GENERAL DESCRIPTION

NO. 3 ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section describes in general terms the physical and functional characteristics of the No. 3 Electronic Switching System (ESS).

1.02 This section is being updated to include some general aspects of equipment and software changes. These changes are indicated by change arrows.

1.03 The No. 3 ESS is a small electronic central office which offers modern telephone services to small communities. The extensive use of new devices and technology provides a stored program system that is not only compact and highly efficient but is also readily maintained and can function unattended.

SYSTEM CHARACTERISTICS

1.04 The No. 3 ESS is a common control switching system. Common equipment, which is not part of the talking connection, is used to establish a connection through the network and then becomes available to establish other connections. The No. 3 ESS is designed to serve from several hundred up to approximately 4500 lines and has a peak capacity of 11,000 busy hour calls.

1.05 The frames in the No. 3 ESS office are completely assembled, interconnected, and system tested at the factory with the actual program and office parameters. The use of a fixed floor plan (Fig. 1) eliminates the engineering of frame location, cable racks, and cabling. The modular design of the network frames provides network, associated control, trunks, and service equipment in one package with no options except for plug-in trunks and service circuits.

1.06 The No. 3 ESS utilizes high-speed electronic components, remanent reed (remreed) switches, ferrod sensors, and insulated gate field effect transistor (IGFET) memory storage devices to perform its functions. Stored program control provides flexibility of operation in that additions and changes in basic service may be accomplished primarily by software changes.

1.07 Some of the system techniques which characterize the No. 3 ESS are as follows:

(a) ***Stored Program Control:*** The No. 3 ESS uses software for administrative, operational, maintenance, and miscellaneous support functions.

(b) ***Microprogram Control:*** This is an integral part of the central control. It provides most of the complex controls and sequencing operations required for implementing the system instructions.

(c) ***Central Control:*** Duplicated control executes all program instructions. Under normal conditions, the control equipment can process all calls and perform routine maintenance functions.

(d) ***Modular Design:*** Traffic-dependent units (ie, network frames) are grouped in modular blocks to facilitate growth and maintenance.

(e) ***Remote Maintenance Capability:*** Remote maintenance can be accomplished at the switching control center (SCC). Displays and keys available in the SCC repeat those functions provided at the central office.

(f) ***Duplication for Reliability:*** Continuous operation is maximized by providing duplicate units which the software automatically calls in to prevent service loss due to major equipment failure. Two complete systems, system control (SYC) 0 and 1, handle call processing.

(g) ***Automatic Fault Detection, Fault Location, and System Switch:*** The No. 3 ESS provides facilities under software control which automatically detect failures, identify the faulty unit(s), take the unit(s) out of service, and then switch in the duplicated standby SYC to handle call processing and maintenance tasks.

SYSTEM ORGANIZATION

1.08 Functionally, the No. 3 ESS consists of three major equipment areas:

(1) Control complex

(2) Periphery

(3) Power equipment.

1.09 The ***control complex*** (Fig. 2) consists of the equipment necessary to access the system for administration, operation (call processing), and maintenance functions. It is the area where the man-machine interface functions are accomplished.

1.10 The ***periphery*** consists of the necessary equipment selected by the control complex to switch calls through the office and to perform various integrity checks. Upon command from the control complex, the periphery performs tasks such as scanning customer lines, selecting paths through the office, and changing state relays.

1.11 The major ***power equipment*** consists of the rectifiers, converters, inverters, fuses, and controls necessary to supply office power requirements. Ringing and tone plant will also be identified in the power section of this BSP.

1.12 The functional areas are interrelated to provide two systems, each capable of assuming total office operations instantaneously. The SYC (0 or 1) consists of a control unit (CU) and associated controllers located in the periphery (Fig. 3). The CU (which is part of the control complex) consists of the 3A central control (3A CC), the main store (MAS), and the system status panel (SSP), which is not duplicated. The controllers located in the periphery (and referred to as peripheral controllers) include the frame input/output controller (FIOC), the scanner controller (SC), the network controller (NWC), and the peripheral pulse distributor (PPD). Power, ringing, and tone requirements are fulfilled without regard to which SYC has control of the office.

1.13 Each SYC is switched as a unit since the supporting components assigned to each SYC cannot be interchanged. It should be noted, however, that the active (on-line) SYC has the responsibility to update the standby (off-line) SYC memory. There are two equipment units (duplicated) which support both SYCs but which are not specifically assigned to either SYC. These are:

(1) Teletypewriter controllers (TTYCs) 0 and 1

(2) Tape data controllers (TDCs) 0 and 1.

SYSTEM FEATURES

1.14 A list of No. 3 ESS features, over a full range of line sizes, is provided in Tables A through E. The following is a glossary of these features. Within each category, the individual features are listed alphabetically.

A. Line Features

Billing Treatment

(a) ANI—Automatic number identification for toll calls. Calling numbers are outpulsed to a CAMA center.

(b) Bill to Listed Directory Number—LDN outpulsed to CAMA on billable DDD calls.

(c) Flat Rate—Permits calls to a group of selected NXX codes without additional charge.

(d) Free Terminating—Answer supervision is not returned when such a line is called.

(e) Hotel-Motel—Same as message rate service plus provision of a remote message register to determine the charge on individual calls.

(f) Message Rate—Telephone service for which a charge is made in accordance with a measured amount of usage (message units).

(g) ONI—Operator number identification for calls routed to the CAMA operator for charging.

(h) Remote Message Register—A hardware register located on customer premises to provide the charge information (in terms of message units) used to compute the actual charge of individual message rate calls.

(i) Software Message Register—A software register located at the No. 3 ESS office to provide charge information (in terms of message

units) used to compute customer monthly billing for message rate calls.

(j) QZ Billing—Toll calls from lines having this feature are routed to a CAMA operator for identification.

Hunt Arrangements

(a) Multiline Hunt—A customer feature that allows calls to hunt over a specified group of lines in an attempt to connect the calling party to an idle line within the group. A multiline hunt group may contain up to 64 members and offers three optional features that alter the hunting sequence as follows:

(1) Night Stop—This feature allows one member to be designated as a night stop member. When night stop is activated, the sequential hunt for an idle member begins at member number 00 instead of the first hunt member and stops when the night stop number is reached.

(2) Stop Hunt—The stop hunt feature allows a member to be designated as the stop hunt member. When stop hunt is in effect, the hunt will begin at the normal member but will not hunt past the stop hunt member or the specified last hunt number, whichever comes first.

(3) Remote Make Busy—This feature allows a preselected set of members to appear busy to incoming calls. This set may include any number of members which are not restricted to sequential members. A multiline hunt group (MLHG) may have as many as seven remote make-busy groups.

(b) No Hunt—The No. 3 ESS is capable of associating directory numbers with individual facilities which may also be part of a multiline hunt group. Calls to these directory numbers do not cause hunting to occur.

(c) Series Completion—When the dialed number is busy, the call will be routed to other numbers in the series until an idle line is found. The numbers in the series must be within the same office code.

Custom Calling Features

(a) Call Forwarding—When activated by a station user, this feature automatically routes calls intended for his station line to another station line the user has designated. Forwarded calls may be toll charged if the forwarded-to party is in a different rate area.

(b) Call Waiting—Permits a customer who is in the talking state of an established call to be notified of an incoming call. The customer may then elect to receive the second call, via switchhook flash, while holding the existing connection.

(c) Speed Calling—Permits a station user to originate calls to frequently called numbers by dialing predesignated codes consisting of fewer digits than normally required. Speed calling lists may contain 8 or 30 entries or both. Individual entries may be changed by the subscriber.

(d) Threeway Calling—A station user can add a third party to any established call for a 3-party conference without the assistance of an operator.

Miscellaneous Features

(a) Call Tracing—On both intraoffice and interoffice calls, provides originating line identification or incoming trunk identification on calls completed to a specified line or number.

(b) Denied Originating—Prohibits a line from originating a call.

(c) Denied Terminating—Prohibits a line from receiving a call.

(d) Emergency Manual Line—Provides manual service to certain customers when a service-affecting equipment failure exists. This is a separate circuit, compatible with No. 3 ESS.

(e) Emergency Line (Fire, Police)—Terminates up to ten different simultaneous calls to a public emergency line and rings the station(s) on this line. This is a separate circuit, compatible with No. 3 ESS.

(f) Ground Start—Signaling method which uses a ground connected to the ring lead to saturate a line sensor when an off-hook condition exists.

(g) Group Alerting—Provides a means, independent of the switching network, to alert a special group of customers (fire, police, etc) over regular message telephone lines. This is a separate circuit, compatible with No. 3 ESS.

(h) Immediate Ring—Reduction of the 1.33-second average delay for start of ringing which is encountered in existing step-by-step and crossbar systems.

(i) Line Lockout—Normally caused by equipment malfunction, it automatically disconnects a line from the switching equipment so that the equipment is not held busy.

(j) Loop Start—A method of signaling an off-hook condition by completing the loop current path.

(k) Make Busy—Permits the business customer to make lines appear busy to the central office for any subsequent terminating calls.

(l) Nonsynchronized Audible Ring—The audible ring heard at the originating end and the ring heard at the terminating end are not synchronized.

(m) Partial Dial Treatment—A call is given partial dial treatment when the customer dials at least one digit but fails to dial an accepted number of digits in the time allotted for completing a call. Such calls are routed to a tone or announcement and then given permanent signal treatment, if necessary.

(n) Permanent Signal Treatment—Such a condition exists if a line fails to disconnect after a call is torn down or if an originating line remains off-hook for an excessive period of time without transmitting digits. If no action is taken by the customer, the line will be set to the high and wet state.

(o) Plug-Up List—Lines on this list are busied for maintenance purposes. Calls to these lines are routed to trouble intercept.

(p) Reverting Calls—Calls originated by 2, 4, or 8-party stations which are terminated to stations served by the same line.

(q) Sleeve Lead—Third wire (in addition to tip and ring) used for line service observing or busy indication.

(r) Toll Diversion—Places a restriction on the calling area available to PBX extensions by transmitting a diversion signal to the PBX.

(s) Toll Restriction—Customers with this class of service are permitted to complete calls to preselected NXX codes only in certain NPAs.

(t) 911 Calls—Customers dialing 911 are connected to the emergency service bureau. The service bureau can hold the connection for as long as the attendant remains off-hook. Other features provided are emergency ringback, switchhook status, and abandoned call indications.

Protective Arrangements

(a) Dynamic Service Protection—Lines designated class A are given preference over class B lines for originating calls when overload conditions are reached in emergency situations.

(b) Overload Announcement—An overload announcement is available that can be enabled by the maintenance TTY or by a remote traffic TTY. This announcement, when enabled, is heard instead of overflow tone when the connected junctor is placed in the overflow state.

Coin Features

(a) Coin First—Requires deposit of the initial coins before the customer receives dial tone.

(b) Dial Tone First—Dial tone is returned without deposit; no initial deposit is required for operator (dial 0), information (411), or emergency service bureau (911) calls.

(c) Local Coin Overtime—An optional feature that controls overtime charging on local coin calls.

B. Trunk Features

Trunk Signaling

(a) Delay Dial (Incoming Loop Only)—The called office signals off-hook toward the calling end and remains in the off-hook condition until a register sender is attached and is ready to receive pulses. At that time, the called office changes to an on-hook condition which is a start dialing indication to the calling office.

(b) Immediate Start—The originating distant switching system (usually SXS) does not wait for a start signal before sending dial pulses. The terminating switching system must be ready to receive pulsing in less than 65 ms. The No. 3 ESS is ready in 40 ms.

(c) Reverse Battery—A supervisory arrangement in which the battery and ground potentials on a trunk are reversed to indicate that the called party has answered.

(d) Stop Go—A momentary off-hook signal given during an interdigital interval to indicate that dial pulsing should stop until the transition from off-hook to on-hook, or GO signal, is returned. This feature is used when connected to a step-by-step tandem.

(e) Wink Start—A momentary off-hook signal sent from the terminating office to the originating office as an indication that outpulsing may begin at the end of the timed off-hook wink. An off-hook of 140 ms to 190 ms is required.

Miscellaneous Trunk Features

(a) Automatic Ring—A method for supervision alerting on a nondial trunk where closing the loop at the originating end results in a ringing signal at the terminating end.

(b) Class-of-Service Tone—Short tone to the operator which identifies the type of originating call.

(c) Inband Coin and Rering—Coin collect, coin return, and rering features are signaled by a wink, followed by multifrequency tones.

(d) Multiwink—A series of on-hook winks to indicate operator released, operator attached, coin collect, coin return, or ringback from TSPS.

(e) No-Test Access—Trunk is bridged onto an existing connection to enable an operator or maintenance personnel to complete calls to facilities which may be busy.

2. PHYSICAL DESCRIPTION

2.01 The No. 3 ESS uses standard equipment frames which are 7 feet high. The depth of the frame is 12 inches in the periphery and 18 inches in the control complex and power areas. The low-profile combined distributing frame (LPCDF) is approximately 24 inches deep, has a maximum height of 9 feet, and each module is approximately 6 feet long.

CONTROL COMPLEX

A. Processor Frame

2.02 The processor frame (Fig. 4) is a double-bay frame provided on a one-per-office basis. This frame contains the duplicated 3A CCs and MASs. It also contains the necessary power converters, filters, and fusing for this equipment.

B. Maintenance Frame

2.03 The maintenance frame (Fig. 5) is a single-bay frame provided on a one-per-office basis. This frame houses the teletypewriter (TTY), the system status panel (SSP), tape units, and associated controllers for each of these units. Each of the two teletypewriter controller units (0 and 1) provided on the maintenance frame has space to equip two independent teletypewriter controllers (TTYCs); however, in the No. 3 ESS, only one TTYC will be used in each teletypewriter controller unit. Each TTYC provides four TTY ports. The maintenance frame also contains the necessary power converters, filters, and fusing for this equipment.

PERIPHERY

A. Network Frame

2.04 Each network frame (Fig. 6) provides the first- and second-stage remreed switches for 384 terminals, 32 junctor circuits, and some associated control and power equipment. It is

arranged for and provides, on an optional basis, 24 universal trunks, 4 customer dial pulse receivers, and 3 regular ringing circuits. Since neither optional units nor wiring (except for ground start, loop start options) is required on the network frame, the only variation betwen frames is the quantity and type of circuit packs for trunk and service circuits. A total of 512 ferrod sensors are located on this frame for the universal scanner. The first and second stages of the network are connectorized to facilitate repair and are organized to minimize interruption of service during repair. The trunk units are universally wired to accept all trunk circuits. A total of 15 network frames may be provided for a full-size office (5760 terminals, maximum).

2.05 The switching network is constructed of concentrator groups. Associated with each network frame is one concentrator group which accommodates 384 terminals. A full-size office consists of 15 concentrator groups (one per network frame) capable of handling approximately 4500 customer lines (about 300 lines per concentrator group or per network frame).

2.06 Each concentrator group is made up of two concentrators, and there are 192 terminals associated with each concentrator. Within each concentrator are first- and second-stage remreed switches. There are twenty-four 8-by-8 first-stage remreed switches and eight 8-by-8 second-stage switches per concentrator (Fig. 7). The first and second stages of switches are connected by A-links which represent access paths.

First-Stage Switching

2.07 The first stage of switching concentrates the 192 input terminations to 64 outputs in each concentrator. (The outputs of the two concentrators in a concentrator group are multipled to provide a 6:1 concentration ratio.) The 64 outputs are connected to the second stage such that each of the single 8-by-8 switches in the first stage has access to each of the second-stage 8-by-8 switches.

Second-Stage Switching

2.08 Eight 8-by-8 switches are used in the second stage of each concentrator. This arrangement provides 64 inputs and 64 outputs for the second stage. The two 64 second-stage outputs per concentrator are connected to maintain the fixed 6:1 concentration ratio per concentrator group.

Junctor Circuits

2.09 Thirty-two junctor circuits are necessary for each concentrator group. The junctors are electrically located between the second and third stages of switching as shown in Fig. 7. Junctor circuits provide seven states and are used in all connections between terminals. The states are as follows:

(1) Bypass state

(2) Open state

(3) Line-to-line state

(4) Line-to-trunk state

(5) Trunk-to-line state

(6) Audible ring state

(7) Overflow tone state.

Scanner Ferrod Arrays

2.10 There are two types of scanner ferrod arrays associated with the No. 3 ESS. One is designated the universal scanner and is located on each network frame. The other is the master scanner and is located on control frame 0 only. Each ferrod array consists of 512 ferrods and interfaces with the scanner controller to provide status information to the 3A CC.

Service, Auxiliary Line, Universal Trunk, and Test Circuits

Service Circuits

2.11 Ten special-function service circuit types are required for the initial features provided by the No. 3 ESS:

(1) A customer dial pulse receiver receives dial pulses and serves as an interface to a TOUCH-TONE® receiver when TOUCH-TONE service is provided.

(2) A TOUCH-TONE detector circuit is utilized with a customer dial pulse receiver to detect TOUCH-TONE frequencies or dial pulses.

(3) A superimposed ringing circuit provides ringing to 4-party full select lines and 8-party semiselect lines. It is also used for revertive ringing and operator ringback.

(4) A regular ringing circuit type is used to ring individual, coin, revertive, PBX, 2-party lines, 4-party semiselect, and 8-party coded lines.

(5) A dial pulse transmitter sends dial pulses to a distant office.

(6) A coin control circuit is used to collect or return coins and to make initial and overtime deposit checks.

(7) The tone or recorded announcement circuit provides an interface between the ringing and tone plant and the network for high tone, low tone, receiver off-hook tone, and custom calling service tones as well as recorded announcement sets.

(8) A multifrequency (MF) receiver circuit detects MF signals.

(9) An MF transmitter circuit is used to transmit MF pulsing.

(10) A remote recording of the announcement circuit is provided to allow verification or changes of the recorded announcement from a location removed from the No. 3 ESS office.

Line Circuits

2.12 There are six special purpose auxiliary line circuit types which are compatible with the No. 3 ESS:

(1) ***Emergency Manual Line Circuit:*** This circuit is used to provide manual service to certain customers when a service-affecting equipment failure exists.

(2) ***Public Emergency Line Circuit:*** This circuit is used to terminate up to ten different simultaneous calls to a public emergency line (eg, fire department) and ring the station or stations on this line.

(3) ***Group Alerting Line Circuit:*** This circuit provides means, independent of the switching network, to alert a special group of customers (fire departments, etc) over regular message telephone lines.

(4) ***Emergency Line Circuit:*** Operators may complete direct emergency calls (independent of the switching machine) to police, fire, or other emergency line with this circuit.

(5) ***Dial-Tone-First Coin Line:*** The purpose of this line is to provide additional signals needed for dial-tone-first operation for coin phone lines.

(6) ***Noise Immunity Line:*** This type of circuit can be used for coin-first lines and lines from a PBX system.

Applique Circuits

2.13 There are three applique circuits currently being used with the No. 3 ESS:

(1) ***Scanner Applique:*** An interface between a scanner and various non-ESS equipment.

(2) ***Distributor Applique:*** This applique circuit provides the interface between a peripheral decoder located on one frame and state relays associated with a circuit located on another frame.

(3) ***E and M Applique:*** This circuit provides the capability for the E and M trunk facility or carrier to be compatible with the No. 3 ESS E and M trunk circuit (if that compatibility does not already exist).

Universal Trunk Circuits

2.14 Table F lists the universal trunk circuits offered by the No. 3 ESS and applications according to pulsing, signaling, and class. Any of these may be connected at any position of the universal trunk unit in the network, control, or miscellaneous frames.

Test Circuits

2.15 ▶Test circuits are mounted on type FB circuit packs in the test frame and control frame(s). False cross and ground, power cross detector, and

restore verify circuits, which are part of the test vertical test circuit, are located in bay 1 of the control frame(s). The remainder of the test circuits are located in the test frame. These are:

- Local Test Desk
- Line Insulation
- Station Ringer Test Line
- Trunk and Line Test Panel
- Transmission Test Termination
- Continuity Polarity Test
- Milliwatt and Transmission
- Environment Test
- Dial Pulse Receiver Test
- TOUCH-TONE® Receiver Test
- Tone Presence Detector Test
- Loop Environment Test.◀

B. Control Frame

2.16 The control frame (Fig. 8) is a double-bay frame. It houses the duplicated peripheral controllers with the associated +3 volt power converters and the basic third stage of the network. The network third stage is also connectorized to facilitate repair and expansion. The remaining space on the frame is used for master scanner ferrod sensors, trunk, and service circuit equipment which is provided according to individual office needs. The initial control frame (0) is equipped to accommodate the first seven network frames. A second control frame (1) is required to accommodate network frames 8 through 15. This frame houses the additional peripheral controllers, +3 volt dc-to-dc converters, and some of the switches required for expanding the third network stage.

Third-Stage Switching

2.17 The third stage of remreed switching consists of thirty-two 8-by-8 switches. One-half of the outputs (of a concentrator group) is distributed (one each) via wire junctors as shown in Fig. 7 to the inputs of the 32 third-stage switches. The other half of the outputs is connected, via circuit junctors, to the output of the third-stage switch. This arrangement allows the third stage to accommodate, without link rearrangement, up to seven concentrator groups or 2688 terminals. B-links or access paths connect the second and third stages of switching. There are wire B-links (wire junctors) and circuit B-links (circuit junctors).

2.18 Wire B-links are the connections from the output of the second-stage switch to the input of the third-stage switch.

2.19 Circuit B-links provide a junctor circuit between the remaining outputs of the second stage and the outputs of the third stage of switching.

C. Miscellaneous Frame

2.20 The miscellaneous frame (Fig. 9) accommodates different types of units. It is a single-bay frame initially provided on an as-needed basis. This frame houses the equipment overflow from the control frame (line, trunk, and service circuits), the announcement machine, plus additional units. A maximum of seven miscellaneous frames can be provided.

D. Test Frame

2.21 The test frame (Fig. 10) is a single-bay frame provided on a one-per-office basis. This frame will house the trunk and line test panel (TLTP), the incoming local test desk (LTD) trunk circuit, and the test circuits required for maintenance of the trunks, junctors, and service circuits. An inverter for one recorded announcement machine and the TTY is also located on this frame. This frame is located adjacent to the maintenance frame in the control complex lineup.

E. Low-Profile Combined Distributing Frame

2.22 The No. 3 ESS utilizes a low-profile combined distributing frame (LPCDF) (Fig. 11). The LPCDF is approximately 2 feet wide, 9 feet high, and 6 feet long. It is called a module. A maximum of two modules is needed. The second module is required when the eleventh network frame is added or if additional terminations are required for an unusual amount of toll equipment.

2.23 Each vertical side has provision for nine verticals, each equipped with up to five 303-type connectors. This can accommodate a total of 4500 outside plant pairs.

2.24 The horizontal side has provision for eight bays of connecting blocks. The horizontal side can accommodate either a 96-pair block (code 89A11-96 or 89A12-96) or a 100-pair block (code 89A1-100). A typical module would terminate up to 7840 equipment pairs.

POWER EQUIPMENT

A. ▶The 151-Type Power Plants

2.25 Two types of -48 volt power plants are available for use in the No. 3 ESS: the 151A and 151C. Each of these plants consists of a double-bay power frame and a single-bay supplementary power frame(s) (Fig. 12). The power frame contains rectifiers, filters, distribution fuses, and power control and alarm circuitry. The supplementary power frame contains additional rectifiers. The 151A power plant is capable of supplying up to 400 amperes while the 151C power plant is capable of supplying up to 600 amperes.

2.26 The -48 volt plant frameworks (ED-5A001-70 and ED-5A002-70) are 25 inches wide, 7 feet high, and 18 inches deep. The power frames are in the same lineup as the maintenance, test, and processor frames.

2.27 The 151A or 151C power plant will require one or more strings of battery cells, depending on the No. 3 ESS office load. These batteries may be either the rectangular KS-15544 or the cylindrical KS-20472 and arranged in 2-tiered single rows.

B. Power Frame

2.28 The -48 volt double bay power frame is capable of supplying up to 200 amperes (one of the three 100-ampere rectifiers is a spare or backup). Bay 0 of this frame contains one 100-ampere rectifier, power control and alarm circuitry, and distribution fuse panels. Bay 1 contains two additional 100-ampere rectifiers.

C. Supplementary Power Frame

2.29 The optional supplementary power frame is available to provide up to 200 amperes additional capacity for the -48 volt power plant. This frame provides two 100-ampere rectifiers. One power frame and one supplementary power frame enables the 151A power plant to supply up to 400 amperes. One power frame and two supplementary power frames enable the 151C power plant to supply up to 600 amperes. The additional supplementary power frame of the 151C power plant may be located near the battery stand.◀

D. Miscellaneous Power Frame

2.30 The miscellaneous power frame (Fig. 13) is a single-bay frame 12 inches deep, provided on a one-per-office basis. It is provided at the initial installation and is located in the same lineup as the network frame. It houses the following major units:

(1) Ringing and tone plant

(2) +24 volt converter, 8 amps per converter (four converters total, 16 amps per bus)

(3) ±130 volt converters, 1/4 amp per polarity (two converters)

(4) +48 volt converter, 1.8 amps per converter (two converters total).

2.31 The +24, ±130, and +48 volt converters are all plug-in units. The converters are used in the following manner:

(a) +24 volt dc-to-dc converter used in place of more conventional battery plant

(b) ±130 volt dc-to-dc converter for coin control and false cross and ground (FCG) tests

(c) +48 volt dc-to-dc converter for superimposed ringing, dial long lines, and dial tone first lines.

These converters are not for toll equipment use.

3. FUNCTIONAL EQUIPMENT DESCRIPTION

3.01 A functional description on the control complex, periphery, and power equipment follows. A detailed functional block diagram is provided in Fig. 14.

A. Control Complex

3.02 The control complex serves in an executive (or administrative control) capacity, directing all system functions to process and handle data for the No. 3 ESS.

3A Central Control (3A CC)

3.03 The main controlling unit of the No. 3 ESS is the 3A CC, which operates in a duplex mode. One 3A CC always has active control over the system while the other operates in a standby mode. Therefore, each 3A CC is a separate, complete unit capable of controlling the periphery and system actions. The active 3A CC keeps both the active and standby main store memory up-to-date. The standby 3A CC can assume control of system tasks when required.

Main Store

3.04 The MAS contains the call records, translation data, and system program. The MAS is electrically alterable (except blocks that are write-protected against unauthorized access), and memory contents can be changed by software. Recent change (RC) messages are used to alter translation data in the MAS when there are subscriber changes, trunk additions, additions of new routes, service observations, or changes in office code treatment.

3.05 The MAS is divided functionally into temporary store or call store, program store, and translation store. The temporary store is used by the 3A CC to store transitory data; the program store contains the generic program; and the translation store provides access to all line, trunk, class, and peripheral equipment information.

Tape Data Controller and Tape Unit

3.06 Each 3A CC has its own preferred cartridge tape system and may access the other cartridge tape system under normal operating conditions. Each tape unit contains all the programs, parameters, and translation data which reside in the MAS. It also contains other programs vital to the No. 3 ESS but which are infrequently used. These programs are referred to as ***nonresident*** (since they are not stored in the MAS) and include system diagnostics, maintenance utilities, and administrative and recent change programs. The most important function of the tape unit is to serve as the backup unit for the MAS.

Teletypewriter and Teletypewriter Controller

3.07 The TTY is the primary means of man-machine communication with the system. The TTY will print out test results, trouble records, traffic reports, office records, diagnostic results, etc. The TTY can be used for requesting tests, diagnostics, removal of equipment from service, restoring equipment to service, and directory number assignments.

3.08 The No. 3 ESS has a minimum of two TTY control units which are accessible by the on-line 3A CC. (Up to four TTY control units may be provided.) Each TTY control unit may be equipped with two independent TTY controllers. Each controller provides four ports to accommodate four TTYs. The No. 3 ESS only uses one controller in each of the two basic TTY control units. One controller is designated the maintenance unit and the other is the miscellaneous unit.

Maintenance TTYC

3.09 Each of four ports of the maintenance TTYC is dedicated to a particular user (Fig. 15). One port is used by a local maintenance TTY. The remaining three ports can be associated with up to three remote maintenance TTYs. The local and remote maintenance TTYs will receive the same messages from the system. Each may be used to input maintenance requests.

Miscellaneous TTYC

3.10 The miscellaneous TTYC also provides four ports (Fig. 15). These ports are reserved for other than maintenance functions. The miscellaneous TTYC provides for direct distance dialing (DDD) data link access for one or more centralized TTYs and is used for service/circuit orders or traffic measurements. The miscellaneous units may be redirected for priority maintenance should the maintenance unit become inoperative.

Autoconnect

3.11 The autoconnect facilities provide a means for establishing dial-up connections to the TTY ports from a location removed from the No. 3 ESS office. Remote TTY functions can then be

performed from that location. When the No. 3 ESS is operating normally (unattended), maintenance messages are sent to the remote switching control center (SCC) via port 1 of TTYC 0 and the private line. Port 0 of TTYC 1 is unused and port 1 of TTYC 1 serves autoconnect users. When the office is unattended, the maintenance messages are printed out on the local TTY via port 0 of TTYC 0.

E2A Telemetry Unit

3.12 The E2A is an interface between the No. 3 ESS and the SCC. The SCC is a centrally located control center capable of providing administrative, operational, and maintenance functions of up to 16 switching system central offices. The E2A equipment provides a means of transferring control and status information between the SCC and each No. 3 ESS office.

System Status Panel (SSP) and System Status Panel Controller (SSPC)

3.13 The SSP (mounted on the maintenance frame) provides visual indications of normal as well as emergency and alarm conditions (Fig. 16). The SSP provides designated keys to implement system emergency manual control as well as keys for test control, alarm control, and panel power. The SSPC provides the required circuitry to interface the SSP and the 3A CC.

B. Periphery

Frame Input/Output Controller

3.14 The 3A CC controls the entire periphery over a 6.67-megabit serial input/output (I/O) channel. The frame input/output controller (FIOC) serves as an interface between the 3A CC and the peripheral controllers (network, scanner, and peripheral pulse distributor). It converts information between serial and parallel forms (depending on the direction of flow) and gates the data to and from the peripheral controllers. The FIOC, as well as the peripheral controllers, is duplicated for reliability. Each 3A CC has a dedicated FIOC which can communicate with its associated peripheral controllers.

Network Controller

3.15 A network order is sent to the network controllers from the 3A CC via the FIOC. The network controller directs current pulses to selected network crosspoints to establish paths through the network. Verification of proper access pulsing is returned to the 3A CC via the FIOC.

3.16 The network, network access, and network controller circuit interconnect lines, trunks, junctors, and service circuits as directed by the 3A CC. The network controller also operates and releases the line cutoff and test vertical switches associated with the network. When a network order has been sent and the access enabled, the network controller and the network pulser validate the selected network path. If all tests pass, a start signal is sent to the network pulser which generates a pulse to be sent through the control windings of the designated remreed switches.

Scanner Controller

3.17 The scanner controller interfaces the scanner ferrod arrays with the 3A CC. The scanner controller receives address information via the FIOC from the 3A CC for a designated scan (ferrod) row to be interrogated. The interrogation results are sent back to the 3A CC via the FIOC.

Universal Scanner Ferrod Array

3.18 There is one universal scanner ferrod array on each network frame. Each array, which indicates status to the 3A CC via the scanner controller, is wired to most service, trunk, line, and junctor circuits, and the switching network. The scanner array uses ferrod sensors to detect the circuit states. The array consists of 16 columns and 32 rows. Associated with each row are 16 ferrod sensors. One scanner array is composed of 512 ferrod sensors. The universal scanner array is used to notify the system of customer service requests and to provide supervision functions in junctors, trunks, and service circuits.

Master Scanner Ferrod Array

3.19 The master scanner ferrod array is provided on a one-per-office basis and is located on control frame 0. The row and column arrangement of this ferrod array is similar to that of the universal scanner ferrod array. The master scanner array monitors trunk and service circuits, maintenance circuits, and alarm circuits.

Peripheral Pulse Distributor and Peripheral Decoder

3.20 The peripheral decoder (PD) controls peripheral circuit relays (service, trunk, line, test, junctors, tone plant, etc) as determined by the 3A CC. The 3A CC sends information via the FIOC to the peripheral pulse distributor (PPD). The PPD receives this data and directs it to its transformer matrix. Within the PPD this data is used to select 1 of 256 PDs. The specified PD accepts the information from the PPD in its shift register. Each PD has 12 relays under its control. Two PDs are mounted together on one circuit pack and are referred to as a peripheral decoder group (PDG).

Trunk and Line Test Panel (TLTP)

3.21 The TLTP (Fig. 17) is a manual test facility for performing various tests on trunks, service circuits, lines, and junctors.

3.22 The following test capabilities are provided by the TLTP:

- Operational and transmission tests of trunks, junctors, and service circuits
- Leakage and continuity checks on lines and trunks
- Complete functional tests of subscriber lines
- Transmission checks on subscriber lines and PBX trunks
- Removal of trunks, service circuits, lines, and junctors from service and restoral to service
- Voice communications via private lines and regular telephone channels to other points within the No. 3 ESS offices and to distant offices
- Removal of peripheral decoder (PD) groups from service under key control and restoral to service.

3.23 The TLTP is equipped with a voltmeter (KS-19395) and may have an optional 23A transmission measuring meter (KS-20355). These meters are used to indicate testing results.

Emergency Overload Announcement

3.24 The recorded announcement machine is located on a miscellaneous frame. The 7A, 12A, and/or 13A announcement machines may be used. One machine can contain one recorded announcement which must be brought into service via a TTY input message. The announcement on the machine can be changed to provide a different recording, if necessary. Additional announcement machines can be supplied to provide for other types of announcements as required.

Remote Recording of an Emergency Overload Announcement

3.25 The capability of recording an announcement from a remote location can be provided on an optional basis. This capability was provided since the following conditions exist:

(1) The No. 3 ESS office is usually unattended.

(2) The announcement machine is located in the No. 3 ESS office.

(3) The reason for the overload is not always the same.

C. Power Equipment

3.26 ▶Commercial 208/240-volt, 60-Hz, single-phase or 480 volt, 60-Hz three-phase ac power is rectified and filtered in the power frame to supply the No. 3 ESS with a -48 volt dc source.◀ Other required voltages are derived from the -48 volt supply by dc-to-dc converters and dc-to-ac inverters. The -48 volt power is supplied to every equipment frame in the office. The +24, +48, and ±130 volt converters, which supply power to specified circuits on the equipment frames, are located on the miscellaneous power frame. The remaining converters (+3 volt, +5 volt, 200 volt, etc) supply power only to the frames on which they are located and are essentially part of circuitry on that frame.

3.27 To assure reliability, the distribution of the -48 volts is duplicated (A-bus and B-bus) and fed independently to each of the duplicated units and half of the replicated circuits (typically trunk, line, and service circuits). In addition, voltage converters that provide the other voltage levels are duplicated to prevent single faults from causing major service outages.

151A Power Plant

3.28 ▶The -48 volt 151A power plant consists of a double-bay power frame and a single-bay supplementary power frame, which contain rectifiers, distribution fuses, power control and alarm circuitry, and reserve batteries. The plant supplies a maximum of 400 amperes direct current to the No. 3 ESS switching equipment and the toll and transmission equipment. A 24-cell battery string serves as a backup power source in case of commercial power failure. The 24-cell battery string capacity provides a maximum of 15 network frames in an office. There is sufficient time to connect a portable ac generating plant to the service entrance equipment when a commercial power loss occurs.◀ Charging of the battery string is performed by the -48 volt rectifiers on the power and supplementary power frames.

▶The 151C Power Plant

3.29 The -48 volt 151C power plant is a double-bay power frame with one or two supplementary power frames and reserve batteries. The plant supplies a maximum of 600 amperes dc to the No. 3 ESS switching equipment and the toll and transmission equipment.◀

Power Frame

3.30 The -48 volt power frame is capable of supplying a maximum of 200 amperes to the No. 3 ESS office. The rectifiers used in the power frame are -48 volt, 100-ampere, constant-voltage (voltage-regulated) rectifiers suitable for charging or floating (neither charging nor discharging) a string of 24 battery cells. The power plant control unit, which is located in this frame, consists of a voltmeter, ammeter, and associated control and alarm circuitry. This equipment also provides power alarm outputs to the office alarm circuit.

Supplementary Power Frame

3.31 The supplementary power frame provides 200 amperes additional capacity for the 151A or 151C power plants when combined with the power frame. It contains two 100-ampere rectifiers that are combined with the three power frame rectifiers at the charge circuit breaker panel.

Miscellaneous Power Frame

3.32 The miscellaneous power frame contains the office ringing and tone plant, converters, and distribution fuses for +24, +48, and ±130 volts direct current. The ringing and tone plant is used in the No. 3 ESS to generate ringing voltages and tones at frequencies for alerting and signaling purposes. The three converters in the miscellaneous power frame provide the +24, +48, and ±130 volt dc power. Each converter is equipped with a voltage monitor so that an out-of-limit condition will provide a scan point indication and visual indication. The converters automatically shut down if the converter voltage is much higher than the normal voltage.

Network Frame

3.33 Two battery boost circuits are provided on each network frame. The battery boost circuit allows the No. 3 ESS to operate with a 1600-ohm customer loop length without special line treatment. The line supervisory voltage is maintained at a minimum of 53.5 volts from the junctor and customer dial pulse receiver circuits.

Equipment Ground

3.34 The equipment is grounded at a single point to minimize noise and component damage caused by lightning fault currents which may pass through the building structure. All ESS frames are isolated from building ground.

3.35 Table G lists all power and power frames associated with the No. 3 ESS.

4. STORED PROGRAM CONTROL

4.01 The No. 3 ESS performs the functions of a 2-wire central office under stored program control. Virtually all actions of the systems are determined by sequences of instructions coded and stored in memory. These instructions are grouped into functional categories called programs. A program has access to instructions necessary to control a specific task. These programs consist of combinations of precisely defined intructions which are read from memory and transferred one at a time to the central processor for execution via microprogrammed circuitry. The stored program utilizes stored (office) data which contains information pertaining to customer lines, routing, charging,

etc. To alter system operation, changes are normally made to the store program or office data rather than to hardware or wiring.

4.02 The microcode of the 3A CC is the stored sequence of control functions necessary for the operation of the system. It is comparable to the command functions in normal data processing machines. Because of its major importance, it is stored in read-only memory (ROM). Code changes involve replacing circuit packs with no alteration to back plane wiring.

4.03 Microcode executes its own set of microinstructions which control interrupt processing, the front panel functions of the 3A CC, and a certain amount of recovery code including ***bootstrap.*** Checks are built into the implementation of microcode to protect against a faulty read from the ROM.

4.04 The No. 3 ESS stored program is comprised of the common systems division and the applications division. The common systems division consists of programs used by any ESS equipped with a 3A CC. The applications division consists of programs written to perform tasks specifically for the No. 3 ESS.

4.05 Stored programs are either resident or nonresident.

(a) The resident programs are stored in the write protected portion of the MAS of the 3A CC processor. These programs include all call processing programs and some administrative (eg, TTY) and maintenance programs (eg, fault detection, recovery programs).

(b) The nonresident programs are stored on cartridge tape only and are transferred to the MAS as required. The remaining administrative (eg, traffic, most recent change programs) and maintenance (eg, diagnostics) programs which are not used for the normal operation of the system are requested from the tape as required. The tape also includes a backup of all main store memory data, past translation data, and the software program required by the TLTP.

4.06 Subroutines are used extensively to provide for efficient use of the main store. The subroutine is a short program which performs a specific task as requested by another program. Control is passed by the requesting program/subroutine to the called program (subroutine) until completion, at which time control is returned and normal processing continues.

5. FUNCTIONAL PROGRAM DESCRIPTION

5.01 The No. 3 ESS programs are functionally identified by three categories (Fig. 18):

(a) Operational

(b) Administrative

(c) Maintenance.

OPERATIONAL PROGRAMS

5.02 The operational software includes the functions which control the processing of office traffic under normal operating conditions.

A. Base Level Loop and Interrupt

5.03 The base level loop (Fig. 19) is a set of major programs which administer call processing, provide traffic information, and maintain software accuracy. In addition, required maintenance functions are performed, and nonresident software programs are scheduled to perform their functions once they are requested.

5.04 There are two types of interrupt level programs which break into the base level loop:

(1) The first occurs on a periodic, timed basis every 10 ms. It is hardware-initiated and includes such call processing functions as immediate-start trunk scanning, digit receiving, outpulsing, and peripheral orders (Fig. 20).

(2) The second type of interrupt occurs upon a demand basis (ie, TTY demand, fault detection). After the interrupt level has completed its allocated work, control is returned to the base level loop.

B. ▶3E3 Base Level Loop

5.05 The 3E3 base level loop (Fig. 21) for 3E3 generic has been improved to include two major changes. First, the major components of the base level loop routines are reordered so that

all maintenance work is performed after normal call processing tasks have finished. Secondly, a new dispatcher will now control the deferrable maintenance (the multiscan functions, call processing audits, and main store audits). The dispatcher will run these jobs in a "waste time" mode which will allow these jobs to run faster than the unconditional one-transfer-per-scan mode used in issue 4 generics.

General Scheduler

5.06 The general scheduler in CMMON executes out of the CBLM time monitor and controls the sequential execution of routines as defined by MMONA. The manner in which this is done is flexible and convenient since the program is designed to interface with the client programs through their TTY entry points.

5.07 The scheduler can be thought of as a system of tables since the order and conditions for the execution are all presented in tabular form. There are three levels of tables: master table, major sequence table, and minor sequence table.

Dispatcher

5.08 The dispatcher is a real time task dispenser for the class of routines generally thought of as deferrable. The dispatcher is given control after the more critical (nondeferrable) work has completed each base level loop. The dispatcher attempts to execute the defined deferrable jobs when time remains in the base level loop and to skip them when the system is temporarily overloaded. The deferrable jobs are defined in a table called JOBADDR in MMONA which is used to run the job according to its priority and defined minimum rate of repetition. Jobs which fall behind a performance schedule are automatically given priority and may possibly be forced to execute independently of system conditions.

5.09 The jobs normally included in the deferrable class under the control of the dispatcher are all major audits and multiscan functions. While the amount of time taken by a client on each transfer is beyond the control of the dispatcher, it is assumed to be in the range of 2 to 5 msec.

Control Complex

5.10 When a demand interrupt occurs due to a fault, the trouble recovery programs are immediately initiated. Following appropriate recovery actions, the problem is passed for further resolution to the lowest priority base level maintenance programs. After the interrupt level has completed its allocated functions, control is returned to the base level loop.

Periphery

5.11 When a fault is detected by call processing programs, the recovery program is immediately given control. It performs corrective action, as required, and returns control to call processing.

C. Call Processing

Memory Areas

5.12 The call processing software uses allocated blocks of storage to retain data associated with the junctors, lines, trunks, and service circuits during the call interval. Three of the storage blocks used in the description of basic call processing are as follows:

(1) ***Terminal Memory Record (TMR):*** The TMR is a fixed 4-word block of storage assigned to each junctor. For stable calls, the scan point numbers (SPNs) of the calling and called parties are stored. (The record of the call is kept in TMR belonging to the junctor.) For calls in the process of connection or disconnection (transient stage), the assigned transient call record and SPN of the connected circuits are stored. For idle junctors, the TMR serves no function.

(2) ***Transient Call Record (TCR):*** The TCR is a 16-word block of storage assigned to calls in the transient state to:

- Store the state of the call
- Collect and send digits
- Record assigned service circuits
- Store progress marks which identify sections of code to perform certain functions.

The information contained in the TCR and the format of the TCR constantly change as different call processing functions are performed for the call.

(3) ***Input Hoppers:*** These are used to retain changes in the states of line trunks, junctors, and service circuits until the data is used by the software.

Basic Call Processing

5.13 The following is a generalized explanation of the functional sequences of the software involved in intraoffice, interoffice, and incoming calls. Outgoing calls are included in the description of interoffice calls. The first five functions performed for the intraoffice and interoffice calls are the same.

(1) ***Scanning:*** The call is initiated by the originating subscriber going off-hook and thereby activating a line-dedicated equipment device (line ferrod sensor). The input monitor invokes the line scanning program to order the interrogation of the ferrod sensors. Changes (which denote origination) are reported to the monitor via entries in the line origination hopper.

(2) ***Input Monitor:*** Once every base level loop, the input monitor searches the hopper for input; if any input is detected, the monitor selects a TCR to record the progress of the call and distributes the valid service requests accordingly.

(3) ***Dial Tone:*** The dial tone routine is invoked upon receiving a valid service request. A customer dial pulse receiver (CDPR) is selected and placed in the dial tone state as directed by the processor. A path through the network from the line to the CDPR via junctor A (Fig. 22) is selected and connected. Supervision is maintained in the CDPR at this time. An interrupt progress mark is entered in the TCR to indicate that digit receiving functions are required during the next timed interrupts. Dial tone is removed as the first dialed digit is detected.

(4) ***Digit Collection:*** During timed interrupts, the dial pulses detected by the CDPR are counted or tones are translated into digits and recorded in the specific TCR via the digit collection software. The signal digit, as supplied by the digit interpretation program, indicates the number of digits required for further translation. When all necessary digits are received, the collection program alerts base level.

(5) ***Digit Interpretation:*** As the digits are received, the digit interpretation program calls various translation routines to determine the type of call. Once established, the call is routed via a route index to the proper call handling routine; ie, the terminating program for an intraoffice call or the outgoing call handling program for an interoffice call.

5.14 The functions necessary to complete both intraoffice and outgoing calls differentiate at this point in the sequence. Specific information as to how they differ is given in (a) and (b).

(a) ***Intraoffice Call:*** Terminating translation is performed on the number dialed to determine the terminal equipment number (TEN) and terminating treatment (Fig. 22). Tests are performed to establish if the called line is idle and the type of ringing required. Line-busy tone is returned to the calling party by a tone circuit in the case of a line-busy condition. The busy condition is recognized early in the call processing scheme to prevent additional equipment from being unnecessarily used.

(1) ***Ringing Connection:*** If the called line is determined to be idle (based upon line-busy status information in the MAS), a connection is established between the called line and a ringing circuit via junctor B, and the talking path is reserved. Audible ringing tone is applied to the calling line through the talk path junctor. Every 100 milliseconds the ringing circuit is scanned for called party off-hook or answer, and the talk path junctor is scanned for on-hook or abandonment by the calling party.

(2) ***Talking Connection:*** The ringing circuit is released and the remaining part of the previously reserved talking path is established through the junctor (talk) when the called line answers. The TCR is idled, and the TMR maintains a record of the call during the talking state. During the talking state, the junctor (talk) is scanned every 100 ms for supervision. Verification for a true on-hook is made when a change in state is detected which starts the hit timing interval (150 ms).

(3) ***Disconnect:*** Once an on-hook condition is determined, a TCR is obtained and the

disconnect program initiates a timed interval on the line, depending upon the party which goes on-hook first. Releasing the talking path, junctor, TMR, TCR, and returning supervision to the normal line scan (line ferrod) completes the call.

(b) ***Outgoing Interoffice Call:*** Translation information provides the number of digits expected and route index information; ie, the outgoing trunk group number and digit prefixing and deletion actions (if required), type of transmitter, alternate route index, and any required special options. Figure 23 shows a typical interoffice call connection. The dial connection is similar to an intraoffice call. With this information, the calling line continues to be supervised from the CDPR.

(1) ***Ringing Connection:*** An idle outgoing trunk and transmitter are selected. A network path between the transmitter and trunk circuit is established, and a network path between the calling line and trunk circuit is reserved. The transmitter is connected through junctor B to the outgoing trunk; specific checks in continuity and polarity are made; and a seizure signal is sent to the distant office. Outpulsing is begun after reception of the start dial signal (except on immediate start trunks) from the distant office. Upon completion of outpulsing, the transmitter is released and supervision toward the distant office is transferred from the transmitter to the trunk circuit. A connection is established, using the reserved path between the calling line and trunk circuit. Ringing is applied in the distant office (called party); audible ringing is returned to the local office (calling party). The trunk is scanned, via the scanner associated with the trunk, for answer (off-hook). The calling line is scanned, via the junctor (talk), for possible abandonment (on-hook) of the call.

(2) ***Talking Connection:*** When the called line answers, the change in supervision from the distant office (via the trunk) is recognized.

(3) ***Disconnect:*** A similar disconnect function and timing as described for intraoffice calls are used for the calling party.

(c) ***Incoming Call (Terminating):*** Incoming end office terminating calls are handled as follows:

(1) ***Scanning:*** Incoming calls are detected by the scanning of the incoming trunks which can be divided into two categories:

- Immediate start (by-link) and operator trunks (of which 1/4 are scanned at each timed interrupt) (40 ms scan period)
- All other trunks (scanned at base level under the control of the input monitor) (approximately 100 ms scan period).

(2) ***Initial Translation:*** Upon detecting a seizure of an incoming trunk, the input monitor invokes a program to retrieve the trunk scan point number and to select a TCR. An initial translation provides trunk class information, whether or not a receiver is to be used, the type of supervisory signals required, how the call is to be handled, and the number of digits to be received which is stored in the TCR. The 3A CC proceeds by selecting an idle MF receiver, if multifrequency (MF) tones are being sent, and establishing the network path between the trunk circuit and the receiver (Fig. 24). If dial pulses (DPs) are being sent, a receiver is not needed. The DPs are detected at the trunk circuit (Fig. 25).

(3) ***Digit Receiving:*** Digit collection for a dial pulse incoming trunk is performed via the actual counting of dial pulses at the trunk ferrod sensor. Trunks that use MF pulsing are connected to an MF receiver where the tones are received. The junctor and trunk are put in the bypass state and supervision of the trunk is maintained via the MF receiver (loop trunks) or via the trunk ferrod (E&M trunks). A wink start or delay signal may be transmitted to the distant office which, in turn, transmits four or more digits of the called line directory number. The digits are collected in the TCR.

(4) ***Final Translation:*** Final translation is performed after all digits have been received and are recorded in the main store memory. The digits are interpreted until sufficient information is derived to identify

the call as a terminating call. Translation is performed to determine the terminal equipment number and the terminating class-of-service of the called directory number.

The ringing and talking connections for MF calls follow the same sequence of events as in an intraoffice call. When DP calls are detected, an initial junctor is not required to help provide the necessary states to establish a talking network path. The two necessary junctors provide ringing, audible, overflow, and trunk-to-line connections in the same manner as previously described for MF calls.

(5) ***Disconnect:*** If the distant end has disconnected first, the trunk is made available for reseizure, and the connection to the called line is released. A time-release period of 10 seconds is then started. During this time, the called line is being scanned at the line sensor element for on-hook. If after the timed-release period the called line remains off-hook, the off-hook line is treated as a new origination. If the called line disconnects first, the on-hook is transmitted to the distant office.

(d) ***Incoming Call (Tandem):*** Tandem calls are calls which come into the No. 3 ESS office on a trunk but do not terminate in the office and are to be routed through the office to an outgoing trunk. A tandem call is handled similarly to incoming calls except that, during digit interpretation, it is determined that the call is outgoing. The call is then handled as an outgoing call.

A-Link Sharing

5.15 A-link sharing is used to provide a more efficient use of the switching network. By using this sharing, fewer A-links are required for call processing (Fig. 26). A-link sharing is used for intraoffice, interoffice, and incoming calls.

D. Custom Calling

5.16 ▶A No. 3 Electronic Switching System (ESS) customer can subscribe to one or a combination of custom calling services. The custom calling services available are:

- Speed calling
- Call forwarding
- Call waiting
- Three-way calling.

Translations data for each customer line indicates the presence of the custom calling features for the given line.

5.17 ▶In SO-2 generic, the custom calling programs (CUSTOM and TREWAY) handle the processing of calls for a customer using these features. Control is passed to CUSTOM or TREWAY from various other call processing programs. These include the digit interpretation program (DNTRP), the completion of incoming and intraoffice calls program (TERM), the outgoing call program (OUTCAL), and the disconnect progress marks program (DISCON).

5.18 In 3E3 generic, the custom calling programs which are speed calling activation and initiation (SPDCAL-PR3H188), call forwarding activation and initiation (CL4WRD-PR3H189), call waiting tone application (CALLW8-PR3H190), stable call waiting monitor (CW8STB-PR3H191), and conference calling (TREWAY-PR3H184) handle the processing of calls for a customer using these features. Control is passed to the custom calling programs from various other call processing programs. These include the digit interpretation program (DNTRP), the completion of incoming and intraoffice calls program (TERM), the outgoing call program (OUTCAL), and the disconnect progress marks program (DISCON).

Speed Calling

5.19 The speed calling service provides capability for the subscriber to call a number of preselected directory numbers by dialing abbreviated codes of 1 or 2 digits. Subscription to the 1-digit service provides a maximum of 8 stored codes (2 through 9), and subscription to the 2-digit service provides a maximum of 30 stored codes (20 through 49).◀

Call Forwarding

5.20 Call forwarding enables a customer to receive calls at a number other than his own. The customer can activate or deactivate the service at any time.

Call Waiting

5.21 ▶The call waiting (CW) feature allows a customer already involved in a conversation to know by means of a CW tone when another call is attempting completion to that station. Once the second call is answered, the customer may alternate between parties as necessary by flashing the switchhook (one party is in a hold state). The service is in effect regardless of whether the customer was the calling or called party in the original connection.◀

Three-Way Calling

5.22 Three-way calling service enables a customer to add a third party into an existing connection, thereby creating a connection in which the three parties can talk at the same time (Fig. 27).

5.23 ▶The customer with threeway calling service (party A) is engaged in a telephone conversation with another customer (party B). To add on a third party, A flashes the switchhook. (Note that if B is in another central office, A may flash to add on before B answers.) B is then held on a silent termination (the "consultation hold" feature) until A flashes again, and A receives special dial tone. Party A may flash either before or after C answers, establishing a 3-way connection.

5.24 If C does not answer and A wishes to reestablish the 2-way connection with B, A must flash once more. When A flashes the second time, party C is dropped whether or not C has answered, and only A and B remain as in the original connection. If A goes on-hook at any point, all connections associated with the call are released. If B or C hangs up after the 3-way connection is established, the remaining parties are retained in a 2-way connection. Note that either B or C could be an operator, a tone or announcement from a distant office, etc, as well as another customer.◀

ADMINISTRATIVE PROGRAMS

5.25 The administrative programs handle the functions which are related to office operations such as an automatic means for changing office parameters and initiating service orders.

A. Recent Change Programs

5.26 Recent change (RC) programs are used to add, change, or remove translation data from the system. The RC programs are a series of nonresident (tape storage) programs used to modify the translation data, resident and nonresident, in a particular No. 3 ESS office. The RC programs also have the capability for verifying, packing, updating, and retrieving data.

B. System Utilities Programs

5.27 The system utilities programs are common systems, nonresident routines which provide software analysis tools necessary to locate and/or correct problems in the hardware or software of the system. These programs, performed at base level or interrupt, are manually requested via the TTY. These programs include capabilities for monitoring, dumping, and loading specific locations of store. Also included are an overwrite (ie, patch other programs) and a tape utility which manipulates the tape unit.

C. Tape Operations

5.28 The programs which are not required for immediate control of system efforts are stored on magnetic tape. These programs are paged into a paging buffer which is part of the MAS. Software controls the execution of the program entered in the paging buffer.

D. Teletypewriter

5.29 Primary communication with the No. 3 ESS is conducted via the TTY. This communication consists of maintenance messages and commands, entering and updating of office translation data, diagnostic messages, and exercising administrative system control.

5.30 The software directing the TTY devices may be either resident or nonresident, common systems, or applications. All TTY devices operate under the control of the TTY handler program which acts as a software driver between the TTYC and application message processing.

5.31 Embedded in the associated TTY programs are program-initiated fault handling routines which continually check the validity of the TTY input/output transmissions. When an indication of

character mishandling or some other malfunction is detected, these routines take corrective and system self-protecting actions, including removing from service and isolating the malfunctioning TTYC and/or ports.

E. ▶Traffic and Plant Measurements

5.32 The TRAFIC program analyzes traffic information and extracts the necessary information at different scheduled times for the printing of traffic reports by the teletypewriter or for updating a tape.

5.33 The traffic (TRAFIC) program is in two main sections, traffic monitor and traffic measurements. The traffic monitor section determines which traffic tasks should be continued or begun at a certain system time. The traffic measurements section actually increments the traffic counters.

F. System Control

5.34 The basic program structure of the No. 3 ESS is a closed loop in which a set of major programs executes sequentially. This loop is the base level loop. Most call processing programs and those maintenance tasks which can be deferred are performed during base level.

G. Audits

5.35 The audit programs check all resources marked busy to ensure that they are actually busy. The audits attempt to verify that there is a record pertaining to all resources being used with an active call. When a resource without a record is found, the audit idles the resource and prints a teletypewriter (TTY) message so that the program error that caused the trouble can be located. In many cases, audits will not completely clear a call record or an invalid situation; therefore, the situation is corrected by a sequence of audits, which may result in several TTY messages for a single failure.

H. System Cutover Testing

5.36 The cutover functioning office-to-office tests have been designed to test subscriber lines from the No. 3 ESS office to the connection of those lines at the existing subscriber lines served by the old office. These tests check for continuity shorts, crosses, grounds, and reversals. A program automatically performs these tests or this can be done manually, if desired, using the local test desk (14-type) or the local test cabinet (No. 3 type).◀

MAINTENANCE PROGRAMS

5.37 Software and hardware are arranged to detect service-affecting troubles by making the appropriate per-call checks or by performing maintenance checks on the hardware. The maintenance programs handle the functions related to the detection, diagnosis, and reaction to abnormal office operation (Fig. 28).

A. Trouble Detection

5.38 Trouble detection is the primary means of inhibiting performance deterioration. Detection schemes are used throughout the system to facilitate identification of problem areas. These procedures utilize hardware and software operations to further ensure the integrity of the system.

Check Circuits

5.39 Self-check circuits are provided in the 3A CC, MAS, and peripheral controllers. These check circuits act as continuous monitors by which the system is notified of erroneous responses.

Call Processing Tests

5.40 During call processing, many checks are made to ensure the validity of system actions. For example, a check is made for high voltage to prevent damage to sensitive circuits associated with the customer line. Checks are also made to ensure that a customer line is ready for another origination after a previous disconnect (restore-verify check); this verifies that the line attending element was restored to the line to allow an origination.

Routine Testing

5.41 Routine testing is performed as periodic diagnostics or periodic progression.

5.42 Periodic diagnostics are tests of hardware performed automatically on a scheduled basis (every 24 hours). These diagnostics are read in (paged) from the tape cartridge and will be performed by the standby 3A CC. The diagnostics may also be manually requested via the local or remote maintenance TTY.

5.43 Periodic progression testing is comprised of tests wherein test circuits are automatically connected to line, trunk, or service circuits in an effort to detect the latest problems. In addition, the network may also have test circuits associated with it to perform false cross and ground, power cross, and restore-verify tests which are performed on a call basis.

B. Recovery

Duplicated Units (Periphery)

5.44 Recovery programs are automatically initiated when a problem associated with the active SYC is detected. Recovery initiates a retry of the action which was being taken when the problem occurred (eg, scanner order). If the problem persists, recovery initiates an SYC switch which causes the other SYC to assume active control. A second retry of the action previously taken is initiated on the newly active SYC. If the action taken as directed by the data accomplishes the expected results, recovery returns control to normal call processing activity.

5.45 This sequence causes the faulty peripheral controller to be removed from service. A removal from service message and an SYC switch message indicating the SYC currently active are printed out on the TTY. The appropriate lamp lights on the SSP indicating the peripheral controller is removed from service, and a major audible alarm sounds.

5.46 If the second retry does not eliminate the problem condition, the problem is located in the nonduplicated portion of the peripheral controllers. The nonduplicated portions are:

- Scanner matrix (row and column)
- Peripheral decoder (point)
- Network fabric (error analysis).

A TTY message is printed out indicating the problem area as well as the active SYC. A minor audible alarm sounds. Call processing is notified of the problem area and assumes control.

Duplicated Units (Ringing and Tone Plant)

5.47 The critical functions of the ringing and tone (RT) plant are duplicated. Under normal operation one RT plant would be active and the other standby. The critical functions are continuously monitored. A detected problem in the active RT plant causes an RT plant to become active. The SYC is not affected by the RT plant switch.

5.48 The problem indicators available for the RT plant are the RT lamp on the SSP and TTY removal from service messages. A major audible alarm sounds.

Duplicated Units (Control Complex)

5.49 The No. 3 ESS processor is basically a self-checking machine. Detection of faults occurs when a failure of specific checks (error check circuits, program, or program timer) indicates that the integrity of the program system and/or data base is questionable. The detection of faults associated with the error check circuits causes one of the following:

(1) Error interrupt—main memory will function

(2) Unit initialization—main memory may not function

(3) Switch and unit initialization—microcode may not function.

A problem with the active program timer (times out) will cause a switch and initialization of the standby 3A CC. A switch will not occur if the lock or force keys on the SSP is operated. A problem in the program will normally cause a 3A CC switch, depending on the type of program involved.

5.50 There are three classes of fault detection:

(1) The first and most serious involves a fault which affects the operation of the active SYC or which might prevent the microcode of the processor from operating. It may also occur if the active program timer times out. Either of these results in a switch of the processors and initialization of the now active machine.

(2) The second class is keyed by a fault (primarily main store errors) which prevents the main

store from functioning. This results in an initialization of the active processor with no switch of processors involved.

(3) The third class involves peripheral errors.

Unduplicated Circuits (Periphery)

5.51 The unduplicated portion of the system includes the following circuits:

(a) Trunks

(b) Service

(c) Lines

(d) Network links

(1) A-Links

(2) Test vertical

(3) Junctor B-Links

(4) Wire B-Links.

The following circuits are associated with the unduplicated portion of the system:

(a) Scan distributor points

(b) Switches

(c) Crosspoints.

5.52 Special software routines are used to analyze failure rates in the replicate areas. If a circuit fails three consecutive times, it is removed from service. Only a set percentage of the circuits is removed from service. When this percentage is reached, the circuit is not removed from service, but a trouble report is indicated on the TTY.

Error Analysis

5.53 The error analysis resident software of the No. 3 ESS is invoked by failures in call processing involving the replicated portion of the system. This software receives an error report and analyzes problems in categories by comparison. The error rate of a particular circuit is compared with the error rate of its particular group. If the comparative rate is excessive, that particular trunk, line, service circuit, junctor, A-link, or B-link is removed from service and an appropriate TTY message is printed out, indicating a problem which must be diagnosed later.

Quick-Check

5.54 Quick-check is used to analyze problems which affect trunks, service circuits, A-links, B-links, and junctors. If three successive errors occur in a particular circuit, the circuit is automatically removed from service (if allowed), as opposed to the member group failure rate of the error analysis programs.

C. Initialization

5.55 Initialization can be caused by several hardware- and/or software-detected problems. Initialization can also be executed manually from the SSP. The stimulus is the failure of a check that indicates a possible fault in the integrity of the programming system and/or its data base. An initialization consists of the following:

(1) Restoring the 3A CC to a known good state

(2) Restoring the periphery to a known good state

(3) Aborting certain activities

(4) Zeroing or otherwise initializing temporary data

(5) Reloading the programs from tape.

Not all of the above are performed on every initialization. The amount of initialization can vary depending on the extent to which corrective action is required.

5.56 The five levels of initialization are as follows:

(1) First level—partial clear

(2) Second level—partial clear

(3) Third level—partial clear

(4) Fourth level—transient clear

(5) Fifth level—stable clear.

Each level takes more drastic action. The system automatically cycles sequentially through the first four levels as required and, if necessary, initiates a bootstrap. The fourth and fifth levels can also be manually initiated from the SSP.

Bootstrap

5.57 Bootstrap provides a reload of memory only from the 3A CC preferred cartridge tape system. It is a sophisticated, selective reload of only the memory which has been destroyed. Bootstrap is a microprogram-initiated loader with three major segments; the first brings in enough of the loader to continue with a more reliable error checking loader. A second segment, in turn, loads in a more sophisticated system loader and its associated programs. A third more sophisticated loader handles selective reloading of the 3A CC system by interaction with the 3A CC initialization programs. A bootstrap does not affect translation data. A memory reload must be executed from the SSP to accomplish a complete reloading of MAS. This will also initiate a stable clear.

5.58 The periphery will cause an initialization when a dual fault condition exists, eg, a scanner controller failure on both SYCs. Peripheral unit fault recovery will provide a suitable solution for single fault detection without invoking the initialization sequence.

D. Diagnostics

Computer Aided

5.59 Diagnostics are stored on the tape cartridge (nonresident) only and are loaded into the system by requests typed in via the maintenance TTY. The input message manual (IM) provides a listing of available diagnostic input messages.

5.60 The results of the diagnostics are printed out by the maintenance TTY in the form of numbers. These numbers are located in the appropriate trouble locating manual (TLM) and list specific circuit packs which may be responsible for the trouble.

5.61 There are three categories of diagnostics, each having a monitor program which serves as an interface between the test table data and the routines which process the table entries. These are as follows:

(1) Processor diagnostics

(2) Peripheral unit diagnostics

(3) Trunk and service circuit diagnostics.

Processor Diagnostics

5.62 The processor diagnostics are programs (common systems) which employ ***start-small*** philosophy. A small portion of the machine is first diagnosed and, if its operation is correct, is used for further diagnosis. Essentially, each test is dependent upon the previous test(s). There are two divisions of the tests: the main store diagnostics and the diagnostics handling the other hardware of the 3A CC. The active processor may diagnose the standby in three ways:

(1) Via the maintenance channel at the microlevel

(2) By instructing the standby processor to run short sequences of code with the results checked by the active processor

(3) By instructing the standby processor to run code and check its results.

Peripheral Unit Diagnostics

5.63 The peripheral unit diagnostic programs (applications) diagnose the peripheral controllers, when requested. The craftsperson specifies either the network, peripheral pulse distributor, frame input/output controller, or the scanner to be diagnosed. A diagnostic (DGN:) input message designates the controller to be diagnosed. A peripheral controller can be diagnosed using a restore (RST:) message in lieu of the (DGN:). The diagnostic checks the input/output port of the processor and the frame input/output controller verifying that each is operational as it works its way to the designated controller. The output message returned states the results of the diagnostic performed. The ringing and tone plant is diagnosed in a similar manner.

Trunk and Service Circuit Diagnostics

5.64 The trunk and service circuit diagnostics are programs (applications) invoked for the

maintenance of trunks, lines, and service circuits. There are three categories of these operational circuit tests: junctor, trunk, and service. Test circuits are categorized as service circuits for diagnostic purposes.

Network Fabric Diagnostics

5.65 The network fabric exercise program verifies tip-ring wiring for continuity and crosspoints for operation. It also checks for tip and ring reversals. The only crosspoints accessed in the first stage are associated with loop-start lines. All crosspoints in the second stage are accessed. Third stage crosspoint checks depend on the network frame available.

Manual Trouble Clearing

5.66 The TLTP provides manual capability to test trunk, junctor, line, and service circuits. Two access trunks provide access through the network to the circuits that require testing. The access trunks are arranged for key-controlled access to voltmeter and transmission test circuitry and also voice communication facilities.

E. Alarm and Status Reporting

5.67 The alarm and status reporting programs provide a means of notifying the craftsperson of faults or situations which require action. These programs instantly identify, on the SSP, any system abnormality. They also maintain the current status (standby SYC) of the system as determined by various maintenance and common system programs. The SSP, under the control of these programs, provides the craftsperson with the means for remote access to the system and for initializing the system.

Alarms

5.68 System maintenance is supported by an office alarm structure which serves as the stimulus for software-controlled diagnostics. Both visual and audible alarm indications are provided. When a particular alarm is sounded, a corresponding message is printed on the TTY indicating the category and source of the alarm. The alarm classifications are given in (1) through (8).

(1) CRITICAL—Indicates that the system, or a major portion or capability of the system, is inoperable. An audible indication of the CRITICAL alarm is a continuous tone sounded twice, 1/2 second apart. There is a 1-1/2 second interval before the pattern is repeated.

(2) MAJOR—Indicates a partial loss of the system capability or a failure such that another similar failure could result in a critical condition. An audible indication of the MAJOR alarm is a continuous tone that sounds at 1-1/2 second intervals.

(3) MINOR—Indicates a minor loss of the system capability or some other condition requiring the attention of the maintenance personnel. An audible indication of a MINOR alarm is a continuous tone that is silenced after 5 seconds.

(4) MAJOR POWER—Indicates a major power failure in the power equipment.

(5) MINOR POWER—Indicates a minor power failure in the power equipment.

(6) ALARM CIRCUIT—Indicates a trouble in the office alarm circuit or in its battery supply.

(7) FUSE—Indicates a blown fuse.

(8) SERVICE LOSS—Indicates that recovery has taken place with the possible loss of calls approximately within the last 3 minutes.

5.69 There can be two alarm indications; ie, an alarm in classifications (4) through (8) will cause either a critical, major, or minor indication as defined in classifications (1) through (3).

5.70 Only the highest level alarm class is indicated on the SSP at any one point in time. It has priority over a lesser alarm class indication (critical over major or minor), and the lesser alarms would not be indicated until the critical alarm source was eliminated.

5.71 Visual alarm indicators associated with audible alarms remain operated until the alarm is retired. Audible alarms are on a timed interval in the alarm transfer mode (ALARM TRFR key on SSP operated), and can be disconnected manually.

5.72 The software routines related to the alarms initiate the following:

- The TTY message to be printed
- The proper alarm indications, both audible and visible, to be activated
- The proper timing for alarms.

F. Programmed Maintenance Aids

5.73 Programmed maintenance aids assist the craftsperson to either define a problem or verify a predetermined fault within the system. These aids are as follows:

- Station ringer test line
- Loop-around test line
- Milliwatt test line
- Short circuit, open circuit, and chart test line
- Local test desk
- Trunk and line test panel.

6. MAINTENANCE PLAN

6.01 Figure 28 is a block diagram of the No. 3 ESS maintenance plan. The function of the maintenance design of the system is to automatically detect faults and initiate recovery procedures. Various automated procedures for fault confirmation and location are provided for use after fault recovery.

6.02 Automatic trouble detection takes the following forms:

(a) During call processing, many checks are performed which verify the integrity of the peripheral hardware and the accuracy of internal data. Any detected failure initiates a recovery action.

(b) Many hardware checks (self-checking) are made to verify correct hardware conditions. These checking conditions are provided in the 3A CC and MAS as well as the peripheral controllers. The hardware checks are done on a continuing basis.

6.03 Automated maintenance facilities are divided into three general types:

(1,2 ***Detection and Recovery:*** When failures are detected, the system takes corrective action to identify the failed unit and takes it out of service. The results of such actions are indicated on the maintenance TTY and the SSP.

(3) ***Fault Location:*** Programmed diagnostics are initiated manually via the maintenance TTY. These provide the capability for accessing, testing, and exercising selected portions of the system. Manual testing of trunks, junctor, service, and line circuits may be performed using the TLTP.

Maintenance Documentation

6.04 The No. 3 ESS will use basic ESS maintenance and diagnostic tools as follows:

(a) ***Trouble Locating Manual (TLM):*** The TLM is used primarily to identify faulty circuit packs associated with particular failures. The TTY prints out a coded number which, when referenced in the TLM, indicates a list of possible faulty circuit packs. There are many different TLMs identified for No. 3 ESS.

(b) ***Input Message Manual (IM):*** The IM is a listing of TTY input codes understood by the system and used to inform the system that it must perform a specific task.

(c) ***Output Message Manual (OM):*** The OM is a listing of output codes automatically produced on a TTY and initiated by a TTY input for the system. The OM describes the purpose and signficiance of the coding as presented on the TTY.

(d) ***Task Oriented Practices (TOP) BSP:*** Task oriented practices (TOP) are self-contained packages of maintenance tasks which support the following activities for the No. 3 ESS office: routine maintenance, acceptance testing, company order work, and trouble clearing. The data in TOP is organized to direct the user to a successful completion of a task or job from beginning to end. Each task is identified through task analysis and defined from the perspective of the task rather than hardware boundaries.

(e) ***Software Subsystem Descriptions (SSD) BSP:*** Software subsystem descriptions (SSDs) provide an overall explanation of functional program areas and serve as an aid in accessing the program listing. SSDs also provide for a coverage of the software area to go along with the hardware.

(f) ***Descriptive and Theory of Operation BSP:*** Descriptive and theory of operation BSPs are technical manuals that provide descriptions, installation data, operating instructions, theory, and maintenance information pertinent to the equipment covered.

7. MAINTENANCE AND ADMINISTRATION FACILITIES

7.01 The master control center (MCC) is used by maintenance personnel dispatched to the site when severe troubles occur. The MCC may be augmented by connection to an SCC which, when provided, permits complete remote status reporting and control capabilities at a remote location.

7.02 The MCC serves as a system maintenance tool in an operating office and consists of the following components:

(a) The system status panel

(b) The teletypewriter

(c) The trunk and line test panel.

System Status Panel (SSP)

7.03 The SSP provides indications of normal as well as emergency and alarm conditions. The SSP provides designated keys to implement system emergency manual control as well as keys for test control, alarm control, and panel power. Visual indications are provided also, to relate instantaneous system status. The types of indications include sytem control status, other equipment status, equipment troubles, and power failures.

Teletypewriter

7.04 The TTY is used as a means of communicating with the system. The TTY can be used for requesting tests, diagnostics, removal of equipment from service, restoring equipment to service, and also for changing class of service and directory number assignments. The TTY will print out test results, trouble records, and diagnostic results.

Trunk and Line Test Panel

7.05 The TLTP is used for making normal transmission and operational tests on trunks and lines. The TLTP has the capability of busying out trunk and service circuits, making gain and stability tests on outgoing trunks, and providing access to any line terminated in the No. 3 ESS. In addition, the TLTP also has the capability to perform most tests presently performed by the 3A local test cabinet. The TLTP cannot be operated from the SCC.

Switching Control Center

7.06 The SCC is an extension of the technical assistance center concept and permits centralized control as well a monitoring of switching offices. The SCC normal mode of operation involves the automatic polling (interrogation) of remote offices on a continuous basis. This mode is used to collect and display status information from remote offices. The information received indicates office alarms, generalized trouble location information, and building and system status. All TTY maintenance messages are sent from the remote offices to the SCC and stored.

Remote Maintenance and Operation

7.07 Remote maintenance can be accomplished at the SCC. When remote control of an office is provided, the SCC can arrange to remove that office from the polling category. A universal console is connected to the system in conjunction with a TTY to provide remote control capabilities. This provides the equivalent control which is available at the No. 3 ESS office SSP. Displays are available in the SCC and keys operated in the SCC will be repeated to initiate functions in the local office.

8. GROWTH

8.01 A substantial degree of flexibility is provided for growth considerations. ◗New equipment and frames can be added to a No. 3 ESS office without interruption in telephone service. Basically, the amount of equipment required is dependent on the number of terminals in the office.◖

8.02 The network frame is the main growth entity since it provides most of the equipment necessary for each increment of network growth. Each network frame provides for 384 terminals. The third-stage switch provided on the initial control frame (0) can accommodate up to seven network frames or 2688 terminals.

8.03 The addition of the eighth network frame requires an expansion of the third-stage switch. An additional control frame (1) must be provided. It houses the third-stage expansion switches. Also, additional expansion switches must be added to the existing third-stage switch located in control frame 0. The third-stage network is expanded from an 8-by-8 configuration to a 16-by-16 configuration (Fig. 29).

8.04 The only variation between network frames is the quantity and type of circuit packs for trunks and service circuits. The trunk units are universally wired to accept the most commonly used trunk circuits. Junctor rearrangement is not required.

9. COMPATIBILITY

9.01 A summary of requirements for switching, test, and intercept systems to communicate with the No. 3 ESS is provided in Table H. Detailed information on the circuits actually used to provide compatibility and the restrictions on the type of circuits used are provided in the No. 3 ESS AT&T Engineering Letter (E.L. 3000).

10. REFERENCES

10.01 For additional descriptive and maintenance information on the No. 3 ESS equipment, refer to the Bell System Practices Numerical Index, Section 233-000-000. This section contains information on the documentation scheme adopted for the No. 3 ESS. Section 233-000-010, Numerical Index, Non-233 Division, No. 3 Electronic Switching System (ESS) contains information about documentation relating to a No. 3 ESS but numbered in other BSP divisions. Section 233-010-010, Organization and Description of System Documentation, explains the documentation plan developed for the No. 3 ESS and briefly defines the contents of each document.

11. GLOSSARY

11.01 A glossary of terms is provided to aid in understanding definitive words used in this section.

3A Central Control (3A CC)—The combination of logic, microstore, and input/output channel which is primarily utilized to interpret and act upon information read from the main store or from external stimuli through the interrupt mechanism.

Autoconnect—Communications data link or dial-up line used infrequently by one or several remote TTYs on a shared basis, such as the inputting of service orders on the miscellaneous TTY channel.

Base Level Loop—Major software loop including all functions not performed during interrupt level.

Bootstrap—A program in microstore which, in the event of main store memory loss, calls up the initialization program from tape in an attempt to generate a complete workable active system.

Concentrator Group—One concentrator has 192 terminals. A concentrator group is made up of two concentrators (384) terminals which comprise the first two stages of switching. It is packaged on a network frame.

Control Complex—That equipment required to provide control and maintenance of the No. 3 ESS office.

Control Unit (CU)—The combination of 3A CC, main store, power store buses, system status, and control panel.

Direct Distance Dialing (DDD)—Toll service which permits customers to dial their own long-distance calls.

Duplication—Providing two of the same units in vital areas to maintain call handling capabilities if a problem occurs in one of the units.

Fault—A condition which causes a device, a component, or an element to fail to perform in a required manner.

Ferrod Sensor—A current-sensing device used in scanners for supervisory and other purposes.

Ground Start Lines—Signaling method which uses a ground connected to the ring lead to saturate a line sensor when an off-hook condition exists.

High and Wet—The state in which the trunk or line is monitored for an on-hook condition only.

Initialization—Restores the system to a known good operating state. The two basic types are system generated and manually generated.

Input Message Manual (IM)—A listing of TTY input codes understood by the system and used to inform the system that it must perform a specific task.

Interoffice Call—A call switched between different central offices to complete a talking path.

Intraoffice Call—A communication link provided within a central office between subscribers assigned to the same local central office.

Junctor—A circuit associated with the switching network which provides a path for a call through the network.

Line—Any connection to a network terminal which is not classified as a trunk or service circuit. Usually a pair of wires which serves to connect a customer telephone to a terminal on the network.

Loop Start—A signaling method which causes the metallic loop formed by the trunk conductors and terminating bridges.

Main Store (MAS)—That part of the No. 3 ESS which stores program and translation information for the office as well as information collected, used, and deposited during each call.

Microcode—Microcode is the set of instructions encoded in the 3A CC read only memory. Microcode instructions control all internal operations of the 3A CC.

Microinstructions—One of the 32-bit instruction words encoded in the microstore of the 3A CC microprogram control. The microstore is a read-only memory which contains all the microinstructions that control the 3A CC.

Network Fabric—The fabric consisting of network links and switches which serve to provide a 2-wire metallic talking path between any two network terminals. Remreed switches are used in No. 3 ESS.

Nonresident Programs—Those programs housed outside the main store and manually called into use with the system. These programs are stored on the tape cartridge.

Off-Hook—The condition that indicates the active state (closed loop) of a customer line, trunk, or service circuit.

On-Hook—The condition which indicates the idle state (open loop) of a customer line, trunk, or service circuit.

Output Message Manual (OM)—A listing of output codes automatically produced on a TTY. The OM describes the purpose and significance of the coding as presented on the TTY.

Peg Count—A count kept by a traffic register of the number of times a facility is accessed.

Protector Unit—A protector guards against lightning and other foreign potentials and serves tip and ring conductor pairs.

Remanent Reed (Remreed) Switch—The basic switching element used in the No. 3 ESS switching network. Its characteristics are faster operating speeds, fewer moving parts, and a decrease in size.

Replicated—Equipment that is redundant but usage of which is not considered duplicated.

Scan Point—Ferrod sensor used in scanners for supervisory purposes.

Service Circuit—An auxiliary circuit connected through the switching network to lines or trunks as required. It performs a specialized function such as dial-pulse detection.

Service Order—A change or a new addition to the central office affecting subscriber lines.

Single-Sided Network—Lines, trunks, and service circuits are assigned to terminals at one side of the network.

System Control (SYC)—The combination of the control unit, FIOCs, network controllers, scanner controllers, and peripheral pulse distributors which together provide complete control of the periphery and whose status is switchable as a single unit. Except for the system status panel, the system control is duplicated for reliability purposes.

Terminal—A point at which information can enter or leave a communication network.

Trouble Locating Manual (TLM)—Basically used to identify faulty circuit packs associated with particular failures. The TTY prints out a coded number which, when referenced in the TLM, indicates a list of possible faulty circuit packs.

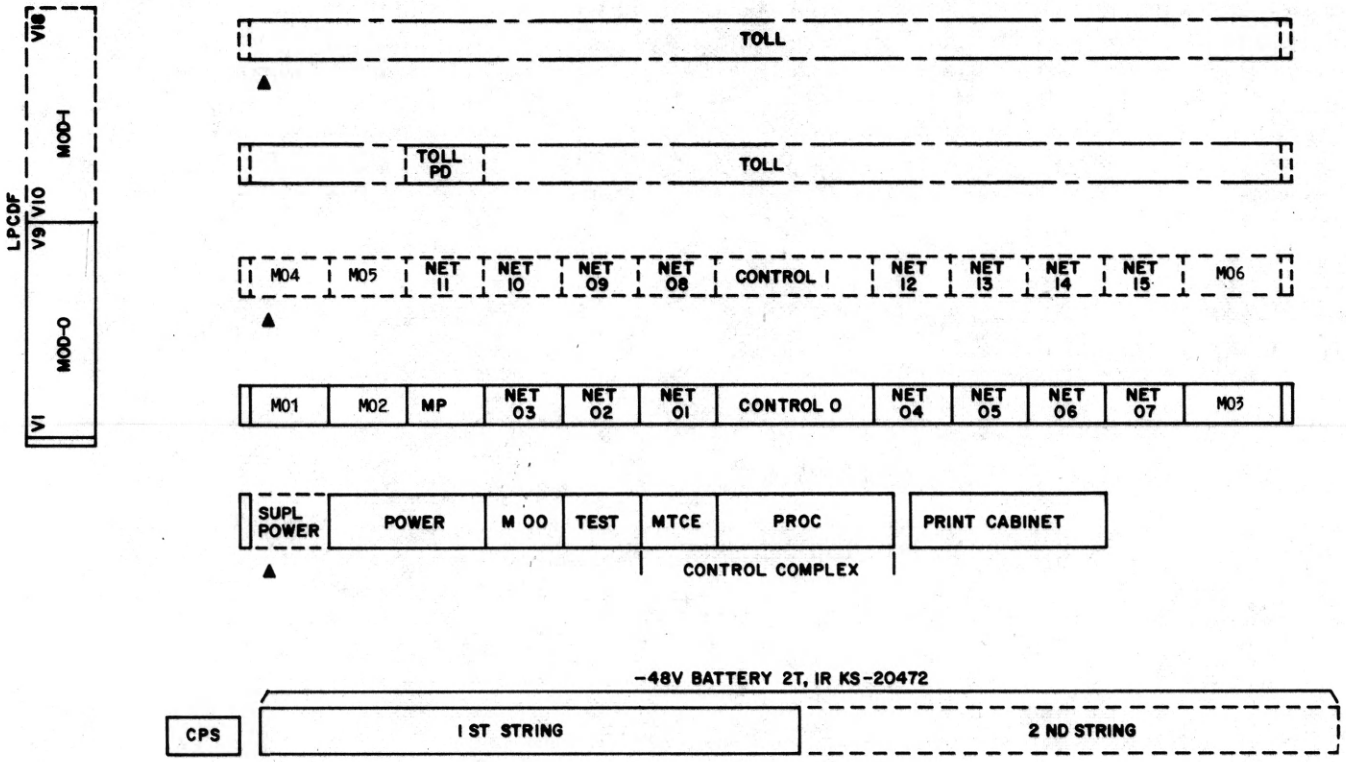
Trunk—A channel connecting switching centers or exchanges. An interface circuit for transmission purposes.

12. ABBREVIATIONS

12.01 The following is a list of abbreviations used in this section.

3A CC	3A Central Control
AIS	Automatic Intercept System
ANI	Automatic Number Identification
CAMA	Centralized Automatic Message Accounting
CDPR	Customer Dial Pulse Receiver
CU	Control Unit
DDD	Direct Distance Dialing
DP	Dial Pulse
EAS	Extended Area Service
ESS	Electronic Switching System
FIOC	Frame Input/Output Controller
IDDD	International Direct Distance Dialing
IGFET	Insulated Gate Field Effect Transistor
IM	Input Message Manual
I/O	Input/Output
JC	Junctor
JSW	Junctor Switch
LPCDF	Low-Profile Combined Distributing Frame
LTD	Local Test Desk
MAS	Main Store
MCC	Master Control Center
MF	Multifrequency
MLHG	Multiline Hunt Group
MTC	Maintenance
NWC	Network Controller
OM	Output Message Manual
PD	Peripheral Decoder
PDG	Peripheral Decoder Group
PPD	Peripheral Pulse Distributor
RC	Recent Change
ROM	Read-Only Memory
RT	Ringing and Tone
SC	Scanner Controller
SCC	Switching Control Center
SPN	Scan Point Number
SSD	Software Subsystem Description
SSP	System Status Panel
SSPC	System Status Panel Controller
SWBD	Switchboard
SYC	System Control

TCR	Transient Call Record	TOP	Task Oriented Practices
TDC	Tape Data Controller	TSP	Traffic Service Position
TEN	Terminal Equipment Number	TSPS	Traffic Service Position System
TLM	Trouble Locating Manual	TTY	Teletypewriter
TLTP	Trunk and Line Test Panel		
TMR	Terminal Memory Record	TTYC	Teletypewriter Controller



NOTES:
1. SOLID LINES INDICATE 2100 LINE OFFICE.
2. DASHED LINES INDICATE GROWTH TO A 4500 LINE OFFICE.
3. MINIMUM REQUIRED FLOOR SPACE IS 22 FT. X 41 FT. 8 IN.

LEGEND:
CPS - CIRCUIT PACK STORAGE FRAME
LPCDF - LOW PROFILE COMBINED DISTRIBUTING FRAME
M00-M06 - MISCELLANEOUS FRAME
MOD - MODULE
MP - MISCELLANEOUS POWER FRAME
MTCE - MAINTENANCE FRAME
NET (01-15) NETWORK FRAMES
PD - POWER DISTRIBUTION
PROC - PROCESSOR FRAME
SUPL - SUPPLEMENTARY
V - VERTICAL
▲ - DENOTES MAINTENANCE AISLE (FRAME EQUIPMENT FACES THIS AISLE)

Fig. 1—No. 3 ESS Equipment Floor Plan

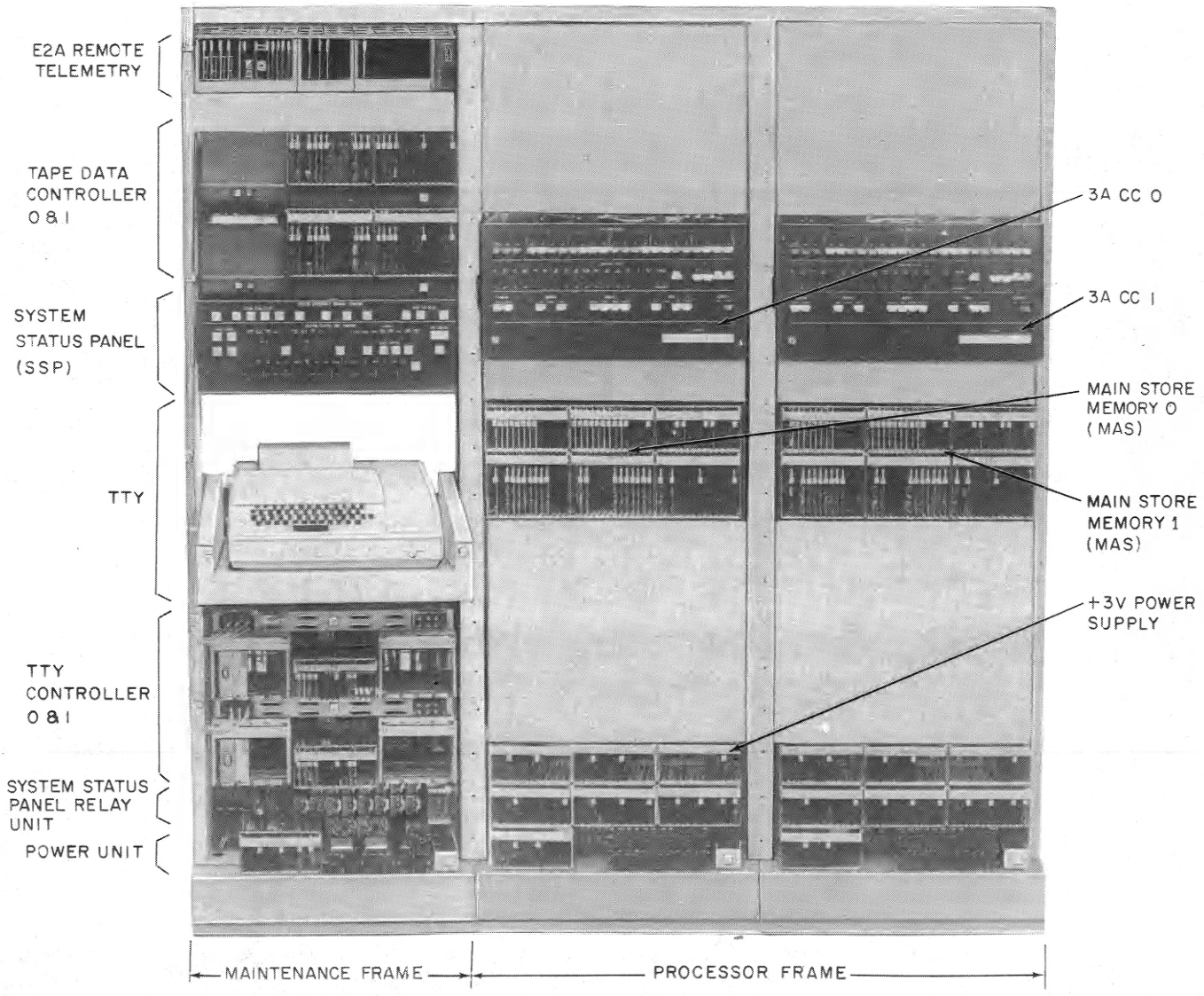


Fig. 2—Control Complex

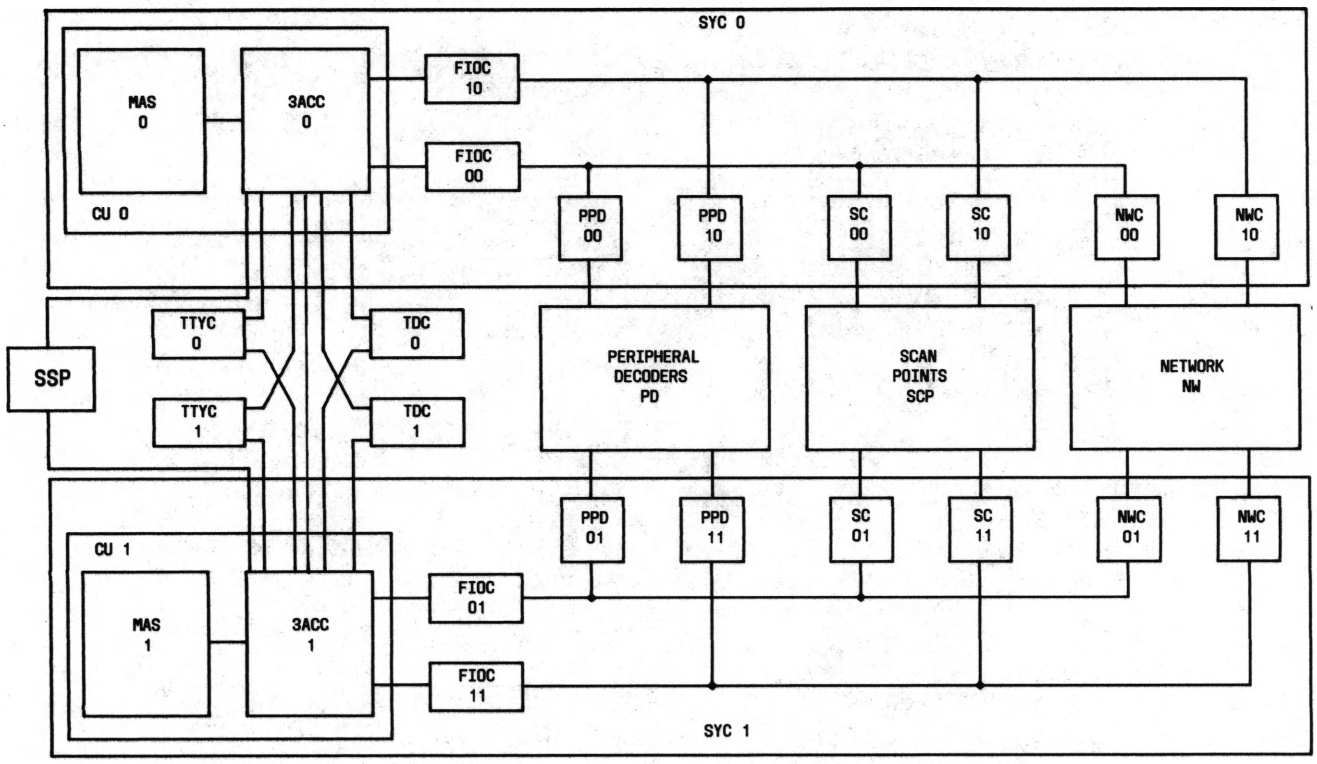


Fig. 3—System Control (SYC0, SYC1)

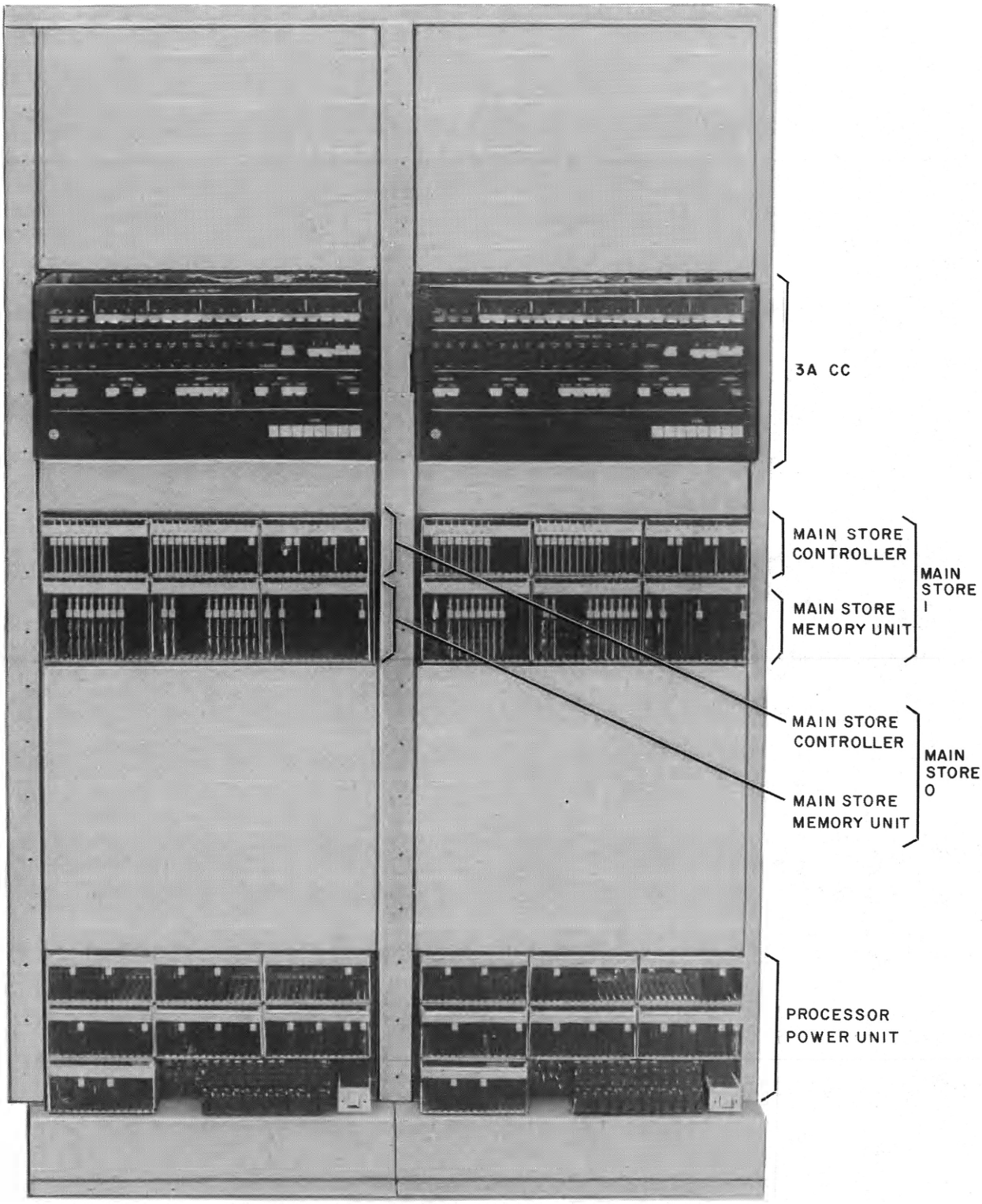


Fig. 4—Processor Frame

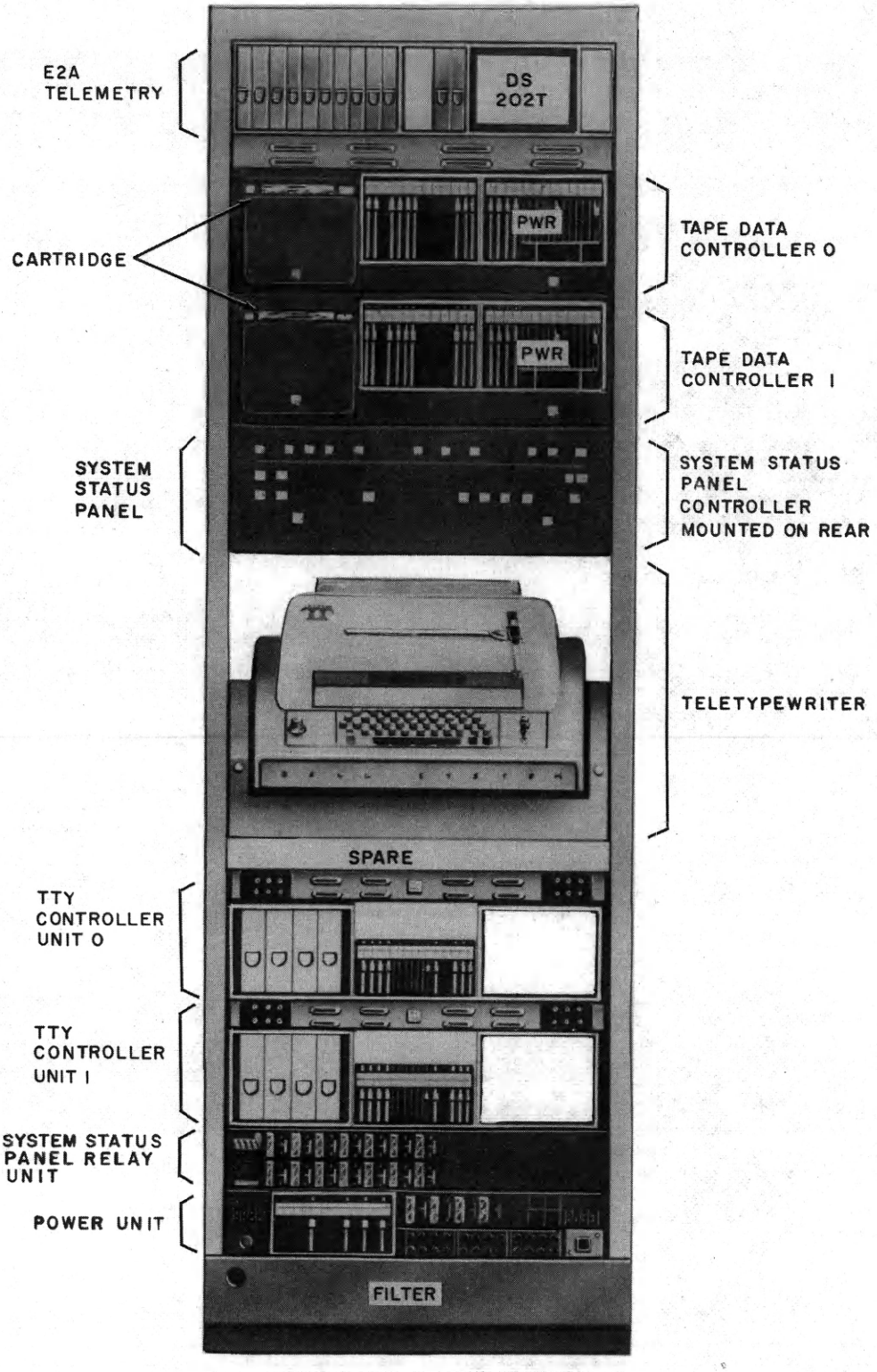


Fig. 5—Maintenance Frame

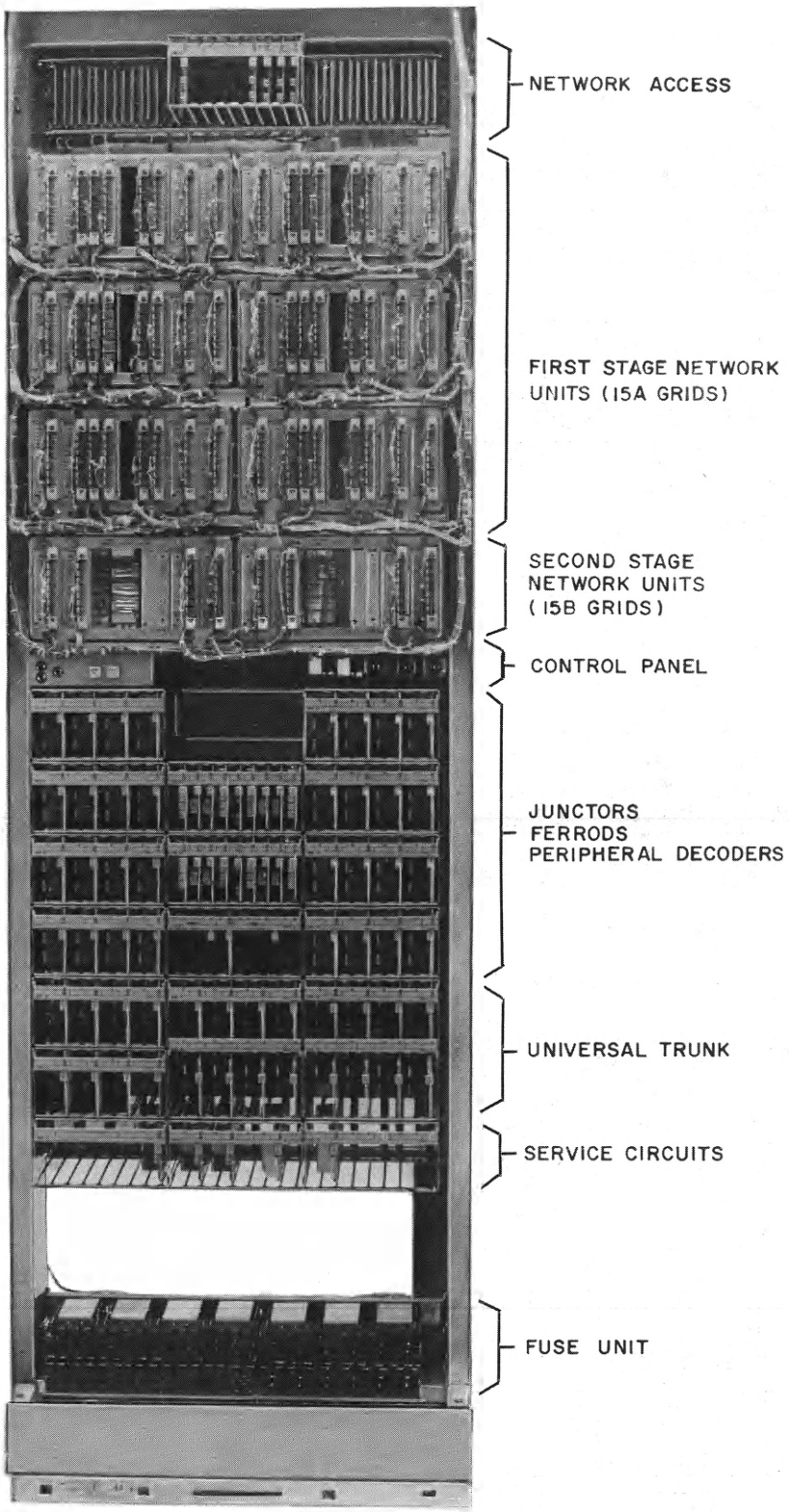


Fig. 6—Network Frame

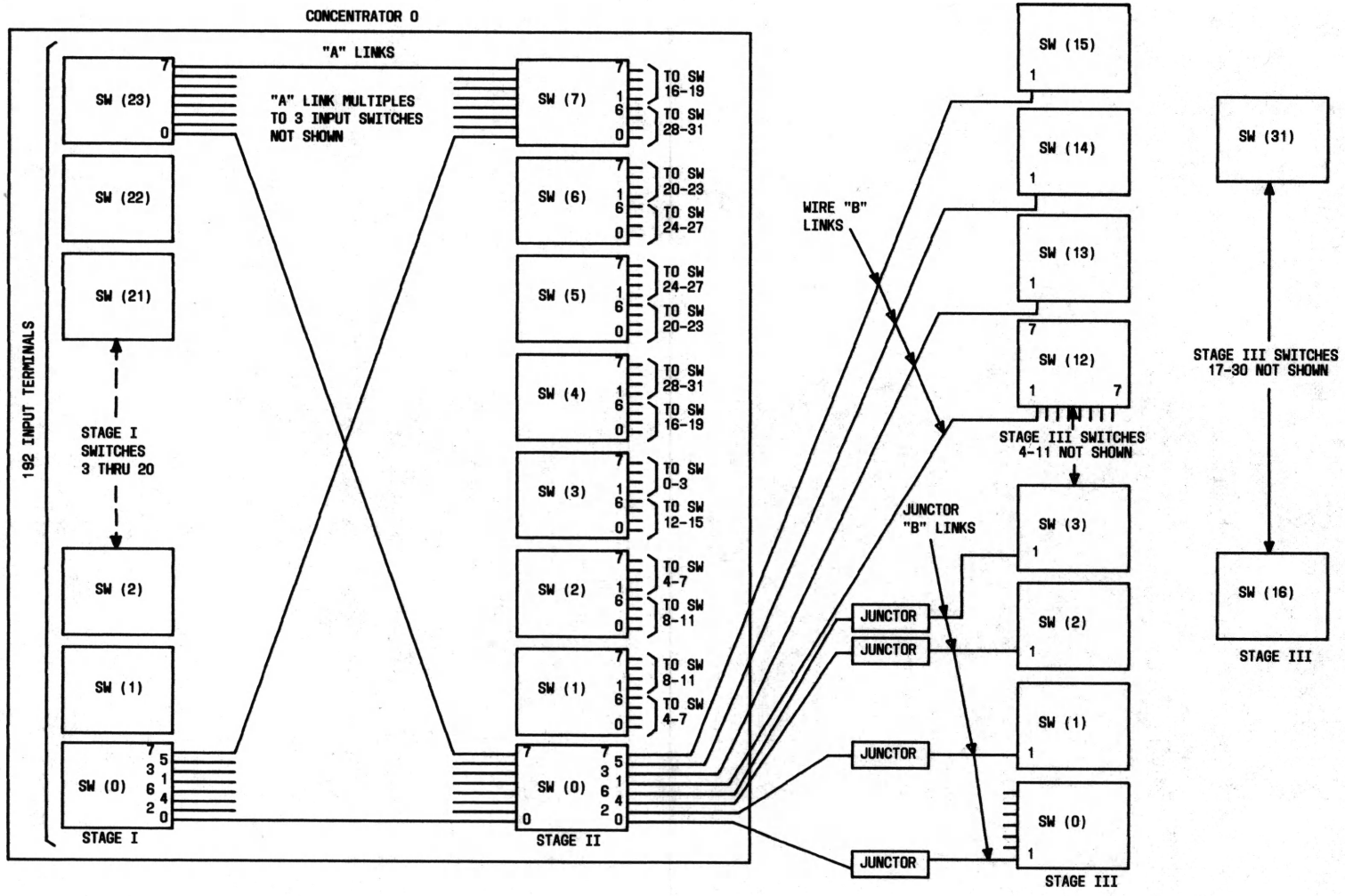


Fig. 7—No. 3 ESS Network Topology

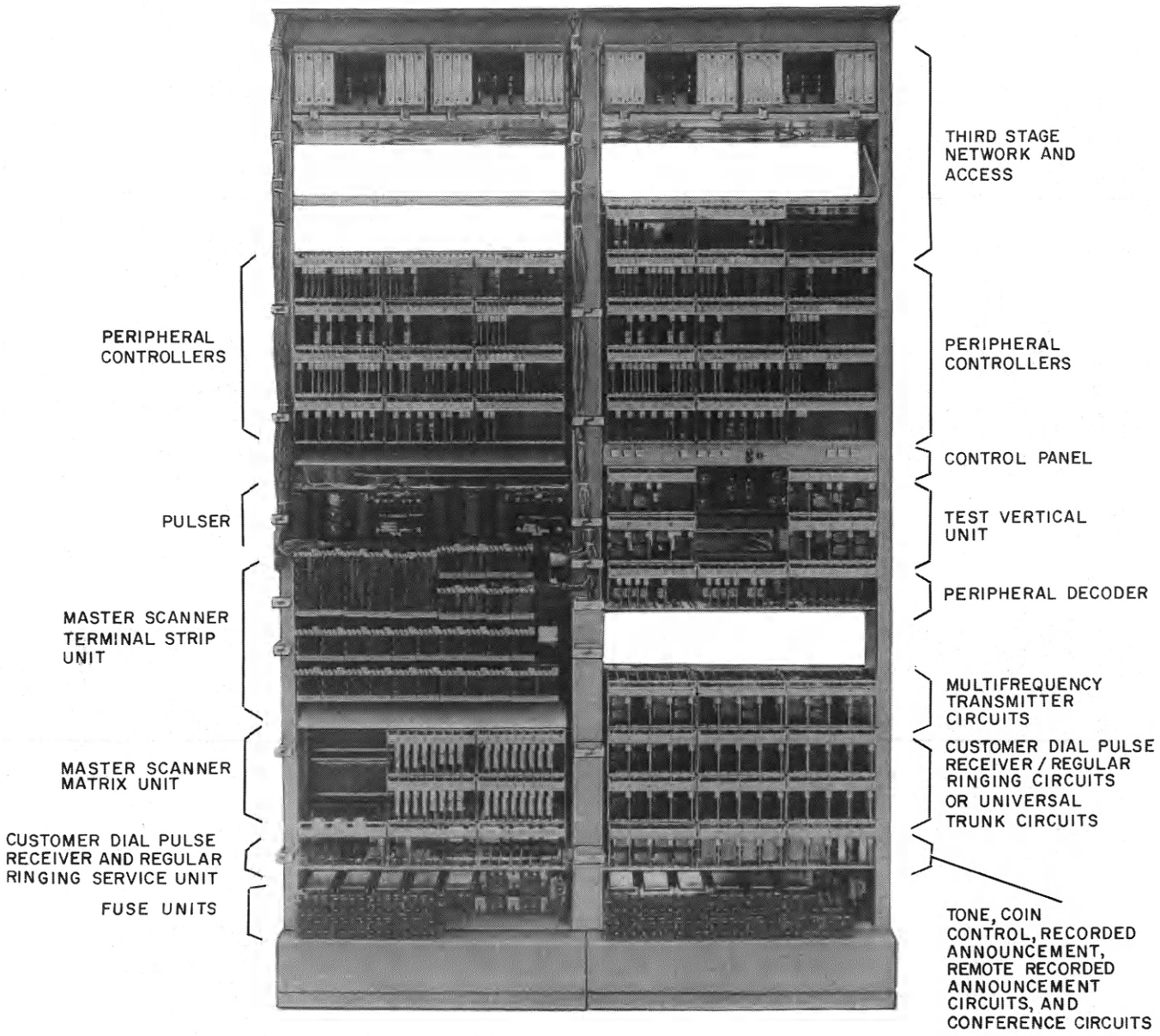


Fig. 8—Control Frame

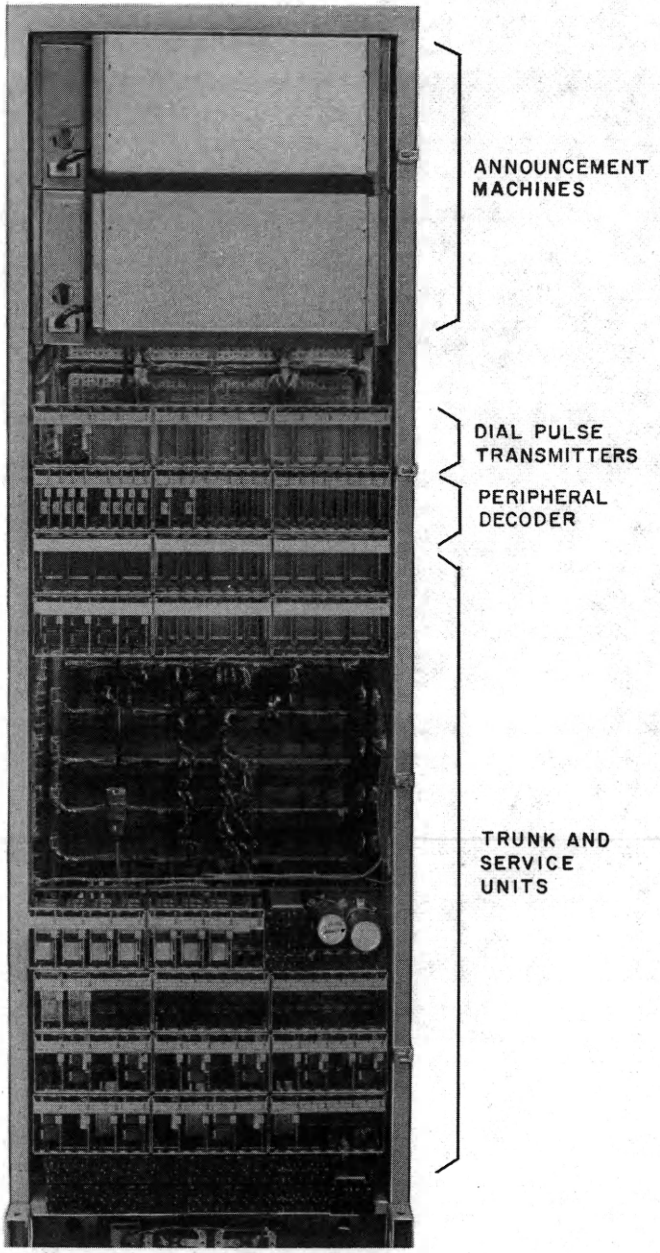


Fig. 9—Miscellaneous Frame

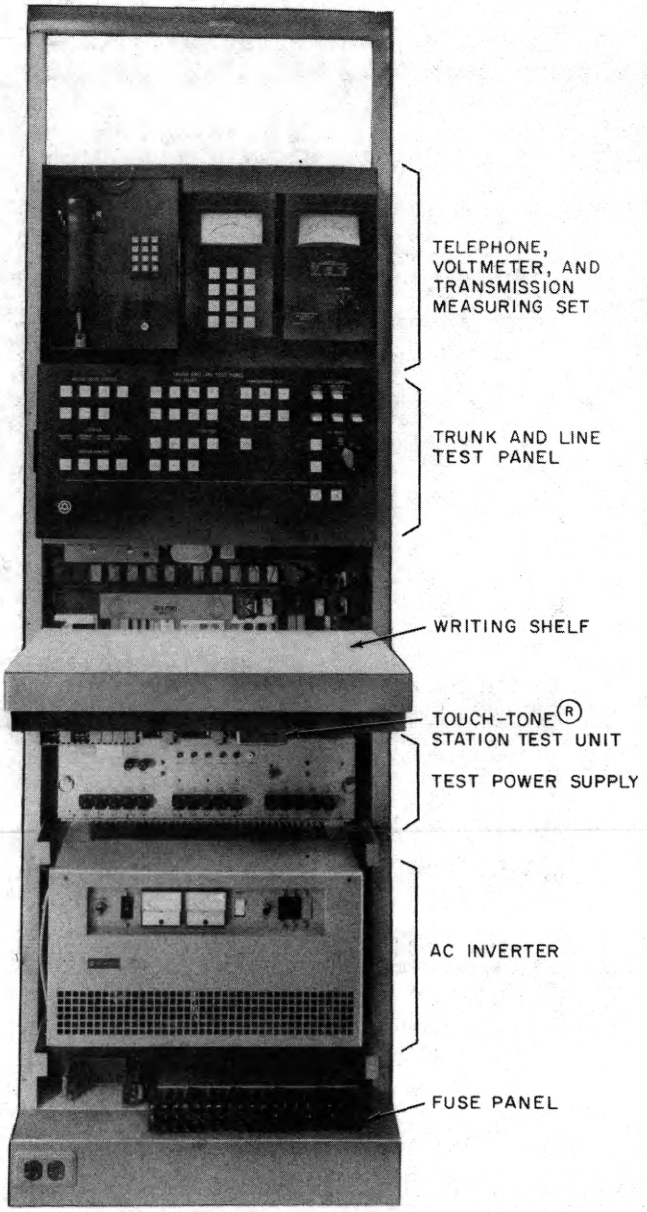


Fig. 10—Test Frame

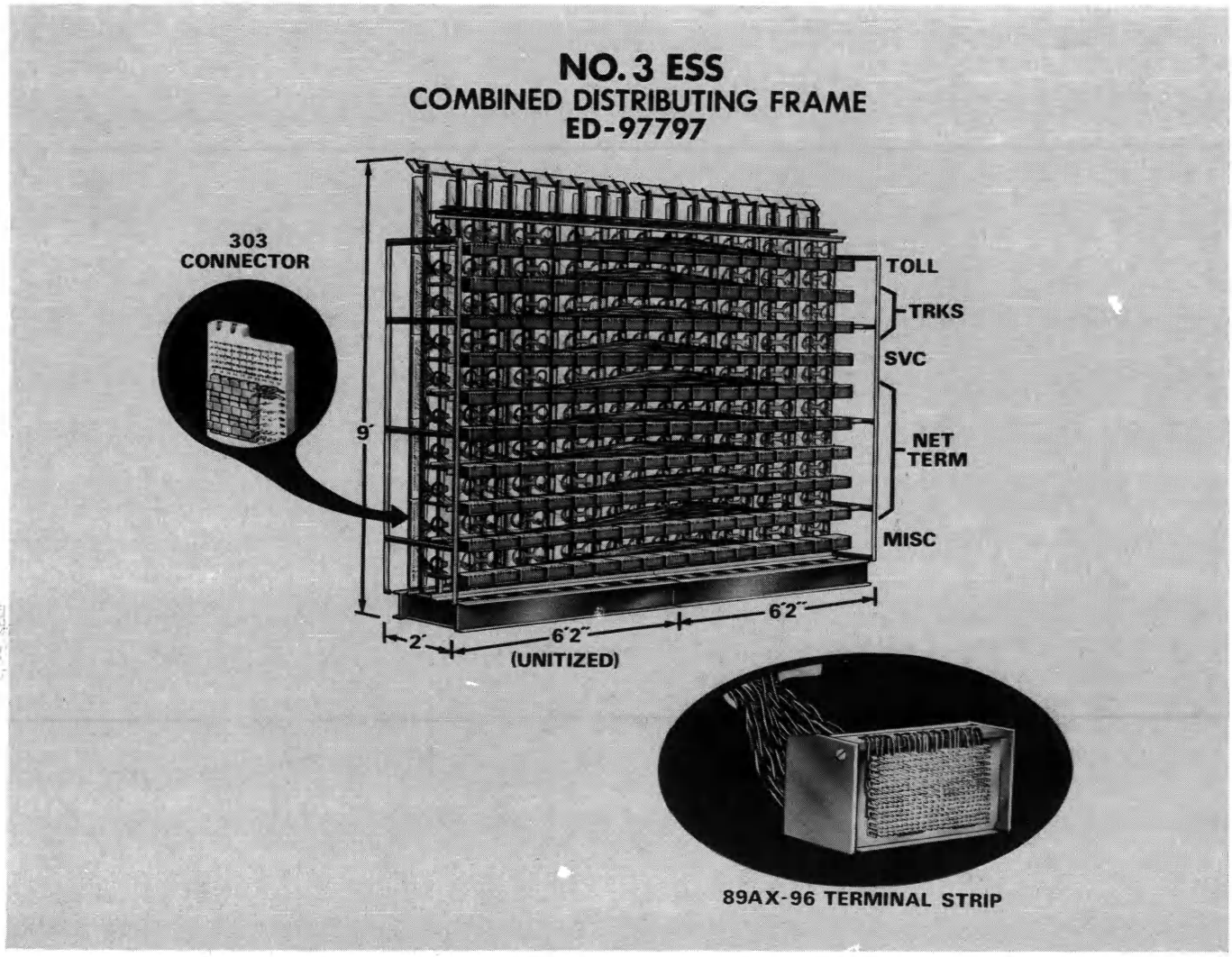


Fig. 11—Low Profile Combined Distributing Frame

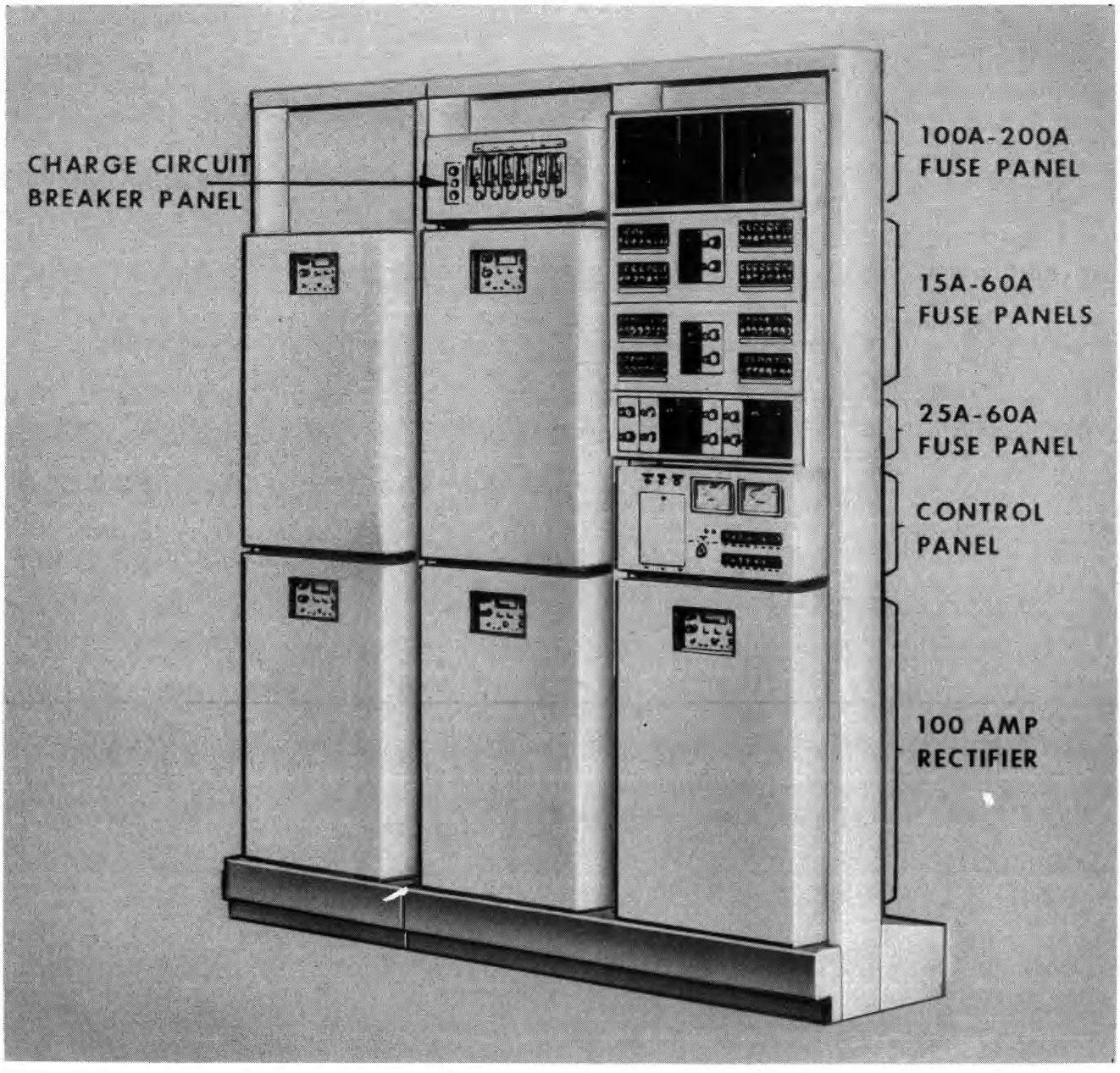


Fig. 12—151 Power Plant

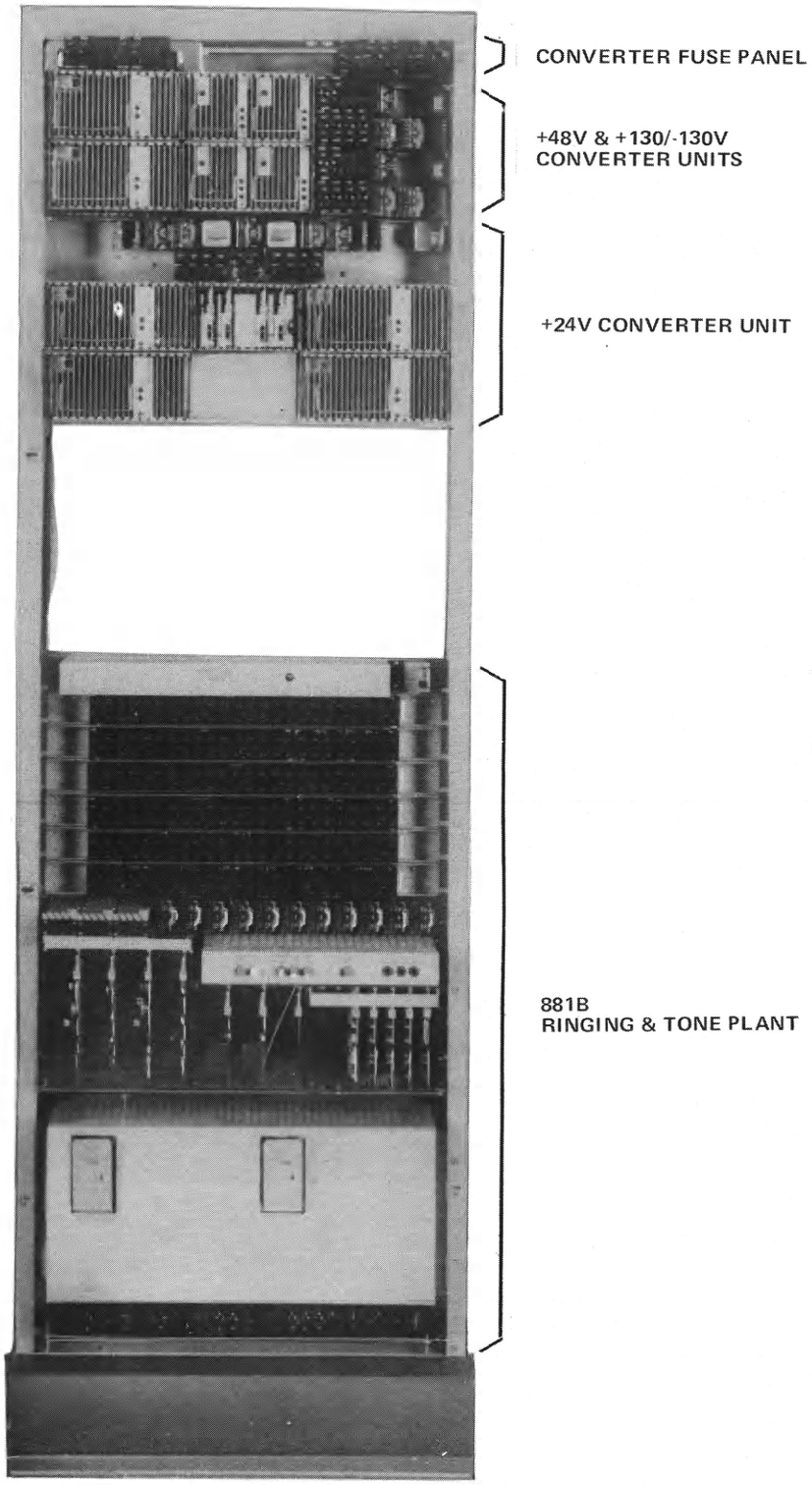
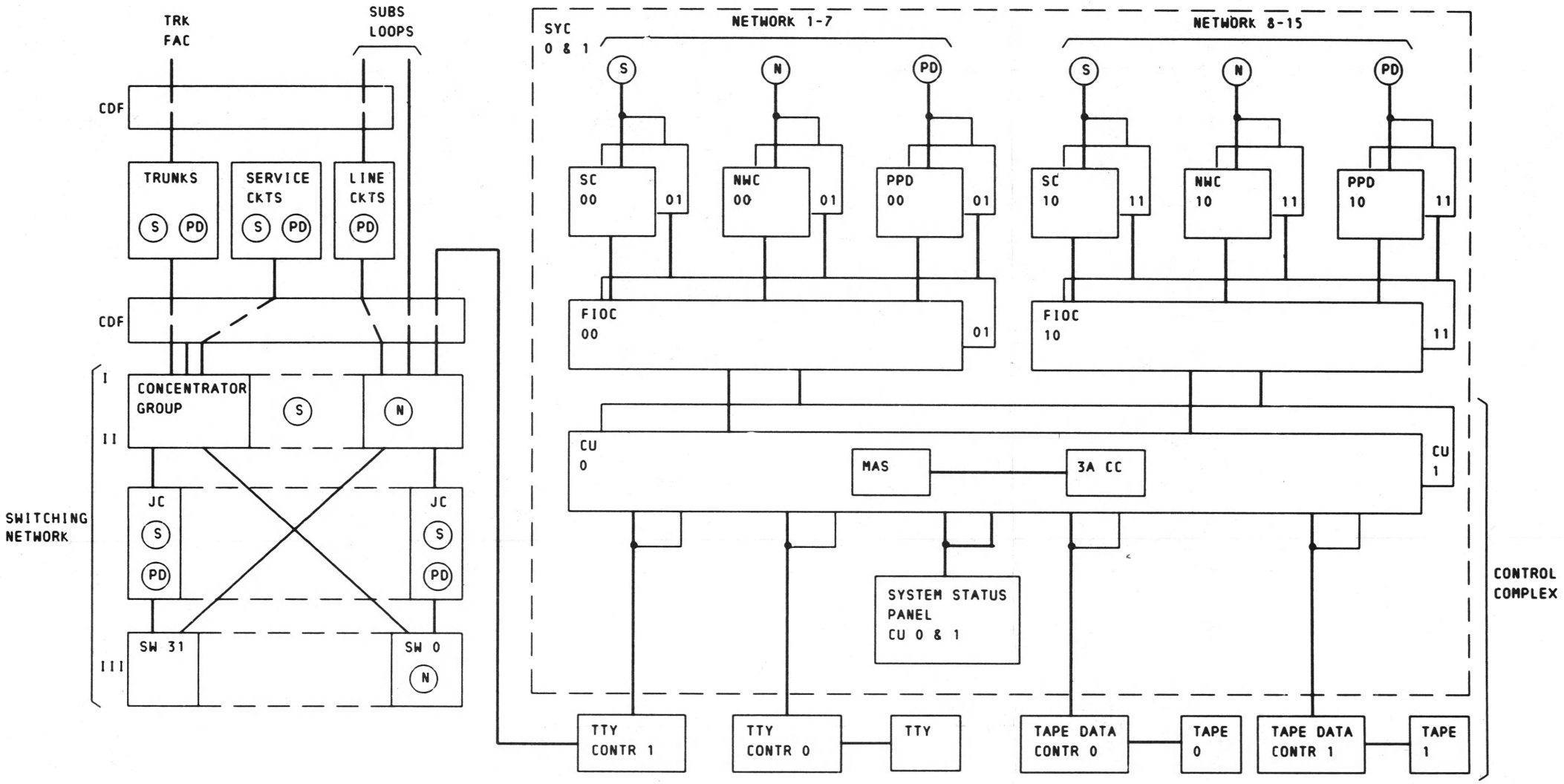


Fig. 13—Miscellaneous Power Frame



PD = PERIPHERAL DECODER POINT
S = SCAN POINT
N = NETWORK CONTROL POINT
JC = JUNCTOR CIRCUIT
SW = SWITCH

SC = SCANNER CONTROLLER
NWC = NETWORK CONTROLLER
PPD = PERIPHERAL PULSE DISTRIBUTOR
FIOC = FRAME INPUT OUTPUT CONTROLLER
MAS = MAIN STORE

3A CC = 3A CENTRAL CONTROL
CU = CONTROL UNIT
SYC = SYSTEM CONTROL

Fig. 14—No. 3 ESS Block Diagram

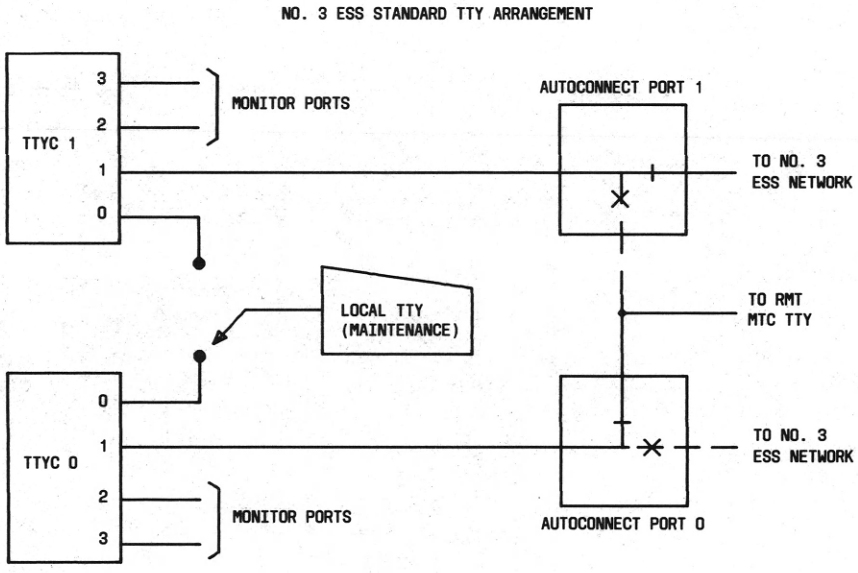


Fig. 15—No. 3 ESS Standard TTY Arrangement

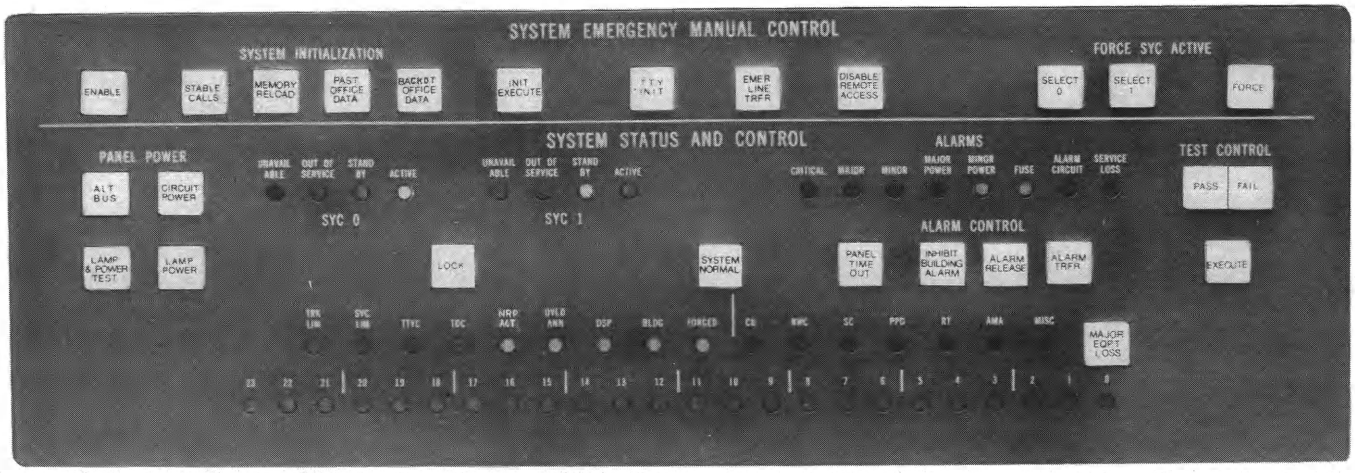


Fig. 16—System Status Panel

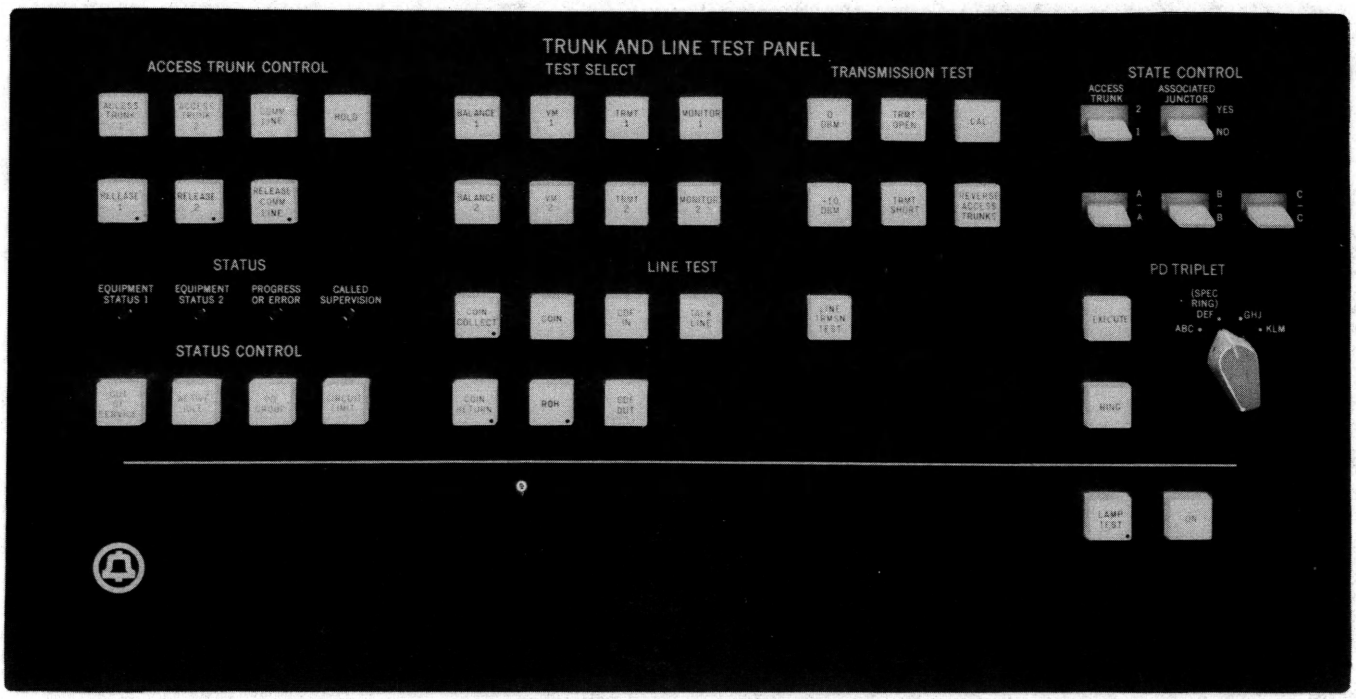


Fig. 17—Trunk and Line Test Panel

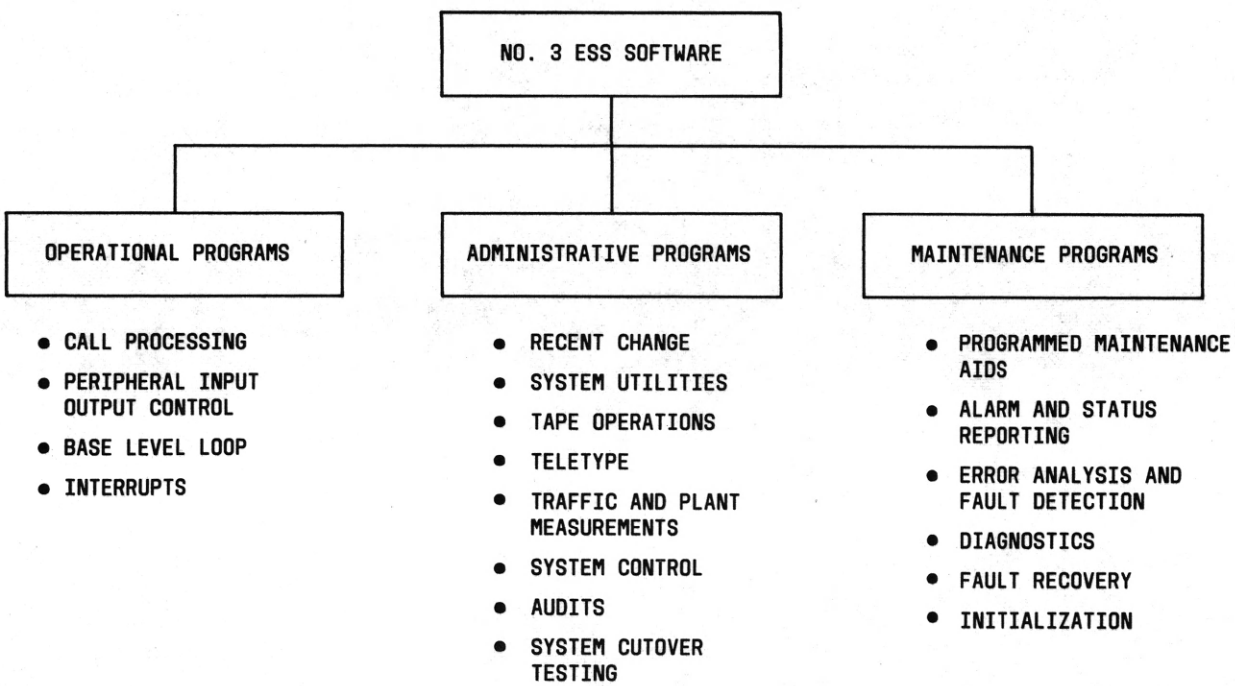


Fig. 18—No. 3 ESS Functional Programs

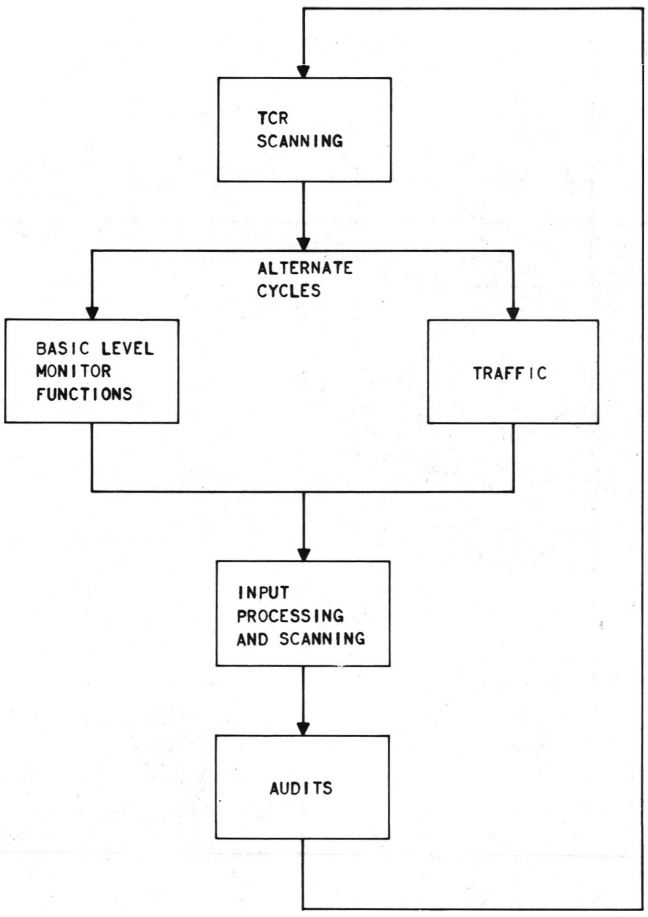


Fig. 19—Base Level Loop

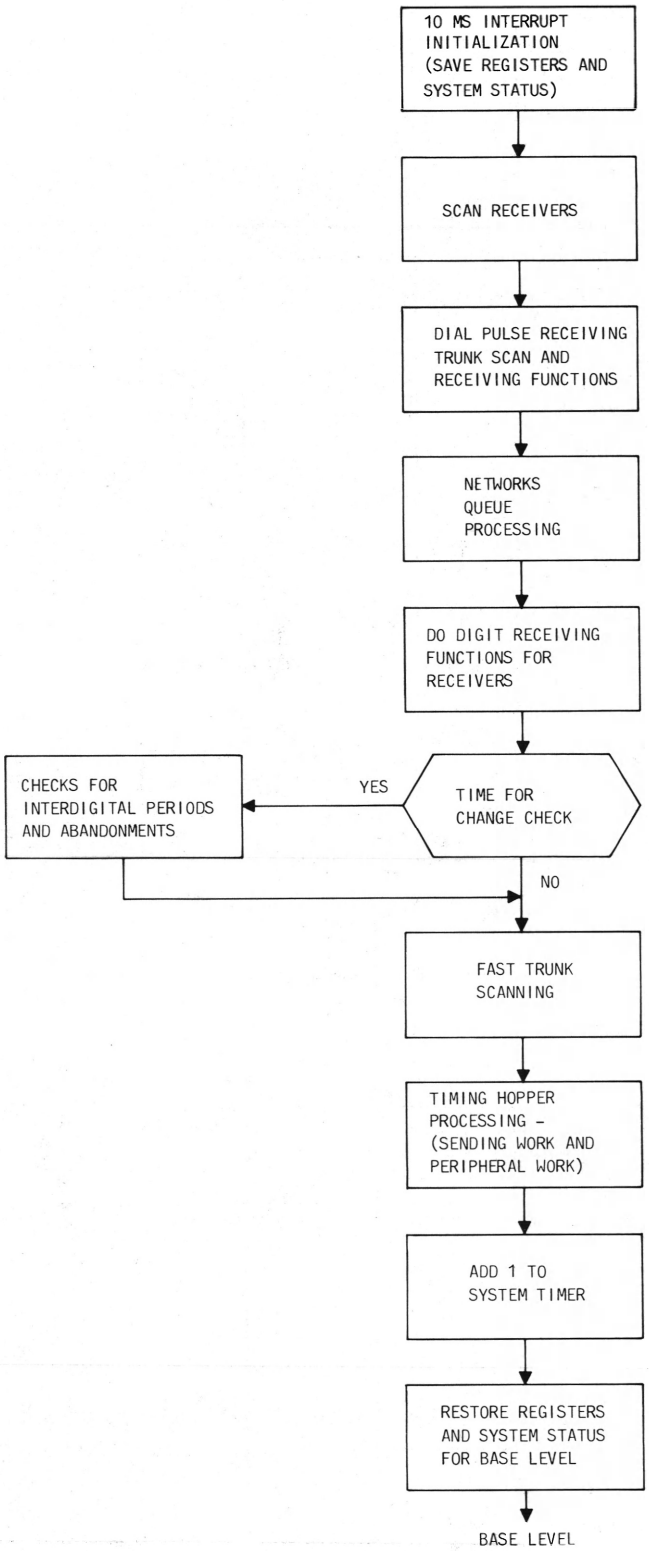


Fig. 20—Timed Interrupt

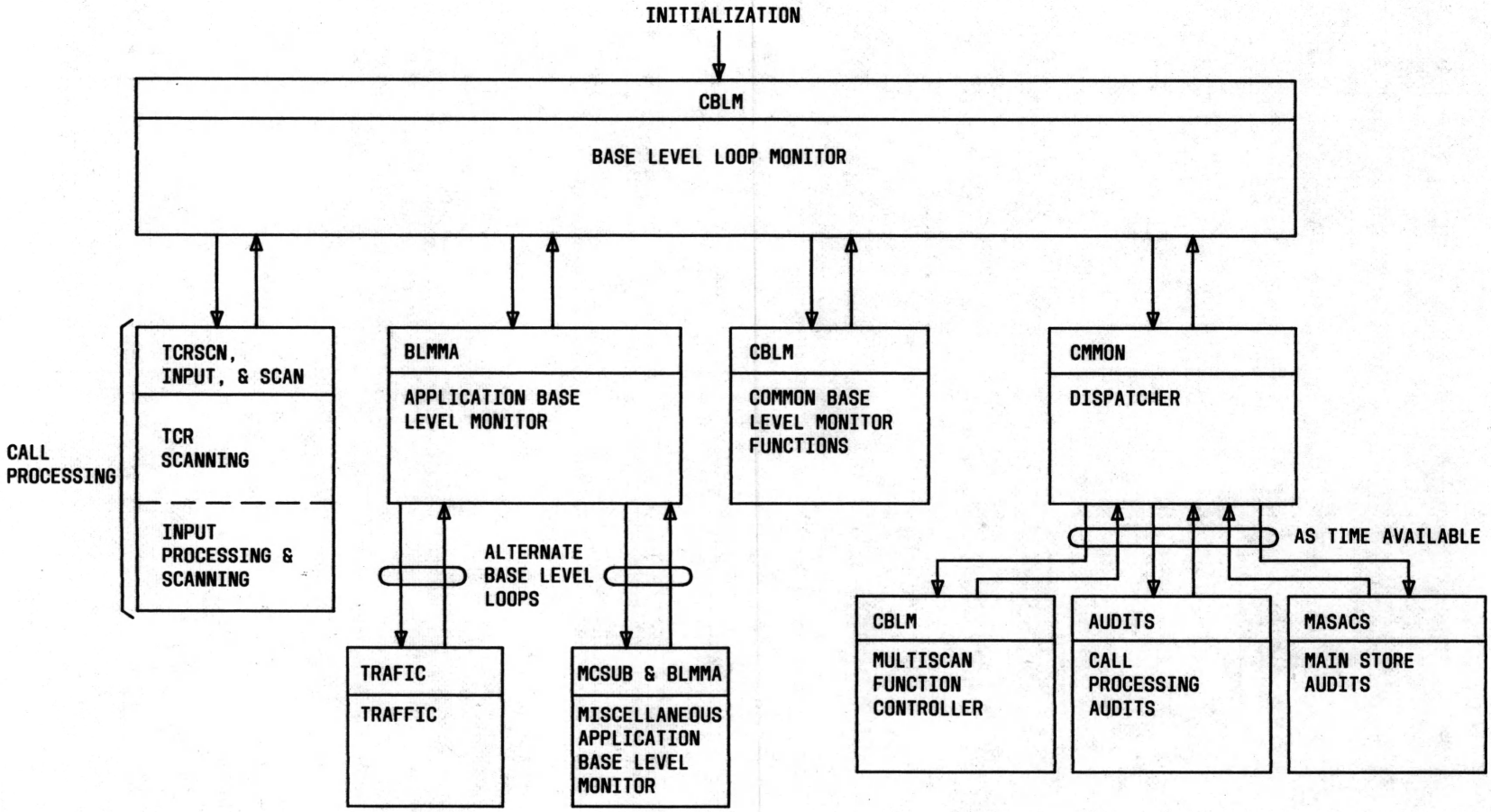


Fig. 21—3E3 Base Level Loop

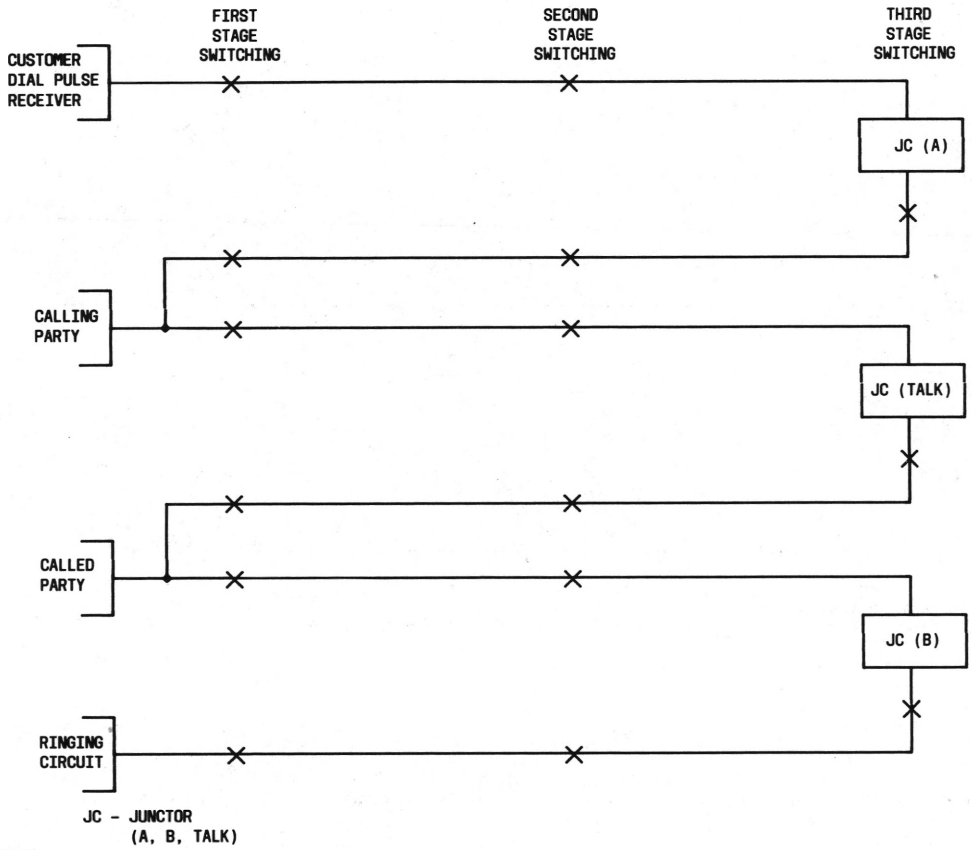


Fig. 22—Typical Intraoffice Call Connections

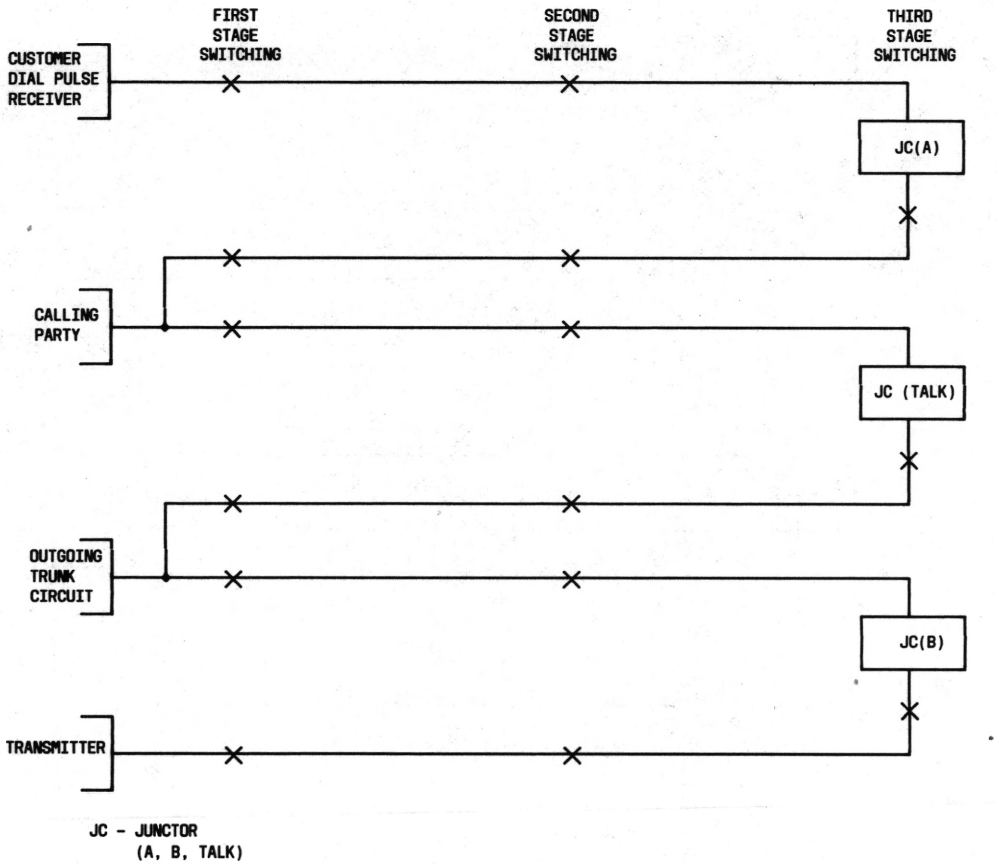


Fig. 23—Typical Interoffice Call Connections

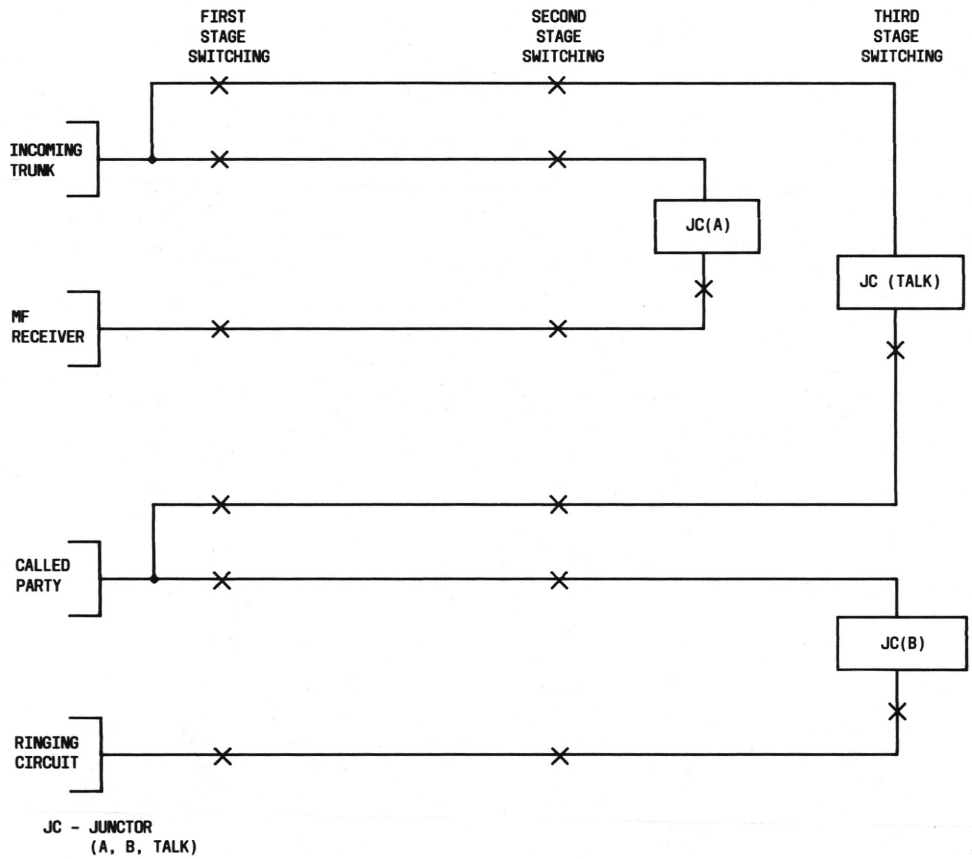


Fig. 24—MF Incoming Call Connections

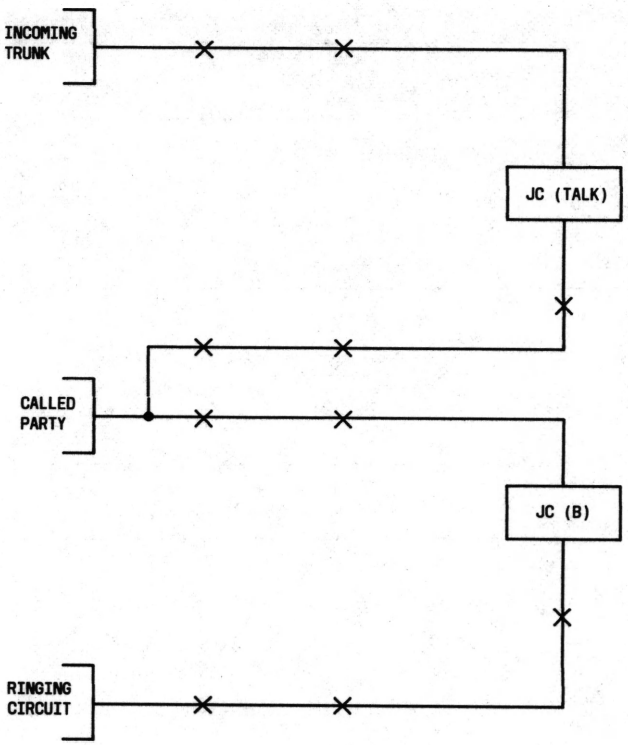


Fig. 25—Dial Pulse Incoming Call Connections

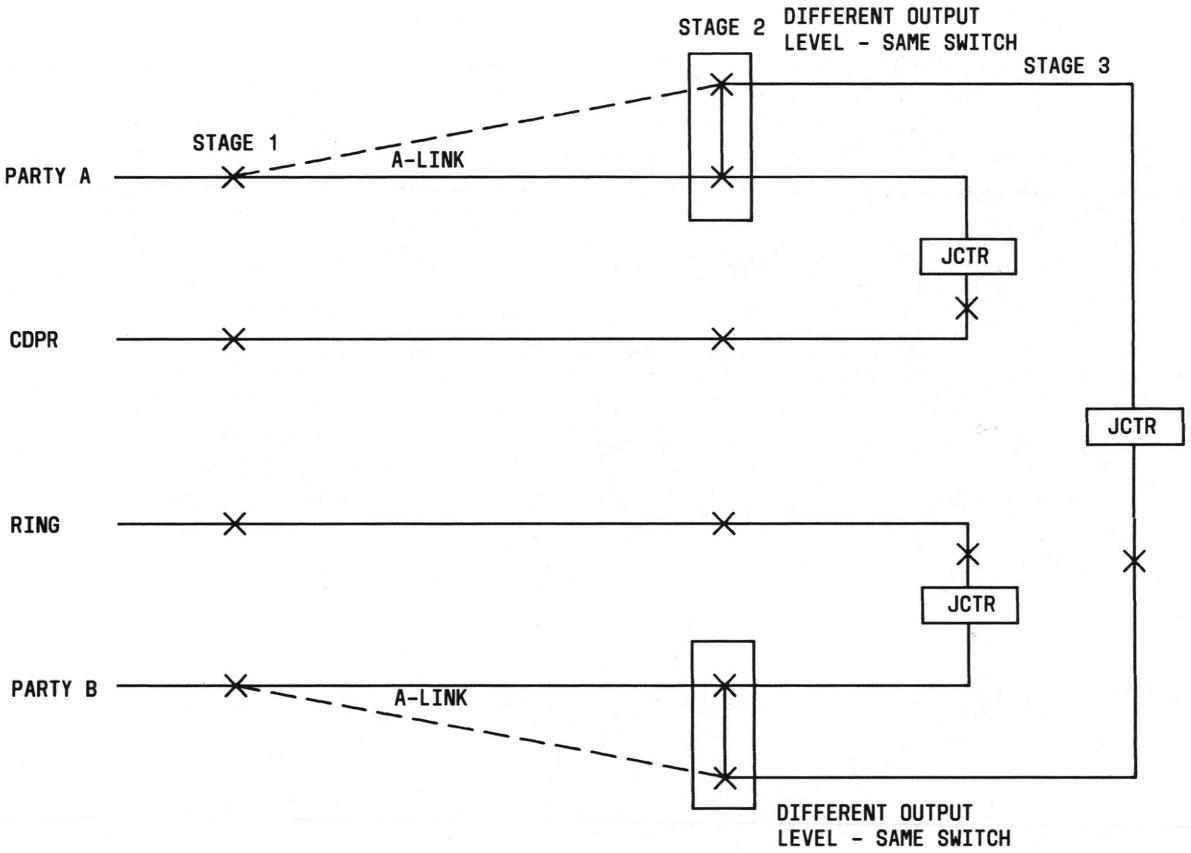


Fig. 26—A-Link Sharing

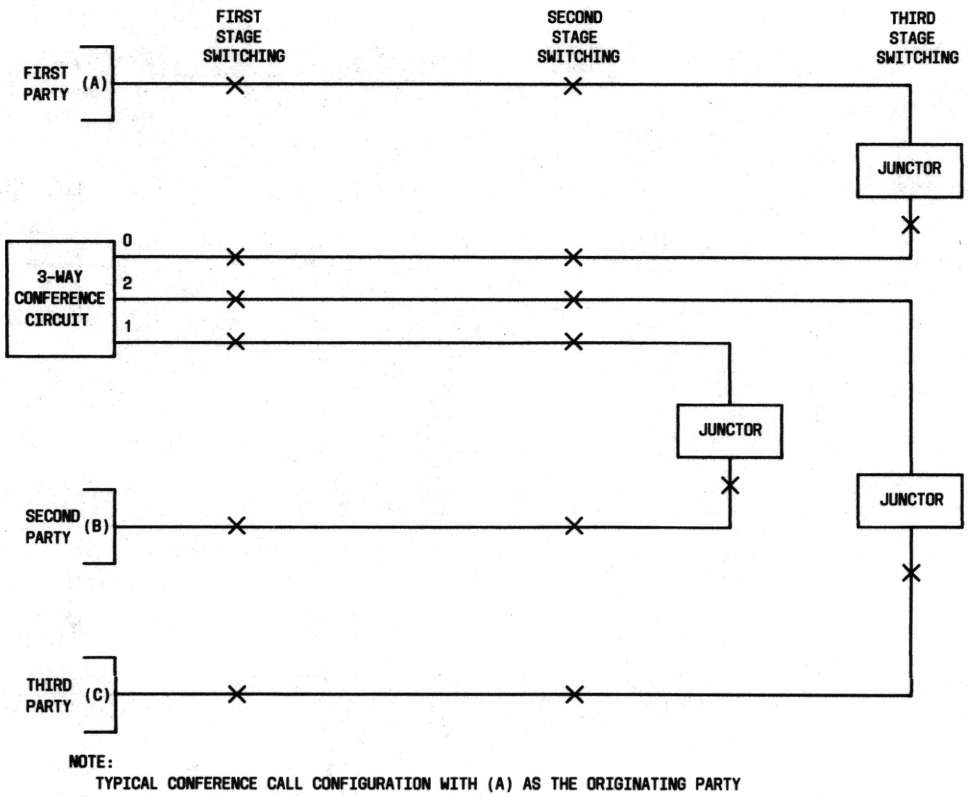


Fig. 27—3-Way Conference Call

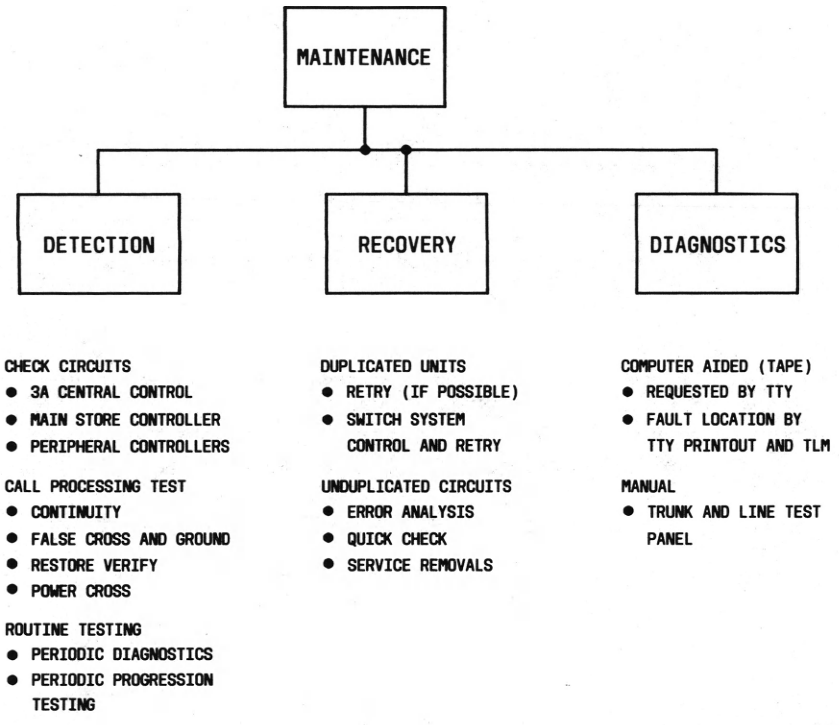


Fig. 28—No. 3 ESS Maintenance Plan

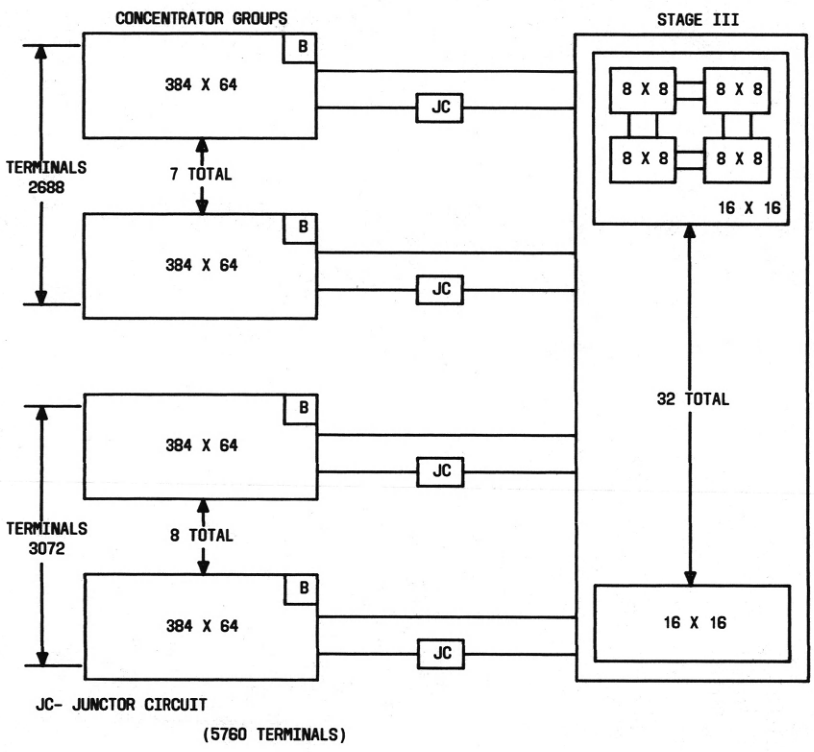


Fig. 29—No. 3 ESS Maximum Network

TABLE A

NO. 3 ESS GENERAL FEATURES

TYPES OF LINES SERVED
Individual-Residence, Business, Manual, PBX, Coin
2-Party
4-Party
8-Party
TRUNK CAPABILITIES
Outgoing Local (Extended Area Service—EAS)
Incoming Local (EAS)
2-Way Local (EAS)
2-Way Operator Office
Outgoing Recording Completing
Incoming Toll Switch
Outgoing CAMA
Incoming Toll
Incoming From Local Test Desk Number 14
Outgoing Intercept
Outgoing Verification Request
Outgoing TSP and TSPS
Outgoing To Repair Service Board
Local Tandem

TABLE B

NO. 3 ESS LINE FEATURES

LINE FEATURE	TYPE OF LINE					
	SINGLE PARTY				MULTIPARTY	
	RES BUS	MAN	PBX	COIN	2	4&8
Originating	X	X	X	X	X	X
Terminating	X	X	X	X	X	X
Flat Rate	X	X	X	—	X	X
Message Rate	X	—	X	—	X	—
Hotel—Motel (To TSP/TSPS)	—	—	X	—	—	—
Free Terminating	X	X	X	—	—	—
TOUCH-TONE@	X	—	X	X	X	X
Dial Pulse 10 PPS	X	—	X	X	X	X
Dial Pulse 20 PPS	X	—	X	X	X	—
ANI	X	—	X	X	X	—
ONI	X	—	X	—	X	X
Bill to Listed Number	—	—	X	—	—	—
QZ Billing	X	—	X	—	—	—
Remote Message Register	X	—	X	—	—	—
Software Message Register	X	—	X	—	—	—
Reverting Calls	—	—	—	—	X	X
Plug Up List	X	X	X	X	X	X
Emergency Manual Line	X	X	X	—	—	—
Emergency Line (Fire, Police)	X	X	X	—	—	—
Denied-Originating	X	X	X	X	X	—
Denied-Terminating	X	X	X	X	X	X
Loop Start	X	X	X	X	X	X
Ground Start	X	—	X	X	—	—
Immediate Ring	X	X	X	X	X	X
Coin First	—	—	—	X	—	—
Dial-Tone-First	—	—	—	X	—	—
Retain Coin on 0 or X11	—	—	—	X	—	—
Return Coin on 0 or X11	—	—	—	X	—	—

TABLE B (Contd)

NO. 3 ESS LINE FEATURES

LINE FEATURE	TYPE OF LINE					
	SINGLE PARTY				MULTIPARTY	
	RES BUS	MAN	PBX	COIN	2	4&8
Local Overtime	—	—	—	X	—	—
Multiline Hunt	X	—	X	—	—	—
Series Completion	X	—	—	—	—	—
No Hunt	X	—	X	—	—	—
Make Busy	X	—	X	—	—	—
Dynamic Service Protection	X	X	X	X	X	X
Group Alerting	X	—	—	—	—	—
Call Waiting	X	—	—	—	—	—
Speed Calling	X	—	X	—	—	—
Threeway Calling	X	—	—	—	—	—
Call Forwarding	X	—	X	—	—	—
Toll Diversion	—	—	X	—	—	—
Toll Restriction	X	—	X	X	—	—
Local Service Observing	X	X	X	X	X	X
Line Lockout	X	X	X	X	X	X
Call Tracing	X	X	X	X	X	—
Nonsynchronized Audible	X	X	X	X	X	X

RES—Residential
BUS—Business
MAN—Manual
PBX—Private Branch Exchange
COIN—Coin Station

TABLE C

NO. 3 ESS TRUNK FEATURES

TRUNK FEATURES	LOCAL			OPERATOR		OGT CAMA OR TSP/TSPS	TOLL ICT	LOCAL TEST DESK #14 & #16 ICT
	OGT	ICT	2-WAY	REC COMP	TOLL SWITCH			
E&M Lead	X	X	X	X	X	X	X	—
Reverse Battery	X	X	—	X	X	X	—	X
Immediate Start	X	X	X	—	—	—	—	—
Wink Start	X	X	X	—	X	X	X	X
Delay Dial	—	—	—	—	—	—	X	—
Stop—Go	X	—	X	—	—	—	—	—
Dial Pulsing	X	X	X	—	—	—	X	X
Multifrequency Pulsing	X	X	X	—	X	X	X	—
Inband Coin & Rering	—	—	—	X	X	X	—	—
Class of Service Tone	—	—	—	X	—	—	—	—
Automatic Ring	—	—	—	—	X	—	—	—
No Test Access	—	—	—	—	X	—	—	X
Local Tandem	X	X	X	—	—	—	—	—

OGT—Outgoing Trunk
ICT—Incoming Trunk
REC COMP—Recording Completing

TABLE D

NO. 3 ESS ROUTING FEATURES

ROUTING FEATURES	
Access Codes	0+, 1+, 01+, 011+
Service Codes	X11, 11X
Information Codes	114, 411, 1+411, 555 1212, 1+555 1212
	NPA+555 1212, 1+NPA+555 1212
0, 0+, 1+, To TSP/TSPS	
01+, 011+, To TSPS (IDDD)	
1, 3, 7, 10 Digit Dialing (Exclusive of Access Codes)	
Dialing Plan—NXX-NXX-XXXX (N=2 thru 9, X=0 thru 9)	
Up thru 2 Alternate Routes	
Shared Office Code Via 1000 s Digit Translation	
Up thru 3 Foreign Area Translators (Optional)	
Extended Area Service (EAS)	
Emergency Service Bureau 911	

TABLE E
NO. 3 ESS MISCELLANEOUS FEATURES

MISCELLANEOUS LINE FEATURES
Partial Dial Treatment Permanent Signal Treatment 8-Party Semiselective Ringing and 4-Party Full Selective 8-Party Divided Code Ringing and 4-Party Semiselective Ringing **SLEEVE LEAD FUNCTION** 32 Major Classes of Service 6 Incoming Office Codes 256 Possible Routes
MISCELLANEOUS TRUNK FEATURES
Delete Digits (Up thru 7) Prefix Digits (Up thru 3)
MISCELLANEOUS EQUIPMENT ARRANGEMENT FEATURES
7-Foot Frames—Single Sided Fire Detection Earthquake and Disaster Bracing (Optional) RF and External Power Protection (Optional) Unitized Frame Shipment Loose Frame Shipment (Optional)
MISCELLANEOUS HARDWARE FEATURES
Low Profile Combined Distributing Frame (30″ deep) Protector Units Reuse of Existing CDF Protector and MDF (Optional) Power Plant—Solid State 151A Type Ringing and Tone Supply Plant, 1/2 Amp

TABLE F

UNIVERSAL TRUNK CIRCUITS

TRUNK CIRCUIT TYPE	PULSING		USE	CLASS		
	DP	MF		NONCOIN	COIN	COIN–NONCOIN
Outgoing Reverse Battery High—Low (FB399)	√	√	EAS* (Outgoing)	—	—	—
	—	√	CAMA	√	√	—
	—	√	TSP	√	√	—
	—	√	TSPS	√	√	√
	√	√	One-Way Out EAS*	—	—	—
	—	—	One-Way Out SWBD	√	√	√
	√	√	One-Way In SWBD	√	√	√
	√	√	One-Way in EAS*	—	—	—
	√	√	One-Way In Toll Collect	—	—	—
E- & M-Lead (FB382 Type Two Interface) (FB391 Type Three Interface)	—	√	CAMA	√	√	—
	√	√	AIS	—	—	—
	—	√	TSP	√	√	—
	—	√	TSPS	√	√	√
	—	—	Regular and Trouble Intercept	—	—	—
	√	√	One-Way Out EAS*	—	—	—
	—	—	One-Way Out SWBD	√	√	√
	√	√	One-Way In SWBD	√	√	√
	√	√	One-Way In EAS*	—	—	—
	√	√	One-Way In Toll Collect	—	—	—
	√	√	2-Way SWBD	√	√	√
	√	√	2-Way EAS*	—	—	—
Incoming Reverse Battery Wink (FB371)	√	√	EAS* (Incoming)	—	—	—
	√	√	Outgoing SWBD	√	√	√
	√	√	Incoming SWBD	√	√	√

TABLE F (Contd)

UNIVERSAL TRUNK CIRCUITS

TRUNK CIRCUIT TYPE	PULSING		USE	CLASS		
	DP	MF		NONCOIN	COIN	COIN—NONCOIN
Incoming Reverse Battery (Delay Dial) (FB370)	—	√	Toll Connect From 4A or 4M Crossbar	—	—	—
Incoming Reverse Battery Immediate Start (FB371)	√	—	EAS* (Incoming)	—	—	—
Tandem Reverse Battery (FB371 or FB399)	√	√	EAS* (One-Way)	—	—	—
E- & M-Lead Tandem (FB382 or FB391)	√	√	Regular and Trouble Intercept	—	—	—
	√	√	AIS	—	—	—
	√	√	One-Way EAS*	—	—	—
	√	√	2-Way EAS*	—	—	—

* EAS includes crossbar tandem and all local offices except panel.

TABLE G

NO. 3 ESS POWER SUPPLIES

POWER SUPPLY	TYPE OF PLANT OR UNIT	CAPACITY (AMPERES)	CODE
* −48 Vdc (−42.75) Thru −52.5V)	Storage Batteries (Without Emergency Cell or Counter Cell Switching) Rectifier Charged	100 Thru 400 100 Thru 600	151A 151C
+24 Vdc (+22.7 Thru +26.9V)	DC-to-DC Solid-State Conversion From −48 Volts	8	188A 189A
+130 Vdc −130 Vdc	DC-to-DC Solid-State Conversion From −48 Volts	1/4 Per Polarity	184B
+48 Vdc	DC-to-DC Solid-State Conversion From −48 Volts	1.8	184A
Reserve AC Supply	120-Volt Single-Phase Solid-State Power Converter	1/2 kW	KS-20816, L2
Ringing and Tones	Solid-State Generator With a Precise Tone Plant	1/2	881A
+3 Vdc	DC-to-DC Solid-State Converter-Processor, Control, Maintenance Frames	5	A8
Battery Boost Converter	Provide Variable Voltage (1 Thru 13 Vdc) to Boost Talk Battery	2	S5
120 Vac for: Maintenance Frame, Test Frame TTY, Data Sets, Test Battery, Supply Unit, and Recorded Announcement	Commercial Power Supplied by Local Power Company; With Protected Supply for TTY and Recorded Announcement		
Appliance Outlets Frame Lighting	Distributed From Ceiling Supported Busway		

* Does not include 1-volt distribution drop to equipment frame.

TABLE H

COMPATIBILITY CHART

COMPATIBLE SYSTEMS	REMARKS
No. 1 ESS	
No. 2 ESS	
No. 5 Crossbar	Immediate start possible but not recommended.
No. 4A and 4M Crossbar	Many 4A trunk circuits require 2-to-4 wire conversion.
Step By Step	No start pulsing signal.
Crossbar Tandem	Immediate start possible but not rcommended.
Panel and No. 1 Crossbar	No. 3 ESS will not receive or out-pulse revertive or PCI pulse.
Traffic Service Position System	No. 1
Switchboards	3C and 3CL or equivalent.
Intercept Systems	6A and AIS
Test Desks	No. 14 and No. 16 local test desks
Announcement System and Desks	
Service Observing Set	No. 7B
PBX	101 ESS