GENERAL SYSTEM MAINTENANCE

NO. 2B ELECTRONIC SWITCHING SYSTEM

CONTENTS PAGE

1. GENERAL

1.01 This section gives information on the general system maintenance in a No. 2B Electronic Switching System (ESS) office. It is intended to familiarize the reader with the maintenance plan and the facilities available to maintain the office.

1.02 This section is reissued to provide a more comprehensive description of No. 2B ESS

general maintenance philosophy. Since this is a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 In a No. 2B ESS office, maintenance procedures are initiated

(a) in response to system-detected troubles,

(b) in response to trouble reports (man-detected troubles), and

(c) to perform manual test routines.

1.04 The TTYs referred to in this section are maintenance TTYs. Section 232-303-301 and Input Message Manual (IM-2H200) provide the TTY information required for interfacing with the system.

1.05 Whenever the term TOUCH-TONE® telephone service is used, it refers to the equipment required to provide this service to the customer.

2. MAINTENANCE PLAN

GENERAL

2.01 The No. 2B ESS is equipped with maintenance circuits and programs designed for detection and diagnosis of failures automatically or by manual request. Detected failures may call for preventive maintenance or corrective maintenance. Some failures are indications of component deterioration which may in the future be service affecting if preventive maintenance is not performed. Failures which are caused by operational faults require immediate corrective maintenance to ensure system integrity.

2.02 Whenever a failure is detected by the system, it is recorded on a TTY printout. The significance of the TTY printout may be determined by using the Output Message Manual OM-2H200. The output message manual lists in alphanumeric order all the system output messages printed by the TTY. This document contains a description of each message, the reason each message was issued, the actions to be taken, if any, as a result of the message and the alarm indications that should accompany the message. When a failure occurs, the appropriate diagnostic test should be run. In some cases the system will automatically run diagnostics. If it is necessary to manually implement a diagnostic test, the appropriate message can be found in the Input Message Manual IM-2H200.

2.03 The input message manual lists TTY messages that can be typed on the maintenance TTYs to request a system action or function. A description of the format and the use of each message, as well as cautions and expected results, are given for each message. The messages are arranged in alphanumerical order, and a topical index guides the reader to the specific message to be used. Some of the types of actions and functions that these messages request are:

(a) To diagnose a system unit,

(b) To initiate traffic counts,

(c) To trace a call, and

(d) To read from or write into memory locations.

2.04 The automatically or manually implemented diagnostic test carefully checks the unit causing the failure printout. If the unit passes the diagnostic test, the fault is considered transient. However, if the unit fails the diagnostic test, the results are provided in a TTY printout which contains a trouble number. This trouble number can be used in conjunction with the Trouble Locating Manual (TLM) to isolate the fault to a replaceable unit such as a circuit pack.

2.05 The TLM is a maintenance document which supplements the OM to help in locating troubles within system units. The TLM lists trouble numbers that match trouble numbers provided in the TTY printout generated by the system when the failure occurred. There are also special instructions and comments in the TLM that facilitate the required maintenance and understanding of why the failure occurred.

2.06 In addition to the maintenance circuits and programs which provide for detection and diagnosis of failures automatically or by manual requests, a maintenance center provides a centralized control point for communicating, controlling, testing, and recording requirements of the system. An office alarm system also notifies office personnel of failures.

2.07 The heart of a successful maintenance program is proper preventive maintenance.

Preventive maintenance is the identification, isolation, and correction of faults before they become service effecting. Therefore, those circuits which are not checked automatically by the system on a periodic basis must be checked manually in accordance with the Equipment Test List, 232-001-01X. This list contains all the manaully implemented tests for No. 2B ESS, for both preventive and corrective maintenance, and indicates the interval for all the preventive maintenance tests.

2.08 Many of the tests prescribed by the ETL must be run from the trunk test panel which provides the facility for connecting test equipment to trunks and service circuits. Trunk circuits may also be tested automatically from a centralized automatic reporting on trunks (CAROT) system provided the office is equipped with the remote office test line (ROTL).

2.09 The maintenance plan is supported by:

(a) Circuits that are made reliable by using long-life components and by providing controlled operating conditions

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

(c) Duplication of equipment which is provided throughout the system except where a failure should affect only a small number of subscribers

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

(e) Various types of redundancy used in the information transmitted between units in order to detect errors.

2.10 Maintenance programs include the following:

(a) Routine tests which detect the existence of trouble.

(b) The 2B processor uses various automatic error-checking techniques such as bit slicing, parity checks, m-out-of-n codes, duplication, and program times. Detection of an error initiates appropriate recovery action.

(c) Fault checking routines which in response to the detection of a failure determine which major unit is in trouble and cause appropriate switching actions to be taken.

(d) Diagnostic tests which pinpoint the location of a trouble within a unit and make this information available as a printout on the TTY.

(e) Peripheral unit testing which provides diagnostic tests for operational testing and X-ray tests which are used for the factory and initial testing at the site, and/or for testing frames being added to an operational office. The X-rays may only be requested manually.

2.11 Certain manual routines are required in a No. 2B ESS central office. Some of these routines include replacing the magnetic tape on the automatic message accounting (AMA) recorder, calling line identification, updating program store data, tape data facility procedures, dynamic service protection, and testing office alarms. Reference should be made to Section 232-000-000 for an index of the sections in Division 232. An alphabetical index of the No. 2B ESS sections is also provided in the No. 2B ESS Maintenance Handbook (405-035).

TROUBLE DETECTING CIRCUITS AND PROGRAMS

2.12 Fault detection within the No. 2B ESS is accomplished by self-checking circuitry and/or software. The technique of detecting errors by self-checking circuitry allows continuous trouble detection without the loss of normal call processing time. Program audits and diagnostics are performed periodically on a time available basis to ensure that the information stored in memory is correct and that the 2B processor and peripheral equipment are operating properly.

2.13 Upon detection of a fault, diagnostic programs may be initiated automatically by the system recovery program to further isolate the fault. These programs can also be initiated manually via the TTY by maintenance personnel.

A. 2B Processor

2.14 The units of the 2B processor are designed to be self-checking and utilize the following error-checking techniques:

- ***Bit-Slicing:*** Two-bit partitioning or bit-slicing is used in the 3A central control (3A CC) and the main store controller to aid in

the detection of errors, especially in areas such as the general registers. Two-bit slicing means that two bits of each register are on a single circuit board. For example, the first circuit pack contains bits 0 and 8 of every general register. Partitioning is used so that a fault on a single board will affect at most only two bits of any register and therefore be detected by the two parity bits.

- ***Parity Check:*** A parity bit is a bit associated with a word to make the total number of ones, including the parity bit, either odd or even. Parity checks are used throughout the 2B processor. Each time information is transferred from one location to another via a data bus, a parity check is performed by a gating bus parity checker. Whenever incorrect parity is found, an error is detected.

- ***M-Out-of-N Codes:*** The m-out-of-n codes are used in various areas of the 3A CC to provide maximum error detection capability such as the control signals required in the I/O channels and microprogram control. The m-out-of-n codes means the "m" number of ones should be present out of "n" number of bits. For example, four-out-of-eight means that exactly four ones will always be present in an 8-bit code. The associated decoder check circuits ensure that the number of ones is correct. If an incorrect code is detected, an error is indicated.

- ***Duplication:*** Some circuits of the 3A CC (such as the data manipulation logic circuit) are duplicated to detect faults. Duplicated circuits are given the same input data and then the output data is compared to determine whether or not the data was processed correctly.

- ***Periodic Diagnostic Test:*** Since the 2B processor uses self-checking circuits, its fault detection is adequate only as long as the check circuits work properly. A combination of hardware and software is used to ensure that the check circuits provide an indication when a fault occurs. Hardware provides a means of simulating test conditions or circuit faults. By appropriately setting up the test conditions and applying a well-designed test sequence, the detection circuitry is checked on a periodic basis to ensure its proper operation.

- ***Program Timer:*** Although the 3A CC is designed to be as self-checking as possible, an overall system sanity check for both hardware and software is provided by the program timer. The use of the hardware timer is closely related to the system program. A reset is generated for the timer only if the program proceeds through the normal program loop correctly within the prescribed period. If the program deviates from the normal course, no reset is given. The timer automatically times out, stops processing, generates an alarm and starts the recovery process.

- ***Program Audit:*** The 2B call store memory contains many items of redundant information associated with the equipment and individual calls. The memory also contains links which connect blocks associated with a call. It is the function of audit programs to ascertain whether these various items in memory are consistent. Separate audit programs are written for the various memory blocks such as the transient call records, terminal memory records, line status bits, originating registers, peripheral order buffers, and the network map. For example, the originating register audit program checks for a correct linkage from the originating register to a terminal memory record and transient call record. When the audit program finds inconsistencies, it attempts to idle the memory blocks and, if possible, the corresponding equipment. To facilitate a quick recovery capability, the 2B on-line main store (MAS), standby MAS, and tape are kept identical. To accomplish this, two updates are performed:

  (1) If the off-line store is known to be out of date, it is updated with the current contents of the on-line store.

  (2) If the two stores are presumed to be the same, both are audited for bad parity and for mismatches between the two stores.

These updates are implemented by the 3A CC update mode of operation and the update program and main store audit. Audit programs can be initiated periodically from the time monitor or manually via the TTY.

B. Scanner

2.15 Each scanner controller contains several maintenance features designed to detect malfunctioning circuitry. The scanner access circuitry, core matrix, and interrogate loop malfunctions are detected by the scanner all-seems-well (ASW) circuitry. The operation of the scanner output amplifiers is verified via a maintenance test signal coupled to the detector inputs.

2.16 Scanner test programs are also used in verifying proper operation of this scanner circuitry. All scanner circuitry except the individual ferrods can be tested using these programs. These programs also test the common access buses and some of the I/O circuitry. The types of scanner tests are access, check circuit, and output.

C. Switching Networks

2.17 Internal checking circuits prevent the network controller from processing an order if an invalid address or other malfunction is detected. If a malfunction is detected the controller will generate an enable verify failure or the controller will become locked up or both. An enable verify failure and/or controller lock-up will occur in response to an incorrect input message, an open pulse path, tip and ring path, and certain types of controller logic troubles. Should a controller become locked up, test programs are run to localize the trouble.

2.18 The network controller test program can be used in either a diagnostic or X-ray mode of operation. Either mode can be initiated manually by TTY request. Diagnostics can also be initiated automatically by the system trouble recovery program or periodically from the time monitor.

2.19 Network diagnostic tests are organized into test blocks. Each test block is designed to test a different portion of the controller logic and/or wirespring relays or current source steering for remreed networks. During a test block, a sequence of orders is sent to the controller. The diagnostic bus, controller state, and enable verify signals are monitored to see if the orders were executed properly. If no faults are found, all nine test blocks are run and ATP (all test pass) will be printed on the maintenance TTY. If a fault is detected, testing is discontinued and a trouble number is printed out. This number is referred to the trouble locating manual.

2.20 The network X-ray runs through the same test sequence as diagnostics. At the first occurrence of failure, testing is stopped. One or more of the following may be printed out:

(a) The failing order including the failing network path

(b) The diagnostic bus at the time of the failure

(c) T, S, and F scan points status 50 milliseconds (ms) after the failure

(d) Test block in which the failure occurred

(e) The controller status at the time of the failure.

NON-SYSTEM DETECTED TROUBLES

2.21 If a customer complaint indicates that a verification of the originating (terminal equipment number) or terminating (directory number) translation should be made, the verification messages in the input message manual are used.

2.22 Methods for using the trunk test panel for testing trunks and service circuits are described in Section 232-130-301.

2.23 Trunk troubles fall into four categories:

(a) Facility troubles—cables, carrier, etc.

(b) Operational troubles—relay operations

(c) Transmission

(d) Translation (the information stored in memory and used by the system to determine the type of supervision, signaling, etc).

The first three categories of troubles can be checked from the trunk test panel. Translation verifications are made from the TTY via the appropriate input

message. Refer to the input message manual for a complete description of this message.

OTHER TROUBLES

2.24 ***Network Failures and Analysis:*** Error records are maintained for network paths. Those paths that incur high error rates are identified as failures. Section 232-108-302 covers the procedure for analyzing and locating ferreed switch troubles and Section 232-108-802 covers remreed switch repair and replacement procedures (use 232-108-301 and 232-108-801 respectively for ferreed networks).

2.25 ***Mechanical Troubles:*** In the No. 2B ESS office, some of the units (TTY and AMA), when detected as being in trouble either by the system or by observation, may have a mechanical trouble rather than an electrical trouble. If the unit passes diagnosis by the system and mechanical troubles are suspected, the proper section should be referred to for checking the mechanical operation of the unit.

MAINTENANCE INTERFACE FACILITIES

A. 2B Maintenance Frame

2.26 The 2B maintenance (MTCE) frame (Fig. 1) provides the interface between the maintenance personnel and the system. The maintenance personnel can access and control the system through the TTY and the system status panel. The MTCE frame also provides a backup image of the program and translation data on the tape data controller (TDC) unit.

2.27 The MTCE frame is a single bay frame and contains the following equipment:

- Maintenance TTY
- Up to four TTY controllers
- System status panel (SSP) and system status panel controller
- System status panel relay unit
- Two TDC units
- Power unit
- Optional E2A telemetry unit

Maintenance Teletypewriter

2.28 The primary means of communication between maintenance personnel and 3A CC maintenance is the TTY. The maintenance personnel can request via TTY input messages specific actions to be performed by the system. In reply to these input messages, the system acts on the requests and reports on the actions completed. The system reports on the actions through TTY printouts and lamp indicators on the system status panel.

TTY Controller

2.29 The purpose of the TTY controller (TTYC) is to provide a controlling interface between the 3A CC and the TTY for system maintenance and a variety of administrative tasks. The controller connects the 3A CC and up to four TTY ports in a hub arrangement whereby signals from any one are seen by the others.

TTYC Mate Operation

2.30 Information which is transmitted to the local maintenance TTY from the 3A CC is also transmitted to the remote maintenance TTY through the mate operation of the TTYCs. Conversely, the same applies to information transmitted to the remote maintenance TTY. This is accomplished through a cross-coupling of TTYC-0 and TTYC-1. The local maintenance TTY is connected to port 0 of TTYC-0 and the remote maintenance TTY is connected to port 0 of TTYC-1. Port 2 of TTYC-0 is cross-coupled to port 3 of TTYC-1 and port 2 of TTYC-1 is cross-coupled to port 3 of TTYC-0. If TTYC-0 is removed from service due to a fault, the 3A CC can communicate with the local maintenance TTY through TTYC-1 via the cross-coupling mechanism. The 3A CC also has access to the remote maintenance TTY through TTYC-0, via the cross-coupling mechanism, if TTYC-1 is removed from service.

System Status Panel and System Status Panel Controller

2.31 The system status panel and system status panel controller are located in the upper midsection of the maintenance frame. The system status panel is mounted on the front of the system status panel controller and provides a communication link between the maintenance personnel and the system. Numerous lamps and keys appear on the panel which display the status of the system and

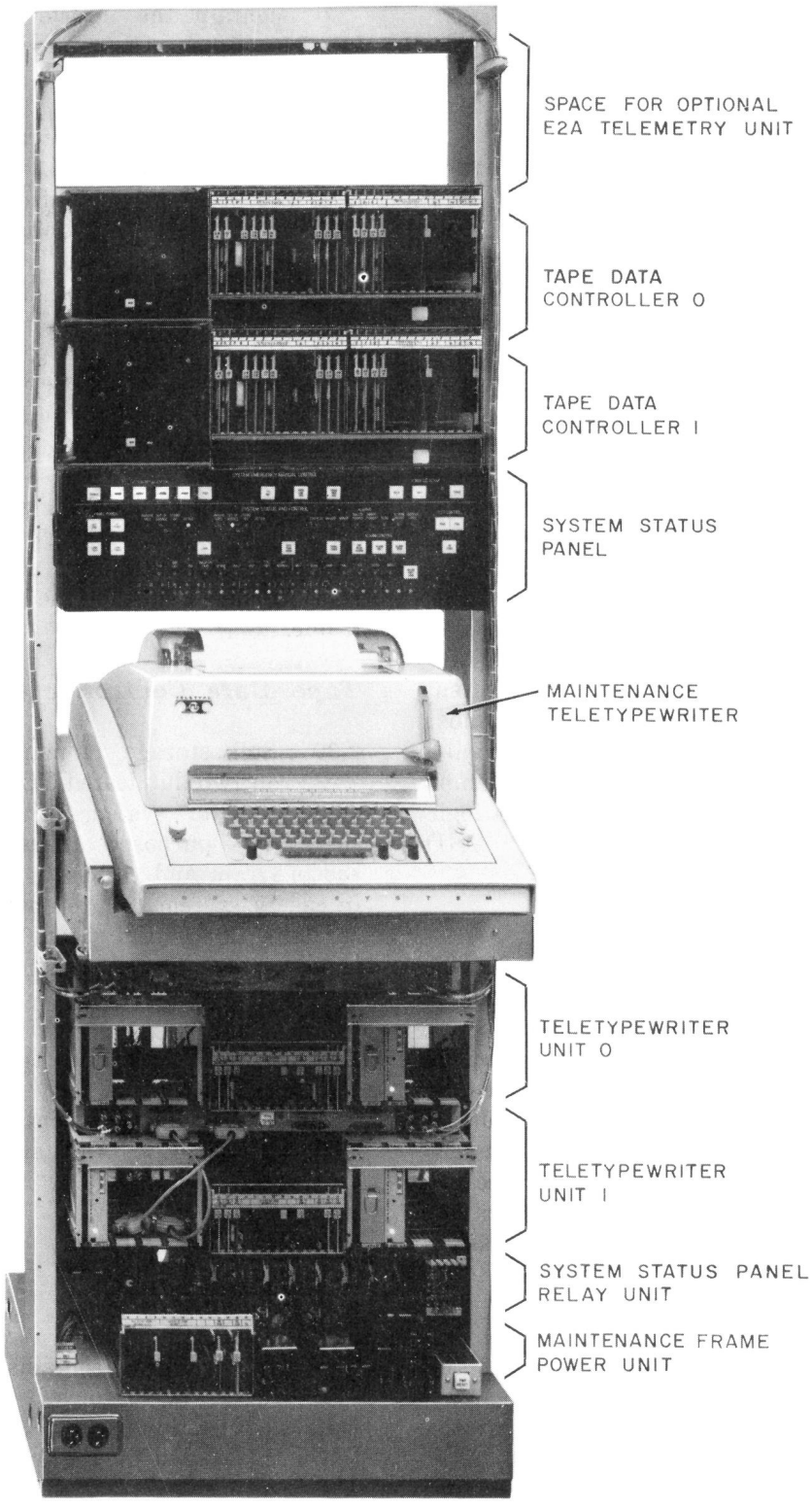

Fig. 1—Maintenance (MTCE) Frame

provide control of the system. The main functions of the system status panel are as follows:

- Visual indicator of the status of the major system units
- Emergency control when manual intervention is needed
- Interface between E2A telemetry and the 3A CCs for Switching Control Center (SCC) application.

2.32 The system status panel is divided into two parts: the SYSTEM STATUS AND CONTROL which reflects the general system condition, and the SYSTEM EMERGENCY MANUAL CONTROL which is used to stabilize the system via manual intervention during an emergency situation.

2.33 The SYSTEM STATUS AND CONTROL portion of the panel is primarily a display of system health. The display reflects the state of the flip-flop memory element in the system status panel controller. These flip-flops, in most cases, are controlled and, in all cases are readable via I/O messages and the 3A CCs. The only lamps or key/lamps not associated with a flip-flop logic element are CIRCUIT POWER, LAMP AND POWER TEST, and LAMP POWER.

2.34 The SYSTEM EMERGENCY MANUAL CONTROL portion of the panel is a means to manually restore the system to a healthy state during service-affecting trouble conditions. Various stages of initialization can be initiated from the SYSTEM EMERGENCY MANUAL CONTROL portion of the panel. These include clearing of transient data and recent change information, initialization of hardware, program reloading, and TTY initialization. Also provided are control of the emergency manual line transfer and disabling of remote access.

2.35 The system status panel controller is the interface between the 3A CC, E2A telemetry interface, system status panel, and system status panel relay circuits. The system status panel controller 3A CC interface packs contain the necessary registers, transmit and receiver transformers, parity checker and generator, etc, to allow communication between 3A CCs and the rest of the system status panel controller.

2.36 The system status panel interface packs contain the interlocking logic for certain keys and flip-flops associated with the system status panel keys and lamps.

2.37 Both the E2A unit and the E2A interface packs are optional. If equipped, the E2A interface packs provide buffering between the panel interface and the E2A unit.

System Status Panel Relay Unit

2.38 The system status panel relay unit provides a relay interface between the system status panel controller and office alarm circuits and various system peripheral frames as needed. The system status panel relay unit also contains a part of the power-sequencing logic for the system status panel controller +3 volt converters. In addition, this unit is an access point for all alarm and alarm test leads leaving or entering the No. 2B ESS maintenance frame.

Tape Data Controller (TDC) Unit

2.39 Bulk storage on magnetic tape is provided on two duplicated TDC units. The units are duplicated for system reliability. This storage serves two purposes. First, a backup image of the program and translation data is kept on tape in case a system failure should mutilate the store contents. Secondly, a copy of the data needed to return translations to the state prior to the last update is kept on tape.

2.40 The TDC provides the following:

- An asynchronous interface and control unit between the 3A CC and a cartridge transport and a data set
- Bulk data storage.

Power Unit

2.41 The power unit contains the dc-to-dc converters necessary to convert -48 volts input to +3 volts at 4 amps. The +3 volts is required by the units located on the MTCE frame.

2.42 Power is supplied to the frame from a power distributing frame through a triple power feeder supplying +24 volts, -48 volts and ground. The power feeders are connected to cables

which run through the hollow frame uprights to the base of the frame. The filters in the base of the frame filter the 24-volt supply while the 48-volt supply is filtered by the converters. The fuse panel provides fusing and power to all units in the frame and the fuse alarm circuitry which operates when a fuse fails.

B. Trunk Test Frame

2.43 The trunk test frame (Fig. 2) is located adjacent to the MTCE frame and provides the following test facilities for the No. 2B ESS:

- Manual testing for trunks, service circuits, lines, junctor circuit, range extension circuits, and attendant loop circuits
- Monitoring of busy connections in the office
- Talking connections over lines or trunks for intra or interoffice communication
- Means to remove circuits from service and to restore circuits to service.

2.44 Connection of a circuit to the trunk test frame is accomplished by dialing prescribed data formats on the panel mounted TOUCH-TONE dial. The trunk test frame has three access trunks, each of which is assigned a directory number and has appearances on the line trunk network. Operating specific keys on the panel sends test call information to the 2B processor. Lamps on the panel indicate the type of test being performed and the success or failure of a request for system action. Optional test gear required by the operating company is mounted on this frame.

C. Switching Control Center System (SCCS)

2.45 The work station in the SCCS allows maintenance personnel to remotely monitor and, when necessary, to manually intervene to correct problems at the various No. 2B ESS offices.

2.46 The No. 2B ESS/SCCS control console 1A (CC1A) remotes selected MTCE indicators and function keys and accordingly allows maintenance personnel to perform various routine and special purpose operations remotely from the SCCS.

2.47 The DISABLE REMOTE ACCESS key at the SSP is set and reset manually to control the SCCS E2A telemetry access into the SSP. Maintenance personnel can activate this key to disable the E2A control leads into the SSP; however, the monitoring ability of the SCCS is not disturbed. This procedure is used if the No. 2B ESS is adversely affected by erroneous E2A telemetry operation.

2.48 The CC1A display includes system status displays which indicate the current alarm status, temporary memory, system registers, or machine occupancy patterns, etc.

2.49 The system status and control portion of the CC1A display is divided into four major areas; (1) ***System Emergency Manual Control*** which includes the ***System Initialization Functions*** and FORCE CU ACTIVE function, (2) ***System Status & Control*** which includes LOCK CU, Alarm Display and Control, Test Control and indications for System Normal & Panel Time Out, (3) ***Peripheral Unit Status,*** (4) ***Display Buffer*** with binary, octal and decimal (for low 16 bits) display, and ***Power Panel*** which includes Alternate Bus and Circuit Power indications. The lamp indications represent the state of major peripheral equipment, and are intended to point the maintenance personnel to trouble areas. If a lamp indication is lighted, maintenance personnel can determine why by requesting status information for the particular unit in question via a TTY input message.

2.50 Interface between the SCCS and a No. 2B ESS can be established with or without the computer subsystem. If the computer subsystem is not functioning, stored program controlled system (SPCS) interface is established by the central office selector and junction unit (COSJU) through the switching network, telemetry, and an auxiliary TTY. The COSJU is used to manually connect the TTY or TTY and console to the selected SPCS. Detailed information pertaining to the COSJU can be found in the BSP 190-110 layer common systems documents.

3. TROUBLE RECOVERY

SYSTEM AUTOMATIC RECOVERY

3.01 After the detection of a fault, the system must quickly and automatically recover itself to a point or condition where it can function to process calls. The error signals that result from the detected faults are buffered to the error register

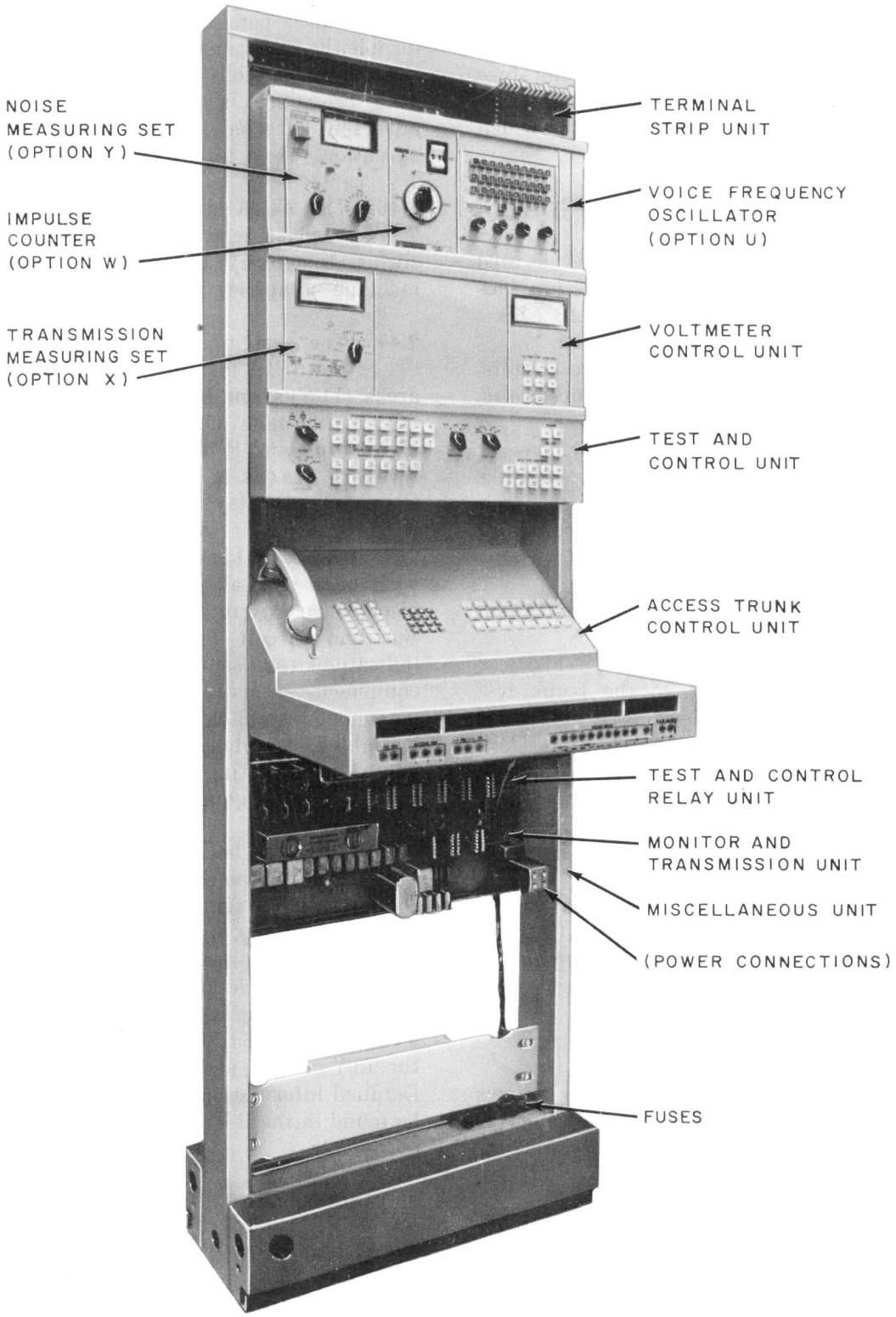

Fig. 2—Trunk Test Frame

or the interrupt set register of the 3A CC. These signals are sorted and divided into three groups with each causing a different set of system actions.

3.02 ***Interrupts:*** A demand maintenance interrupt occurs when a fault or difficulty of high priority is indicated. The interrupt program breaks into the program which is being executed and immediately initiates corrective action. After the appropriate recovery action is taken, control is returned to the base level program which was interrupted. The demand maintenance interrupts are initiated by the following control unit errors:

- Attempted off-line store write in write protected area
- Attempted on-line store in write protected area
- Off-line store parity error
- Off-line fast time-out on read or write function
- Error in I/O main channel selection or error in 3-out-of-6 code check circuit
- Program timer reset received by on-line 3A CC
- Switch message received by on-line 3A CC telling it to go on-line
- I/O subchannel selection error or I/O channel sequence error
- I/O bad parity.

3.03 ***Initialization:*** This action is taken when a trouble occurs which is serious enough to require clearing of memory and/or registers and the restart of the affected unit in a known state. The units of the 2B processor which can be initialized are the 3A CC, MAS controller, MAS, 2B I/O control circuit, TTYC, system status panel controller, and TDC. The level of initialization will depend on prior initializations which occurred in a specified period of time. Initialization restarts are handled by the common system initialization (CINIT) program and the application initialization (INITA) program. The stimulus of an initialization is the failure of a check that indicates the integrity of the processor and/or its data base is questionable. An initialization consists of:

- Restoring the CU to a known good state
- Restoring the periphery to a known good state
- Aborting certain activities
- Zeroing or otherwise initializing temporary data
- Bootstrap partial or complete tape.

Not all of the preceding are performed on every initialization. An initialization can be more or less drastic depending on which, and to what extent, the preceding routines are invoked. For example, a given initialization may zero none, some, or all of temporary store. In general, the system reaction becomes more drastic each time a previous recovery attempt fails. The escalation is encoded in the level number of the initialization, which is incremented on each failure. The higher the level number the more drastic the recovery routine becomes.

3.04 When the main store memory becomes mutilated, the bootstrap program is used to either completely reload the main store or only reload that portion of memory that is mutilated. The bootstrap sequence generally consists of the following steps:

(1) Bootstrap loader program is loaded into MAS from tape unit

(2) Bootstrap loader loads MAS with selected group of system programs which will complete initialization of 3A CC and reload the MAS

(3) Load checksum file into MAS to aid in evaluation of MAS contents

(4) Hardware initialization performed by system initialization program which was loaded into MAS

(5) Mutilated blocks (4096 words) of MAS are determined and reloaded from tape.

3.05 The CINIT program is divided into three parts as follows:

- Restoration of CU to a known good state
- Common system temporary data is zeroed
- Bookkeeping tasks (formatting of TTY output messages, alarms, etc) are performed.

After each of the three parts are performed, an entry is made to the INITA program. The INITA program is also divided into three parts which correspond to the entry points from the CINIT program. The three parts of the INITA program are as follows:

- Analysis of data and determination of level of initialization to be performed
- Initialization of periphery and temporary store at level determined in first entry
- Bookkeeping tasks are performed and finally the restart of normal processing.

3.06 ***Switch to other control unit (CU):*** This action changes control from one CU to the other due to a fault in the on-line system. The newly on-line system then undergoes an initialization as described in paragraph 3.03.

3.07 Although the system is designed to automatically recover itself under trouble conditions, certain software and/or hardware faults may occur in which the system is unable to reconfigure into a working mode (eg, continuously switching CUs). In these cases, manual recovery must be performed via hardware which allows maintenance personnel the capability of forcing the system into a fixed configuration and locking it into that mode. The maintenance personnel have this capability through the 3A CC control panel and the system status panel at the MTCE or remotely from the control console in the SCC via the E2A unit.

3.08 Maintenance programs used to maintain the No. 2B ESS perform the following functions:

- Detecting and reporting of equipment troubles and/or stored program inconsistencies
- Attempting to recover a working system when a failure occurs
- Diagnosing the system or specific units to pinpoint the location of troubles

The programs that perform these functions are categorized as trouble recovery and diagnostic programs.

A. Trouble Recovery Programs

3.09 When the check circuits detect a CU error and call in the interrupt monitor, a trouble recovery program is selected to examine the suspect circuit(s). If the fault is verified, the recovery program then switches the on-line and standby CUs to achieve a working mode. Similar programs exist for troubles detected in various peripheral units.

B. Diagnostic Programs

3.10 Diagnostic programs may be automatically called in by the base level maintenance monitor after trouble detection and recovery have been completed. They may also be manually requested via the teletypewriter, called in by the call processing program which detects abnormal conditions, or initiated periodically from the time monitor.

3.11 A diagnostic is a test sequence that localizes a fault to an area for repair. The diagnostics operate on a "start small philosophy." This means that before the circuit under test is diagnosed, all circuitry used in that diagnostic will be tested. For example, before the on-line 3A CC runs any diagnostics on the off-line 3A CC, the maintenance channel must first be checked to ensure its proper operation. As the diagnostics continue, that portion of the 3A CC that has been checked increases until correct operation of the total 3A CC is verified. If a failure occurs in the diagnostics, a TTY message is printed which gives a trouble number. This trouble number, when looked up in the trouble locating manual, will generally indicate the cause of the trouble. Maintenance personnel must then take the appropriate repair actions, such as the replacement of a circuit pack.

INDICATIONS OF SYSTEM DETECTED TROUBLES

3.12 Two different methods are used to indicate trouble conditions within the frames of the No. 2B ESS and the equipment it monitors:

(a) Maintenance TTY printouts

(b) Audible and visual alarms associated with the office alarm circuit and miscellaneous alarm circuits.

Sometimes combinations of these methods are used to indicate trouble conditions. The alarm indication can be audile, visual, or both, and are usually accompanied by a TTY printout.

A. Teletypewriter Facilities

3.13 The maintenance TTYs report the status of the system to maintenance personnel and are used by maintenance personnel to request a variety of system actions. Typical TTY printouts associated with trouble conditions resulting in alarms indicate the equipment frame or the area involved. Typical input requests for output messages relevant to system maintenance include requests for traffic data, line activity states, diagnostic tests to be run and the results to be printed out, and for translation information associated with a particular equipment number.

Teletypewriter Printouts Accompanying Alarms

3.14 TTY printouts relevant to system trouble conditions usually accompany audible and visual alarms as required. When a trouble occurs in an ESS frame (system unit), in non-ESS equipment, or in the power room, scan points in the master scanner which monitor the particular equipment may be used to detect the trouble. The system prints a TTY message that identifies the equipment frame or the area involved. It is accomplished as follows.

(a) Trouble originating in an ESS frame is determined by the scan point number. This trouble is identified by a TTY printout and results in audible alarms and visual alarm indicators.

(b) The following message is given as an example of the information provided by an output message. This particular message pertains to a CU that has failed a diagnostic test.

DGN CU a status TEST bb SEG cc ADR ddddddd eeeeee number ff TRBL gggg DATA hhhh iiii

Where:

a = CU being diagnosed, either 0 or 1.

status = STOPPED—Diagnosing has been terminated with this failure.

= FAULT—Diagnosing is continuing beyond this failure. This only takes place if the UCL option was used in the input message.

bb = Test number of failing test.

cc = Segment number of failure within failing test.

ddddddd = Generally the octal address of the failure branch in the on-line CU. This field can represent the off-line program address (PA) at the time of failure if specifically stated in the TLM.

eeeeee = The offset octal address from the beginning of the CSECT of the on-line failure branch.

number ff = LOOP ff (The loop within the table-driven structure when a failure occurs. This is 1 if there are no loops.)

= MAS ff (For store diagnostic only. The main store controller which has failed.)

gggg = Trouble number used as index into TLM.

hhhh iiii = Optional data words. Generally for on-line code, the first three digits are 0 and h iiii is the contents of the on-line maintenance channel buffer. If the data words have another

meaning, it is described in the TLM.

(c) Troubles in non-ESS equipment [not covered by the preceding (a)] result in alarms that are grouped as miscellaneous alarms. The TTY printout is given indicating the trouble in the non-ESS equipment. Local office records are used to identify the source of the alarm from the number given in the message and to determine the action to be taken.

(d) Trouble in the power room is detected by the office alarm circuit which operates audible and visual alarm indicators.

Miscellaneous Input Message Used for Maintenance

3.15 Numerous miscellaneous input messages can be used for maintenance. Dump, load, and monitor messages access the on-line system to perform such functions as reading and writing call store, and displaying call store words, registers, and scanner rows available to maintenance personnel. These messages are typed in as DMP, LOD, and MON, respectively, followed by the designation of unit the action is taken on.

3.16 A second group of messages are used by maintenance personnel to perform such tasks as taking a faulty system off-line, performing diagnostics, and restoring the system after the trouble is corrected. If the messages are associated with peripheral equipment that is the same as No. 2 ESS peripheral equipment, the message starts with the letter M followed by the unit that action is taken on and the function to be performed (Example: M JC: RMV removes a circuit junctor from service). If the message is associated with equipment unique to the No. 2B ESS, the message starts with the function to be performed followed by the unit the action is taken on (Example: RST:CU restores the CU after diagnostic tests have passed).

3.17 Other groups of input messages are also available for use. For an explanation of the input messages and their uses, refer to the input message manual.

B. Lamps and Audible Alarms

3.18 Both audible and visible alarms can occur to indicate trouble conditions in ESS and non-ESS equipment. The alarms associated with ESS equipment are controlled by the office alarm circuit, while alarms associated with non-ESS equipment are controlled by the miscellaneous alarm circuit.

3.19 The No. 2B alarm classifications and indications are defined in Table A.

TABLE A

ALARMS LED INDICATIONS

LED DESIGNATION	COLOR	INDICATION
CRITICAL	Red	Panel time-out is activated. ***Immediate response required.***
MAJOR	Red	Partial loss of system capability. ***Immediate response required.***
MINOR	Amber	Minor loss of system capability. ***Attention required.***
MAJOR POWER	Red	Major failure in power equipment. ***Immediate response required.***
MINOR POWER	Amber	Minor failure in power equipment. ***Attention required.***
FUSE	Red	Blown fuse. ***Attention required.***
ALARM CIRCUIT	Red	Power failure in the alarm circuit. ***Immediate response required.***
SERVICE LOSS	Red	Initialization sequence—flashes during initialization and remains lighted after MRF if the level is emergency audit or higher. ***Analyze printout.***

Critical Alarm

3.20 A critical alarm is indicated visually by the CRITICAL LED (Red) being lighted and audibly by a gong sounding at 1-1/2 second intervals. This alarm is set by hardware whenever PANEL TIME OUT is set.

3.21 The critical alarm is reset by clearing the trouble causing the PANEL TIME OUT and depressing the ALARM RELEASE key.

Major Alarm

3.22 A major alarm is indicated visually by the MAJOR LED (Red) being lighted and audibly by a gong sounding at 1-1/2 second intervals. This alarm is set whenever any of the following conditions are met:

- ALARMS—MAJOR POWER LED is lighted
- Some SYSTEM EMERGENCY MANUAL CONTROL keys are active
- At least one CU's main store does not match its tape data controllers tape contents
- A double asterisk (**) prefixed TTY output message is printed. ***Immediate response is required.***

3.23 The major alarm is reset by depressing the ALARM RELEASE. If the ALARM TRFR is set, the audible alarm will automatically reset after 30 seconds. If the ALARM TRFR is set

and an SCC is provided, both the audible alarm and LEDs will be retired after 30 seconds.

Minor Alarm

3.24 A minor alarm is indicated visually by the MINOR LED (amber) being lighted and audibly by a bell sounding. The alarm is activated whenever MINOR POWER LED is lighted, or a single asterisk (*) prefixed TTY output message is printed. It is also set if a minor alarm is reported, whenever there is a minor loss of system capability, or some condition occurs requiring the attention of maintenance personnel.

3.25 The minor alarm is reset by depressing the ALARM RELEASE key. If the ALARM TRFR is set, the alarm will automatically be reset after a 30-second period. If the ALARM TRFR is ***not*** set, the audible alarm will remain until ALARM RELEASE is pressed ***unless*** MINOR POWER is also set.

C. Major Equipment Unit Alarms

3.26 Major equipment unit status is monitored at the system status panel using LEDs. Seven of these indicators are considered major equipment status indicators. This includes MAS, NET, SCAN, AMA, RT, RA, and MISC. When any of these bits are set, the associated LED will be lighted and the MAJOR EQPT LOSS lamp (Red) will light. The following is a functional breakdown of major equipment status.

(a) MAS (Red)—When the MAS LED is lighted, it indicates that the on-line CU does not have access to the standby main store or that a element fault has been detected.

(b) NET (Red)—When the NET LED is lighted, it indicates that a switching network trouble exists.

(c) SCAN (Red)—When the SCAN LED is lighted, it indicates that at least one master scanner, trunk scanner, or line scanner has malfunctioned.

(d) AMA (Red)—When the AMA LED is lighted, it indicates that an automatic message accounting trouble exists.

(e) RT (Red)—When the RT LED is lighted, it indicates that a ringing or tone source has malfunctioned.

(f) RA (Red)—When the RA LED is lighted, it indicates that one or more recorded announcement voice channels are not operating properly.

(g) MISC (Red)—When the MISC LED is lighted, it indicates that a miscellaneous trouble exists somewhere in the system such as trouble in the centrex data link frame, input-output control circuit (including central pulse distributor troubles), supplementary central pulse distributor frame, and automatic identify outward dial frame.

3.27 Other equipment status is monitored by nine additional LEDs but not by the MAJOR EQPT LOSS lamp. The following list provides the functions of each of the additional status monitors.

(a) TTYC (Red)—When the TTYC LED is lighted, it indicates that at least one maintenance TTY controller is out of service.

(b) BLDG (Red)—When the BLDG LED is lighted, it indicates that a building alarm in the miscellaneous alarm field is active. A TTY printout identifies the cause of the alarm.

(c) CKT LIM (Red)—When the CKT LIM LED is lighted, it indicates that the number of trunks or service circuits removed from service in any trunk group has reached or surpassed the number of trunks which may be removed automatically from that trunk group.

(d) TDC (Red)—When the TDC LED is lighted, it indicates that at least one tape data controller is out of service.

(e) MANUAL FORCE (Amber)—When the MANUAL FORCE LED is lighted, it indicates that the maintenance personnel has ***manually*** forced an abnormal condition, such as either control units power or test mode key operated, or the on-line control units manual key is operated, or the off-line control unit is locked or forced unavailable via the system status panel.

(f) TRAFFIC (Amber)—When the TRAFFIC LED is lighted, it indicates that an office traffic overload condition exists.

(g) DSP (Amber)—When the DSP LED is lighted, it indicates that dynamic service protection has been invoked.

(h) TOLL NET (Amber)—When the TOLL NET LED is lighted, it indicates that toll network protection has been manually invoked.

(i) ATI (Automatic Test Inhibit) (Amber)—When the ATI is lighted, it indicates that the time monitor is inhibited, scanner column fault detection is not allowed, an MRF sequence has occurred, a long-term period exercise is not allowed, certain error printouts are inhibited, or any multiscan function is inhibited via TTY request. This LED is controlled by program only.

3.28 The office alarm circuit also activates some visual indicators (pilot lamps only) of the office. The meanings of strategically located pilot lamps are as follows.

(a) A red pilot lamp in the end guard at one or both ends of each equipment aisle is lighted to indicate a major trouble condition in that equipment aisle.

(b) In multifloor offices, there are red, yellow, and green pilot lamps in the end guard at one or both ends of each cross aisle. The red pilot lamp (main aisle pilot) indicates a major trouble in that cross aisle. The yellow and green lamps indicate major and minor troubles, respectively, on some other floor when the alarms are grouped.

(c) In multifloor offices, yellow pilot lamps are provided alongside each main exit door. These lamps are arranged vertically, one lamp for each floor in the office. One exit pilot lamp is stenciled THIS FLOOR. A trouble on a particular floor causes the exit pilot lamp for that floor to light on every floor. If a battery alarm occurs on the floor containing the alarm circuit, the exit pilot lamp representing that floor lights on all other floors unless a fuse in the exit pilot lamp circuit has blown.

(d) For partially unattended operation (maintenance personnel in same multioffice building but not necessarily in No. 2B ESS area), an alarm grouping key and associated pilot lamp are located at the main exit door of the switchroom.

(e) For fully unattended operation, an alarm transfer pilot lamp is located at the main exit.

3.29 Trouble detected by the office alarm circuit is indicated by both audible and visual indicators and by a TTY printout. The audible alarm is stopped by operating the AUDIBLE ALARM OFF pushbutton on the frame on which the out-of-service lamp is lighted or, for some frames, by depressing the ALARM RELEASE key on the SYSTEM STATUS panel.

D. Miscellaneous Alarm Circuits

3.30 Troubles in non-ESS equipment result in alarms that are grouped as miscellaneous alarms. These alarms are divided into the following four categories.

(1) ***Miscellaneous Building Alarms (Major and Minor):*** These alarms are detected by means of a group of scan points associated with equipment within the building that houses the No. 2B ESS. Examples of such equipment are high temperature indicators, high humidity, etc.

(2) ***Miscellaneous Toll Alarms (Major and Minor):*** These alarms are originated in equipment associated with the transmission facilities of the office. Scan points monitor fuses, power status, and other circuit conditions in the toll equipment. Examples of these alarms are the major and the minor alarms of N2 and T1 carrier bays.

(3) ***Miscellaneous Special Alarms (Major and Minor):*** These alarms are originated in non-ESS equipment or common system equipment in the central office that is not specifically associated with toll transmission facilities or building monitors.

(4) ***Service or Alert Alarms (Minor Only):*** These alarms are detected via scan points that monitor alarm panels and other locations within the central office and are used to alert

the local office personnel as to existing conditions. These alarms are not transferred when an alarm transfer is initiated as are all other alarms previously described.

4. NO. 2B ESS PROGRAM DOCUMENTATION

4.01 Numerous documents are provided in a No. 2B ESS central office giving specific maintenance information on all system units. The program document index (PG-2H00X) is an index of the program documents associated with a given generic program. The Numerical Index 232-000-000 is a listing of all Bell System Practices applicable to the No. 2/2B ESS.

INPUT MESSAGE MANUAL

4.02 The input message (IM) manual (IM-2H20X) lists TTY messages that can be typed on TTYs to request a system action or function. A description of the format and the use of each message, as well as cautions and expected results, are given for each message. The messages are arranged in alphanumerical order, and a topical index guides the reader to the specific message to be used. Some of the types of actions and functions that these messages request are

(a) To diagnose a system unit,

(b) To initiate traffic counts,

(c) To trace a call, and

(d) To read from or write into memory locations.

OUTPUT MESSAGE MANUAL

4.03 The output message (OM) manual (OM-2H20X) lists in alphanumeric order all the system output messages printed by the TTY. This document contains a description of each message, the reason each message was issued, the actions to be taken, if any, as a result of the message having been issued, and alarm indications that should accompany the message.

TROUBLE LOCATING MANUALS

4.04 The trouble locating manuals (TLMs) are maintenance documents which supplement the output message manual to help in locating troubles within system units. The TLM lists trouble numbers that are matched with numbers generated by the system during diagnostic tests. A few system units do not have an associated TLM.

4.05 A TLM contains the following sections.

- ***Section A*** contains the index.
- ***Section B*** contains application information which describes how the remaining sections of the document are used. This section also describes the proper procedure for removal of power, removal from service, and restoral to service of the equipment unit.
- ***Section C*** is not used.
- ***Section D*** (initial translation) lists the trouble numbers generated by the system while running diagnostic programs. Adjacent to each trouble number is the suspected equipment type(s) and their location(s), plus any comments, precautions, or hints that would help in repairing the faulty unit.
- ***Section E*** is not used.
- ***Section F*** contains supplementary information such as notes and long comments that help the maintenance personnel to locate troubles that vary from the normal maintenance procedure.
- ***Section G*** is not used.

5. SPECIAL SYSTEM CONSIDERATIONS

5.01 Special consideration and cautions for system maintenance are given below.

5.02 On power distribution frames containing fused filter capacitors, power should ***not*** be removed if the filter fuse (FUSE A) is blown (opened). Damage will result when power is restored

to the unfiltered bus circuits. A typical example of this circuit is shown in Fig. 3.

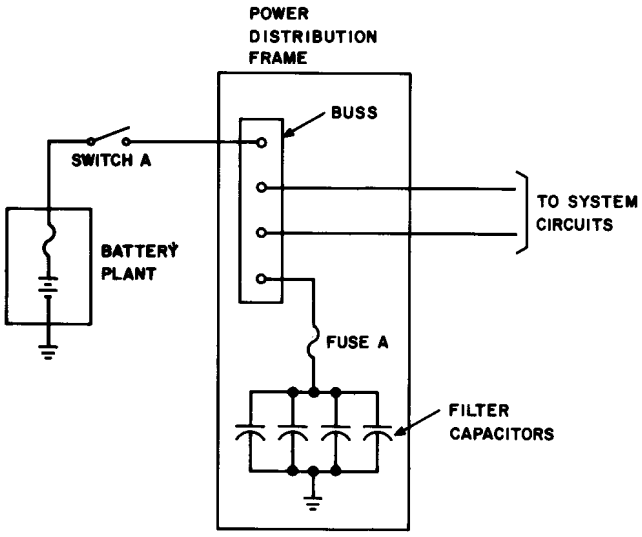

Fig. 3—Power Distributing Circuit—Typical

5.03 When removing the standby control unit for maintenance, caution should be taken to ensure that the on-line control unit is not in a double store read mode of operation. The removal of the standby MAS when the on-line control unit is double store reading can result in on-line control unit failure. The MAS LED located on the system status panel is an indication that the double store read circuit may be in use.