

**EMERGENCY REPORTING SYSTEM**  
**520-TYPE PBX**  
**CONCENTRATOR SYSTEM**  
**GENERAL DESCRIPTIVE INFORMATION**

CONTENTS	PAGE	CONTENTS	PAGE
1. INTRODUCTION . . . . .	3	CONTROLLER . . . . .	14
GENERAL . . . . .	3	A. Line Identification and Selection . . . . .	14
FIELD OF USE . . . . .	3	B. Test of Line and Emergency Telephone and Class-of-Service Operation . . . . .	15
GENERAL DESCRIPTION . . . . .	3	C. Outgoing Trunk Identification and Selection . . . . .	16
A. Emergency Call . . . . .	3	D. Connection of a Line to an Outgoing Trunk . . . . .	16
B. Police Call . . . . .	5	E. Operation of the Controller Under Trouble Conditions . . . . .	16
PRINCIPAL FEATURES . . . . .	6	LINE AND TRUNK RELAY EQUIPMENT . . . . .	17
Concentrator Equipment . . . . .	6	F. Line Relay Equipment . . . . .	17
Terminating Equipment . . . . .	6	H. Incoming Trunk Relay Equipment . . . . .	17
Additional Features . . . . .	7	G. Outgoing Trunk Relay Equipment . . . . .	18
2. SWITCHING PRINCIPLES . . . . .	7	SENDER . . . . .	18
GENERAL . . . . .	7	RECEIVER . . . . .	19
CROSSBAR SWITCH . . . . .	7	PRINTER . . . . .	19
CONCENTRATOR SIZES . . . . .	7	I. General . . . . .	19
A. "Full" Switch — Fire Reporting System . . . . .	8	PRINTER STORAGE AND PRINTER RELAY EQUIPMENT . . . . .	19
B. "Full" Switch — Fire and Police Reporting System . . . . .	9	LINE IDENTIFIER CONNECTOR AND RELAY EQUIPMENT . . . . .	19
C. "Split" Switch — Fire Reporting System . . . . .	9	SWITCHBOARD . . . . .	20
D. "Split" Switch — Fire and Police Reporting System . . . . .	10	J. General . . . . .	20
CONTROLLER . . . . .	10	K. Display Indicator Panel . . . . .	20
3. SIGNALING PRINCIPLES . . . . .	11	L. Direct Line Relay Equipment . . . . .	20
GENERAL . . . . .	11	REGISTERS . . . . .	20
SIGNALING CODES . . . . .	12	Traffic . . . . .	20
SENDER . . . . .	12	Plant . . . . .	20
RECEIVER . . . . .	13	SIGNALING WORKING LIMITS . . . . .	21
4. FUNCTIONS OF PRINCIPAL EQUIPMENT ELEMENTS . . . . .	13	M. Line . . . . .	21
GENERAL . . . . .	13	N. Trunk . . . . .	21

CONTENTS	PAGE
5. METHOD OF OPERATION FOR TYPICAL CALLS . . . . .	21
EMERGENCY (FIRE CALL) . . . . .	21
A. General . . . . .	21
B. Description of Operation . . . . .	21
POLICE CALL . . . . .	23
C. General . . . . .	23
6. TESTING AND MAINTENANCE . . . . .	23
GENERAL . . . . .	23
TESTING AND MAINTENANCE EQUIPMENT . . . . .	24
A. Trouble Indicator . . . . .	24
B. Time-Delay Relay . . . . .	24
C. Manual Patch Arrangement . . . . .	24
TYPICAL TEST . . . . .	25
D. General . . . . .	25
E. Automatic Test . . . . .	25
F. Manual Test . . . . .	25
G. Controller Test . . . . .	25
H. Call-Through Test . . . . .	25
I. Headquarters Call . . . . .	26
7. EQUIPMENT . . . . .	26
CENTRAL OFFICE EQUIPMENT . . . . .	26
A. General . . . . .	26
B. Central Office Test Frame . . . . .	26
C. Controller Frame . . . . .	27
D. Line and Switch Frame . . . . .	27
E. Central Office Floor Plant Arrangements . . . . .	28
HEADQUARTERS EQUIPMENT . . . . .	28
F. General . . . . .	28
G. Incoming Trunk Frame . . . . .	29
H. Call Recorder Frame . . . . .	29
I. Display and Recorder Control Frame . . . . .	29
J. Station Line Central Office Trunk Frame . . . . .	31
K. Central Office Trunk and Common Equipment Frame . . . . .	31
L. Distributing Frame . . . . .	31
M. Switchboard . . . . .	31
N. Printer Unit . . . . .	31
O. Power . . . . .	31

CONTENTS	PAGE
8. ALARMS . . . . .	31
GENERAL . . . . .	31
CENTRAL OFFICE . . . . .	32
HEADQUARTERS . . . . .	32
ALARM EXTENSION . . . . .	32
9. EQUIPMENT AND MAINTENANCE REPORTS . . . . .	32
10. GLOSSARY . . . . .	32
<b>FIGURES</b>	
1 — Example of Use of Concentrator As a Fire Reporting System . . . . .	4
2 — Example of Use of Concentrator As a Combined Fire and Police Reporting System . . . . .	4
3 — Example of Use of Concentrator and Direct Lines As a Combined Fire and Police Reporting System . . . . .	5
4 — "Full" Crossbar Switch As Used for Fire Reporting System and Combined Fire and Police Reporting System . . . . .	8
5 — "Split" Crossbar Switch As Used for Fire Reporting System . . . . .	9
6 — "Split" Crossbar Switch As Used for Fire and Police Reporting System . . . . .	11
7 — Illustration of Pulse Coding . . . . .	12
8 — A Typical 4-Digit Pulse Length Code . . . . .	13
9 — A Number Display Indicator Panel . . . . .	18
10 — Sample Ticket . . . . .	19
11 — Test Frame . . . . .	26
12 — Controller Frame . . . . .	27
13 — Line and Switch Frame ("Split" Switch) . . . . .	28
14 — Line and Switch Frame ("Full" Switch) . . . . .	29
15 — 100-Line Switchboard . . . . .	30
16 — Relationship of Major Equipment Elements for Emergency Reporting — Group 1 . . . . .	34
17 — Relationship of Major Equipment Elements for Central Office Tests — Group 2 . . . . .	35
18 — Block Diagram Showing Line Identification and Selection . . . . .	36
19 — Fire or Police Headquarters Equipment Frame Layout . . . . .	37

## 1. INTRODUCTION

### GENERAL

- 1.01** This section describes the 520C PBX emergency reporting concentrator system.
- 1.02** This section is reissued to reflect changes in design and operation of the emergency reporting system. In addition, this section is reissued on a standard basis. Since this issue covers a general revision, arrows ordinarily used to indicate changes have been omitted.
- 1.03** The 520C emergency reporting concentrator system switches one-way traffic originating at emergency telephones over a small number of trunks to a fire or police PBX switchboard. Concentrator equipment is located in one or more telephone central offices; common terminating equipment is located in a fire and/or police headquarters.
- 1.04** Various arrangements of concentrators and more than one concentrator may be provided depending upon local requirements.
- 1.05** The concentrator method of handling emergency telephone service permits many reporting telephones in an area to communicate over a small number of trunks to a remotely located headquarters, thus permitting a saving in cable conductors where desired or necessary. Concentrators also reduce equipment requirements and PBX switchboard terminations at the headquarters location. The 520C design, in addition, provides flexibility for trunking to one or more headquarters.
- 1.06** This system can be used either alone or in conjunction with the direct line system.
- 1.07** Appropriate terminating and display arrangements are available in the switchboard for terminating concentrator trunks.
- 1.08** A 4-digit number identifying the reporting telephone station is automatically displayed in front of the PBX attendant whenever the attendant is connected to the station.
- 1.09** A 4-digit number preceded by a class digit or letter is graphically recorded at the headquarters for all calls processed through a concentrator. A suffix class letter, A or D,

following the 4-digit number is used as an indication of attendant delay or immediate answer of a call.

- 1.10** A test frame is provided at the concentrator end to permit automatic or manual routine testing of the emergency reporting telephone lines, station equipment, outgoing trunks, and other control equipment. This frame is also arranged to provide automatic routine testing of the terminating equipment.
- 1.11** A manual patch arrangement is provided to permit extending calls at the central office to the headquarters switchboard.

### FIELD OF USE

- 1.12** The concentrator system can be used by a municipality for a fire reporting system, a police reporting system, or as a combined fire and police reporting system.
- 1.13** Flexible arrangements have been provided in the concentrator to permit connection for a maximum of 200 reporting lines and 20 outgoing trunks which can be subgrouped to three fire and three police headquarters. Each reporting line has access to two to nine outgoing trunks depending upon traffic considerations.
- 1.14** Fig. 1 and 2 show the relationship of the major equipment elements when the system is used as a fire reporting system and a fire and police reporting system, respectively.
- 1.15** Fig. 3 shows the relationship of the major equipment elements when the system is used as a fire and police reporting system in conjunction with the direct line system.

### GENERAL DESCRIPTION

- 1.16** The following paragraphs briefly describe the progress of a fire or emergency call from an emergency reporting telephone to a central headquarters. A description of a police call is also given.

#### A. Emergency Call

- 1.17** The caller opens the door of the emergency reporting telephone station set and lifts the handset off the switchhook. The concentrator automatically establishes a connec-

tion between the telephone set and an idle outgoing fire trunk.

1.18 The outgoing trunk sends a connect signal to the PBX switchboard at the fire headquarters. Flashing line lamps and an audible signal alert the attendant. Simultaneously, an audible ringing signal is returned to the caller until the attendant answers the call.

1.19 When the attendant answers, the line lamps change from a flashing to a steady condition and the audible signal is silenced.

1.20 The outgoing trunk recognizes an answer signal from the switchboard and removes the audible ring from the station, attaches a sender, identifies the station box number, and prepares the transmission path from the station to the PBX switchboard.

1.21 The sender encodes the station box number and pulses information signals to the PBX switchboard equipment. At the termination of these signals, the sender releases and cuts through the talking path from the station to the PBX headquarters.

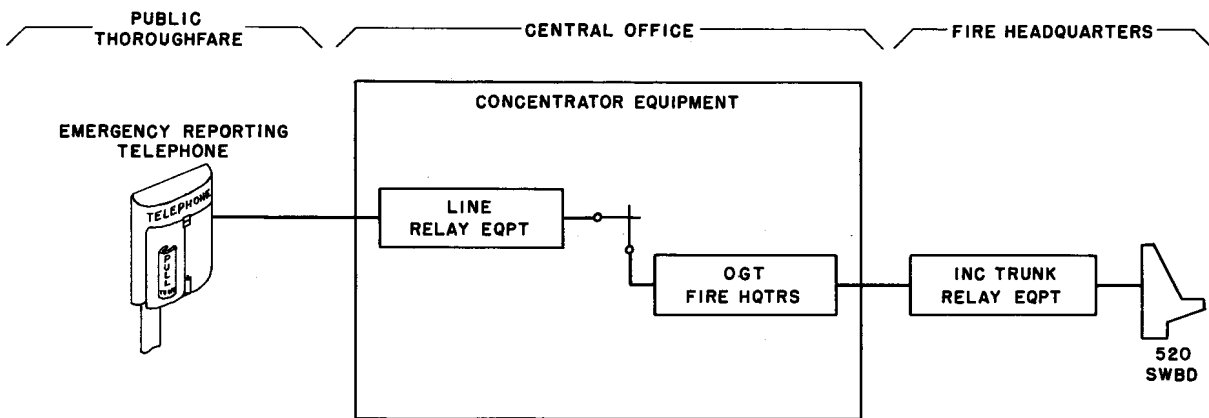


Fig. 1 - Example of Use of Concentrator As a Fire Reporting System

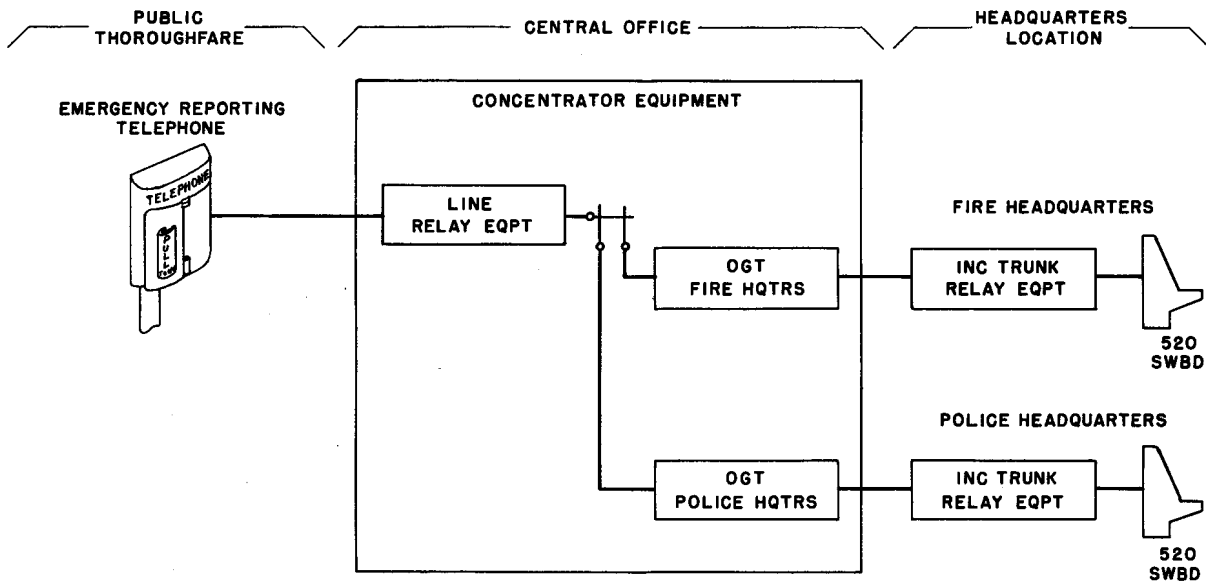


Fig. 2 - Example of Use of Concentrator As a Combined Fire and Police Reporting System

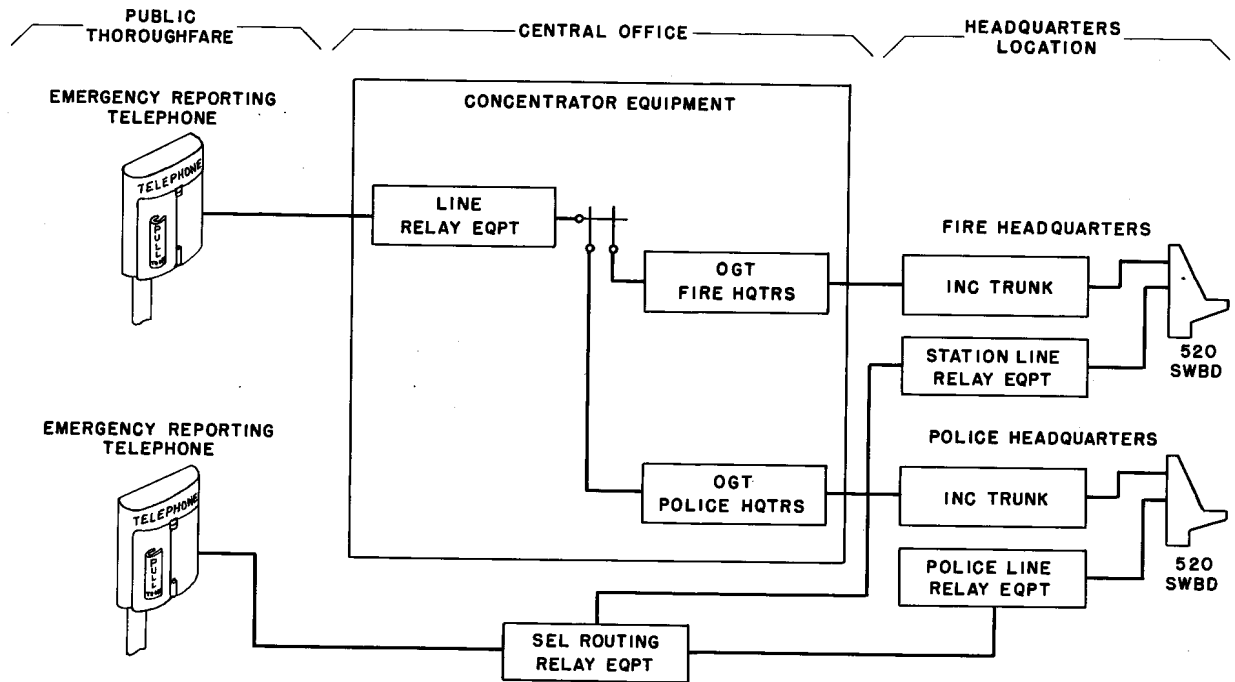


Fig. 3 – Example of Use of Concentrator and Direct Lines As a Combined Fire and Police Reporting System

1.22 Equipment at the PBX switchboard decodes the identification signals from the sender, displays a 4-digit station number to the attendant on a number display panel, and prints a record of the call on a printer. Simultaneously, the talking connection is established to the station. This 4-digit number display is maintained as long as the operator is connected to this line.

1.23 If the station hangs up before the PBX attendant disconnects, the attendant receives a disconnect signal which is an indication to release the connection. The attendant depresses a common release key and returns the line to the fire stand-by condition.

1.24 If the attendant disconnects first, the concentrator releases the connection and locks out the station line equipment. After the caller replaces the handset on the switchhook, the lockout is removed from the line returning it to fire stand-by condition. This feature prevents a continuous trunk seizure toward headquarters while an off-hook persists and frees

the trunk for other calls that may be waiting for service during peak loads.

1.25 A printer provides a printed record of the station number and the month, day, and time-of-day record at the headquarters location when a connection is established to the switchboard.

#### B. Police Call

1.26 A nonlocking switch, referred to as a selective routing key, is provided, mounted alongside the emergency reporting handset, when the emergency reporting telephone system is used for combined fire and police reporting. This key, when operated, controls selective routing equipment in the concentrator which connects the station to the police trunk group.

1.27 In general, when placing a police call, the operation is the same as described above for a fire call except that the caller must operate the selective routing key before and while the handset is being lifted from the switchhook.

**PRINCIPAL FEATURES**

**1.28 Concentrator Equipment**

- (a) The concentrator control equipment responds instantly to a line seizure from an emergency telephone line.
- (b) A line test feature guards against false line seizures due to momentary irregularities on the line.
- (c) A selective routing feature permits switching of a line requesting service to a police or fire headquarters trunk group.
- (d) The concentrator is arranged to maintain an established connection until the call has been answered at the headquarters PBX.
- (e) If a concentrator is used for fire and police reporting, arrangements have been provided to route fire calls to the police headquarters over police trunks if all fire trunks are busy.
- (f) Audible ringing tone is provided to the emergency telephone station when a connection is established and until the PBX attendant answers.
- (g) A single controller provided with duplicate circuits, relays, and preference chains is used to control and perform the switching function. The controller has been designed for maximum reliability.
- (h) Cross-connection flexibility is provided for line and trunk assignment to the crossbar switches.
- (i) Cross-connection flexibility is provided for an individual 4-digit station number assignment on line equipment.
- (j) The concentrator will transmit a 4-digit station number to the terminating equipment for each service call.
- (k) A self-checking "fail-safe" code has been provided for the transmission of the call box number.
- (l) Registers are provided to permit traffic and plant analysis of the system.
- (m) Automatic or manual testing of the line equipment, trunk equipment, and other control circuits can be performed from a common test frame.

- (n) A cross-connection arrangement permits a central office to vary the frequency of automatic tests. The line equipment, cable pair, and station transmitter and cord may be tested at intervals of 6 to 90 minutes.
- (o) A trouble indicator display panel has been provided on the test frame to indicate trouble conditions encountered by the controller during a service request.
- (p) A test line has been provided for automatic call-through testing of the headquarters equipment and also to provide facilities for the central office maintenance forces to communicate with the headquarters.
- (q) Lines found open during testing periods are automatically locked out of the system. Alarm signals at the concentrator location alert the central office forces and a printed ticket and suitable alarms are automatically provided at headquarters to alert the attendant during line failures.
- (r) Each trunk is under continuous electrical supervision at all times. During trouble conditions, the trunk is automatically made busy to the control equipment.
- (s) During an all-trunks-busy condition, a call will be locked into the system and be placed to headquarters when a trunk becomes available even though the caller has hung up prior to being connected to headquarters.
- (t) The controller is arranged to automatically hold calls if all trunks are busy. When a trunk is cleared, the controller sets up a held call to headquarters.
- (u) A manual patch arrangement is provided to permit the extension of a call to headquarters via a patch cord and jacks if the controller is then out of service for maintenance reasons.

**1.29 Terminating Equipment**

- (a) The use of the building block principle provides compatibility with switchboard terminating arrangements and operational procedures of the direct line system.

- (b) Each trunk incoming from the concentrator location has dual appearances for key or cord and jack answer in the PBX switchboard.
- (c) Locked-in flashing trunk lamps are provided in the switchboard until the attendant answers.
- (d) A 4-digit reporting telephone station number is automatically displayed in front of the PBX attendant whenever the attendant is connected to the station.
- (e) Provision has been made to permit a re-display of the station number by the attendant at any time while the connection is established.
- (f) A hold feature has been provided in the trunk equipment to permit an attendant to hold a trunk while he answers a second call.
- (g) Two display panels are provided, one associated with the left and one with the right switchboard position.
- (h) Provision has been made to permit the attendant to lock out any line when required to remove a permanent signal from the switchboard.

### 1.30 *Additional Features*

- (a) A printed record at the headquarters location for each call processed through the concentrator is provided. The system is arranged to print a record before and during the attendant answer.
- (b) A printed record is made also when the test frame finds open-circuit lines.
- (c) Class-of-service digits or letters identify the type of call processed.
- (d) Alarm indicating devices are provided in the face equipment of the switchboard to indicate circuit conditions to the switchboard attendant.

## 2. SWITCHING PRINCIPLES

### GENERAL

**2.01** The switching plan for the concentrator system is designed to provide for the connection of any one of many lines to one of a few trunks to a headquarters.

**2.02** Crossbar switches, station line relay equipment, outgoing trunks, and a single controller perform the switching function. The lines from the emergency reporting stations appear on the horizontals of the crossbar switch; the outgoing trunks appear on the verticals of the switch. The controller functions to determine the lines requiring service, whether a fire call or a police call is being placed, and establishes the necessary connection between the calling line and an outgoing trunk through the crossbar switch.

**2.03** Flexible arrangements are available for assignment of station lines and trunks to crossbar switches.

### CROSSBAR SWITCH

**2.04** The concentrator equipment uses 4-wire, 10 by 10 crossbar switches. Two crossbar switch arrangements are available, a "full" switch and a "split" switch.

**2.05** The "full" switch accommodates one line group of ten lines on the horizontals of the switch and provides access to a maximum of nine trunks on the verticals. Vertical nine is used by the controller for line and station testing.

**2.06** The "split" switch accommodates two line groups of ten lines each on the horizontals of the switch and provides a maximum of four trunks on the verticals. The ten verticals are divided evenly between the two line groups. Vertical four and nine are used by the controller for line and station testing.

### CONCENTRATOR SIZES

**2.07** The number of switches required, and hence, the size of a particular concentrator system installation, will vary by the extent to which trunks are multiplied and grouped on the verticals of "full" or "split" switches. In any event, the capacity of one concentrator system is 200 lines and 20 trunks.

**2.08** Basically, all concentrators work in the same manner regardless of size. They all use the same simple switching principles to determine the type of incoming call and to connect an outgoing trunk to a station line circuit. A single controller is used to perform this operation.

2.09 Four examples are given below to illustrate how different arrangements of concentrators can be obtained.

A. "Full" Switch — Fire Reporting System

2.10 Fig. 4 illustrates the arrangement for "full" crossbar switches to provide access between 40 station lines and a maximum of nine outgoing trunks to a fire headquarters.

2.11 The first line group (LG-0) of ten stations (00 to 09) appears on the horizontals of switch 0 and has access to trunks 0 to 3 appearing on verticals 0 to 3. The second line group (LG-1) of ten stations (10 to 19) appears on the horizontals of switch 1 and has access to the same trunks 0 to 3 appearing on verticals 0 to 3.

2.12 Each even and odd line group alternately is assigned to the even and odd switches, respectively.

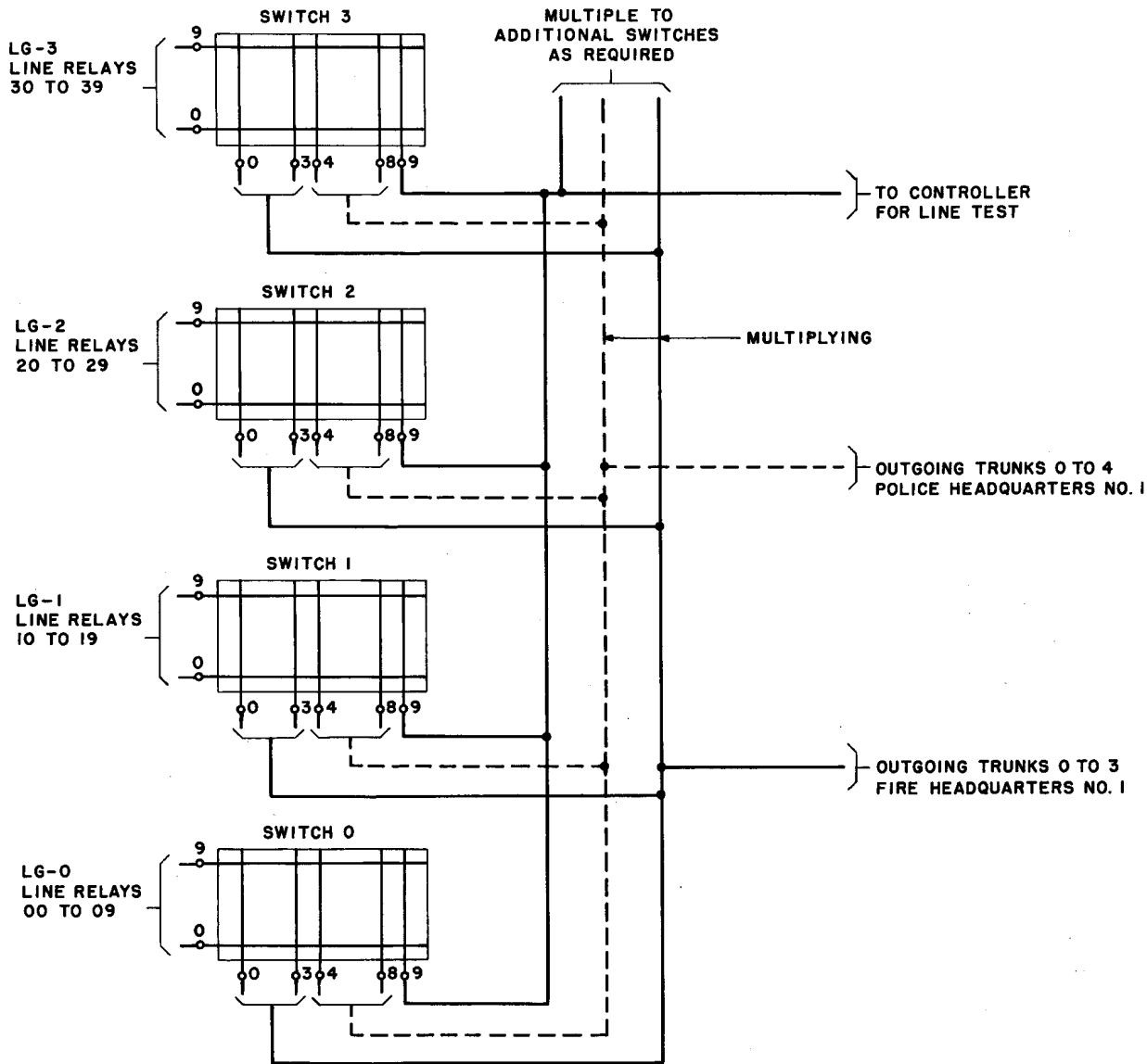


Fig. 4 — "Full" Crossbar Switch As Used for Fire Reporting System and a Combined Fire and Police Reporting System



2.13 By trunk multiplying from the verticals of each switch, all lines are provided with access to the same trunks 0 to 3 (trunk group).

2.14 Verticals 4 to 8 can be used to expand the trunk group from four trunks to a maximum of nine or can be used for a second trunk group to provide access to a police headquarters.

**B. "Full" Switch — Fire and Police Reporting System**

2.15 The "full" crossbar switch of the fire system, discussed in 2.10 to 2.14, inclusive, can be used to provide access to a police headquarters. This is also illustrated in Fig. 4 and shown by dotted lines.

2.16 The arrangements of the "full" switch, therefore, permit a concentrator fire system the extra growth facilities which can be used to expand to a fire and police reporting system.

2.17 Where call box concentration to more than one fire and police headquarters is required, separate trunk groups can be provided and multiplied from line group to line group.

**C. "Split" Switch — Fire Reporting System**

2.18 Fig. 5 illustrates the arrangements of the "split" crossbar switch to provide access for 80 stations to four outgoing trunks terminating at a fire headquarters.

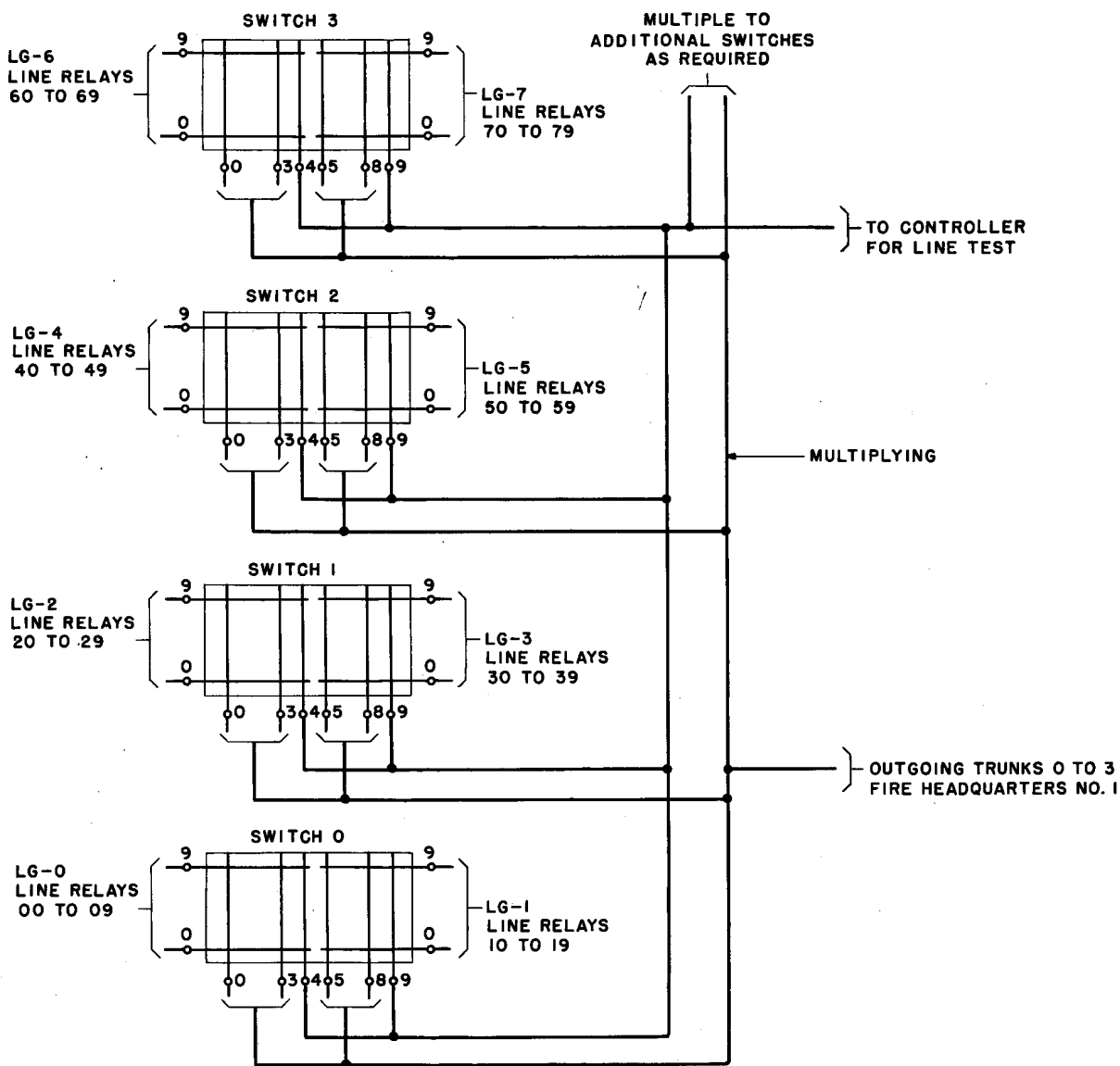


Fig. 5 - "Split" Crossbar Switch As Used for Fire Reporting System

**2.19** The crossbar switch is split to provide two 10 by 5 switches. The first line group (LG-0) of ten stations (00 to 09) appears on the horizontals of the left half of switch 0 and has access to fire trunks 0 to 3 (trunk group 0) appearing on crossbar verticals 0 to 3. The second line group (LG-1) of ten stations (10 to 19) appears on the horizontals of the right half of switch 0 and has access to the same fire trunks 0 to 3 appearing on verticals 5 to 8.

**2.20** The third line group (LG-2) of ten stations (20 to 29) appears on the horizontals of the left half of switch 1 and has access to the same fire trunks (0 to 3) to the fire headquarters.

**2.21** Each odd and even line group of ten lines is alternately assigned to the right and left half of the crossbar switches, respectively, and is grouped in common to the same fire trunks 0 to 3.

**2.22** Multipling the trunk group from the verticals of one half of the switch to the other half of the switch and from switch to switch gives all 80 lines access to the same fire trunk group.

**2.23** When station concentration is required to more than one fire headquarters, separate trunk groups of four trunks for each fire headquarters are provided on half switches and multiplied to other half switches.

**2.24** It is thereby possible to provide line group access of ten stations per group to separate fire trunk groups to different headquarters.

**D. "Split" Switch — Fire and Police Reporting System**

**2.25** Fig. 6 illustrates the arrangement for "split" crossbar switches to provide access for 80 stations to four outgoing trunks, two trunks to a fire headquarters, and two trunks to a police headquarters.

**2.26** The crossbar switch is "split" to provide two 10 by 5 switches. The first line group (LG-0) of ten stations (00 to 09) appears on the horizontals of the left half of switch 0 and has access to fire trunks 0 and 1 appearing on verticals 0 and 1 and police trunks 0 and 1 appearing on verticals 2 and 3. The second line group (LG-1) of ten stations (10 to 19) appears on horizontals of the right half of switch 0 and has

access to the same fire trunks 0 and 1 appearing on verticals 5 and 6 and to the same police trunks 0 and 1 appearing on verticals 7 and 8.

**2.27** The third line group (LG-2) of ten stations (20 to 29) appears on the horizontals of the left half of switch 1 and also has access to the same fire and police trunks appearing on switch 0.

**2.28** Each odd and even line group of ten lines is alternately assigned to the right and left half of the crossbar switches, and is grouped in common to the same fire and police trunk groups.

**2.29** By trunk multipling from half switches to half switches and from switch to switch, all 80 lines (LG 0-7) have access to the same fire and police trunk group.

**2.30** When station line concentration is required to more than one fire and police headquarters, separate trunk groups are provided and assigned to one or more half switches. By trunk group multipling from half switch to half switch, as many line groups as are required can be grouped to a fire and police headquarters.

**CONTROLLER**

**2.31** The controller performs and controls the switching.

**2.32** Basically, the controller is operated as follows. The off-hook signal from the station is recognized by the line circuit which seizes the controller.

**2.33** The controller determines the crossbar switch on which the line appears. It then closes the horizontal select and vertical hold magnets to the line test and selective routing circuit to test the line for a legitimate call and determine the class of call (fire or police).

**2.34** The controller locates an idle trunk to the fire or police headquarters, depending on the class of call, and closes a second crosspoint on the crossbar switch to establish the talking connection from the call box to the headquarters.

**2.35** The first crosspoint is then released and the controller is ready to serve a second call.

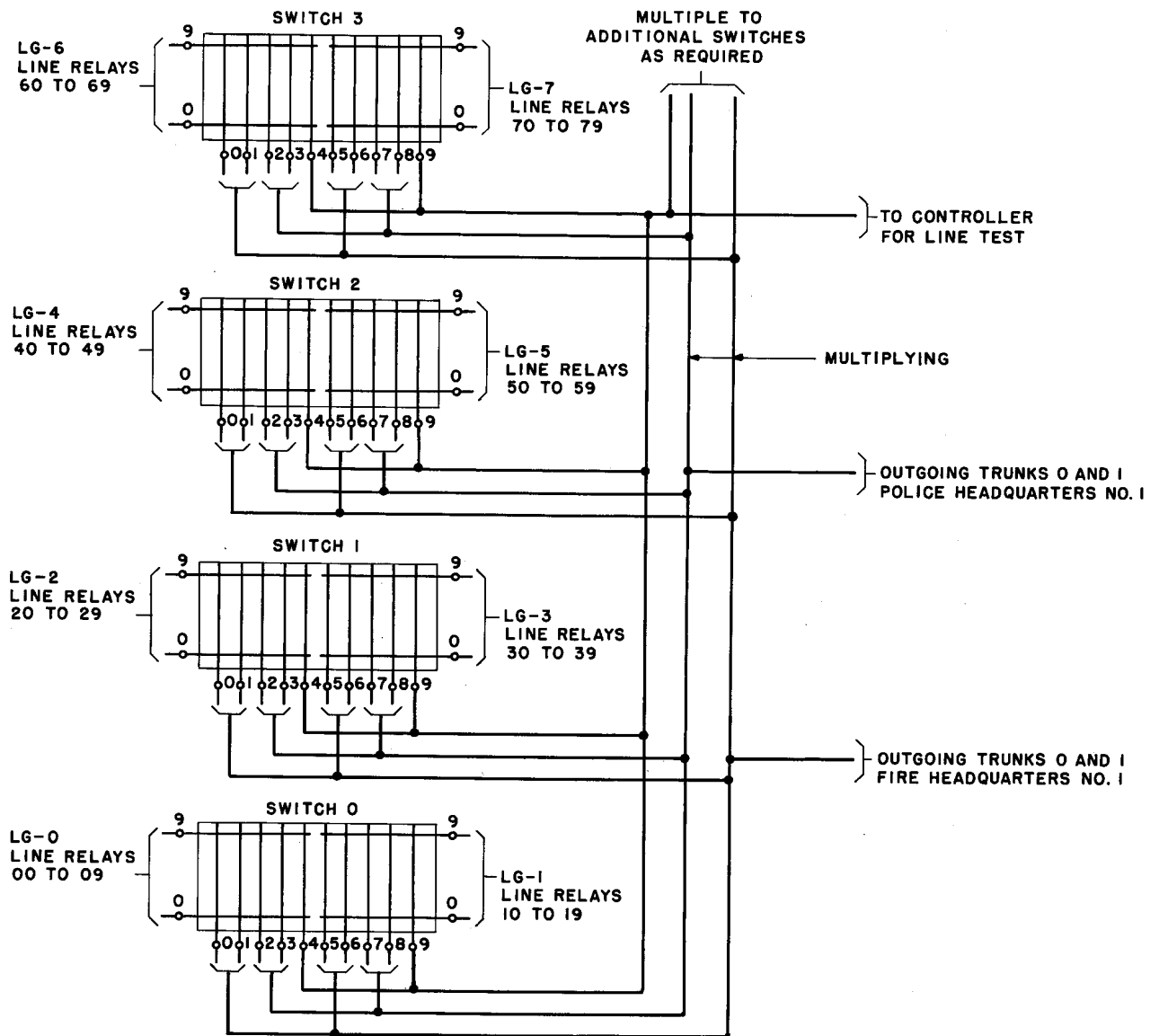


Fig. 6 - "Split" Crossbar Switch As Used for Fire and Police Reporting System

2.36 A description of the controller operation is given in Part 4.

### 3. SIGNALING PRINCIPLES

#### GENERAL

3.01 The major signaling plan for the concentrator is designed to transmit a 4-digit station number preceded by a class digit to the headquarters PBX switchboard for visual display and ticket printing.

3.02 The signaling system and codes used to perform this function have been designed for "fail-safe" reliability.

3.03 Briefly, a sender obtains a coded station number from the line circuit which is encoded to decimal signals and transmitted to a receiver at headquarters. The receiver decodes these signals and provides new signals which are used to light a 4-digit visual display and provide information to a printer circuit to print a record of the call.

**SIGNALING CODES**

**3.04** The codes transmitted from the sender to the headquarters provide for extreme "fail-safe" reliability. Any mutilation of the code received by the receiver due to line hits or other irregular conditions results in the rejection of the code by the receiver.

**3.05** The high degree of reliability of the signaling system is based, to a large extent, on the structure of the "2-out-of-5" pulse length code used for transmitting the station number.

**3.06** Each digit of a station number is composed of a combination of short and long pulses. The pulse form for individual digits is shown in Fig. 7.

**3.07** Each transmitted digit must have two and only two long pulses and three short pulses coded as illustrated in Fig. 7. Any other combination of pulses will not be accepted by the receiver.

**3.08** In addition, a parity check at the receiver insures that only five pulses are received for each digit of the 4-digit number.

**3.09** The five pulses of a digit are designated in order 0, 1, 2, 4, and 7 as shown in Fig. 7. The value of any digit is given by adding the designation of the long pulses. An exception to this arises if the long pulses occur in positions 4 and 7. In this case, the digit value is zero. A typical 4-digit code is shown in Fig. 8.

**SENDER**

**3.10** The sender transmits information to the receiver by means of pulse length code signals.

**3.11** Each digit transmitted is derived from coded signals received from the line circuit. A class-of-service digit is derived from the type of call processed.

**3.12** Cross-connecting flexibility permits the assignment of any 4-digit station number to any line circuit regardless of its position on the crossbar switch.

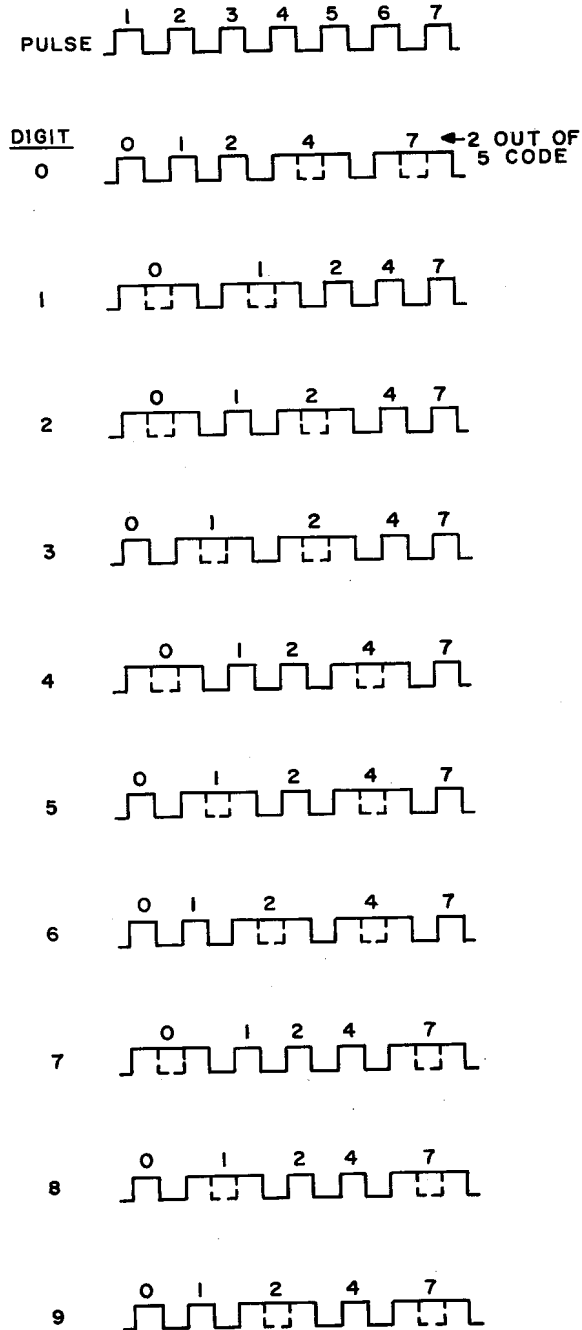


Fig. 7 - Illustration of Pulse Coding

**RECEIVER**

**3.13** The receiver identifies the coded pulses transmitted by the sender as to the time sequence in the series of pulses received and translates this information to a printer storage circuit.

**3.14** Translation of the "2-out-of-5" code to a "1-out-of-10" code is required to display and print "1-out-of-10" character per digit on the number display panel and printed record, respectively.

**3.15** Each digit of the 4-digit number is displayed on an "indicating" cold cathode tube. Each tube has ten anodes, lined up one behind the other, formed into "1-of-10" numbers, 0 to 9. The receiver, by energizing one out of the ten of these anodes, causes one and only one number to light per digit.

**3.16** The same signals used to provide a visual display of the call box number are also used to provide call information to a printer circuit. The printer circuit is used to store the box number until the printer is available.

**4. FUNCTIONS OF PRINCIPAL EQUIPMENT ELEMENTS**

**GENERAL**

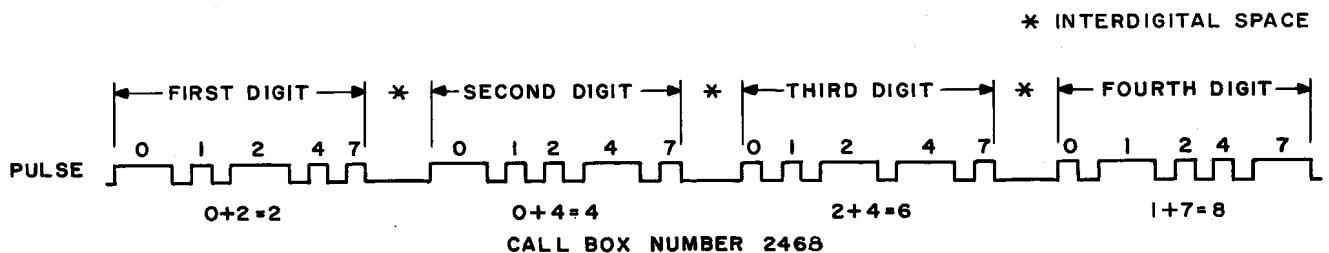
**4.01** The major equipment used for the emergency reporting system concentrator can be classified into two groups of elements. The first group of elements functions to set up a call to the fire or police headquarters and provides a supervisory and transmission path from the

call box to the headquarters operator and a signaling path from the line identification equipment to the headquarters number display equipment and printer equipment. The second group of elements functions to provide an automatic or manual test of the major equipment elements of group 1.

**4.02** Fig. 16 illustrates the relationship of major equipment elements in group 1. The talking and supervisory path of the call is from the station over a cable pair, through the line relay equipment, a crosspoint of the crossbar switch, an outgoing trunk relay equipment, a cable pair to headquarters, an incoming trunk and number display relay equipment, and a switchboard position, cord, and grouping relay equipment. The identification signal path of a call is from a sender, an outgoing trunk relay equipment, the transmitting cable pair to headquarters, an incoming trunk relay equipment, a receiver, number display relay equipment, and the number display panel. In addition, the printed storage relay equipment receives information for a graphical record of the call.

**4.03** The second group of elements is illustrated in Fig. 17 and shows the major equipment elements used in testing a concentrator. The test frame has access to a line relay equipment and the crossbar switch, the sender, and the outgoing trunk relay equipment.

**4.04** The test frame is common to all line equipments and outgoing trunks and is responsible for the proper testing of the concentrator. It knows which line equipment and outgoing trunks are idle and provides a test of these. The test frame also tests the sender.



**Fig. 8 - A Typical 4-Digit Pulse Length Code**

**4.05** There are other equipment elements such as the switchboard position cord, and grouping equipment and traffic registers. The function of some of these elements is described in more detail in the following paragraphs.

**CONTROLLER**

**4.06** The controller is the brain of the concentrator. It is used on every emergency call; it takes charge from the time a call is received and directs operations until a connection is made from the station to the PBX equipment.

**4.07** Although the concentrator establishes only one connection at a time it can accept requests for service from many line equipments. After accepting the request, the controller identifies and serves each line according to a definite pattern. When it has served the last line it repeats the process of accepting, identifying, and serving and continues to do so, as long as there are requests.

**4.08** A definite sequence is used also in selecting idle outgoing trunks. After each connection is established, the controller advances to the next idle outgoing trunk, identifies it, and selects it for the next connection.

**4.09** When a combined fire and police reporting system is used, the controller will connect a fire call to a police trunk if all fire trunks are busy. This is done to guarantee service on a fire call without delay.

**4.10** After the controller identifies the line and determines its location on a crossbar switch, it operates a select and hold magnet which closes a single crosspoint to a line test and selective routing circuit. The controller tests the line and the station and determines the class of service, fire or police. It then finds an idle outgoing trunk which can be connected to the line and operates a hold magnet, thus closing a second crosspoint to provide a talking and supervisory path from the call box to the outgoing trunk.

**4.11** When a connection is completed, the controller job for this call is finished and it proceeds to the next call.

**4.12** The controller normally connects a line equipment to an outgoing trunk in less than 1 second. Because the controller is used on every call, it is important that a trouble condition encountered on any one call should not delay other calls. If the controller fails to establish a connection within the allotted time interval, a trouble record is displayed on the test frame. It then serves other waiting calls if calls are waiting or attempts to place the first call a second time.

**4.13** The following paragraphs describe how the controller:

- (a) Makes a line identification and selection.
- (b) Tests the line and emergency reporting telephone and determines the class of call (fire or police).
- (c) Makes outgoing trunk identification and selection.
- (d) Connects the line to an outgoing trunk.
- (e) Operates on trouble conditions.

**A. Line Identification and Selection**

**4.14** The lines are divided into line groups of ten which are numbered consecutively starting at zero (a concentrator can have a maximum of 20 such line groups numbered 0 to 19). The controller, during each serving cycle, goes from line group to line group and from line to line within each group identifying and serving calls in a definite sequence.

**4.15** The line group gate circuit opens and accepts all requests from line groups with calls waiting. Late requests from other line groups are locked out of the controller after the line group gates close. Once a controller starts its serving cycle, a preference chain determines which line will be served first, second, and so on.

**4.16** The gates and chain functions are more easily visualized by describing a typical serving cycle using line numbers. Fig. 18 shows the relationship of 20 groups of lines, the gate circuits, and preference chains. The figure also shows how the controller serves requests from three line groups during a typical service cycle.

**4.17** While the controller is idle, the line group gate is open to requests from all line groups. As soon as a line requests service, it

sends a signal through the open line group gate to its associated line group relay which operates. This operation tells a controller that the line group wants service. The controller starts to close the line group gate so that it can begin its serving cycle. Before closing it completely, however, the controller allows a start interval of time during which other line group relays requesting service may be operated by their associated lines. Thus, in Fig. 18, three line group relays (2, 10, and 18) are shown operated because lines in their associated groups signaled that they wanted service before the line group gate closed.

**4.18** After the line group gate closes, a preference chain circuit associated with the 20 line group relays takes over and directs the controller to the line group to be served first. There are two preference chain circuits associated with the line group relays; one tells the controller to serve from the lowest to the highest number line group (low to high selection), the other tells the controller to serve from the highest to the lowest line group (high to low selection). The direction of selection remains fixed through a particular serving cycle.

**4.19** The preference chain for the typical case chosen is set for low to high direction of selection and therefore the controller goes first to line group 2.

**4.20** When the controller examines the line group 2, it opens the units gate to this group only and permits all the lines within the group that want service to signal this information to the controller. Each line requesting service signals this information by operating an associated units relay. There are ten of these relays (common to all groups), one for each within a group. In this example, 2 and 5 are operating in group 2. This indicates to the controller that lines 22 and 25 want service.

**4.21** After the units relays are operated, the controller closes the units gate and locks out any late arriving calls in the line group 2. During this service interval, the controller serves only the two lines which have their units relays operated. It does not permit any other line within the same line group to operate its associated unit relays.

**4.22** However, this is not true of late arriving calls in other line groups which have already signified a request for service, line groups 10 and 18 in this example. Because the units gate has not yet been open to these other line groups, the controller can still accept calls in these groups. All that the controller knows at any time is that the same line or lines in these other groups want service. The controller does not find out which individual lines until it is ready to serve the particular line group.

**4.23** After the units gate closes on line group 2, a units preference chain tells the controller to serve lines 22 and 25 in that order, low to high selection. There are two units preference chains which can tell the controller in which order to serve the individual lines within a group. The one units preference chain in use during a particular cycle is set for the same direction of preference as the line group preference chain.

**4.24** After an incoming line is served, it is locked out from the serving cycle. This is done so that the line will not be served again during the same serving cycle.

**4.25** After the controller serves lines 22 and 25 in line group 2, it moves on to another next higher line group requesting service, line group 10. The controller then opens the units gate to line group 10 and, using the same units relays, records the identity of the individual lines within group 10. It then closes the units gate on group 10 and serves lines 101 and 106.

**4.26** In this manner, the controller goes from line group to line group serving line groups from the lowest number to the highest number.

**4.27** After line groups 2, 10, and 18 are served, the controller starts another serving cycle by opening the line group gate to all 20 line groups. With the gate opened, any line group can then request service.

#### **B. Test of Line and Emergency Telephone and Class-of-Service Operation**

**4.28** After identifying and selecting the line, the controller must close the proper cross-point on a crossbar switch in order to test the line and determine the class of service. As de-

scribed in Part 2, Switching Principles, each line appears on a crossbar switch and has access to vertical 4 and 9 on a "split" switch and vertical 9 on a "full" switch. These verticals are used to provide the controller with a means of providing a line test and to determine the condition of the selective routing key at the call box.

**4.29** When the controller has progressed to the stage for closing the crosspoint, it operates the line select magnet corresponding to the unit digit of the line.

**4.30** The controller must now operate a hold magnet to hold the proper select finger in place. It does this after checking that only one select finger has been operated.

**4.31** With the closure of the crosspoint, the tip, ring, and sleeve leads of the line circuit are extended into the controller line check and selective routing circuit. Line continuity is made and then a check is made to determine if a police or fire call is being placed (class of service).

**4.32** This test is made on all lines requesting service. The crosspoint remains operated until after the outgoing trunk has been connected to the preferred line.

#### **C. Outgoing Trunk Identification and Selection**

**4.33** Although the controller has no influence over which lines are selected, it does have control over the outgoing trunks. It exercises this control to see that insofar as practical, each trunk gets an equal share of the outgoing traffic.

**4.34** The outgoing trunks are divided into groups of five and for each group there is an associated headquarters group relay within the controller. The headquarters group relay is operated under control of the line group relay used in preferring a call. The headquarters group relay provides a method for the controller to select a trunk group to the particular fire or police headquarters requesting connection by the line.

**4.35** The controller selects an idle trunk by extending a control lead into the headquarters group of trunks. A preference chain of trunk relays determines for the controller what idle trunk will be selected. This preference chain

functions to provide a reversal of selection of outgoing trunk relays at regular intervals, that is, low to high or high to low.

**4.36** After the controller has gone through the outgoing trunks to the last trunk, it reverses its direction of selection. It does this by operating a reversal trunk relay which changes the controller preference in selecting idle trunks. This reversal of preference occurs each time all idle trunks have been selected by the operation of the preference trunk relay.

**4.37** When all fire trunks become busy to the controller and a new call is originated, a major alarm alerts the maintenance force, an overflow register is stroked, and the controller attempts to place the call over any trunk that becomes idle.

**4.38** If all trunks are busy to the fire headquarters and a police trunk is available, the controller extends the call to a police outgoing trunk group and connects the police trunk to the line.

#### **D. Connection of a Line to an Outgoing Trunk**

**4.39** When the controller has progressed to the stage of closing a crosspoint to connect the line to the trunk, it operates the trunk hold magnet on the line switch. Once a crosspoint is closed, the controller releases the select magnet and the hold magnet used for line test. The release of the select magnet frees the select bar so that it can be used on another connection.

**4.40** The line is now cut through to the outgoing trunk. Similar procedures are used for connecting other lines to outgoing trunks.

#### **E. Operation of the Controller Under Trouble Conditions**

**4.41** Because the controller is common to all incoming lines and outgoing trunks, a trouble condition encountered while setting up any one connection must not be permitted to delay the setting up of other connections. The controller recognizes certain types of trouble conditions, and, when it encounters such a trouble, takes action which tends to prevent this trouble from affecting subsequent calls. The type of action taken depends upon the type of trouble condition and can consist of one or more of the



following operations: reversing the selection of line circuits, seizure of the second line test and selective routing circuit, reversing the control for operating the trunk hold magnet, and opening the tens gate to accept a new request for service.

**4.42** Timing circuits within the controller enable it to determine when a trouble condition exists. Two timing circuits are used, a short time-out and a long time-out.

**4.43** The short time-out starts a time period whenever the controller is seized. It provides a guard on the controller to insure that it will complete its functions within the guard period.

**4.44** Four functions are guarded as follows.

- (a) Line selection.
- (b) Cut through of the line to the controller from a line test.
- (c) Line test and selective routing determination.
- (d) Outgoing trunk selection.

**4.45** If the connection is not established within the short time-out interval, the controller assumes that a trouble condition exists. It then seizes the trouble indicator and causes progress lamps to appear on the trouble display lamp panel and brings in a minor alarm. Simultaneously, it begins to release the controller.

**4.46** The controller releases and attempts to serve either the same or another line depending upon the type of trouble that was encountered. To do this, the controller performs one or more of the operations mentioned in 4.41 so that the trouble condition that was encountered while the controller was attempting to set up the first connection will not be encountered while setting up another connection.

**4.47** The long time-out circuit provides a time guard on the controller to insure that it has served its functions and releases. It starts timing at the same instant the short time-out circuit begins during its first guard period.

**4.48** If a long time-out occurs due to trouble, a major alarm will sound and a master time-out register will stroke.

## LINE AND TRUNK RELAY EQUIPMENT

### F. Line Relay Equipment

**4.49** Line relay equipment provides for signaling and transmission from an emergency telephone station, a 4-digit identification number to a sender, and a lockout of the station from the concentrator after the headquarters operator has disconnected until an on-hook signal is provided from the station set.

### G. Outgoing Trunk Relay Equipment

**4.50** The outgoing trunk relay equipment provides for the following.

- (a) A continuous supervisory test of the line to headquarters.
- (b) Control of the connection to the line relay equipment.
- (c) Audible ringing tone toward the station set as a connect signal.
- (d) A talking path between the station and headquarters equipment.
- (e) Supervision to and from the incoming trunk and number display relay equipment.
- (f) A signaling path between the sender and a headquarters receiver.
- (g) Signaling leads to the test frame for testing purposes.
- (h) Release of the sender if outpulsing is not completed in a 2-second interval.

**4.51** The continuous supervisory test feature prevents the seizure of a trunk by the controller if it is in trouble.

**4.52** The outgoing trunk relay equipment receives a supervisory signal from the terminating end which is used to seize the sender. When a sender is attached, the outgoing trunk extends the tip and ring conductors from headquarters to the sender for pulsing purposes and provides for signaling the line relay equipment to provide coded information to the sender for outpulsing the station number. If the sender does not complete its functions within a 2-second interval, a trunk timing circuit functions to dismiss the sender and cut through the trunk for talking.

**H. Incoming Trunk Relay Equipment**

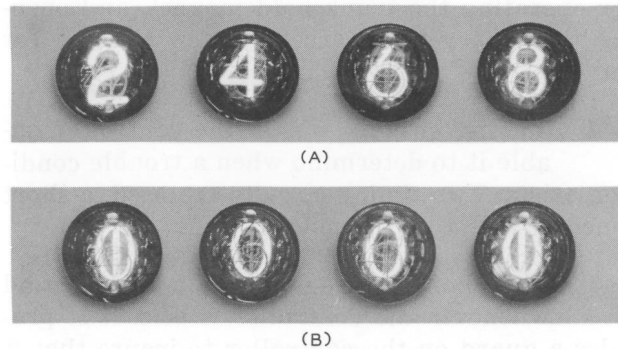
**4.53** The incoming trunk relay equipment combines functions for supervision, transmission, and signaling between an outgoing trunk equipment and the fire or police PBX position equipment.

**4.54** A supervisory signal, reversed battery and ground, is received from the outgoing trunk to indicate connection of a line equipment at the concentrator. This signal seizes the incoming trunk circuit.

**4.55** Supervisory signals are sent to the outgoing trunk by the incoming trunk when the attendant answers a call or if the attendant is delayed in answering a call and an automatic printing is requested. A 130-volt battery supervisory signal is provided on the conductors as an indication to the outgoing trunk that an identification of the station number is required. Simultaneously, the trunk functions to attach a receiver and prepare it to receive pulses from a concentrator sender.

**4.56** When a receiver is ready to accept transmission from the sender, it prepares a signaling path through the incoming trunk relay equipment which removes the 130-volt battery from the conductor pair. The sender transmits a 4-digit number preceded by a class digit which is decoded by the receiver and stored on its storage relays. During the pulsing interval, the receiver signals the number display lamps to provide a 4-digit station number display and signals the printer circuit to register the 4-digit number and the class digit. When pulsing is completed, the talking path from the station to the PBX switchboard is cut through.

**4.57** Two timing control circuits are incorporated in the incoming trunk relay equipment to time the receiver operation. The first timing period checks that the receiver is ready for sender pulsing; the second timing period is used to check that the receiver has completed the station number registration. The failure of the receiver to prepare for pulsing or to complete station registration will provide a failure display on the number display panel. The failure display provides a ① 00 ① pattern on the display lamps. (See Fig. 9.)



**Fig. 9 – A Number Display Indicator Panel**

**4.58** Each group of eight incoming trunk relay equipments has associated with it a relay which is used to provide connection to the PBX switchboard position, cord, and group relay equipment.

**4.59** Dual appearances are provided for termination in a switchboard for key or cord and jack answer. A hold feature permits attendant holding of an incoming trunk.

**SENDER**

**4.60** The sender transmits a 4-digit station number, preceded by a class digit, to the receiver.

**4.61** The sender can be engaged by any outgoing trunk. A preference and control relay chain is provided to prevent any one trunk from seizing the sender if some other trunk has made it busy.

**4.62** When the outgoing trunk attaches the sender, the line relay equipment identification relay operates and extends leads into the sender to control outpulsing. The class digit information is obtained from a circuit in the test frame.

**4.63** The sender outpulses the station number to the receiver by reversing the tip and ring polarity. When the number is completely transmitted to the receiver, the sender releases.

**RECEIVER**

4.64 The receiver at the headquarters location is used to accept pulses from the sender at the concentrator location under control of the incoming trunk.

4.65 The receiver translates the two long and three short pulses from the sender and stores coded information on "2-out-of-5" relays per digit to process information to the display panel and printer circuit.

**PRINTER****I. General**

4.66 Fig. 16 illustrates the major equipment elements used to provide a printed record of calls processed by concentrators.

4.67 The printed record (see Fig. 10) consists of a 4-digit equipment location of the station line termination on a concentrator prefixed by a class-of-service digit. An answer class digit, either A or D, is printed after the station numbers, depending upon whether the attendant answers the call (A) or an automatic printing (D) was required prior to the attendant answer. Two class-of-service digits are normally used; digit 1 to indicate a service call, and digit 9 to indicate a trouble on a station line. Any one of the other eight digits can be assigned as required. The digit 1 is translated in the printer circuit to permit the printer to print an E. The digit 9 is translated in the printer circuit and a T is printed.

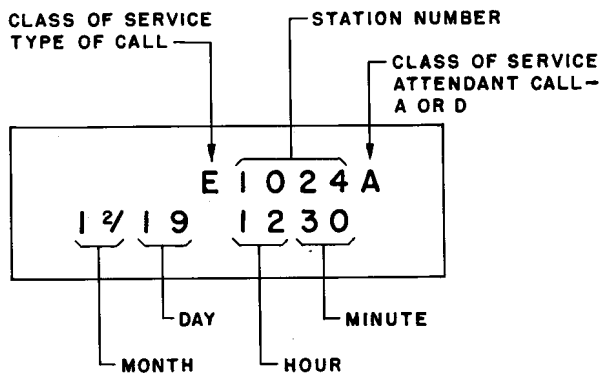


Fig. 10 - Sample Ticket

4.68 Following the 4-digit number and class-of-service letters on the ticket, a month, day, hour, and minute entry completes the information that is printed.

**PRINTER STORAGE AND PRINTER RELAY EQUIPMENT**

4.69 Each call received by the headquarters equipment, either from the concentrator equipment or direct line equipment, will cause the printer relay equipment to print a record. A 4-digit station number prefixed with a class-of-service digit and suffixed with an A or D letter will be printed for a concentrator call.

4.70 The printer relay equipment accepts service requests from the printer storage relay equipment. It then prepares the printer and controls the transfer of information from the printer storage relay equipment for graphically recording the station number.

4.71 The printer storage relay equipment then releases and attaches the time-of-day relay equipment. The time-of-day numerical information is printed on the ticket.

**LINE IDENTIFIER CONNECTOR AND RELAY EQUIPMENT**

4.72 Line identifier connectors are required when direct lines are terminated in common with concentrator trunks on a PBX switchboard.

4.73 The line identifier connector consists of a 10 by 10 crossbar switch arranged to provide connection for 100 direct line relay equipments. The connector functions to provide a 4-digit equipment number to the printer relay equipment for ticket printing on direct line calls.

4.74 Briefly, the sequence of operations is as follows. When a direct line relay equipment is seized by the emergency reporting call box, a signal causes the line identifier connector to close one of 100 crosspoints. If the printer relay equipment is idle, the line identifier relay equipment connects to it.

4.75 A lockout circuit prevents the simultaneous seizure of the printer relay equipment by the line identifier or the printer storage relay equipment. If the printer relay equipment

is processing a call, the line identifier relay equipment will wait until the lockout circuit opens and accepts its seizure.

**4.76** The line identifier relay equipment is released from the printer relay equipment after the number is printed. This opens the lockout circuit and permits other connectors or the printer storage relay equipment to seize the printer relay equipment.

## SWITCHBOARD

### J. General

**4.77** The terminating headquarters uses a switchboard to terminate the incoming trunk relay equipment from the concentrator equipment. The switchboards are discussed in Section 981-225-100 and will not be discussed here. However, those features required as an adjunct to these switchboards for concentrator operations will be discussed.

### K. Display Indicator Panel

**4.78** Two number display indicator panels are provided per switchboard, one for the left position and one for the right position.

**4.79** Each display has four indicating lamps; one lamp is used for the thousands digit, and one each for the hundreds, tens, and units digit. When "1-out-of-10" control leads are energized per lamp, a number is displayed on the panel. Each digit is approximately 3/4 inch high and 1/2 inch wide.

**4.80** Fig. 9 illustrates the display indicator panel. Two different combinations of digits are shown displayed. Display A illustrates a call box number display and display B illustrates the failure pattern (described in 4.57).

**4.81** The use of the left or right number display indicator is determined by a position grouping key (POS-GRP) mounted on the face panel. When the key is thrown to the left position, the left number display equipment and the left number display panel are used; when the key is thrown to the right position, the right number display relay equipment and right number display panel are used. When the position grouping key is in the center position, the left and right number display relay equipment and

left and right number display panel are operated independently of each other. A display transfer key is provided in the PBX switchboard face panel (right panel) to provide the operator with a means for manually transferring from the left or right display relay equipment.

**4.82** Associated with each number display relay equipment is a right and left display receiver. These receivers function independently if 2-attendant operation is used.

### L. Direct Line Relay Equipment

**4.83** Direct lines from emergency reporting telephones can be worked in conjunction with the concentrator system. These relay equipments function and operate as discussed in Section 981-225-100.

## REGISTERS

**4.84** Registers are provided at the concentrator location to indicate to the traffic forces the load on the system and to indicate to the plant forces the trouble performance. The following registers and their functions are provided.

### 4.85 Traffic

- (a) *Peg Count Fire* — scores each time the controller seizes a fire trunk.
- (b) *Peg Count Police* — scores each time the controller seizes a police trunk.
- (c) *Fire Trunk Overflow* — scores if a new call is originated and all fire trunks are busy.
- (d) *Police Trunk Overflow* — scores if a new call is originated and all police trunks are busy.
- (e) *Overflow* — scores if all fire and police trunks are busy and a new call is originated.

### 4.86 Plant

- (a) *Peg Count Trouble* — scores each time a trouble indicator is seized.
- (b) *Master Time-Out* — scores when the controller "long time out" functions.
- (c) *Peg Count Controller* — scores each time the controller operates.

(d) *Second Trial Failures* — scores when the controller fails to complete a cycle after requesting the trouble indicator.

## SIGNALING WORKING LIMITS

### M. Line

4.87 The line relay equipment permits a reporting telephone station conductor loop range of 1800 ohms. A long line circuit may be provided if the station requires a conductor loop range beyond 1800 ohms.

### N. Trunk

4.88 The interconnecting trunks between the concentrator equipment and the PBX switchboard should not exceed the sender and receiver pulsing circuit resistance design of 2000 ohms.

## 5. METHOD OF OPERATION FOR TYPICAL CALLS

### EMERGENCY (FIRE CALL)

#### A. General

5.01 This part traces a typical fire call through a concentrator to a fire headquarters from start to completion. During the description of the call, the functions of various equipment elements are described in the sequence in which they are performed. Not all the functions are discussed; only the main functions are highlighted as the call progresses.

#### B. Description of Operation

5.02 To place a call, the caller opens the self-closing door on the emergency telephone and lifts the handset off the switchhook. This off-hook condition is recognized by the line relay equipment at the concentrator as a seizure signal.

5.03 The line equipment sends a signal to the controller indicating that a connection to an outgoing trunk is required. This signal operates the line group relay associated with the group containing the line requesting service. The controller closes the line group gate to prevent any other call from seizing the line group relay.

5.04 After the line group gate is closed, the controller, directed by the preference chain, associates the units relays with the group requesting service. The unit relay corresponding to the number of the line operates and identifies the line requesting service. The units gate then closes.

5.05 Now that the controller has identified the line to be served and has closed the gate to any others, it proceeds to cut the line through to the line check and selective routing circuit. It does this by operating a select magnet associated with the crossbar switch on which the line appears and then operates No. 4 or 9 hold magnet depending upon whether "split" or "full" switches are used. After the crosspoints close, the tip and ring conductors from the line equipment are extended into the controller for line test.

5.06 After a line test is completed, the controller determines from the line the condition of the selective routing key. On this call the key is normal, therefore, the controller operates the fire control relays.

5.07 The controller then proceeds to select an idle outgoing trunk to fire headquarters.

5.08 A ground is extended through the trunk group preference relays to operate the selected trunk hold magnet to provide a crosspoint closure. The line circuit connection is now established from the outgoing trunk to headquarters.

5.09 The outgoing trunk immediately sends a connect signal to the fire headquarters and sends an audible ring toward the telephone station as a waiting signal to the caller that a connection has been established to the PBX attendant at the fire headquarters.

5.10 With the closure of the crosspoints, the outgoing trunk takes over from the controller and holds the hold magnet operated for the remainder of the call. The outgoing trunk sends a signal to the controller notifying it of this change. The signal indicates to the controller that the connection is completed to the distant office. The controller drops the select magnet and hold magnet to the line test and selective routing circuit and releases from the connection ready to accept another call.

## SECTION 981-226-100

- 5.11** At the PBX, the incoming trunk relay equipment recognizes the reversed battery supervision from the outgoing trunk, signals the PBX attendant by flashing dual line lamps in a key and jack appearance, and sounds an audible alarm.
- 5.12** The attendant answers the line lamp either by key or cord. With key operation, he depresses the answering key associated with the line lamp; with cord operation he places an answering cord in the line jack and operates the talking key. Either operation extends the position, cord, and grouping circuit to the incoming trunk.
- 5.13** The incoming trunk recognizes the attendant answer signal and functions to change the flashing line lamps to a steady lamp condition, silence the audible alarm, prepare the number display control circuit, select a receiver, signal the outgoing trunk that the call has been answered by lowering the loop resistance, and place positive 130-volt battery on the tip and ring conductors as an identification request signal.
- 5.14** The outgoing trunk recognizes the answer signals and seizes the sender, removes the audible ring from the line to the station, sends a signal to the line circuit to operate the identification relay which is used to control the sender outpulsing, and prepares itself to extend the tip and ring conductors to the sender.
- 5.15** The sender is attached to the outgoing trunk and signals the trunk to cut through the tip and ring for outpulsing and starts its pulse generator.
- 5.16** At the terminating end, the incoming trunk cuts through the receiver to the line. The receiver sends a connect signal to the sender after cut through.
- 5.17** The sender recognizes the signal from the receiver and begins outpulsing. The extended identification leads from the line circuit and test frame determine the code signals to be transmitted by the sender.
- 5.18** After the sender has completed outpulsing a 4-digit number preceded by a class digit, it releases. The outgoing trunk recognizes the release of the sender and cuts through the talking path from the station to headquarters.
- 5.19** The receiver circuit meanwhile has closed through "1-out-of-10" leads per digit to the number display relay equipment to light a 4-digit station number and connected to the printer storage relay equipment to translate the class information and 4-digit station number to it for use by the printer in printing a ticket. It simultaneously returns the incoming trunk to the cut-through condition and the talking connection is established from the station to the PBX attendant.
- 5.20** The transmission of a station number from the sender to the receiver consumes approximately 1.7 seconds of time.
- 5.21** While the attendant is talking to the caller at the station to accept the fire report, the station number is continuously displayed. If the attendant wishes to hold the connection while he answers a second incoming call, he can do so by depressing the hold key associated with the line lamp or releasing the talking key associated with the cord.
- 5.22** This action erases the number display and holds the trunk connection. With key answer, the line lamps will change from a steady condition to a "winking" condition (slow flash) as an indication that the trunk is in the hold condition. The position of the talking key denotes the hold condition for cord answer.
- 5.23** To return to the held trunk, the attendant again answers by key or by reoperating the talk key associated with the cord. If he answers by key, he depresses the answer key associated with the "winking" line lamp. This reseizes the incoming trunk and a second identification is requested from the concentrator equipment.
- 5.24** With key answering, the "winking" line lamp changes to a steady condition and a second display of the station number appears in the number display panel. With cord answer, the reoperation of the talk key produces a second display of the station number. The attendant again has an established talking condition to the station.
- 5.25** Two conditions can exist after the fire report is made. The caller replaces the handset on the switchhook, thus releasing from

the connection or the attendant disconnects from the connection before the caller has returned the handset to the switchhook.

**5.26** If the caller disconnects first, a supervisory signal (on-hook signal) is sent to the PBX switchboard. This signal lights the common release lamp on the switchboard face panel or the disconnect lamp on the cord pair in use. The attendant recognizes this disconnect signal and releases the connection by depressing the common release key (RLS) if key answered, or by removing the cord from the line jack if cord answered.

**5.27** The release by the operator sends a disconnect signal to the incoming trunk circuit. The incoming trunk circuit releases from the PBX switchboard equipment. Simultaneously, a disconnect signal is passed to the outgoing trunk in the concentrator.

**5.28** The outgoing trunk recognizes the disconnect signal and releases the hold magnet on the line switch. This drops the crosspoint and the line circuit begins its release.

**5.29** Three simultaneous release actions occur.

- (a) The incoming trunk circuit removes the line lamp signal and erases the number display, and the incoming trunk returns to normal.
- (b) The outgoing trunk after dropping the crosspoint completes its release and returns the trunk to the continuous supervisory test.
- (c) The line circuit releases and restores to normal or fire stand-by condition.

**5.30** If the operator disconnects before the station is returned to its on-hook condition, the normal release of the connection follows as explained above with one exception; the lock-out relay remains operated under control of the reporting line relay.

**5.31** This places the line circuit in a locked-out condition to the concentrator to prevent its reseizure. This condition remains until the caller returns the handset to the switchhook, or the caller flashes the switchhook, which re-

leases the lockout and presents a new seizure to the concentrator which requests a new connection to the fire headquarters.

**5.32** When the caller replaces the handset or the switchhook, the line equipment drops its lock-out relay and returns to a fire stand-by condition.

## POLICE CALL

### C. General

**5.33** A police call from an emergency reporting telephone proceeds in a manner similar to a fire call. Therefore, the description of a fire call applies to a police call with the following exceptions.

- (a) The calling party reporting to a police headquarters will usually be a police patrolman.
- (b) The patrolman initiates a call by operating the selective routing key before and while he lifts the handset from the switchhook and until audible ringing is heard. This action will provide class information to the controller that will condition it for a police call.
- (c) The call will be connected to the police outgoing trunk.
- (d) The outgoing trunk will terminate at a police headquarters.

**5.34** As in the case for a fire call, a printed record will be made at the police headquarters on calls placed from emergency telephone stations. For police calls, a P or R letter precedes the station number to identify it as a patrolman or routine test call.

## 6. TESTING AND MAINTENANCE

### GENERAL

**6.01** This part briefly describes the concentrator equipment that requires routine preventive maintenance testing. It also describes the test equipment used and the general testing procedures for some typical tests.

## SECTION 981-226-100

**6.02** The tests of the line and outgoing trunk relay circuits, and terminating headquarters relay circuits are made from the central office. To make these tests, each office is provided with a test frame, a test line circuit, and miscellaneous test facilities.

**6.03** Tests of the line circuits, outgoing trunks, sender, controller, and headquarters relay circuits can be made on an automatic basis or on a manual basis.

**6.04** Cross-connection arrangements are provided to permit local adjustment of automatic test cycles over a wide range of timing intervals. The line tests may be adjusted to start line test cycles from 6- to 90-minute intervals. However, the minimum time period depends on how long a complete test can be made over all in-service lines. The sender and trunk test cycle period may be made every 2, 4, or 8 times the line test interval while the call-through test cycle period may be varied in multiples of 2 to 40 times the line test interval.

**6.05** For manual testing, the test frame has a series of control keys which enables the test personnel to test a particular line, outgoing trunk, sender, controller, and headquarters equipment.

**6.06** The test frame has the ability to call for a sender and cause a printed record at the headquarters location when lines are found to be in trouble while being tested. The number printed is a station number preceded by the letter T. The number is also displayed on the number display panel. The attendant knows this call to be a trouble call because, upon answer, a low-level tone is received in the attendant headset.

### TESTING AND MAINTENANCE EQUIPMENT

#### A. Trouble Indicator

**6.07** A lamp-type trouble indicator is provided in each office to aid in locating trouble conditions. The trouble indicator is seized whenever a controller times out due to trouble.

**6.08** The type of information given to the trouble indicator by a controller is as follows.

- (a) The number of the controller.

- (b) The number of the incoming line.

- (c) The number and type of the outgoing trunk.

- (d) The stage of the call before trouble was encountered.

- (e) In some cases, the nature of the trouble.

**6.09** The trouble indicator is mounted on the test frame together with the miscellaneous test facilities already described. Maintenance registers are also mounted on this frame.

**6.10** Briefly, a trouble indicator records trouble conditions as follows. When a controller encounters trouble while serving a call, it times out and seizes the trouble indicator. The controller then passes to the trouble indicator the information pertinent to the call. This information is stored in the test frame and the controller releases so that it may serve other calls.

**6.11** When the trouble indicator is seized, a minor or major alarm sounds and the lamps corresponding to the information stored in the trouble indicator light.

**6.12** While the trouble indicator is recording a trouble, a second call in the controller may encounter trouble. Under these conditions the controller cannot seize the trouble indicator display; however, it makes a record of the fact that a call tried to seize it by scoring registers.

#### B. Time-Delay Relay

**6.13** The setting of the time-delay relay is a function of the following factors.

- (a) The average time to complete a test cycle.

- (b) The number of concentrators terminating at a headquarters.

**6.14** The frequency of tests is determined by the headquarters and telephone personnel after a study of these and other local considerations. Local cross connections can be made to provide a variety of test frequencies for line tests, sender, trunk tests, and call-through tests.

#### C. Manual Patch Arrangement

**6.15** The manual patch arrangement is used by the central office maintenance force to extend calls to the headquarters switchboard



while the controller is out of service during a maintenance test interval.

**6.16** Each line and trunk relay equipment is assigned a jack and lamp appearance on the manual patch layout.

**6.17** When a patch is to be made, a cord terminated at both ends with plugs is used. One end is inserted into the line jack requesting service and the other into a jack associated with an idle outgoing trunk.

**6.18** The controller has been provided with a make-busy key and lamp which permits taking the controller out of service for maintenance.

## TYPICAL TEST

### D. General

**6.19** The purpose of this part is to give a general picture of several typical tests. No attempt is made here to describe all the tests, or to give all the details of those tests which are described.

### E. Automatic Test

**6.20** When the proper cross connections have been established, the test frame will commence testing the line relay circuits, outgoing trunk circuits, sender, controller, and headquarters equipment automatically at a predetermined rate.

**6.21** The test frame will function to test each line to provide a test of each of its possible combinations of crosspoints. Each line is tested for leakage, continuity, opens, and grounds before the test frame advances to the next crosspoint. In addition, the test frame may be arranged to test only one crosspoint.

**6.22** After each line is tested, the test frame automatically begins testing the outgoing trunks. Operational tests are performed for marginal relay operation.

**6.23** On completion of the outgoing trunk test, the test frame seizes the sender and performs operational tests. Five tests using a combination of 4-digit numbers are used to test its function for pulsing with the test frame receiver circuit.

**6.24** At the conclusion of sender test, the test frame seizes each headquarters, one at a time, and performs a call-through test. This test functions to test operational features of the headquarters equipment. Supervisory tests are also performed. When the attendant depresses the position release key, the test frame retires and advances, in order, to the next headquarters.

**6.25** During the call-through test, the sender functions to send a test line number to headquarters for display and ticket printing.

**6.26** On call-through tests, the operator knows that a test is being made by the number displayed. A 4-digit number, locally selected by the telephone company and the headquarters personnel, is displayed. The number selected should not be in conflict with any number used for station identification.

**6.27** Upon conclusion of the call-through tests, the test frame stops and waits for the time-delay relay to close through its contacts for the next testing cycle.

### F. Manual Test

**6.28** Manual tests of the concentrator equipment can be performed by the operating personnel by selecting and depressing keys which will control the tests. The tests described above can be performed on a manual basis.

### G. Controller Test

**6.29** The test frame is not required to test all the functions of the controller. With the use of the trouble indicator panel, any trouble that would slow down the operation of the controller or prevent a call from being set up initially will be displayed. A trouble record kept of these calls will indicate to the maintenance personnel conditions that require investigation.

### H. Call-Through Test

**6.30** While performing the automatic test, the test frame tests the controller and each individual headquarters equipment. It does this by performing a call-through operational test using test lines assigned to switches which have appearances of the outgoing trunks to the particular headquarters that are to be tested.

6.31 The call-through test permits signaling, supervisory, and transmission tests to be made to a headquarters.

6.32 Test line circuits are provided on the basis of one per concentrator when a concentrator is provided to a fire and/or police headquarters. If more than one fire and/or police headquarters is provided per concentrator, each group of switches offering concentration of lines to these headquarters must be provided with a test line.

**I. Headquarters Call**

6.33 To make a test manually, the central office maintenance personnel can operate an individual headquarters key which automatically places a call to the headquarters operator over the test line. A handset provided at the test frame is used to permit communication with the attendant.

**7. EQUIPMENT**

**CENTRAL OFFICE EQUIPMENT**

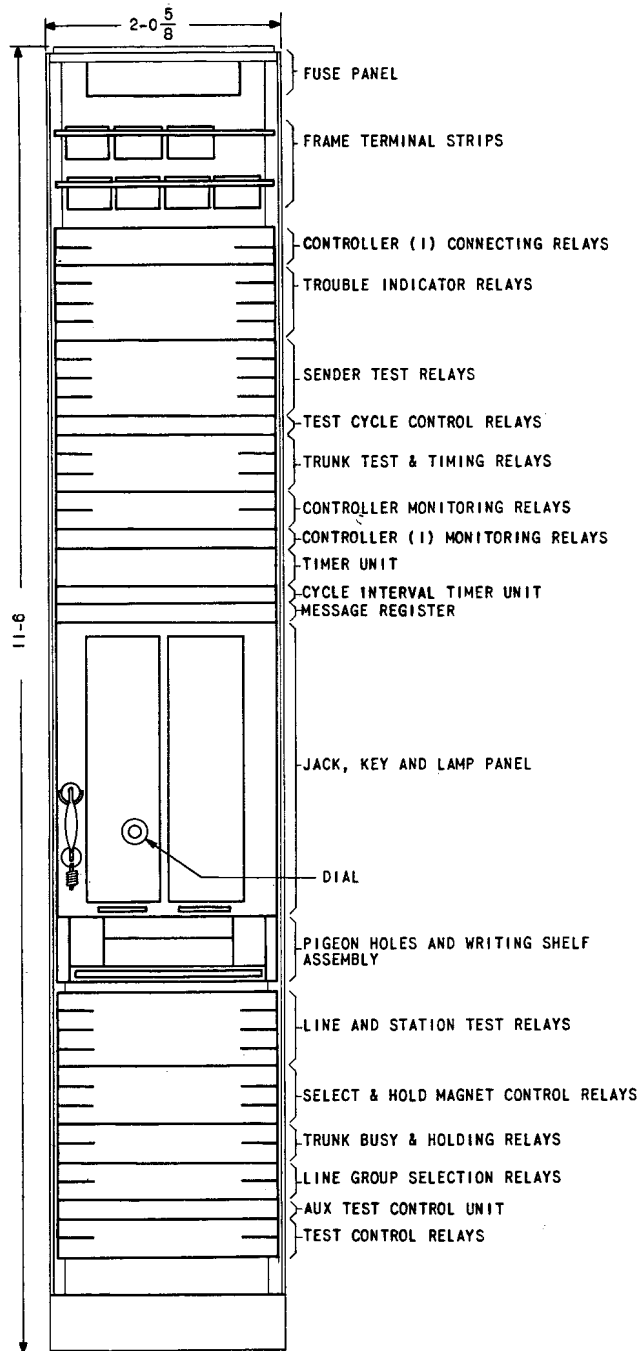
**A. General**

7.01 The concentrator equipment at a central office consists of one test frame, one controller frame, and one to four line and switch frames. The frames are of bulb-angle construction, 11 feet 6 inches high, arranged for 2- by 23-inch mounting plates. Each frame has a fuse panel mounted at the top and is arranged for connection to dial system central office battery and ground feeders.

**B. Central Office Test Frame**

7.02 This frame, illustrated in Fig. 11, is arranged to mount relay units, pigeon holes and a writing shelf, message registers, frame terminal strips, trouble indicator panel, test panel with associated keys, jacks, and lamps, and miscellaneous alarm units.

7.03 Provision has been made for facilities to test one or two concentrator systems, or up to 400 emergency reporting telephone line relay equipments and 40 outgoing trunks.



**Fig. 11 - Test Frame**

**7.04** Associated with this frame is a handset and dial which can be used with central office equipment to originate and receive calls. This handset is also used in association with a test line which can be used to initiate a call to a headquarters location.

**7.05** As with the other equipment elements of the concentrator system, the equipment elements of this frame are grouped according to the functions they serve. The cut-in relays used to gain access to the trunks and line and switch equipments are mounted on the associated controller and line and switch frames.

**C. Controller Frame**

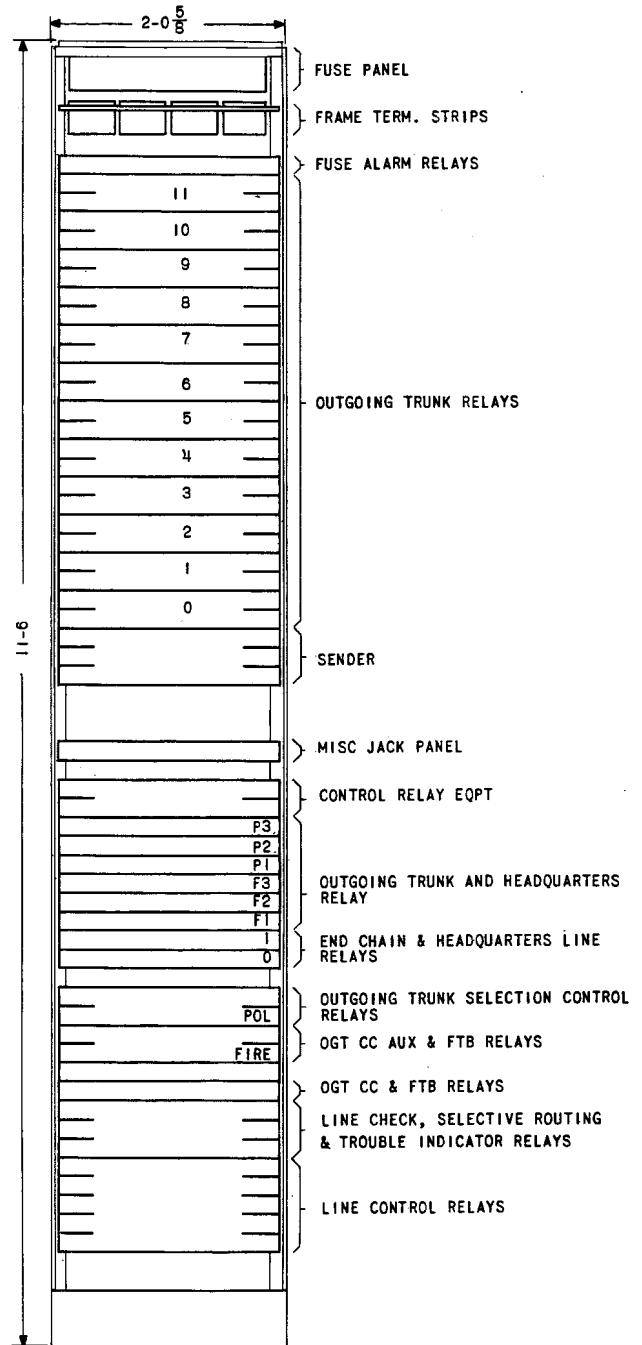
**7.06** This frame, illustrated in Fig. 12, is arranged to mount relay units, miscellaneous jack panels, frame terminal strips, a sender, outgoing trunk relay equipments, miscellaneous alarm units, and a fuse panel.

**7.07** Provision has been made for facilities to serve a maximum of three fire and three police headquarters. The trunk groupings to each headquarters are arranged on a cross-connection basis for flexibility. As noted in Fig. 12, there are six outgoing trunk and headquarters relay units provided for this purpose. Depending upon local arrangements for trunk grouping to a headquarters location, facilities may be provided for a maximum of nine combinations. However, the maximum number of trunks available for these combinations is 20.

**7.08** When ordering a controller frame, the telephone company is required to specify whether one headquarters to a fire or police location or a combination of headquarters to fire and police locations are required for trunk access.

**D. Line and Switch Frame**

**7.09** Two types of line and switch frames are available for use with this system. The first type, the "split" switch type, illustrated in Fig. 13, is arranged to mount four line and switch units, the miscellaneous jack panel, the frame terminal strips, and a fuse panel. Facilities for eight line groups (maximum of 80 lines) are provided with each line group having access to a maximum of four outgoing trunks per switch. The second type, "full" switch type, il-



**Fig. 12 - Controller Frame**

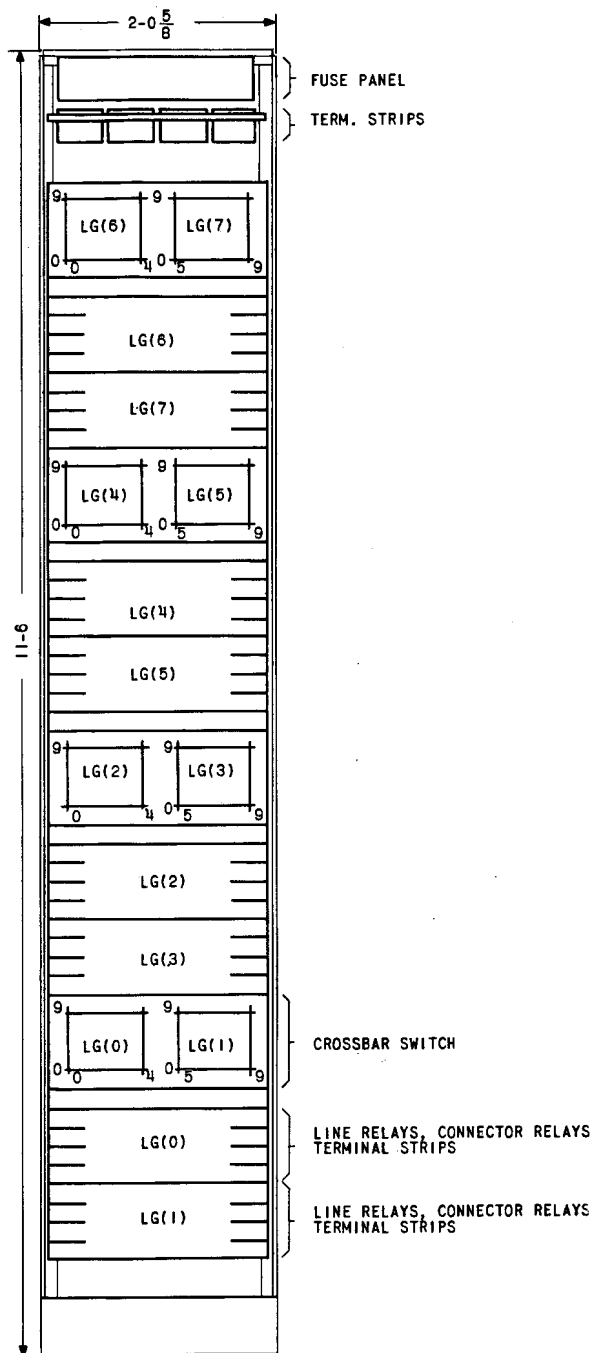


Fig. 13 – Line and Switch Frame ("Split" Switch)

illustrated in Fig. 14, is arranged to mount five line and switch units, miscellaneous jack panels, frame terminal strips, two outgoing trunk relay equipment units, and a fuse panel. Facilities for five line groups (maximum of 50 lines) are provided with each group having access to a maximum of nine outgoing trunks.

7.10 Each ten lines of a line group on a line and switch unit has access to a fire and/or police headquarters. Flexibility is provided for assignment by local wiring and cross-connection arrangements.

7.11 Each line and switch unit has associated cut-in or connector relays which are required for access to the controller and the test frame circuits.

#### E. Central Office Floor Plan Arrangements

7.12 The emergency reporting system central office frames may be located in the central office equipment lines or in separate locations as required. Conductor length limitations require that the emergency reporting frames be in adjacent locations.

7.13 In view of the essential nature of this equipment, it is desirable to provide separate line frame and distributing fuses for it.

#### HEADQUARTERS EQUIPMENT

##### F. General

7.14 The concentrated lines from the central offices terminate on incoming trunk relay equipment at a headquarters location. Interconnection with other control relay equipments and a switchboard is provided for signaling, supervision, and transmission. However, each installation will have a variation of equipment elements to be described.

7.15 The headquarters equipment consists of a group of frames mounting equipment elements associated with the concentrators, direct line relay equipments, and the switchboard. The concentrator equipment consists of one or more incoming trunk frames, a call recorder frame and a display and recorder control frame. The direct line equipment elements, if provided, con-

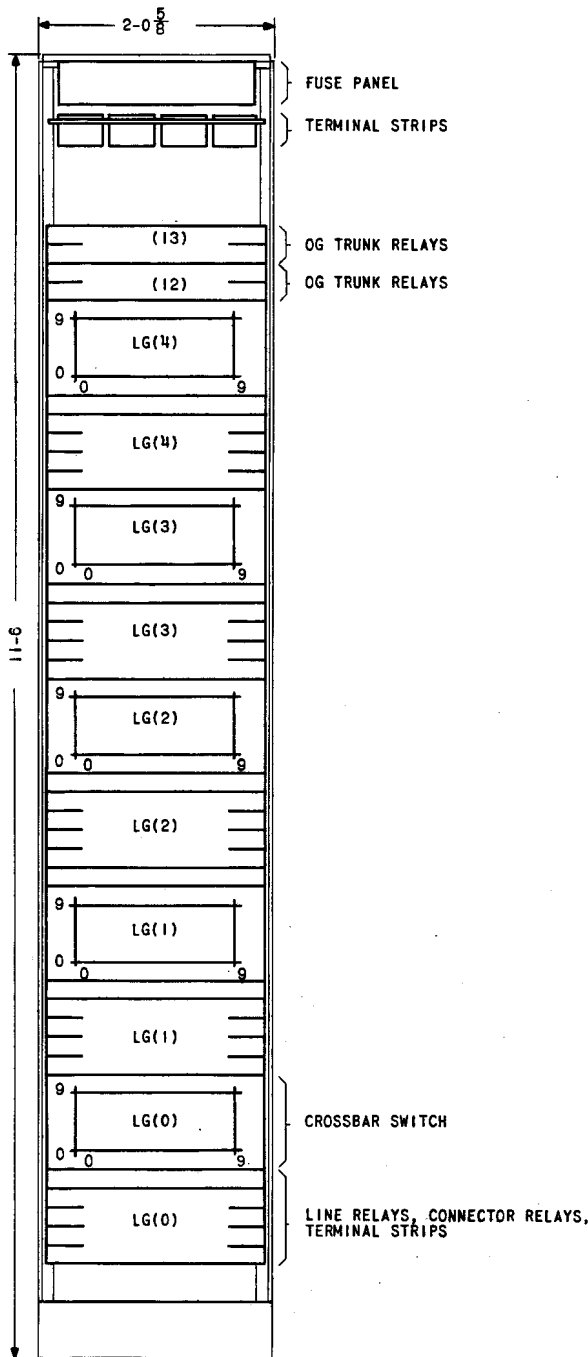


Fig. 14 - Line and Switch Frame ("Full" Switch)

sist of station line and central office trunk frames, a station line frame, and a line identifier frame. The switchboard relay equipment control elements are mounted on a central office and common equipment frame. Other switchboard relay equipments are mounted in the switchboard.

7.16 Fig. 19 illustrates a possible equipment frame layout at a headquarters location and will be explained in the following paragraphs. The frames are a bulb-angle construction, 7 feet high, arranged for 2- by 23-inch mounting plates.

**G. Incoming Trunk Frame**

7.17 This frame mounts the relay equipment for incoming trunk circuits. Two signal equipment units of the incoming trunk circuit are mounted in pairs, alternate units being associated with the left and right switchboard position circuits.

7.18 Also mounted on this frame is an incoming trunk auxiliary unit and incoming alarm unit. The incoming trunk auxiliary unit provides position grouping relays and the flash and wink control relays required for the incoming trunk circuits. The incoming alarm unit is required to provide for frame fuse alarm indication.

**H. Call Recorder Frame**

7.19 The call recorder frame mounts the time of day, the printer control relay equipment, and line identifier crossbar switches. The line identifiers are used with the direct line system in conjunction with the time-of-day relay equipment and printer control relay equipment.

**I. Display and Recorder Control Frame**

7.20 The display and recorder control frame mounts the storage relay equipment which is used to store the station identification numbers used for display and recording. The frame consists of relay equipment for the left and right receivers and display storage units, and the left and right printer storage units. In addition, the switchboard position display unit, an incoming alarm unit, and a fuse panel are mounted on this frame.

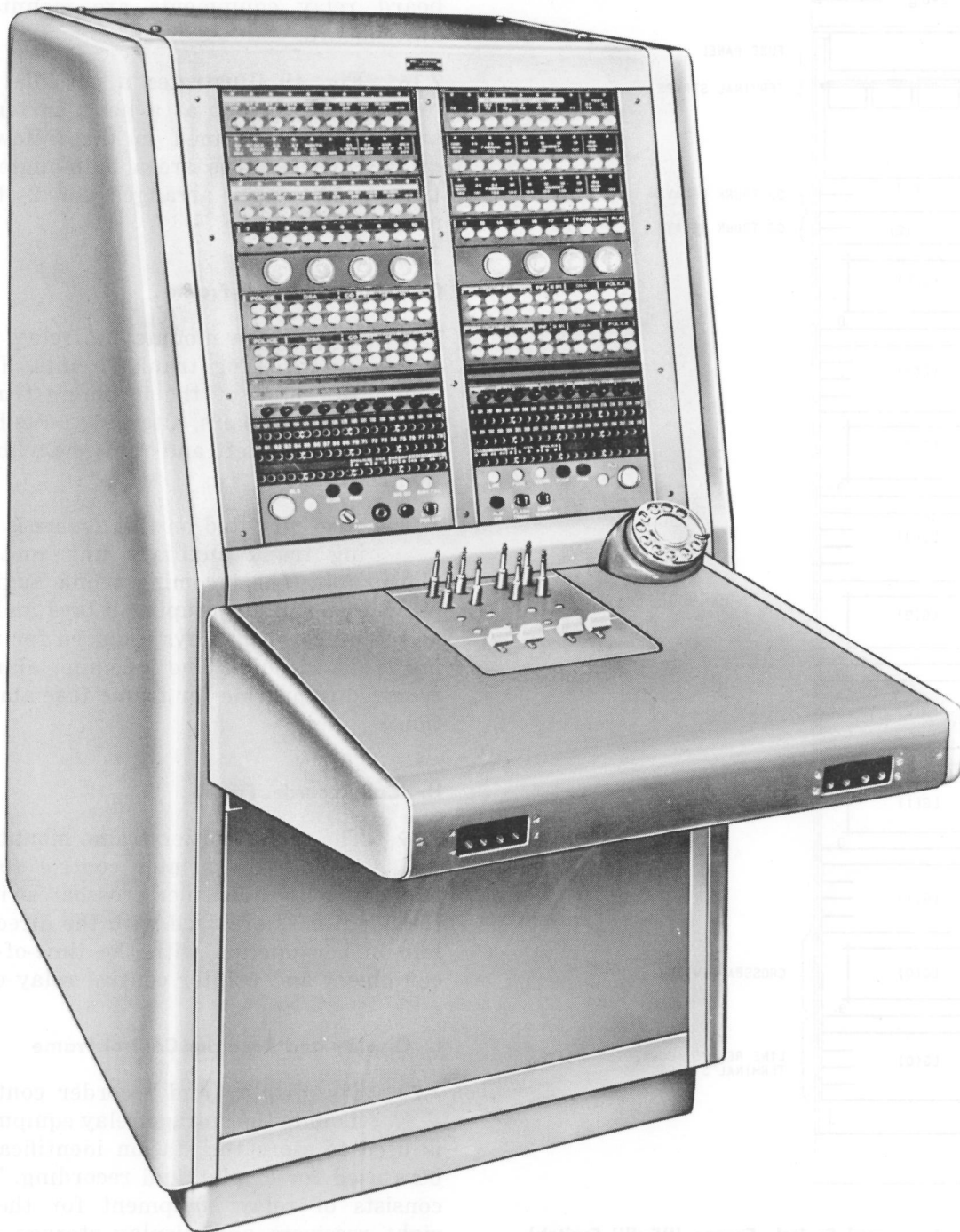


Fig. 15 - 100-Line Switchboard

**J. Station Line Central Office Trunk Frame**

**7.21** The building block principle of the emergency reporting system provides for concentrator and direct line emergency reporting telephone terminations at a headquarters. These frames are used in a direct line system and can be associated with a concentrator system when direct lines are required. The station line frame mounts fire or police station line relay equipments, the associated auxiliary line relay equipment, a fuse alarm unit, and a fuse panel. The line and central office trunk frame can mount a combination of fire or police station line circuits and central office trunk relay equipments.

**K. Central Office Trunk and Common Equipment Frame**

**7.22** This frame mounts equipment for central office trunk relay equipments, the central office trunk auxiliary unit, a flash and wink relay equipment, alarm relay equipment, a paging unit, and a fuse panel. Each headquarters must, however, be equipped with a flash and wink relay equipment and alarm and relay unit. Depending on traffic requirements, central office relay equipment units are provided as required. The paging unit may or may not be required in the headquarters depending upon the requirements for this feature.

**7.23** This frame is also used in conjunction with a direct line system and does not have to be reordered if a direct line system is converted to a combined concentrator and direct line system.

**L. Distributing Frame**

**7.24** A 7-foot high distributing frame can be provided at a headquarters location.

**M. Switchboard**

**7.25** The 40-line, 100-line, or 400-line PBX switchboards may be used with the concentrator system. The selection of the switchboard will be determined by the number of incoming trunks from concentrators and the number of direct line relay equipments required for a particular installation. The 2-panel, 100-line switchboard is illustrated in Fig. 15.

**7.26** The details of these boards are discussed in Section 981-225-100.

**N. Printer Unit**

**7.27** A printer unit, a Victor Digit-matic Machine should be provided for this system. This machine is arranged with an automatic take-up reel which permits the keeping of a duplicate record of calls placed over the system in addition to the normal ticket which can be detached from the machine. The machine can be provided at the switchboard location.

**O. Power****Central Office**

**7.28** The central office equipment requires connection to a negative 48-volt power plant, a positive 130-volt power plant, and 115-volt ac power service. Suitable taps from an office-ringing supply generator and control circuit are also required.

**Headquarters**

**7.29** A suitable negative 48-volt power plant and a positive 130-volt power plant of adequate capacity with stand-by batteries are required.

**7.30** Ringing current and audible ringing tone for these systems can be supplied by a ringing power plant. A stand-by hand generator is provided at the switchboard for use in cases where the regular ringing supply fails.

**7.31** Failure of either the ringing power plant or the 48- or 130-volt power plant will provide audible and visual alarm indications at the switchboard location.

**8. ALARMS****GENERAL**

**8.01** Equipment relay circuits are suitably protected by alarms in the central office concentrator location and the headquarters location. This part briefly discusses the alarm protection provided for this system.

**8.02** Two types of alarms are normally provided in the central office and at the headquarters location, a major and a minor alarm. The major alarm is used to provide instant maintenance assistance to correct equipment failures; the minor alarm is used where prompt correction of abnormalities is not required, but some priority in clearing equipment failures is demanded.

**CENTRAL OFFICE**

**8.03** In a central office, the major and minor alarm protection provided for this system is grouped as shown in Table A. Column one of the table designates the type of alarm condition and column two the location of the indicator.

**TABLE A**

MAJOR ALARM	LOCATION
Power (48 Volts, 130 Volts)	Fuse Panel Lamp
Line Test	Test Frame Lamp Panel
Controller, Second Trial	Test Frame Lamp Panel
Controller, Master Time-Out	Test Frame Lamp Panel
Controller, All Trunks Busy	Test Frame Lamp Panel
Call-Through Test	Test Frame Lamp Panel
MINOR ALARM	LOCATION
Trunk Open	Test Frame Lamp Panel
Trunk Test	Test Frame Lamp Panel
Controller, First Trial	Test Frame Lamp Panel
Sender Test	Test Frame Lamp Panel

**8.04** Central offices that do not have 24-hour coverage can be provided with an alarm extension circuit which will extend the concentrator system alarms to an attended central office.

**HEADQUARTERS**

**8.05** The miscellaneous alarm relay equipment provided at the headquarters location is also arranged to indicate minor and major

alarms. Suitable lamps and audible signals are provided at the switchboard face equipment to indicate to the operator all abnormalities.

**ALARM EXTENSION**

**8.06** An alarm extension circuit is available which can extend the PBX equipment alarms to an attended central office to provide for major and minor alarm indications.

**9. EQUIPMENT AND MAINTENANCE REPORTS**

**9.01** *The nature of this service requires the telephone company to correct abnormal conditions immediately.*

**9.02** All central office records on this system should be designated with suitable and appropriate notations.

**9.03** The use of a tie trunk between the switchboard and the local telephone company test center is suggested to provide a communication channel for maintenance and trouble report dispatching.

**9.04** Cable terminals, distributing frame terminations, and equipment fusing should be provided with suitable central office marking or protector guards.

**10. GLOSSARY**

***Call Box Identification Number***

The actual 4-digit number assigned to a station line by the municipality.

***Call Recorder or Printer***

A device which is used to graphically record numerical information on a paper ticket.

***Continuous Line Test***

Feature used to monitor outgoing trunks and to indicate automatically trunks disabled due to trouble.

***Controller***

A control circuit which performs and controls switching of station lines to outgoing trunks.



***Cut Through***

Term used to describe condition of the transmission path.

***"Fail-Safe"***

Term used to describe a signaling and code feature which prevents false digit registration during the transfer of digits from the sender.

***Fire and Police Reporting System***

A concentrator arranged with trunks to both a fire and police headquarters.

***Fire Reporting System***

A concentrator arranged with trunks to a fire headquarters only.

***Fire Stand-By***

The normal condition of a line equipment which is ready to accept service requests by recognizing an off-hook signal from the emergency reporting telephone.

***"Full" Switch***

The use of one 10 by 10 crossbar switch to provide access for ten line equipments (ten stations).

***Graphical Identification***

The graphical recording of the station line equipment number at a headquarters location when calls are placed over emergency reporting lines.

***High to Low Selection***

Term used to describe the operation of the controller preference chains. Preference for idle line or outgoing trunk selection is from the highest-numbered line or outgoing trunk to the lowest-numbered line.

***Line Group***

Each ten line equipments assigned to consecutive levels (0 to 9) of a crossbar switch.

***Low to High Selection***

Term used to describe the operation of the controller preference chain. Preference for idle line or outgoing trunk selection is from the lowest-numbered line or outgoing trunk to the highest-numbered line.

***Number Display Panel***

A switchboard panel which mounts four numerical cold cathode tubes and visually displays a 4-digit station line number when a reporting telephone is cut through from concentrator equipment to switchboard.

***Selective Routing***

A circuit feature which provides for switching of emergency reporting telephone calls over reporting lines to either of two reporting centers. Switching is controlled by operation of a non-locking key at the reporting telephone set.

***"Split" Switch***

The name of a crossbar switch when it is divided in half to provide access for 20 line equipments (20 stations).

***Test Frame***

A frame which mounts the equipment necessary to provide tests of the emergency reporting system.

***Trunk Group***

All trunks appearing on one or more crossbar switches which are used to connect a line relay equipment to one fire and/or one police headquarters location.

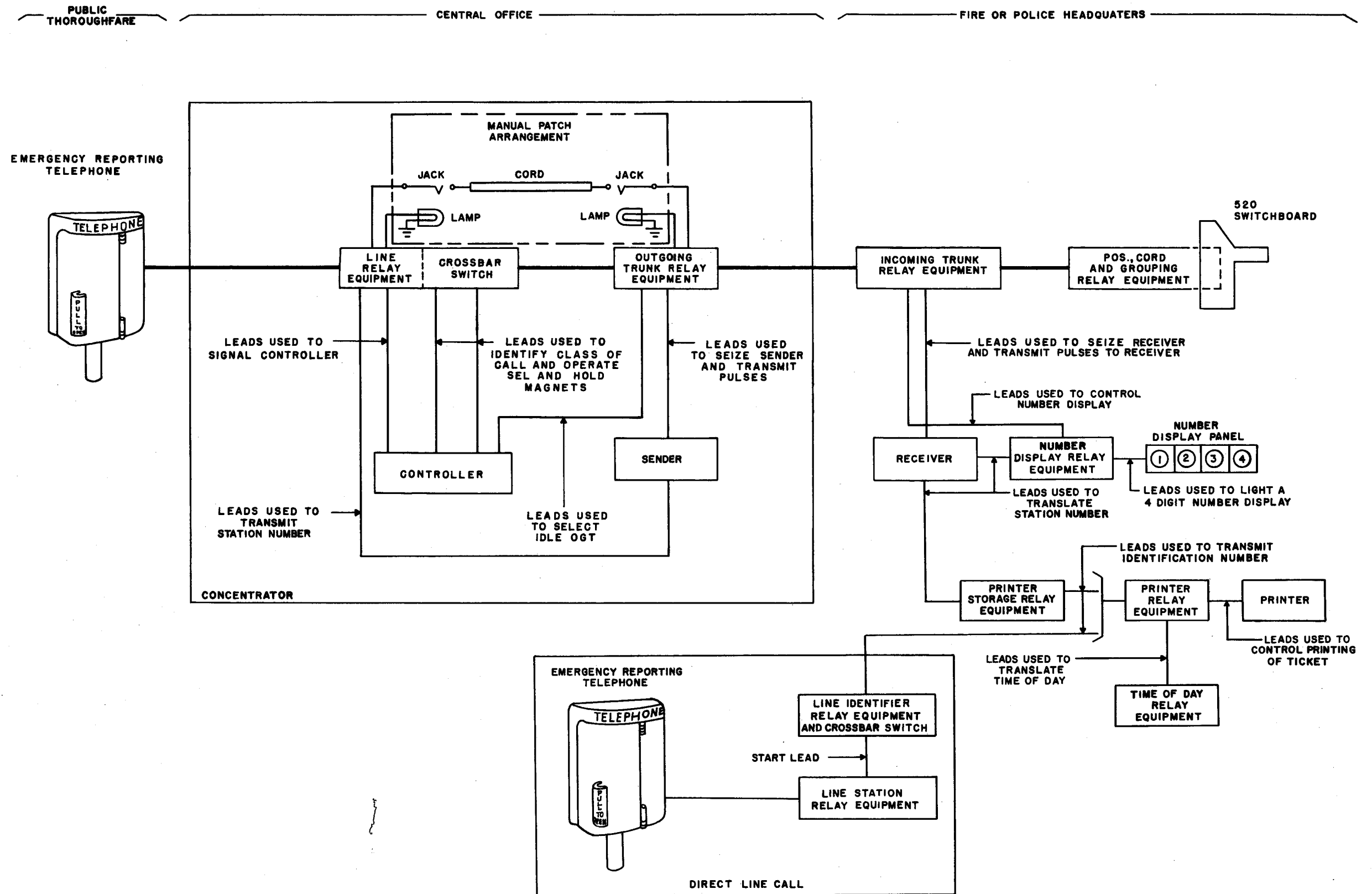


Fig. 16 - Relationship of Major Equipment Elements for Emergency Reporting - Group 1

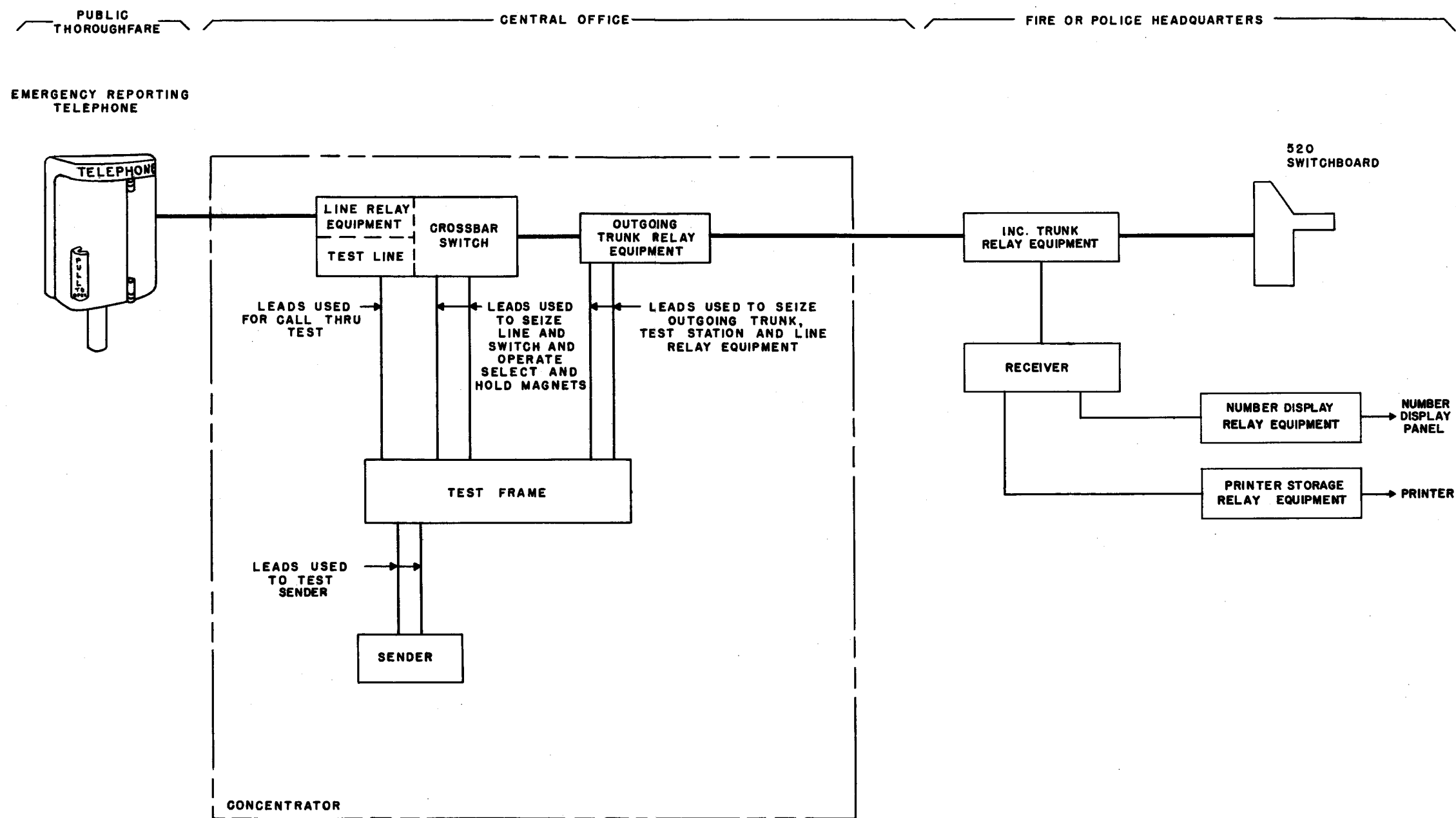


Fig. 17 - Relationship of Major Equipment Elements for Central Office Tests - Group 2

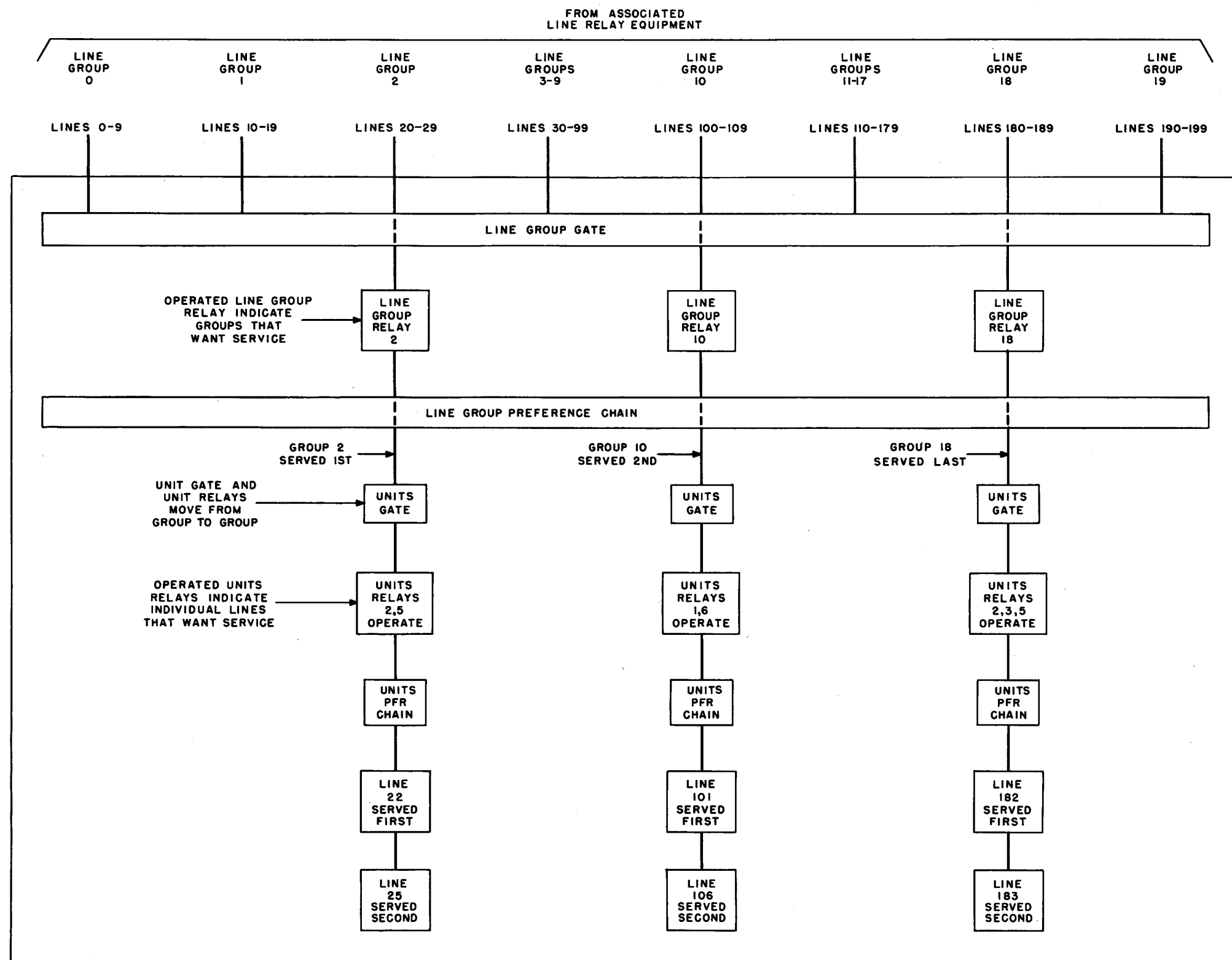


Fig. 18 - Block Diagram Showing Line Identification and Selection

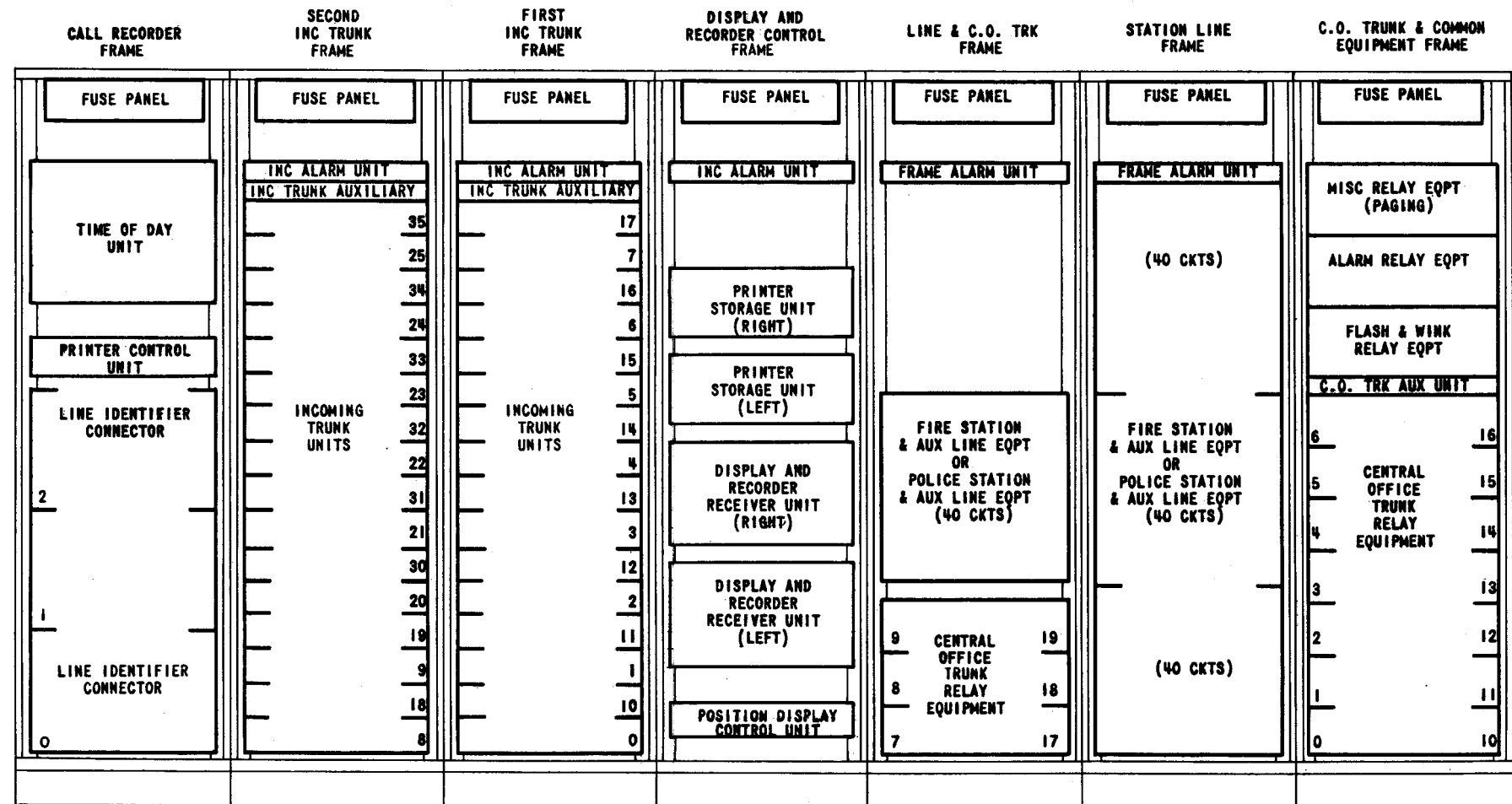


Fig. 19 - Fire or Police Headquarters Equipment Frame Layout