E2 STATUS REPORTING AND CONTROL SYSTEM

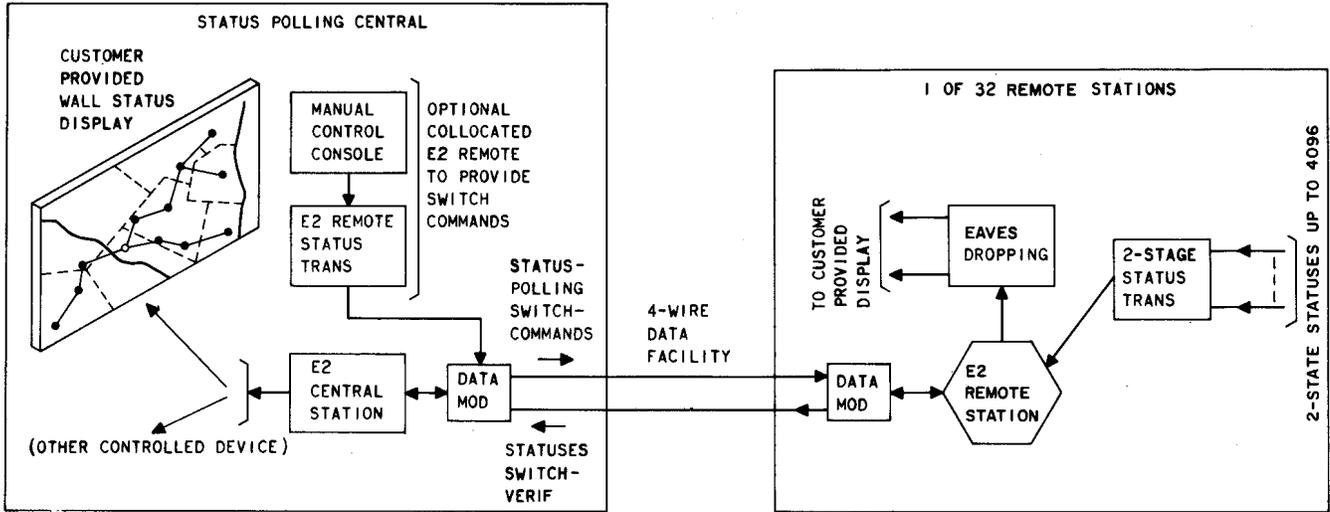## DESCRIPTION

OVERALL SYSTEM

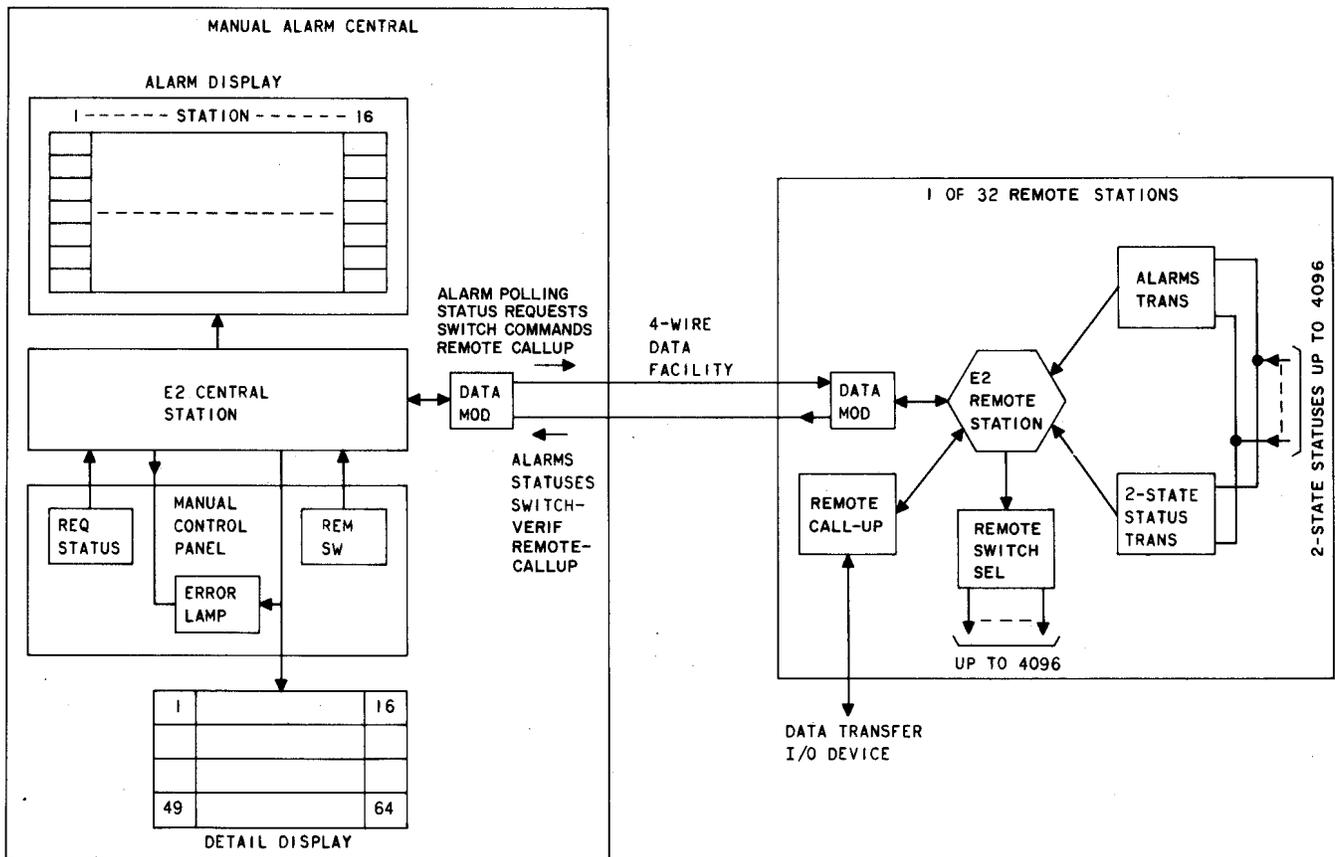## 1. INTRODUCTION

1.01 The E2 Status Reporting and Control System is a general-purpose telemetry system with multipoint data access. It is modular in nature and can be tailored for specific tasks of centralized data gathering and control. An E2 System consists of a central station and a number of remote stations connected by a 4-wire voice-frequency facility (Fig. 1).

1.02 This section is reissued to include the new remote callup (RCU) turnaround feature. Revision arrows are used to emphasize the more significant changes.

1.03 The E2 System is capable of reporting large amounts of status information from remote stations to a central station. This permits centralized and automated processing of alarms, status points, data collection, and remote control. The system is typically used for the centralized and automated maintenance of microwave systems, carrier systems (both analog and digital) traffic network management, etc.

1.04 The basic equipment at each remote station is modular and universal. Remotes respond to the operating mode of the central station. In general, only the types of status points to be monitored, the amount of alarm combining required, and the number of remote switches to be controlled determine the amount of equipment required at each remote. On the other hand, several types of central stations are available which permit the

A. STATUS POLLING SYSTEM

B. ALARM POLLING SYSTEM

Fig. 1—E2 System Configuration

system to be configured to the particular requirements and operating modes dictated by the functions to be performed. Thus, remote station equipment is multipurpose while that of the central, once configured, dedicates the E2 System to its specific application.

2. E2 DATA TRANSMISSION

2.01 Transmission of information between E2 locations is normally by 600 bit-per-second data words on 4-wire voice-frequency data-grade facilities. Data modems apply frequency-shift-keyed (FSK) binary signals to the line at normal data levels. Logic 1s are converted to 1300 Hz and logic 0s to 2100 Hz. Three 150 bit-per-second option. are also available for special applications.

A. Transmission Facilities

2.02 E2 System data networks are composed of multipoint 4-wire voice-frequency data-grade facilities. Figure 2 shows a typical E2 System multipoint network. For 600 bit-per-second voiceband operation, the network must meet basic 3002 channel transmission requirements. Essentially, a 3002 channel must meet certain gain, phase, and noise limits.

2.03 The data network may be extended by the use of E2 data regenerators which provide isolation between the two parts of the network for attenuation, delay distortion, and noise. The data regenerator is available separately or as part of the central or remote equipment, as shown in Fig. 3 and Fig. 7. If a second data network is required, an additional data module (data set) must be incorporated in the central bay (see Fig. 3).

B. Word Format

2.04 The word format used by the E2 System contains 30.5 binary bits, as shown in Fig. 4. Each word consists of three parts; a preparatory-and-word start sequence, a control-and-information sequence, and a parity sequence.

2.05 The preparatory sequence consists of a marking tone 5.5 bits long followed by a logic 0. The marking tone is used to turn on the data receivers. The logic 0 is referred to as a synchronizing bit or start bit. It is used to synchronize the clock circuit in the remotes or central during the receive mode so that they will properly accept the information and parity portion of the word which follows.

2.06 The 17 bits following the start bit are the control and information portion of the word. The first of these bits (control bit) indicates that the information being sent is from either a central or a remote. The individual bit assignments (16 bits) are determined by such information as station address and by the function being performed: alarm polling, status display reporting, etc.

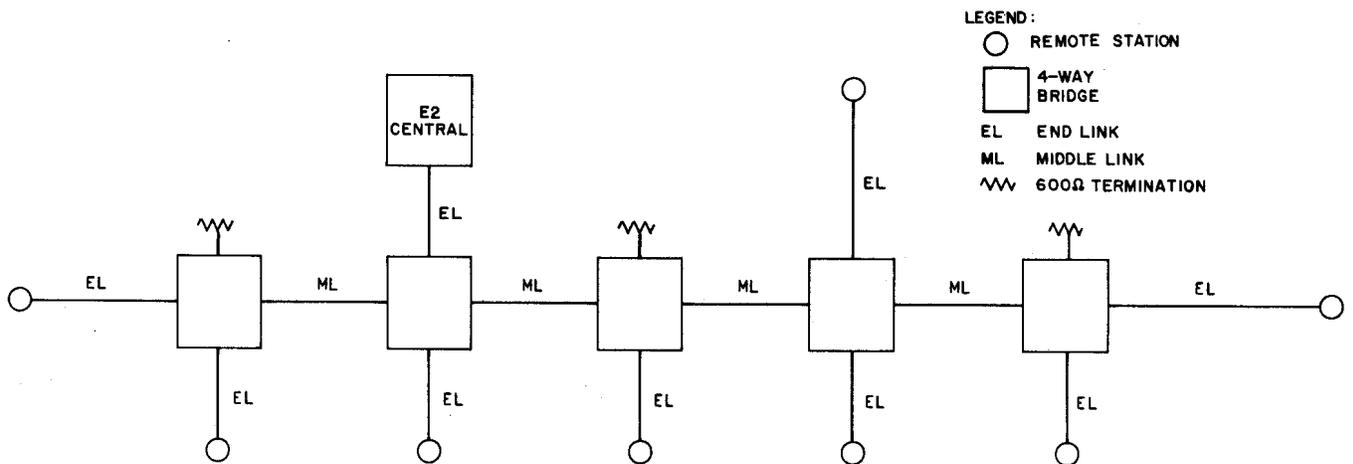**2.07** Hits on a 4-wire facility caused by impulse noise and other disturbances can cause errors

LEGEND:
○ REMOTE STATION
□ 4-WAY BRIDGE
EL END LINK
ML MIDDLE LINK
⋁⋁⋁ 600Ω TERMINATION

Fig. 2—Typical E2 Multipoint Network

```
┌─────────────────────────────────┐
│                                 │
│  ┌───────────────────────────┐  │
│  │                           │  │
│  │      FILTER AND FUSE       │  │
│  │                           │  │
│  ├───────────────────────────┤  │
│  │                           │  │
│  │      DATA MODULE           │  │
│  │                           │  │
│  ├───────────────────────────┤  │
│  │      JACK STRIP            │  │
│  ├───────────────────────────┤  │
│  │      LOGIC                 │  │
│  ├───────────────────────────┤  │
│  │      LOGIC                 │  │
│  ├───────────────────────────┤  │
│  │ ALARM        ┌────────┐    │  │
│  │ DISPLAY      │        │    │  │
│  │ PANEL        │        │    │  │
│  │              └────────┘    │  │
│  ├───────────────────────────┤  │
│  │                           │  │
│  │  STATUS AND CONTROL PANEL  │  │
│  │                           │  │
│  ├───────────────────────────┤  │
│  │                           │  │
│  ├───────────────────────────┤  │
│  │      WRITING SHELF         │  │
│  ├───────────────────────────┤  │
│  │    DATA REGENERATOR        │  │
│  ├ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┤  │
│  │        JK FLD              │  │
│  ├───────────────────────────┤  │
│  │ RCU WITH OR WITHOUT        │  │
│  │ TURNAROUND                 │  │
│  ├───────────────────────────┤  │
│  │      SPARE                 │  │
│  │    CIRCUIT                 │  │
│  │      PACKS                 │  │
│  ├───────────────────────────┤  │
│  │                           │  │
│  │                           │  │
│  └───────────────────────────┘  │
│  ┌──────┐    ┌──────┐           │
│  └──────┘    └──────┘           │
└─────────────────────────────────┘
```
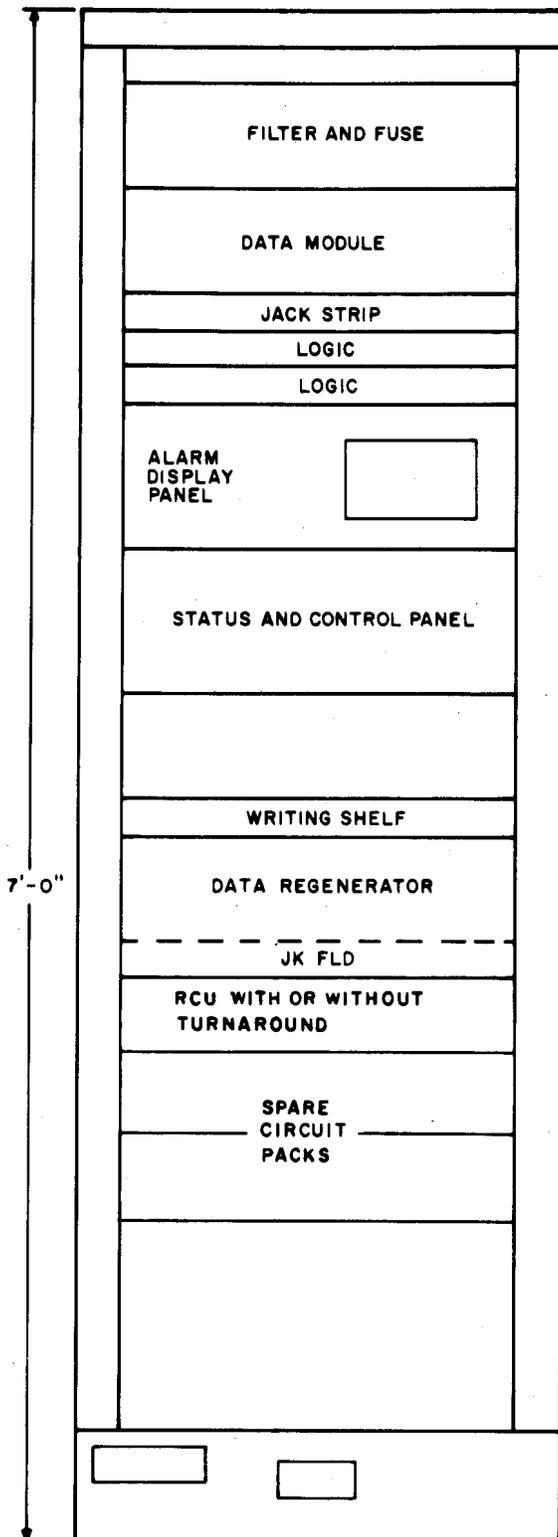
7'-0"

Fig. 3—Typical Manual Alarm Central

to appear in received data words. Such hits usually result in sequential bursts of two or more errors but may also affect single bits at random. Therefore, the last 7 bits of each E2 word transmitted are parity or check bits and are used to guard against erroneous information being used by an E2 station. The parity bits are generated from the control and information bits. When a word is received at a station (central or remote), parity bits are again generated from the control and information portion of the received word. These newly generated parity bits are compared with the parity bits which were generated at the transmitting station. If both sets of parity bits match, the information bits are assumed to be without error. The parity code will detect any combination of up to three random bit errors and any error burst of seven bits or less per word. If an error is detected, that word is simply ignored; no error correction is provided.
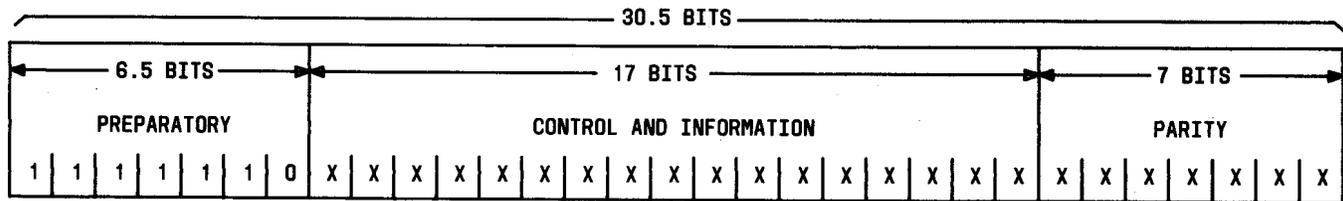
3. CENTRAL STATIONS

A. Manual Alarm Central

3.01 The manual alarm central (Fig. 3) can provide automatic alarm polling, manual status display reporting, and remote switching features. One or two data facilities and their associated remotes can be polled simultaneously and independently. When alarm conditions are encountered, they are displayed on the central station alarm display panel. Automatic alarm polling can be manually interrupted in order to request a display report for the purpose of determining the cause of an alarm from a particular remote station. In addition, automatic alarm polling can be interrupted to execute a remote switch operation at a particular remote station.

3.02 A more detailed description of the manual alarm central is contained in Section 201-644-112.

B. Status Polling Central

3.03 The status polling central automatically and continuously requests and receives large amounts of status information from up to 32 remote stations on a facility. The received information is then used to control a wall display or similar device provided by the customer. The status polling central consists of some basic E2 logic circuits and a relay memory. It is completely automatic; ie,

```
                           ┌──────────────────────── 30.5 BITS ────────────────────────┐
┌──── 6.5 BITS ────┐      ┌──────────── 17 BITS ────────────┐      ┌──── 7 BITS ────┐
        PREPARATORY              CONTROL AND INFORMATION                  PARITY
┌─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┐
│1│1│1│1│1│1│0│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│
└─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘
```

NOTE:
  X INDICATES EITHER A LOGIC 0 OR 1

Fig. 4—Basic E2 Word Format

there are no switches, dials, etc, used for normal operation.

3.04 Remote stations used in conjunction with a status polling central are equipped to provide only status group reports. This type of E2 System configuration permits the eavesdropping feature to be used as described in paragraph 5.10.

3.05 A form of remote switching can also be incorporated at the status polling central if a remote is collocated with the central equipment. This type of remote switching works on the same principle as eavesdropping but instead of lighting a status lamp the relay closure is used as a control.

3.06 A detailed description of the status polling central is contained in Section 201-644-113.

4. REMOTE STATIONS

A. General

4.01 Each remote on a data facility is assigned a specific address number. All remotes on a facility receive the commands sent by the central station but only the remote with the address that is specified in the central command word will respond with the requested information.

4.02 Each 2-state status indication from the office equipment to be monitored is brought to the E2 remote via a wire or pair of wires. Groups of 16 related statuses are hard-wired to the remote to form *status subgroups.* The condition of these 16 statuses can then be transmitted to the central in 16 bits of the 17-bit information word (see Fig. 4). Status subgroups can be further grouped into *status displays* and *status groups,* as shown in Fig. 5, for ease in addressing from

the central. The statuses may also be combined to allow the remote to summarize status or alarm indications for reporting to the central.

B. Alarm Reporting Remotes

4.03 Two types of alarm reporting remotes are presently being used. The original type of remote, shown in Fig. 6, can be equipped on an A&M-only basis. The later prepackaged type of remote, shown in Fig. 7, can be equipped to handle up to 4096 remote switch outputs and 4096 status inputs. Each remote comes equipped with a minimum of 64 remote switches and 128 status inputs and can be increased in multiples of 64 and 128, respectively. Once the main remote bay has been filled to capacity, an expansion bay, shown in Fig. 8, can be ordered to accommodate the additional remote switches and status inputs required. The alarm reporting remote is described in detail in Section 201-644-111.

C. Status Reporting Remotes

4.04 The status reporting remote is not available prepackaged in a manner similar to that of the alarm reporting remote. Instead, it must be configured from a number of panels. The size of the remote depends mainly on the number of status inputs and relay memory shelves required. Each remote comes equipped with the provision for a minimum of 128 status inputs. Relay memory shelves are provided only if required. Expansion bays can be provided to increase the relay memory and the number of status inputs to the maximum of 4096.

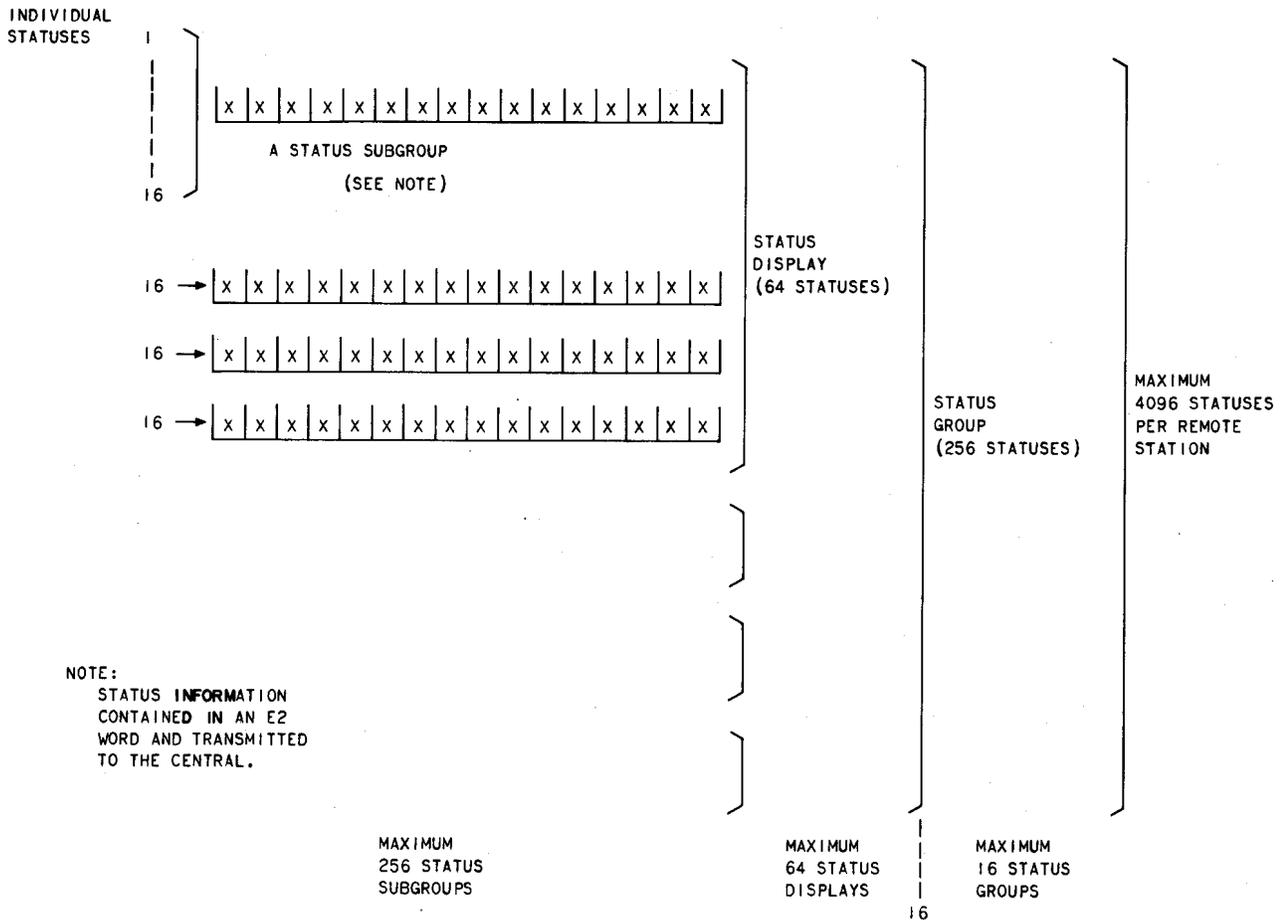**4.05** The status reporting remote is described in detail in Section 201-644-114.

INDIVIDUAL
STATUSES

```
        I  ⎫
        |  |
        |  |
        |  |      ┌─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┐
        |  ⎬      │X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│
        |  |      └─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘
        |  |          A STATUS SUBGROUP
        |  |             (SEE NOTE)
        16 ⎭
```

STATUS
DISPLAY
(64 STATUSES)

```
   16 → ┌─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┐
        │X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│
        └─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘

   16 → ┌─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┐
        │X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│
        └─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘

   16 → ┌─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┐
        │X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│X│
        └─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘
```

STATUS
GROUP
(256 STATUSES)

MAXIMUM
4096 STATUSES
PER REMOTE
STATION

NOTE:
  STATUS INFORMATION
  CONTAINED IN AN E2
  WORD AND TRANSMITTED
  TO THE CENTRAL.

MAXIMUM
256 STATUS
SUBGROUPS

MAXIMUM
64 STATUS
DISPLAYS

MAXIMUM
16 STATUS
GROUPS

16

Fig. 5—Status Grouping

5. SYSTEM FEATURES

A. Automatic Alarm Polling

5.01 Table A lists the principal features and capabilities of the manual alarm and status polling systems. Each of the features are discussed in detail in the following paragraphs.

5.02 Automatic alarm reporting is the result of continuous automatic sequential polling of alarm indications at remote stations by a manual alarm central. This feature, known as alarm polling, allows any abnormalities in large groups of statuses to be reported and displayed in summary form at a central station in near-real-time.

5.03 In order to provide an alarm report to a central station, a number of critical 2-state status points at a remote station are combined to form summaries of alarm conditions. When a remote station is alarm polled (by the central transmitting an alarm poll word), any of the combined statuses which has changed from the normal to abnormal state will be detected. The alarm poll response word from the remote will contain the summary of all such conditions. This summary information is contained in a maximum of 6 of the 16 information bits in an alarm poll response word. Figure 9 shows a portion of an alarm display panel at a manual alarm central and illustrates how the information in the poll response word can be displayed.

5.04 After a remote replies with its alarm conditions, the next higher-numbered remote station in sequence is automatically addressed. This continues until all remote stations on the data facility are alarm polled. The addressing sequence is predetermined at the central station so that,
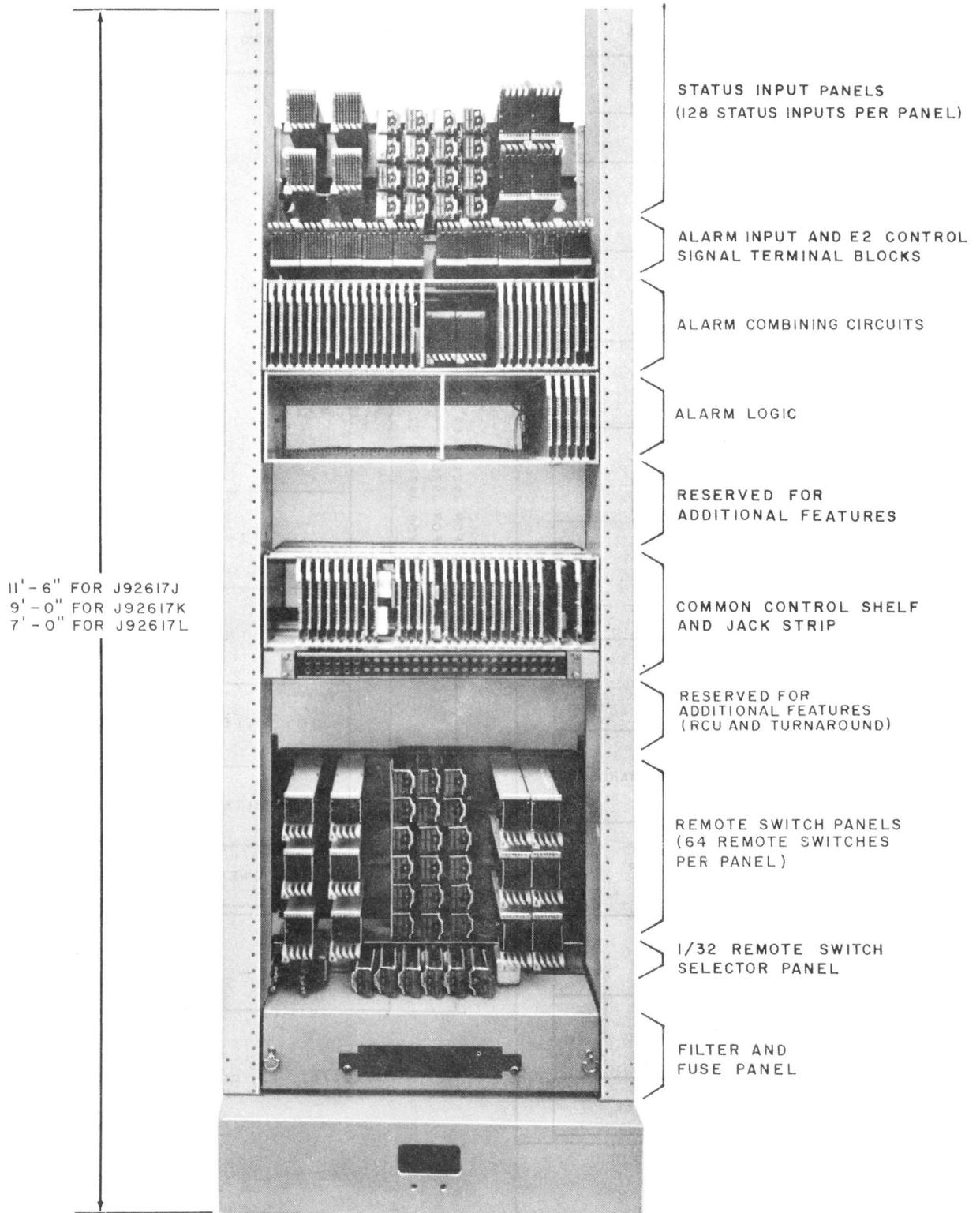
STATUS INPUT PANELS
(128 STATUS INPUTS PER PANEL)

ALARM INPUT AND E2 CONTROL
SIGNAL TERMINAL BLOCKS

ALARM COMBINING CIRCUITS

ALARM LOGIC

RESERVED FOR
ADDITIONAL FEATURES

COMMON CONTROL SHELF
AND JACK STRIP

RESERVED FOR
ADDITIONAL FEATURES
(RCU AND TURNAROUND)

REMOTE SWITCH PANELS
(64 REMOTE SWITCHES
PER PANEL)

1/32 REMOTE SWITCH
SELECTOR PANEL

FILTER AND
FUSE PANEL

11'-6" FOR J92617J
9'-0" FOR J92617K
7'-0" FOR J92617L

Fig. 6—Typical J92617J, -K, or -L Remote Station Bay

TWO SWITCH BLOCKS

TWO SWITCH BLOCKS

TWO DISPLAYS

TWO DISPLAYS

NEW INDEX

ANY INDEX

LOGIC

DATA MODULE

JACK STP

RESERVED

RCU WITH OR WITHOUT TURNAROUND

DATA REGENERATOR

FILTER & FUSE

FILTER & FUSE

POWER DISTRIB. PANEL

11'-6" FOR J92617 AJ
9'-0" FOR J92617 AK
7'-0" FOR J92617 AL
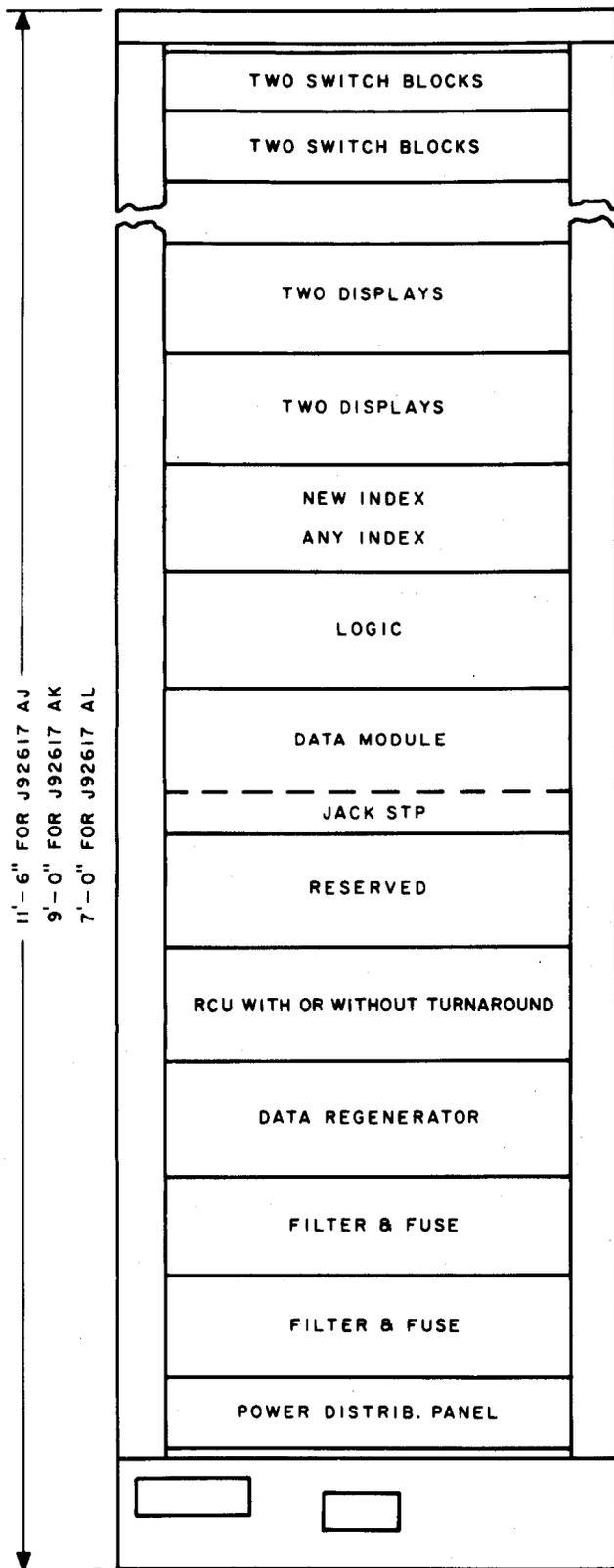
Fig. 7—Typical J92617AJ, -AK, or -AL Remote Station

TWO SWITCH BLOCKS

TWO DISPLAYS

TWO DISPLAYS

FILTER & FUSE PANEL

FILTER & FUSE PANEL

POWER DISTRIB PANEL

11'-6" FOR J92617 EJ
9'-0" FOR J92617 EK
7'-0" FOR J92617 EL
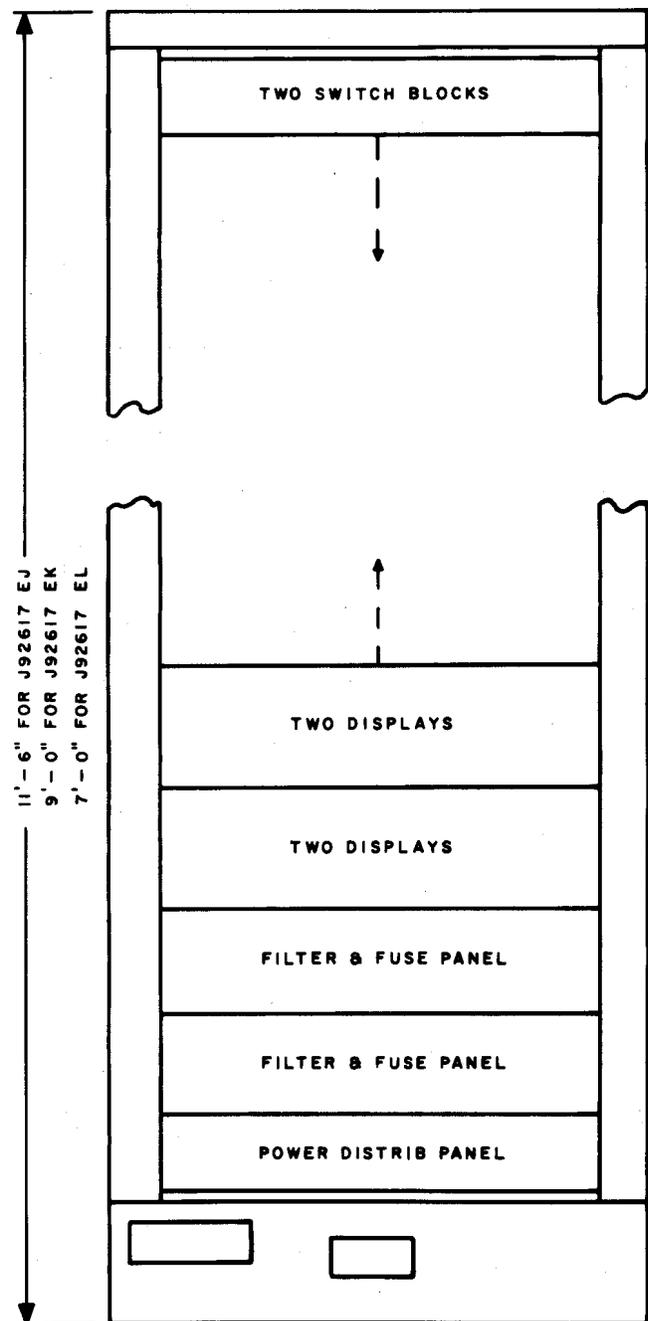
Fig. 8—J92617EJ, -EK, or -EL Remote Expansion Bay

after all remote stations have been polled, the process is repeated. The alarm display panel information is updated during each alarm polling sequence.

B. Automatic Status Polling

5.05 Automatic status polling (available only with the status polling central) provides the central with the condition of up to 4096 status indications at a remote station. This is accomplished by the central transmitting a word requesting the remote station to report the first group of statuses. The remote station replies with up to 16 words each containing the states of 16 status indications. The central then automatically requests the next group of statuses to be reported. When all status groups at a remote are reported, the next higher-numbered remote station in sequence is automatically addressed. This continues until all remote stations on the data facility are status polled. This process is continued repeatedly. The central stores the information for display on a locally provided visual display.

C. Status Group Reporting

5.06 Status group reporting is a feature available for use with a status polling central. Remote stations, arranged to status group report, transmit a group of up to 256 statuses (16 words) upon request from the central station. As described in paragraph 5.05, the status polling central automatically and continuously requests group reports from each remote in sequence.

D. Status Display Reporting

5.07 Status display reporting is a feature which permits a particular group of 64 individual status points at a remote station to be reported and displayed at a central for trouble analysis purposes. A status display report is displayed on a panel at a manual alarm central when a request is manually initiated by station personnel. Figure 10 shows a typical status display report at a manual alarm central. Four alarm words transmitted from the remote, each containing 16 status information bits, make up the display.

E. Remote Switching

5.08 This feature permits an E2 manual alarm central to command the momentary (300 ms) closure of one of a number of switches located at a remote station. These remote switches are used to perform various functions at remote telephone offices or other unattended locations such as starting diesel engines, switching units of equipment, etc. Each remote station may have up to 4096 remote switches as required.

5.09 Normally, a central station is automatically polling all remote stations. When a remote switch command is initiated, automatic polling is interrupted and the remote switch command is sent to the remote station. Upon completion of the remote switch operation, the remote station sends a "command complete" transmission to the central. The central then resumes automatic polling.

F. Eavesdropping

5.10 The eavesdrop feature permits one or more remote stations to receive the transmissions of one or more other remote stations. This is a feature that can be provided only in systems having a status polling central. For example, it may be desired to know the status indications of remote station A at remote station B. Station B can be arranged to recognize the address of station A. When station A is status-polled and replies to the central, remote B will also receive the status information. The status information received at station B is loaded into a memory circuit. The output of the memory provides the user with a means of driving a visual display or other devices external to the E2 system.

G. Remote Callup Data Transfer (RCU)

5.11 The RCU feature permits independent surveillance systems to use the E2 data network to transmit information between alarm reporting remote stations on the same data network. Any input/output (I/O) device located at a remote station may use the E2 data network on a shared basis with the central to transfer information to similar devices at other E2 remote stations.

5.12 A block of 16 words may be transmitted from one remote to another remote. The first word contains the address of the remote to receive the information and the address of the I/O device. The remaining 15 words contain the information bits (240 bits) to be transferred. The I/O device requests the use of the E2 data network by inserting a special bit in the alarm poll reply word to the central. The central acknowledges

with a "transmit data" command. The remote then transmits the data by addressing the desired remote and its I/O device.

H. ▶Turnaround Panel

5.13 The turnaround feature is available with the RCU function only. The turnaround is used to isolate troubles between the RCU and the I/O equipment. The central operator will transmit one of two data bit patterns to any RCU turnaround equipped remote. The remote is selected by thumbwheel address switches on the central turnaround panel. A second command is sent automatically to the remote. The remote should transmit the same data bit pattern back to the central. At the central, the data bit pattern is displayed on the station display panel.◀

6. MAINTENANCE PHILOSOPHY

6.01 The E2 maintenance philosophy is trouble isolation and circuit pack replacement. To maintain the system under this philosophy requires the use of an E-telemetry station test set (KS-20937), a circuit pack test set, and a remote callup test set (model RCU-100), if required. In addition to the test sets, a complete set of circuit packs (CP), which are known to be good, are needed for use as replacements.

6.02 The first step in trouble isolation (see Sections 201-644-312 and 201-644-504) is sectionalizing the trouble to the central, the remote, or the data facility. After sectionalization, the appropriate test equipment can be used to further isolate the trouble to a circuit pack or group of circuit packs. The CPs are then replaced by the spares and the removed CPs tested on the circuit pack test set (KS-21448). The CPs which check good are then placed in the set of spares. Faulty CPs are repaired or replaced and then also placed in the set of spares.

7. REFERENCES

7.01 The following sections contain the descriptive, operation, and maintenance information for the E2 Status Reporting and Control System and its associated data network.

TABLE A

E2 SYSTEM CAPABILITIES

FEATURE	MANUAL ALARM CENTRAL	STATUS POLLING CENTRAL
Automatic alarm polling	Yes	No
Automatic status polling	No	Yes
Status group reporting	No	Yes
Status display reporting	Yes	No
Remote switching	Yes	Yes*
Eavesdropping	No	Yes
Remote callup	Yes	No
Turnaround	Yes	No
Maximum number of remote stations per central	32	32
Maximum number of facilities	2	1
Number of status indications per remote	Up to 4096 in steps of 128	Up to 4096 in steps of 128
Number of switches at each remote that can be remotely operated	21 minimum, then from 64 to 4096 in steps of 64	*16 minimum to 4096 in steps of 16

* By collocating a status transmitting remote station with the status polling central.
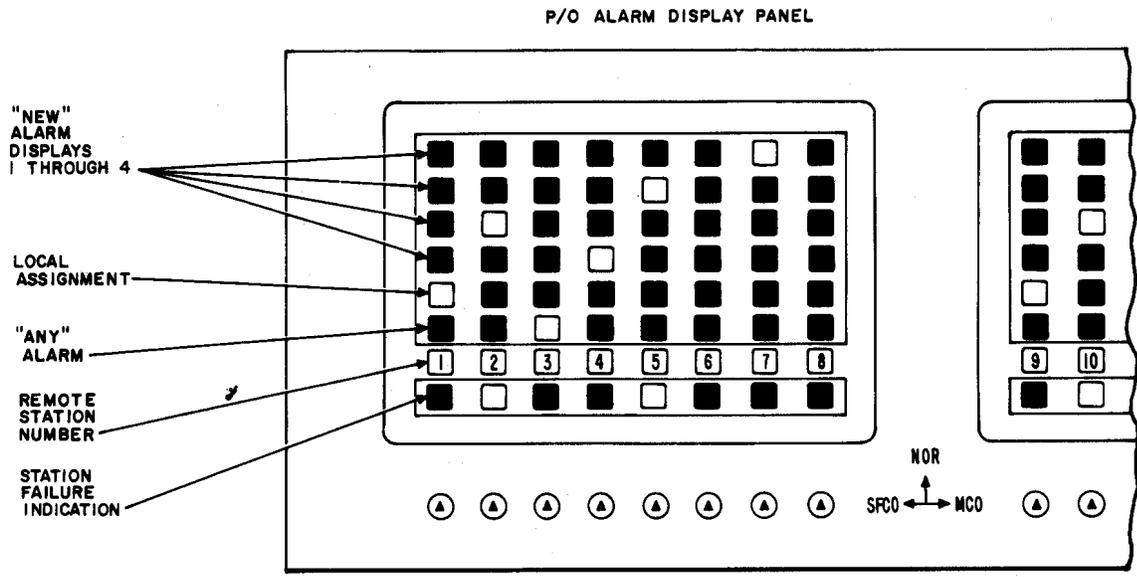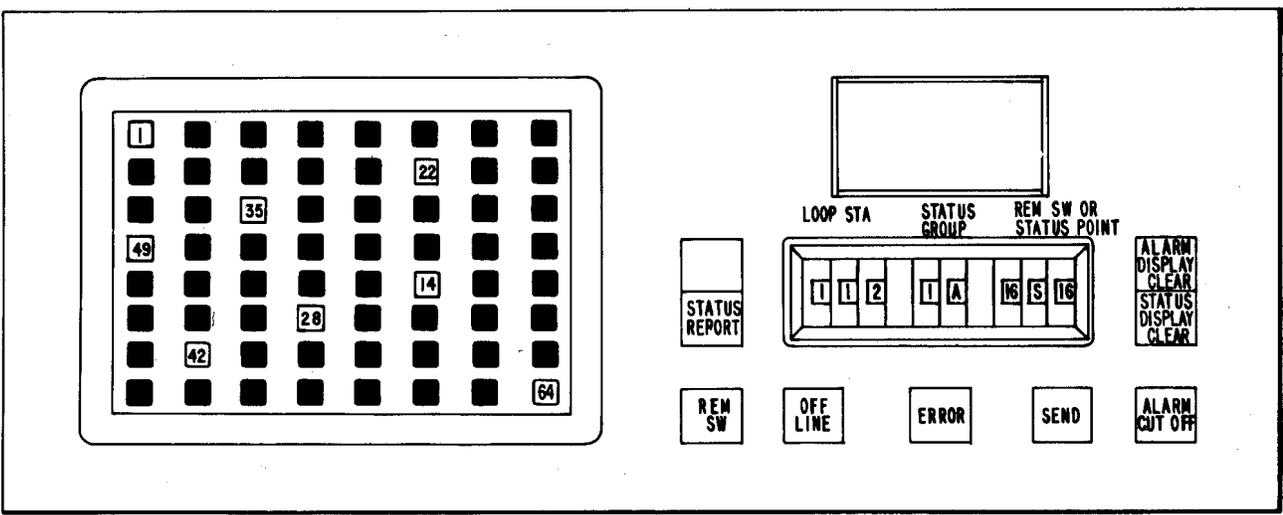
P/O ALARM DISPLAY PANEL

Fig. 9—Alarm Display Panel

Fig. 10—8X8 (64) Status Display and Control Panel