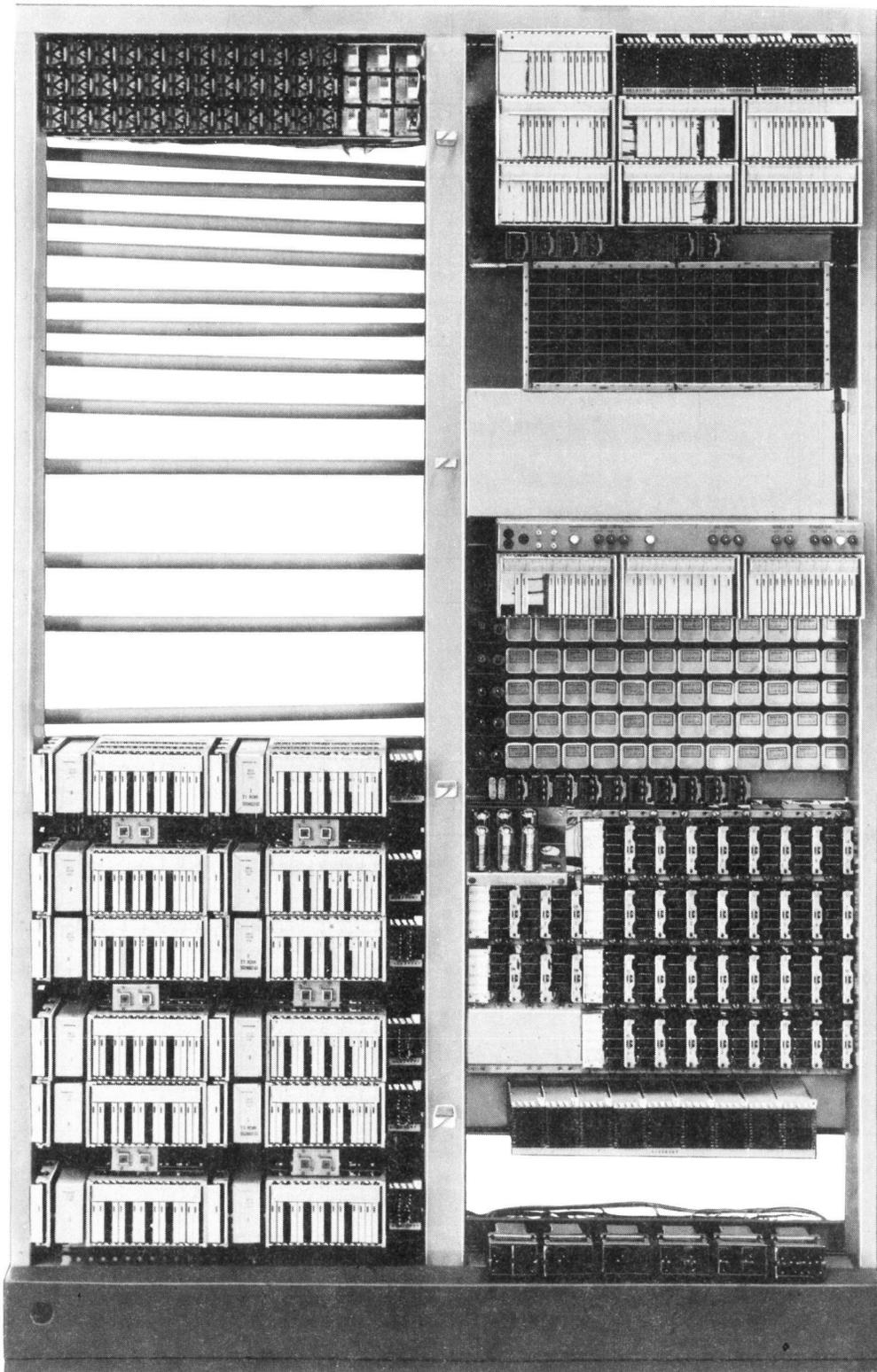
Fig. 24—Power Distributing Frame
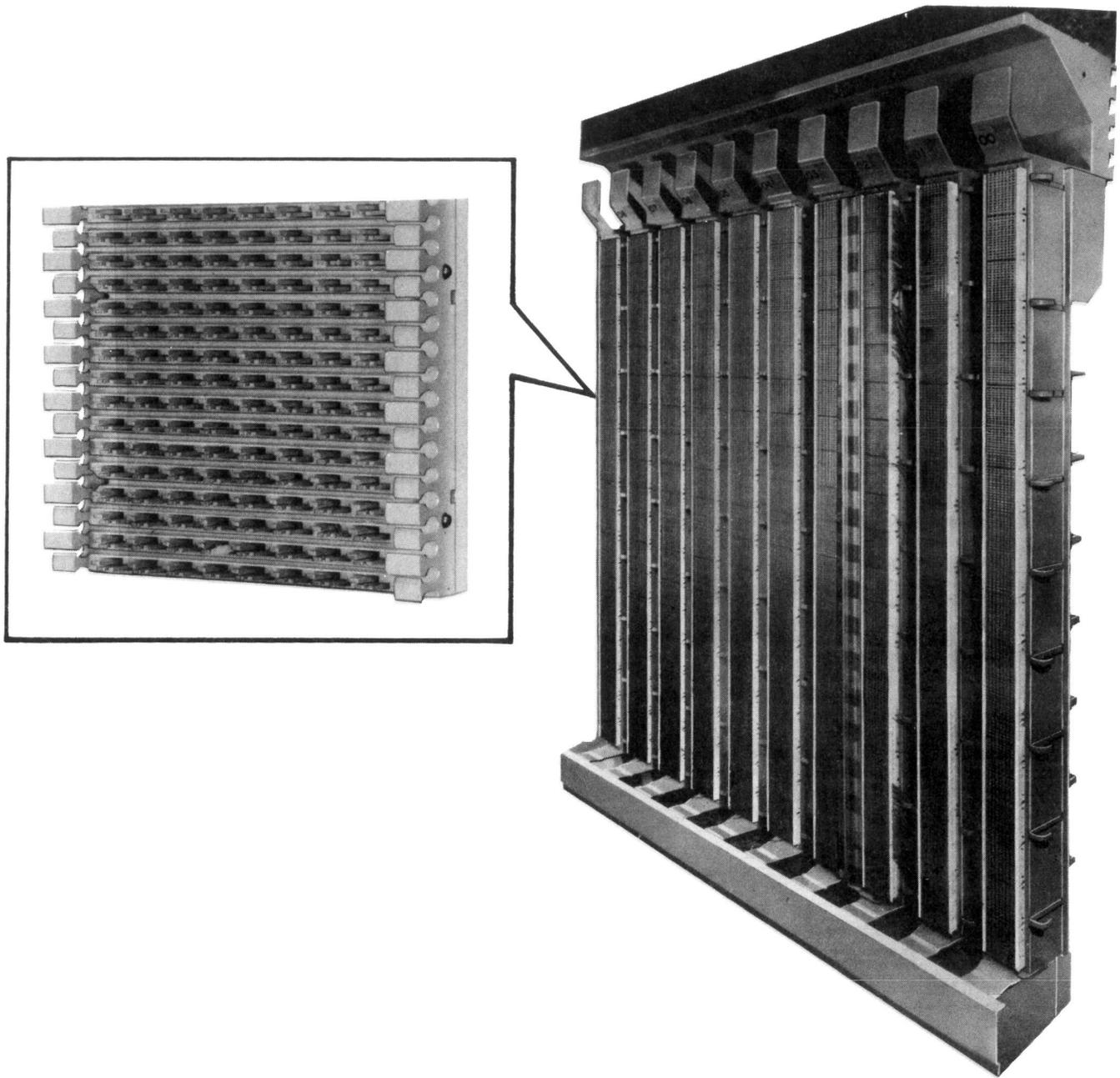
Fig. 25—Main or Intermediate Distributing Frame

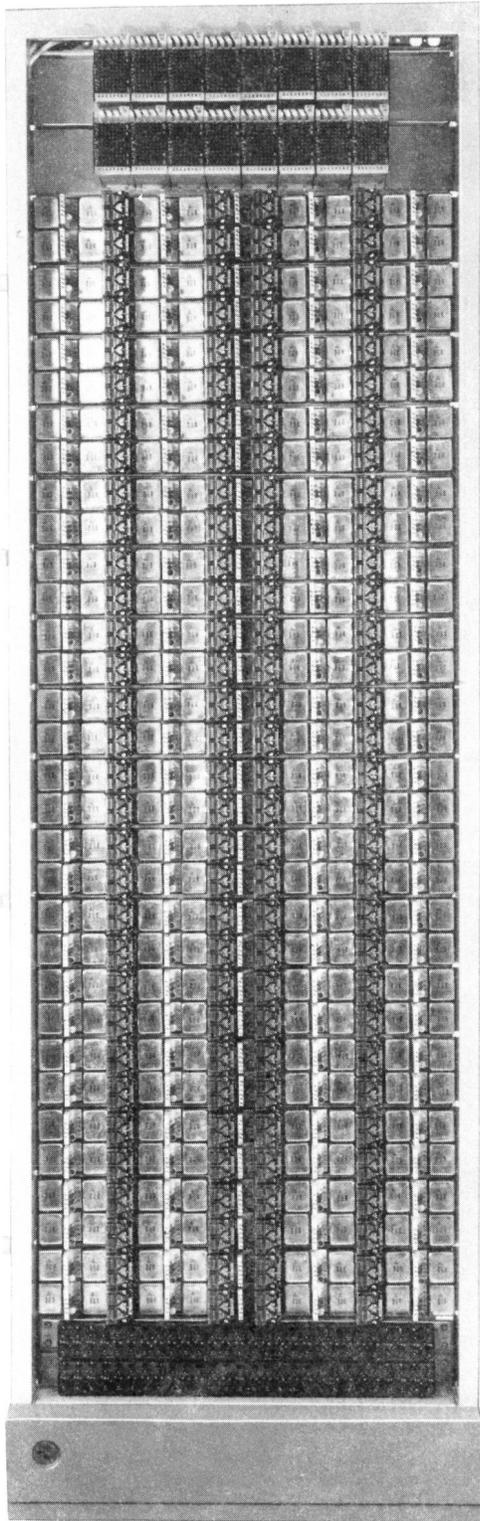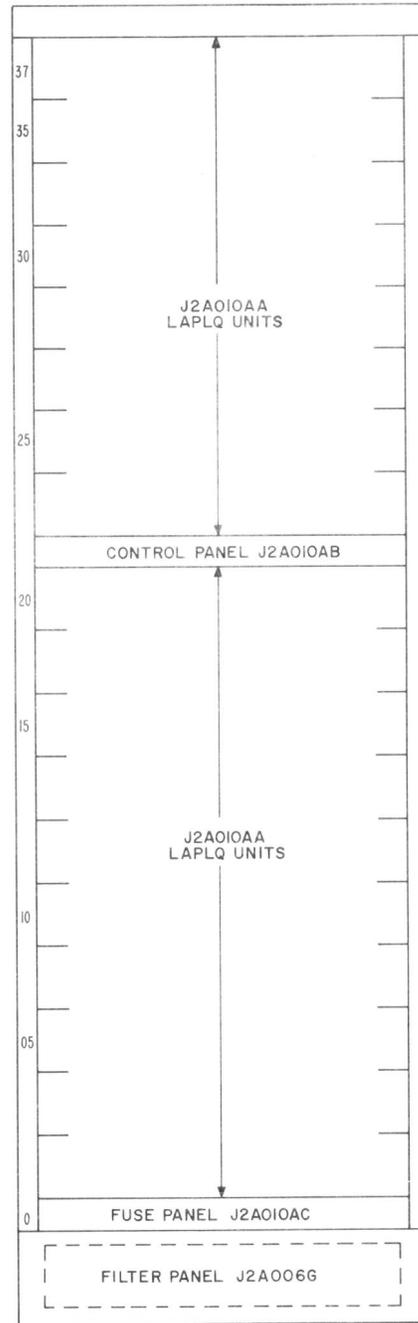between the interrogate and readout windings of each are determined by the current in their control windings (Fig. 32). This current or absence of current gives the state of the circuit. An example of this is the sensing of an on-hook or off-hook condition of a line. The on-hook condition gives a binary 1 output and the off-hook condition gives a binary 0 output.

MAGNETIC LATCHING RELAYS

3.05 The magnetic latching wire-spring relays look like conventional wire-spring relays. The main characteristic of magnetic latching relays is the remanent core material which retains enough residual magnetism to hold these relays operated after the operating current is removed. Actual

Fig. 26—Trunk Distributing Frame

DISPLAY
PANEL

DIGITAL CLOCK
AND PRINTER

PRINTER LOGIC
AND BINARY
CONVERSION

CLOCK AND
ALARM
RELAY UNIT
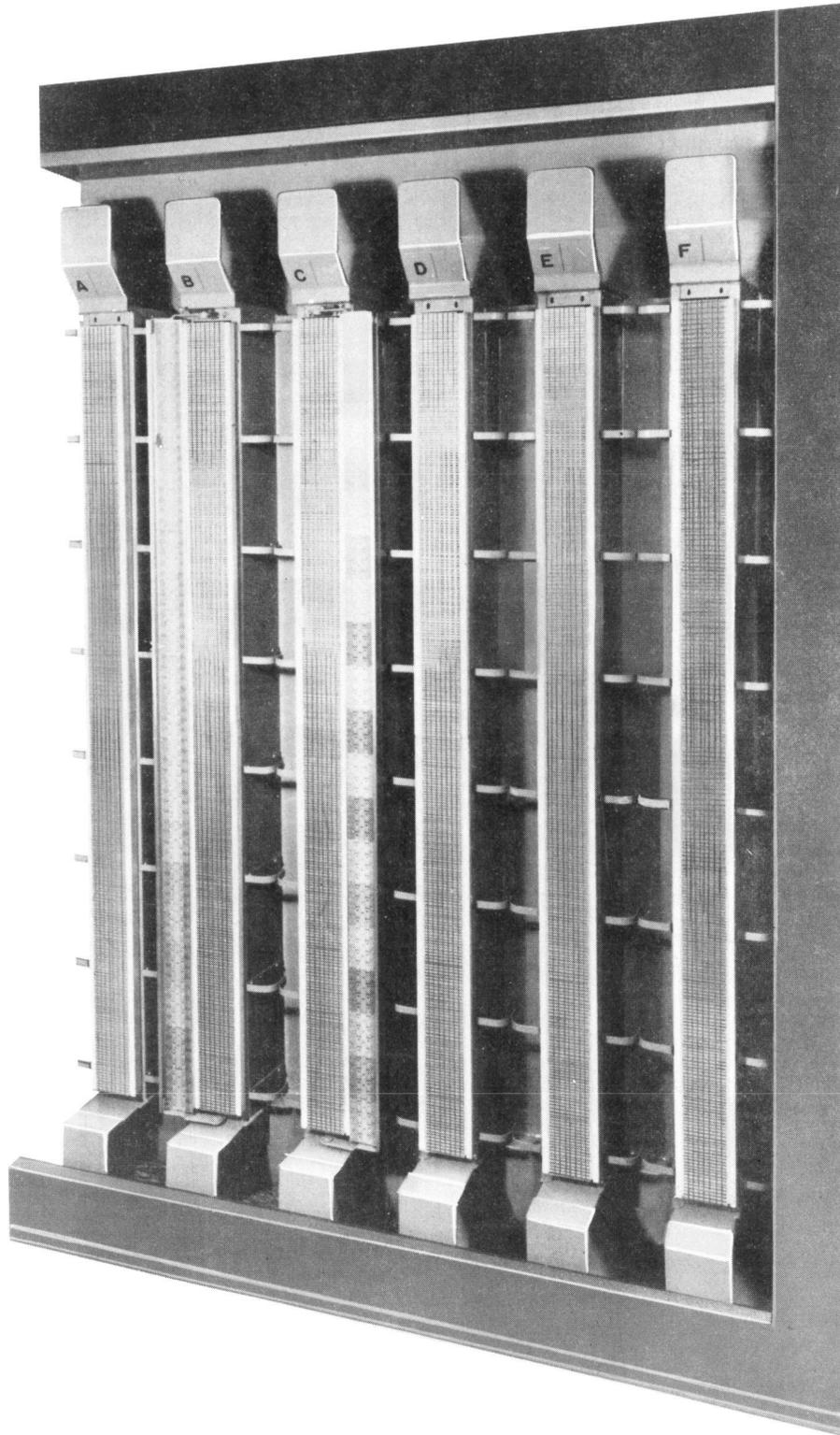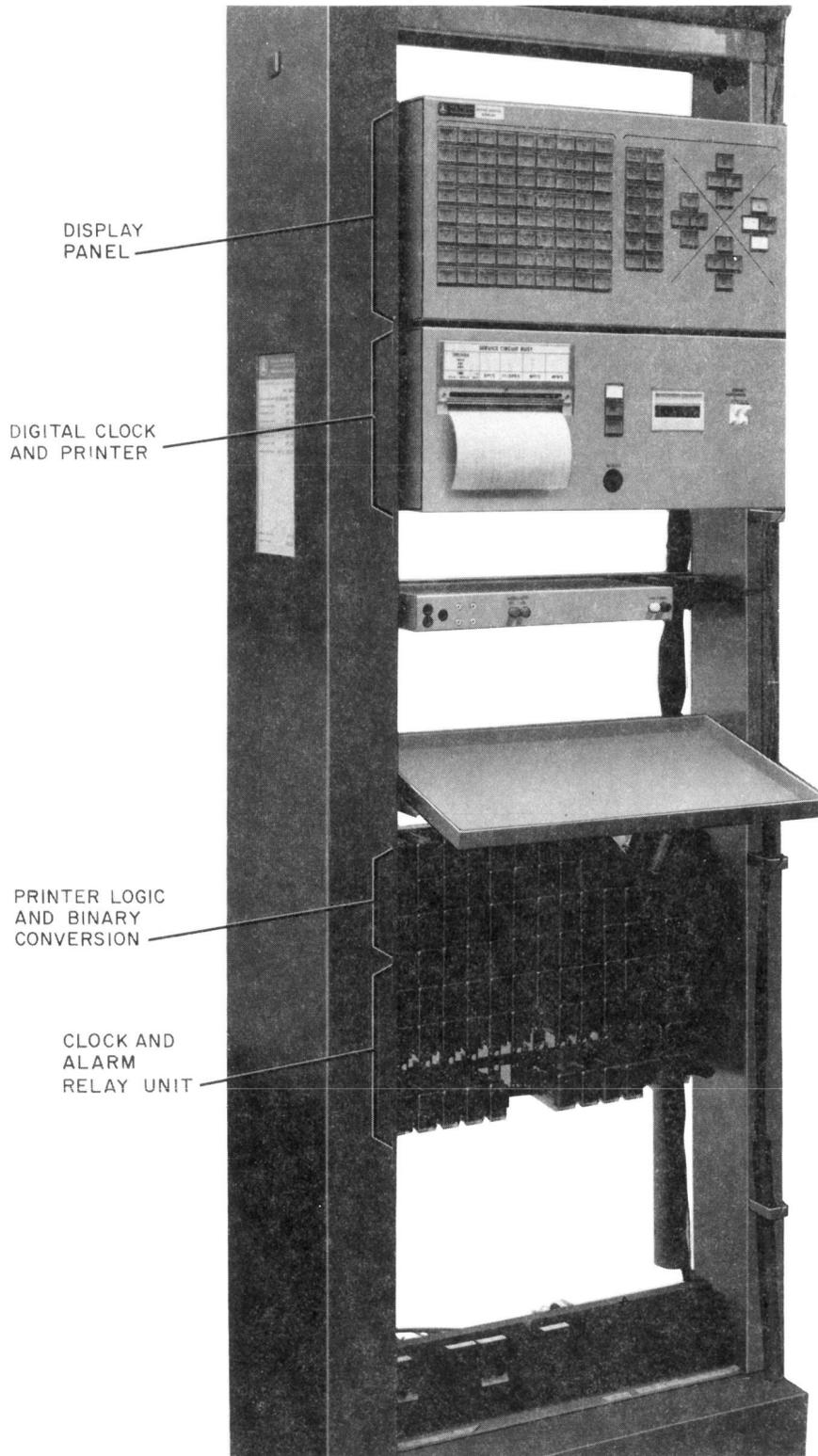
Fig. 27—Office Status Display Frame
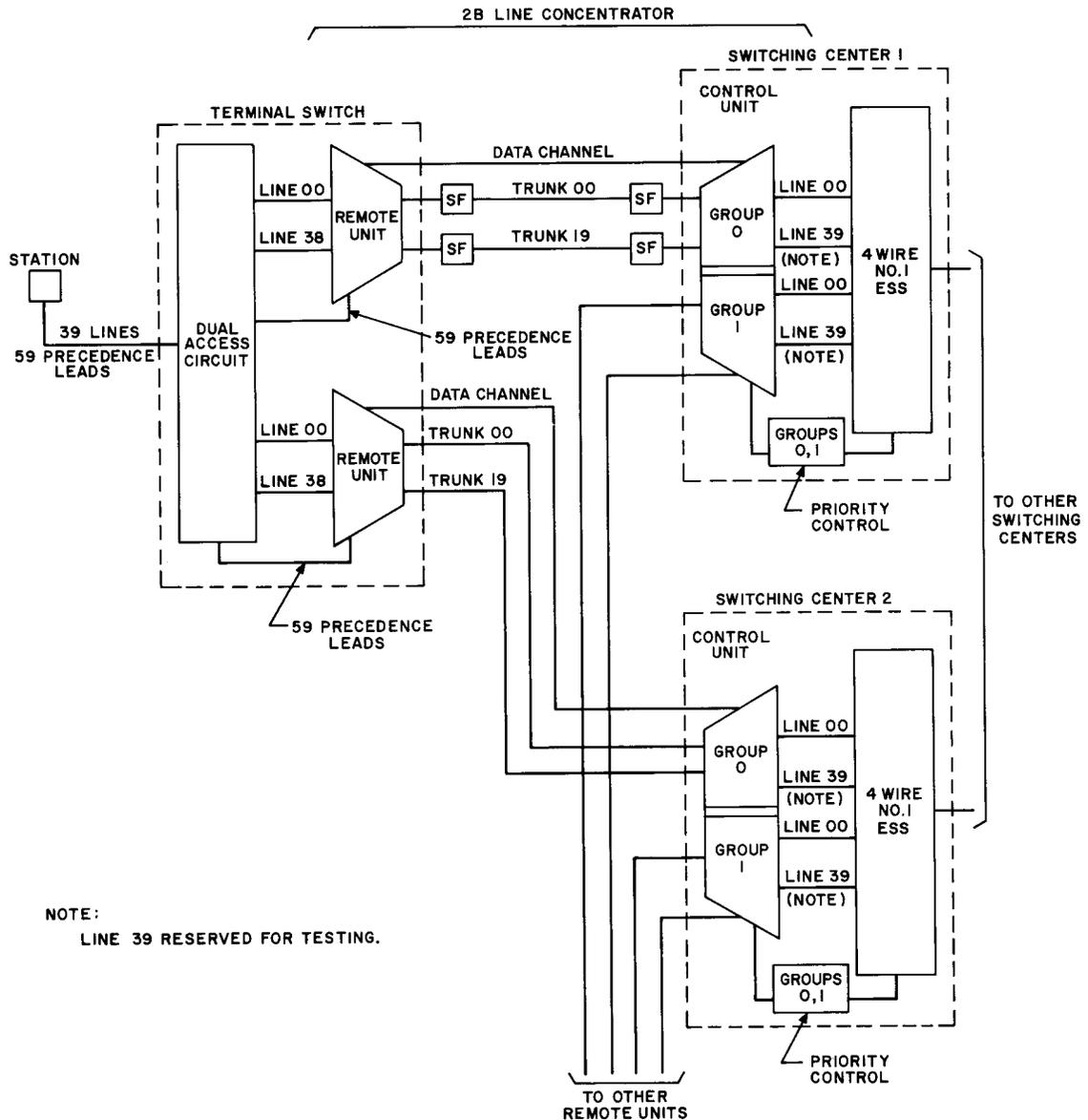
Fig. 28—System Layout Using 2B Line Concentrator

operation and release are similar to the bipolar ferreed, where operation is accomplished by a negative pulse and release by a positive pulse. No current is required to maintain an operate or a release state.

3.06 The magnetic latching relays are operated and released by SDs and make the final closing of a metallic path in the specified circuit. When this 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 broken.

TWISTOR MEMORY MODULE

3.07 The twistor memory module is used in the PS to store and read the information. It is a semipermanent read-only memory. 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. 33). A plain wire which

parallels the twistor wire serves as a return current path. The twistor wire and plain wire are shorted together at one end to form a sensing or readout loop. The unshorted end of the pair is connected to read out 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. A bar magnet on the memory card is positioned at the intersection of the solenoid loop and the readout loop. If the bar magnet is magnetized, no pulse will be generated. However if the bar magnet is not magnetized, a pulse will be generated and detected by the readout circuit. Both the permalloy tape of the twistor wire and the ferrite core that drives the solenoid have square-loop magnetic characteristics.

3.08 Information from the twistor memory 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 PS. A view showing the small magnets on the memory card is shown in Fig. 4. Each aluminum memory card contains 64 words; each word is composed of 44 binary bits.

FERRITE SHEET MEMORIES

3.09 Ferrite sheet memories are the basic storage elements in the CS and provide temporary or read-write storage. Information can be stored, read, altered, or erased by the system.

3.10 The ferrite sheet is made of magnesium-manganese material. Each ferrite sheet contains 256 holes in a 16 by 16 array (Fig. 7). The ferrite material around each hole in the ferrite sheet stores one binary digit.

3.11 The direction of current applied to conductors passing through a hole in a ferrite sheet determines the polarity of magnetization. The two magnetic polarites are used to store binary 0 and binary 1. Combinations of these zeros and ones form the words in the CS.

SEMICONDUCTOR DEVICES

3.12 Semiconductor devices mounted on plug-in circuit packs are used for most of the logic and controls. The circuit packs and the apparatus on which the packs are mounted are shown in

Fig. 34. Semiconductor devices make possible the operating speed and reliability required by the system. The circuit pack makes it possible to quickly replace circuitry which has become defective and to restore the unit to service.

4. CALL PROCESSING

4.01 The 4-wire ESS features are listed and described in 1.16 through 1.42. In conjunction with these features, the ESS will accept and process TOUCH-TONE, dial tone, or MF types of signaling. Dial pulses, when used, are received on appropriate E leads via E&M (SF) signaling. The numbering plan and keying formats used in 4-wire ESS are described below.

NUMBERING PLAN

4.02 The numbering plan consists of five parts: precedence, special routing digit, area code, destination office code, and specific line identification. This yields a maximum keyed heading of

P 1X NYX NNX XXXX

P = Precedence

1X = Special routing digit

NYX = Extended area code

NNX = Destination office code

XXXX = Specific line identification.

The originator of a call must key a minimum address of seven digits (NNX-XXXX) unless abbreviated dialing is authorized or operator assistance is requested. In addition, the prefix (NYX) may be used for extended area calling, plus a routing digit (1X) for special route treatment, and a prefix (P) to exercise a precedence authorized. Four levels of preemption are normally used throughout the network; therefore, the appropriate precedence digit (if other than routine call) is used before dialing the number.

4.03 *Abbreviated Keying Subscriber:* The call originator has the capabilities described in 4.02 or may key a minimum of two digits as follows:
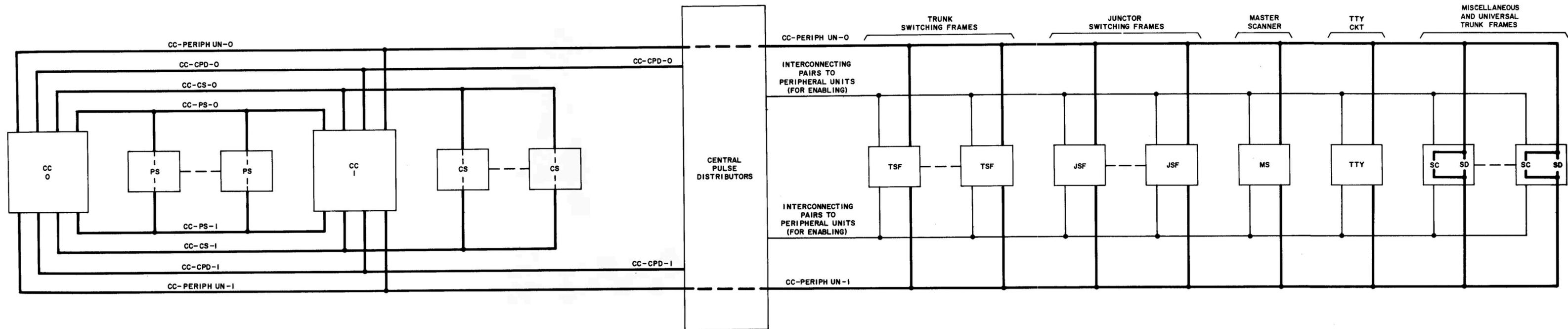
NX A

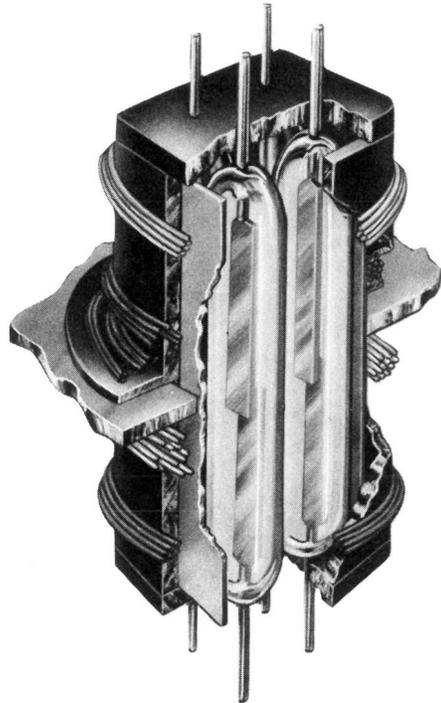Fig. 29—Bus System and Interconnections Simplified Diagram

Fig. 30—Crosspoint Ferreed Switch

SEALED
REED
SWITCHES

50 TURN
WINDING

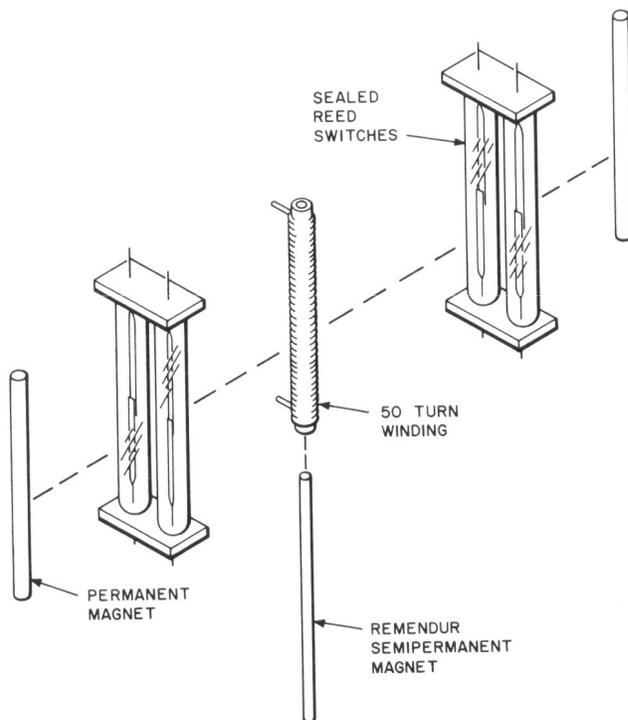PERMANENT
MAGNET

REMENDUR
SEMIPERMANENT
MAGNET

Fig. 31—Bipolar Ferreed, Cutaway View

N = Any TOUCH-TONE digit 2 through 9

X = Any TOUCH-TONE digit 0 through 9

A = Key A on keyset.

The prefixes (P) and (1X) can also be used.

4.04 ***Direct Station Selection Subscriber:*** The call originator has the capability of keying 1 of 16 TOUCH-TONE digits (individually). Each key causes a prespecified 7- or 10-digit number to be dialed. No other key format is permitted.

4.05 ***Off-Hook Subscriber (Hot Line):*** No keying is required for this type of subscriber.

4.06 ***PBX Access Lines:*** PBX address information to the ESS occurs by one of two methods.

(a) Switchboards (TOUCH-TONE equipped) may use TOUCH-TONE key pulsing and may have a class of service equivalent to a 4-wire subscriber.

(b) PBX users dial 7- or 10-digit numbers to the ESS of the form (NYX-NNX-XXXX).

NORMAL CALLS

A. Intraoffice Calls

4.07 When a dial pulse/TOUCH-TONE call is originated [subset goes off-hook (Fig. 35)], a current flows through a supervisory ferrod sensor element (scanner point) 1 associated with the originating line. On the next scan 2, the CC receives no sensor output indicating that the line is off-hook. The call processing programs utilize CS memory to maintain the line state (busy-idle), etc. Having identified the originating line by its scanned location, a translation sequence is performed which provides class-of-service information.

Dial Tone Connection

4.08 The CC (under program instruction) selects an idle TOUCH-TONE receiver 3. A path must now be established through the trunk link networks to connect the TOUCH-TONE receiver to the originating line 4. The CC (under program instruction) operates the cut-through relays in the two universal couplers 5. Then the CC operates a relay in the TOUCH-TONE receiver that causes

FERROD SENSOR MOUNTED IN CELL

MOUNTING CATCH TO HOLD FERROD

FERROD SENSOR

128 CELLS IN AN 8 X 16 ARRAY
EACH CELL WILL HOLD 2 FERRODS

(REAR VIEW)
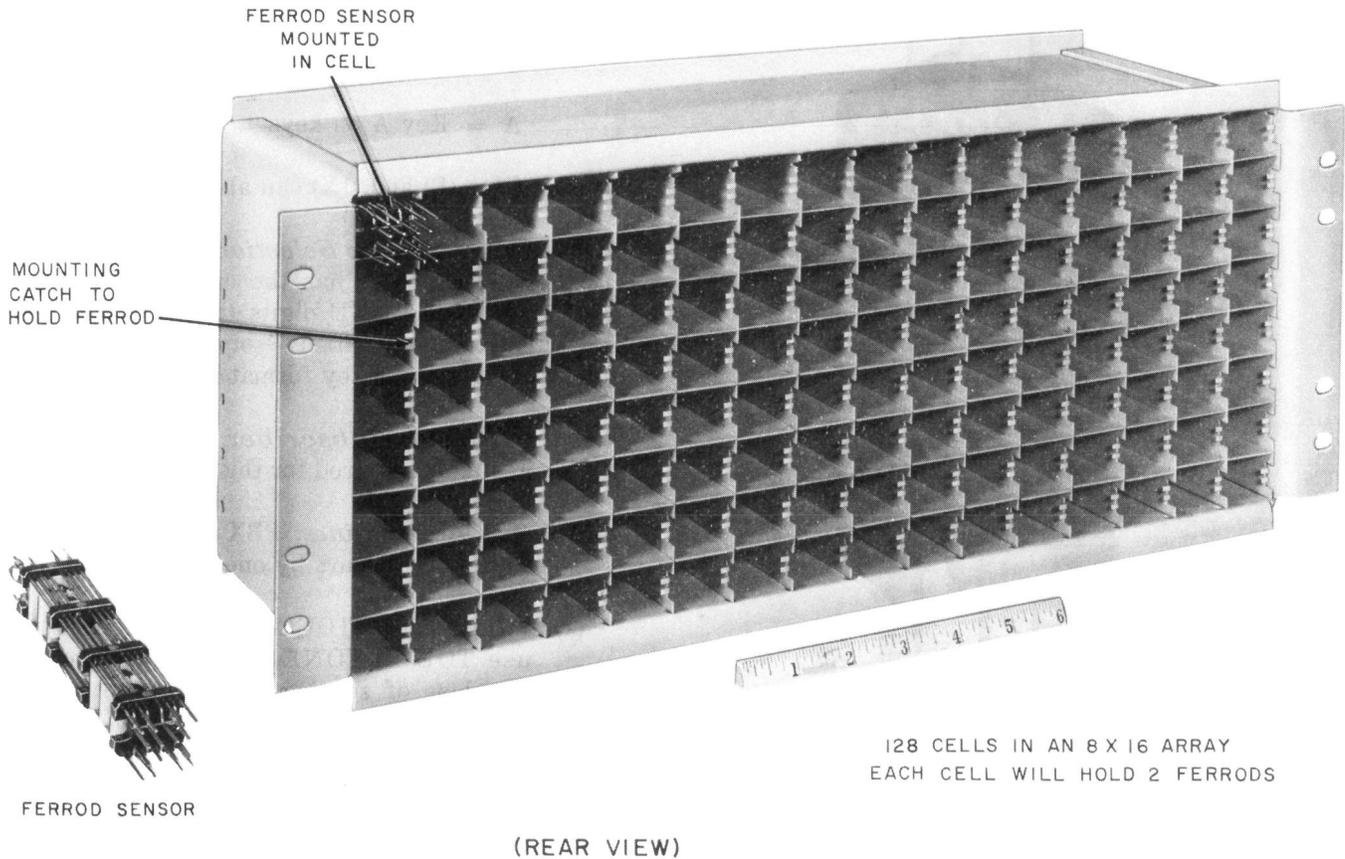
Fig. 32—Ferrod Sensor and Apparatus Mounting

dial tone to be sent to the calling line 6 . Dial tone is later removed when the first digit is received.

Digit Analysis

4.09 Digit analysis is performed on all types of calls. For example, TOUCH-TONES are sent from the subset to the TOUCH-TONE receiver 1 as shown in Fig. 36. Digits are received by the CC by means of the receiver scanner points and recorded in the CS register memory 2 . When the first digit is received, a check is made to see if a 0 or 1 has been dialed, either of which may require different translation procedures. The second and third digits are then detected and recorded. A translation of the first three dialed digits (assuming a 0 or 1 has not been dialed) indicates the call type (intraoffice or outgoing) and the number of digits to expect. When all digits have been received, CC opens the cut-through relay to the TOUCH-TONE receiver 3 .

Ringing Connection

4.10 Upon receipt of the last digit, the CC executes program instructions which provide the trunk network number and terminating class-of-service information for the called line. The busy-idle memory of the called line in CS is checked; if the line is idle, it is marked busy. The class-of-service information indicates the method to be used for providing audible ringback to the calling line and for alerting the called line. Audible ringback may be provided either by means of a tone generator in the switching office or by a tone from the called station (confirmed audible). Alerting may be provided either by signals on the M and/or S relays of the called line or by use of a ringing generator in the office. An example of one possible ringback and alerting method is shown in Fig. 37 and 38. Here, an audible tone generator 3 (Fig. 37) and a path to connect it to the calling line 2 are selected. Also a path from the calling line to the
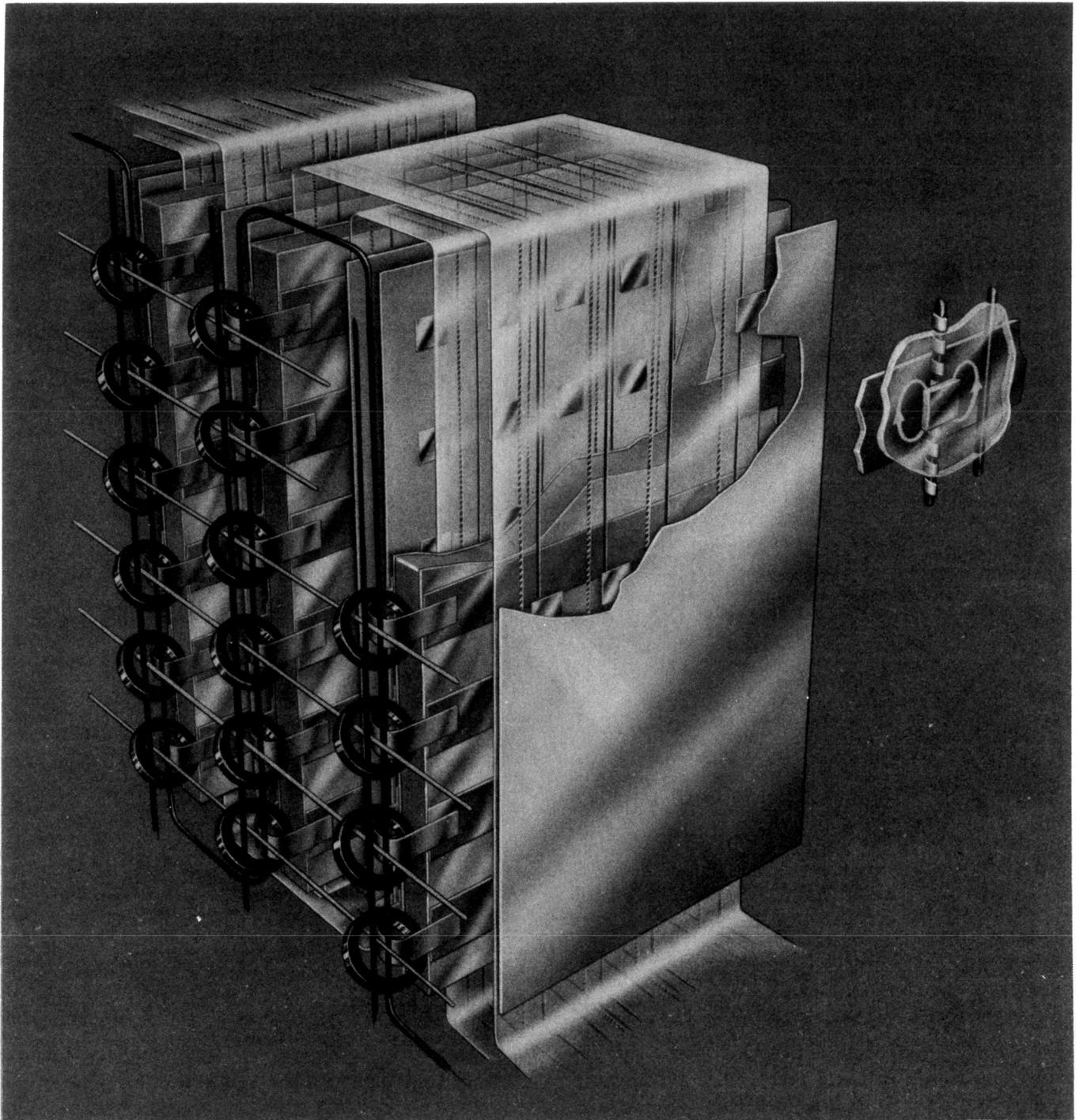
Fig. 33—Twistor Memory Module
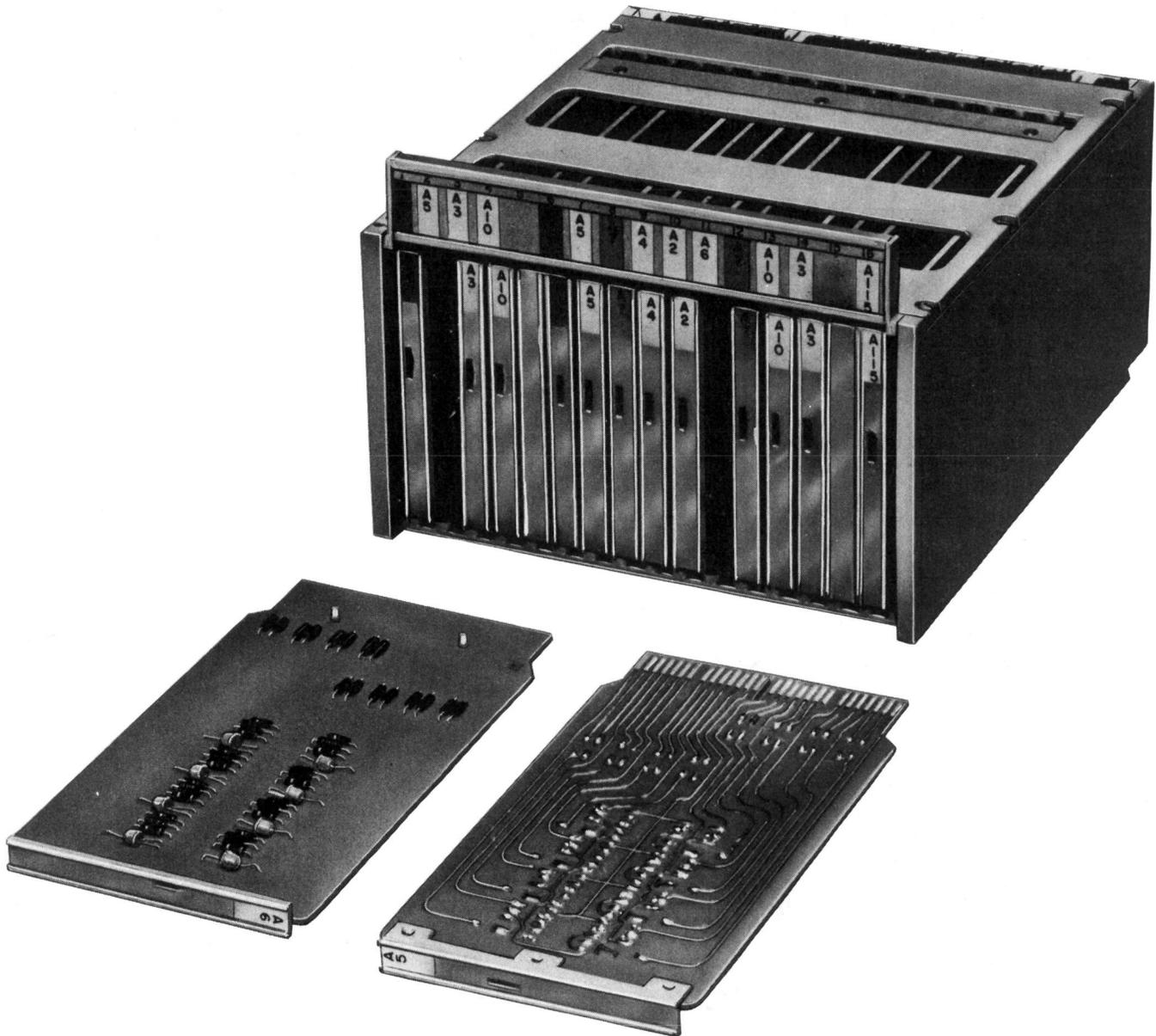
Fig. 34—Circuit Packs and Apparatus Mounting

called line is selected and reserved in CS memory (Fig. 38). The M relay 3 (Fig. 38) is now operated. This action causes station equipment to provide ringing. The audible tone generator is now connected to the calling line. When the called line goes off-hook, current flows through scan point 4 ; this action is detected by the central processor 5 . The audible ringback circuit is then disconnected and the connection is established between the calling and called lines.

Talking State and Abandon Sequences

4.11 The originating and terminating coupler scanner points associated with a talking state call are scanned every 50 milliseconds. When a change to on-hook by either subscriber is detected, a timing interval of 200 to 300 milliseconds is initiated. This is a safeguard against momentary on-hook conditions which could cause premature disconnect actions. After the 200- to 300-millisecond

Fig. 35—Dial Tone Connection

timeout following an on-hook, a 4- to 5-second time (calling party hold) is monitored provided the originating line remained off-hook. During this interval, if the terminating line returns to off-hook, the network path is left estab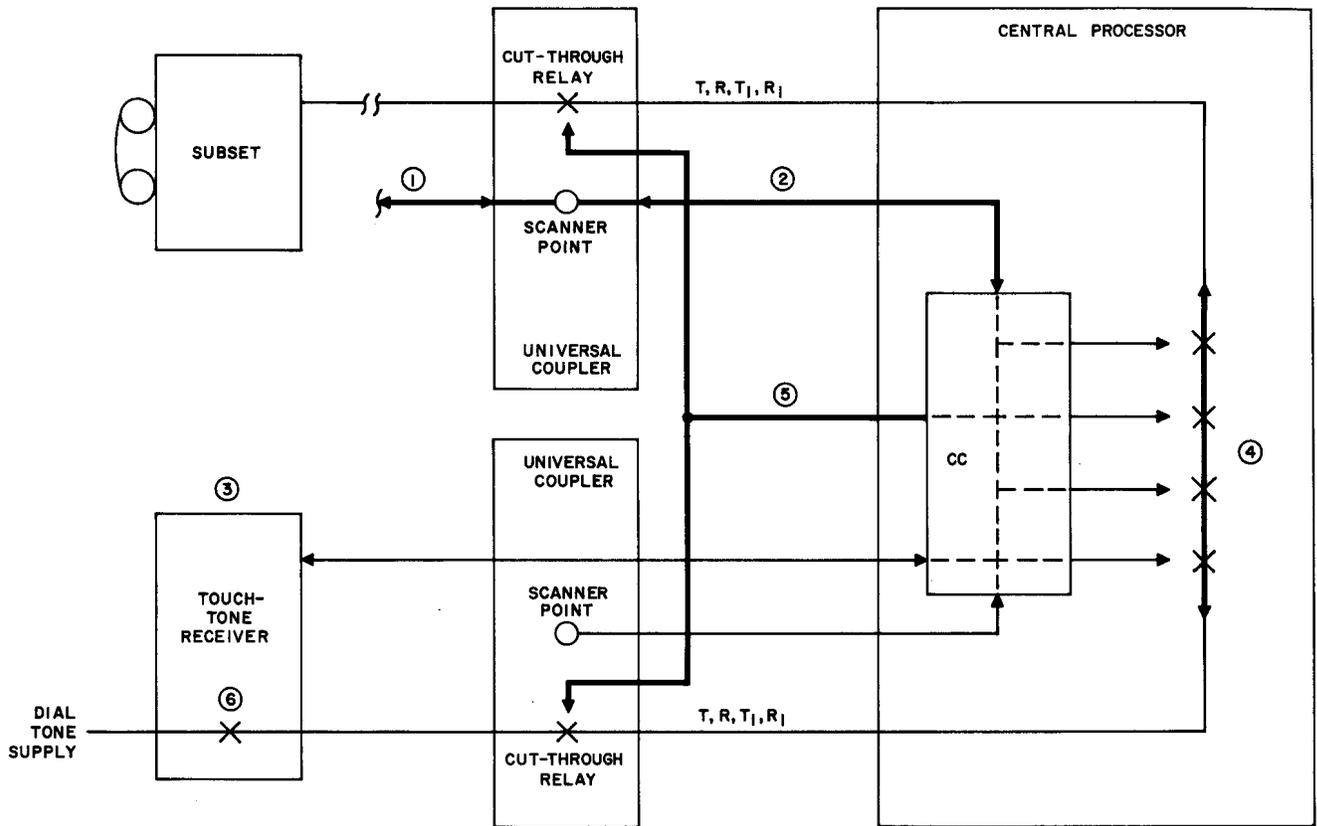lished. If an on-hook is detected from the originating line or timeout occurs, the connection is released. If the originating line goes on-hook first, the terminating line is timed for 10 to 11 seconds for an on-hook signal (false origination timing) before the off-hook signal is interpreted as a new service request.

B. Outgoing Call

4.12 When intercenter routing of a call is indicated, translation data is provided to allow the call to be processed from specified route pattern information. This information provides, for example, the outgoing trunk group, transmitter type, routing required, etc. With this data available, the ESS continues to supervise the subscriber line and proceeds as follows (Fig. 39).

(1) An idle member of the outgoing trunk group is selected.

(2) An idle transmitter is selected.

(3) A network path between the transmitter and trunk circuit is established.

(4) A network path between the line and trunk circuit is reserved.

(5) A seizure signal towards the distant office is sent, a path continuity check is made, and supervisory signaling is initiated before outpulsing.

(6) Outpulsing is completed, the transmitter is released, and the reserved path between the subscriber line and trunk circuit is connected.

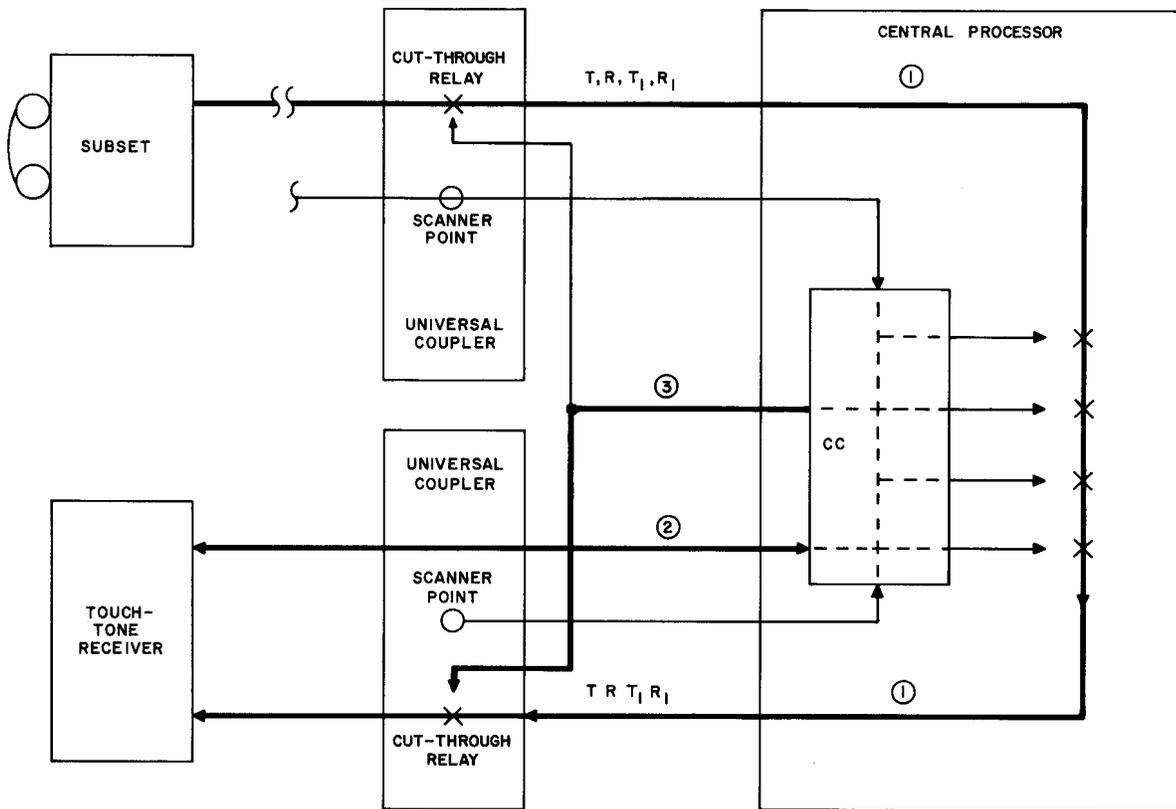(7) Scanner points associated with the trunk are scanned for answer (off-hook) and points

Fig. 36—Call Processing Data

associated with the subscriber line are scanned for possible abandonment of the call.

(8) When an answer is detected, the calling line is set off-hook and the CS memory (busy-idle) is updated to the busy state.

(9) Call is monitored and disconnect timing is initiated when an on-hook is detected.

> *Note:* Similar disconnect and timing sequences are used for interoffice calls as those described in 4.11 for an intraoffice call except that a guard interval of approximately 750 milliseconds is imposed during which the outgoing trunk circuit cannot be reseized.

C. Incoming Call

4.13 When an incoming intercenter call is detected by supervisory scans of a trunk group member's scanner point, the ESS proceeds to complete the call as follows (Fig. 40).

(1) The trunk circuit seized is identified by its scan point assignment, and translation data is analyzed to determine the trunk class information necessary for processing the call.

(2) The ESS selects the type of receiver to be used and establishes a network connection between the trunk circuit and receiver.

(3) The trunk circuit is monitored at its scanner point and a start-dial signal transmitted to the distant office if required.

(4) Incoming digits are received and recorded in CS memory and a directory number translation is performed to determine the terminating class of service and office assignment for the terminating line or trunk.

(5) A busy-idle check of the terminating line is made. If the line is idle, a talking path is reserved and alerting is initiated to the line,
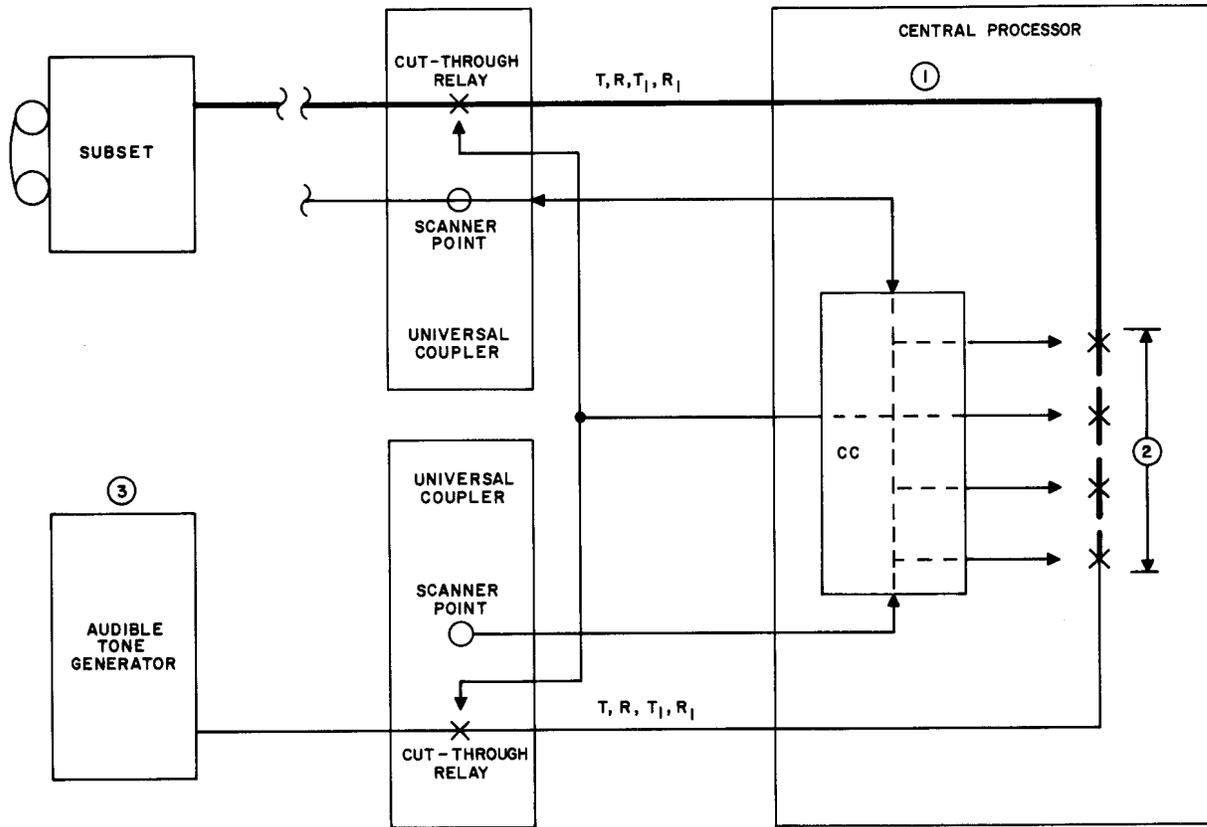
Fig. 37—Audible Ringback

etc. If the terminating line is busy, busy tone is connected to the incoming trunk.

The call is completed and supervision maintained with the talk state and disconnect sequence previously described in 4.11.

5. PROGRAM ORGANIZATION

5.01 The organization of the ESS program has been influenced by several factors, among which are the following objectives:

● To handle a large number of calls

● To provide sufficient flexibility for office growth and new service features

● To provide automatic detection and diagnosis of trouble conditions.

5.02 The entire program consists of approximately 130,000 instructions. Of these, approximately one half is devoted to call processing and related functions; the other half is devoted to automatic maintenance.

5.03 The ESS program is divided into a number of major functions. These functions are programs designed to perform a particular system operation. The following are some of the general categories of call processing programs.

(a) Input-output programs specialize in collecting a particular type of input information to be processed (for instance, dial pulses) or in transmittimg to peripheral equipment information that has resulted from processing.

(b) Call processing programs specialize in the processing of information pertaining to a particular type of call or to a phase of a call.

(c) Service routine programs specialize in serving other programs (call processing or maintenance) in a common way. These routines are called
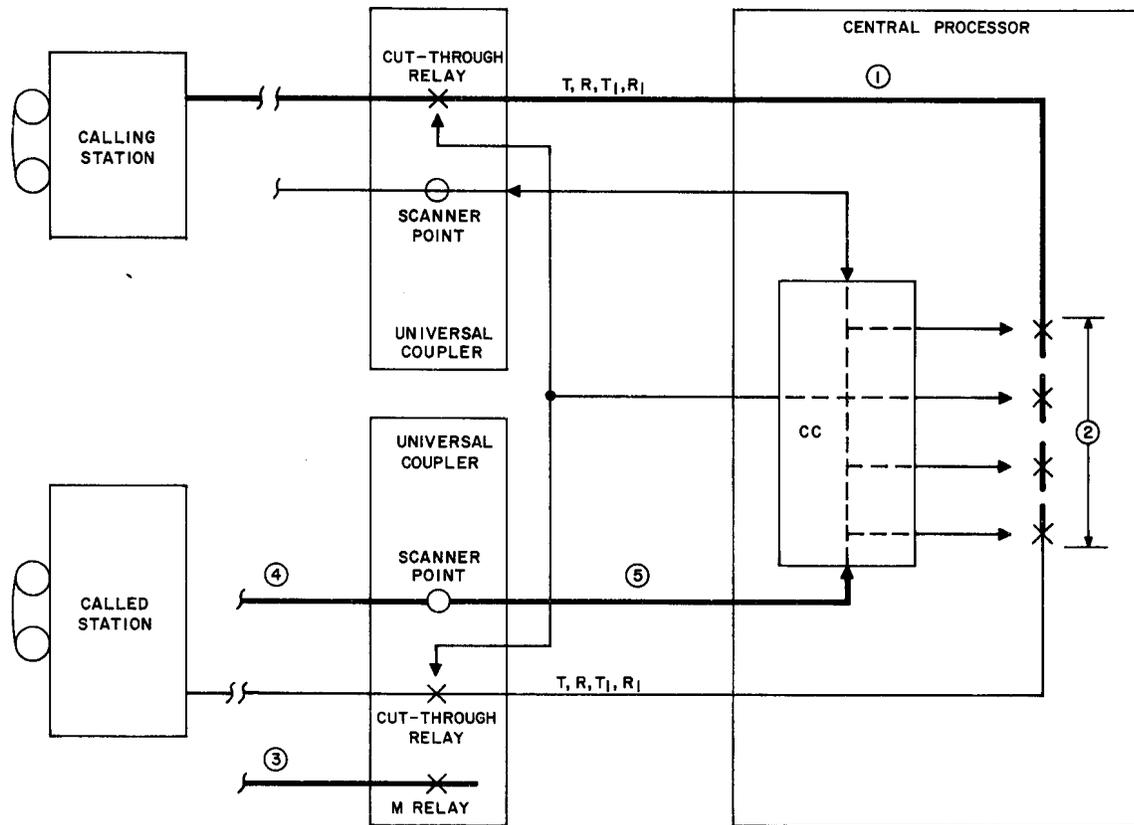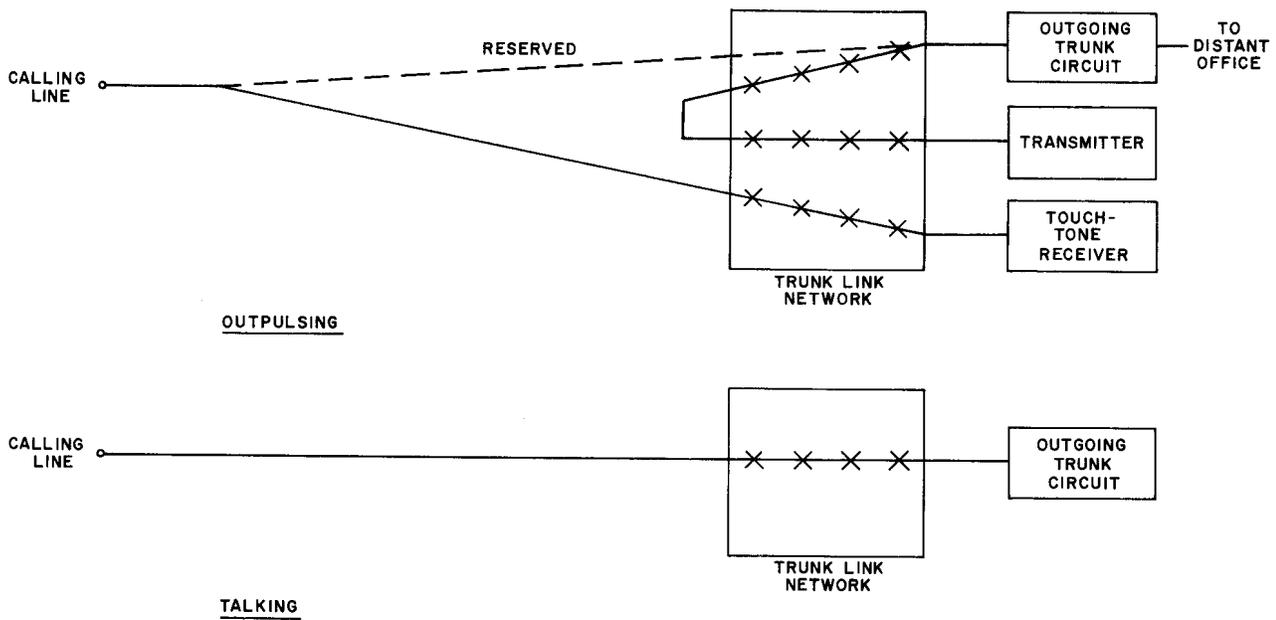
Fig. 38—Talking Connection

Fig. 39—Sequence of Actions on an Outgoing Call
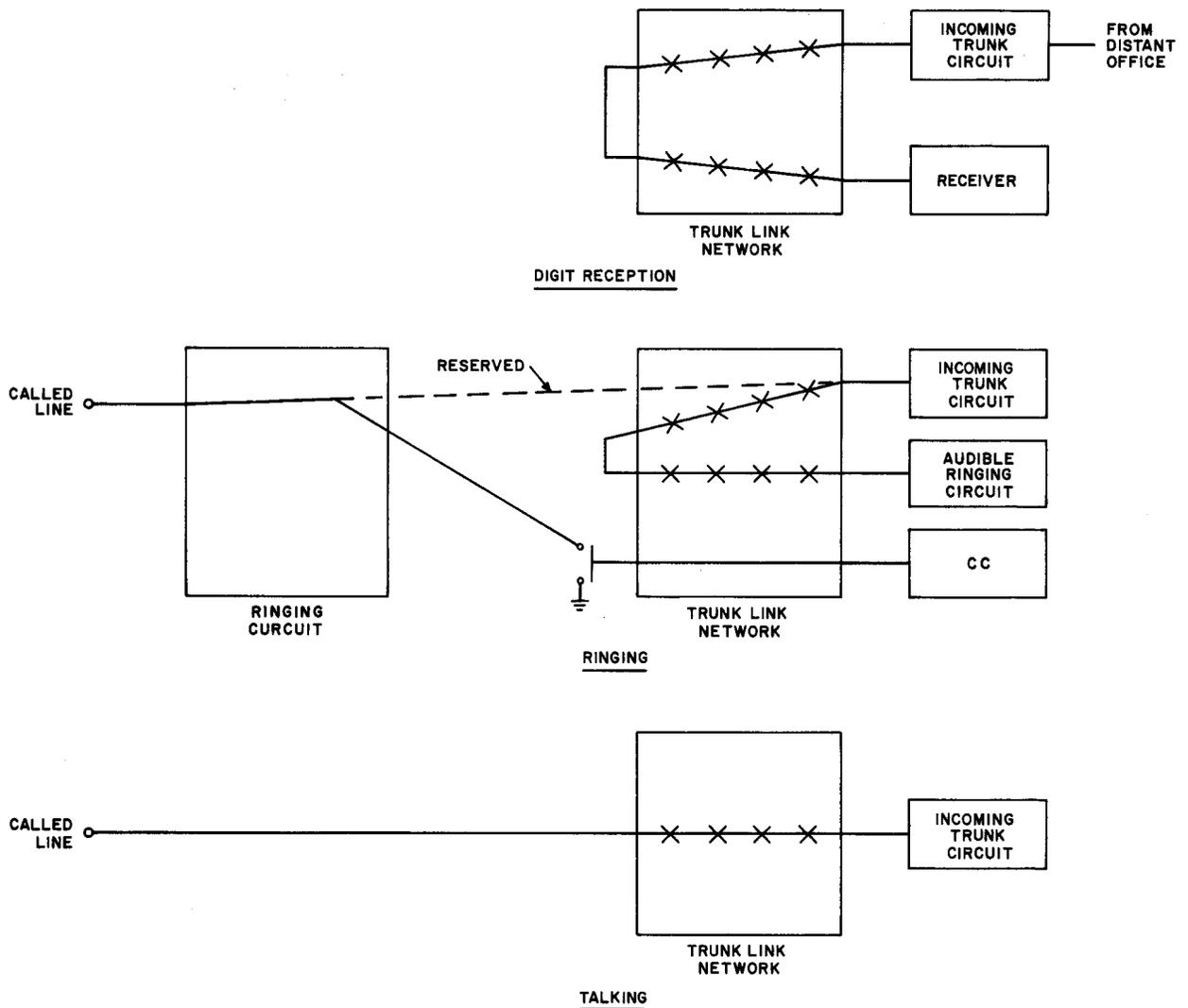
Fig. 40—Sequence of Actions on an Incoming Call

upon, when needed, by the various call processing or maintenance programs which are referred to as clients of the service routine programs. As an example, any program can request a translation routine to determine the equipment number that corresponds to a given DN.

(d) An executive control program schedules the work of the input-output and call processing programs.

5.04 The organization of the program is also related to the organization of the information stored in the temporary memory of the CS. In general, each program works with one or more CS

areas. The contents of these areas are modified to reflect the occurrence of events or the results of processing. Information recorded by one program may later be used by the same program and/or by others.

5.05 Each CS area consists of one or more words. Size and layout of the area vary. A CS word may be divided or used in its entirety to store an item of information. Each word or part of a word has a precisely defined assignment. A whole word may be used to store the identity of the trunk link network terminal being used for a particular call. Groups of four bits may be used

to store the various digits dialed by an originating customer.

5.06 The organization of the ESS program is strongly influenced by the fact that, like other telephone switching systems, the ESS must operate in real time; that is, it must respond promptly to actions that occur at times that are not under the control of the system. In the case of the ESS, a single time-shared high-speed CC must keep up with the flow of information from stations and from distant office systems. When it fails to do so, the improper handling of individual calls or a general degradation of service may result. Consequently, it is necessary to establish a hierarchy of prioritiies. Some system functions are of a nondeferrable nature and must be carried out under tightly controlled schedules. Other functions are of a deferrable nature and ocassionally can be delayed without significantly adverse effects. For example, monitoring for originations is a deferrable type job because there is not a noticeable effect on service if it is postponed for 5 milliseconds. Detecting dial pulses is a nondeferrable type job because pulses may be missed if it is postponed for even 5 milliseconds.

5.07 To perform nondeferrable work, the CC must generate an interrupt. Any one of several sources may generate an interrupt signal. The program being executed is immediately interrupted and a transfer is made to a program associated with the source of the interrupt signal. When the interrupting program has completed its functions, the program that was interrupted resumes its operation as though no interrupt had occurred.

6. MAINTENANCE

MAINTENANCE PLAN

6.01 Maintenance provisions for the ESS consist of the following.

(a) Maintenance circuits and programs provide for detection and diagnosis of failures automatically, or the system performs diagnostics on manual requests.

(b) An MCC provides a centralized control point for communication, controlling, testing, and recording requirements of the system.

(c) An office alarm system for system detected and locally detected failures is provided.

6.02 The maintenance plan is supported by the following.

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

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

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

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

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

(f) Snap call facilities obtain TTY printouts of peripheral output buffers, call registers, and other blocks of CS.

(g) Traffic overload conditions are detected by program action and are given to the maintenance personnel. Manual intervention causes the system to initiate line load control.

(h) Call tracing procedures are used to determine the trunk network number of a call in progress through the network.

FAULT RECOGNITION PROGRAM

6.03 When a malfunction is detected, call processing is momentarily interrupted by the CC interrupt sequencer which transfers the program control to an appropriate fault recognition program. The occurrence of a malfunction is detected mainly by circuits which perform matching, by parity checking, and/or by scan points which monitor circuit conditions. The fault recognition program reestablishes an operational configuration, determines which system has failed, and removes it from service. Then it requests that an appropriate diagnostic program be initiated at a later time and

returns control to the call processing programs. Normally the interruption of call processing does not last long enough to result in the loss of any dial pulses.

DIAGNOSTIC PROGRAM

6.04 A diagnostic program carries out a systematic sequence of tests aimed at localizing a fault to a small number of plug-in circuit packs. This work does not interrupt normal telephone service because diagnostic actions are segmented and interweaved with the processing of calls. The diagnostic results are printed out via a maintenance TTY. With the aid of a trouble locating manual, these results are translated by the maintenance personnel into the location and type of the circuit pack(s) to be replaced.

A. Exercise Program

6.05 The exercise program is a low-priority scheduled routine which includes service circuit tests and network map verifications.

B. Audit Program

6.06 The audit program is a form of exercise program used to eliminate erroneous or inconsistent information in the CS.

OFF-LINE MAINTENANCE

6.07 An off-line method of maintenance is one in which a CC, a PS, and in some cases a CS are separated from the rest of the system to carry out repeatedly fault recognition or routine exercise programs. For instance, a high-error count may be experienced only with a particular central control-bus-program store combination. The source of errors, in this case, cannot be isolated by on-line methods because switching out any of the units involved causes the errors to stop.

6.08 Off-line maintenance is initiated manually via the maintenance TTY. Appropriate tests can be repeatedly performed off-line until the source of trouble is identified.

7. GLOSSARY

7.01 The following is a glossary defining terms used in the 4-wire No. 1 ESS.

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

Bit A binary unit of information represented by one of two possible conditions: 0 or 1, on or off, high potential or low potential, conducting or not conducting, magnetized or demagnetized.

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

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

Cable Driver An amplifier, transformer coupled to a bus, used to amplify pulses transmitted over the bus.

Cable Receiver An amplifier, transformer coupled to a bus, used to amplify pulses received from the bus.

Destructive Readout The process whereby information read out of a memory element is thereafter not retained by the element.

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

Error A random malfunction which cannot be reproduced by the system under program control.

Fault A malfunction that can be reproduced by the system under program control.

Hopper An area in call store memory used to record items for communications from input-output programs to central control programs.

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

Index Register A register that is used to store a numerical quantity for the modification of addresses or data.

Instruction   A binary word which directs central control to perform a particular function.

Interrogate   To determine the state of a device or circuit.

Logic Circuit   A circuit capable of producing one or more outputs only when specified input conditions are satisfied.

Malfunction   A unit failure that can be detected by the system under program control.

Mask   A binary word used to specify the bit positions to be operated on without affecting other bit positions.

Masking   The process of specifying certain bit positions of a binary word. The word to be masked and the word to be used as a mask are combined by means of the logic product (AND).

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

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

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

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

Peripheral Units   The part of No. 1 ESS exterior to the central processor. The perpherial units consist of the network controllers, the scanners, the signal distributors, and the master control center.

Queue   An area in call store memory used to record a waiting list for some particular facility (for example, the waiting for multifrequency receiver queue).

Real Time   Actual time of occurrence of an event. A real-time control system is one in which operations are performed by the control equipment in time for the outputs obtained to be useful in controlling that process.

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

Register   A functionally associated set of memory elements with or without its controls and access; a word repository.

Subroutine   A sequence of programmed instructions to perform a particular function which is commonly used by several programs.

Supervisory Scan   The sequential reading of groups of scan points to determine the state of lines, junctors, trunks, or service circuits.

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

Translation Information   Information contained in the program store or call store pertaining to individual lines or trunks. It may be used to convert a directory number into an equipment location, to derive the class of service, etc.

Trouble   A malfunction or other condition that causes a deviation from normal system operation.