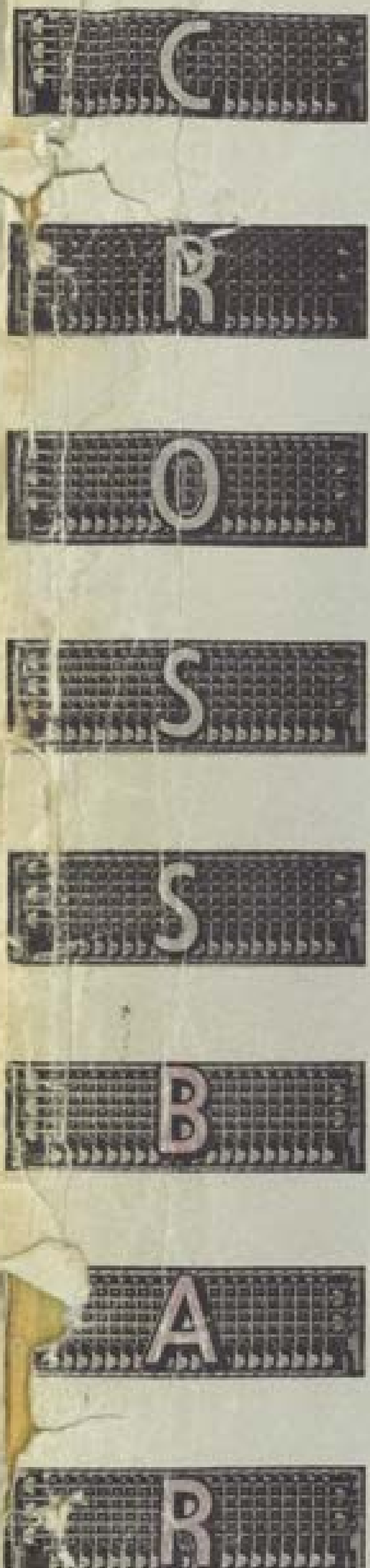

NO. 5
CROSSBAR SWITCHING SYSTEM

VOLUME 1
Equipment Applications

TELEPHONE SYSTEMS TRAINING

Lesson No. 5B

Western Electric Company
INCORPORATED

Central Region
Engineering

Technical Training
Section

Western Electric Co., Inc.
Central Region Engineering
Technical Training Section

Telephone Systems Training
For Information Purposes Only

NO. 5 CROSSBAR SWITCHING SYSTEM

LESSON 5B
VOLUME I

EQUIPMENT APPLICATIONS

This lesson is issued to describe in general the application and functions of the equipment in the No. 5 Crossbar Switching System. Information contained herein is to be used for training purposes only.

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BIBLIOGRAPHY

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INTRODUCTION

One of the important post-World War II switching projects of the Bell Telephone Laboratories was the development of the No. 5 crossbar switching system. This system was primarily designed to provide a small central office which could be installed in any area, providing direct trunking to all switching systems, without major changes in the existing local central offices.

At that time, a central office incorporating this flexibility was urgently needed because direct trunking facilities were not available between customer controlled step-by-step central offices and panel, or No. 1 crossbar offices with common control features. Signaling and pulsing methods were incompatible. Inter-office traffic was routed through manual or tandem offices.

In addition to local traffic, the system was designed to serve tandem and toll traffic. Calls from a step-by-step office to a panel office could be routed through the No. 5 office on a tandem basis. Calls to distant terminations could be routed directly into tandem or toll trains.

The adaptability of the No. 5 machine leads to its initial installation in areas on the outskirts of large cities, where a small office was required to complete calls to metropolitan offices as well as to a variety of outlying suburban offices. However, subsequent improvements in equipment and advances in switching techniques, have lead to the replacement of the large No. 1 crossbar office by the No. 5 machine. In the other direction, the Centrex feature was developed enabling the No. 5 machine to switch PBX extensions.

The following are some of the highlights of this system:

(A) COMMON CONTROL: The control of switching the traffic in an office is concentrated in certain equipment units which are common to all frames. An advantage of common control operation is that only a few circuits need be provided to set up the connection, and these can be equipped with selfchecking and service safeguarding features. The cost of these features would be prohibitive if many circuits were involved.

(B) BI-DIRECTIONAL CHANNELS: The basic No. 5 crossbar switching pattern differs from all other electromechanical systems in that the common control equipment will use the same elements to establish either an originating or terminating talking channel.

(C) METHODS OF CHARGING: Automatic Message Accounting (AMA) is especially well suited for operation with the No. 5 crossbar system. This method makes a permanent record of charge data on paper tape and requires very little manual operation. The No. 5 system is arranged for local AMA and centralized automatic message accounting (CAMA) with operator or automatic identification of the calling customer. Message register and coin service can also be provided by the No. 5 system. Coin zone dialing is a more recent feature added to the No. 5 crossbar system.

(D) MAINTENANCE: This system is more selfchecking than other systems. The marker (a unit of common equipment) has access to most of the elements in an office, and it is able to gather information from many sources on the performance of the different circuits. It can, therefore, automatically refer to the maintenance force information about trouble conditions. When a trouble occurs, a trouble recorder makes a permanent record on punched cards. These cards are used by the maintenance force in locating the trouble. Most of the testing equipment is mounted on several bays, called the master test frame.

No. 5 crossbar can handle the dialing of directory numbers consisting of four to eight digits and codes of 1 to 3 digits. It also can handle up to eleven digits for any extension of subscriber and operator dialing outside the home numbering plan area.

One hundred classes of service are available, including coin and non-coin, flat rate and message rate, individual, party lines and centrex groups.

Centrex is a more recent feature of the No. 5 crossbar system. A No. 5 crossbar central office incorporating this feature can provide up to one hundred groups of stations with P.B.X. service that previously would have been connected to an attendant switchboard or local P.B.X. dial equipment.

Tandem and toll center switching features can be provided in a No. 5 crossbar office. Such an office acts as a toll and tandem office center as well as a local office.

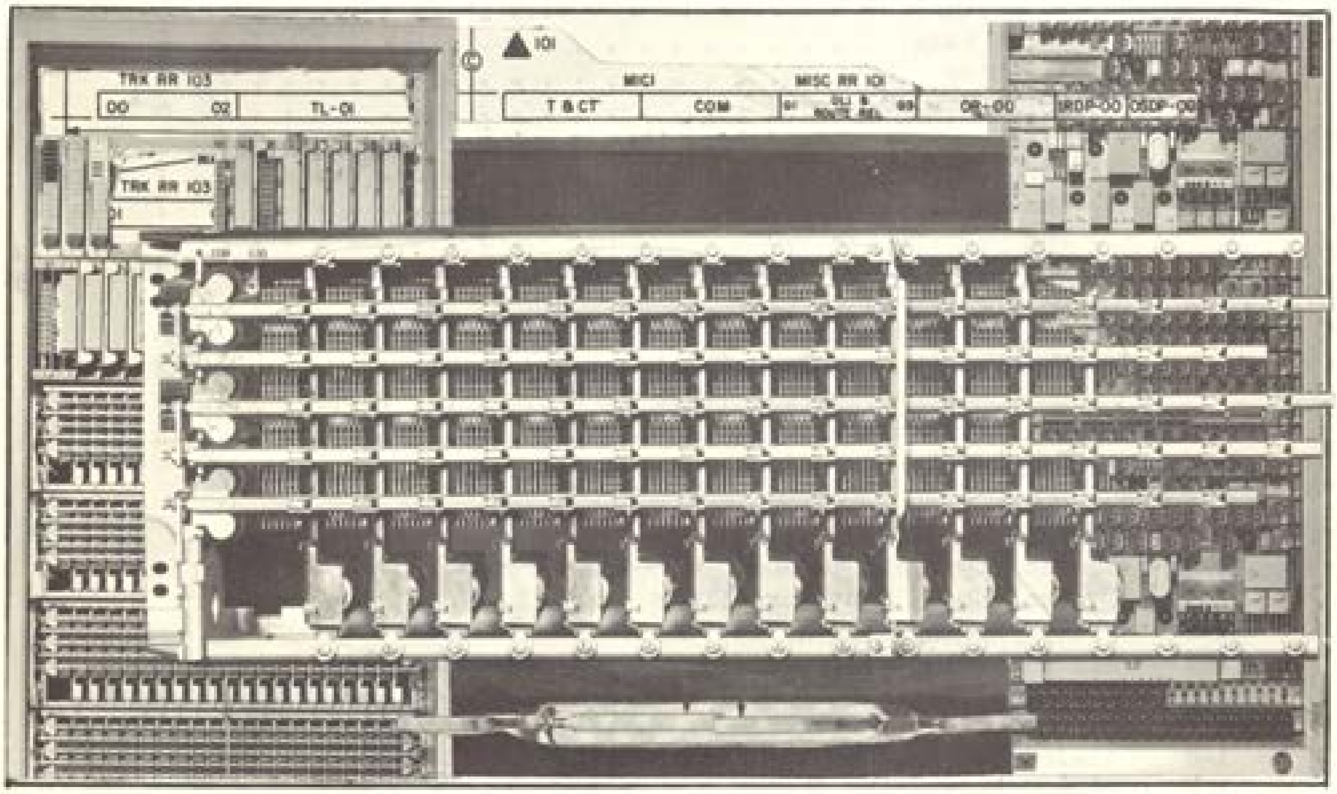
This system can operate with present dial systems with their particular types of pulsing: dial, revertive, or multi-frequency. However, because multifrequency pulsing is faster, it is used by the No. 5 office whenever practical. Table A shows the usual kinds of pulsing or manner of operation for the various combinations of No. 5 crossbar and connecting offices. When more than one type of pulsing is available the preferred type is shown first.

Table A

Type of Pulsing Received From No. 5 Crossbar Office	Type of Office	Type of Pulsing Sent to No. 5 Crossbar Office
Multifrequency (MF) Dial (DP) Revertive (RP)	No. 5 Crossbar	Multifrequency (MF) Dial (DP) Revertive (RP)
Multifrequency (MF) Revertive (RP) Dial (DP)	No. 1 Crossbar	Revertive (RP) Multifrequency (MF)
Revertive (RP)	Panel	Revertive (RP)
Dial (DP)	Step-by-Step	Dial (DP)
Panel Call Indicator (PCI) Straightforward (Nonpulsing) Step-by-Step Call Indicator (DP)	Manual	Multifrequency (MF) Dial (DP) Straightforward (Via DSB Switchboard)
Panel Call Indicator (PCI)	Panel Sender Tandem	Revertive (RP) Dial (DP)
Multifrequency (MF) Dial (DP)	Crossbar Tandem	Multifrequency (MF) Dial (DP) Revertive (RP)
Multifrequency (MF) Dial (DP)	No. 4-type Toll (Crossbar)	Multifrequency (MF) Dial (DP) Revertive (RP)
No Provision	Panel Distant Office Tandem (2-way Office)	Revertive (RP)

SECTION I

EQUIPMENT ARRANGEMENTS AND ELEMENTS



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SECTION I - EQUIPMENT ARRANGEMENTS AND ELEMENTS

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Figures

A. EQUIPMENT ARRANGEMENTS

General

Standardization and flexibility are two inherent features in the No. 5 crossbar equipment arrangements. Although no two offices are exactly alike, these features provide the means whereby each job can be engineered, manufactured, and installed with just the equipment it needs.

J-Units

Standard functional units have been designed to package circuits and their options. Each unit is J-coded for engineering and administration efficiency. These J-units are bench assembled, wired, and tested in straight line assembly methods. Interconnecting wires, precut to length and pre-skinned, are run along the surface of the mounting plates which support the components, and are connected as run. The wire used is covered with plastic insulation, which reduces wiring congestion, fire hazard, and contact troubles from lint. A typical J-unit is shown in Figure 1-1.

Frames

Frame equipment arrangements are similarly standardized to accommodate any grouping of J-units. In addition to these J-units each frame is equipped with its own common equipment consisting of 48 volt fuse panels, talking battery filters, appliance outlets, terminal strips, and miscellaneous circuits. (see Figure 1-2).

This arrangement permits the frame and its common equipment to be manufactured apart from its functional units. At a later stage in the assembly, units and frames are brought together, interconnected and assembled in a flexible manner.

As a result, the No. 5 frames are fully equipped, wired and tested in the shop. Field installation is reduced to setting up the frames on the office floor, interconnecting them with switchboard cable, and testing the components and the system as a whole before turning it over to the Telephone Company. A section of a typical No. 5 office is shown in Figure 1-3.

Another feature of No. 5 crossbar is frame construction. Heretofore, most switch frames have used angle, channel, or I-beam steel sections. In the No. 5 system, the uprights are of sheet metal formed into a rectangular box section, which is much lighter and stronger than former types; formed sheet metal sections are also used for the other structural members.

Front and rear covers are incorporated in the frame in a way that enables frame areas to be covered to any extent desired. This not only avoids a variety of strip covers and sender type casings, but it frees from cover restrictions the arrangements of apparatus on units and of units on frames.

These covers as shown in Figures 1-3, 1-4 and 1-5 protect frame equipment from dust, fire or mechanical injury. Frames with wire-spring relays omit these covers since the relays are individually covered and fire resistant wire is used for their unit and frame wiring. On frames with flat spring type relays covers are required, except that crossbar switches are generally uncovered and multicontact relays are protected by individual covers.

Fuse panels are mounted on all frames requiring 48V talking battery. Figures 1-2 and 1-6 show the base of the frame with its fuse panel, fuse alarm lamps, 115-volt appliance outlets, frame talking battery filter, and the power connections for 48-volt and 115-volt power. Each has a 20- or 30- ampere common supply fuse mounted on it so that no other frame will be put out of service if a particular fuse panel is temporarily overloaded. The rear cover of the frame base is removed to expose the capacitors and fuses of the talking battery filter. One or two lamps, as required, in the sloping front section of the base indicate blown fuses on the frame.

The test jacks and miscellaneous testing apparatus, as required, for each frame are shop-installed in jack boxes, incorporated in the frame upright to the right of each bay (Figure 1-2). A spare fuse and plug holder also fit this jackbox and one can be specified for any unused jackbox. As an alternative, a 12A fuse holder can be mounted on the end guard of any frame line-up.

A simple end guard (Figure 1-7) is furnished to protect and dress up the end of each line of frames. It accommodates the aisle pilot unit, the power fuses which feed the line of frames, and the light switches where frame-supported lighting is provided.

Power wiring on the frame is shop-installed. The 48-volt frame feeders from fuse panel, and filter when required, extend through a frame upright and terminate at solderless connectors which connect to power feeders in the wiring aisle. The 115-volt appliance outlets connect to patching cords for ready interconnection between frames. The 115-volt power is also required for circuit operation on several frames and units. Each such frame (or unit) is equipped to accept a patching cable with 115-volt supply.

Power Wiring, 48 Volts and 115 Volts

The 48-volt power supply is distributed from the power plant to 100-ampere fuses on the end guard of each line of frames. Two battery feeders (from two of the 100-ampere fuses) and one ground feeder, all of one standard size, are run along either side of the cable rack over the aisle. The Installer taps the frame cables to the aisle cables, alternating the frame battery feeders over the two battery feeders for the line of frames. This guards against leaving all frames of a type on the same 100-ampere line-up fuse.

Power Ringing and Tone Distribution

Distribution of power (other than 48-volt and 115-volt ac) and of ringing and tones is with few exceptions from the power, ringing and tone distributing frame (PRTD), one or more of which is located on each floor of an office.

The supply leads from the power room for +130 volts, -130 volts, ringing, and tones are terminated on the PRTD frame nearest the power room and multipled to other PRTD frames on the same floor. For 130 volts, ringing, and low tone, two (or more) supplies are provided from the power room for each potential and the switch frames are fed through fuses at the PRTD in a way which distributes the frames of each type evenly over the supplies so that the blowing of one fuse will not disable all frames.

Supplies from the power room such as high tone, pickup, howler, and ringing ground, do not require fuses at the PRTD frame and are distributed directly from terminal strips. Ballast lamps for ringing and pickup leads are also located on the PRTD frame.

The 22-volt ac is supplied to switch frames from a power unit and fuses on a PRTD frame.

The PRTD will also mount 48V talk fuse panels for fusing required beyond the standard capacity of switching frames.

Cable Rack

Cable rack, cabling, and lighting have been simplified. Much of the effort in planning and arranging switchboard cable on the job has been avoided by adopting a basket type cable rack in which cable is laid without being confined by clips or sewing. Cable rack is confined to the wiring aisles, and serves two lines of frames. Two lines of frames, equipment sides facing each other, form a maintenance aisle. Thus, the rear or wiring side of the frames in the line up form the wiring aisles between two adjacent maintenance aisles.

Switchboard cable drops off the sides of the cable rack into either the front or the rear of the frames. Cables to the rear of frames are carried down the channels confined by the cable brackets, while cables to the front of frames drop through knock-outs in the top member of each frame or in front of the top member.

Lighting

Office lighting is by flourescent lamps supported over maintenance aisles. This is provided in one of two ways:

a) From the ceiling hanging above the auxiliary framework as shown in Figure 1-8. This will be provided by the Telephone Company.

b) From below auxiliary framing bars as shown in Figure 1-9. In this case the lamps and their power supplies are installed with the office equipment.

Rolling Ladders

Standard rolling ladders are accommodated by a standard ladder track supported from auxiliary framing bars over the tops of frames as shown in Figure 1-8. Auxiliary framing is supported 3 1/2 inches above the frames so that additional frames may be installed in existing line-ups without disturbing the original installation of ladder track.

B. EQUIPMENT ELEMENTS

General

Like its forerunner, No. 1 crossbar, the No. 5 machine is an all relay and relay-like switching system. Cricuits in No. 5 originally used flat spring relays. These "U" and "Y" type relays were designed for, and functional with No. 1 crossbar. However, with the later development of the wire spring general purpose relay, the wire spring multi-contact relay, and the dry-reed relay, the system was redesigned, creating the wire spring version of No. 5 crossbar.

The essential features of the wire spring version are the same as the flat spring. In fact, many wire spring No. 5 crossbar circuits are functionally interchangeable with their flat spring counterparts. However, because wire spring components require less physical space than the flat spring, a cost reduction program developed certain equipment arrangements. These new arrangements are not mechanically interchangeable with the earlier product and special coordination may be required between the old and new designs on additions to flat spring offices.

Since the operation of the No. 5 machine is primarily electromechanical, we have limited our reference in this section to the principal types of relays used in its circuitry.

The Crossbar Switch

The basic element in any crossbar system is the crossbar switch, from which the system takes its name. Talking connections through switching frames are made by crossbar switches.

The crossbar switch is essentially a relay mechanism consisting of ten horizontal paths and ten or twenty vertical paths, depending on what size switch is needed. Any horizontal path can be connected to any vertical path by means of magnets. The points of connection are known as crosspoints. The switch with ten vertical paths has 100 crosspoints and is called a 100-point switch; the one with twenty vertical paths has 200 crosspoints and is called a 200-point switch. Figure 1-10 shows a partial perspective view of a crossbar switch.

There are five selecting bars mounted horizontally across the face of each switch. Each selecting bar has flexible selecting fingers attached to it, one finger for each vertical path, and the bars can be rotated slightly to cause the select fingers to go either up or down under control of select magnets. This forms two horizontal paths per bar, making a total of ten horizontal paths.

Ten or twenty vertical units are mounted on the switch and each unit forms one vertical path. Each unit operates under control of a hold magnet and has ten groups of contacts (one for each horizontal path) associated with it.

Each group of contacts may consist of three to six pairs of contact springs. A switch is classified according to the number of cross-points and pairs of springs; for example, a 200-point, 3-wire crossbar switch.

Operation of the Crossbar Switch:

The normal position of the selecting fingers is horizontal, lying between two groups of contacts. When a select magnet operates, the selecting bar is rotated and one of the horizontal paths available to this bar is chosen. The selecting fingers now lie in front of a group of contacts.

The hold magnet of the vertical path to be connected to this horizontal path then operates its holding bar which, using the selecting finger as a wedge, causes the group of contacts beside the selecting finger to operate, thus connecting the horizontal and vertical paths. Both the select and hold magnets must be operated in order to close a crosspoint. The other groups of contacts on this vertical unit do not operate since there is no selecting finger between them and the holding bar.

After the operation of the hold magnet, the select magnet releases, returning the horizontal bar and all but one of the selecting fingers back to normal. The finger used to establish the connection, being flexible, remains wedged against the contacts by the holding bar. In this way it keeps the contacts operated. When the hold magnet releases, the connection is broken and the selecting finger returns to normal.

General Purpose Relays (Flat Spring)

The U type relay (Figure 1-11) is an improved general purpose flat spring relay, designed with a heavy and more efficient magnetic structure than previous types. It will accommodate up to 24 contact springs (12 upper and 12 lower) each series of 12 being capable of arrangement in any combination of "make" contacts, break contacts, make before break, and etc.

The springs are equipped with twin contacts, and the relay has characteristics which make it free from contact chatter. The front ends of the core and armature, and the adjusting nut are chromium plated to reduce any tendency of the armature to "stick" either against the core or the adjusting nut. The coil is form-wound for a snug fit around the core. Each winding layer is separated by a sheet of cellulose acetate and each sheet is hermetically sealed to the spool head at both ends.

The Y type relay (Figure 1-12) is a slow acting U type. Delay of the action is secured by inserting a copper or aluminum sleeve between the core and the winding coil. The armature of the Y relay differs slightly from that of the U in having a small area, raised by embossing, for contact with the core instead of two non-freezing discs. This area provides more definitely controlled air gaps between the armature and core with the relay operated, tending to provide more uniform release-time characteristics.

The UA Relay (Figure 1-13) differs from the U type in having a much larger pole-face area due to swaging of the core. The enlarged pole-face area and the use of a one-piece armature with a hinge bracket of thicker material permit the relay to operate on lower current than is required by the U type. Other differences include the UA type being made up with two diameters of core and two thicknesses of armature. The small diameter core is usually used with the thinner armature (Figure 1-13). The thicker armature is used with either diameter core for operating a large number of contact springs (Figure 1-14). The improved operating characteristics of the UA type relay as compared with the U type relay permit magnetic-iron UA type relays to be used in place of many permalloy U type relays, and in place of B type relays where sufficient current for operation is available. UA type relays are used as supervisory relays that supply talking battery in trunk circuits. Individual covers for cross-talk shielding are not required on these relays.

The UB type relay (Figure 1-15) is a U type relay with a "card" arranged to replace the studs which transmit the armature pressure for moving the springs. The card consists of a piece of insulating material with slots that engage the tips of the moving springs.

The card is intended to reduce changes in adjustment due to stud wear because the adjustment of each spring on the UB will only change by an amount determined by its own slot wearing whereas in the U type with one stud operating the following one, the wearing of all studs adds up to affect the last spring of a pileup. The card is also intended to reduce the tendency of contacts to "lock" since the card may assist the springs in returning to normal. The UB is a general purpose relay and will mount interchangeably with U types of comparable design.

General Purpose Relays (Wire-Spring)

AF, AG, AJ and *AK type relays were developed to supersede the U, UA, UB and Y type relays. They are known as wire spring relays, because spring wire instead of the conventional flat stock is used for the contact springs.

The important features that have been incorporated in these relays include the use of pretensioned springs, a fixed armature travel, a single fibre card for actuating the moving twin contact springs, a transparent contact cover, and terminals arranged for wire wrapping connections. From an operational standpoint, the relays are capable of faster operate and release times, have reduced contact chatter and armature rebound, and negligible magnetic interference.

The wire spring relay consists essentially of an E shaped core with a filled coil, a U shaped armature, three or four molded contact spring blocks and a contact spring actuating card, held together in rigid alignment by a spring clamp. The magnetic structure, that is the armature and core, are made of silicon steel. Two sizes of armatures are provided, a short armature with 1/2" long legs for AF type relays, and a long thicker armature with 1-1/4" long legs for AG and AJ type relays. The armature is supported by a hinge spring assembly and is held in position against the backstop by the tension of a U shaped balancing spring. A non-magnetic core plate, tightly fitted over the ends of the E shaped core, holds the three legs of the core in alignment. The core is zinc plated and the armature and backstop chromium plated to eliminate sticking on the backstop. Figure 1-16 shows a wire spring relay with the contact cover in place.

Three basic types of molded wire spring blocks or combs are employed, two for the moving nickel silver twin wires for make and break contacts, and one with 12 heavy silicon copper wires for the fixed contacts. No. 2 contact metal is used on the contacting surfaces. The spring wires are actuated by a single phenol fibre card, held against the armature by the tension of the balancing spring. The twin wires that form the make contacts are tensioned against the outer edge of the card, and the twin wires that form the break contacts are tensioned in the opposite direction against the inner edge of the card. As the armature moves toward the core, the card allows the twin wire make contact springs to move forward and make contact with the fixed contacts. As the armature movement continues, the card picks up the twin wire break contact springs to open the break contacts.

Wire spring relays are equipped with either 12 or 24 contact positions, arranged in two vertical rows of movable twin contact springs and one or two rows of fixed contact springs. The twin wire contact springs are held in position by guide slots in the fixed contact spring block. Figure 1-17 shows a 12 position AF relay with the cover removed. A 24 position AJ type relay without cover is shown in Figure 1-18.

 *AK Relays, see page [illegible] of this section.

The twin wire contact springs mounted to the left of the associated fixed contact springs provide the make contacts, and those to the right the break contacts. In addition to ordinary make and break contact arrangements, the make and break contacts can be operated in three stages of the armature travel, designated preliminary, early and late, to meet contact sequence requirements. This is obtained by providing recesses for early makes, and shoulders for early breaks, on the edges of the card which engages with the twin wires. Twin wire contact springs are omitted in any contact position where no contact make or break is required. Although the fixed contact springs are always provided, the entire contact portion is omitted when not required.

In order to meet release requirements, some wire spring relays are provided with a U shaped buffer spring. The pretensioned legs of this spring have notches that engage with the front spoolhead to hold the spring in position on the relay. Wire spring relays operating at high speed, such as pulsing relays, are equipped with dampers to reduce vibration of the movable wires. The dampers consist of a strip of soft material placed between each movable wire spring assembly and the rear molded section of the fixed contact spring assembly. To facilitate the application of electrical requirements, the winding terminals of wire spring relays extend through the front spoolhead.

Each wire spring relay is provided with a molded plastic cover that is held in position by means of a cover spring attached to the front molded section of the fixed contact spring assembly. The cover encloses only the contacts, protects them from dirt and traps the twin wires in the guide slots to avoid displacement and crossing during shipment and pressure cleaning operations.

There are four types of wire spring relays, designated AF, AG, AJ and AK. The AF type relay shown in Figure 1-17 is a general purpose relay, equipped with a short armature and stop discs. The operate and release times of this relay are approximately one half the time required by a comparable U type relay. The AG type relay is a slow releasing relay to replace the Y type. Like the Y type relay, it is generally equipped with a copper or aluminum sleeve over the center leg of the core, uses a thick armature with long legs, and is provided with a dome shaped embossing on the armature in place of stop discs. The AJ type relay is used for operating the heavier spring loads and also for light loads where greater sensitivity is required. It has a thicker armature with long legs and uses stop discs.

Some AJ type relays are provided with laminations, consisting of a strip of iron on each side of the core to obtain increased impedances at talking current frequencies. A copper sleeve over the core and two copper washers and one iron washer over the front end of the core are used on the AJ 25 relay. This relay is for use as a trip relay in incoming trunk circuits. The iron washer, placed between the copper washers increases the leakage flux between the core and the armature, which makes the relay more insensitive to the ac ringing current. The armatures and most of the additional parts used in the construction of AG and AJ type relays are shown in Figure 1-19.

Where more than 12 make contacts are required, AJ type relays with 24 make-contact positions are provided. The 24 make-contact relay uses four molded wire blocks, two with twin-wire moving springs and two with fixed contact springs, as shown in Figure 1-18. To prevent crosstalk between adjacent relays used in transmission circuits and mounted at close centers, AJ type relays are fitted with a magnetic crosstalk shield. Figure 1-20 shows an AJ type relay equipped with a crosstalk shield.

The requirements and adjusting procedures for wire spring relays have been reduced to a minimum. Contact spring tension and armature travel requirements have been eliminated, since the relays are equipped with pretensioned springs and use a fixed armature travel. Adjustments are few and include changes in balancing spring tension to meet armature back tension requirements, adjustment of separation between movable and fixed contacts to meet contact make and break requirements, and adjustment of the buffer spring on relays so equipped.

Multi-Contact Relays (Flat Spring)

The use of common control circuits, in crossbar system switching, leads to the necessity of connecting a host of control leads between the control **frames** and the switching frames during the instant of setting up a connection. The simultaneous connecting of this multitude of leads is done principally by the multi-contact relay (Figure 1-21) which resembles in appearance the vertical unit of a crossbar switch. This relay is actually made up of an assembly of two relays on a common mounting, since each half of the relay has its own separate magnet, armature, and spring assemblies. Each assembly may therefore be used as an independent relay, or when desired they may be used as one relay by connecting the two magnet coils in multiple.

The spring nests consist of normally open or "make" contacts with all springs brought out individually at the front and rear and with no internal multipling of contacts. Energizing a magnet operates all springs under control of that magnet and the contacts are closed. All springs have split ends and twin contacts.

The multi-contact relay is available in 4 spring capacities, of 30, 40, 50, and 60 pair of "make" contacts, and when each half of the relay is used separately, spring capacities of 15, 20, 25, and 30, respectively, may be obtained. The relay is mounted with the armature vertical and occupies a mounting space of approximately 2 inches by 11 inches. A tight fitting can-type cover slips over the spring pile-ups, covering the contacts and leaving the magnets and armatures exposed.

The multi-contact relay is made in two designs; one, the 263 type, is equipped with soldering lugs for common bare-wire strapping between corresponding springs of two or more relays, and the other, the 264 type, arranged for individual wiring only. On the first type, a fiber detail mounted on the soldering lugs guards against accidental shorting of adjacent terminals and also maintains a fixed spacing between the terminals. A specially designed terminal strip, the 218 type, is provided for terminating the multiple strapping and for making the cable connections to that multiple.

Multi-Contact Relays (Wire Spring)

The 286, 287 and 288 type relays are multicontact relays of the wire spring type and supersede the 263 and 264 types. They employ many of the features of the general purpose wire spring relays (AF, AG and AJ types) such as pretensioned wire springs, molded wire spring blocks, transparent plastic contact cover, an E shaped core, etc. Like the general purpose wire spring relays, they are capable of faster operate and release times and have reduced contact chatter and rebound.

A 286 type relay with contact cover is shown in Figure 1-22. The relay had 30 make contacts arranged in 2 rows of 15 contacts. Each row again is subdivided into five groups of three contacts. The relay has an E shaped core of silicon steel that is similar but much larger than that of the general purpose wire spring relay. A non-magnetic core plate, tightly fitted over the ends of the E shaped core, holds the three legs of the core in alignment. The magnetic iron armature is U shaped with two short legs that serve as pivot points. It is made thin to obtain a low mass moving element and has a triangular shaped cutout to decrease the pole face area for obtaining the most favorable operating time. The armature is held in place by a retaining or hinge spring which bears against the two legs of the armature to hold them against the core legs. This spring pressure also holds the armature against the actuating card which in turn is being held against the core legs by the balancing spring. Details at the ends of the spring fit into slots in the armature to hold the armature in the proper position.

Multicontact wire spring relays are provided with four molded wire spring blocks, two that contain the moving nickel silver twin wires and two with the heavy silicon copper wires for the fixed contacts. In the unoperated position of the relay, the twin contacts are held away from the single contacts by an actuating card which in turn is held against the two side legs of the core by two prongs of a three-pronged flat balancing spring. The third prong of the balancing spring holds the cover in place. When the relay is energized the armature moves the actuating card forward, allowing the twin-wire contacts to make with the stationary fixed contacts. The operation of the armature differs from the general purpose wire spring relay in that the armature operates from right to left instead of left to right and pushes, rather than pulls, the operating card.

The 286 type relays are intended for use in new circuits instead of the 263 type, but are not interchangeable with the 263 type. The terminals of the movable twin contact springs on 286 type relays are arranged for individual wiring, while the terminals of the fixed contact springs are arranged for horizontal strapping.

The 287 and 288 type relays consist of an assembly of two units, each similar to the 286 type relay. These units are assembled one above the other on a bracket and the relays mount interchangeably with all 263 and 264 type relays. The 287 type relay, shown in Figure 1-23, which replaces the 263 type, has movable twin contact spring terminals arranged for individual wiring and fixed contact spring terminals arranged for horizontal strapping. This arrangement of terminals is the reverse of that on 263 type relays. On 288 type relays, which replace the 264 type, the terminals of both fixed and movable contact springs are arranged for individual wiring, as in the case of the 264 type relay.

The 287 and 288 type relays are intended as replacements for the 263 and 264 type relays in existing equipment and must therefore match the speed of the 263 type. Since the 286 type is considerably faster operating and releasing than the 263 type, the two 286 type units used on 287 and 288 type relays incorporate the following changes in design to match the speed of the 263 type. To increase the operating time, the 286 type unit is provided with a magnetic shunt across the three legs of the core to increase the leakage flux, a thicker armature to increase the moving mass and a core of magnetic iron instead of silicon steel. Other changes to obtain the required operating and releasing times include an increased number of turns in the winding to retard the flux buildup and a larger armature travel. A core with the magnetic shunt in position is shown in Figure 1-24.

As in the case of AF, AG, and AJ type wire spring relays the requirements and adjusting procedures for 286, 287 and 288 type relays have been reduced to a minimum and relate to contact separation, contact make and electrical requirements.

Dry Reed Relays

These relays are known as dry-reed relays because the contacts consist of metal reeds sealed in gas-filled glass tubes. They are fast operating and releasing relays, since the only moving parts are contact reeds of low mass. The relays provide a high degree of contact reliability, as the contacts are enclosed in a glass tube and thus protected from dust and other atmospheric contaminations. In general, dry-reed relays are for use in circuits where they are not required to make or break current. The relays are non-adjustable and their principal use is in AMA assembler computer circuits and in No. 5 crossbar register and sender circuits.

The element common to all dry-reed relays is the dry-reed switch shown in Figure 1-25. This switch consists of a gas-filled glass tube into each end of which is sealed a magnetic reed whose terminal extends through the end of the tube. The inner ends of the reeds overlap by approximately 1/16 inch and normally are separated by a gap of about 0.010 inch. The gas in the tube is under low pressure which eliminates breakage hazards present where high-pressure gas is used. One or more dry reed switches are placed in the core space of a coil to form a single unit of a dry reed relay. When current is applied to the coil a magnetic field is set up which causes the tips of the reeds to come together and make contact.

A 289 relay is shown in Figure 1-26. This relay is equipped with five switch units, each unit consisting of a coil with one dry-reed switch. Each coil is provided with a series resistor to limit the current through the coil. The five units of this relay are enclosed in a wrapping of insulating material for protection and are held in position by a spring clip formed from each side of a base shield. The seven leads of the relay are connected to a terminal block, which is attached to the base shield.

The five series resistors are located between two relay units in a channel shaped portion of the base shield. They are held in position by two small terminal blocks attached to the base shield. A cover shield placed over the relay units and held in position by locking tabs that engage with holes in the base shield, completes the magnetic return path.

The terminals are arranged for solderless wrapped connections and are insulated by sleeving where they pass through the holes in front of the relay cover. The assembly is enclosed in a relay cover with cover legs that engage with holes in the mounting plate. The base and cover shields and the relay cover are made of magnetic material and serve both as magnetic return paths for the coil flux and as shields against magnetic interference from adjacent apparatus. Figure 1-27 shows the internal arrangement of the parts of a 289 type relay.

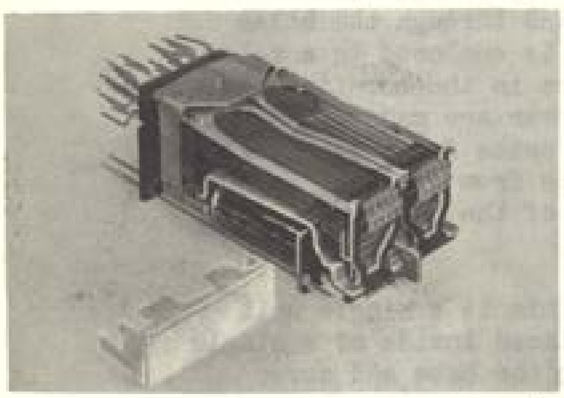
Figure 1-28 shows a 290 type relay. This is a single unit relay consisting of 12 dry-reed switches placed inside of a single flat coil. The coil is held in position in the base and cover shields by projections on the rear spoolhead which fit into positioning slots in the base and cover shields. The coil leads and the contact terminals of the individual dry-reed switches are connected directly to the wiring terminals of two terminal blocks. The terminal blocks are held in place by projections that engage with positioning slots in the base and cover shields. The cover shield fits over the base shield and is held in position by locking tabs that fit into holes of the base shield. Added mechanical protection for the coil is provided by a sheet of insulating material placed between the cover shield and the coil.

There are 14 wiring terminals in the front and 12 wiring terminals at the rear of the relay, the first and last terminals in the front being those of the coil winding. All wiring terminals are arranged for individual solderless wrapped connections and with the exception of the two coil winding terminals, are also arranged for vertical strapping. Like the 289 type relay, the assembly is enclosed in a relay cover with cover legs that fit into holes in the mounting plate, and the base, cover shields and the cover are made of magnetic material. The internal arrangement of the parts of a 290 type relay is shown in Figure 1-29.

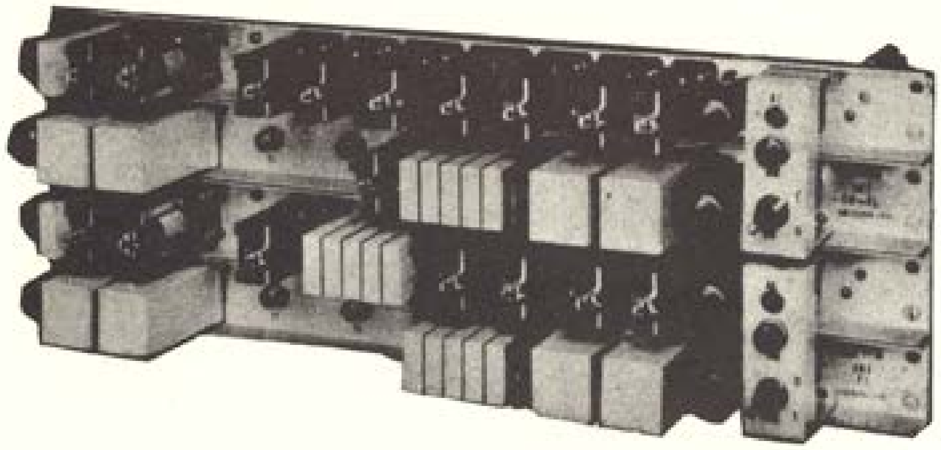
A 293 type relay is shown in Figure 1-30. The five units of this relay, each consisting of a coil with two dry-reed switches, are supported between two terminal blocks. Each unit has five terminals which extend to the front and rear of the relay. The ends of the terminals in the rear are arranged for solderless wrapped connections and the ends of the terminals in front are formed to permit the application of test connectors.

A single shield, slit on one side extends between the terminal blocks, completely enclosing the five units. The unit assembly with the shield in place slides into the relay cover which is equipped with mounting legs for securing the relay to the mounting plate. The shield and relay are made of magnetic material and serve the same purpose as explained for the 289 type relay. A 293 type relay with cover and cover shield removed is shown in Figure 1-31.

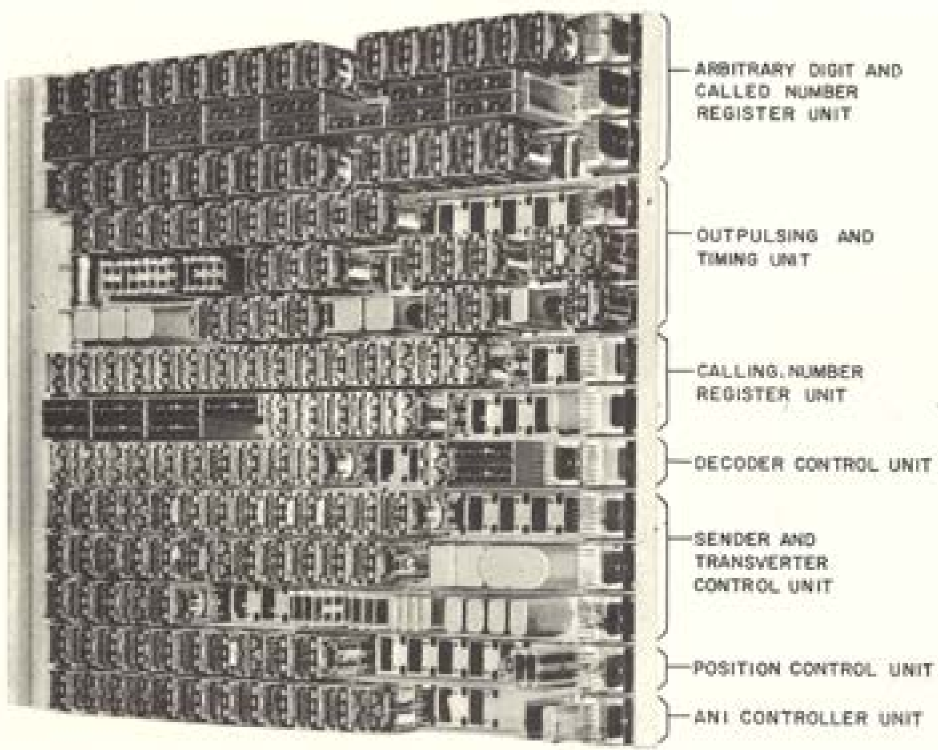
The AK Type Wire Spring Relay



The AK wire spring relay consists of two functionally independent relay units mounted on a common core and base. The windings of the two units are separated by a magnetic shield which is an integral part of the relay. Each of the two relay units has either two or three parallel rows of wire contact springs consisting of a combination of stationary and movable contacts. Each row is molded into an individual base. The springs are pretensioned during manufacture to provide contact force. All stationary springs are positioned in a fixed molded plastic block. The movable springs associated with each of the two relay units are independently actuated by movable cards through the medium of separate armatures. Relays having two rows of springs incorporate either make or break contacts only. Those having three rows incorporate both make and break contacts. Stationary contact springs have bar type contacts of No. 2 metal. Movable contact springs are arranged in pairs to provide twin contacts, each moving wire having a bar contact of No. 2 metal with a gold overlay. All terminals are arranged for mechanically wrapped connections. AK type relays have been used in the 756 PBX, 1A1 Key Telephone System, and the 1A Line Concentrator.

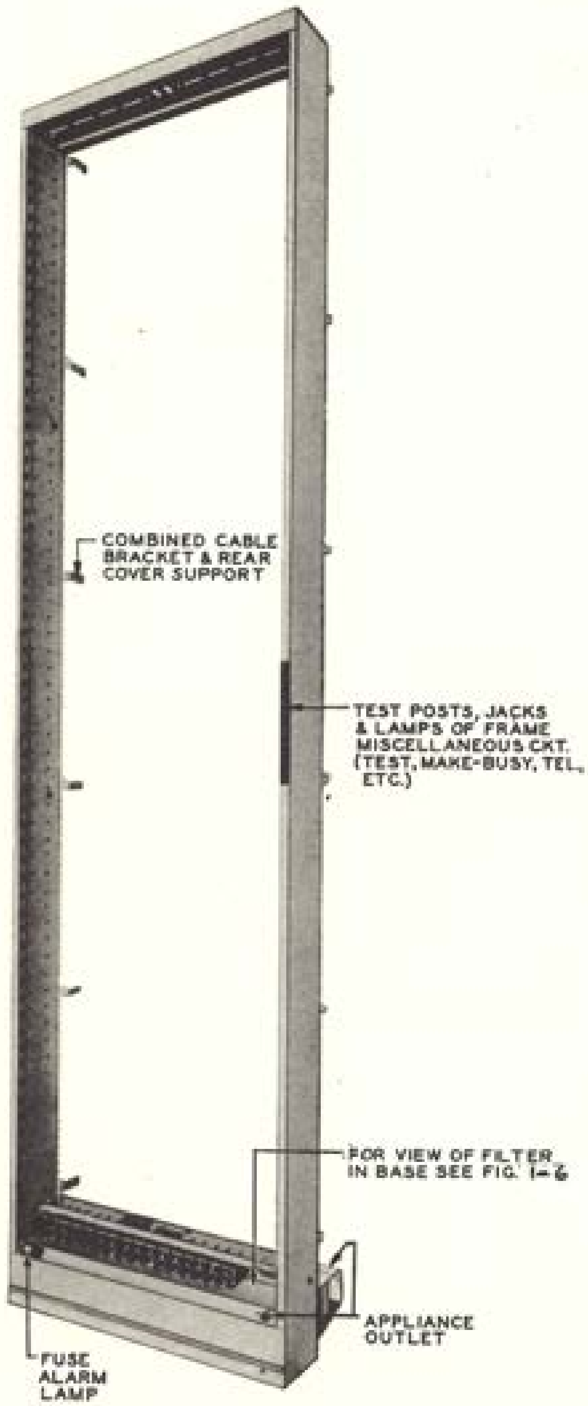


U & Y Type Relay
Interrupter Unit



Wire Spring Relay Units
Included in CAMA Sender

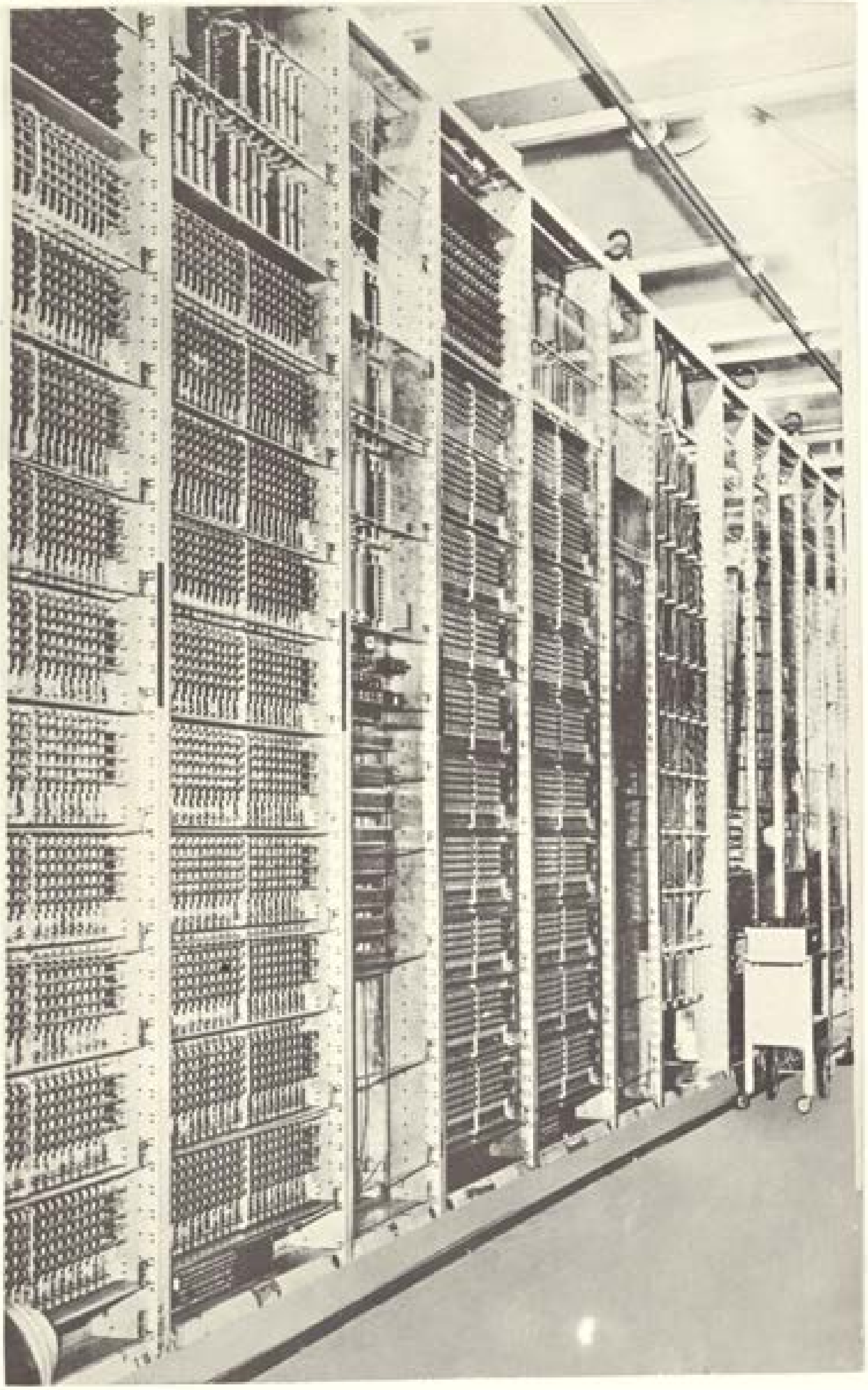
Figure 1-1



SINGLE BAY FRAME EQUIPPED WITH FUSE PANEL

FRONT VIEW

Figure 1-2



Typical No. 5 Crossbar Office

Figure 1-3

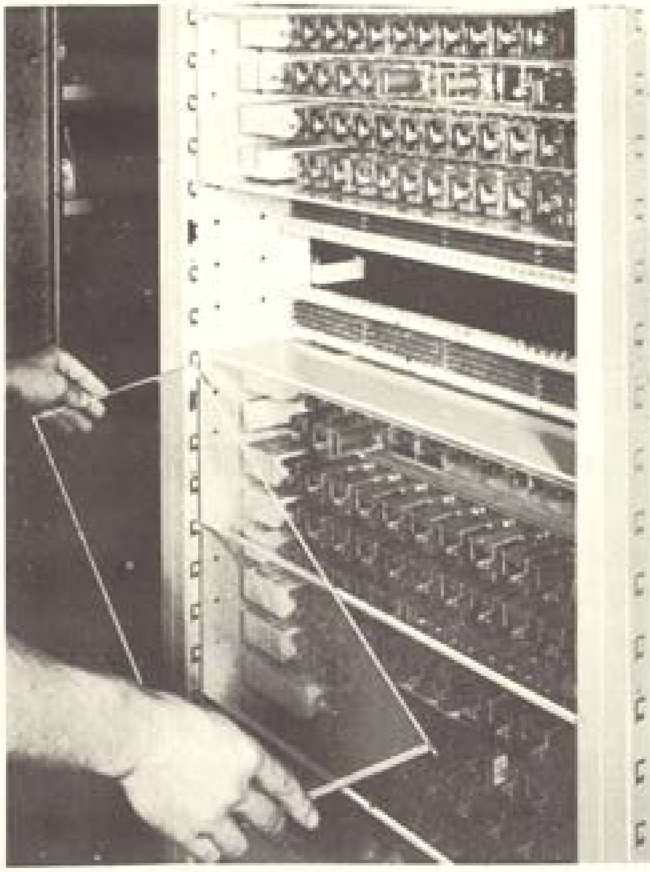


Figure 1-4 Frame Showing Removal of Plastic Front Cover

Figure 1-5 Frame Showing Removal of Horizontal Front Baffle

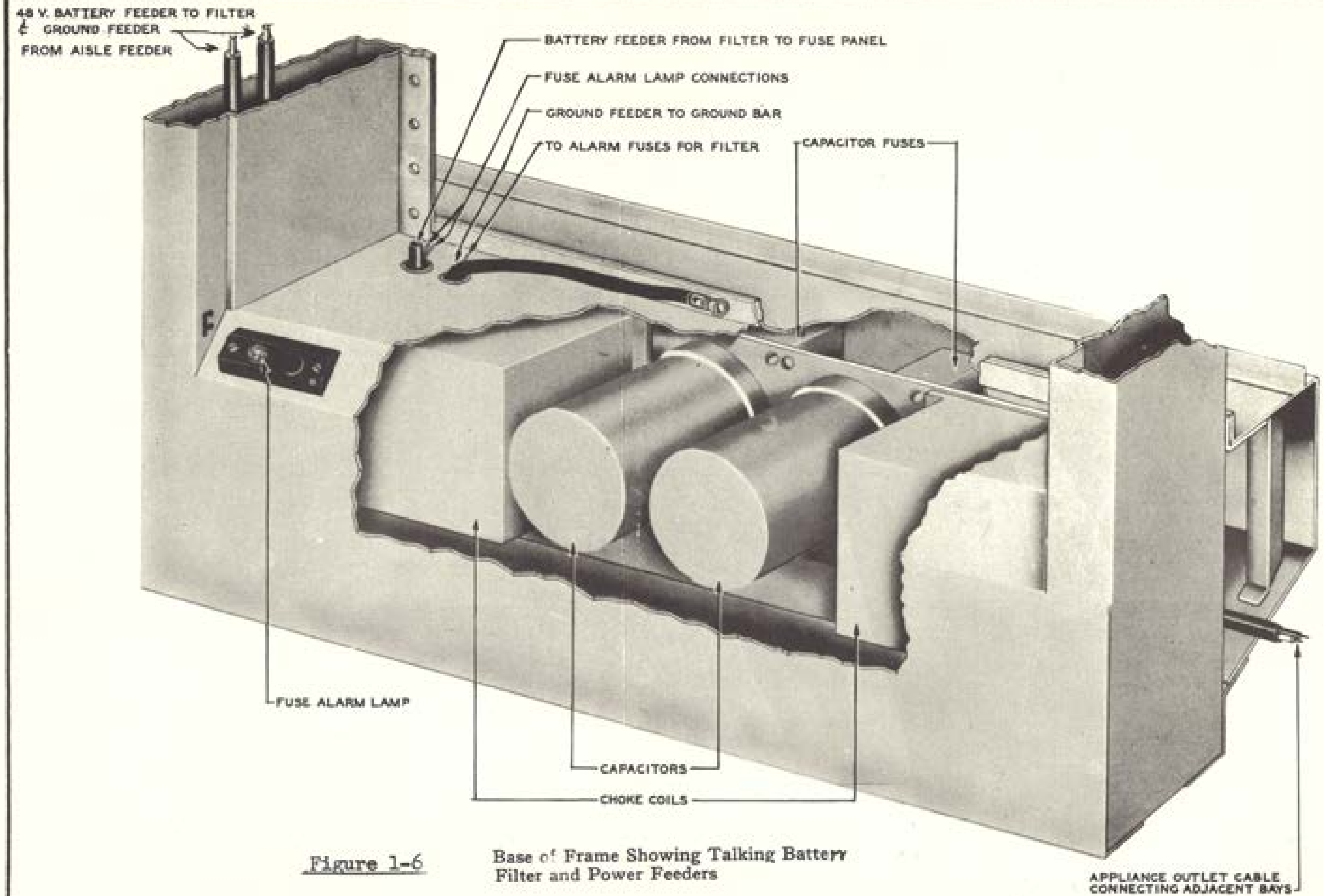


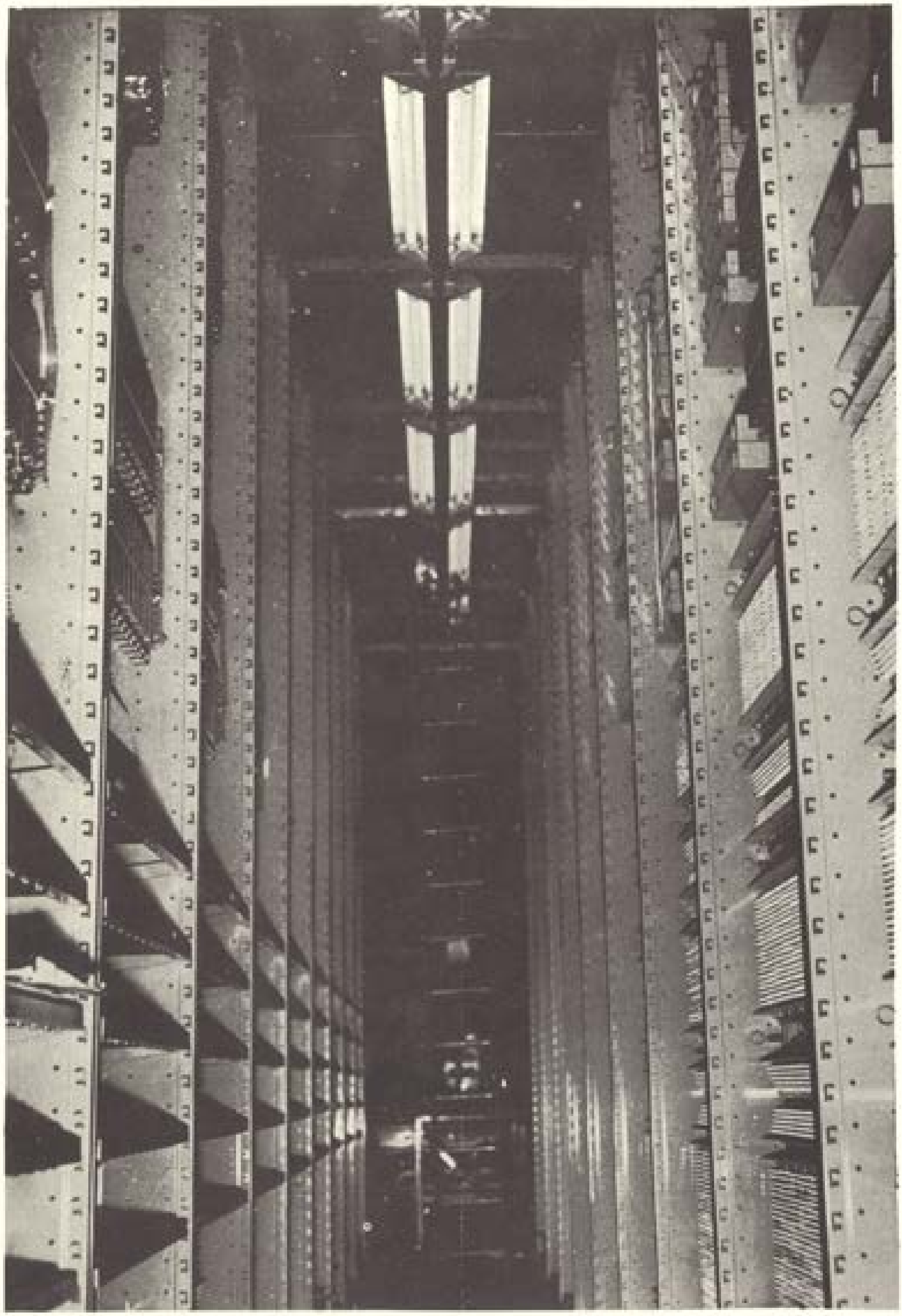
Figure 1-6 Base of Frame Showing Talking Battery Filter and Power Feeders

END GUARD WITH AISLE FEEDER
FUSES AND AISLE PILOT

Figure 1-7

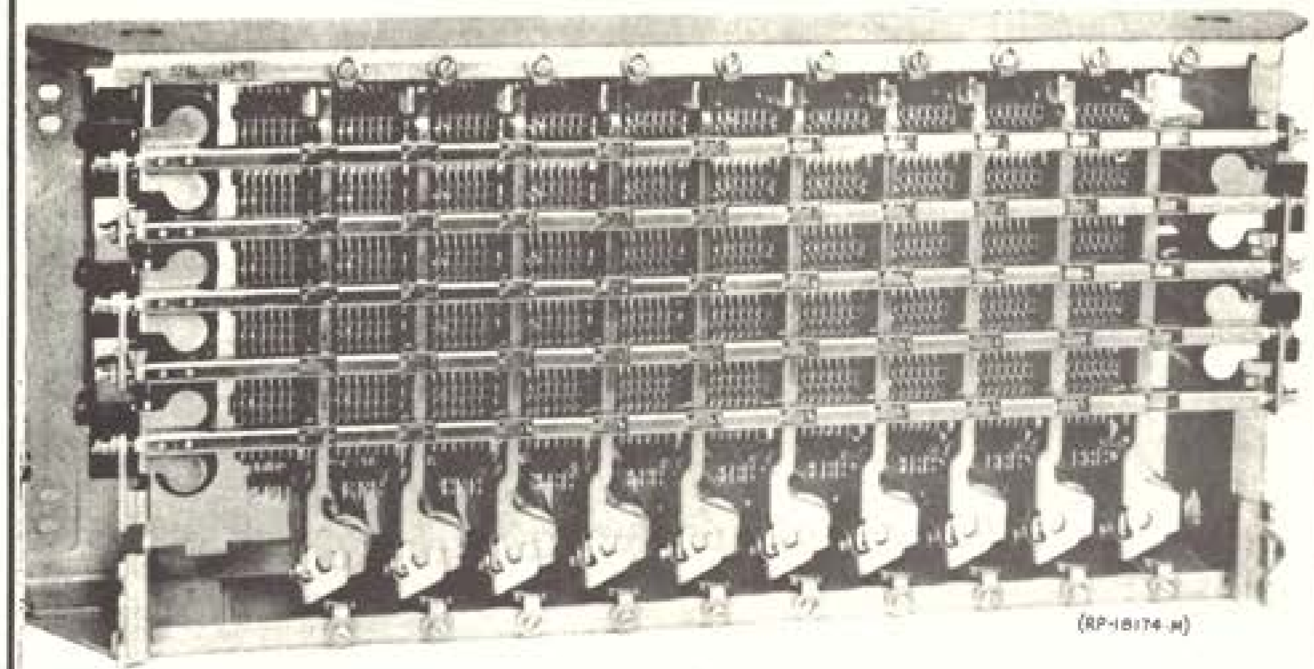
Aisle With Ceiling Mounted Lighting
And Standard Rolling Ladders

Figure 1-8

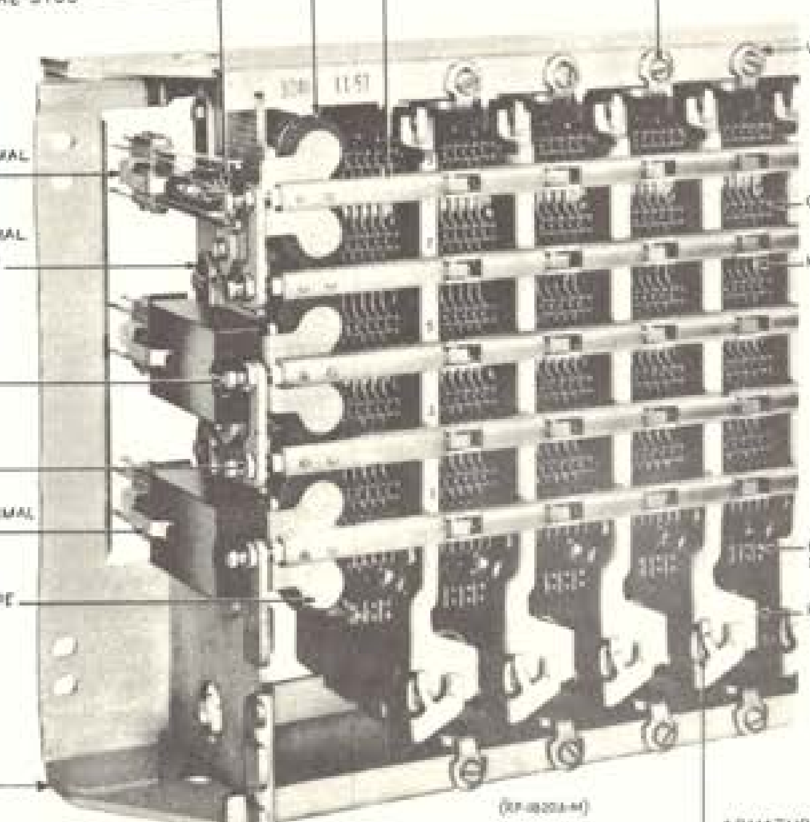


Framework Mounted Lighting

Figure 1-9



100 POINT 324 TYPE CROSSBAR SWITCH



SECTIONAL VIEW OF 324 TYPE SWITCH

Figure 1-10

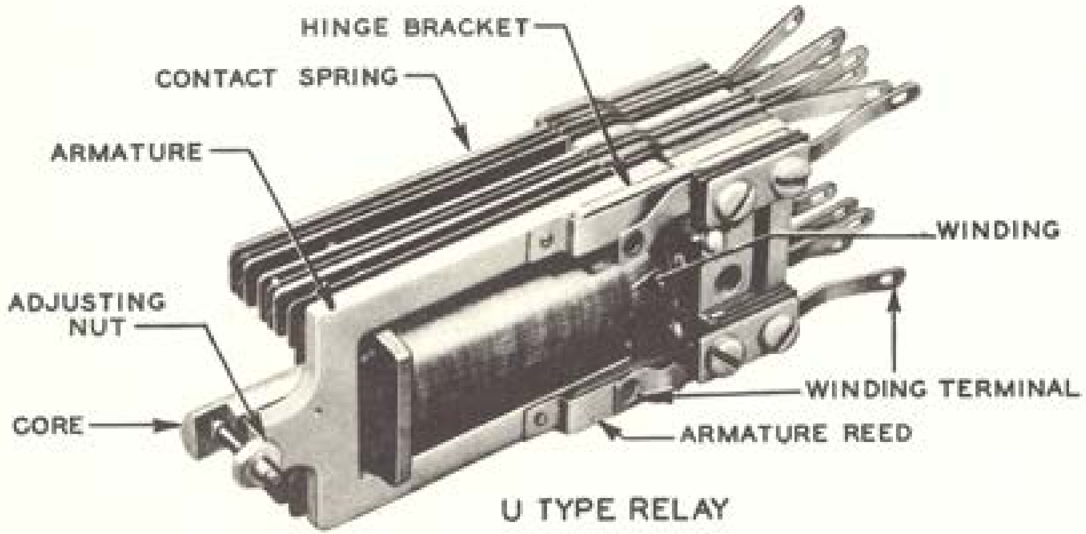


Figure 1-11

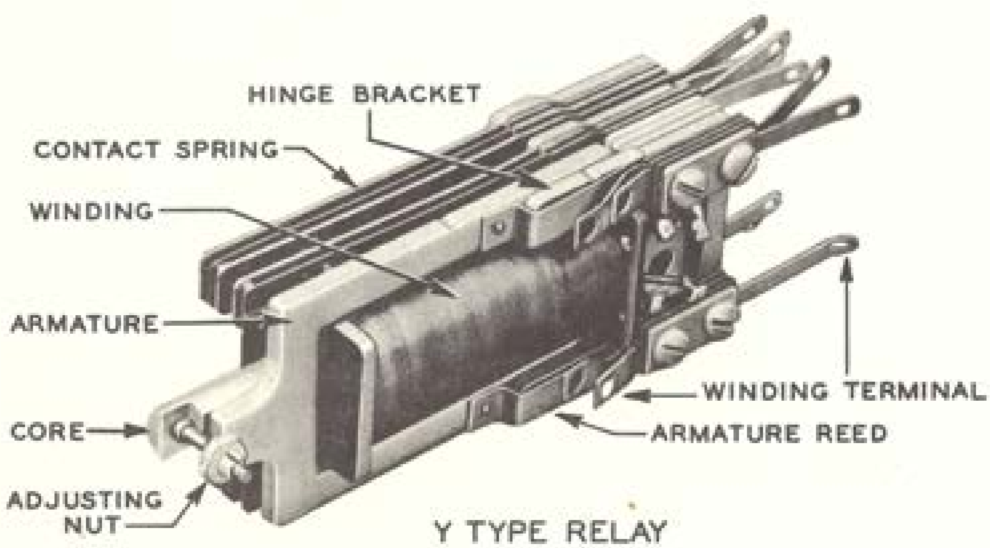


Figure 1-12

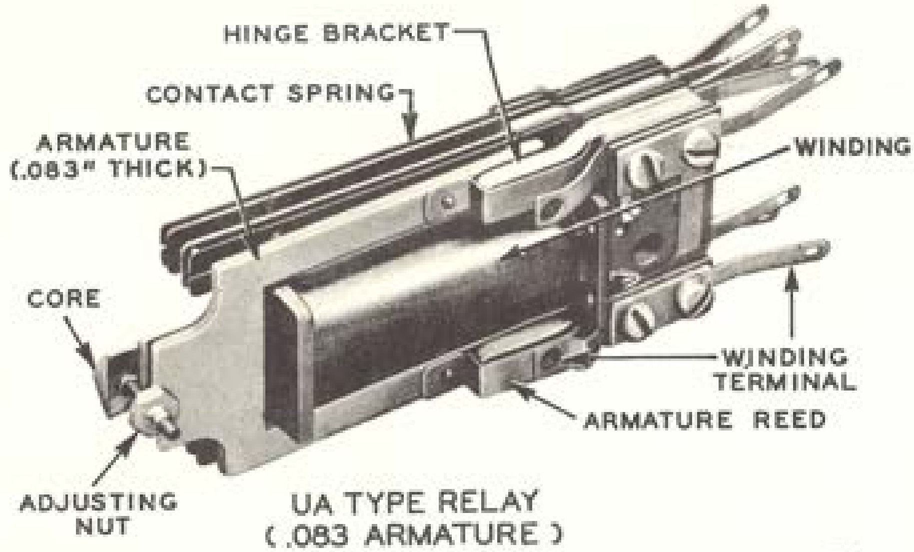


Figure 1-13

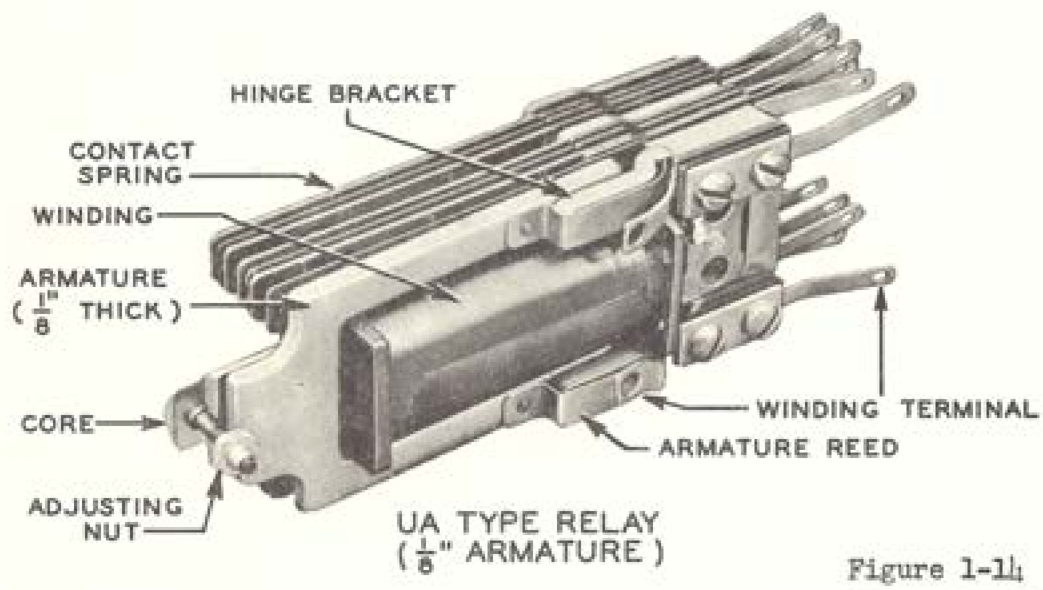


Figure 1-14

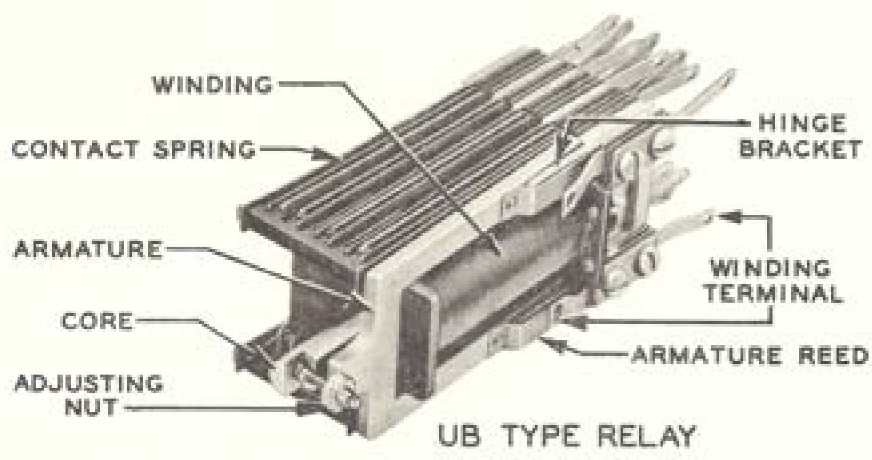
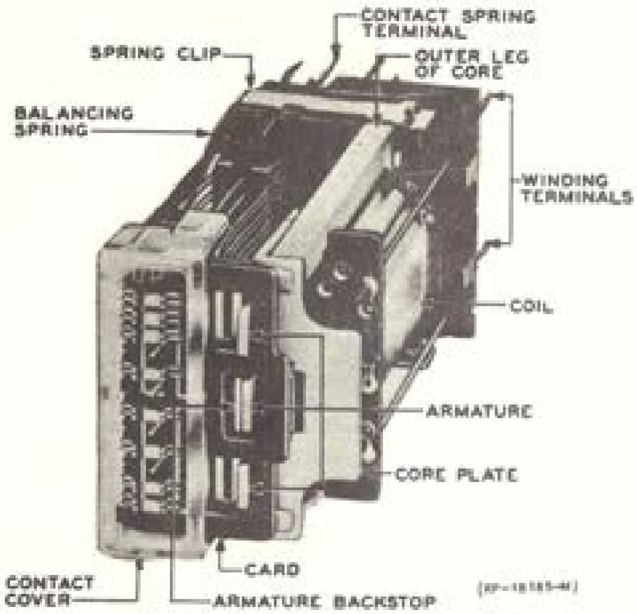
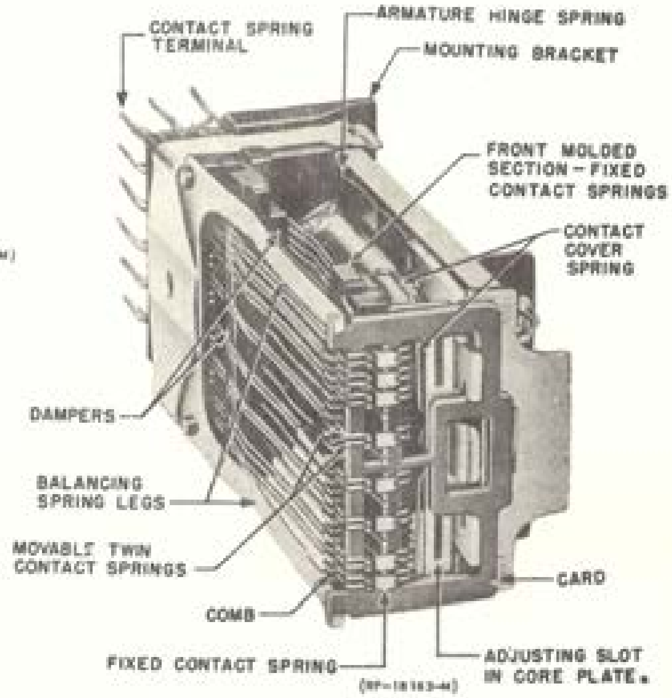


Figure 1-15



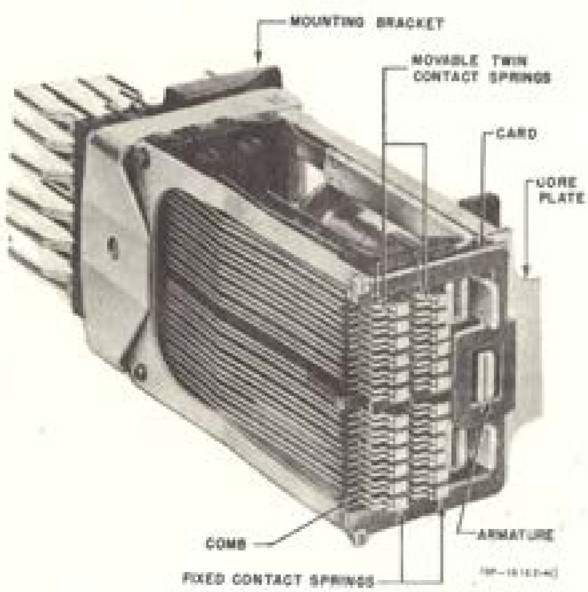
WIRE SPRING RELAY

Figure 1-16



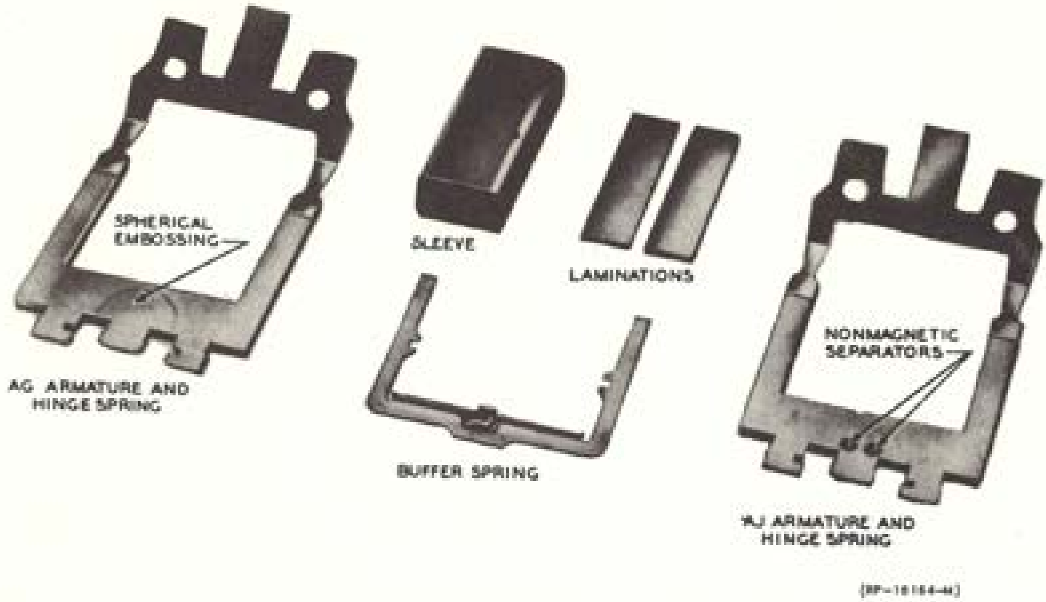
12 POSITION AF TYPE RELAY

Figure 1-17



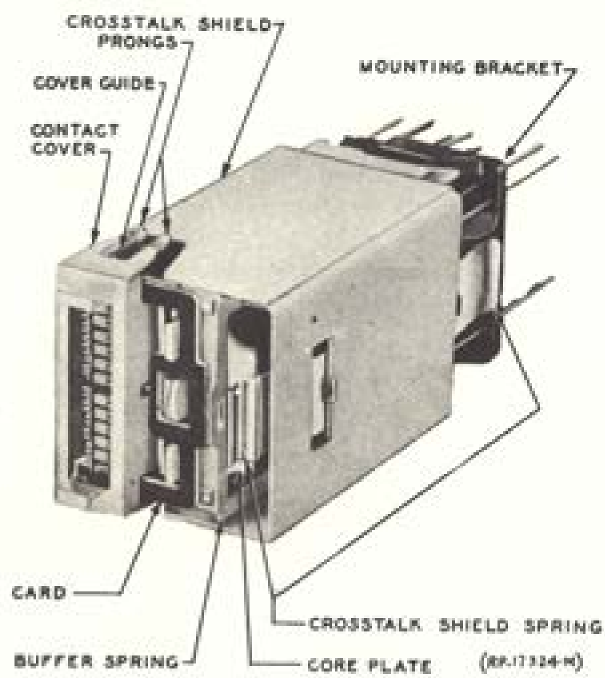
24 POSITION AJ TYPE RELAY

Figure 1-18



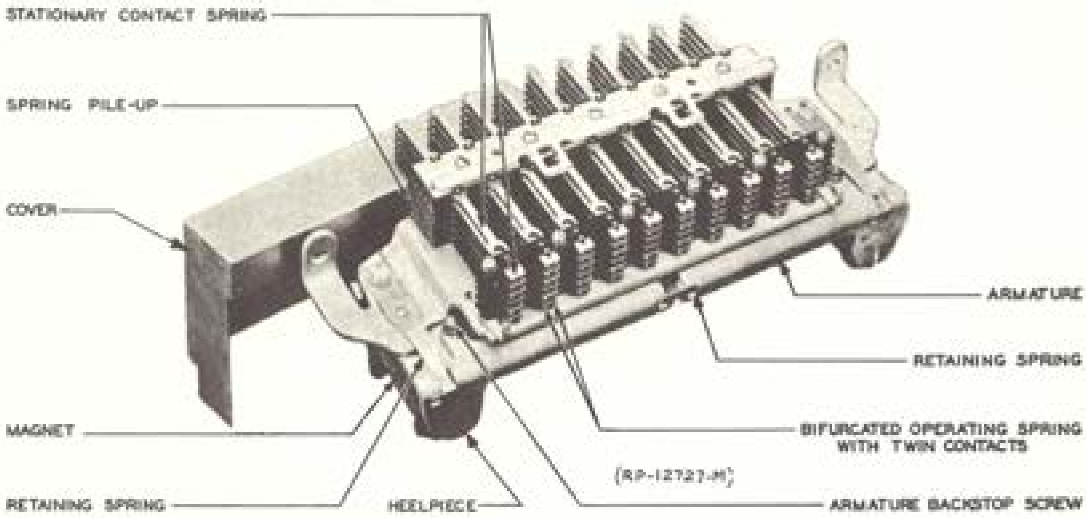
ARMATURE AND ADDITIONAL PARTS OF AG AND AJ TYPE RELAYS

Figure 1-19



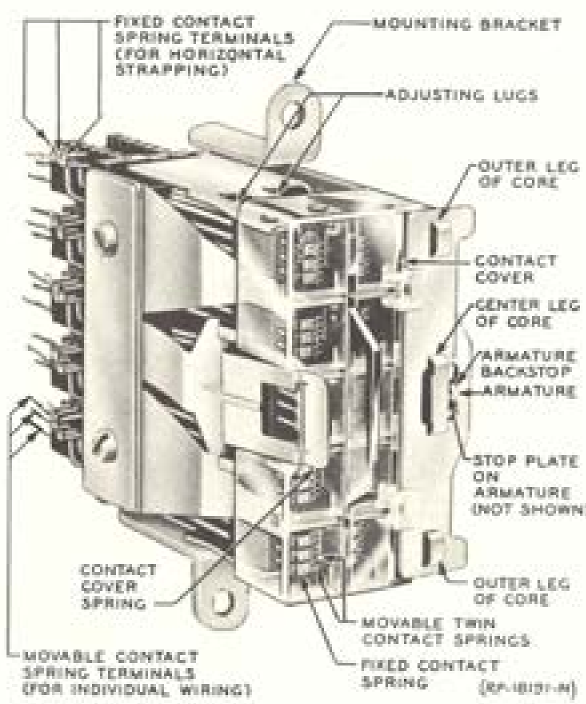
AJ TYPE RELAY EQUIPPED WITH CROSSTALK SHIELD

Figure 1-20



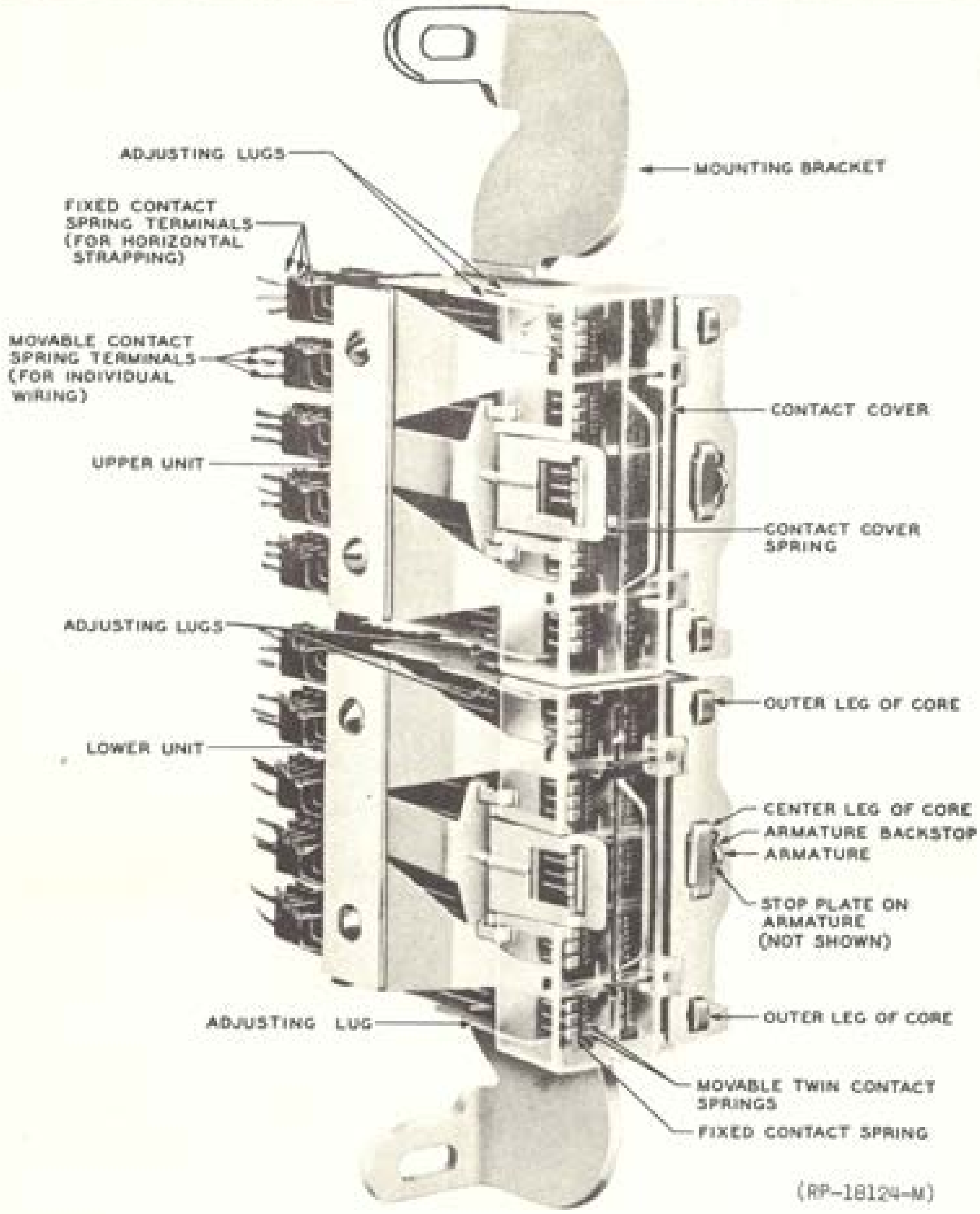
263 TYPE RELAY

Figure 1-21



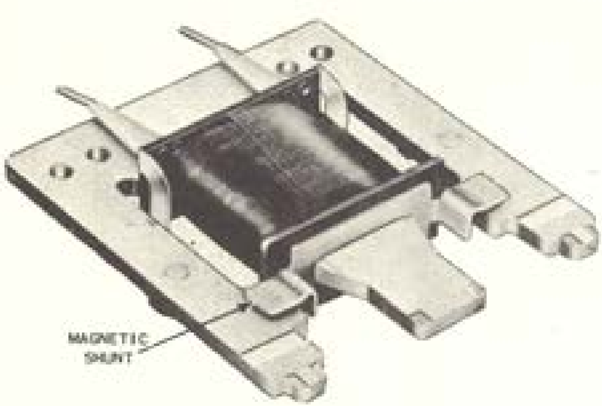
286 TYPE RELAY

Figure 1-22



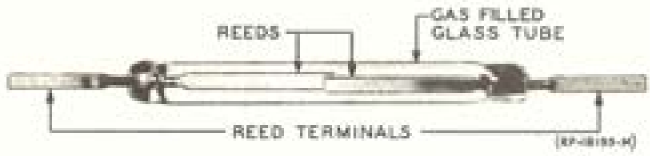
287 TYPE RELAY

Figure 1-23



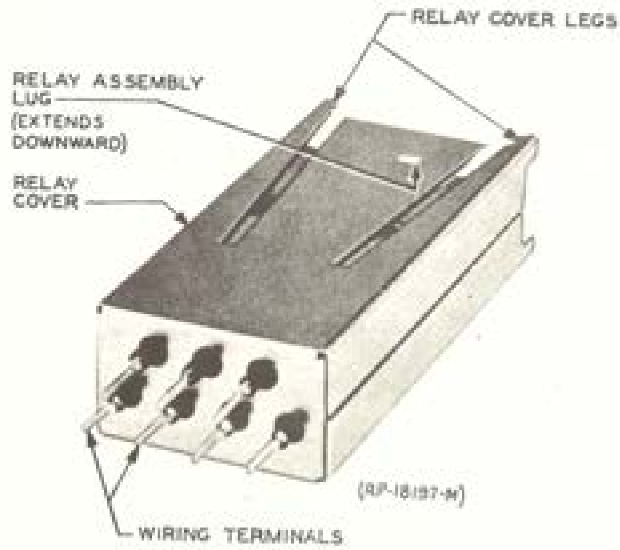
287 TYPE RELAY CORE WITH MAGNETIC SHUNT

Figure 1-24



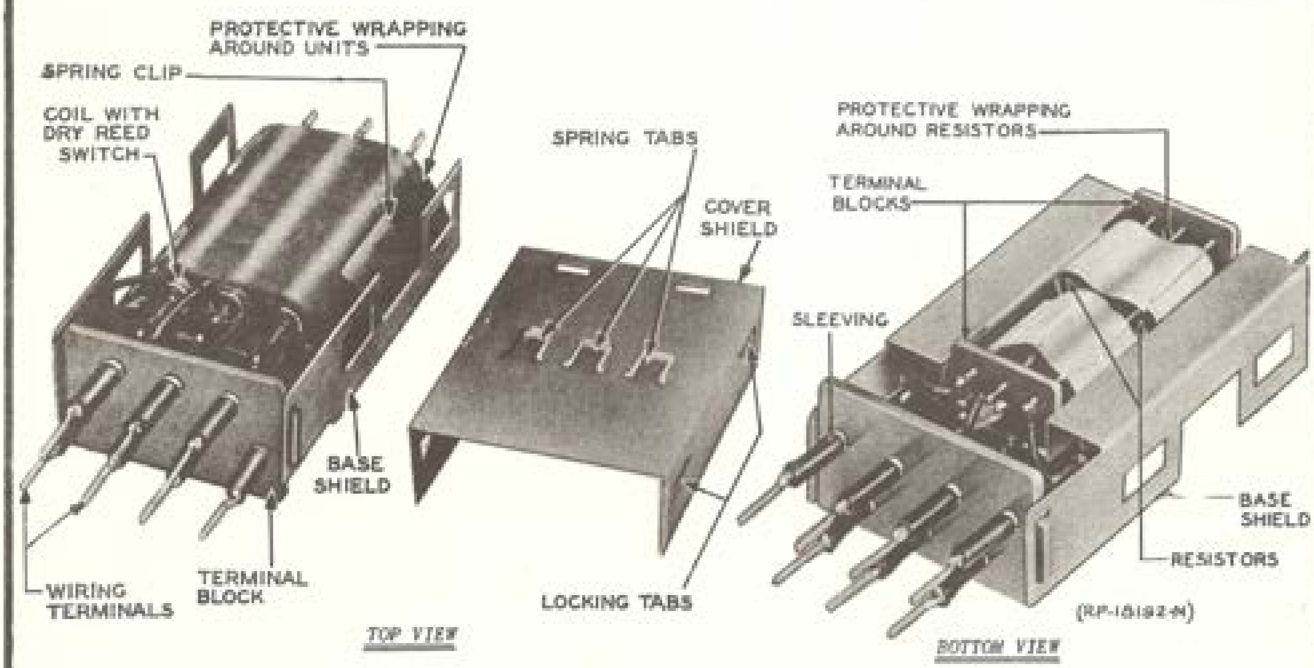
DRY-REED SWITCH

Figure 1-25



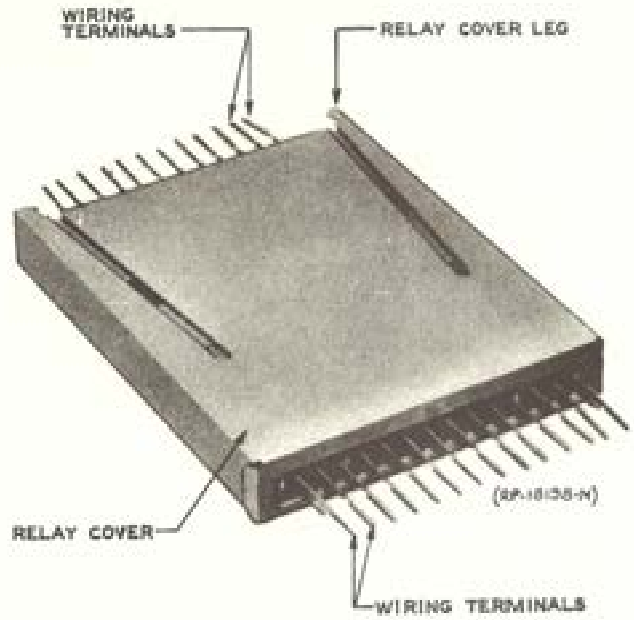
289 TYPE RELAY

Figure 1-26



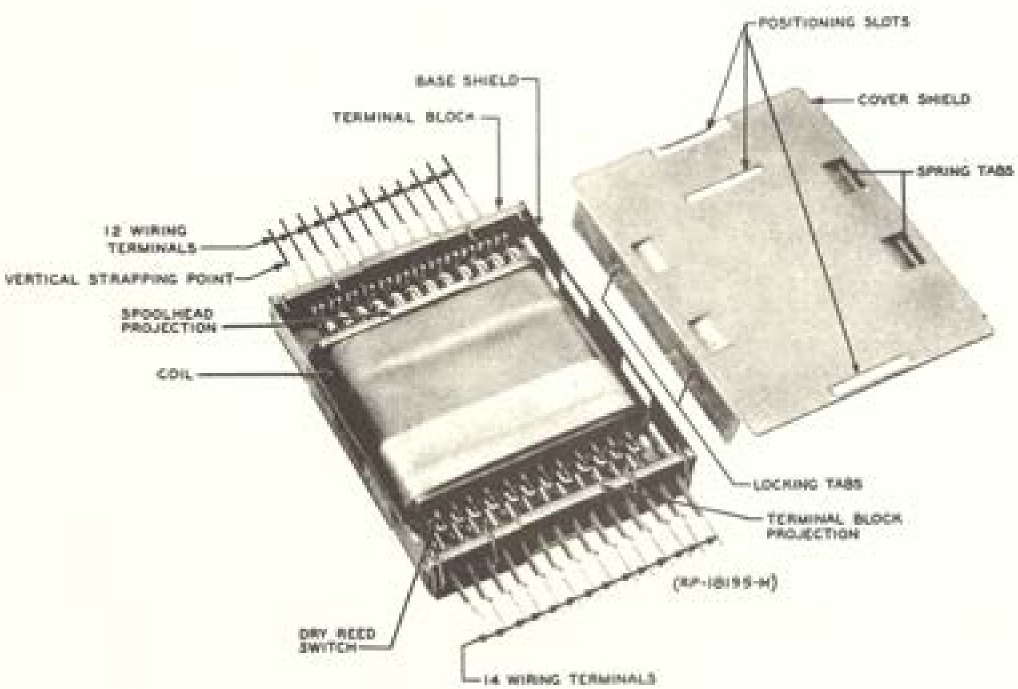
289 TYPE RELAY WITH COVER AND COVER SHIELD REMOVED

Figure 1-27



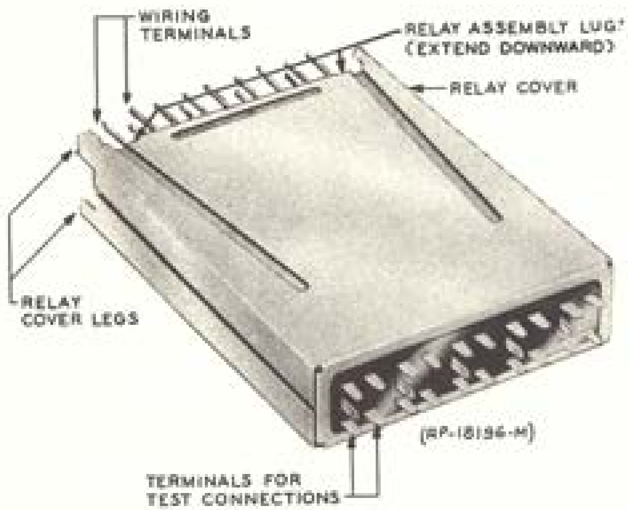
290 TYPE RELAY

Figure 1-28



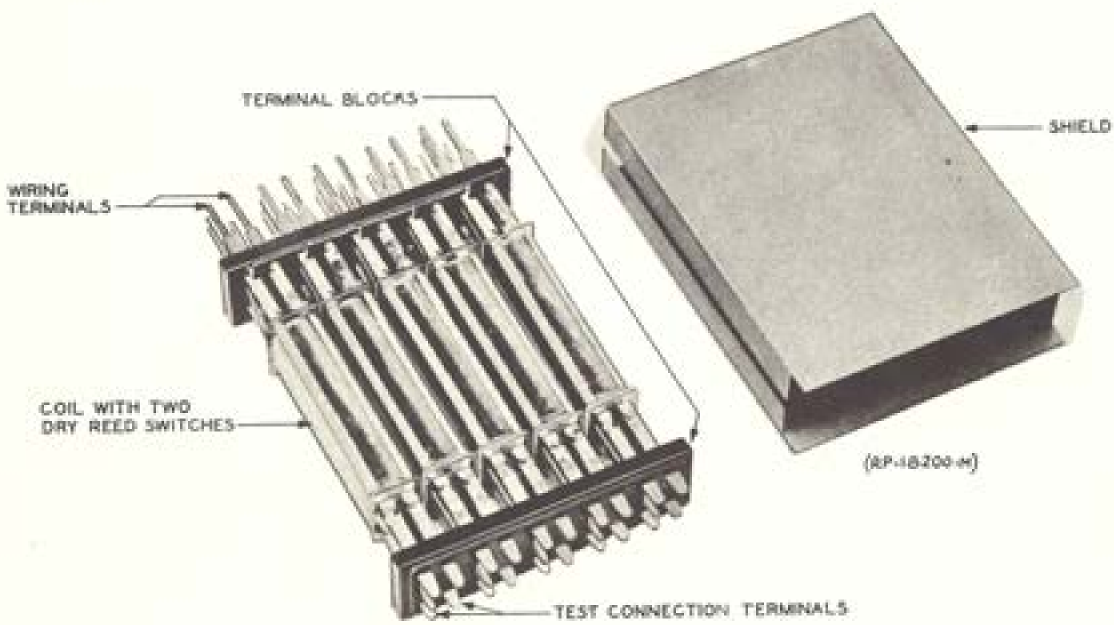
290 TYPE RELAY WITH COVER AND COVER SHIELD REMOVED

Figure 1-29



293 TYPE RELAY

Figure 1-30



293 TYPE RELAY WITH COVER AND COVER SHIELD REMOVED

Figure 1-31

SECTION II - THE TALKING PATH

NO. 5 CROSSBAR

FIGURES

A. PATHS OF A CALL

A talking path in the No. 5 crossbar machine is established by the marker through two kinds of switching frames; line link frames and trunk link frames. Subscriber lines are assigned to line switches on line link frames, and the various types of trunks and originating registers appear on trunk switches on trunk link frames. These frames are interconnected by junctors. The junctors are attached to the junctor switches on the line link and trunk link frames.

There are three basic talking channels established through these switching frames; outgoing, incoming and reverting. In addition, a fourth path, a dialing channel is established and required when a subscriber originates a call. The dial tone channel is shown in Figure 2-1A.

A call between subscribers with different subscriber lines, who are served by the same office, is an intra-office call. The talking path in this type of call consists of a terminating channel and an originating channel established between the subscriber lines through an intra-office trunk as shown in Figure 2-1B.

A reverting call is a call between two subscribers served by the same subscriber line (party line service). The talking path is between the subscribers on this line. Supervision of the call is provided by a reverting channel between the subscriber line and a reverting trunk as shown in Figure 2-1C.

A subscriber, who makes an outgoing call to another office, is connected through an originating channel to an outgoing trunk as shown in Figure 2-1D.

An incoming call to a No. 5 office is connected to the called subscriber by means of a terminating channel between the incoming trunk and the called customer as shown in Figure 2-1E.

B. LINE LINK FRAMES

General

The crossbar switches on the line link frame are divided functionally into line switches and junctor switches. Subscriber lines are connected to the line switches, and junctors to the junctor switches. Line links, which are merely connecting wires, are provided for interconnecting the line switches and junctor switches; hence the name line link frame. Figure 2-2 is a simple diagram of a line link frame.

There are two general types of line link frames currently in use. The newer design employs wire spring type relays and has been provided on all jobs shipping after the third quarter of 1955. The older design employing flat spring type relays is rated "Manufacture Discontinued," and will not be discussed in detail in this section.

The basic wire spring line link frame is available in two sizes, 190 lines and 290 lines. The 290-line frame (Figure 2-3) most commonly used is a 2-bay framework with each bay mounting ten 200-point crossbar switches. One and one-half switches on each level are used as line switches. Each vertical on a line switch is used for a subscriber line, except one which is used for no-test access to the remaining 29. One advantage of using a vertical for a customer line is that the off-normal springs of the hold magnet can be used as a cutoff relay. The half switches not used as line switches are used for junctors, thus providing ten verticals for terminating the junctors on each level. Line relays, one for each customer line, are mounted at the top of the line link frame.

Line links appear on the horizontals of the switches, ten line links on each switch. These ten line links are distributed among the ten junctor switches, one line link to one horizontal on each of the ten junctor switches. This system of line links permits each line on a line link frame to reach any one of the 100 junctors serving that frame. Figure 2-4 shows how each line switch has access to all the junctor switches.

Any particular line link can be readily traced by the following method. The number of the horizontal on the line switch end of the line link is the same as the number of the switch on the junctor switch end, and the number of the horizontal on the junctor switch end is the same as the number of the switch on the line switch end.

Since each common basic line switch is made up of one and one-half 200-point crossbar switches, the 290 line basic line link frame has a capacity of 300 line switch verticals (30 on each switch) and 100 line links. However, the actual number of subscriber lines on this frame is 290 because ten line switch verticals (one on each line switch) are required for no-test operation, such as obtaining access to busy lines from the local test desk and verification of busy lines by DSA operators.

Greater line capacity than that provided by the basic frame can be obtained by the addition of supplementary bays of switches. The number of lines which can be served by 100 links, and therefore by a frame, is determined by the average incoming plus outgoing usage (calling rate times holding time) of the lines. To take care of varying requirements, provision is made for adding supplementary bays to the basic frames to serve from 240 to 590 lines in steps of 50, 100, or 200 lines, as required. The size of the frame does not affect its functions. The specific arrangements for the various frame sizes are shown in Figure 2-5.

Line link frames of either type are universal in that all classes of subscriber lines may be assigned to any frame. The office can accommodate a maximum of 60 or 100 service-classes if all the completing markers are of the wire spring relay type and 30 service-classes if flat spring relay type completing or combined markers are employed. In either case each frame is arranged to handle all of these classes. The line capacity for each class of service on a frame is a multiple of ten since class distinction is made by vertical files. A vertical file is the corresponding vertical location on each of the ten switches located on the frame.

The circuits are so arranged that the line link frames may serve up to six office codes having rate discrimination. Lines for these office codes may be mixed on the line link frames.

It is the recommended procedure in new installations that all frames be of the same size, and that lines of all classes be as equally divided among frames as feasible in order to attain a uniform load balance.

In addition to assigning subscribers, certain types of trunks are connected to the line link frame. These include intercept and verification trunks, one appearance of each incoming tandem trunk, two appearances of each incoming intertoll trunk, and in some cases the information, repair service, official P.B.X. trunks, etc. In determining the frame sizes and number of frames, the number of terminations of these trunks and the load which they handle must be taken into account in addition to subscriber line terminations and usage. Trunks connected to the line link frames may be assigned to any vertical file, i.e., they may be assigned in a file which otherwise mounts flat rate, or message rate, or coin subscriber lines. However, it is recommended that, where available, they be assigned on verticals associated with a P.B.X. class of service.

This will allow a simple cross connection to be made, if desired, to allow the Line Insulation Test Frame to skip these trunks without requiring the special resistance otherwise needed.

When it is contemplated that a relatively large number of intertoll and/or tandem trunks (in the order of 300 or more) will be terminated on a No. 5 crossbar system, two factors should be given careful consideration -

(a) The economies, initially and ultimately, of using No. 5 for handling toll and tandem traffic and thus limiting the local main station capacity should be compared with the alternative of using a separate system for toll and tandem switching, such as a crossbar tandem.

(b) In a combined local and toll switching system, such as No. 5, consideration should be given to the fact that severe peaks occurring in the same busy hour in either type of traffic may adversely affect both services.

Originally, forty line link frames were the maximum a No. 5 crossbar office could accommodate in one marker group. However, a new development permitting a maximum of 60 line link frames and 30 trunk link frames per marker group became available in 1957. This development applies only to offices equipped with wire spring completing markers.

Classes of Service

The common control equipment (originating registers, markers, etc.) for a No. 5 installation is arranged for a maximum of 30 classes of service with non-wire spring relay type completing markers and 60 or 100 classes of service with wire spring relay type completing markers. The class of service indication given the originating register is determined by the vertical file to which the calling line is assigned. Each vertical file can be assigned a different class of service, and any one or all line link frames within the same marker group may serve as many as 30 or 100 classes of service depending on types of markers.

On frames equipped with 100 classes-of-service, twenty rate treatments are also available. These rate treatments are only required to supplement classes-of-service when the marker group serves Centrex customers.

As an exception, in non-wire spring relay offices where both a flat rate and a message rate station are served on the same two-party line, only 29 classes of service are available. In this case the flat rate station must always be on the same side of the line, preferably but not necessarily the ring side.

The per cent distribution of lines by classes of service need not be the same for all line link frames but the deviation should be kept to a minimum to obtain traffic balance by spreading the lines of major classes evenly over all the frames.

A separate class of service indication must be given the marker and originating register for each class of lines which:

> Requires a separate routing or a tone signal to the special service or CLR operator.
>
> Requires differentiation by service class on permanent signal holding trunks.
>
> Has a dialing area different from other classes of lines.
>
> Receives treatment different from other classes of lines with respect to the initial and overtime rates to points within the dialing area.
>
> Represents each Centrex group (100 C/S only)

Where AMA equipment is not provided, flat rate lines may be assigned the same class as message rate lines if separate routes to the operator are not required and the dialing areas are the same. Where AMA equipment is provided, flat rate and message rate lines should not be given the same service class since this would result in unnecessary perforations on the AMA tape.

The originating register will make a two-party test on calls originated from two-party lines on which it is necessary to determine, for charging purposes, which party is making the call. This is not required on four-party lines since automatic charging is not available for four-party service. This test results in a slight additional delay in receipt of dial tone. Because of this, flat rate party, message rate, or flat rate individual and P.B.X. lines generally should not be assigned to vertical files serving such lines.

In general, all lines or trunk groups served on the line link frame which require the trunk hunting feature on incoming calls as well as certain test lines require sleeve cabling. In addition, all lines associated with a message register must be assigned to verticals having sleeve cabling.

Line Equipment Arrangements

The standard line equipment arrangement provides that each frame shall have 90 verticals (9 vertical files) equipped with sleeve leads, for use with terminal hunting lines, non-AMA message rate lines, and trunks requiring line link frame appearances.

Coin lines operating with 191-type or similar type coin boxes for use with 10-cent local coin rates require ground start line equipments. Non-coin lines use loop start line equipments. In order to meet the requirements for most offices, 70 "universal" type line equipments (on 7 vertical files) are provided on each line link frame. By a single wire strapping arrangement these can be made to operate either as ground start or loop start. Unless otherwise specified, 20 of the universal type line equipments are shipped with wiring for ground start VG02, VF1 & 2 and 50 for loop start, (VG01, VG04). If different proportions of the 70 are required, changes can be made on the job.

The standard arrangement provides specific locations for the sleeve leads and universal line equipments, which are shown in Figure 2-6. They are shown by vertical group and files. A vertical group consists of five consecutive vertical files, or 50 line equipment locations. Vertical groups 00 and 01 are on the half-switch mounting line equipments in the junctor switch bay; and vertical groups on any supplementary bays are numbered 02 and upward to the last vertical group involved on the frame. A maximum size frame (590 lines) would contain 12 vertical groups numbered 00 through 11.

Provision is made in the vertical group 02 on each line link frame whereby calls originating from lines in this location will be served by a marker before waiting calls in other vertical groups are served. The 0 vertical file in the vertical group 02 is always reserved for gaining access to busy lines on a no-test basis, which leaves 40 line terminations in the other four vertical files available for assignment of subscribers' lines. Generally, the lines for police, fire, and ambulance as well as coin lines will be assigned in the 02 vertical group. Any remaining capacity may be assigned to other classes of lines. Coin lines may also be assigned in vertical group 01.

NO TEST

Frame Size

The engineering capacity of a No. 5 crossbar line link frame is 1260 busy hour CCS. Since frame size is dependent on the CCS load per line, which is difficult to estimate precisely in advance, it is important that new offices be installed with line link frames of sufficient size to provide line equipment margins which will allow optimum frame loading consistent with good service as determined by experience after the office is cut over. Actual CCS load per line will usually vary to some degree from the theoretical estimate made when the office was engineered since there are so many variables in estimating future traffic loads that there is never complete assurance of operating an office during its engineered busy season at precisely the estimated loading.

The first step in establishing frame size for a new office is to estimate the total line link frame office busy hour CCS. Originating and terminating CCS is obtained from recent manual calling rate and holding time data projected so as to reflect as accurately as possible conditions anticipated after cutover. In addition, there will be other items of traffic which will involve line link frame usage. Tandem and through switched traffic fall in this category and such usage should be added to the manual data referred to above. If intra-office traffic has not already been included in the terminating data, then it should be added since it involves the line link frame usages - one originating and one terminating. Traffic handled on a "junctor" trunk basis should be included as an additional traffic item even though the traffic has already been counted as originating from a subscriber's line. The reason for this can be illustrated by an example. Assume that all interoffice outgoing coin traffic is handled on coin junctors, the traffic load is carried on the line link frame as originating traffic; it is trunked to coin junctors and re-enters the office for completion through the line link frame to an outgoing trunk on the trunk link frame, hence, this item of traffic involves two different line link frame usages.

Having estimated the total office busy hour line link frame CCS, the next step is to calculate the theoretical number of line terminations per line link frame which will load the frames to 1260 CCS. The following formula is recommended for this purpose:

$$\text{Theoretical working line terminations per line link frame} = \frac{1260}{\dfrac{\text{Total office BH LLF CCS}}{\text{Total working LLF terminations}}}$$

The total working line link frame terminations in the above formula should, of course, be based on line requirements which contemplate party line fills that experience indicates are possible of attainment.

It is most essential that the ultimate requirements be estimated in determining the proper frame size as well as the requirements for the engineering period. In this connection, possible changes in party line and business development and changes in the relationship of trunk and line assignment requirements should be considered.

Experience indicates that many offices can be loaded above the theoretical line loading per frame. It is, therefore, most important that allowance be made in the original engineering for this contingency recognizing that line equipments constitute a rather small proportion of the total cost. For this reason, it is recommended that the line link frame size selected for a new office provide at least 10 per cent margin in line equipments over and above theoretical requirements.

The following table allows for the minimum 10 per cent margin suggested above.

Theoretical Working Line Terminations Per Line Link Frame	Line Link Frame Size
170 or less	190
171 to 215	240
216 to 260	290
261 to 305	340
306 to 350	390
351 to 395	440
396 to 440	490
441 to 485	540
486 or more	590

Where experience in existing offices indicates that the line link frame size is too small to permit terminating sufficient lines to load to capacity, consideration should be given to adding supplementary frame additions to correct this situation. In such cases it is possible to add supplementary bays in a different line-up from the original line link frames.

From an administrative standpoint, it is desirable, when supplementary frames are to be added, that the ultimate plan contemplate all frames of the same size. This plan is also usually the most economical arrangement when numbers are not limiting. Interim arrangements may, of course, contemplate adding supplementaries on only part of the frames as required.

The new wire spring and former flat spring relay line link frames may have supplementary bays added as shown in the following table.

It will be noted from the following table that the 190 size frame can have but one 50 line supplementary added, and the 240 size frame has no provision for additional supplementary bays; therefore, these sizes obviously should be specified only in cases where the margin and line equipment available above requirements is deemed adequate to meet all future contingencies.

Original Frame	Frame size to which original can be raised: 240	290	340	390	440	490	540	590	Maximum Number of Supplementary Frames That Can Be Added
190#	x								1 (50 lines)
240#									0
290			x	x	x	x	x	x	* 4 (50 or 100 up to 590 lines)
340#				x	x	x	x	x	* 3 (50 or 100 " " " ")
390					x	x	x	x	* 3 (50 or 100 " " " ")
440#						x	x	x	* 2 (50 or 100 " " " ")
490							x	x	* 2 (50 or 100 " " " ")
540#								x	1 (50 lines)
590									0

Wire spring type only.
* Requires special cabling to add more than one frame.

Number of Frames

The number of line link frames required is determined by dividing the estimated total working line link frame terminations at the end of the engineering period by the theoretical terminations required to load the frames as estimated by the method described above. Where the result includes a fractional frame requirement, a decision must be made as to whether to reduce or raise the frames to be ordered to the nearest whole number. The provision of the nearest lower whole number of frames will, of course, affect appreciable cost saving (particularly if trunk link frame requirements are correspondingly reduced) and in many cases, where the fractional requirement is a small percentage of the total requirement, may have little effect on over-all performance.

4-Wire Line Link Frames

A 4-wire line link frame is also available in wire spring marker groups. This frame provides appearances for lines and trunks that require a 4-wire termination for separate transmission paths in each direction.

These frames serve 190 lines or trunks, one hundred classes-of-service, and twenty rate treatments.

A maximum of forty 4-wire line link frames can be served by one marker group. However, up to sixty line link frames can be served when both 2-wire and 4-wire frames are provided.

Non-wire spring marker groups are not arranged to work with 4-wire line link frames.

Line Link Frame Line Identification (Line Link Address)

A subscriber's line termination on the line link frame is in no manner numerically associated with his listed directory number. The marker recognizes this line termination on outgoing calls as line link address. In the case of a terminating call, the marker must refer the directory number to a number group frame for translation into line link address in order that it may complete the call.

The line link address is identified in terms of the line link frame number, horizontal group, vertical group, and vertical file number. Please refer to Figure 2-21.

A horizontal group is one switch high and extends across the frame. There are always ten horizontal groups on a frame.

A vertical group of customer lines is five verticals wide and ten switches (horizontal groups) high for a total of fifty lines. Thus, the number of vertical groups on a line link frame will vary from four for a 190-line frame to twelve for a 590-line frame.

A vertical file is one vertical wide and ten switches high for a total of ten lines. The number of vertical files on a frame depends on the size of the frame.

C. THE TRUNK LINK FRAME

Physical Description of Frame

The fundamental trunk link frame is a two-bay framework having ten 200-point, 3-wire crossbar switches in the left, or junctor bay and ten 200-point, 6-wire crossbar switches in the right, or trunk bay, (See Figure 2-7). The frame has capacity for terminating 200 junctors which are used to interconnect the trunk link frames and line link frames. The trunk switches provide terminations for a maximum of 160 circuits. These circuits include originating registers, intraoffice, interoffice, intermarker group, incoming, outgoing, two-way and miscellaneous trunks.

The system of trunk links that permits any trunk or originating register on a trunk link frame to be connected to any one of the 200 junctors serving that frame is similar in principle to that used on line link frames. The number of trunk links, which is 200, is the same as the number of junctors. Trunk links run from vertical to vertical. Junctors connect to the horizontals of the junctor switches, and trunks to the horizontals of the trunk switches, (See Figure 2-8).

In order to terminate twenty junctors on the horizontals of one 200-point junctor switch, the horizontal multiple must be split into left-hand and right-hand half-switches. The two half-switches thus formed are treated separately and numbering of the verticals in each half is similar, but they are identified as left and right. Although the trunk switches are not physically split, the numbering of verticals are also on a left and right basis.

Trunk link distribution is similar to line link distribution. The vertical number at one end of a link is always the same as the switch number at the other end of the link. In addition, a vertical on the left half of a switch is always connected to a vertical on the left half of the switch at the other end of the link, and a vertical on the right half of a switch is always connected to a vertical on the right half of a switch at the other end of the link. (See Figure 2-8).

Since the trunk switches are 6-wire and junctors and links are 3-wire, each crosspoint provides space for connecting a link to two trunks. Means of determining which of the two trunks is to be used on a particular connection are, of course, required. Horizontals 0 and 1 on each trunk switch are used to provide this distinction and two circuits are connected to each of Horizontals 2 to 9, inclusive. This arrangement is illustrated in Figure 2-9. Thus 16 circuits may be connected on each switch or a total of 160 on a frame.

The eight appearances on each switch which are selected by Horizontal 0 are called A appearances, and those selected by Horizontal 1 are called B appearances.

Complete identification of a circuit location on a particular trunk link frame is obtained by specifying:

The appearance - A or B.

The trunk switch number - 0 to 9 from the bottom up on the frame.

The horizontal level on the trunk switch, usually called "level," which may be 2 to 9, inclusive.

The arrangement of the junctors between the line link frames and trunk link frames is such that all line link frames have equal access to all trunk link frames and vice versa. Since a line link frame provides space for 100 junctor terminations and a trunk link frame provides space for 200 junctor terminations there are normally one-half as many trunk link frames as line link frames. The minimum number of junctors between one line link frame and one trunk link frame is 10. Hence the maximum number of frames with which a particular line link frame may be interconnected is 10, or the maximum number of line link frames with this arrangement is 20.

In order to increase the maximum number of frames which may be used in one marker group, extension bays are provided on the junctor switch side of the trunk link frames when desired. The extension frame consists of ten 200-point, 3-wire switches similar to the junctor switches located on the junctor switch bay. The switches on the extension frame have capacity for 200 junctors and the junctor switches also have capacity for 200 junctors, thus providing a total capacity of 400 junctors per trunk link frame. The junctors on the extension bay are assigned to line link frames 20 to 39. The junctor terminations of two trunk link frames are multiplied, providing a total of 400 junctors per pair of frames. With this arrangement when 20 trunk link frames are provided, a total of 4000 junctor terminations will be available. This is also the capacity of 40 line link frames and provides for a minimum of 10 junctors between each pair of trunk link frames and each line link frame.

A later development permitting a maximum of 30 trunk link and 60 line link frames per marker group was made available in 1957. This development applies only to offices equipped with wire spring completing markers. With this arrangement a second extension trunk link frame is added to each trunk link frame and is interconnected with the extension trunk link frame for triple-frame operation. This is necessary to provide at least ten junctors between each line link frame and each trunk link frame. The second extension trunk link frame is the same as the extension trunk link frame and provides means for terminating an additional 200 junctors to line link frames 40 to 59. Thus a total of 600 junctors are provided for the triple frame combination, or ten junctors each to a total of 60 line link frames.

Cabling of Trunks and Originating Registers

Trunk relay equipment is required for every type of trunk associated with the trunk link frames. These trunk units are mounted on relay racks. Each trunk circuit and each originating register has a number of leads cabled to a relay equipment unit on a trunk link frame; among these are the tip (T), ring (R), sleeve (S) and frame (F) leads. These leads are cabled to either an FA or FB relay depending on whether the trunk is given an A or a B appearance on a trunk link frame. Each trunk link frame is equipped with 80 FA and 80 FB relays corresponding to the 80 A and 80 B locations for trunks and originating registers.

Each trunk which handles calls either originating or terminating outside the office is cabled to the MDF for cross connection to the outside conductors and to a line link frame equipment location if required. Trunks which require association with incoming registers for incoming calls are cabled to incoming register link frames. Trunks which require the use of outgoing senders are cabled to outgoing sender link frames.

All trunks which may be used to complete a call to a subscriber line in the office, for example, intraoffice, reverting ringing, incoming, and two-way trunks, are associated with ringing selection switches. Each ringing selection switch serves a maximum of ten trunks. Usually a ringing selection switch is mounted on the relay rack immediately above the trunk relay equipment it serves.

Due to the control arrangements used, it is necessary that the trunks served by a particular ringing selection switch appear on a given trunk link frame, on the same trunk switch level, with one trunk on a trunk switch. Conversely, the ten trunk link locations made up of a particular level on the ten switches of a particular trunk link frame must be served by the same ringing selection switch if all ten are used for trunks requiring ringing. Of course, some of these locations may be unequipped or may be used for trunks which do not require ringing.

Trunks associated with ringing selection switches must be cabled to B appearances on the trunk link frame. Thus a trunk link frame has capacity for 80 trunks which require ringing.

All circuits selected as the result of the operation of a route relay in the marker (out-going trunks, originating registers, calling end of intraoffice trunks, etc.) must be assigned to trunk link frame locations which are provided with busy test leads so that the marker can select an idle circuit in the group desired. The busy test leads are cut through to the marker for testing by trunk block (TB) relays. The cabled association of busy test leads, trunk block relays and locations on the trunk link frame is shown in Figure 2-10.

Circuits to be selected by marker action may be cabled to either A or B appearances to the extent that busy test leads are provided as shown in Figure 2-10. Since there are six trunk block relays each with 20 associated locations, a maximum of 120 circuits which are to be selected by operation of a route relay in the marker, may be cabled to one frame.

Circuit Operation for Trunk Selection

On an incoming call the marker is directed to the particular trunk in use by an indication received from the incoming register. The particular trunk used for a particular call is determined by the selecting mechanism at the originating office. If the call is one which is to terminate in the No. 5 office, the marker obtains access to the trunk through the trunk link connector and sets up a connection to the called line. If the call is one which is to be switched through the No. 5 office, the marker obtains the trunk number, consults a trunk number group to determine the line link frame address of the trunk and then sets up a connection to a tandem completing, toll switching, intertoll, or miscellaneous trunk as required. If the called line is busy, or if all completing trunks are busy, the incoming trunk is set to return the line busy or overflow signal as required.

The trunk number is a 3-digit number. For tandem trunks incoming from other offices, the trunk number is obtained from the incoming register link frame. The units digit of the number must be the same as the units digit of the vertical with which the trunk is associated on the incoming register link frame. The tens and hundreds digits may be assigned by cross connections on the incoming register link frame but must be the same for all trunks associated with a particular right or left half-switch on the incoming register link frame. For intermarker group tandem trunks the trunk number is obtained from a vertical assigned to each trunk for that purpose on the out sender link frame.

In the case of a demand for dial tone connection to an originating register, a demand from an originating register for connection to an outgoing, intraoffice, or other trunk, or a demand from an incoming register for connection to a tandem completing, toll switching or intertoll trunk, the marker must select an idle circuit in the proper group. Except for particular situations, which are discussed later, the trunks in the group of which one is to be selected by the marker are spread over all trunk link frames. The procedure followed in locating an idle circuit of a particular group is discussed in the following paragraphs. For convenience it is assumed that an outgoing trunk to a particular destination is to be selected although the principles apply to the selection of an originating register or any type of trunk selected by marker action.

The operation of the route relay in the marker for the desired route causes the operation of a frame connector (FC) relay, also in the marker, and cabled to the particular route relay. As mentioned above each trunk location on the trunk link frame has an associated FA or FB relay. One of the contacts of each of these relays associated with a location having a busy test lead as shown in Figure 2-10 is brought out to an FT (frame test) terminal in a cross-connection field on the trunk link frame. When the particular trunk is idle this terminal is grounded.

The FT terminals for the trunks in a particular group on one trunk link frame are strapped together and a cross-connection run to an FTC (frame test connector) terminal, also on the trunk link frame. The FTC terminal is cabled to a contact of the FC relay, associated with the particular route in each marker. The FTC terminal from each trunk link frame having trunks in the particular route is cabled to a different contact on the FC relay. The FTC terminal will be grounded unless all trunks in the route on a trunk link frame are busy. Thus by operation of the FC relay the marker is able to determine which trunk link frames have idle trunks in the desired route.

Each route relay provided in each marker has an associated FC relay. These FC relays are numbered to correspond with their associated route relays. The corresponding contacts on correspondingly numbered FC relays in all markers are strapped together and each set of contacts cabled to an FTC terminal on a particular trunk link frame. Thus each FC relay has as many working contacts as there are trunk link frames and, by means of the FT to FTC cross connections any equipment locations on the trunk link frames which have busy test leads, may be associated with any FC relay and thereby with any route relay. A total of 460 FTC terminals are provided on each trunk link frame so that a maximum of 460 FC relays and corresponding route relays may be used in a marker group (Flat spring markers).

A memory circuit in the marker retains the number of the trunk link frame with which the marker worked on the last call it handled. If there are idle trunks of the desired group on all frames and, if there is no interference from other markers, the marker will select the next higher numbered trunk link frame. However, if this first choice frame has no idle trunks of the desired group, or if it is being held busy by another marker attempting to complete a connection, the marker will select the next higher numbered frame which is idle and has at least one idle trunk in the desired group.

Having selected the trunk link frame through which it will attempt to complete the call, the marker must make a selection among the idle trunks of the desired route on that frame. The operation of the TB relay assigned to the trunk link frame locations on which the trunks of the desired route are located closes through the busy test leads to the 20 trunk equipments (assuming all 20 locations are equipped) with which the TB relay is associated. The proper TB relay is operated by the route relay in the marker. Thus, it is seen that all trunks of a particular route must be assigned to locations associated with one TB relay (except for allotted groups discussed later) on a particular trunk link frame and with the same numbered TB relay on all frames. It is not necessary, however, that the equipment locations be identical on all frames.

In the general case only a part of the 20 trunk link frame locations associated with the TB relay are used by trunks of the desired route. Each trunk link frame location which is associated with a TB relay has a lead brought out to an "F" punching on the trunk link frame. The "F" punchings for the trunks to the desired destination are strapped together and cross-connected to a TG (trunk group) terminal on the trunk link frame. The marker reaches the TG terminal for the desired route by means of a contact on the route relay. The combination of an operated TB relay and the TG indication of the route relay causes the busy test leads of all trunks associated with the desired route on the selected trunk link frame to be presented to the marker for testing. A sequence circuit in the marker determines which trunk is first choice for the particular call and the order of testing if the first choice trunk is busy.

The result of the method of trunk selection just described is that the traffic over a particular trunk group is distributed practically uniformly over all the trunks in the group with each trunk carrying its proportionate share of the CCS load on the group.

Since the TB relay is designed to handle the busy test leads from twenty trunk appearances, this is the maximum number of trunks on one trunk link frame which can be tested at one time by the marker. Hence the maximum number of trunks in one group, if the allotter feature is not used, is twenty times the number of trunk link frames.

The 20 busy test leads associated with each TB relay may be used for as many as 20 (00-19) TG indications. Hence, the associated 20 trunks may be assigned to as many as 20 different trunk groups. Since the TG indication for a particular route is given by the route relay assigned to the route, all trunks in a particular group must be given the same TG number on all the frames on which they appear. The same TG number on the same TB relay may be used for two different groups of trunks provided the two groups are on different trunk link frames, that is, there is no instance in which trunks from both groups appear on the same trunk link frame.

If more than 20 trunks per trunk link frame are required in a particular group of interoffice or one-way outgoing trunks, or more than ten trunks per trunk link frame in a particular group of two-way trunks, approximately half of the group is assigned to each of two trunk block relays on each frame to provide two subgroups. A two-step allotter circuit in each marker is used to cause it to alternate its first choice between the two subgroups on alternate calls. On any particular call, if the marker finds all the trunks in its first choice subgroup busy, it will test the trunks in the other subgroup before advancing to an alternate route or to set overflow. In this way a group equal to 40 times the number of trunk link frames can be obtained as a maximum. Since the allotter feature causes some increase in marker holding time it is seldom used unless necessitated by a group size larger than mentioned above.

With allotted trunk groups it is possible to have each subgroup served by a different group of outgoing senders. When this is done, the marker will advance to test its second choice subgroup in cases where it finds all senders associated with the first choice subgroup busy even though there are idle trunks in the first choice subgroup.

Number of Frames

Since the traffic load capacity of trunk link frames is 2520 CCS, the number of frames required for load is half the number of line link frames. However, with the limited number of trunk spaces on a trunk link frame (160), it is sometimes difficult to obtain good arrangements of trunks on the frames with this minimum provision because of:

a. The need for providing an adequate number of the many separate types of trunk equipment.

b. The relatively high number of miscellaneous trunks.

c. The inefficiency of small trunk groups in small jobs.

d. The difficulty in accurately estimating trunk needs for a growth marker group making it necessary to provide reasonable margins.

e. The necessity for providing trunk arrangements for two entirely different conditions; a cutover period with maximum operator handling of calls and an exhaust period with maximum subscriber dialing of calls.

All of the factors mentioned above tend to increase the number of trunks of all types required, and providing initial frames on a load basis may result in excessive trunks per frame when compared to full marker group requirements. A choice has to be made, therefore, as to whether to place these initial trunks on the fewest number of frames or provide frames on the basis of the ultimate trunk arrangement.

As it does not appear probable that any of these conditions can be wholly eliminated, it is recommended that on any No. 5 crossbar job two layouts of the assignment of trunks to trunk link frames be made; the first based on minimum number of trunk link frames only, and the second based on a full marker group with ideal trunk distribution over all frames. This would be cut back to the number of trunk link frames needed to provide the trunks for the current job. It will then be possible, on a job basis, to weigh the cost of advancing the installation of trunk link frames against the cost of any later rearrangement.

The above recommendation will normally result in spare trunk link terminations being provided initially and care should be taken to assure proper apportionment of these spare appearances among the various trunk classes.

As a final check it is recommended that a minimum of 10% spare terminations be provided on each trunk link frame in offices having a reasonable growth potential.

When the number of trunk link frames provided exceeds one-half the number of line link frames the junctor pattern will be provided on the basis of the number of trunk link frames. For example, if 16 line link and 10 trunk link frames are provided, the junctor pattern for 20 line link - 10 trunk link frames will be used and 10 junctors (100 divided by the number of trunk link frames) will be provided between each line link and each trunk link frame. Thus the junctors will carry the planned load for the pattern used but the trunk link frames will carry less than 2520 CCS assuming that the line link framer are normally loaded. On the other hand, the number of junctors provided between each line link and trunk link frame will be decreased by using a 16 LLF -

10 TLF rather than a 16 LLF - 8 TLF pattern. The combined effect of these factors on matching loss performance varies depending on the frame quantities involved. However, in no case where this type of pattern is employed should the matching loss exceed engineered service objectives.

Distribution of Trunks on Trunk Link Frames (New Offices)

Since the trunk units are cabled to their locations on the trunk link frames, it is necessary that detailed assignments be made for all types of circuits appearing on the trunk switches. Starting from a trunk estimate,the number and type of trunk circuits to be used for each trunk group can be determined. In many instances several groups will require the same type of unit. The total number of relay equipments of each type, including spare equipments is determined. It is the usual practice to carry the type designation of the trunk unit for classification purposes throughout the traffic order and specification.

In the case of trunks requiring association with incoming registers, particular trunk circuits are usually cabled to particular incoming register link frames. Thus for assignment purposes the trunk units associated with each type of incoming register pulsing are considered separately. They are usually distinguished by adding a lower case letter to the trunk type designation, (d for dial pulse, m for multi frequency).

Occasionally it may be necessary to change the association of certain incoming trunk groups from one register group to another. This may occur, for example, in the case of trunks from a manual office to be cut over to dial within the engineering period of the No. 5 job. If the manual office has dials on the switchboard the trunks require association with dial pulse incoming registers. Assume that the manual office is to be cut over to No. 1 crossbar with customer dialing to the No. 5. The trunks must then be associated with revertive pulse incoming registers after cutover. These cases should be reviewed with the Engineering Department so that the reassociation can be made at cutover without the necessity of providing trunk units for both the manual and dial basis since the same trunk relay can usually be used for both types of pulsing.

In some jobs it may be found that only a relatively small number of outgoing trunks requiring a particular type of out pulsing are required. In such a case a saving in outgoing sender link frames can be made if these trunks are confined to a minimum number of trunk link frames. The outsender link switch arrangement per trunk link frames resulting from this plan should be specified in the Telephone Company specification.

The use of the type designations of trunk relay equipments is illustrated in Figure 2-11.

Originating registers are not given a trunk type number but are usually designated by a capital "A". Similarly, the location on a trunk link frame used by the master test frame is usually designated by "B" as it does not require a trunk relay equipment.

When the number of relay equipments of each type has been determined the various types are separated into groups according to the way the trunks are to be assigned to locations on the trunk link frames. Figure 2-11 shows a simple case of a local No. 5 office where the groups are:

Intraoffice trunks
Two-way trunks - those requiring both ringing selection switches and TB relays
Originating registers
Outgoing trunks - those requiring TB relays
Incoming trunks - those requiring ringing selection switches.

As shown in Figure 2-11, the various types of trunk equipments within each group and subgroup are arranged in order by the number of trunk equipments to be provided starting with the type requiring the largest number.

Figure 2-11 also shows the distribution of trunks over the trunk link frames. The chief objective in making this distribution is to spread the CCS load over all frames as evenly as is economically practical. For the most part this objective can be accomplished by spreading the trunk equipments of each type over all frames so that, as nearly as possible, the same number of trunks of each type appear on each frame. However, there are a number of factors which tend to prevent complete application of this principle so that compensating adjustments are required. The more important considerations are:

a. Many of the equipments are provided on the basis of two or more trunk circuits per unit in order to save space on the trunk relay racks. This makes no difference in the case of trunks not requiring ringing selection switches except that the number provided should be an integral multiple of the trunks per mounting unit. However, in the case of trunks requiring ringing selection switches, the trunks which are mounted as a unit must be cabled to the same trunk link frame. Hence, a number which is an integral multiple of the number of trunks per mounting unit must be assigned to each frame.

b. The number of trunk circuits of some types is less than the number of trunk link frames.

c. In offices having paired or tripled trunk link frames it is desirable that all types of trunk equipments be spread over as many pairs, or triples of frames as possible. This principle becomes applicable only when the number of trunks is less than the number of frames. Normally frames 00 and 01, 02 and 03, etc., are paired and 00, 01, 02, and 03, 04, 05, etc., are tripled that is, they are served by the same group of junctors. Thus, for example, suppose that 8 trunks of a particular type are provided in an office having 16 trunk link frames. If one trunk is associated with each pair of frames the junctor access to the group will be at a maximum and hence calls lost due to failure to match will be at a minimum.

d. Intermarker group subscriber-to-trunk, that is, trunks for completing calls from subscribers in a non-tandem marker group to outgoing trunks in the tandem marker group, use the units digit of the number of the trunk link frame on which the called ends are located as the hundreds digits of their number group trunk numbers. These trunks are assigned as "bunched" trunks, that is, several trunks use the same trunk link frame location on the incoming ends. It is important that the locations used for the incoming ends be coordinated with the directory numbers reserved for trunk numbers. When subscriber number groups are used for trunk numbers it may be necessary to limit these trunks to not more than two trunk link frames.

e. There are a number of limitations on the association of trunks requiring incoming register link frames which may affect the way these trunks are distributed over the trunk link frames. These limitations are discussed in Section V. covering incoming registers and incoming register link frames.

f. Complete flexibility does not exist in the cabling of originating registers to trunk link frames. Considerations involving trunk link frame assignments of wire spring type originating registers are covered in Section V.

Non-wire spring type originating registers are mounted five on an originating register frame. The five registers or less on a frame must be cabled to either one or two trunk link frames. When split between two trunk link frames the split may be made between any two consecutively numbered registers. It is not necessary that the cabling be to two adjacent or consecutively numbered trunk link frames. The problem of making this distribution is somewhat simplified if the number of originating registers per five trunk link frames is computed and a distribution made as shown by the following table.

Orig. Regs. per 5 TL Frames	Trunk Link Frame No. Orig. Regs. 00	01	02	03	04
15	3	2	3	4	3 & Repeat
16	3	3	4 & Repeat		
17	3	4	3 & Repeat		
18	4	3	3	4	
19	3	4	4	4	4 & Repeat
20	4 & Repeat				

A chart showing the particular originating registers cabled to each trunk link frame shall be provided by the Telephone Company in the Telephone Company specification. Since the CCS load on originating registers is comparable with that on large trunk groups, the unbalance caused by these restrictions can be compensated for most easily by providing a compensating unbalance in the distribution of outgoing trunk equipments of a type that are to be used for large groups of trunks.

g. On jobs where the number of line link frames is one less than twice the number of trunk link frames, some reduction in the work of moving and recabling trunk equipments with the first addition may be effected by special attention to the way in which the trunk equipments are arranged initially. The trunk estimates may be made and the layout work done on the basis of the number of lines which would require the additional line link frame. The locations for the excess number of trunks obtained are indicated as reserved for the particular types required. When this is done, the engineer will reserve space on the trunk relay racks and provide cabling so that the trunk equipments may be added later at a minimum cost.

In making the distribution of trunk equipments over the trunk link frames, the most efficient procedure is to arrange the various types of equipments required in the order shown in Figure 2-11. Assignments are started with the first item and the various items taken in the order in which they appear with one exception.

It is well to leave the types of incoming trunks which produce no CCS load on the trunk links (bunched trunks) until last as they will not disturb the loading balance.

The first type of trunk is distributed as evenly as possible over all of the trunk link frames. The second type is handled in the same way except that adjustments are made to compensate for unavoidable unbalances in the first type. This process is repeated until all types have been distributed. It will be found helpful if subtotals by major groups are maintained as illustrated in Figure 2-11.

The case where only a relatively few outgoing trunks require a particular type of pulsing and it is desired that their distribution be restricted to only a part of the trunk link frames in order to economize on outgoing sender link frames requires special consideration. Exact rules to be followed in such cases can not be established. The general principle is that any restriction in the distribution will tend to increase marker holding time by increasing the number of times the marker can find an idle trunk only on a frame which is being held by another marker. However, the effect is not serious if the trunks are spread over a number of trunk frames which is greater than the number of markers and if the number of calls involved is less than five per cent of the total originating calls. In general it is not desirable that the number of frames over which important groups, such as groups to tandem used as an alternate route, are spread be limited artificially.

Additions to Existing Offices

Additions to existing offices should be possible with a minimum of trunk rearrangements, provided the initial job was engineered as recommended.

Where trunk distribution is substantially changed from original plans due to such factors as changes in traffic distribution by individual trunk groups, rate changes, area transfers, etc., it may be found that the number of additional trunk equipments required does not provide the proper numbers and types to continue the previous distribution patterns on the new trunk link frames.

In these latter instances a complete redistribution of trunk equipments in accordance with the practices followed with initial jobs is not practical because of the cost. Outgoing trunk equipments not requiring senders can be recabled rather easily but those requiring senders must have the cabling to both the trunk link and outgoing sender link frames changed. Because of the restrictions on the association of trunks requiring ringing selection switches with these switches, and with incoming register link frames the cost of reassociation with trunk link frames is high.

In view of the above factors trunk link frames added under these circumstances are generally loaded by the following procedure:

a. Associate the new trunk equipments and originating registers with the new trunk link frames insofar as is practical. Of course, if a new type of trunk is being added, the equipments must be spread over an adequate number of trunk link frames.

b. Change the association of existing trunk equipments from the old frames to the new ones as required to obtain an adequate load. In general, preference is given to moving in the following order: outgoing trunks not requiring senders, outgoing trunks requiring senders, incoming trunks, inter-marker group trunks, intraoffice trunks, and originating registers. Consideration should be given to the fact that standard cabling of equipment is always from the lowest numbered relay rack unit of a group, up. Therefore, it is always easiest to disconnect the highest numbered unit of a group and, generally, it is possible to do so without disturbing the lower units. Furthermore, when the lower units are to be disconnected, it is necessary to take all higher numbered units of that group out of service until the necessary recabling within the group is completed. This unnecessarily increases and complicates transition work.

It is recommended, in the traffic engineering practices, that when trunks which require ringing selection switches are to be moved the preferred practice is to physically move the trunk relay equipment to the new trunk relay rack. This can be done without requiring additional expenditure for ringing selection switches and trunk relay rack space if the number of trunks moved is such that they do not increase the number of ringing selection switches on the new relay racks. For example, assume that an addition requires one new trunk link frame and fifteen new trunks which require ringing selection switches all of which are to be associated with the new trunk link frame. Two ringing selection switches must be provided for the fifteen trunks. Five or fewer trunks can be moved from old frames to the new one without increasing the expenditure for ringing selection switches. In most cases, the total trunk relay rack requirements will not be affected nor will the cabling costs be materially increased.

In any compromise involving deviations from ideal balance it is desirable that the relationship between incoming and outgoing CCS load be fairly uniform over all the frames.

In cases where an addition results in the number of line link frames being one less than twice the number of trunk link frames, it may be desirable to estimate the number of trunk equipments and make the new trunk layout as though one more line link frame were being provided. The locations on the new trunk link frames occupied by the excess trunks are marked as reserved for the particular types of equipment involved. Space will be reserved on the trunk relay racks and cabling arranged so that later additions and changes can be made at a minimum cost.

In cases where changes in requirements result in an excess of trunk equipments of a particular type, it is not necessary that the equipments be physically removed or the cabling disconnected unless the locations on the trunk link frames or the trunk relay rack space is required for other purposes.

Location of Trunks on Trunk Link Frame

It is necessary that the Telephone Company specification show the assignments of trunks and originating registers to particular locations on the trunk link frames. Because of circuit operation the assignments must be made in accordance with certain rules. Figure 2-12 shows a form which is used for making these assignments. These forms are provided as a part of the No. 5 Questionnaire. The arrows on this form show the general order of making assignments. The following rules cover the limiting requirements.

A. Intraoffice Trunks

These trunks are a combination of outgoing and incoming trunks. Since one trunk of the group must be selected by the marker the outgoing end of the trunk requires a TB relay. Since the incoming end is associated with a ringing selection switch it must be assigned to a B appearance. Both appearances of a particular trunk are on the same trunk link frame and on the same level, but the A appearance is on the next lower numbered switch from the B appearance. Number 9 is considered as next lower than 0 in making these assignments.

These trunks are assigned in order to level 6, 7, 8, or 9 since these levels do not have a TB relay associated with the B appearances.

B. Two-Way Intertoll Trunks, Reverting Ringing Trunks, Ringer Test Trunks

Two-way intertoll trunks are considered in two categories. When these trunks are both selected by the markers for outgoing calls and terminate on the switches for incoming calls, they are similar to outgoing trunks in that they require TB relays. They are also similar to incoming trunks in that they require ringing selection switches. Hence, they must be assigned to B appearances on level 2, 3, 4 or 5. They are usually started at 5B and continue downward on the form.

In some cases the two-way intertoll trunks appear on the No. 5 switches for incoming traffic only with the appearances at the toll board used for all outward traffic. In such cases the trunks do not require TB relays but do require ringing selection switches. Assignments may be made to any B appearance but, because of the possibility of a future need for selecting the trunks by marker action for outgoing calls, the usual practice is to make assignments as described in the preceding paragraph.

Reverting Ringing and Ringer Test Trunks require both ringing selection switches and TB relays. They are assigned to B appearances on level 2, 3, 4 or 5 usually starting at 5B and continuing downward on the form.

C. <u>Originating Registers</u>

Originating registers require a TB relay. The circuit operation requires that they be assigned to 2A starting with switch 0 and continuing consecutively to the higher numbered switches.

D. <u>Outgoing Trunks</u>

Outgoing trunks require TB relays but not ringing selection switches. Assignments are made in order to the A appearances of level 2 where the originating registers end and continuing upward to meet the outgoing end of the intraoffice trunks and to fill through level 9. They are then continued to the B appearances of levels 2, 3, 4 and 5.

Those types of circuits used for only one trunk group all must be assigned to the same TB relay except when allotted.

Where the trunk equipments of a particular type are to be used for a number of different trunk groups, for example, outgoing interoffice trunks, they may be assigned to more than one TB relay. However, the greatest flexibility of trunk administration is obtained when they are all associated with the same TB relay. To obtain this result, assignments are made to B appearances of levels 2, 3, 4 and 5 before all A appearances have been assigned.

When the number of trunk circuits of a particular type is in excess of 20 per trunk link frame, it is necessary to assign them to more than one TB relay. If the circuits are to be used as a single trunk group the allotter feature in the marker is used and the equipments are divided equally between two TB relays. If the circuits are to be used for several different trunk groups not one of which exceeds 20 per trunk link frame, no allotting is done. In this latter case, the best method of dividing the circuits between the two TB relays is determined by the number and sizes of the expected trunk groups with the division made in such a way as to provide maximum flexibility of administration. All trunks in a particular trunk group must be on one TB relay on a particular frame and on the same TB relay on each frame.

E. Intermarker Group Trunks

The intermarker group trunks require TB relays on the trunk link frames of the originating marker group, and ringing selection switches on the trunk link frames of the terminating marker group. Hence, they are assigned with the outgoing trunks of the originating marker group, and with the incoming trunks of the terminating marker group. It is usually desirable that the outgoing ends of intermarker group subscriber-to-subscriber trunks be assigned to the same TB relays as the intraoffice trunks having the same charge features. When a marker group has reached full size and growth in the building is being taken in other marker groups, the number of intermarker group trunks per trunk link frame will tend to increase, while the number of intraoffice trunks decreases. Adjustments can be made with decreases. Adjustments can be made with less expense if the two types are associated with the same TB relay. To meet this situation, the allotting feature may be required for groups having fewer than 20 trunks per trunk link frame.

F. Incoming Trunks

All types of one-way trunks which handle calls terminating in the No. 5 office require a ringing selection switch, but do not require a TB relay. These trunks may be incoming interoffice trunks, tandem trunks, one-way intertoll trunks, and various others for which at least some of the calls terminate in the No. 5 office. The types that handle traffic which are totally switched through the No. 5 office are discussed below.

These incoming trunks are started at 9B and continue downward through the B appearances until they meet the terminating appearances of the intraoffice trunks. They skip the terminating appearances of these latter trunks and the appearances of the two-way intertoll, reverting ringing and ringer test trunks and then continue downward to 2B.

G. Master Test Frame

One location on a B appearance on any trunk link frame is required for the master test frame to obtain access to subscriber lines. This location is assigned as if it were an incoming trunk.

H. Bunched Trunks

Trunks outgoing from the switchboard, which require appearances on the No. 5 equipment for marker pulse conversion and a few types of trunks which are used entirely for calls to be switched through the No. 5 equipment, require locations on trunk link frames so that the marker may obtain access to them for setting up an overflow signal under certain conditions. Several of any one type of these trunks may be multipled on one trunk link frame location. The location used may be either an A or B appearance but the level used must be equipped with a ringing selection switch. In general, an A appearance is preferred in order that the corresponding B appearance may be used for a trunk requiring a ringing selection switch. The types of trunks which may be so treated are indicated in this section under trunks.

In making the assignments each such type of trunk is considered separately and assigned one appearance per trunk link frame for all trunks which are to be associated with that trunk link frame. These assignments are usually made last after a switch balance has been obtained.

In making the assignments of trunks, it is found most advantageous to proceed in the order in which the trunks are shown in Figure 2-11. Under each major category the types are assigned in descending order by the number of equipments provided. Each type of trunk is assigned on all trunk link frames before proceeding to the next type in order to keep the frames as nearly alike as possible.

Insofar as possible each level is completely filled as trunks are assigned to it.

One ringing selection switch serves the trunks assigned to the ten switches on a particular B appearance and level. Hence, if any trunks requiring ringing selection switches are assigned to a particular level, it is desirable that all trunks assigned to that level be types that require ringing selection switches to the extent required to keep the number of ringing selection switches at a minimum. Trunks requiring ringing that are provided two per unit must be assigned to the same level and preferably to consecutive switches on the trunk link frame.

When locations are to be especially reserved for particular types of trunk equipments which are to be provided in the future, the assignments are made as though the trunks were being provided initially with suitable notations to indicate the reserved status. Such action is particularly desirable in connection with trunks which require ringing selection switches in order that the proper space will be reserved on the trunk relay racks.

Except for known requirements, it is usually unnecessary to reserve locations on the trunk link frames for specific purposes. In general, the number of originating registers and trunks per trunk link frame will tend to decrease as additions are made to an office.

This general tendency is due to the increase in trunking efficiency as the group sizes increase. When the marker group is filled, there is little tendency for the number of trunks per trunk link frame to change except in case of a major rate change or a change in trunking arrangements in the area. In an area where the number of offices in service is increasing rather rapidly, there is a slight tendency for the number of trunks per trunk link frame to increase. Such an increase applies primarily to the outgoing and incoming interoffice trunks. In these areas it may be desirable to reserve a few locations as spare on the TB relay used for outgoing interoffice trunks. Such action is exceptional, however, as the requirements can almost always be handled by making the assignments initially and with additions in such a way as to concentrate the unused locations on B appearances of levels 2, 3, 4 and 5 with preference given to the level having outgoing interoffice trunks on the A appearance. These spare locations are then usable as required for any types of trunks except intraoffice.

It is important in making assignments that all switches on a trunk link frame be given the same CCS load. If each type of trunk is spread over as many switches as possible and each switch assigned the same number of trunks, this requirement normally will be met adequately. Further refinement can be attained by taking into account the CCS load on each trunk by dividing them into two major classes of high, medium, and low usage in accordance with group sizes and use of the trunk. When any unbalance among the switches is unavoidable, it is best to have the switches with which originating registers are associated, lightly loaded in order to reduce failures to match on dial tone attempts.

On the basis of the typical trunking requirements shown in Figure 2-11 the assignment of trunks to Trunk Link Frame 00 is shown in Figure 2-12. A similar layout is prepared for each trunk link frame, and these frame layouts become a part of the Telephone Company specification.

D. JUNCTORS AND CHANNELS

Junctors

A junctor is a 3-wire circuit extending between a line link frame and a trunk link frame. It terminates on a vertical on the junctor switch of a line link frame and on a horizontal on a particular trunk link frame or pair of trunk link frames.

Each line link frame has 100 junctor terminations which are used to connect to all the trunk link frames in the office. Since each trunk link frame has 200 junctor terminations for connecting to all line link frames, the ratio of line link frames to trunk link frames in an office generally is 2 to 1. There are no half frames. (In an office with thirteen line link frames, there are usually seven trunk link frames.) However, conditions peculiar to a particular office may cause some variation in this ratio.

The 100 junctors from each line link frame are divided into approximately equal groups, with one group from each line link frame going to each trunk link frame. The number of junctors in a group depends on the number of trunk link frames in the office. The number of junctors per group is determined by dividing the 100 junctors on the line link frame by the number of trunk link frames. However, there is a limiting factor; for efficient service no group can contain less than ten junctors.

Junctor group sizes are provided in accordance with standard patterns and the standard pattern which most nearly fits the particular case is used. The standard patterns are listed in Figure 2-13.

The junctors in a junctor group are divided into subgroups of ten or less for test purposes. Figure 2-13, also shows the subgrouping for each pattern. Not more than two subgroups are tested on a particular marker usage and a walking and stepping circuit is provided in the marker to rotate the use of the various subgroups. The number of subgroups tested on each marker usage is limited in order to reduce marker holding time.

When there are ten or fewer trunk link frames in an office, each junctor group has ten or more; for example, in an office with six trunk link frames and twelve line link frames, each junctor group contains sixteen or seventeen junctors. Figure 2-14 illustrates the junctor distribution for two trunk link frames and four line link frames.

When more than ten trunk link frames are required to meet the needs of an office, each junctor from a line link frame is multiplied to two trunk link frames, which has the effect of doubling the number of junctors from the line link frames. Then each line link frame can supply a group of 10 junctors to as many as twenty trunk link frames.

With twice as many line link as trunk link frames for an office having twenty trunk link frames, there are a total of 40 x 100 or 4000 junctors from the line link frames. Since each of these junctors connects to two trunk link frames, there must be terminations on twenty trunk link frames for 8000 junctors, which are 400 per frame, twice the number shown in Figure 2-14. To secure these additional junctor terminations, extension bays are added to the trunk link frames and are connected to them as indicated in Figure 2-15. These extension frames are arranged like the regular junctor bays of the trunk link frames, and the verticals of the junctor bay and the extension bay are multipled. In this way terminations for 400 junctors are provided for each trunk link frame. When such extension frames are used, the trunk link frames are grouped in pairs, and each junctor from a line link frame is connected in multiple to junctor terminals on both frames of a pair.

In offices with 21 to 30 trunk link frames, each junctor is multipled to three trunk link frames. In an office with 60 line link frames, each junctor group contains ten junctors. Figure 2-16 illustrates the junctor distribution for 30 trunk link frames, their associated two extension frames, and 60 line link frames.

If there were always twenty line link frames and ten trunk link frames, the junctor terminals on the line link frames could be permanently connected to the junctor terminals on the trunk link frames; ten on each line link frame being connected to each of ten trunk link frames. Since the number of frames in an office may vary over a fairly wide range, however, and may change from time to time, a junctor distributing bay is provided to which the junctors from both line link and trunk link frames are connected. Here they may be interconnected by jumpers in the best way for each set of conditions.

This junctor grouping frame consists of fifty terminal blocks arranged in five columns of ten each, as indicated in Figure 2-17. Each terminal block provides double ended terminals for forty junctors - one end of each terminal projecting to the front of the bay and the other, to the rear. Junctor cables from four line link frames are run vertically down the front of the frame adjacent to each column of terminal blocks, and ten junctors from each of the four cables are connected to the terminals of each block. Junctor cables from the trunk link frames run horizontally across the rear of the bay; the 200 junctors from each frame are connected to the terminals of each of the five blocks in one row.

A channel is a combination of a line link, a junctor and a trunk link that can be formed, by crosspoint closures, into a chain that interconnects a line and a trunk. Each line link, junctor and trunk link consists of a tip, ring, and sleeve lead with a switch appearance at each end.

The ten or more junctors in a group connecting a line link frame with a trunk link frame are distributed over the ten junctor switches of both the line link and trunk link frames, the junctor switch number being the same on both ends for each junctor. There are ten line links serving each particular subscriber line on the line link frame, and these are also distributed over the ten junctor switches.

There are twenty trunk links serving each particular trunk on the trunk link frame, and these are also distributed over the ten junctor switches. Thus, when a particular line and a particular trunk for a unit consisting of, for example, twenty line link and ten trunk link frames are considered, there are ten channels available for a connection. These channels are numbered according to the junctor switches on which they terminate, as illustrated in Figure 2-18. An idle channel is selected by testing the ten channels at the same time. For job sizes other than the above, there are more than ten channels available. For example, in a 10 line link and 5 trunk link frame job, there are twenty channels provided, as illustrated in Figure 2-19. In these cases, additional tests are made when an idle channel is not found in the first ten channels tested.

It will be seen that the channel number also corresponds to the number of the line switch horizontal on which the line link appears, as well as the number of the trunk switch vertical on which the trunk link appears.

E. TRUNKS

General

In the No. 5 crossbar system all circuits connected to locations on the trunk switches of trunk link frames, except originating registers and a location for master test frame access, are classified as "trunks." Trunk relay equipment is required for each such circuit. In addition, a number of circuits which may be connected to line link frame locations, such as intercepting trunks, are also included in this section.

The types of trunks to be used in a particular office depend upon a large number of factors.

Some of these factors are:

- Method of charging - message registers or AMA.
- Presence or absence of coin lines.
- Whether local overtime charges are made.
- Whether the office functions as a tandem switching point.
- Whether the office functions as a toll center.
- Transmission requirements.

The variety of these conditions and the desire for economy in the provision of equipment have led to the design of a large number of different trunk units. These trunk units are mounted on relay rack frames. (See Figure 2-20)

All trunk units are listed in a trunk catalogue, with a separate type designation for each unit. Each trunk represents a unique combination of the features which are provided by different circuit drawings, or different wiring or equipment options.

The following is a general description of all the trunk types available in No. 5 crossbar.

Type A - Intraoffice and Reverting Call Trunks

Intraoffice Trunks

Intraoffice trunks are used for completing calls between subscribers in the same marker group only. Each trunk is given two locations on the same trunk link frame, one to be connected to the calling line and one to be connected to the called line.

Separate groups are required for non-coin and coin service. Because of the differences in the cost of the trunk equipment it is usually economical to provide two non-coin groups; one group for flat rate calls and another for AMA charging. Where message registers are used separate non-coin groups must be provided; i.e., flat rate and message register.

Reverting Call Trunk

A reverting call trunk is required to connect subscribers assigned the same line. Two means of handling reverting calls are available for flat rate lines, depending on the type of multi-party service furnished in the office. Two corresponding types of reverting call trunks are available.

One type is used for two-party full selective, four-party semi-selective, and ten-party divided code ringing. With this arrangement, the calling party dials the listed number and receives a busy signal. When he hangs up, the code ringing for the called party is put on the side of the line on which the called station is located and the reverting ringing code is put on the other side of the line. Thus the calling party may hear either the reverting ringing code or the called party's code.

The other type is used for four-party full selective and eight-party semiselective ringing. With this arrangement, the calling party dials the listed number and receives a steady high pitched tone. This tone is a signal to the calling party to dial his own station code which is usually shown on his number plate. The station code is a single digit number. After dialing the station code, a busy signal is returned and the calling party hangs up. Each party receives his regular ringing code. This arrangement may be used for two-party service, but the general practice is to provide a separate group of the first type of reverting trunks to avoid the dialing of the station code and to simplify the Plant Department work in connection with reassociation.

Type B - Trunks Incoming to No. 5 Equipment - Except Intertoll and Maintenance

An incoming trunk relay equipment is required for each trunk incoming to the No. 5 office, except trunks for maintenance purposes, or intermarker group trunks, all of which are covered elsewhere.

Interoffice Trunks

The types of trunk equipments shown under "interoffice" are used for incoming calls from other dial offices (except another No. 5 marker group in the same building, which uses intermarker group trunks). They all provide for immediate ringing of the called number. They may also be used from switchboards as toll switch trunks where immediate ringing is satisfactory.

By-Link Trunks

The by-link feature is required for trunks which are directly accessible to subscribers in a step-by-step office where second dial tone is not used.

The by-link feature avoids second dial tone and reduces the probability of loss of some of the pulses which may be dialed while the incoming register link is in the process of connecting the trunk with an incoming register. The feature does not store incoming pulses but is simply a means of rapidly gaining access to an incoming register. If pulsing starts before an incoming register is available, an overflow signal will be returned by the trunk equipment.

Trunks for Tandem Switching

When the No. 5 office is used as a tandem switching point some incoming trunks may be of a type which handle only traffic which terminates in the No. 5 office, while others handle calls which may either terminate or switch through, and still others handle only calls which switch through. The trunk circuits are different for these purposes, and generally it is not practical to convert from one type to the other. Hence, any required tandem operation should be anticipated with the initial installation.

Tandem trunks require one appearance on a line link frame and two number group appearances in addition to the usual trunk link location and incoming register link frame appearance. Tandem trunks that do not terminate traffic, may have a "bunched" appearance on the trunk link frame; i.e., all trunks on one trunk link frame use the same location.

Combined Terminating

Incoming trunk groups which handle only calls terminating in the No. 5 office may be combined into one group to a pair of offices provided the originating dial office or switchboard is properly arranged.

With incoming multi-frequency or dial pulsing, an initial digit prefixed to the numericals may be used for discrimination between different number series or between numbers within a number series as required. With incoming central "B" (Cordless "B") and revertive pulsing registers the High 5 - Low 5 indication may be used for selection between two number series or discrimination within one number series.

An incoming trunk group which handles both terminating and switched through calls will handle calls to all terminating designations by use of the office codes or, if the number of destinations is nine or less, by use of an initial digit prefixed to the numericals.

No-Test Trunks

A no-test trunk permits the DSA board or Test Desk to gain access to busy lines. The total number of trunks for both purposes can not exceed nine per marker group. The equipment provides for a maximum of ten trunks which have access to the no-test verticals on the line link frames but one is used by the master test frame. Access to the no-test trunks may be either on a 4- or 5-digit basis.

DSA Regular Trunks or Toll Switching

This trunk can be used for completing from either a DSA switchboard or toll board. Variations are provided for such features as coin control, controlled ringing, intramural, or extramural switchboard.

Operator Interlocal Junctor

These trunks, for use with No. 1 or No. 3 type switchboards are used to give operators at intramural switchboards access to the outgoing trunk layout of the No. 5 office. These trunks may be provided to complete traffic only to outgoing tandem trunks. Operator junctors used to complete calls to numbers in the No. 5 office are rated A&M only. Calls to numbers in the No. 5 office from the switchboard are completed over a separate group of regular DSA or a group of toll switching trunks. In cases where other than the above-mentioned type switchboards are installed two-wire circuits can be used to gain access to the No. 5 equipment.

Operator interlocal junctors used to gain access to outgoing trunks in the No. 5 crossbar office can only give a tandem class mark to the incoming registers and, therefore, can not be used to gain access to intertoll trunks. It is usually not economical to furnish these trunks unless the office is also arranged with tandem features for other items of traffic.

Operator junctors may prove economical for use in No. 5 offices which serve as a tandem center to permit completion of operator assistance traffic to those offices reached by the No. 5 office.

The same type of service can be furnished from a distant switchboard by providing regular outgoing trunk equipments at the switchboard and regular incoming interoffice tandem trunks at the No. 5 office.

Like any other incoming tandem trunk, operator interlocal junctors require line link frame appearances.

Information concerning operator intertoll junctors is covered under intertoll trunks.

Association with Incoming Registers

Each incoming trunk must be associated with a group of incoming registers in accordance with the type of pulsing involved. The association is by means of an appearance of the trunk on the appropriate incoming register link frame. Please refer to Section V for the assignment of trunks to incoming register link frames.

Type C. Outgoing Full Selector Trunks Except Intertoll

There are many outgoing trunks available incorporating many features. These trunks are used to connect to other dial offices, manual offices, either call indicator or straightforward, and tandem offices except for intertoll, toll switching, or intermarker group operation.

When outward pulsing of digits is required, the outgoing trunk must be associated with an outsender for the appropriate type of pulsing involved. The association is by means of an appearance of the trunk on an out sender link frame. Straight forward trunks to manual offices also require association with a sender when a subscriber line is connected directly to the trunk (i.e., it has not been routed via an AMA junctor as described below) and AMA charging may be involved on the call, or when through switched calls are completed to the trunks.

The chief problem involved in the selection of the proper types of outgoing full selector trunks for a particular office is in determining the most economical arrangement from the standpoint of the various charging conditions required.

Trunking for Coin Calls

There are available several different methods of handling dialable coin traffic and some of these are discussed below. Just which method should be used depends on several factors, i.e., amount of coin traffic, effect of type of trunking on common control, cost of a particular method, etc.

In offices where the coin lines are allowed to dial only one or two interoffice destinations, it may be the most economical arrangement to provide separate direct coin groups to each destination, or to provide a separate coin group to a tandem office to handle all outgoing coin traffic, or to provide a combination of these arrangements.

In other offices, it will be more economical to provide the "coin junctor" method of operation, providing separate high usage coin trunk groups to each destination where warranted, and routing the overflow coin traffic from all such routes via the coin junctors. These latter trunks carry the traffic back into the office as incoming tandem traffic to be distributed onto the appropriate non-coin outgoing interoffice trunks. Where coin junctors are employed it should be remembered that each call handled on this final route requires two completing marker uses and thereby adds to the load of those markers. Also, the junctor method of operation entails the addition of the tandem feature to markers and outgoing trunks which may not otherwise be necessary and adds materially to the customer's waiting time for start of ring on calls requiring out dial pulsing.

Trunking For Non-Coin Calls

Any or all of the three situations described below may be encountered in considering the trunking for non-coin, customer dialed, outgoing interoffice calls. The charging features required in the trunks are described in each instance.

To some destinations free service is given to all non-coin classes of service. For these groups the trunk equipments for direct trunks require flat rate charging conditions only.

To some destinations the calls may be free from some classes of service and charged, either by means of message registers or AMA, from other classes. For these trunk groups it is usually economical to provide common trunks for both the free and charge calls. However, if the proportion of the calls involving charging is extremely small, it may be more economical to use separate, high usage, direct groups with alternate routing for the message register or AMA calls. The alternate routing may be via a separate or common group to a tandem office, or via Message Register Junctors or AMA Junctors. AMA Junctors would be made up of a 1C5 Type Trunk plus a C174 Auxiliary circuit. Message Register Junctors would be made up of 1C145 Type Trunk plus C174. The plan of using separate groups is most likely to be economical when message registers are used and overtime is charged. The AMA feature adds little to the trunk cost but additional AMA trunks may increase the requirements for call identity indexers and recorders.

To some destinations the calls may be charged either by message registers or AMA to all non-coin classes. For these groups trunk equipments which provide the appropriate charging conditions are selected.

In all of these situations the usual practice is to plan the trunking on an alternate route basis whenever a tandem office is available. In most cases the tandem groups which carry the alternate routed calls are provided as a common group for flat, message register, or flat rate and AMA charge traffic.

When the No. 5 office operates as a tandem or when operator, coin, AMA or message register junctors are used, the tandem completing feature must be provided in all outgoing trunks over which calls switched through the No. 5 office are to be completed. This feature is required to give proper supervision when an incoming tandem trunk is connected to an outgoing tandem completing trunk. The tandem completing feature may be added to trunk equipments for which it is not provided initially but at a higher cost than for its initial provision.

Direct Distance Dialing

With the availability of customer direct distance dialing (DDD) the problem arises as to the proper method of handling that type of traffic.

Where the No. 5 office is an end office or has access to the intertoll network only through a No. 4A office, trunks such as 1C5 type will normally be used. These trunks may require a loop to CX converter such as a C172 type circuit depending upon signaling considerations.

Where the No. 5 office serves as a toll center or switching center with intertoll trunks appearing on the machine, two methods are available to provide customers access to the intertoll network.

a. AMA intertoll junctors. This circuit is a combination of a 1C5 outgoing plus a K75 incoming trunk. This, of course, is a junctor method of handling the call which means that these calls require two marker attempts as well as additional incoming register and associated link capacity.

b. Intertoll auxiliary circuit. With this method an auxiliary circuit such as 1K53 must be provided with each K-type two-way or one-way outgoing intertoll trunk to which the customers are to have access. This arrangement will provide direct subscriber access to the intertoll network.

To determine which method should be used requires careful analysis of the cost factors involved as well as the effect on the common control capacity, and will probably vary from office to office or from group to group depending upon particular conditions, routing plans, etc., for each office.

There may be situations where a combination of these methods might be used. For example, in order to provide service protection for DDD-type traffic from customers within a No. 5 office which is also used as an intertoll switching point it may appear desirable to put a direct group of high usage trunks (1C6-type trunk) to a 4A system for customer dialed traffic overflowing on intertoll junctors. This would permit some customer access to the intertoll network even when peaks occur on the intertoll trunk groups due to switched through traffic. In planning these arrangements it should be remembered that the marker can not route advance from an initial route of L-type trunks, or K-type equipped with subscriber direct access auxiliaries, to an alternate route of K-type trunks without auxiliaries.

Type D - Outgoing Trunks to Switchboards and Desks - Except Intertoll and Maintenance

The selection of the proper type trunks depends on the type and location of the switchboard or desk and various operating features required. Some of the operating features include coin operation, ringback from switchboards, coin control from switchboards, information and repair service arrangements, official line and official P.B.X. arrangements, and discrimination tones.

The trunks arranged for coin operation are all usable with ground start coin operation with coin boxes, or are convertible to this arrangement.

Recording-Completing or Special Service Trunks

From an equipment viewpoint, recording-completing trunks to toll boards, special service trunks to DSA positions, or a common group for both purposes, utilize the same type of trunk equipments. In some references to these trunks elsewhere in this text, they are mentioned as RC-SS trunks as a matter of convenience.

RC-SS trunks are always provided in separate groups for coin and non-coin. The latter may be further subdivided into separate groups for other classes of service where appropriate.

Vacant Code Trunks

When a subscriber dials a non-existent code, the call is routed to a vacant code trunk. Two types of vacant code trunks can be provided. One type of trunk will return a vacant code tone. The other type of trunk will route the call to an operator trunk (information, repair service, etc.). These trunks are provided for the type of service for which they are designed. For a more detailed explanation see Section VIII on other features and arrangements. Free trunk (official PBX), auxiliary for 191 coin collector, and announcement (time and weather) trunks are included in this group.

Type E - Trunks for Maintenance Purposes

All maintenance trunks are included in this series. They are provided for the following tests:

Transmission Test
Intertoll Trunk Test
Balance test termination

Intermittent trouble test
Permanent signal test
Incoming test
Message Register test
Outgoing to Local Test Desk
Incoming from Local Test Desk
Station Ringer Test
Test Trunk Ringing

Outgoing to Local Test Desk Trunks

These trunks are used so that installers and repairmen may reach the local test desk for tests of station equipment. They are usually reached by the dialing of a service code (XII or IIX). However, if pretranslation is provided, a central office type of code may be used.

Station Ringer Test Trunks

One group of ringer test trunks is provided for each marker group. In early jobs it was necessary to provide separate coin and non-coin groups where ground start coin operation was used. Effective with Issue 27D of the marker (shipment latter half of 1954) and 4B of the ringer test circuit improvements were provided which permits a single combined coin and non-coin group. To test a station ringer, an arbitrary central office code followed by the four numerical digits of the directory number of the station is dialed. The central office code provides information to the marker for routing to the ringer test trunk group while the numerical digits enable the marker to consult the number group and set the trunk ringing selection switch for the proper ringing code. In combined terminating offices different codes are required for each number series group. These trunks are also used to permit the installer to verify that the ring or tip party station of message rate lines is properly connected.

Test Trunk Ringing Circuits

The test trunk ringing circuit is required in connection with outgoing to local test desk trunks, incoming from local test desk trunks, and permanent signal test trunks when the test desk is so located that it is beyond a certain ringing range.

Type F - Line Link Frame Trunks

Line link frame trunks, type F, are a special type of trunk. They terminate on line link frames instead of trunk link frames. These trunks, therefore, require the assignment of subscriber (not trunk) directory numbers and line equipment locations. When these trunks are provided in groups, the size and assignment of each group are subject to the same requirements and limitations as subscriber lines in a terminal hunting group.

Line link frame trunks include, information service, office PBX, verification request, intercepting and no-such-number tone. For various applications of these trunks see the section on other features and arrangements.

Type G - Miscellaneous Lines, Circuits, Control and Indicating Units

Miscellaneous G type units are not actually trunk circuits. They do not have the usual trunk link appearances required for trunks. These units are used to connect subscribers to various tones or to care for irregular conditions. They are usually ordered as miscellaneous units in the 530 specification. Some of these units are specified by the Telephone Company while others must be added for operational features in the office.

Combination Tone Trunks

Intraoffice calls encountering a line busy, all originating calls encountering an overflow within the No. 5 office, partial dialed calls and, usually, vacant code calls are routed to combination tone trunks to permit the appropriate tone to be returned to the calling subscriber.

One group of trunks is required for non-coin lines and another for coin lines. The coin trunks are associated with coin supervisory link frames to provide for coin return when the calling subscriber hangs up after receiving the tone.

In general, the following provision of trunks is adequate unless local conditions indicate otherwise:

Non-Coin Trunks -

20 for 20,000 numbers
16 " 10,000 "
10 " 5,000 "

Coin Trunks -

15 for 1,000 coin lines
10 " 500 " "
6 " 250 " "

Common Overflow Trunks

Common overflow trunks are provided as a final route when all permanent signal holding or non-coin combination tone trunks are busy. Connection to the trunks will cause the subscriber to receive an overflow (paths busy) signal if the call reached these trunks because of all combination tone trunks being busy. Coin return and an overflow signal are furnished by the originating register if all coin combination tone trunks are busy.

Common overflow trunks are relatively simple circuits and may be provided on a somewhat liberal basis in order to protect the originating registers in the event of a cable failure. Ordinarily about 10 trunks per trunk link frame are installed unless this results in reducing the available spare trunk link frame locations below a desirable limit. A maximum of 99 trunks per marker group appears to be adequate for any installation.

Permanent Signal Holding Trunks

When an originating register fails to receive any digits within its time-out interval, it causes the subscriber line to be connected to a permanent signal holding trunk. The holding trunks are usually provided on the basis of one trunk per 700 main stations with a minimum of five per marker group. The one group of trunks is common to all classes of service.

Facilities are required for concentrating these trunks over a small group of trunks to a switchboard located either in the same building as the No. 5 equipment or in a distant building. A maximum of 21 permanent signal holding trunks may have access to one group of concentrating circuits. Usually two concentrating circuits for each 21, or fraction thereof, permanent signal holding trunks will be adequate. If more than 21 permanent signal holding trunks are required, a second group of concentrating circuits is provided and the permanent signal holding trunks equally distributed between the two groups.

Auxiliary Line Circuits (For Incoming-Only Subscriber Lines)

An auxiliary line circuit is required for each subscriber line which is to be used for incoming calls but not for calls originated by the subscriber.

Auxiliary Line Circuits (Ten-Party Tube Sets)

When tube type station sets are used with ten-party lines each such line must be associated with an auxiliary line circuit.

Auxiliary Line Circuits (Service Furnished on Common Line in more Than One Office)

These auxiliary circuits, listed as type G, are used when two line numbers, in different offices, are to be associated with the same subscriber line. These are primarily used with certain official line arrangements.

Outgoing Auxiliary Line Circuits and Emergency Subscriber Line Equipments

The outgoing auxiliary line circuit provides a jack appearance of selected lines at a No. 3 or 3CL switchboard in the same building, through which the operator may gain access to the line for an emergency call at any time.

The emergency subscriber line equipment provides a means of transferring the originating service of selected lines, by key control, to switchboards in the same or a distant building for use in catastrophe conditions.

The number of such circuits to be provided, and the lines with which they will be associated, are determined by consultation with the Commercial Department.

Auxiliary Coin Lines

This is a circuit which can be associated with a loop start coin line equipment, as a means of converting to ground start operation. One per coin line is required. Its general use for this purpose is not recommended; replacement of the line relay with a universal line relay will usually be more economical.

Coin Supervisory Circuits

The use and functions of coin supervisory circuits are discussed in considerable detail under the subject of coin operation in Section VIII.

The number of coin supervisory circuits provided for traffic is based on the coin busy-hour calls. Since the circuits are provided in groups of ten or less, including those provided for maintenance, it is necessary to provide additional groups if the total requirements exceed ten. A group of coin supervisory circuits can be used for the coin trunks of two marker groups in the same building.

Coin supervisory concentrating circuits may be provided to reduce the number of conductors to the switchboard if desired. These circuits are generally used when the switchboard is located in a distant building and may be used when the switchboard is in the same building. Usually the concentrating circuits are provided for each group of coin supervisory circuits. A maximum of twenty coin supervisory circuits may be associated with one group of concentrating circuits.

When concentrating circuits are used, one start circuit is required for each coin supervisory circuit.

Register Group Busy Circuits

One register group busy circuit is required for each group of originating and incoming registers, except incoming MF registers. The principal function of this circuit is to reduce permanent signal and partial dial time-out intervals when the respective register groups encounter a heavy load condition. (Exception: There is no reduced permanent signal interval in the case of incoming RP registers.) The reduced intervals contribute materially to the ability of the system to handled overloads.

All Markers and Transverters Group Busy Circuits

One circuit is required for each group or subgroup of markers and one for each transverter group. The circuit lights a lamp at the switchboard and at the master test frame when all markers or transverters in the group have been busy for a period of 41-73 seconds.

Ringback for Recording-Completing Trunks and Emergency Ringback Circuits

The ringback and emergency ringback possibilities are discussed in Section VIII covering other features and arrangements. The decision as to the type of service to be rendered on each RC-SS, regular DSA or toll switch trunk group is specified by the traffic engineer, but the quantities of ringback trunk circuits required are thereafter usually determined by the Telephone Company equipment engineer.

Type H - Marker Pulse Conversion Trunks - Except Intertoll

The marker pulse conversion job requires a trunk connected to a switchboard where it is desirable to convert the MF keyset outpulsing to either dial (DP) or revertive (RP) pulses as required by the particular trunk. This trunk only makes use of the pulsing paths in the office. It does not require a talking path.

Each circuit is arranged for an appearance at the switchboard as well as the necessary No. 5 equipment appearances. The circuits are ordered as part of the No. 5 office equipment.

Each marker pulse conversion trunk requires a location on an MF incoming register link frame and on an out sender link frame. In addition, all the trunks associated with a particular trunk link frame require a common trunk link location.

There is no access to these trunks for calls originating in the No. 5 office or incoming to the No. 5 office. (Certain CDO and intertoll trunks with marker pulse conversion features, which do have access for through switched traffic, are discussed later in this subsection.)

The coin control features of these trunks are the same as those for regular DSA or toll switching trunks.

The number of trunks is determined by the principles used for outgoing trunks and the particular function of the trunk, that is, interoffice, DSA regular, toll board toll switching, etc.

Type J - Intermarker Group Trunks

When two or more marker groups are located in the same building, trunking between them may be provided on a normal interoffice basis. However, it will usually be more economical to provide intermarker group operation. This consists of providing trunks designed for this specific purpose.

These trunks use locations on the trunk link frames in the calling marker group and also on the trunk link frames in the called marker group.

Three general classes of intermarker group trunks are available. The first class (subscriber-to-subscriber) is used purely for local traffic; that is, for calls originating in one marker group and terminating in the other. The particular types selected in this general class depend upon the charging requirements in the same way as intraoffice trunks. These trunks are provided on the basis of the same capacity tables as are used for intraoffice trunks.

The second general class of trunks (subscriber-to-trunk) is used for subscribers in one marker group to dial calls which are switched through the second (tandem) marker group to other offices. The particular types selected in this general class depend upon the charging requirements in the same way as intra-office trunks. The quantities of these trunks are determined in the same way as trunks to any other tandem center. On the called end, these trunks have one location for all trunks assigned to the same trunk link frame, but an individual appearance for each trunk on a line link frame.

For completion of customer DDD calls from one marker group, switched through a second marker group which has an intertoll trunk network and intertoll junctors, subscriber-to-trunk circuits similar to type J43 may be used. Where auxiliary circuits such as type 1K53 are used in place of the junctors, subscriber-to-trunk circuits similar to 1J3 should be used.

The third general class of trunks (trunk-to-subscriber) is used for calls which originate in other offices and are switched through the tandem marker group to subscribers in the non-tandem marker group. The quantities of these trunks are determined in the same way as other tandem completing trunks. As described below, two groups of this class of trunks are required when completion of toll calls is involved, one group from toll trunks and one from non-toll.

General Intertoll and Associated Trunks

The various types of trunk equipments used when the No. 5 office acts as a toll center are listed on Trunk Tables K to N, inclusive. A few of the "Trunks for Maintenance Purposes" listed on Table E are used in toll centers only.

Calls can not be switched to or from the trunks listed on Tables K to N and trunks listed on the other tables except for the following:

The "Combination Toll Switching with Outgoing and Tandem Completing" trunks listed as type L may be used for completing calls which originate in the No. 5 office itself (Outgoing), calls received over incoming tandem trunks (Tandem Completing), and calls received over incoming or two-way intertoll trunks (Toll Switching).

The "Trunk-to-Subscriber" intermarker group trunks listed as Type J may be used for completing calls received over incoming tandem trunks or over incoming or two-way intertoll trunks. Separate groups are required for tandem completing and toll switching.

As covered previously under "Outgoing Full Selector Trunks" - except intertoll (Type C) outgoing access to the intertoll trunks may be gained either through the use of auxiliary circuits (1K53) or intertoll junctors (1C5 + K175).

The "Line Link Frame Trunks" listed on Type G will complete calls received over any type of incoming or two-way trunk.

The types of "Trunks for Maintenance Purposes" indicated on Type E as required in connection with toll center switching, of course, work with intertoll trunks.

Type K - Intertoll Trunks

Intertoll trunks may require the following appearances on the equipment:

At the switchboard. Outward and two-way trunks. For use by the operator in completing calls.

On the trunk link frame. All intertoll trunks. When the trunks are one-way incoming, and are used only for through switched traffic, the appearances on any trunk link frame may be "bunched".

On the line link frame. Incoming and two-way trunks. For use in establishing through switched connections, or connections to auxiliary operators such as inward (Code "121"), TX (Code "11X"), etc. These trunks require two line link frame appearances.

On the incoming register link frame. Inward and two-way; and outward trunks involving marker pulse conversion.

On the outsender link frame. Two-way and outward trunks involving either through switched calls or marker pulse conversion.

When a switchboard in another building requires access to outgoing or two-way intertoll trunks on the No. 5 equipment, the trunks from that switchboard to the No. 5 equipment must be intertoll trunks. The same holds true for intramural switchboards when there is no switchboard multiple appearance of the outgoing or two-way intertoll trunk.

Operator Intertoll Junctors

In some No. 5 offices which serve as an intertoll switching center, it may prove desirable to provide the operators with access through the No. 5 switches to the intertoll network. This can be done by means of operator intertoll junctors. The incoming trunk circuit at the No. 5 office end would be type K80. Some of the advantages from handling operator toll traffic in this manner are:

1. Save switchboard multiple.
2. Make full use of machine alternate routing where used.
3. Peak on certain intertoll groups may cause overload on the junctors.
4. Normally it is desirable to have a final route to a higher CSP which may not be available on the regular No. 5 network.

Obviously then all the factors must be carefully weighed before a decision can be reached as to whether or not operator intertoll junctors should be used.

Operator intertoll junctors can only be employed in connection with a 3CL, 3C or 3 switchboard equipped with MF key pulsing, and do not have transmission characteristics satisfactory for through switched 121 calls. They are satisfactory for either originating or terminating intertoll traffic.

Type L - Combination Toll Switching With Outgoing and Tandem Completing

Type L trunks are outgoing from a No. 5 office, which may be used for completing, over the same trunk group, calls which reach the No. 5 office over intertoll trunks, originate in the No. 5 office, or reach the No. 5 office over incoming tandem trunks. The decision as to whether to use this arrangement or separate groups for a particular route usually depends upon economic considerations.

No provision is made for coin charging on these trunks as it is anticipated that the coin junctor arrangement will be used for coin calls which may be completed over them.

These trunks are not equipped for controlled ringing of the called number.

Type M - Two-Way Trunks to CDO

When the No. 5 office operates as a toll center for a CDO it is sometimes desirable to interconnect the two by means of two-way operator office trunks.

These trunks provide a path by which a CDO subscriber may reach the operator at a toll board located in the same building as the No. 5 equipment. Any type of call for a CDO number which reaches the toll operator is completed via the switchboard appearances of the trunks using marker pulse conversion to provide the necessary dial pulsing. A call for a CDO number which reaches the No. 5 office over an intertoll trunk is completed by the equipment via the trunk link frame appearance of these trunks.

The auxiliary equipments also shown as Trunk Type M are for use in cases where the switchboard trunk equipments for two-way operator office trunks have previously been installed at a toll board equipped with dials or DC key sets, and it is desired that they be adapted to provide a trunk link frame appearance in the No. 5 office for completing calls incoming over intertoll trunks. These trunks provide for immediate automatic ringing of the called number.

Type N - Other Trunks for Toll Centers

Trunk type N provides a list of other trunks required for toll center operation of a No. 5 office.

These toll switching trunks are used for completing incoming intertoll calls which are switched through the No. 5 office to terminate in other local or tributary offices served by the No. 5 office as an inward toll center. They provide immediate automatic ringing of the called number. No provision is made for switchboard appearances of these trunks. These trunks may operate with any type of outpulsing or may be used for completing calls to manual tributaries on a straightforward or ringdown basis.

The auxiliary outgoing equipments for use with ringdown intertoll trunks are required when a trunk link frame appearance is to be provided for existing ringdown intertoll, or toll switching trunks from the indicated types of toll boards located in the same building as the No. 5 equipment. Such a trunk link frame appearance is used to complete calls which reach the No. 5 office over an intertoll trunk.

This type includes the types of trunk equipments used for TX and three-digit operator codes. This type also includes some of the trunks for use on certain toll test desks.

Type P - CAMA Trunks

Type P trunks provide incoming, intertoll, multi-party junctor, intermarker group and 2-way circuits access to the CAMA facilities of a No. 5 crossbar office serving as a CAMA center.

Type R - Coin Zone Outgoing Trunks

Type R trunks or junctors provide features which permit No. 5 crossbar coin subscriber to dial directly beyond the local zone. An operator is required to determine that the correct amount is deposited for the initial interval and again if the call extends into overtime.

The Ringing Selection Switch

In providing telephone service, it is often necessary to connect more than one customer to a single line (party lines). This makes it necessary to supply different types of ringing codes in order to identify the party called. A party who has full selective ringing hears ringing only when his station is being called. A party who has semiselective ringing hears ringing for his own and one other station. On individual, 2-party, and 4-party full selective lines, each party hears only his own ringing. On 4-party and 8-party semiselective lines, he hears also the ringing for one other party. However, on 10-party lines, he hears the ringing for four others.

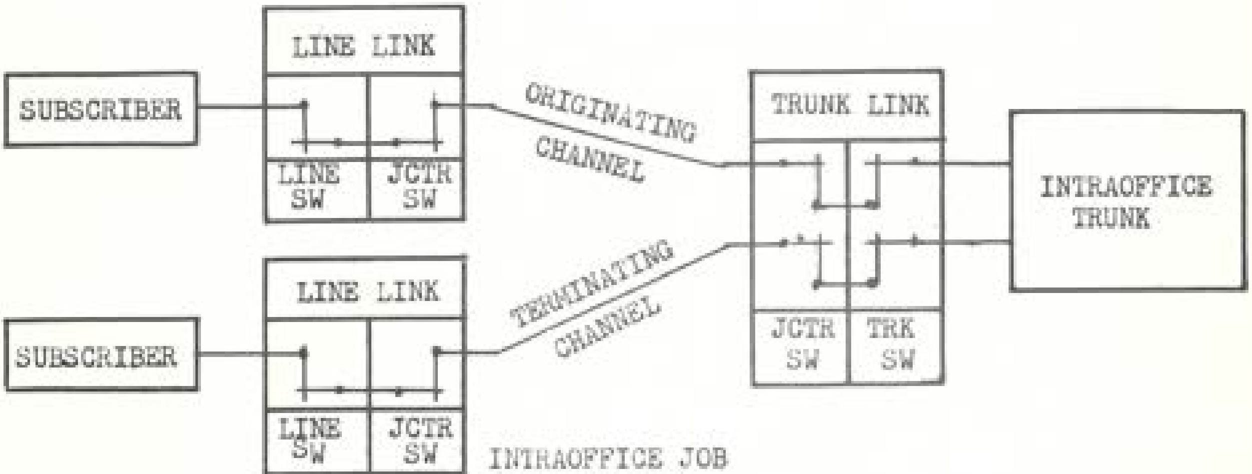
On party lines, one half of the stations are arranged to be rung over the ring conductor and one half over the tip conductor. Ringing current is 20-cycle current superimposed on a negative DC component to permit the tripping relay to operate when the party answers. However, on 8-party semiselective lines and 4-party full selective lines, a further limitation in the ringing, a party hears, is made possible by superimposing the interrupted 20-cycle ringing current on either negative or positive direct current. To specify a ringing code completely, it is therefore necessary to state the side of the line to which ringing is applied, whether it is negative or positive superimposed, and the particular code to be used.

In the No. 5 crossbar system, crossbar switches are used to apply ringing to the trunks. One 10-vertical crossbar switch is used for each ten trunks per trunk link frame, per level which requires ringing. Each trunk circuit is connected to a switch vertical through which any one of the required types of ringing is selected.

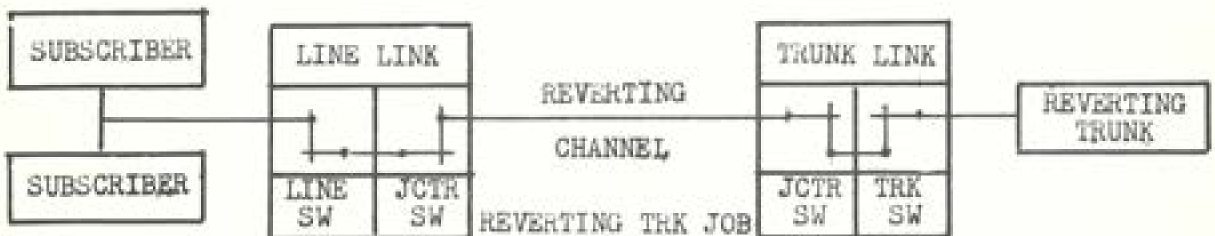
The number group selects the ringing combination for a particular line and passes it to the marker. The marker sets up the ringing condition on the horizontal selection switch and then transfers the control of the ringing to the trunk.

Levels 0 and 1 on the crossbar switch are used to apply ringing to either the tip or ring conductors of the line and ground to the other conductor. Level 2 to 8 select the types of ringing supplied by the ringing power plant. Level 9 is used to indicate busy and overflow conditions. Each ringing selection requires that two out of ten of the select magnets are operated.

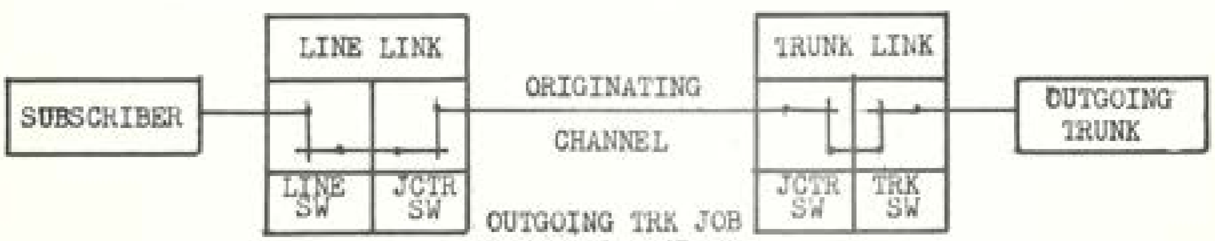
DIAL TONE JOB
FIGURE 2-1A



INTRAOFFICE JOB
FIGURE 2-1B

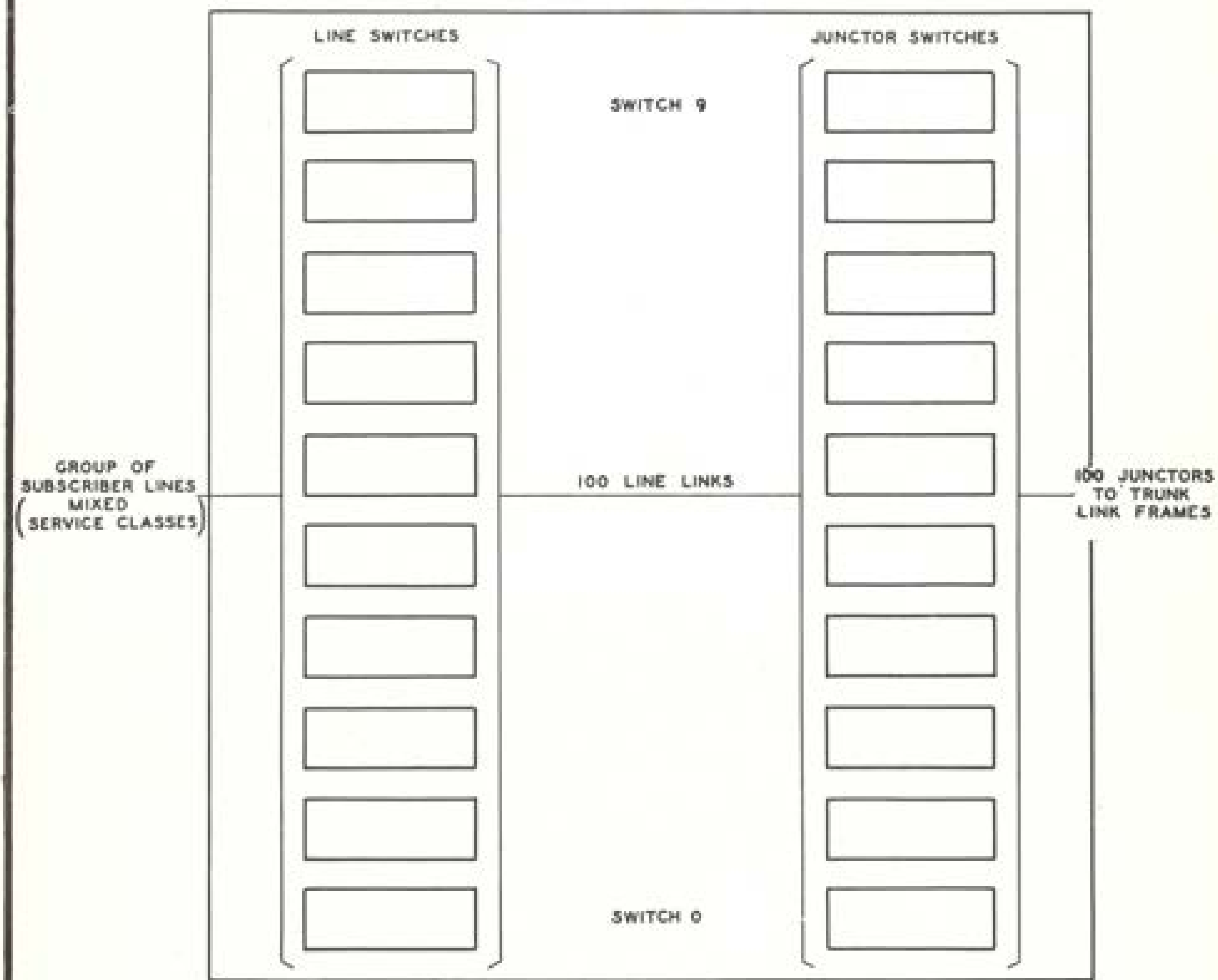


REVERTING TRK JOB
FIGURE 2-1C



OUTGOING TRK JOB
FIGURE 2-1D

INCOMING TRK JOB
FIGURE 2-1E



LINE LINK FRAME

FIGURE 2-2

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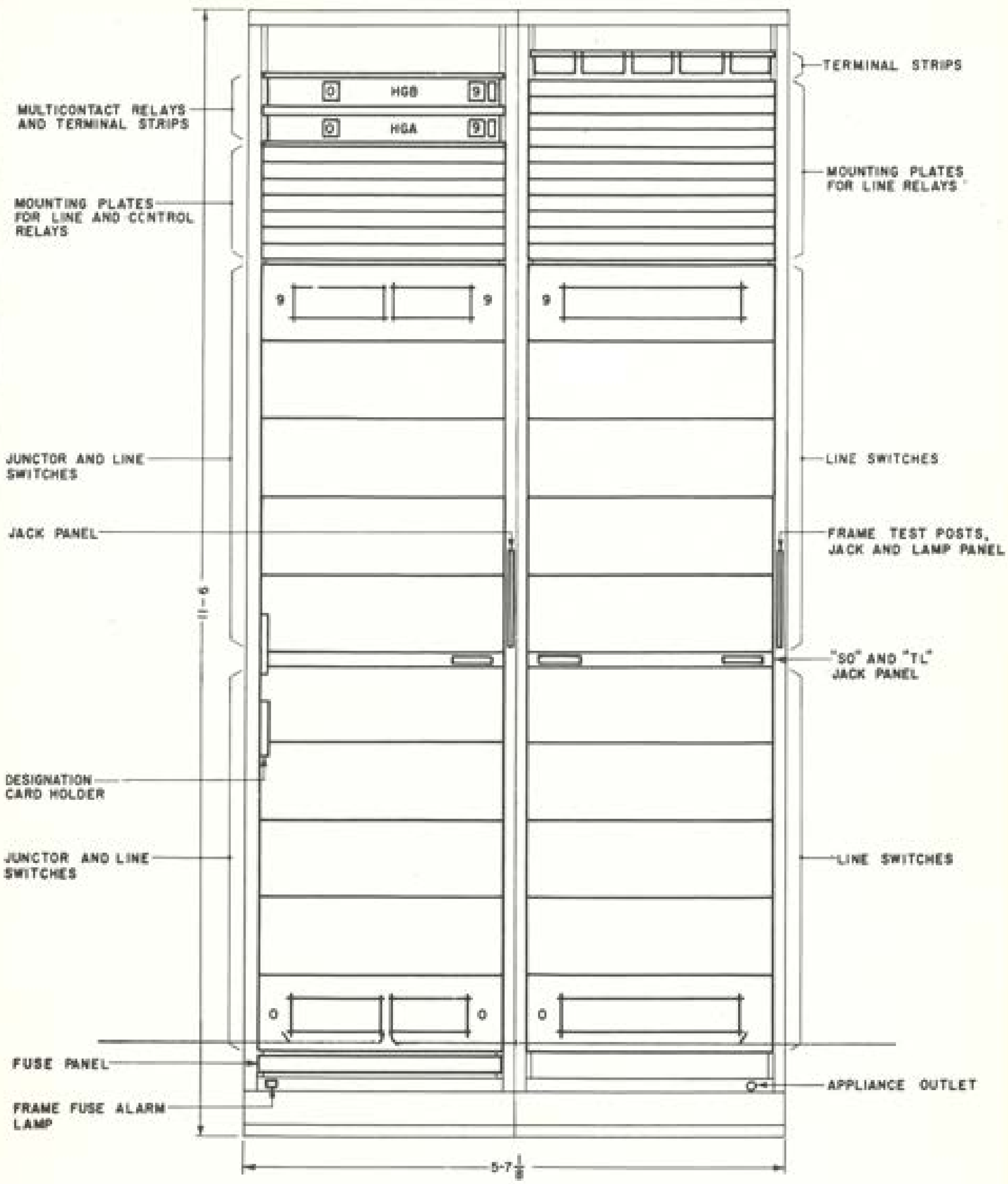
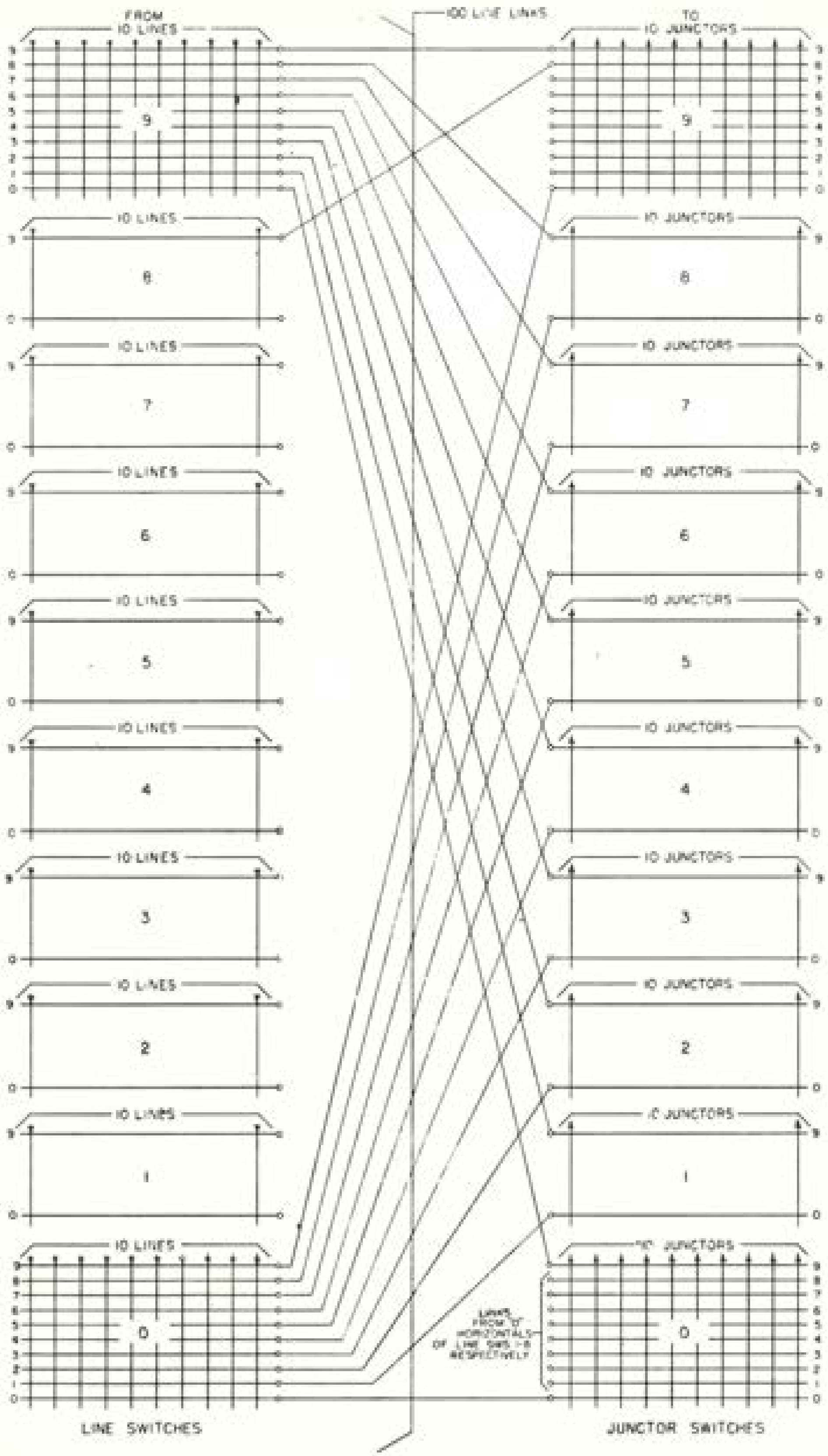


Basic Line Link Frame for 290 Lines

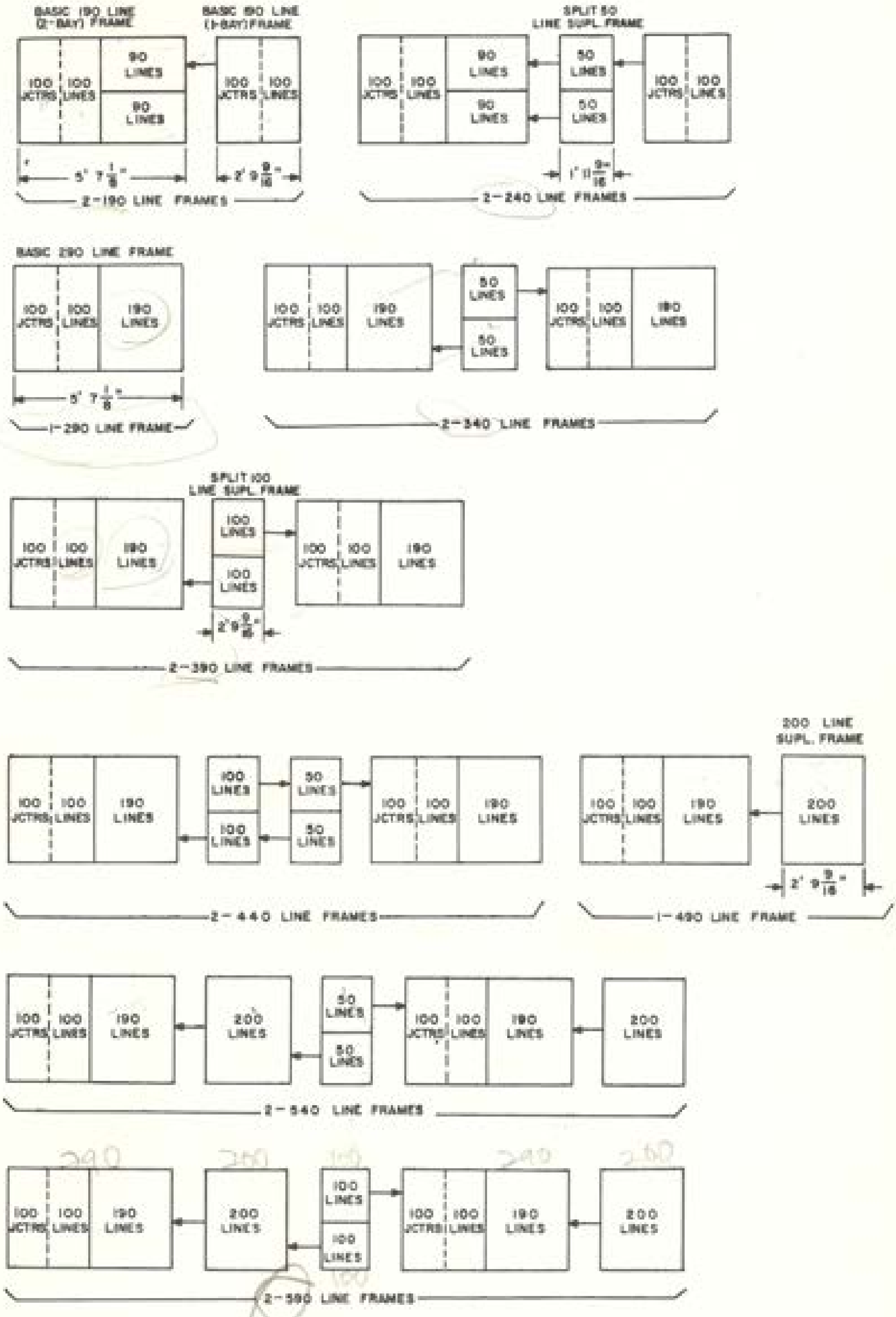
Wire-spring

FIGURE 2-3



Line Link Distribution

FIGURE 2-4



Association of Line Link Basic and Supplementary Frames for 50-line Increments

FIGURE 2-5

STANDARD LINE LINK FRAME

LINE EQUIPMENT ARRANGEMENT

The following is the standard arrangement for the 290-size line link frame. When additional supplementary frames are provided, their vertical groups are equipped like vertical groups 04 and 05 on the basic frame. When 190-size line link frames are provided vertical groups 04 and 05 are omitted. 240-size line link frames omit vertical group 05.

Type of Line Equipments	Note	Vertical Groups 00	01	*02	03	04	05	Total Eqpts
Non-universal - Loop Start	1	0-4	-	3-4	0-4	0-4	0-4	220
Universal - Wired Loop Start	2	-	0-4	-	-	-	-	50
Universal - Wired Ground Start	3	-	-	1-2	-	-	-	20
Total								290

* "0" file used for no test access

Notes:

1. Used for non-coin or coin lines operating with loop start.
2. Used for non-coin or coin lines operating with loop start; may be rewired by installer for ground start on job basis.
3. Used for coin lines operating with ground start; may be rewired by installer for loop start on job basis.

General

Vertical groups 02 and 03 are fully equipped with sleeve leads.

Vertical groups 04 and 05 are normally first choice for tip translators which are required for two-party with AMA charging. When required, any other vertical group may be used. With larger frames the higher numbered vertical groups are equally desirable.

FIGURE 2-6

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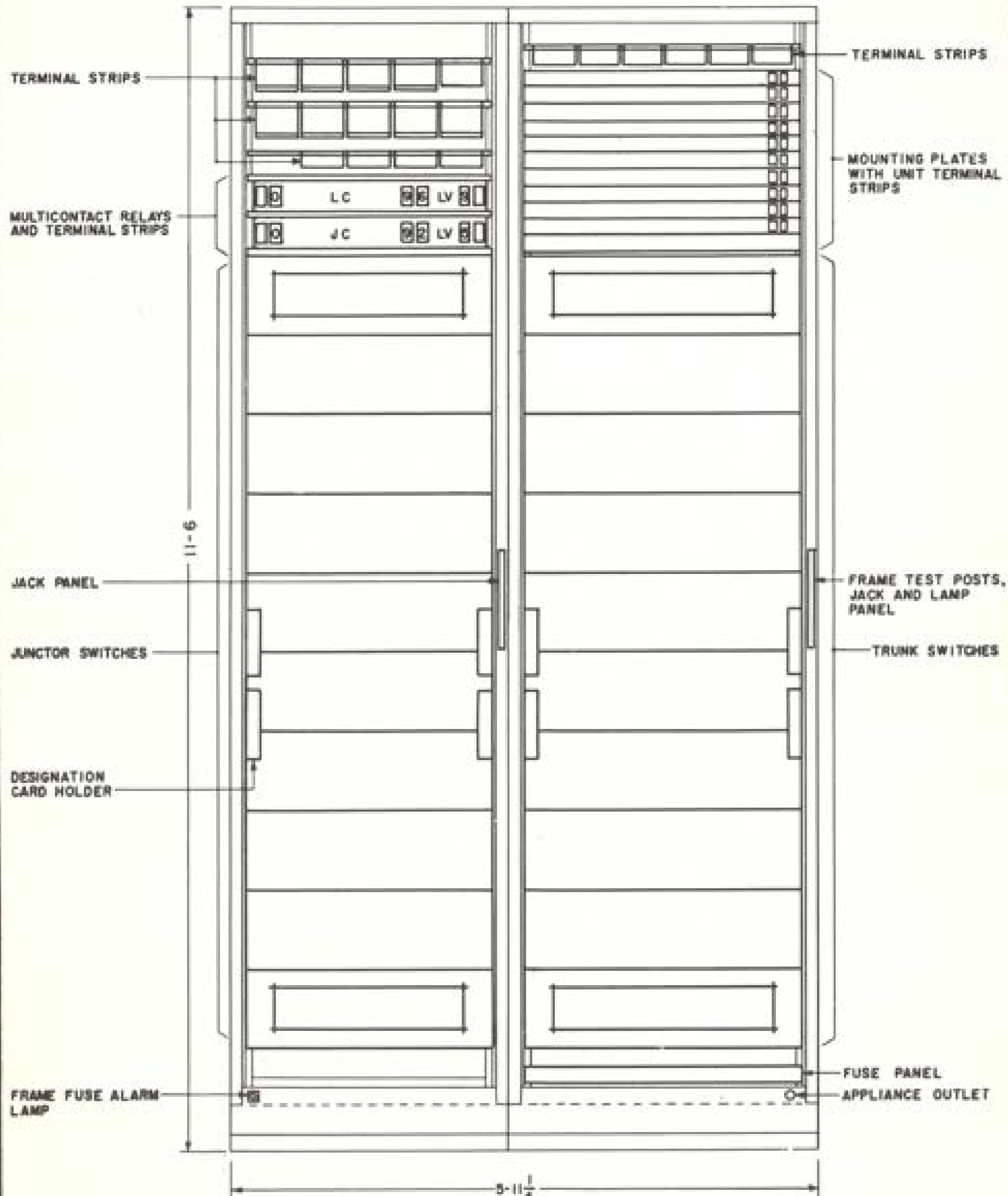
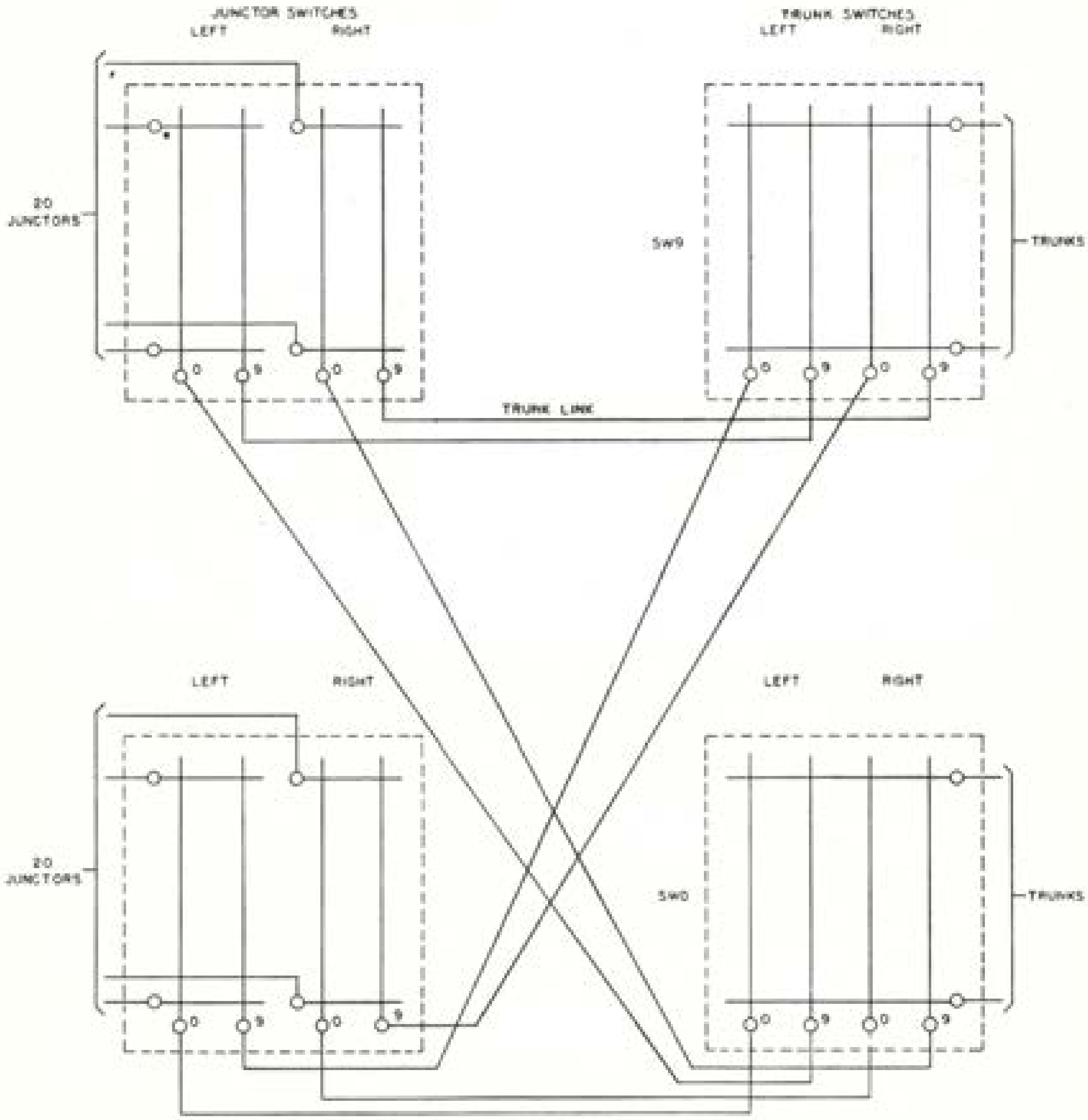


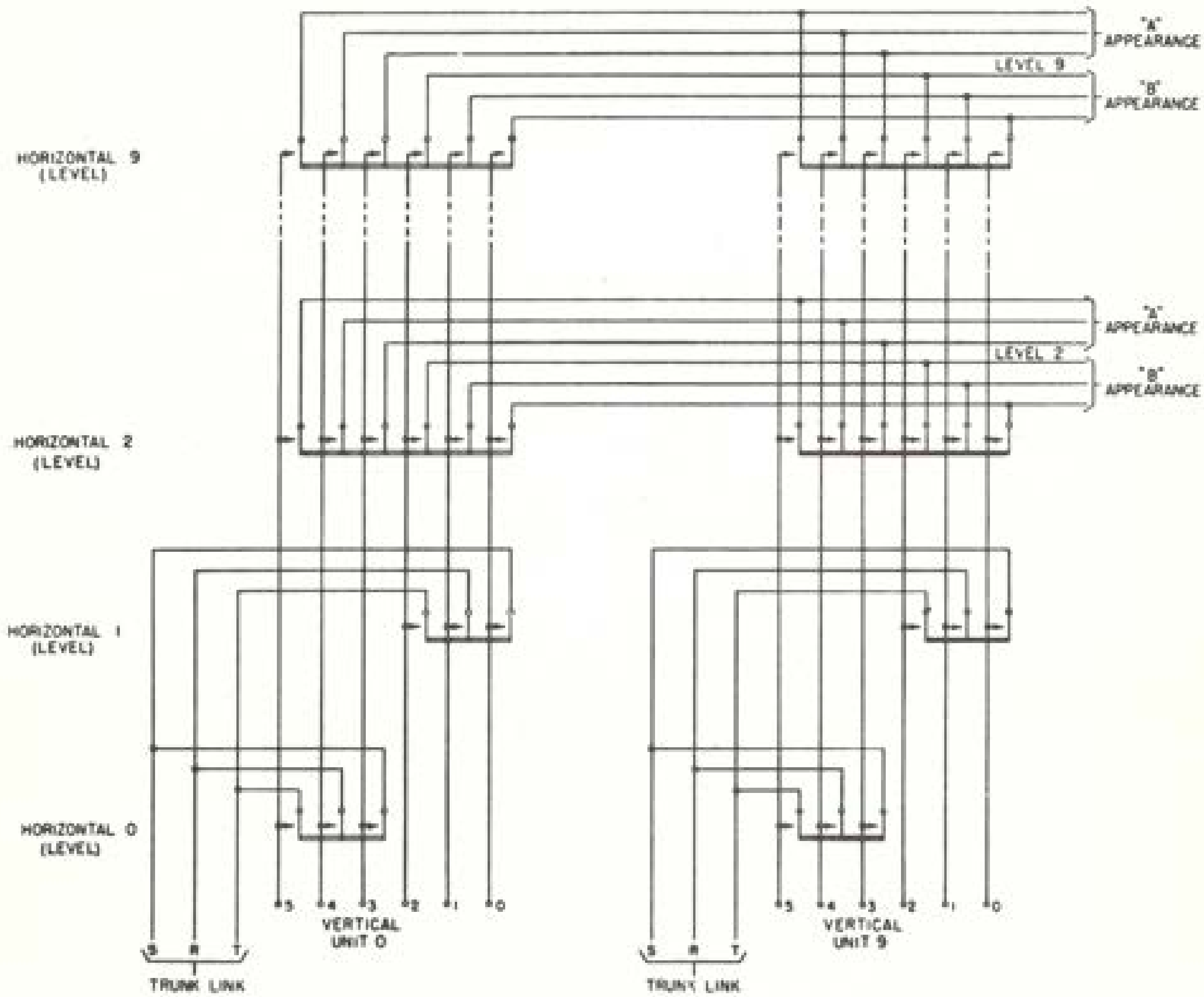
Trunk Link Frame

FIGURE 2-7



TRUNK LINK DISTRIBUTION

FIGURE 2-8



SWITCH ARRANGED FOR 16 TRUNK APPEARANCES

FIGURE 2-9

Association of Trunk Block Relays,

Busy Test Leads and Locations on Trunk Link Frames

	Trunk Link Frame		
Busy Test Leads	Appearance	Level	Switch
0- 9 of TB0	A	2	0-9
10-19 of TB0	B	2	0-9
0- 9 of TB1	A	3	0-9
10-19 of TB1	B	3	0-9
0- 9 of TB2	A	4	0-9
10-19 of TB2	B	4	0-9
0- 9 of TB3	A	5	0-9
10-19 of TB3	B	5	0-9
0- 9 of TB4	A	6	0-9
10-19 of TB4	A	7	0-9
0- 9 of TB5	A	8	0-9
10-19 of TB5	A	9	0-9

FIGURE 2-10

EXAMPLE OF
DISTRIBUTION OF TRUNKS
BY TRUNK LINK FRAMES

LOCAL OFFICES

(1) EQUIPMENT FOR	(2) Type No.	(3) No. Trk. Equips.	(4) TLF Term.	(5) Ckts per Unit	(6) TB REL	(7) Trunk Link Frames 00	01	02	03	04
INTRAOFFICE										
*Intraoffice - Flat	1A13	120	240	2	4,5	24	24	24	24	24
*Intraoffice - Coin	1A12	10	20	2	4	2	2	2	2	2
*Intraoffice - AMA	1A 1	6	12	2	4	2	1	1	1	1
TOTAL INTRAOFFICE		136	272			28	27	27	27	27
TWO-WAY										
*Reverting Ring	A20	5	5	1	0	1	1	1	1	1
*Ringer Test	E26	2	2	1	0				1	1
*ORIGINATING REGISTERS	A	26	26		0	5	5	5	5	6
OUTGOING										
F.S. Interoffice	1C 5	110	110	2	0,1	22	22	22	22	22
CLR - Non Cn.	1D23	50	50	1	2	10	10	10	10	10
*Common Oflo	1C43	51	51	3	3	10	10	10	10	11
CLR - Coin	1D58	15	15	1	4	3	3	3	3	3
*Comb. Tone - Non Cn.	1C45	10	10	2	5	2	2	2	2	2
*Comb. Tone - Coin	1C44	6	6	2	4	1	2	1	1	1
*Perm. Sig. Holding	1C51	6	6	2	5	1	1	2	1	1
Local Test Desk	E15	6	6	2	5	1	1	1	1	1
Information	D75	4	4	2	5	1	1	1	1	
Repair	D77	3	3	1	5			1	1	1
*Stuck	G42	2	2	2	5	1	1	—	—	—
TOTAL		263	263			52	53	53	53	52
INCOMING										
Interoffice - DP	B61d	92	92	1		18	18	18	18	20
Interoffice - MF	B61m	40	40	2		8	8	8	8	8
Toll Sw.-Immed. Ring	B61m	22	22	•2		4	4	5	5	4
Toll Sw.-Contr. Ring Non Cn.	B13	10	10	1		2	2	2	2	2
Toll Sw.-Contr. Ring-Coin	B15	5	5	1		1	1	1	1	1
*L.T.D. Regular	E18	4	4	1		1	1	1	1	
*L.T.D. No Test	E22	3	3	1			1		1	1
*D.S.A.-No Test	334m	2	2	1		1	1			
*Master Test Frame	B	1	1							
TOTAL		179	179			35	36	36	36	36
GRAND TOTAL - TRUNK EQUIPMENTS		611				121	122	122	123	123
" " - TLF TERMINATIONS			747			149	149	149	150	150

* No day-to-day administration.

FIGURE 2-11

TRUNK ASSIGNMENT CHART (EXAMPLE)

TRUNK LINK FR _00_

INTRA OFFICE TRK	INC TRK	REGISTER	OUT TRK	APPEARANCE	LEVEL	(TB) REL	0	1	2	3	4	5	6	7	8	9
							SWITCH NUMBER									
		→		A	2	0			A					1C5		
				A	3	1						1C5				
				A	4	2						1D23				
				A	5	3						1G43				
				A	6	4						1A13				
				A	7	4		1D58		1A1		1A12		1A13		1G44
				A	8	5						1A13				
				A	9	5	✕	✕	1G45	E15	1A13		D75	G42	1G45	
				B	9	-			B61d			1A13			B61d	
				B	8	-						1A13				
				B	7	-			B61d		1A1		1A12		1A13	
				B	6	-						1A13				
				B	5	3		B61m					B61d			
				B	4	2				B61m					B13	
				B	3	1	✕	1C5	✕	✕	✕	✕	✕	✕	✕	✕
				B	2	0				1C5			E18	B34m	A20	B15

PERIOD

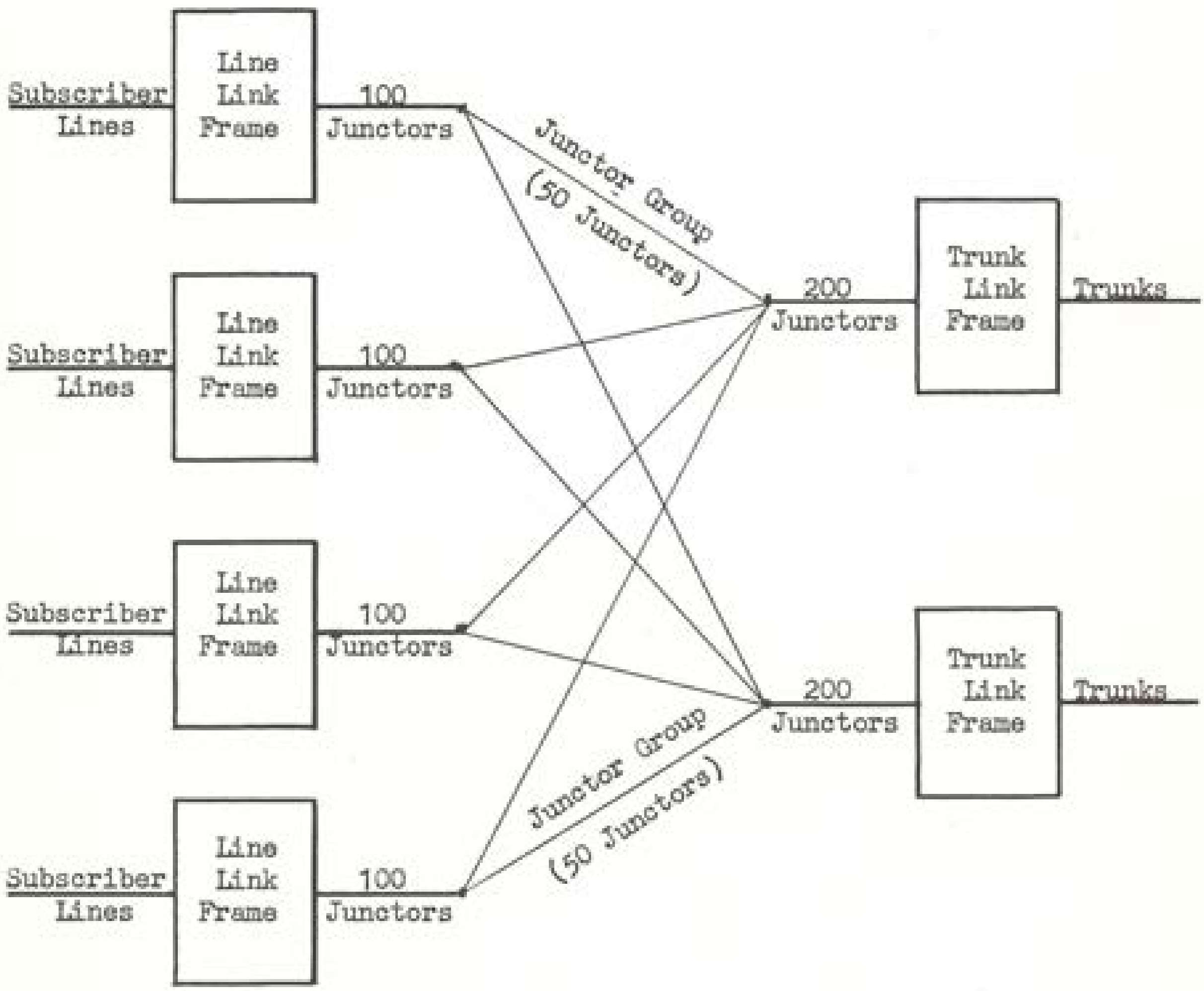
Figure 2-12

NO. 5 CROSSBAR SYSTEM

JUNCTOR PATTERNS

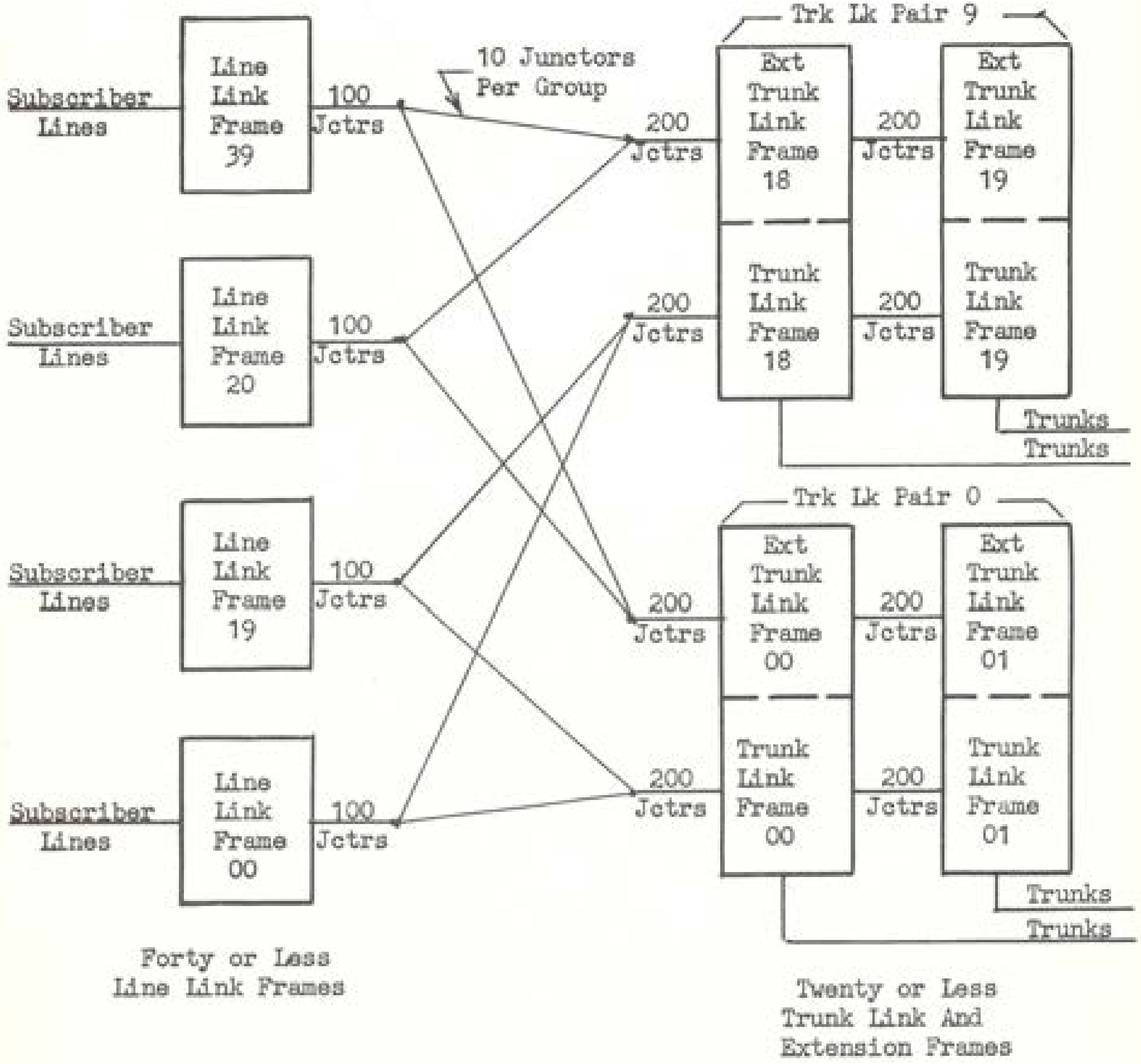
Pattern Size	Number of Junctors: Groups	Subgroups: 1st	2nd	3rd	4th	5th
4LL-2TL	50	10	10	10	10	10
6LL-3TL	33 or 34	10	10	10	3 or 4	
8LL-4TL	25	10	10	5		
10LL-5TL	20	10	10			
12LL-6TL	16 or 17	10	3 or 7	3		
14LL-7TL	14 or 15	10	2,4, or 5	2		
16LL-8TL	12 or 13	10	2 or 3			
18LL-9TL	11 or 12	10	1 or 2			
20LL-10TL	10	10				
8LL-2TL Pairs	50	10	10	10	10	10
12LL-3TL Pairs	33 or 34	10	10	10	3 or 4	
16LL-4TL Pairs	25	10	10	5		
20LL-5TL Pairs	20	10	10			
24LL-6TL Pairs	16,17 or 18	10	3,4, or 7	3 or 4		
28LL-7TL Pairs	14 or 15	10	2,4, or 5	2		
32LL-8TL Pairs	12 or 13	10	2 or 3			
36LL-9TL Pairs	11 or 12	10	1 or 2			
40LL-10TL Pairs	10	10				
12LL-2TLF Triples	50	10	10	10	10	10
18LL-3TLF Triples	33 or 34	10	10	10	3 or 4	
24LL-4TLF Triples	25	10	10	5		
30LL-5TLF Triples	20	10	10			
36LL-6TLF Triples	16 or 17	10	3 or 7	3		
42LL-7TLF Triples	14 or 15	10	2,4, or 5	2		
48LL-8TLF Triples	12 or 13	10	2 or 3			
54LL-9TLF Triples	11 or 12	10	1 or 2			
60LL-10TLF Triples	10	10				

Figure 2-13



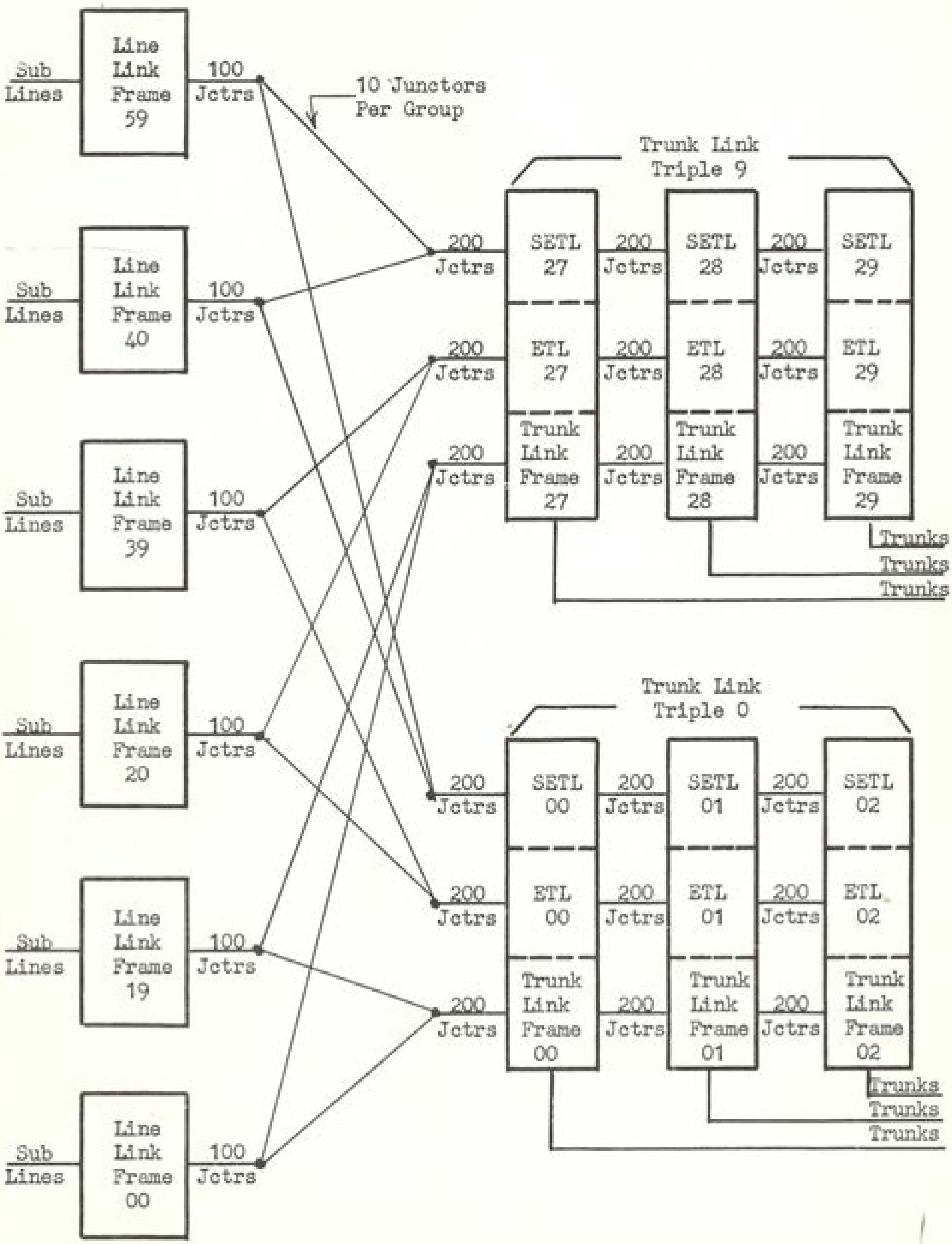
Junctor Distribution
(Four Line Link and Two Trunk Link Frames)

Figure 2-14



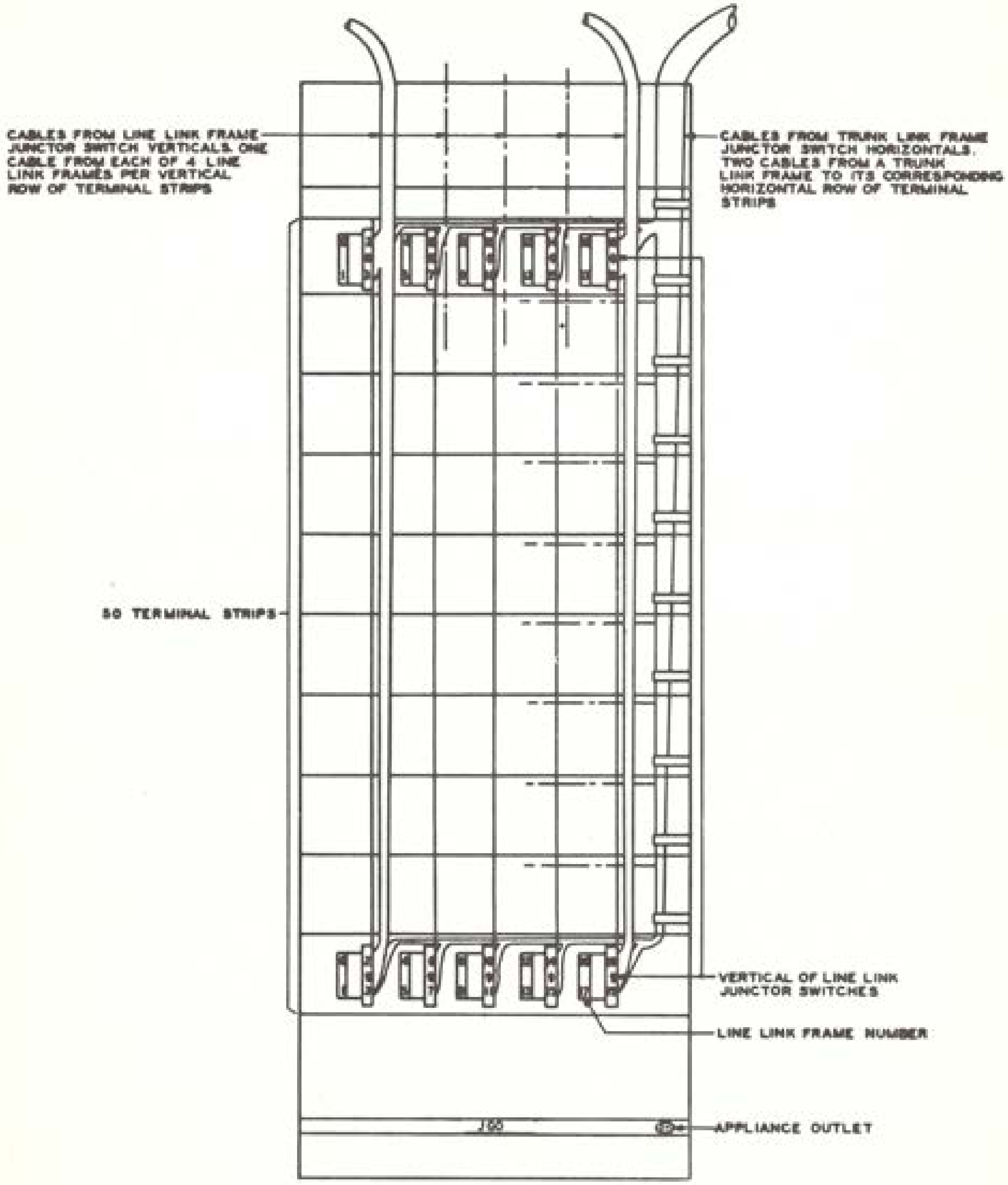
JUNCTOR DISTRIBUTION
WITH
PAIRED TRUNK LINK FRAMES

Figure 2-15



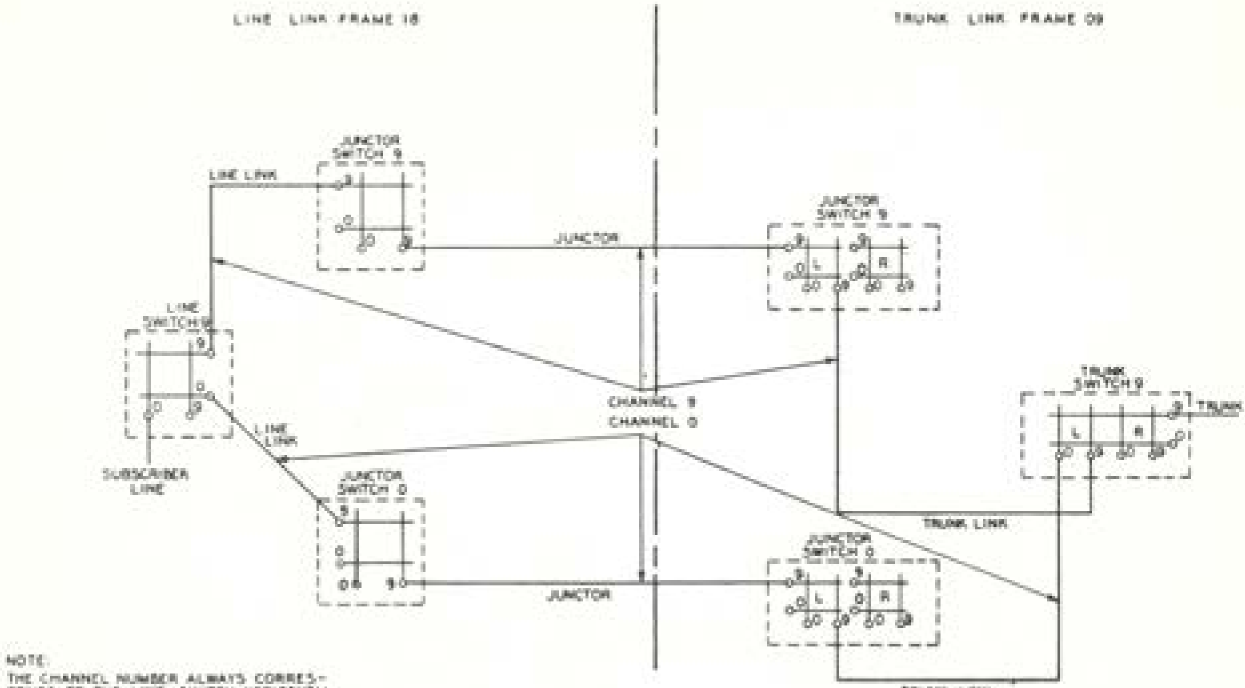
JUNCTOR DISTRIBUTION
TRUNK LINK FRAME TRIPLES

Figure 2-16



JUNCTOR GROUPING FRAME ARRANGED FOR 20 LINE LINK AND 10 TRUNK LINK FRAMES

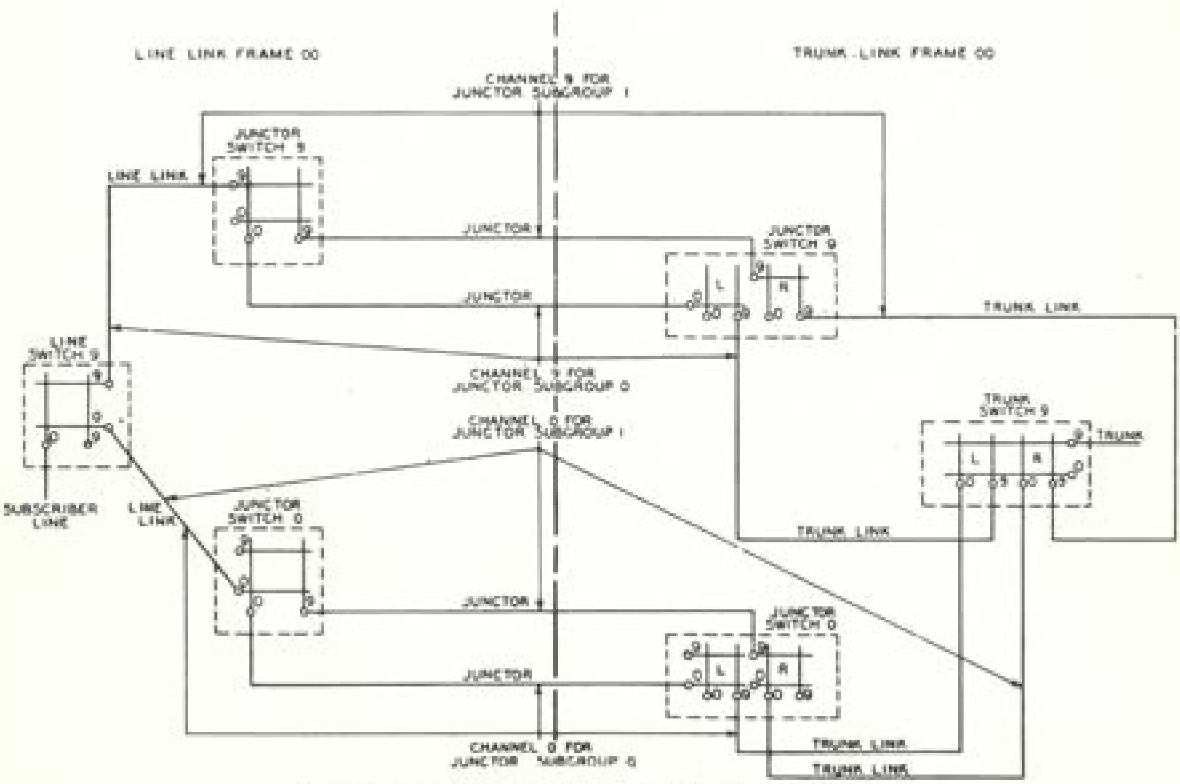
Figure 2-17



NOTE:
THE CHANNEL NUMBER ALWAYS CORRESPONDS TO THE LINE SWITCH HORIZONTAL NUMBER OF THE LINE LINK, THE TRUNK SWITCH VERTICAL NUMBER OF THE TRUNK LINK, AND THE JUNCTOR SWITCH NUMBER. ALL OTHER ELEMENTS ARE NUMBERED INDEPENDENTLY OF CHANNEL NUMBER CONSIDERATIONS.

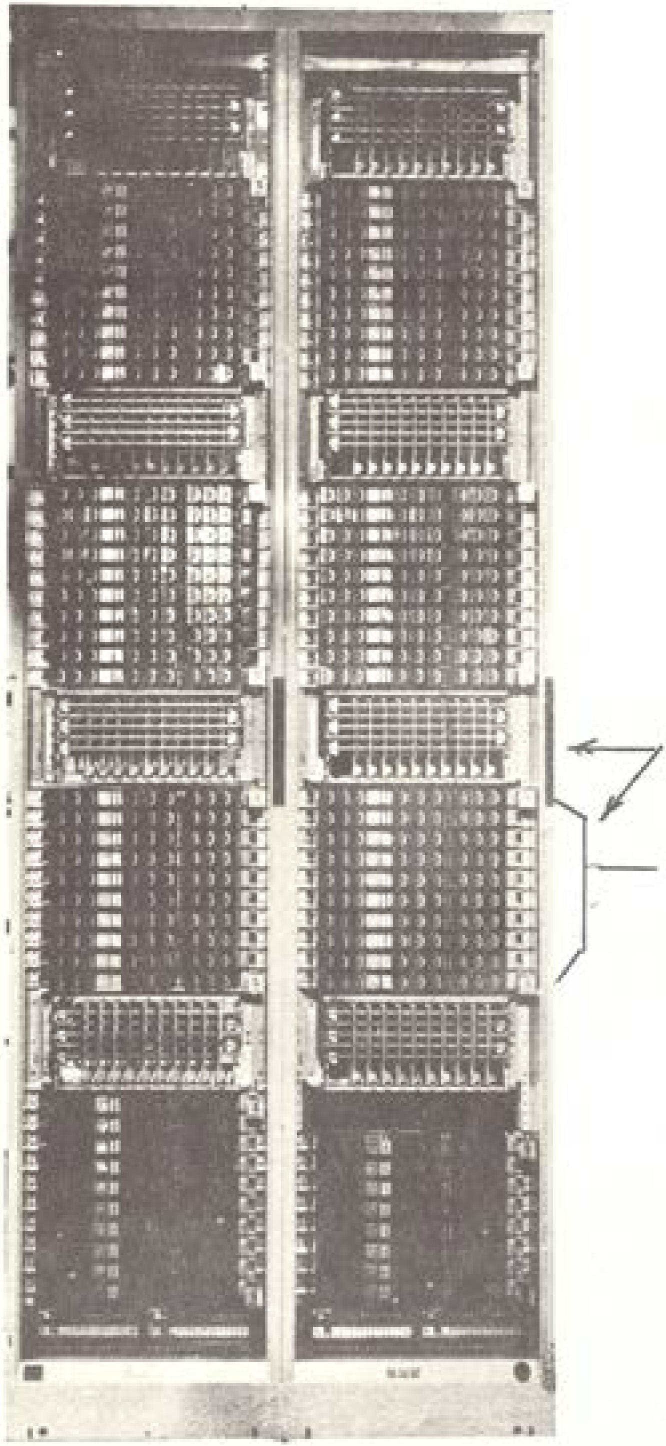
CHANNELS FOR 20 LINE LINK-10 TRUNK LINK FRAMES

Figure 2-18



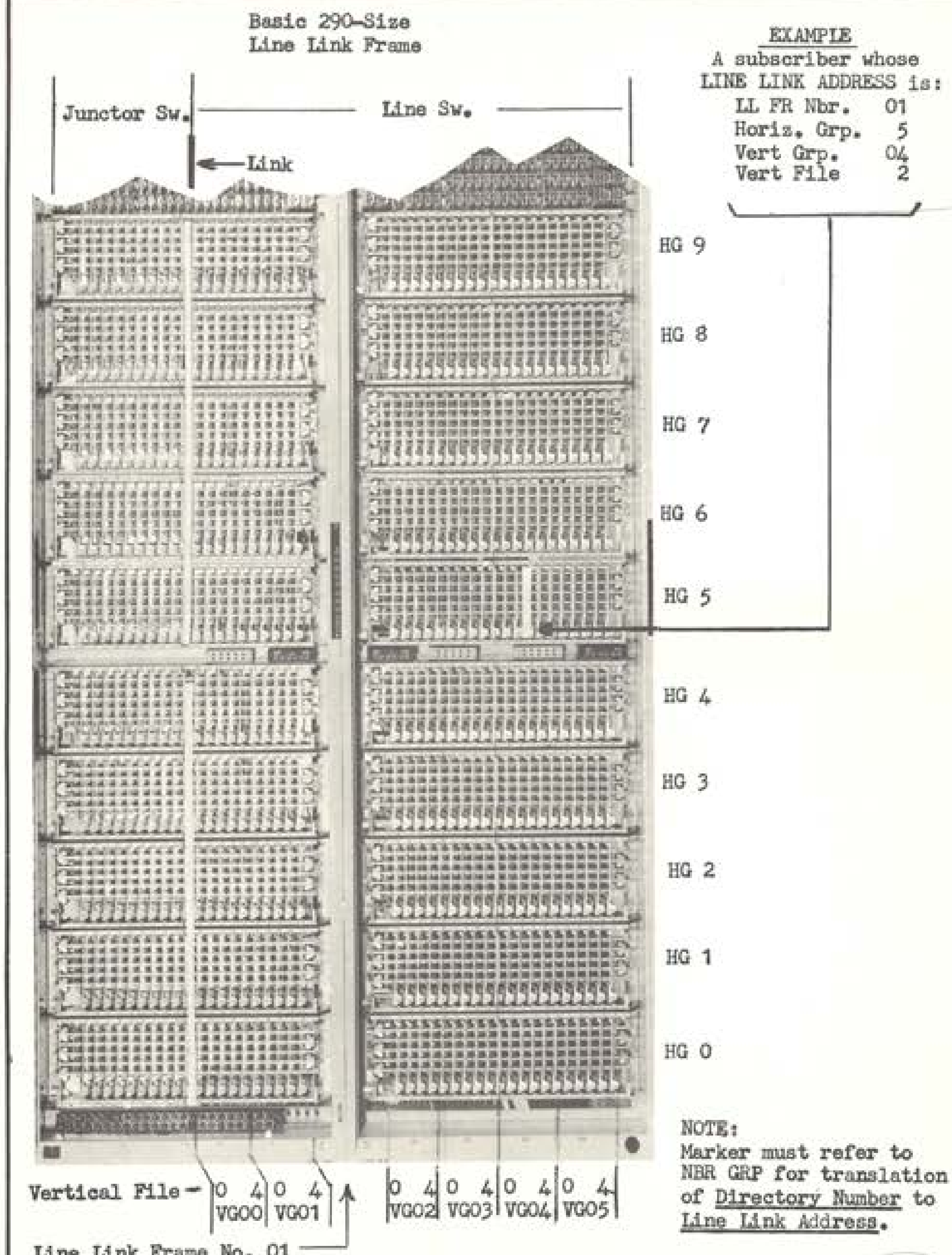
CHANNELS FOR 10 LINE LINK-5 TRUNK LINK FRAMES

Figure 2-19



Double Bay
Trunk Relay Rack

Figure 2-20

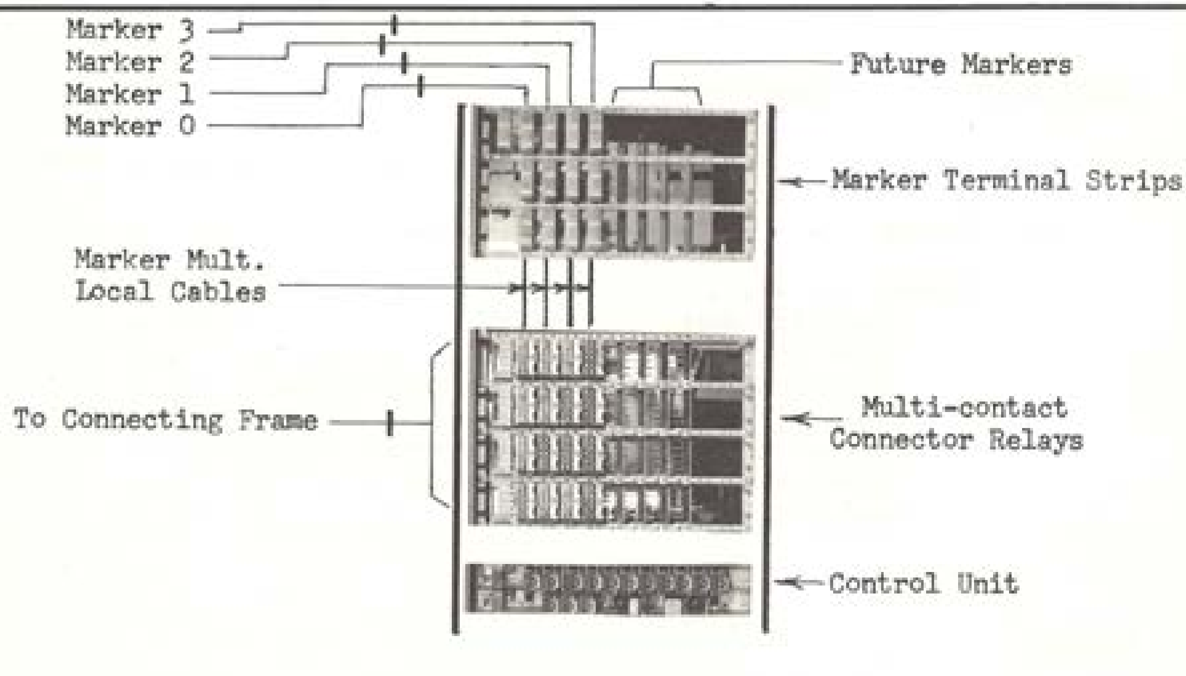


LINE LINK ADDRESS

Figure 2-21

SECTION III

CONNECTORS



Connector Elements

Reference and Credits -

Connectors For The No. 5 Crossbar System - G. S. Bishop - BLR 1/50

Central Office Equipment - General No. 5 Crossbar - J29259 iss.4

NO. 5 CROSSBAR

SECTION III - CONNECTORS

FIGURES

CONNECTORS

A. THEORY

Connectors are used for associating markers with other common control circuits, and with the switching frames for brief intervals during the switching of a call. Eight major types of connectors are employed in the No. 5 crossbar system as indicated in Figure 3-1. This diagram, in addition to showing the circuits with which each type of connector is used, shows the number of paths closed by each connector, and also the direction of the connection, that is, whether the marker seizes the frame, or the frame seizes the marker. This difference in the direction of connection is also indicated in the name of the connector.

Where the marker seizes a frame, the connector is given only the name of the frame the marker seizes. Thus, there is a line link connector, a trunk link connector, an outgoing sender connector, a number group connector, and master test connector. When it is the marker that is seized by the frame, both the word marker and the name of the frame are included in the name of the connector. Thus, there is an originating register marker connector, an incoming register marker connector and a line link marker connector.

For the line link frames, both types of connectors are required. Thus, there are both line link connectors and line link marker connectors; the former is used while the marker is setting up connections between line link and trunk link frames, and the latter only when a subscriber lifts his handset to place a call.

Each connecting frame is given access to each marker through one or more multicontact relays. Each multicontact relay has thirty (or sixty) pairs of contacts. The number of relays required for each connector depends on the number of leads to be closed through to each marker, and on the number of dial tone, completing, or combined markers to be served.

Each thirty (or sixty) leads from a connecting frame is multipled in bare wire strapping to the multicontact relays on one horizontal row across a 23-inch bay, one relay representing each marker served. Similar rows in adjacent positions on the bay provide the horizontal multiple for all of the leads from one connecting frame. These one or more rows of relays serving one connecting frame (together with any associated control or preference relay units) constitute a connector. The number of connectors on one connector frame depends on the number of rows of relays per connector.

Switchboard cables from each marker appear at terminal strips at the top of a connector frame above the vertical file of relays associated with that marker. A vertical local cable extends the multiple to other connectors on the frame and switchboard cable multiple extends the marker connections to other connector frames of the same type.

Two different circuit patterns are used for associating the multicontact relays to form a connector, as shown in Figure 3-2. The arrangement shown at (a) is called a single-ended connector, while that at (b) is a double-ended connector. The latter is used only for registers and senders. Only one multicontact relay is shown connected to each marker, but as pointed out above, there will always be more than one of them depending on the number of paths that must be closed.

With the single-ended connectors, used for line link, trunk link, and number group frames, the connector multiple is connected to the armature contacts of all the multicontact relays and extended to the switch frame the connector serves. There is thus one connector for each frame.

With the double-ended connectors, on the other hand, used only for senders and registers, the connector multiple is connected to the armature contacts of both a group of multicontact relays for the markers and another group for the circuits to be connected to them. With this type of connector, therefore, a single connector will serve a group of similar circuits.

The reason for the provision of two types of connectors is that as soon as a line link, or number group frame has been released by one marker, it is free for seizure by another. After a register or sender has been disconnected from a marker, however, it will not, in general, be free for connection to another, since it will be busy recording the digits dialed by a subscriber or transmitting pulses over an outgoing trunk. Double-ended connectors are thus used for registers and senders to permit the connector, after it has been released by one register or sender and a marker, to be at once reused for another connection.

If single-ended connectors were used for these equipments, there would be relatively long intervals while the sender or register was performing its other functions when the connector was not in use. The two sets of multicontact relays used with double-ended connectors are mounted in different locations. Those that connect the marker to the connector multiple are on the connector frames, as are those of the single-ended connectors, while those that connect the registers or senders to the connector multiple are on the register or sender frames.

downloaded from: TCI Library - http://www.telephonecollectors.info - Source: Connections Museum, Seattle, WA

Dial tone and completing markers require connector appearances as follows:

(a) Dial tone markers only in line link marker connectors
(b) Completing markers only in

Originating register marker connectors
Incoming register marker connectors
Number group connectors
Outsender connectors

(c) Both dial tone and completing markers in

Line link connectors
Trunk link connectors
Master test connector

With combined markers (which were economical for only the smallest marker groups and are now MD) each marker is given an appearance in each connector. Combined marker groups can grow into separate subgroups on additions by converting the combined markers to completing markers, adding dial tone markers, and revising the connectors to serve the separate marker subgroups.

A master traffic control unit is associated with a group of combined markers to assure that all marker connectors are served uniformly. For a marker group split into a dial tone marker subgroup and a completing marker subgroup, a master traffic control unit is associated with each subgroup to assure equitable service to the line link marker connectors and the register marker connectors, respectively. These units are mounted on a relay rack frame on the same floor and in the vicinity of the majority of the marker connectors.

Figure 3-3 shows block diagrams of various connector frames.

B. FRAMES

Line Link Marker Connector (Figure 3-4)

The new line link marker connector frame provides connectors for twenty line link frames and four dial tone markers. Where there are mixtures of U-relay and wire-spring relay types of dial tone markers, the total may exceed four. In this case, a second line link marker connector frame is used as a supplementary frame for any markers beyond four.

There are two prior designs of line link marker connector frames in the field. The original frame, rated "A & M Only" some years ago, has a capacity of four connectors and six markers; it is arranged for fourteen vertical groups (690-size line link frame) and the connector control relays are mounted on the connector frame. In the second design, the number of vertical groups per line link frame was reduced from fourteen to twelve and the capacity was increased from four to eight connectors. By rearranging some of the leads through the connector and eliminating those leads associated with vertical groups 12 and 13, the number of multicontact relays in the line link marker connector was reduced from one and one half to one per marker. At the same time, the connector control relays were moved to the associated line link frame.

The new connector frames may be added to offices having either of the above arrangements. Provision has been made for omitting the control relays from "A & M Only" connector units when they are to be added on the original design of line link marker connector frame and associated with wire-spring relay type line link frames, each of which includes these control relays. However, two 23-inch bays of the new design will connect a full complement of forty line link frames to four dial tone markers and it will often prove economical to provide the new frame with the first line link addition rather than fill out spare space on existing connector frames.

Line Link Connector (Figure 3-5)

The new line link connector frame is arranged for five connectors and ten markers; dial tone and completing. Where total markers exceed ten, a supplementary line link connector frame provides for two additional markers and fourteen connectors. The new frames may be used without restriction for additions to existing jobs.

Trunk Link Connector And Control Frames (Figures 3-6 and 3-7)

The new trunk link connector frame, as a result of the following design changes, connects three trunk link frames to ten dial tone plus completing markers where the previous basic frame connected one trunk link frame to six markers:

(a) The number of multicontact relays per marker is reduced as a result of the introduction of the originating register line memory frame, which mounts the MD1 and MD2 relays previously mounted on the connector.

(b) Cross connections on the trunk link connector frame are reduced to those associated with junctor patterns and office size. Those associated with trunk circuits and formerly located on the trunk link connectors are now incorporated in the trunk link frames.

(c) The control and preference relays, formerly on the connector frame, are now located on a separate trunk link connector control frame which serves twenty trunk link frames and twelve markers.

Where total markers exceed ten, a supplementary trunk link connector frame will provide for four dial tone markers and ten connectors, and the basic trunk link connector frame will be used for completing markers only.

The new connectors may be used for additions, the only restriction being that trunk link connectors of the wire-spring relay type must be associated with trunk link frames and originating registers of the new types with wire-spring relays.

Originating And Incoming Register Marker Connectors (Figure 3-8)

Both of these new connectors have a capacity of four connectors and eight completing markers. The connectors are arranged for eleven digits, thus eliminating the need on new jobs for auxiliary and supplementary auxiliary connector frames previously required when the number of digits exceeded eight.

In general, it is expected that wire-spring type originating and incoming registers will be assigned to wire-spring-type marker connectors. However, the new registers may be assigned to U- and Y-type relay marker connectors and old-type registers may be assigned to wire-spring-type marker connectors.

Revertive pulse, tandem incoming revertive pulse, and cordless B incoming registers and intermarker group senders, all of which have U-type relays, may be mixed with wire-spring types in the same old- or new-type marker connector provided that these register frames are equipped in the shop with:

(a) Wire-spring type register selection (RS) relays,
(b) 287-type multi contact relays.

New-type registers in old-type marker connectors may have up to eleven digits since auxiliary connector arrangements for digits beyond eight in old-type connectors (a) required no change to provide for the new incoming registers and (b) have been adapted to provide for the new originating registers as well.

Number Group Connector and Control Frames (Figures 3-9, 3-10 and 3-11)

The basic wire-spring number group connector frame accommodates five connectors arranged for eight completing markers as compared to the previous three connectors and six markers. In addition, a split basic connector frame is arranged for ten connectors and four markers; if this latter frame is installed initially, a second similar frame may be added later to increase the marker capacity above four completing markers.

The connector control relays are located on a number group connector control frame. One such frame will accommodate control relays for 24 connectors and eight markers. A second frame provides for the remaining number group and trunk number group frames for a maximum of 40,000 numbers. The new connector frame may be used for additions without restriction.

Outgoing Sender Connector Frame (Figure 3-12)

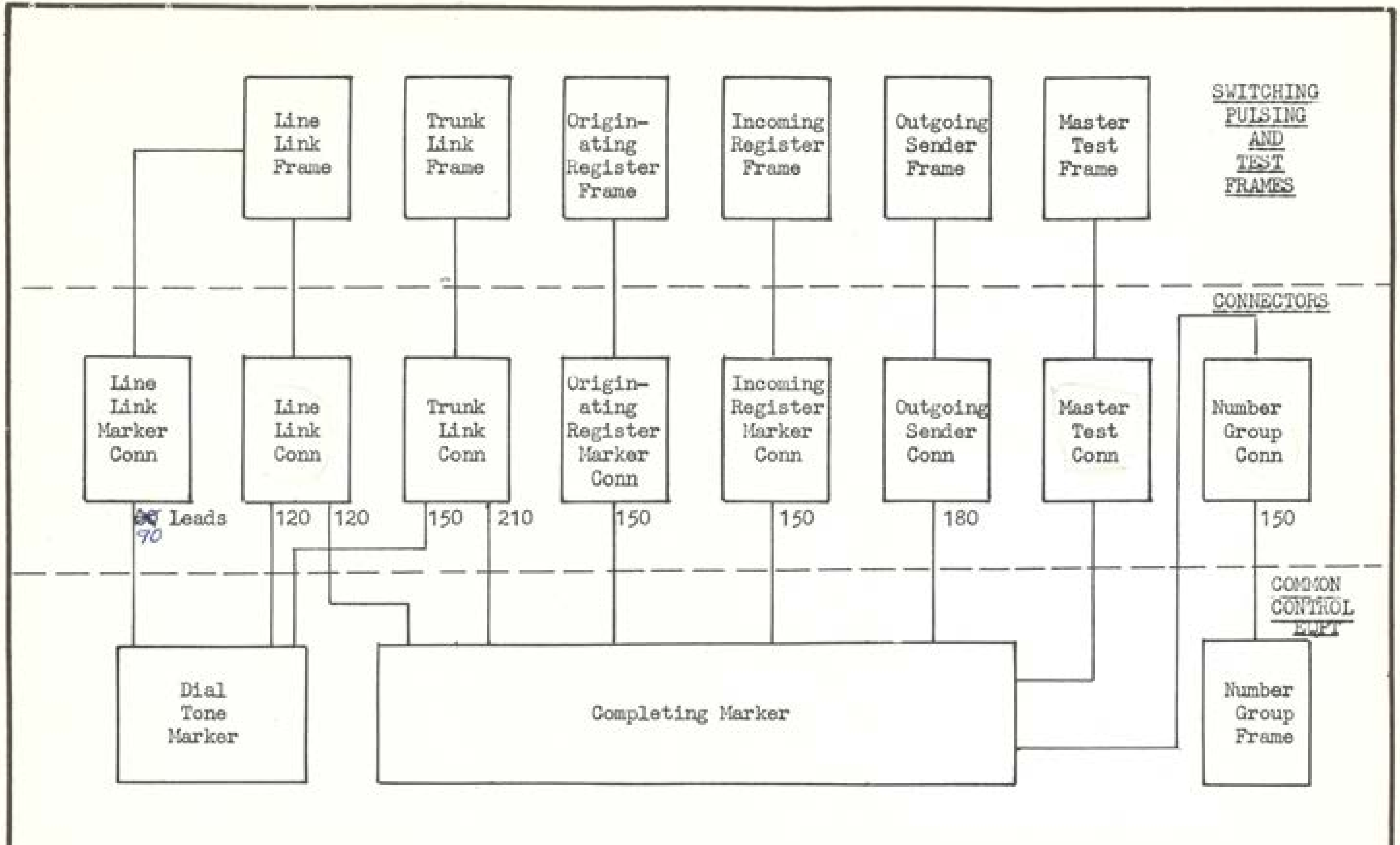
This connector employs multicontact relays in the conventional manner to pass memory information from the markers to the senders over 180 leads. In addition, it provides an auxiliary connector consisting of one 24-make wire-spring relay per marker, per sender, to maintain a 24-lead connection between the marker and the sender for later marker functions and to release the main connector quickly for use on other calls. A 2-bay frame provides four of the multicontact relay connectors to eight markers and their associated control and preference relays. It also provides the auxiliary connector relays for fifty senders (in ten sender groups) and eight markers.

There are no restrictions to the assignment of old- or new-type senders to old- or new-type sender connectors.

Master Test Connector Frame (Figure 3-13)

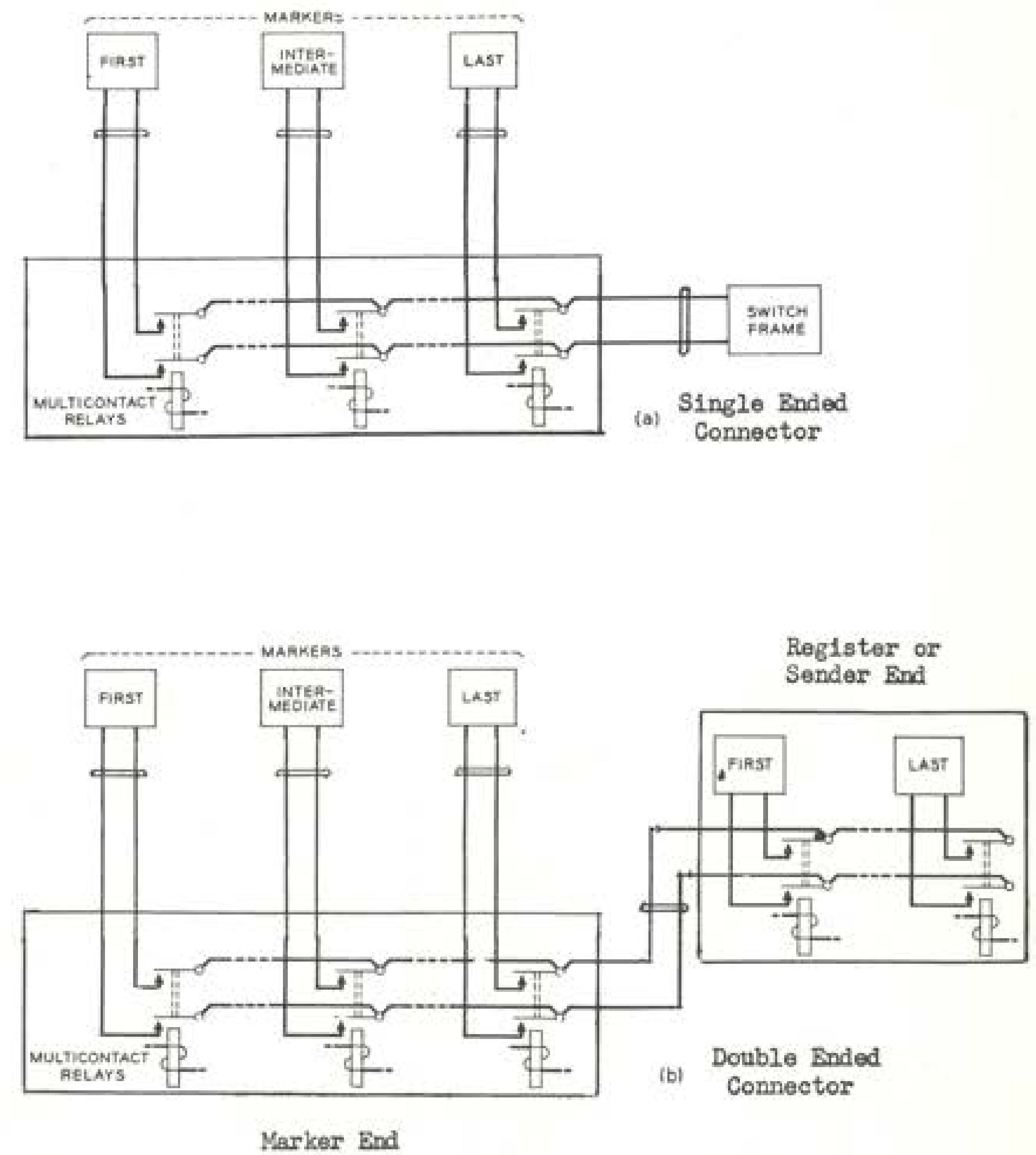
The master test connector frame and its associated auxiliary and supplementary frames accommodate circuits which connect markers, pretranslators, foreign area translators, transverters, AMA recorders, automatic monitor, and master timing frame to the master test frame for trouble recording or test calls as the case may be.

A master test connector frame is required for the first six completing or combined markers and a supplementary connector frame for each additional three markers. A dial tone master test connector frame (DMTC) having a capacity for six markers is provided for each marker group equipped with dial tone markers. An auxiliary master test connector frame (AMTC) is required when marker groups are equipped for AMA. It has a capacity for six transverters, eleven AMA recorders, and one master timing frame.



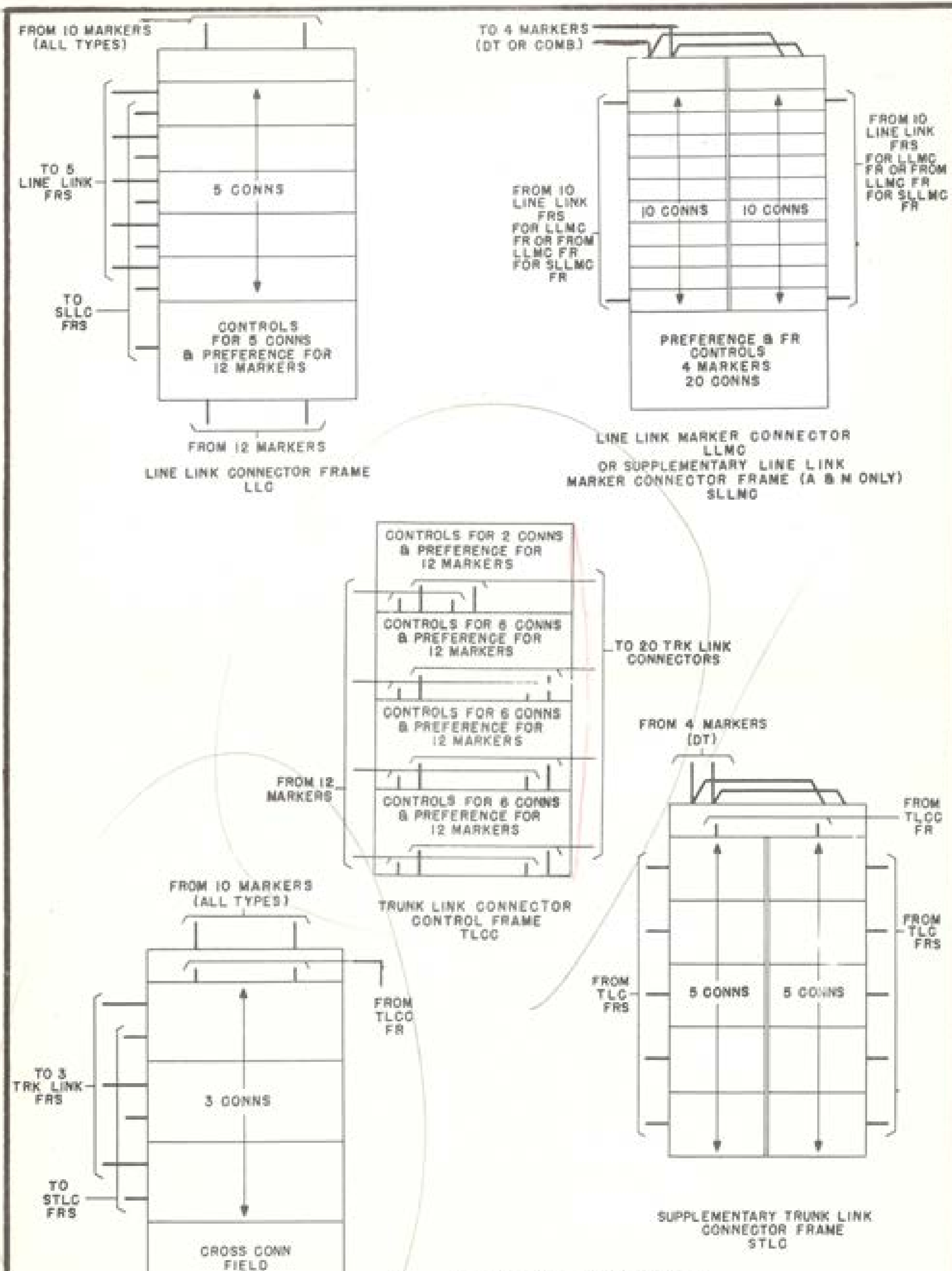
The Eight Principal Types Of Connectors Used In The No. 5 Crossbar System

Figure 3-1



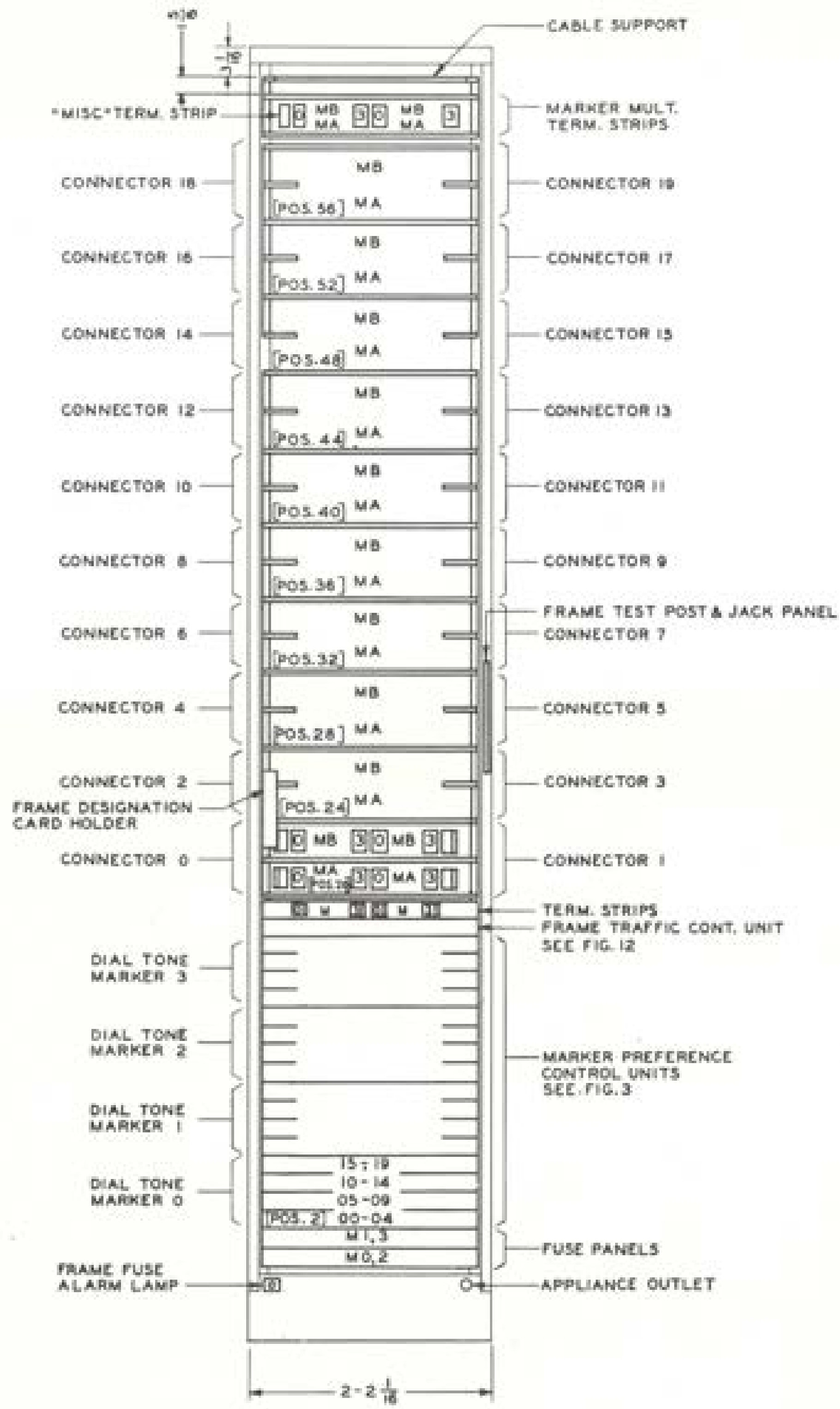
Two types of connectors are employed: single-ended connectors arranged as indicated at (a), and double-ended connectors as arranged at (b).

Figure 3-2



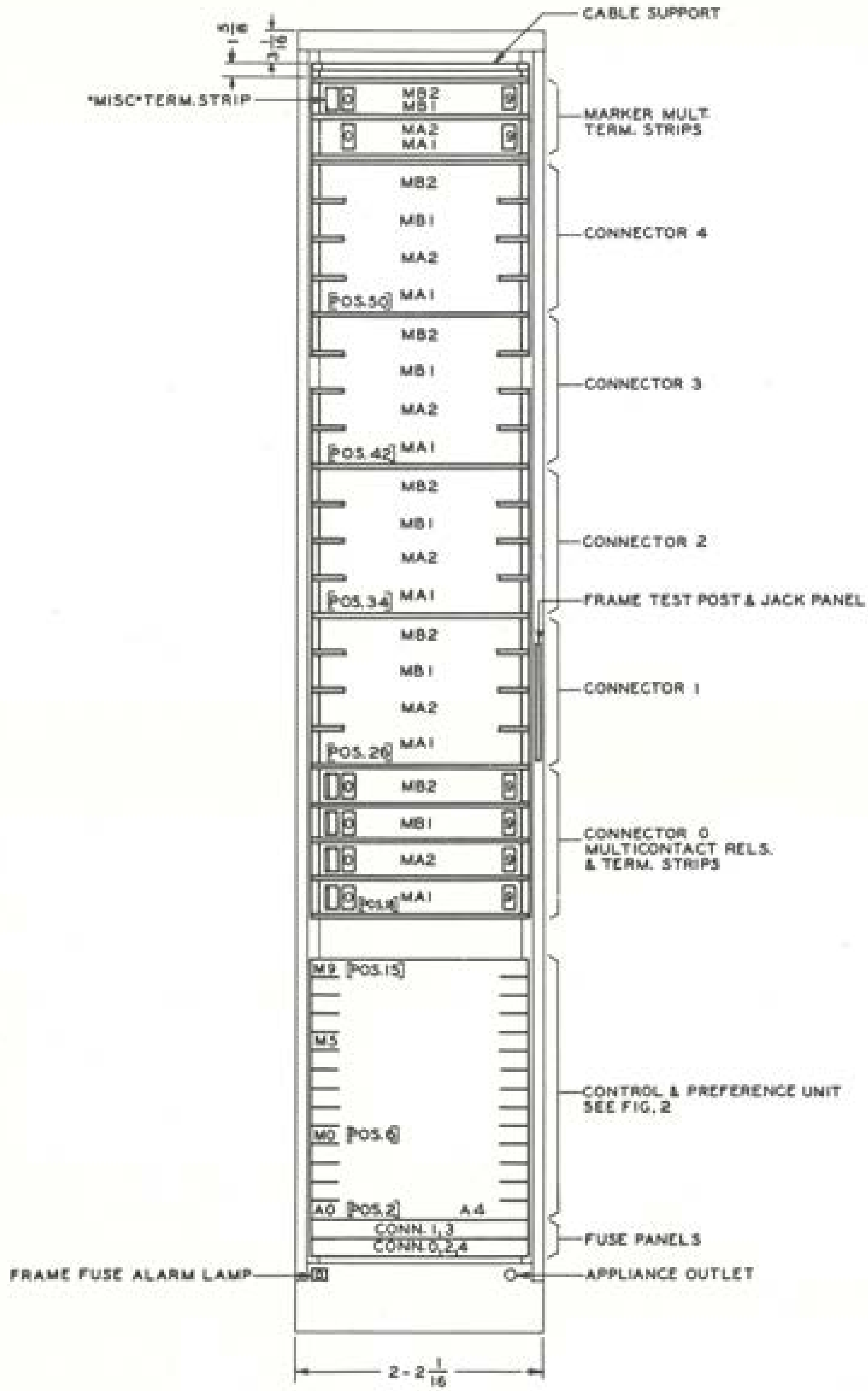
EQUIPMENT ARRANGEMENTS
CONNECTORS

Figure 3-3



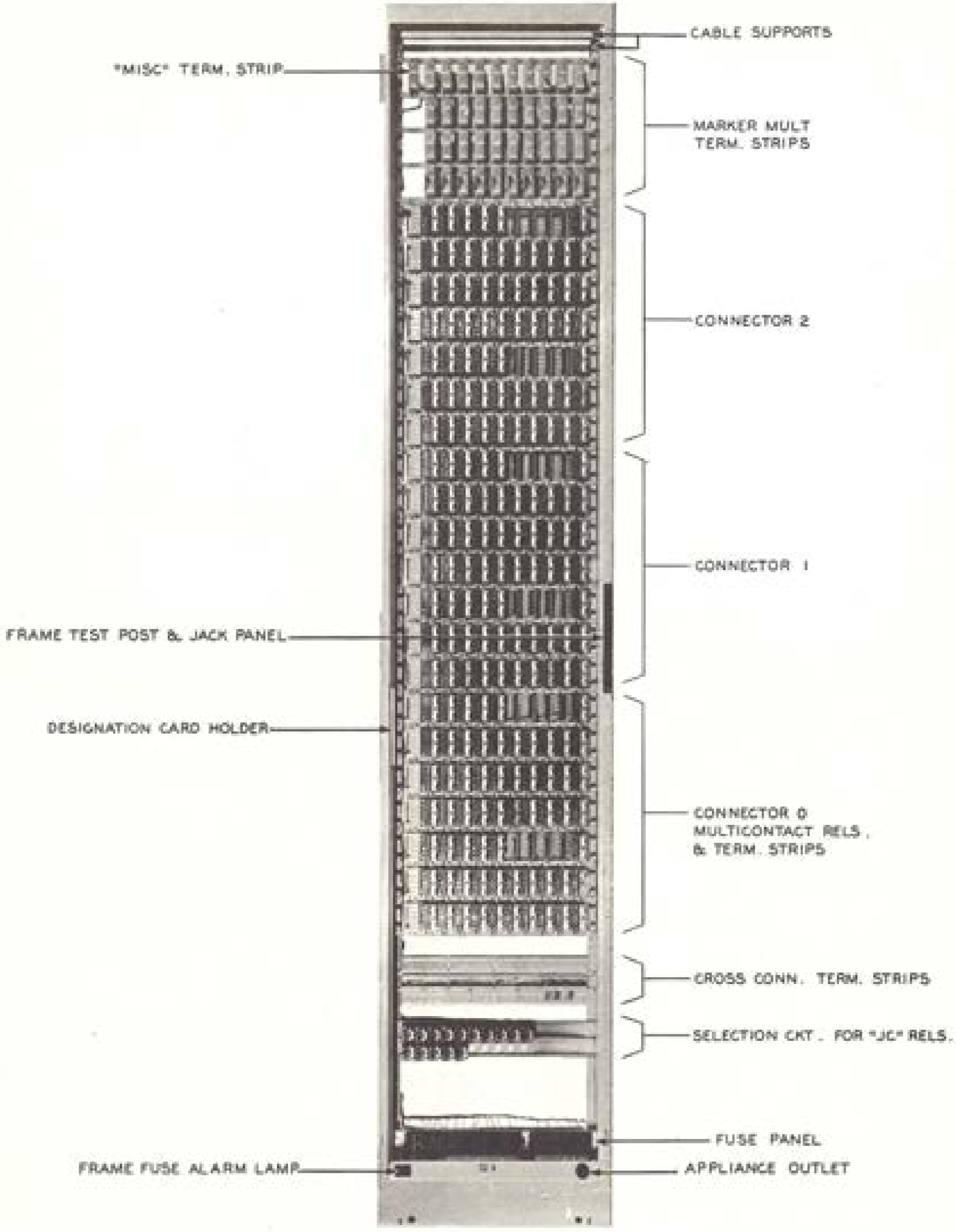
Line Link Marker Connector Frame

Figure 3-4



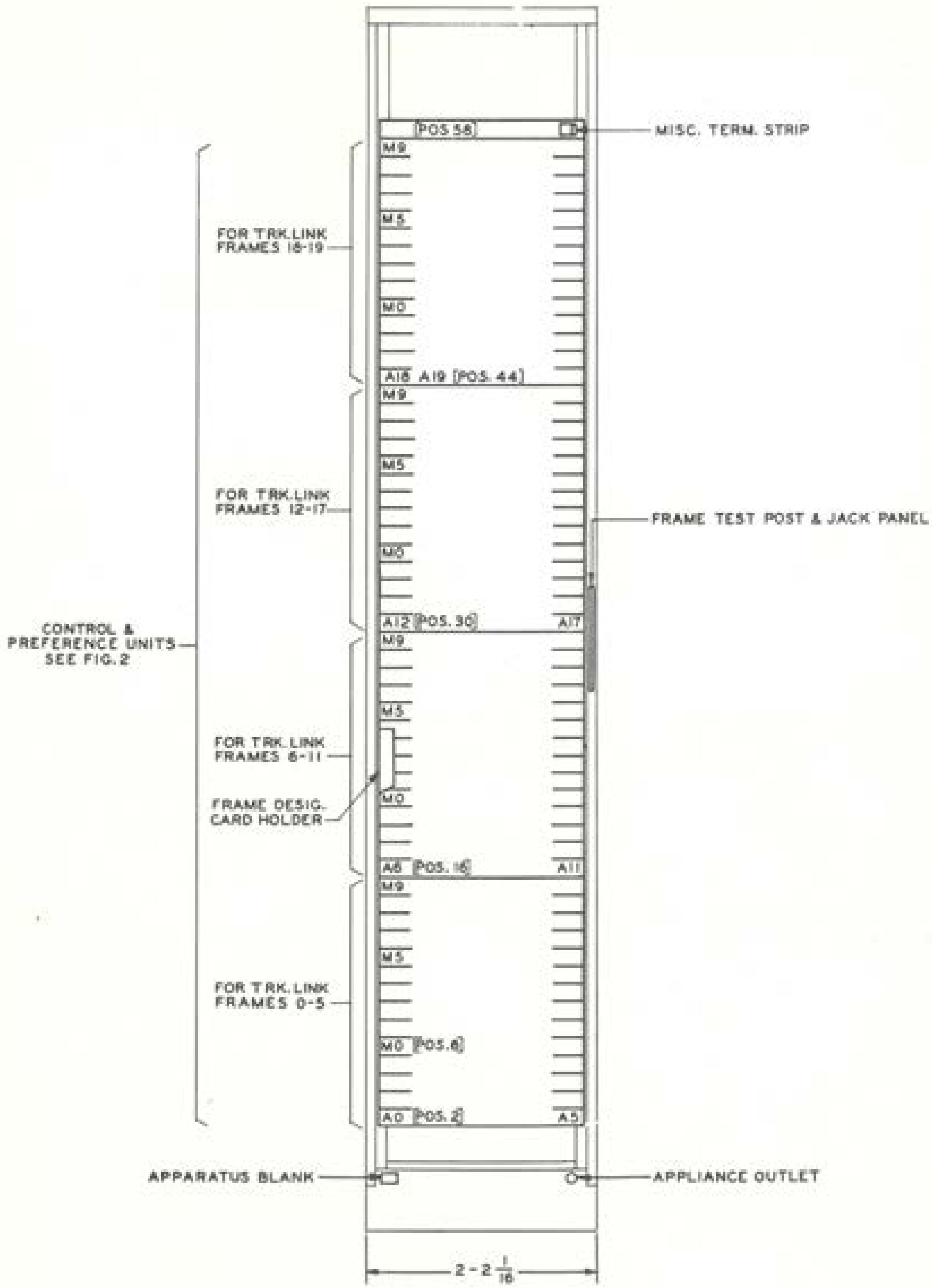
Line Link Connector Frame

Figure 3-5



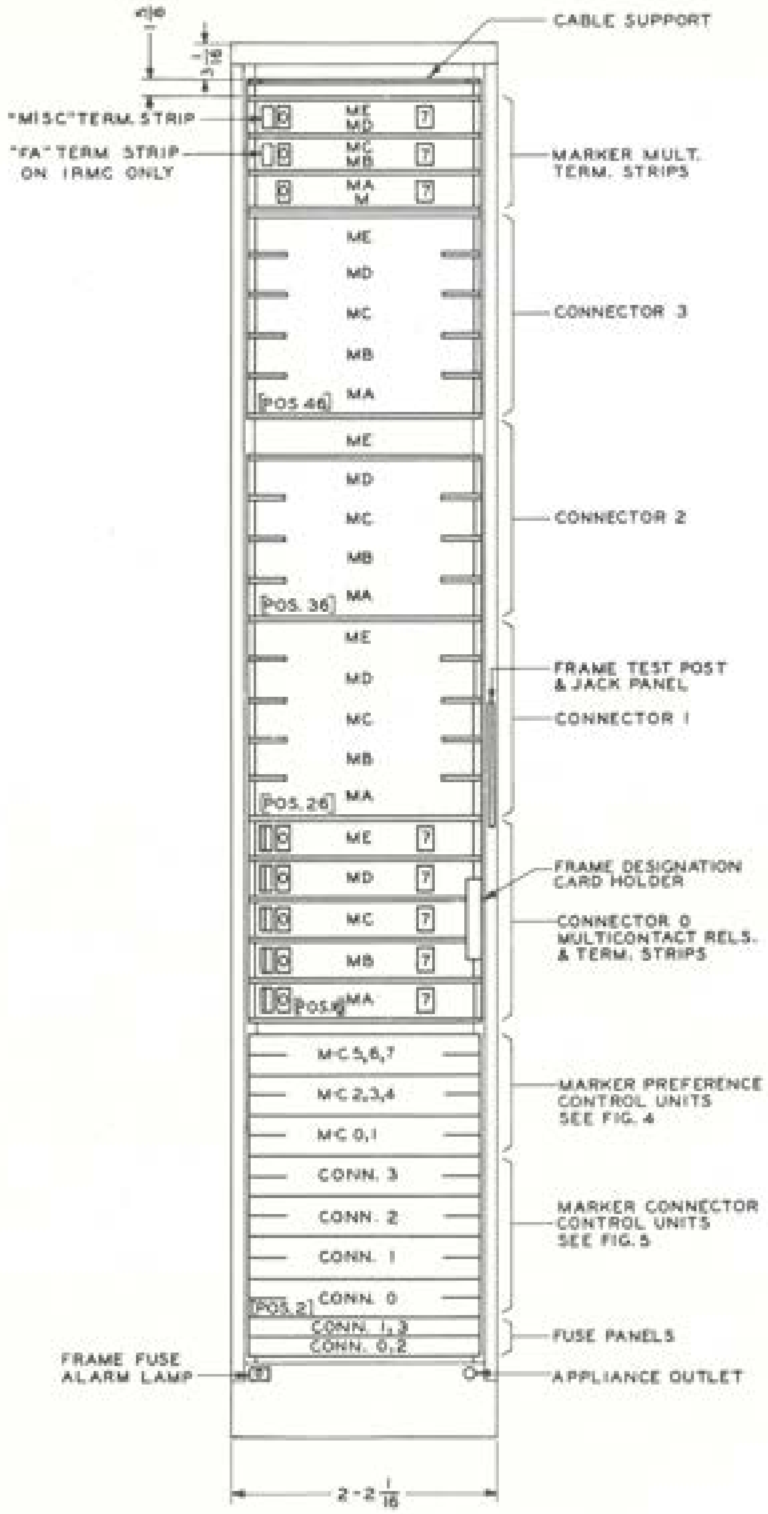
Trunk Link Connector Frame

Figure 3-6



Trunk Link Connector Control Frame

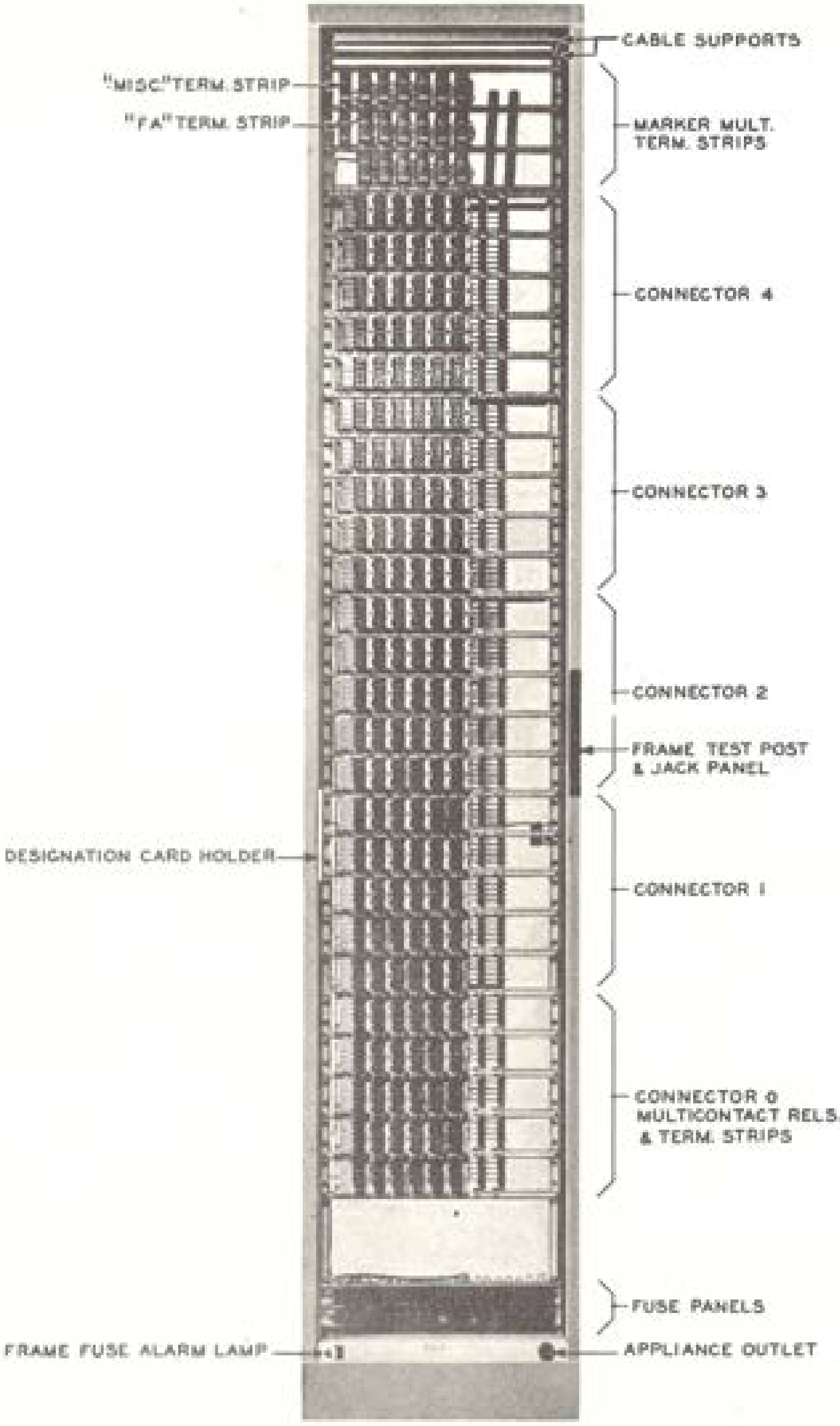
Figure 3-7



Originating and Incoming Register Marker Connector Frames

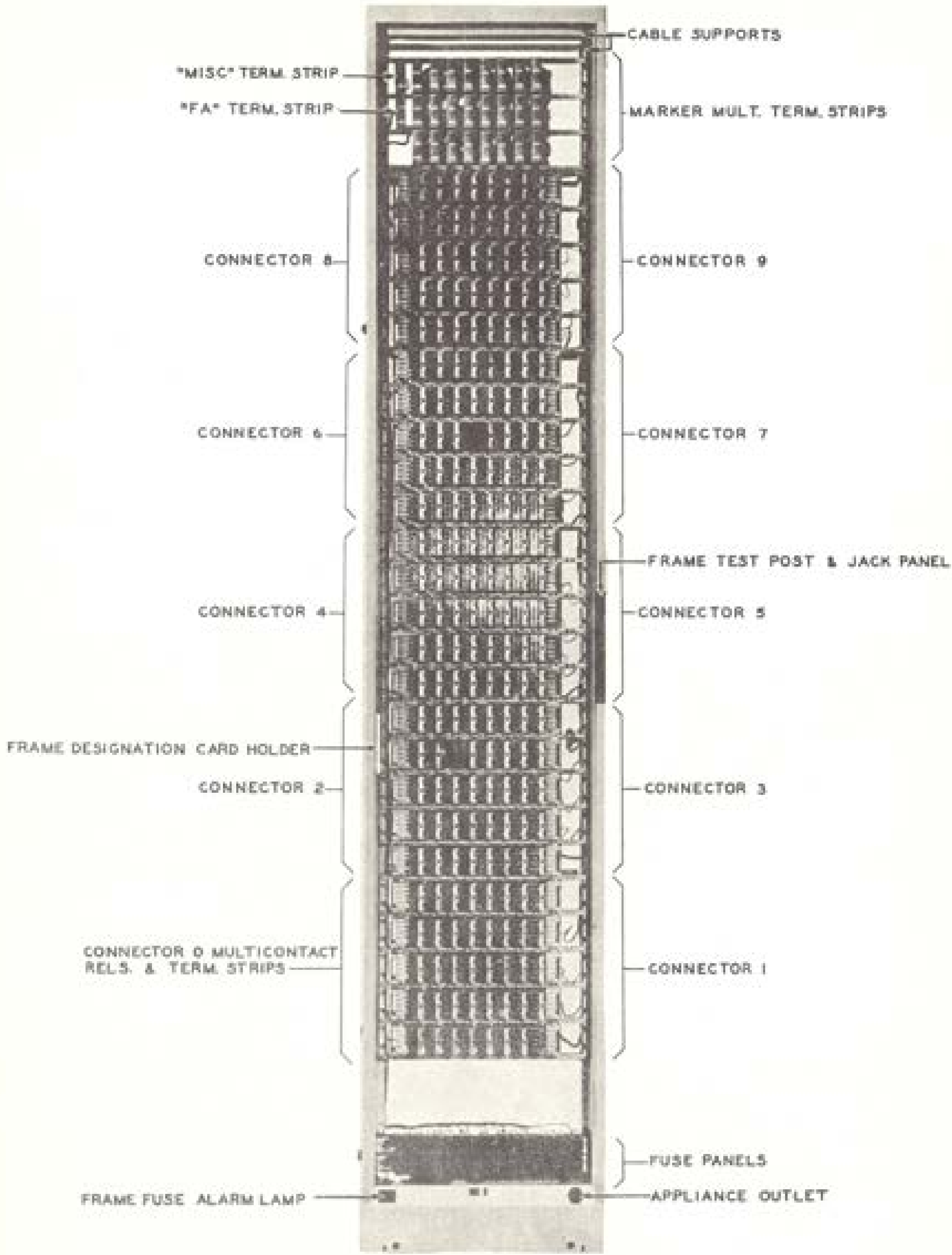
With Wire-spring Relays

Figure 3-8



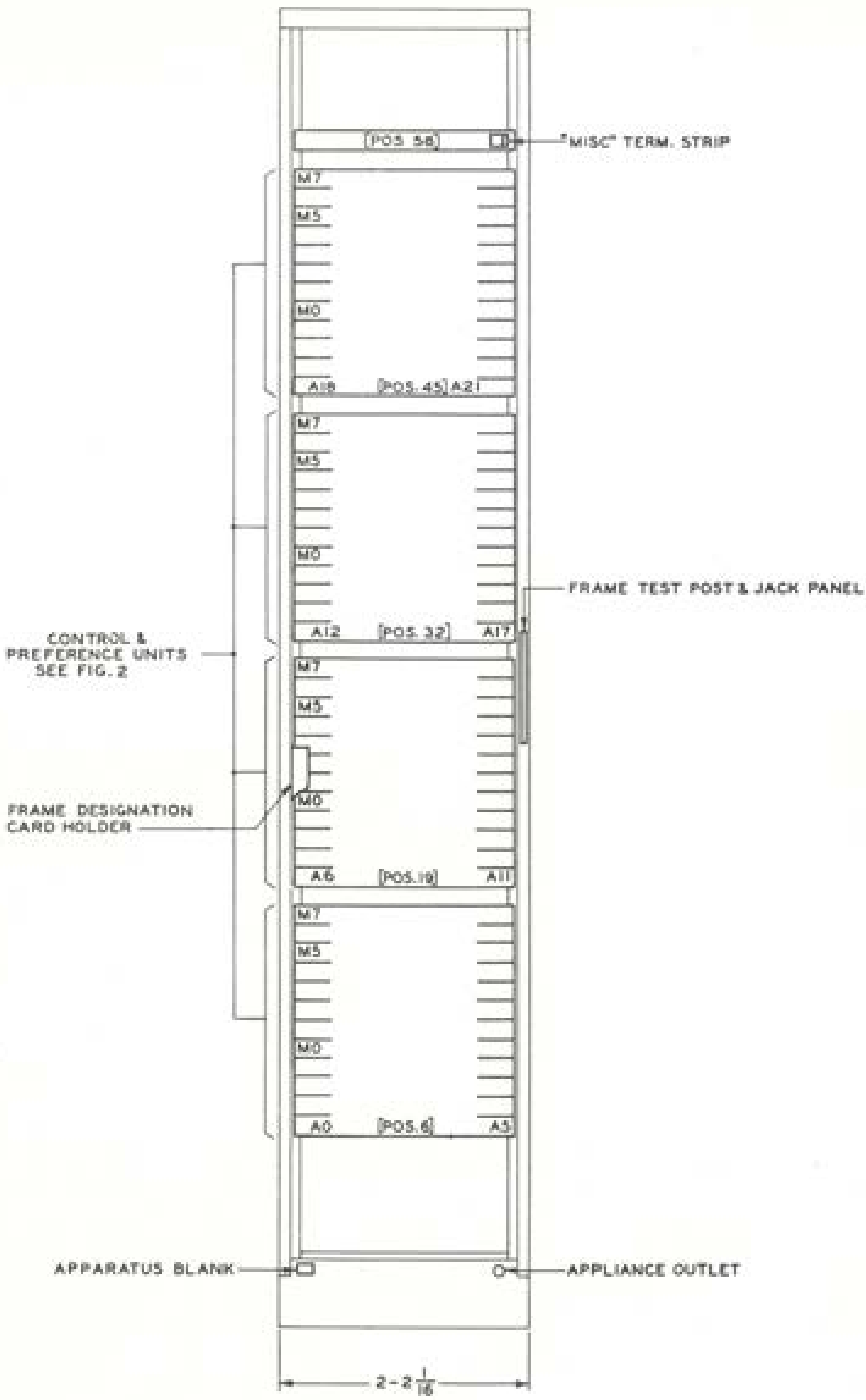
Basic Number Group Connector Frame

Figure 3-9



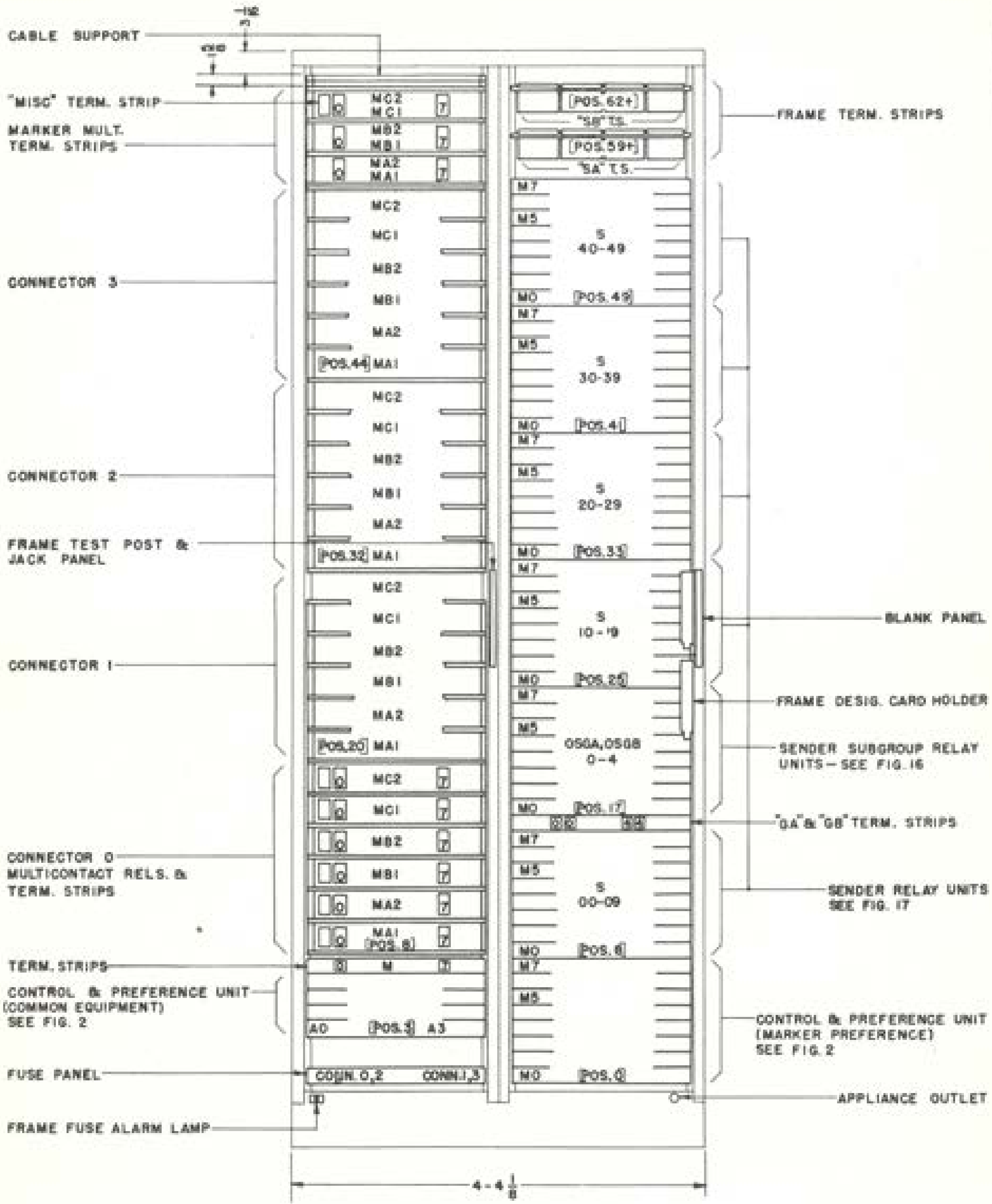
Split Basic Number Group Connector Frame

Figure 3-10



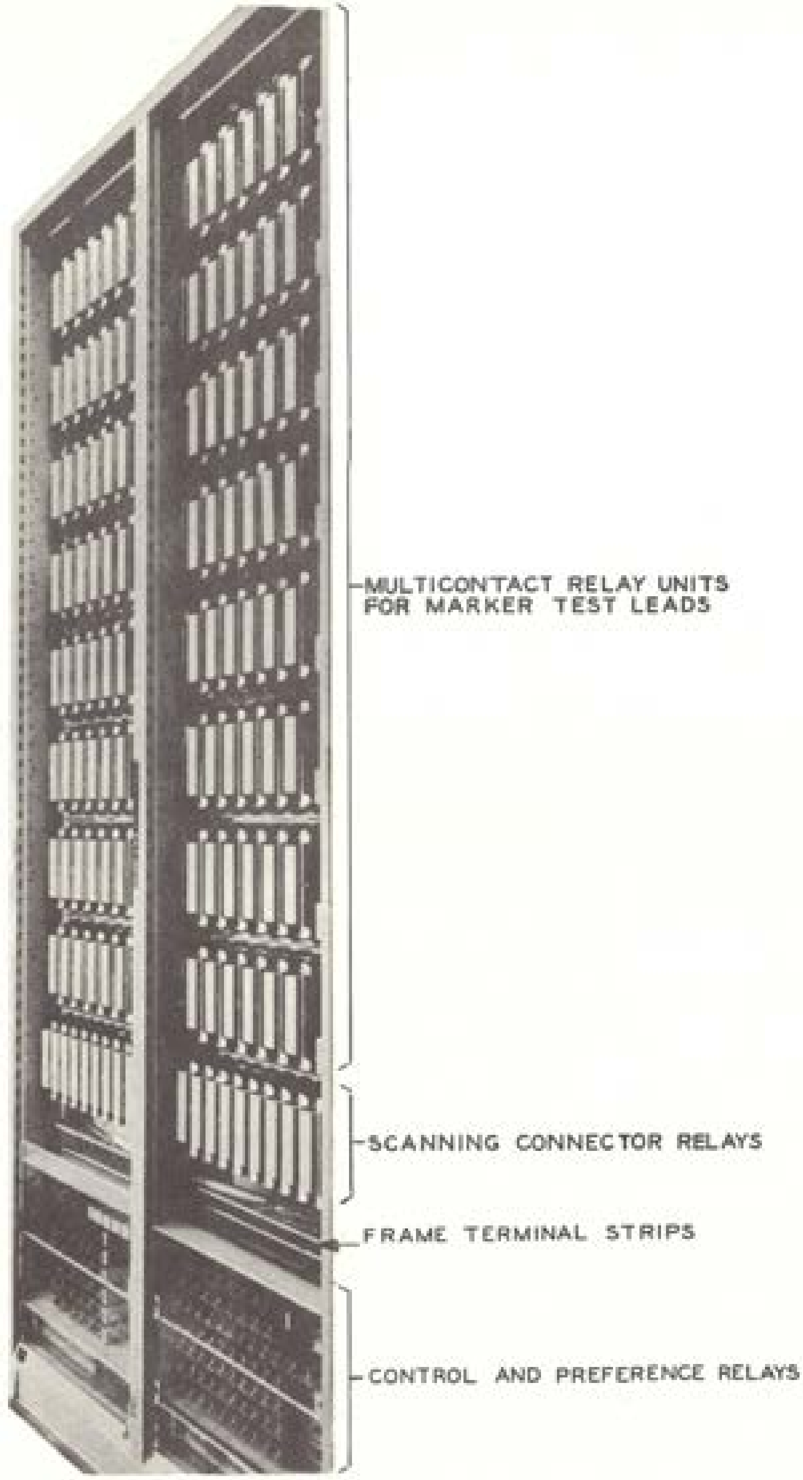
Number Group Connector Control Frame

Figure 3-11



Outgoing Sender Connector Frames

Figure 3-12

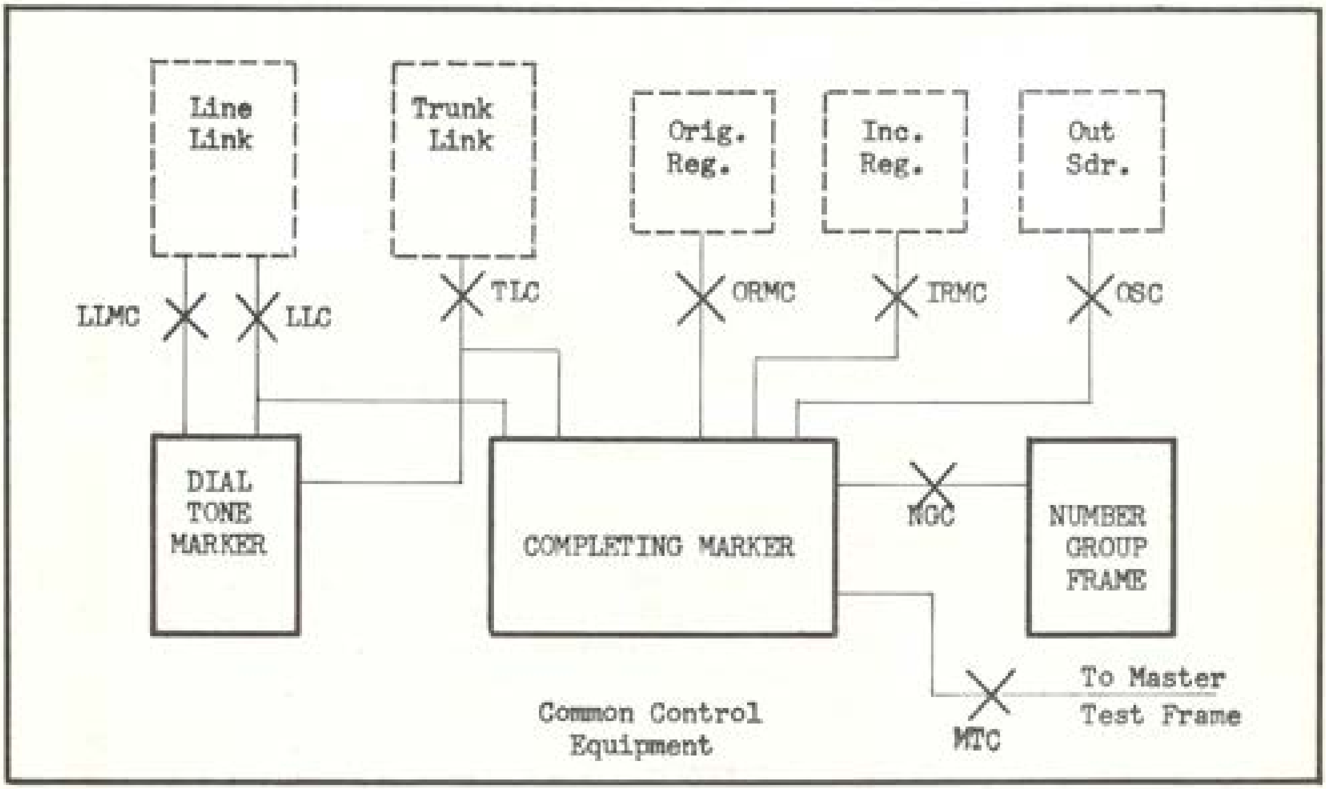


Master Test Connector Frame
With U-type Relays

Figure 3-19

SECTION IV

COMMON CONTROL EQUIPMENT



Reference and Credits -

Traffic Engineering Practices - Markers - Division D, Sec. 8e

Traffic Engineering Practices - Number Groups - Division D, Sec. 8i

Central Office Equipment - General No. 5 Crossbar - J29259 iss. 4

Bell System Practices - Equipment Engineering -

No. 5 Crossbar - Dial Tone Marker - J28759 iss. 2

No. 5 Crossbar - Completing Marker - J28760 iss. 2

SECTION IV - COMMON CONTROL EQUIPMENT

FIGURES

COMMON CONTROL EQUIPMENT

A. MARKER GROUP

General

Markers are the principal pieces of common control equipment in the No. 5 crossbar machine. They are used in the completion of every call. The number of markers required in an office varies depending on the size of the office and the amount of traffic. A maximum of twelve markers and their associated equipment which may serve a maximum of 40,000 numbers comprise a marker group.

Originally, only one type of marker was provided. This marker, later named the combined marker, handled all marker jobs. These jobs included the dial tone, intra-office, outgoing, incoming, tandem, toll completing, inter-marker group, junctor, reverting, and pulse conversion calls.

The combined marker is no longer manufactured and has been gradually replaced on additions and modifications by the more efficient separate subgroup of dial tone and completing markers.

These separate markers were developed as the result of a cost reduction program. Operating experience indicated that dial tone calls required about thirty-five per cent of the total combined marker usage time, while all eight completing call operations only required sixty-five per cent usage. Consequently, the marker group was divided into two subgroups; one subgroup consisting of a maximum of four dial tone markers, and a second subgroup consisting of a maximum of eight completing markers.

Marker Numbering Plan

The markers in each marker group are identified as M0 to M11. The digits 0 to 11 are used for trouble record card identification, and for association with relay positions in line link connectors (LLC), trunk link connectors (TLC), and sometimes the master test connector (MTC). M0 and M1 are always assigned to the first two completing markers, and these two markers are arranged to perform certain "special" marker uses. The M2 to M11 numbers may be assigned to completing or dial tone markers in any convenient order.

Within the subgroup, completing markers are identified as C0, C1, C2, etc. Dial tone markers are designated D0, D1, D2 and D3. The numbers C0, C1, C2 etc., are used for association with relay positions in originating register marker connectors (ORMC), incoming register marker connectors (IRMC), number group connectors (NGC), sender connectors (OSC), and the master test connector (MTC). The assignments of the markers to relay positions in the connectors are as follows:

Connector Frame	Relay Positions	Marker Numbers	Type of Marker
LLMC	0-3	DO-D3	Dial Tone
LLC	0-11	MO-11	Completing and Dial Tone
TLC	0-11	MO-11	Completing and Dial Tone
ORMC	0-7	CO-C7	Completing
IRMC	0-7	CO-C7	Completing
NGC	0-7	CO-C7	Completing
OSC	0-7	CO-C7	Completing
MTC*	0-7	CO-C7	Completing

*Normally only completing markers are assigned to the MTC frame, since dial tone markers are served by a DMTC frame. However, in some offices both dial tone and completing markers are assigned to the MTC frame, and the relay assignments then agree with those for the LLC frames.

B. DIAL TONE MARKER

General

The dial tone marker with wire-spring relays (Figure 4-1) consists of a 1-bay frame arranged with surface-wired units for line and class identification, trunk link frame selection, originating register selection, junctor and link selection, and other controlling and checking units for setting up the dial tone connection between a calling subscriber line and an originating register. Fewer markers are required with the new design because of its increased speed.

The dial tone marker with U-type relays rated "Mfrg. Disc." is the common equipment frame of the combined marker with certain units and relays omitted which are needed only for completing marker functions.

Each dial tone marker frame accommodates the equipment for one dial tone marker circuit and is arranged to operate with the No. 5 crossbar system frames and units as follows:

Line Link Frames	40 (LL00-39)
Trunk Link Frames	20 (TL00-19)
Line Link Vertical Groups	12
Subscriber Class-Of-Service Identification	100
Types of Originating Registers	2

The purpose of the dial tone marker in the No. 5 crossbar system is to set up connections between the calling subscriber line and an originating register. The register then returns dial tone as a start dialing signal to the subscriber. This involves connections between the dial tone marker and a line link frame through line link marker connector and line link connector, to the trunk link frame through the trunk link connector, and to the originating register through the originating register line memory frame.

When a subscriber lifts his handset from the switchhook, the line relay operates causing the line link frame to bid for connection to the dial tone marker through the line link marker connector. From this connection, the marker can identify the line link frame number and calling line vertical group and horizontal group locations. The marker then selects a trunk link frame associated with an idle originating register and makes connection through the trunk link connector. This permits selection of an idle originating register to which the marker also makes connection through the originating register line memory frame.

After selection of the trunk link frame, the marker bids for connection to the line link frame through the line link connector which closes leads for identification of calling line vertical file number and class-of-service number. The line link frame, vertical file, vertical group, horizontal group, and class-of-service information are all transferred to the originating register's memory circuit where it is stored for future use by the completing marker.

Connections through the line link and trunk link connectors also permit selection of an idle channel from the subscriber's line through a line link, a junctor, and a trunk link to the originating register. The marker, after selection of the channel, operates the select and hold magnets through these connectors, checks for proper operation, and disconnects from the frames involved.

The dial tone marker consists of a single-bay, sheet-metal framework 11 feet 6 inches high and 2 feet 2-1/16 inches wide. The equipment (see figure 4-1) consists of two fuse panels, a resistance lamp unit, fourteen relay equipment units, four module-type frame terminal strips, and a 50-watt resistance unit. Local cable is used for all frame wiring between units, between units and the frame terminal strips, for battery and ground connections to the fuse panels, for looped leads at unequipped apparatus positions, and for options which involve wiring only.

Each of the units, as far as practicable, is arranged for a particular function as denoted by the unit title. Surface wiring is used for all wire connections within the unit. Except on the 50-watt resistance unit and the trunk link frame memory and check unit, no unit terminal strips are used since external connections are made by local cable terminations on the apparatus springs.

Supplementary Dial Tone Marker Frames (Figure 4-2)

This frame is used as a supplement to the dial tone marker frame when more than 40 line link frames and/or more than 20 trunk link frames are provided or when tripled trunk link frame feature is provided in anticipation of future expansion beyond 40 line link frames and 20 trunk link frames. It requires one 23-inch sheet metal bay and provides supplementary relay equipment and cross connection fields for four dial tone markers. No fuse panels or ground bars are required since battery and ground leads are furnished by the associated dial tone marker frames.

C. COMPLETING MARKERS

General

Each completing marker with wire-spring relays requires one 2-bay common equipment frame and one 2-bay translator and code treatment frame. In addition, one 2-bay frame provides the route relays for 100 routes for each of four markers. Optional frames not always required in a completing marker and furnished separately are code conversion, supplementary service treatment, and PBX allotter frames.

Common Equipment Frame (Figure 4-3)

The completing marker common equipment frame requires two 23-inch bays. It accommodates the functional units which are associated with trunk link frame and trunk selection, identification of calling and called line locations on line link frames, channel test and selection, junctor group and pattern control, hold magnet operation, number group and connector control, ringing switch control, sender and sender connector selection, route advance and recycle control, sender link control, trunk charge information on intraoffice or outgoing call, identification of trunk class on incoming call, identification of AMA recorder number for AMA charging, pulse conversion class control, over-all timing, cross detection, and master test frame connector and trouble recorder control. The no-test call control unit and message register detector unit for special markers (0 and 1) are also located on this frame.

Four fuse panels with 70-type fuses are located at the base of the frame. Six fuse positions are assigned for +130-volt 1/2-ampere fuses. All other fuses are assigned for 48-volt 1-1/3-ampere fuse. Seven assemblies of 251-type terminal blocks are located at the top of the frame. These are for termination of switchboard cables from other frames, and for most of the marker "Office Size" cross connections.

Translator and Code Treatment Frame (Figure 4-4)

The translator and code treatment frame requires two 23-inch bays. It accommodates the relay units and cross-connection fields associated with (a) translation and routing of called office codes, (b) subscriber and trunk class screening, (c) transfer of AMA billing, called number, and route information to senders, (d) route series and preroute relays and (e) transfer of called line number to the number group.

One panel of 70-type fuses is located at the bottom of the left bay. Seven assemblies of 251-type terminal strips are located at the top of the frame for termination of switchboard cables from other frames.

The code points, class-of-service, route relay, route series, and associated cross-connection terminal strips are located in the left bay. Assemblies of 251-type terminal strips are used for code points, R, RC, SC, S, and other punchings which require single terminals. Assemblies of Nos. 256A 256B terminal strips are used for code grouping, route series, message billing, S grouping, and R grouping. Please refer to section IV-D.

Route Relay Frame (Figure 4-5)

The route relay frame consists of two 23-inch bays arranged to accommodate 100 route relays for each of four completing markers. A wire-spring relay marker group is limited to a maximum 398 route relays per marker; thus, from one to four route relay frames may be equipped for each four markers. These frames are designated RR0, 1, 2, and 3, and the M( ) C( ) numbers for the four associated markers are also stamped on the base of the frame.

Each route relay is a 286-type multi-contact relay. Twenty contacts are used for FTC leads from trunk link frames 00-19. One contact is used for peg count (PC), and another is used for overflow (OF) registrations for the traffic register frame. The remaining eight contacts are used for CS, CP, CR, DL, CL, RA, TB, and TG leads which are terminated on cross-connection punchings for assignments of sender group, sender information, route advance, trunk block connector, and trunk group connector as required for the associated trunk group. Winding terminals R and RC are cabled from 251-type terminal strips back to the cross-connection fields in the associated marker translator and code treatment frame.

The 28 multicontact relay assemblies are located on the left bay giving 70 route relays for each marker, and 12 multicontact relay assemblies are located in the upper portion of the right bay giving 30 route relays for each marker. The lower part of the right bay is equipped with terminal strips for the cross connections of CS, CL, DP, CP, CR, RA, TB, and TG information, and for switchboard cabling of RC, R, and ground supply multiple leads for G55 and G56.

The terminal strips at the top of the frame are for switchboard cabling the FTC leads to the trunk link frames and the PC and OF leads to the traffic register frame.

Except for the first route relay assembly for each marker, route relays are equipped ten at a time on a per marker basis.

Ten relays and a terminal strip are assembled on a 23-inch mounting bar. Bare-wire strip multiples connect the fixed contacts of the relays to the terminal strip so that each assembly of ten relays can be served by the same ground supply. The frame local cable has a fixed wiring pattern between terminal strips to permit a distribution of route relay assignments to ground supplies 1, 2, 3, and 4.

The first route relay assembly for each marker on route relay frame 0 has three terminal strips and eight relays. The terminal strips are for termination of ground supplies 1, 5 and 6. Assignments of relays may be made to each of these ground supplies by cutting the bare-wire strapping between the relays. Ground supplies 5 and 6 together will require a minimum of three relays for non-coin overflow, coin overflow, and non-coin "catch all" trunk groups. The remaining relays may be assigned to ground supply 1 for general use or assigned to ground supplies 5 and 6.

Code Conversion Frame (Figure 4-6)

Code conversion is an optional feature which is used when 2- or 3- digit arbitrary codes are required in place of directory codes for completion of calls from No. 5 offices through offices, such as step-by-step tandem or toll centers.

The code conversion frame consists of one 23-inch sheet-metal bay and accommodates 96 code conversion preroute relays, one transfer and check unit for A and B arbitrary digits, and code conversion cross-connecting fields for each of four completing markers. No fuse panels or ground bars are required on this frame since battery and ground leads are cabled over from the basic marker frame.

The code conversion preroute relays (CV) are arranged in single-plate surface-wired units, and each unit accommodates 12 relays and one D-type terminal strip. One relay is required for each converted code. As the word "preroute" implies each CV relay operates ahead of an associated route relay. The information supplied by the CV relay must be subject to control of the same ground supply circuit as the associated route relay. All 12 relays on each unit are wired for a common multiple which terminates at the unit terminal strip. The frame wiring is arranged for cross connection of the CV relay multiple to any ground supply 1, 2, 3, or 4 at each unit terminal strip.

Supplementary Service Treatment Relay Frame (Figure 4-7)

This frame is used as a supplement to the marker translator and code treatment frame when more than 60 service treatment relays are required. It requires one 23-inch sheet-metal bay and accommodates 60 service treatment relays and cross-connection fields for each of four completing markers. No fuse panels or ground bars are required since battery and ground leads are furnished by the associated translator and code treatment frames.

PBX Allotter Frame (Figure 4-8)

PBX allotting is an optional feature whereby lines connecting large PBXs with the No. 5 office may be allotted into two or more number groups. On completing calls the markers, when searching for idle lines to a given PBX, are steered to different number groups on a preference basis. This procedure helps relieve a possible "backup" condition caused during periods of heavy traffic to a given PBX when, without allotting, several markers might be waiting for connection to the same number group. It is recommended that all PBXs having 30 or more lines to the No. 5 office should be considered for allottment. There are, however, no restrictions and smaller PBXs may be allotted if such is considered desirable by the Telephone Company.

The PBX allotter frame consists of one 23-inch sheet-metal bay and accommodates a PBX allotter control unit, two allotted PBX identifier units, and the cross-connection fields for each of four completing markers. No fuse panels or ground bars are required since battery and ground leads are cabled over from the associated marker common equipment frames.

The PBX allotter control unit requires four 23-inch mounting plates. One unit is required for each marker. The allotted PBX identifier unit requires two 23-inch mounting plates and each unit serves one marker for allottment of five PBXs. Thus, two PBX identifier units per marker will permit a maximum of ten allotted PBXs per marker group. Each PBX may be allotted into two or more number groups.

Any PBX directory number may be in any of the six possible office number "series," but lines of a given PBX must be allotted into number groups which are in the same office number "series" as the PBX directory number.

FC Relay Frame (Figure 4-9)

The FC relay frame is provided on an optional basis for association with trunks on trunk link frames 20 through 29. The completing marker FC relay frame consists of a 23-inch bay arranged to accommodate 100 FC relays of each of four completing markers. A wire-spring relay marker group is limited to a maximum of 398 FC relays. Thus from one through four FC relay frames may be equipped for each four markers. These frames are designated FCR0, 1, 2, or 3, and the M ( ) C( ) numbers for the four associated markers are also stamped on the frame. No fuse panels or ground bars are required on this frame, since battery and ground leads are cabled over from the associated common equipment frame.

Each FC relay is associated with one route relay (R). The FC and its associated R relay have the same numerical number and are always in the same ground supply. The winding of the FC relay is wired in parallel with the winding of the R relay. The FC relay circuit requires 12 make contacts. Ten contacts are used for trunk block check (TBC), and another is used for FC cross detection (XFC). R and RC winding terminals are cabled back to the associated R and RC terminals on the route relay frame.

Foreign Area Translator Frame and Foreign Area Translator Connector Frame (Figure 4-10 and 4-11)

A foreign area translator is required for translation of called office codes when called offices in a foreign area are reached (a) over more than one trunk route or (b) over one trunk group to a tandem or a toll center where different AMA bulk billing treatments apply, as determined by the calling office code and the destination of the call.

One translator frame extends this service to one, two, or three foreign areas and two of these frames will care for six foreign areas, the maximum provided for in the design.

On a call requiring the help of a foreign area translator, the completing or combined marker is momentarily associated with the translator through a foreign area translator connector. Eight connectors on one frame may serve the markers in one or two marker groups. When the second foreign area translator frame is required, an additional connector is provided for each marker.

One area route indication (out of 100 maximum) is transmitted from the foreign area translator to the marker. Each foreign area translator frame can translate for a maximum of 72 direct routes to called offices. These routes are assignable in the three foreign areas in groups of twelve with a maximum of 48 in any one area. Provision is also made for 24 routes to tandem or toll centers for subscriber or tandem traffic per area and five routes to toll centers for toll traffic per area.

Four Wire Frame (Figure 4-16)

The 4-wire frame is provided on an optional basis when the marker group is arranged for 4-wire network traffic. It consists of one 23 inch bay and serves four completing markers. The frame provides the mounting locations and cross-connection terminal strips for three units associated with 4-wire operation; the 4-wire control unit. the 4-wire control digit screening unit and the camp-on unit.

D. ROUTE RELAYS AND ALLIED ITEMS

General

A combined or completing marker determines how to dispose of an originating, or tandem/toll through call principally by the operation of a route relay, the closing of whose several contacts condition the marker to perform most of its functions insofar as the particular call is concerned. The number of route relays may vary from as few as forty, or on some jobs up to a maximum of 398 per wire-spring marker. All markers of a given type (completing, or combined) must be equipped identically on any given job.

A particular combination of area or office code digits, as received by the marker from an originating register, incoming register or intermarker group sender, causes a ground to be placed on a "code point." This operation is called marker translation. The code points appear as punchings on terminal strips on the translator and code treatment frame. Each code point that can be grounded in a given office is ultimately cross-connected to the winding of a route relay which will furnish the routing information required to complete the call when that code point is grounded. Several code points can be "bunched" and cross-connected to the same route relay.

The route relay does not furnish the information as to what charge condition is to be met in the trunk; i.e., that the call is free (flat rate), that a message register must be operated, etc. This is accomplished by inserting a "route series" relay between the route relay and battery. These route series relays (NCNC or MRS - for instance) also appear on the translator and code treatment frame.

In most cases, a given code point will involve either routing or charging of the call as a function of the class of service of the calling line. This is accomplished by means of "SC points," or Service Common punchings. Each SC punching is wired in multiple to the movable contacts of service treatment relays. The corresponding fixed contacts are wired to punchings designated as "S" points. Thus, by cross-connecting an SC point between a route relay and route series relay, different charge conditions are available for a particular route relay. Where class of service requirements involve different trunk groups for the same code point, an SC point is inserted between the code point and route relays. In some offices, it is necessary to arrange for "trunk or tandem screening," an arrangement whereby certain incoming tandem trunks will be given one routing treatment, and others different treatment. With this arrangement, incoming tandem trunks may be segregated into five categories. The arrangements required are discussed in a separate heading later on in this subsection.

Code Translation and Code Points

The code translation facilities available for the combined and completing markers provide for a wide variety of numbering plans for subscriber dialing, and for tandem or toll switching. Since the listing of all combinations is impossible, the discussion here will be limited to that information which should be sufficient for the Engineer to visualize the interrelationship of the code translation and the provision of route relays.

The general function of the marker translator is to cause a ground on a "code point," in accordance with a particular combination of digits received from an originating register, or an intermarker group sender which at the incoming end of an intermarker group trunk functions as an incoming register. This translation is done by a "tree" arrangement of translator relays, such that if the code is "234" the "2" relay in the first set of relays, then the "3" relay of the set following the "2", and then the "4" relay following the "2-3" relays, are cut through to the code point "234."

A certain few code points are grounded by means other than a combination of digits, and are referred to as "special code points." One of these is the "D" code point, provided only in the dial tone marker or combined marker, and is automatically grounded when the marker is seized by a line link marker-connector to start the routing of a call to an originating register. Other special code points are automatically grounded by the originating register under the following conditions:

PD - Partial dial. When an originating register times out because it has received an insufficient number of digits.

PS - Permanent signal. When an originating register times out without receiving any digits.

ZO - Zero operator. When "0" is the initial digit dialed into the originating register.

More than one field of translators will often be required in the same office. For example, the number of digits to be translated on a subscriber dialed call may be different than on an incoming call for the same destination. The available translator fields are:

For Originating Register Calls

LT - Local translator. This may be for 1-digit, 2-digit, 3-digit, or combined 2- and 3-digit home area numbering plan codes, and for 3-digit foreign area directing codes.

X11 - Service code translator. Used only in offices using this type of service code.

11 - Service code or extended area translator. Used where 11X service codes are used, or where the code "11" is used for dialing to a foreign numbering plan area.

For Incoming Register Calls

LT - Local translator. Incoming call directed to same local translator as above.

TT - Toll translator. Used for certain toll service and routing codes.

FVD - One directing digit translator. Used for incoming trunks where one digit only of a 2- or 3-digit code is used as a directing digit. (This single digit may cause the operation of the same route relay as a combination of three digits dialed by a customer.)

2DT - Two-digit translator. Sometimes referred to as BX translation. Used where the incoming trunk receives only the second and third digits of a 3-digit code (the B and X of an ABX code).

In order that the call will be directed to the proper translator, various translator leads are provided from the registers to the marker via the marker connectors, to indicate the type of call involved, such as incoming terminating, incoming tandem, etc., and the type of translation involved, such as FVD or 2DT, etc. There are also certain leads from incoming registers to indicate that translation of a code is not required. These included OA and OB, to indicate that only four numericals of the line number are involved to be completed to either Office A or Office B, PCR, PCD and PCD1 to indicate that the call is a marker pulse conversion call involving an out revertive pulse sender, out dial pulse sender in Group 0, or out dial pulse sender in Group 1, and RO, to indicate that the incoming trunk should be set to return a reorder signal.

Foreign Area Translation

In toll centers and in offices with customer toll dialing there may be a need for foreign area (six-digit code) translation. This need will arise when subscriber originated traffic, or incoming tandem or toll traffic requires access to more than one trunk group to reach called offices in a foreign numbering plan area. Subscriber originated traffic may also require foreign area translation when different message unit treatments in the form of AMA bulk billing are necessary for different called offices or codes in the foreign area.

On a call requiring foreign area translation, the completing or combined marker is momentarily associated with the translator through a foreign area translator connector. A translator frame provides duplicate equipments of (A) and (B) translators serving one, two or three foreign areas. If required, a second frame of (A) and (B) translators with another foreign area translator connector frame may be provided to serve three additional foreign areas (maximum 6). Regardless of the number of foreign areas requiring translation, one of a maximum of 100 area-route indications may be passed back to the marker on a given call. The area-route indication identifies a route and rate treatment pattern in the marker. When the marker requires one or more route relays or code conversion (CV) relays for an out-trunk group, the translator is required to provide a like number of area-route indications. The 100 foreign area-route indications may be assigned to "direct routes" or "switched routes" for called offices. They cover all the translator outputs for one through six foreign areas. The terms direct route or switched route as used here refer to various equipment arrangements within the translator and not necessarily the destination of the trunk group to be selected by the marker. A "direct route" represents a trunk route to another office building with no intermediate switching involved. A "switched route" represents an out-trunk route to another office building where further switching is required. From a traffic standpoint the 100 foreign area-route indications are flexible and can be assigned to any type of traffic.

Each translator frame provides for 72 direct route treatments assignable in groups of 12 to any one foreign area, with a maximum of 48 for one area. In addition, provision is made for 87 switched routes with a maximum of 29 for any one area; 24 for incoming tandem or subscriber originated calls and 5 for incoming intertoll calls. Switched route equipments are assigned in groups of 5 for incoming tandem or subscriber originated traffic and individually for incoming toll switch traffic.

Route Relay Functions

The operation of a route relay makes it possible to condition the marker for the items of information listed below. In general, all calls which require identical treatment for all of these items are directed to the same route relay. Where there is a difference in any one of the items, different route relays are required. Please refer to Figure 4-13.

Trunk Selections
Sender Group Selection
Route Advance
Digit Deletion
Prefixing of Digits
Code Conversion
High 5 Low 5 Indication
Called Number Structure
Code Pattern

<u>Trunk Selection</u>

Cross-connection of the TB (trunk block) TG (trunk group) punchings furnish leads through the trunk link connector circuit to cause the selection of a trunk in the desired trunk group on the trunk link frame (FTC 00-19).

<u>Sender Group Selection</u>

Associates the proper sender group (OSG punching) with the trunk group selected.

<u>Route Advance</u>

When all trunks in the trunk group are busy, or when all senders which can be associated with the trunk group are busy, or when the marker encounters a failure to match when attempting to establish the connection, the "ground supply" connected to the usual operational contacts of the route relay is opened, and ground is placed on the RA contact instead. This in effect causes the normal functions of the route relay to become inoperative, and the operational functions of whatever is cross-connected to the RA contact to become effective instead. The usual RA cross-connections are as follows:

Outgoing extramural trunk group for which there is no alternate route - there are three possibilities, as follows:

(1) If only subscriber originated calls reach the route relay, the route advance is to a route relay for combination tone trunks.

(2) If only tandem and/or toll calls reach the route relay, the route advance indicates to the marker that it should set the incoming trunk to return a reorder signal.

(3) If subscriber originated calls, and also tandem and/or toll calls reach the route relay, the route advance is as follows: For subscriber calls, the route advance is

to the combination tone trunk; on tandem or toll calls the marker sets the incoming trunk to return a reorder signal.

Outgoing extramural trunk groups for which there is an alternate route - there are two possibilities as follows:

(1) If there is alternate routing of any incoming tandem or toll class traffic in the office, the route relay must have the final route advance arranged to set the incoming trunk to return busy tone. Since subscriber dialed traffic must be route advanced to combination tone trunks or an alternate route, it follows that separate route relays must be provided for subscriber dialed vs. tandem and/or toll class calls. This is true not only on the final route, but also on any first or intermediate route in order that the two general categories may arrive as separate entities of traffic at the final route.

(2) If there is alternate routing of subscriber calls, but no alternate routing of tandem or toll calls, separate route relays are required. The tandem and/or toll calls will be route advanced to set the incoming trunk to return busy tone and the subscriber calls will be route advanced to the alternate route.

Intraoffice and reverting call trunk groups - to the route relay for the combination tone trunks.

Permanent signal holding trunks - to the route relay for the common overflow trunks.

Coin combination tone trunks - no RA cross-connection is required. If there is no trunk available, the marker signals the originating register to return the all paths busy signal (optional 60 or 120 IPM tone).

When route advance occurs, the charge condition is established by the route series relays to which the first route relay is connected. Hence, the route relay to which the call is advanced need not discriminate for charge condition. Because of this, the windings of the route relay to which calls are route advanced are connected directly to route battery (RB), instead of to battery via a route series relay. Hence, when a trunk group has both first route traffic offered to it, and also traffic which is route advanced to it from another group, it is the usual procedure to provide a separate route relay for handling the traffic which is route advanced to the group.

Digit Deletion

A marker transfers to an out sender all digits that it receives from the originating or incoming register, except, of course, where an out sender is not equipped to record the first, the first two, or the first three digits. In the case of a DP, MF or PCI sender, all of the digits so transferred may be outpulsed onto the trunk, or the initial one, two, etc., up to six, may be deleted. For example, on a call to a step-by-step office with seven digit numbers only four digits might be required to be outpulsed. In this case the marker and sender would be arranged to delete the first three digits of the number. The desired arrangement is accomplished by proper cross-connection of the DL (delete) contact of the route relay.

Thus, if calls for several different office codes are routed via the same trunk group and require different digit deletion, one route relay is required for each deletion arrangement (delete none, delete one, etc.).

Prefixing of Digits

Arbitrary digits may be prefixed to other digits transferred by the marker to an out DP or MF sender for outpulsing on other than marker pulse conversion calls. MF senders may prefix "11" and/or one arbitrary digit. DP senders may prefix 1, 2, or 3 arbitrary digits. The desired arrangement is accomplished by proper cross-connection of the CR contact of the route relay. Where no digits are to be prefixed a cross-connection is required to indicate "no prefix."

If calls for several different office codes are routed via the same trunk group and more than one "digit prefixing" treatment is required, separate route relays are required for each treatment except when code conversion arrangements are provided, one route relay and one or more CV relays may suffice. It should be noted that, if the initial "11" is to be outpulsed on originating register class calls, the "11" must be supplied to the sender by the CR cross-connection. This is required because the "11" is not passed from the register to the marker. Toll and tandem class calls differ in that the "11" is passed to the marker and can in turn be transferred to the sender.

Code Conversion

Code conversion consists of deletion of one or more digits of a code as received and prefixing of 1, 2, or 3 arbitrary digits in an out sender. One arbitrary digit, or "11", or "11X" may be prefixed with no additional equipment in the marker. However, when 2 or 3 arbitrary digits are to be prefixed by DP senders, a code conversion relay (CV) is required for each particular combination of digits required and the number of such digit combinations should be specified in the traffic order. CV relays are mounted on a separate code conversion frame, and a maximum of 96 may be installed. Any number of CV relays may be associated with a single route relay. Code conversion is often used when two or three arbitrary digits are required to route a call through a distant step-by-step intertoll train to reach a tributary or toll trunk group.

High 5 Low 5 Indication

On out revertive pulsing trunks, the use of "high 5" and "low 5" incoming brush selection may be required to provide Office A vs. Office B, or physical vs. theoretical discrimination at a distant crossbar office reached over a common trunk group. This is accomplished by a cross-connection of the CL (class information) contact of the route relay. This feature permits trunking economies by the routing of traffic to two different offices in a distant building over a common trunk group. Where this discrimination is required, two route relays are used, one for each code.

Called Number Structure

The phrase "called number structure" refers to the total number of digits and whether a party-line letter suffix may be involved, in the numerical portion of the called number. The indication is required only in AMA offices, and is provided in order that the numericals of the called number may be properly punched on the AMA tape. The indication is obtained by proper cross-connection of the DL contact of the route relay in the case of the DP, IMG, or MF sender, and a combination of the DL and CL contacts in the case of PCI senders. The RP sender is not involved since the number structure can not vary with this type of sender.

Intertoll trunk groups, or groups to tandem offices, may employ two or more called number structures. If so, a route relay will be required for each indication. Other trunk groups will each have only one called number structure indication.

Code Pattern

The phrase "code pattern" refers to the number of digits in the called office code and in a foreign area directing code. The indication is required only in AMA offices in order to properly punch the AMA tape. Different indications are obtainable for DP, IMG, RP, and MF senders, by proper cross-connection of the CP (Code pattern) contact of the route relay. Code pattern indications are not required for trunk groups using PCI senders, since a particular sender group can handle calls of only one code pattern. If more than one code pattern is required for calls routed via a particular trunk group, a corresponding number of route relays are required by this item alone.

Route Relay Mounting and Ground Supply Arrangements

A maximum of 450 route relays are available in the flat spring combined or completing markers. These route relays are numbered 00 to 99 on the translator and route relay frame, 100 to 219 on supplementary bay serving two markers or on the CV bay, and 220 to 449 on the supplementary bay serving one marker. Unless otherwise specified for reasons outlined below, the relays will be mounted in the consecutively lowest numbered spaces on a frame.

A maximum of 398 route relays are available when the wire spring completing marker is used. These relays are mounted on the route relay frames. One route relay frame for each hundred relays per four markers (RR-0 - relays 00-99, markers C0 - C3).

Each route relay is assigned in one of six ground supplies, and route advancing may be from a relay in any one ground supply to any other ground supply except route advance can not be made from ground supply six. Within a given route advance "chain," it is not permissible to return to a ground supply used by a relay in a previous position in the chain. Ground supplies 5 and 6 are reserved for "last end" route relays, such as tone trunks, and are confined to very few uses described below. "Normal" trunk groups are assigned to ground supplies 1 to 4, route advancing from one to another (alternate routing), and eventually into "last end" trunks.

Route relays 00-09 are assigned in ground supplies 5 and 6, and may be divided between these ground supplies in such a way that relays in ascending numerical order from 00 are in ground supply 6 and in descending order from 09 are in ground supply 5. The point of this split must be specified by the Telephone Company. In most offices, this may be an even split, i.e., relays 00 to 04 in ground supply 6, and 05 to 09 in ground supply 5.

In practically all cases, the standard arrangements will be satisfactory. However, if the provision of all route relays in a consecutively numbered order does not furnish the distribution by ground supplies needed for a particular job, certain strips are left unequipped. The Telephone Company must specify the arrangement desired in this case. An arrangement of route relays by ground supplies other than the standard can be specified if the requirements for flat spring supplementary route relay bays are thereby reduced.

The following restrictions should be observed in assigning route relays to ground supplies:

Allotted Trunk Groups:

Relays 10 to 19, in ground supply 4, must be used for allotted groups. These ten relays provide for a maximum of five allotted trunk groups. The trunk group is assigned to an even numbered relay, and the next higher odd numbered route relay can not be used for other purposes.

Intraoffice Trunk Groups:

In any of the first four ground supplies. However, they must be in a different ground supply than the trunk group to which a call for a number on the same line will route. Calls to a number on the same line may be routed to reverting call, special service or tone trunks.

Permanent Signal Trunks, Stuck Coin Trunks, and Non-coin Combination Tone Trunks:

Ground supply 5.

Originating Registers, Coin Combination Tone Trunks, and Common Overflow Trunks:

Ground supply 6.

Outgoing Routes:

These include outgoing interoffice, intermarker group, groups to tandem, toll switching, intertoll, service routes, special service, recording-completing, marker pulse conversion, and miscellaneous routes except as specifically covered above. These may be in any of the first four ground supplies.

Service Treatment (S) Relays, Service Common (SC) Punchings, and Service Screening (S) Punchings

Service treatment (S) relays, also known as class of service relays, are provided in the marker as a means of controlling the proper charging or routing of a call in accordance with the class of service of the calling line, or proper routing in the case of an incoming tandem class (TAN) or toll class (TOL) call. The originating register passes the class of service information to the marker on each subscriber originated call, which causes the service treatment (S) relay for the particular class to operate; similarly, the incoming register or intermarker group sender passes the information that a tandem or toll class is involved.

The operation of the (S) relay provides the service screening feature of the marker. Service screening requires the use of two sets of cross-connection punchings, service common (SC), and service treatment (S) punchings.

One service common (SC) punching is required for each code, code group, or equivalent which requires variations in treatment according to the classes of service. Service common (SC) punchings are wired to a common multiple of make contacts on a number of service treatment relays, and each relay represents one class of service or a group of classes requiring the same treatment.

Service treatment (S) punchings are individual to each class of service, and they are wired to fixed contacts of the service treatment (S) relays.

In the marker cross-connection field, SC points may be considered as inputs, and they are cross-connected to or at least toward code points. The S points are outputs, which are cross-connected to punchings which control billing, routing, denial, etc. (See Figure 4-12)

The number of customer and trunk classes, the number of S relays, and the multipling arrangement of SC points must be selected to suit the requirements of the particular installation. The cross-connections for the SC and S points are determined from a careful study of the service requirements for the office. In offices with relatively few classes and SC points, it is probably desirable to order one S relay per class, per twelve SC points. This will provide individual treatment for SC points for which treatments are variable from class to class with no particular pattern.

In offices with more complex service treatment patterns, substantial reductions in numbers of S relays and S punching cross-connections are often possible by use of group sort treatments. In the group sort arrangement all classes of service which may be treated alike are assigned to one S relay.

Screening Arrangements

The arrangement and number of service treatment (SC) points, service treatment (S) relays, service screening (S) punchings and route relays is the responsibility of the Telephone Company. There are, however, two basic screening arrangements; screening for different routes, and screening for different charge conditions.

The first arrangement, screening for different routes, is applicable when different classes-of-service require different routings. For example, coin subscribers would be routed to a trunk group incorporating coin features. This arrangement requires a separate route relay for each trunk group for each charge condition and the service screening relays are placed between the SC points and the route relay. (Figure 4-14, sk A)

The second arrangement, screening for different charge conditions, is applicable when calls from all classes of service are routed to the same trunk group. The route relay associated with this trunk group is inserted between the code point and the SC point. (Figure 4-14, sk B) The (SC) point is then assigned to the service treatment (S) relays, the operation of which provides the proper charging condition via cross-connection of (S) punchings to route series punchings.

Alternate Routing

Alternate routing is accomplished by route advancing from the route relay of the initial trunk group, to a route relay for the next (alternate route) trunk group. A maximum of four routes (first route and three alternates) is permissible. This limitation is due to the fact that each successive route must be in a different ground supply, and route relays for outgoing trunks may be in ground supplies 1, 2, 3, or 4. The subject of ground supplies is discussed in more detail under a separate heading.

The route advance may be from a route relay in any of ground supplies 1, 2, 3, or 4 to a route relay in any of the other ground supplies. If the trunking is such that a third or fourth route is involved, the same ground supply can not be involved at any point in the chain.

The final route, which is the only route when there is no alternate, is generally route advanced to combination tone trunks, whose route relay is either in ground supply 5 (non-coin) or 6 (coin), and hence, is outside the four basic ground supplies for outgoing trunk groups.

Any traffic which is route advanced to another group should utilize on the second route a route relay separate from that used by traffic which is offered to that second group as first route traffic. This is in order that the route relay for the alternate routed traffic can be connected direct to battery, while that for first route traffic may be connected through route series relays as required for proper charge conditions.

Vacant Codes

The route relay arrangements for vacant codes depend on the routing desired for those calls.

If calls for vacant codes are to be routed to a tone trunk, the code points are cross-connected directly to a PB (paths busy) punching on the translator cross-connecting field. Calls originated in the No. 5 crossbar office will be routed automatically to the combination tone trunks and given the vacant code tone. On incoming tandem or toll calls, the marker will set the incoming trunk to return a reorder signal.

If calls for vacant codes are to be routed to vacant code intercept trunks, a route relay is provided in a manner similar to other outgoing trunk groups. In this case also, the marker will set incoming tandem or toll trunks to return reorder.

For offices having customer toll dialing, it is recommended that vacant codes be routed to intercepting operators in all cases.

Presort (Flat Spring Markers)

The presort feature is an option which may be provided in conjunction with the service treatment relays either to reduce the required number of SC points or to insure that the maximum of 36 SC points is adequate. The feature is used when classes-of-service may be divided into two groups such as coin and noncoin, or local and foreign exchange service. Two groups of two relays each are provided (capacity, 24 PSC points). The contacts of the relays are multipled in the same manner as described for the (S) relays. The presort points are cross-connected between the code point and the route relay and permit two or more route relays to be cross-connected to an SC point. Thus offering (1) a possible reduction in the number of SC points required and, (2) increasing the total number of service treatments that can be handled in the office.

Diverted or Denied Routes

Under some circumstances, there may be one trunk group to a particular destination to care for all traffic except from certain classes-of-service. This could be cared for by an arrangement of the SC point preceding the route relays. This would generally be wasteful both of route relays and of SC points. To overcome this, each marker is provided with twenty DR relays. These may be used when the route relay precedes the SC point. The "S" punching of the "S" relay for the class-of-service which is to be denied to the trunk group is cross-connected to the DR relay. This relay has such a high resistance that the current flow is insufficient to operate the route relay for the trunk group. Instead, a contact of the operated DR relay is cross-connected to another route relay. The use of the DR relay in effect by-passes the trunk group route relay and the resultant operation for the class-of-service involved is the same as though the code point were cross-connected to whatever the NR (new route) contact of the DR relay is cross-connected.

The operation of the DR relay is generally used when a route is to be denied to a given class of service and the call routed to an operator or a combination tone trunk. These relays are particularly useful when several trunk groups have the same charge conditions for the accepted traffic for some classes of traffic but either classes-of-service are to be denied or rerouted uniformly. Thus, the same SC point can be used for the several trunk groups involved.

If calls from certain classes of service are to be routed to outgoing trunk groups, while calls from other classes are to be furnished with a tone or routed to an operator, three general arrangements are available. In this instance, tandem and toll are considered as classes of service. Where the distinction involves different treatment for various incoming tandem groups, the principle of "tandem screening" is applied, as discussed under a separate heading. Otherwise, if the arrangement is such that the route relay precedes an SC point, the classes of service which are not to be routed to the outgoing trunk group utilize the denied route relay principle described above. The third possibility is where the arrangement is such that the SC point precedes the route relay, in this case the classes of service which are not to be routed to the outgoing trunk are cross-connected either to route to an operator or to a tone trunk.

Tandem or Trunk Class Screening Arrangements

In all previous discussions, it has been assumed that all incoming tandem type trunks will be treated alike, as to completion or denial of service for each respective code point. However, this will not always be the case. Tandem or trunk class screening is an arrangement whereby the incoming DP tandem trunks may be assigned to five different categories (TAN, TANI, TAN 2, TAN 3, and TAN 4). Each category may receive its own denial or completion treatment for each code point. Its value and use are best illustrated by an example: assume six incoming DP tandem groups (from Offices A through F) and three tandem completing groups (to Offices X, Y, and Z): further assume that the groups from A and B are to be denied access to Office X, and the groups from C and D are to be denied access to Office Y but otherwise completion is to be permitted to the three completing groups. Some form of "screening" is required in order to accomplish the denials listed, and the six incoming trunk groups can be classified in three categories for this purpose - A and B (TAN), C and D (TAN 1) and E and F (TAN 2).

The screening is accomplished by an arrangement similar to the SC points, but in this case designated "TSC points," or Tandem Service Common points, which are wired to the movable contacts of seven class relays, five for the five tandem categories, one for toll (TOL) and one for originating register (OR) class of traffic. The fixed contact of each relay is wired to cause denial or completion, as required. The TSC point may be cross-connected either to a code point or a route relay. The number of TSC points to be provided may be 22, 34, or 46.

E. NUMBER GROUP FRAMES

General

In a No. 5 crossbar office, there is no permanent or pre-arranged association of directory numbers with switch positions on the line link frames. A marker upon receiving the number for a terminating call must therefore ascertain which one of the many switch verticals in the office is associated with that particular directory or trunk number so that a connection may be established. The marker obtains this information from the number group frame. This frame in a manner of speaking, is a large central memory kept up to date with the latest directory number assignments, to which each marker in turn applies for the necessary translation. Asking, in effect, the line link address and ringing required for the line corresponding to the directory number.

The following description covers the wire spring relay type number group frame (Figure 4-15). Inasmuch as this new number group frame is fully compatible with the older non-wire spring type frame, the manufacture of the older type frame has been discontinued. Most of the newer features described, such as the increases in capacity from 20,000 to 40,000 numbers per marker group, can be added, if needed, in older type offices. Associated connectors may also be added on existing non-wire spring type connector frames, space permitting.

It should be noted that the earlier concept of Office A numbers and Office B numbers as well as the terms physical, theoretical and extra-theoretical are no longer in use.

These early marker groups equipped for a maximum of 20,000 (directory and trunk) numbers could accommodate three office codes in each of two number series (0000 through 9999), as follows:

Office A	Office B
Physical Office A	Physical Office B
Theoretical Office A	Theoretical Office B
Extra-Theoretical Office A	Extra-Theoretical Office B

This is known as physical-theoretical office operation.

The new marker groups equipped for a maximum of 40,000 (directory and trunk) numbers are arranged for six number series, as follows:

Number Series Group A	Number Series Group B
No. Series 0	No. Series 1
" " 2	" " 3
" " 4	" " 5

This is known as number series operation.

Thus, in new offices it is now possible to begin the numbering of each of six possible office designations with the "0" thousands digit and grow into the "1" and "2", etc., thousands digits as required.

Each 1000 directory numbers comprises a number group. A marker group can accommodate 40 such number groups (numbered 00-39) or a total of 40,000 directory numbers including trunk numbers. Number groups are provided to fill the needs of the respective number series and should be considered as independent of number series groups. The frames are numbered as they are added from 00 to 39.

In addition to the frame number, the office code or codes are associated with the frame either by stenciling on the frame or through the use of designation cards. The association of the code and the frame must be specified by the Telephone Company.

A marker group can be arranged to discriminate for rate purposes for a maximum of six different office designations. One or more local office codes used to identify numbers which are given the same rate treatment are called an "office code group". To permit discrimination by the marker, it is necessary that all numbers within a hundreds block (all of the 100 numbers in a number group with the same hundreds digit) be given one rate assignment (P, T, or E).

Under the new arrangement P, T, and E designations are arbitrary designations used to perform the same functions as the former physical, theoretical and extra-theoretical designations with respect to the number group. In the marker the P, T, and E designations are used not only as a means of distinguishing between office codes with different rate treatment but also as a means to direct the marker to the number series on which the called number is assigned.

The P, T, and E indications in the number group are required to check the translated information with the directory number assigned in the number group. If the check is satisfied the call is completed. If the check is not satisfied the call is routed to intercept. The purpose of the check is to permit the office code groups of a number series group to share the same 1000 numbers of a number group. Number series groups A and B, however, can not share numbers in the same number group.

Each number group has associated with it a number group frame. This is the only place in the No. 5 crossbar system where subscriber directory numbers are gathered together in numerical sequence. Number group frames are fully equipped for 1000 numbers; hence, a No. 5 office is always equipped in multiples of 1000 directory numbers.

Examples of the way the marker is directed to the proper number group for various typical numbering plan arrangements are discussed below:

a) Four-digit call to a number series group with a single number series.

In this case, the call is directed to a particular number series group (A or B) by means of cross connections in the incoming register link frame and incoming register. These cross connections are required even though the office involved has but a single number series group. Since the number series, the thousands digit of the called number is used to direct the marker to the proper number group frame.

b) Four-digit call to a number series group with more than one number series.

This situation requires that a separate incoming trunk group per number series be provided. The proper number series group is determined by means of cross connections in the incoming register link frame and incoming register. Cross connections in the trunk link connector and the trunk link frame furnish the marker with a P, T, or E indication which is used to direct the marker to the proper number series. The thousands digit is then used to direct the marker to the proper number group frame. The P, T, or E indication may be used for rate or number discrimination purposes and, of course, must match the corresponding indication in the number group for the call to be completed.

c) Five-digit call to a number series group with more than one number series.

This arrangement will permit a single trunk group to serve several number series in an office using the first digit as a directing digit (FVD Translation). The proper number series group is, as above, determined by means of cross connections in the incoming register link frame and the incoming register. The directing digit determines the proper number series and the call is directed to the proper number group by the thousands digit. The FVD Translation feature may be used only on incoming MF or DP calls. High-low discrimination may be used with RP incoming registers to direct a call to one of two number series groups.

d) Six- or seven-digit call to a number series group with more than one number series.

This arrangement covers those cases in which the distant office transmits more digits than normally would be required at the No. 5 crossbar terminating office. The call is directed to the proper number series group as covered in the examples above. The translation of the BX or ABX digits then directs the call to the proper number series and the thousands digit directs the call to the proper number group.

Since each number group serves a particular thousands series, leads for the thousands digits are unnecessary. On the number group frame, cross connection fields are provided so that each directory number is cross connected to punchings in order to return the following information to the marker: line link frame location of each working number; type of ringing current to apply to the line; and, whether the hundreds digit involved serves P, T, or E numbers. The lack of a cross connection will cause the call to be routed to a regular intercept trunk. Intercepted calls, except incoming toll calls, can be divided into two categories, by specific cross connections for one category, and a lack of any cross connection for the other. Routing of calls to trouble intercept may also be accomplished by cross connection at the number group frame.

For each number series, arrangements are available in the marker to direct subscriber numbers with two different thousands digits to the same number group. For example: In the number series with subscriber numbers 0000 through 5999, it may be desired to assign 200 coin lines in the 9000 series even though a number group for the 9000 series has not been provided. In this case the numbers 9800-9999 might be assigned to coin, and the marker directed to the number group representing the 5000 series of the number series. Then for this example, subscriber numbers 5800-5999 could not be used and calls to these numbers and to 9000-9799 are routed to intercept. This can be done in only one number group of each number series.

A busy test is not made at the number group frame on individual or party lines (except for interchange of busy for a single line), the marker is directed to line link frame location of the line where the line is tested for the busy condition. In the case of terminal hunting groups, sleeve leads of all lines in the group are brought to the number group frame, so that a busy test can be made and the marker directed only to a line link frame location of an idle line in the group. Sleeve leads are also brought out for special lines having emergency manual service. A more detailed account of terminal hunting arrangements is outlined later.

While the following information should more properly be considered under markers, it is included here because of the possible effect on the assignment of numbers.

On calls using incoming DP or MF pulsing a single trunk group may be used to complete to the maximum of six number series provided there are non-conflicting directing digits. Calls coming in revertive pulsing using a high five feature with incoming brush selection can indicate number series group A or B by the high or low five and by means of the trunk link frame cross connections a P, T, or E indication for a particular number series. Thus, in an office with six office code groups (AP, AT, AE, BP, BT, BE) three separate trunk groups would be required and would complete calls as follows:

Code Groups: AP, BP
AT, BT
AE, BE

In those cases where only one number series group (A) is in use with two office code groups, the high five and incoming brush selection could be used to indicate a P and the low five could be used to indicate T office code group. Thus a common trunk group could be provided to complete to AP and AT. If a third office code group (AE) is required a separate trunk group would be needed.

Auxiliary Relays

Each number group frame may have associated with it a number of auxiliary relays. The number and type of each must be specified in the Telephone Company specification for each number group. For jobs provided with wire spring number groups, a maximum of 176 auxiliary relays may be mounted on each number group frame. For earlier jobs the maximum is 91. Additional relays beyond the capacity of these frames may be mounted on miscellaneous relay racks.

The types and purposes of the auxiliary relays and the number required are as follows:

	Standard Maximum No. of Relays
OF - Overflow traffic register circuit for non-hunting lines. May be associated by cross connection with any directory number group. Usually one or two (maximum) are provided per number group.	2
POF - P.B.X. overflow, the same as above, but for terminal hunting groups. Usually one or two (maximum) are provided per number group.	2
FN - Free number relay. One FN relay can be assigned to the directory number of a terminal hunting group of official lines. With this arrangement, an incoming call to a number other than the listed directory number will be charged. If it is necessary to protect against this contingency, an FN relay may be provided for each number in the group. One per marker group for assignment to trunk test circuit of master test frame (free number test). Any number group may be selected for this purpose. An SC relay as well as an FN relay should be provided for use in the number group selected. FN relays are not required with 6-wire ringing selection switches for non-hunting free numbers.	10
TN - Trunk number relay. One for each tens block to which trunk numbers are assigned. The use of trunk numbers in the number group frame is described in more detail later. Where two number group frames are provided for the	10

Standard
Maximum
No. of Relays

exclusive use of trunk numbers, the TN relays are not required. TN relays may be equipped on only two number group frames.

SC - Sleeve Connect. One per terminal hunting group per tens block within which the lines are assigned. 80

One per line arranged for emergency transfer to a switchboard. The SC relay normally provided for terminal hunting lines will also suffice for this purpose should any or all of the terminal hunting lines be so arranged. One per line arranged for multiple appearance at a switchboard for operator emergency connections; Fire, Police, Ambulance, etc.

One per tens block containing any lines arranged for originating only service. These are cross connected to cause a line busy tone to be returned on attempted terminating calls but to permit access for testing purposes. One per manual originating - dial terminating line of the type having a line appearance on the switchboard.

One per marker group for an originating test line.

Two per marker group for a terminating test line, one for regular numbers and one for free numbers (should be in same number group).

One per line to be made busy by operation of a key, such as, 523B business office set.

A - Hunting Group Advance. One per terminal hunting group for each tens block except the first over which the lines of a terminal hunting group are assigned. 20

TBA - Tens Block Auxiliary. One per tens block to which more than one SC relay is assigned for any purpose. 10

		Standard Maximum No. of Relays
AN	Allotted Number. One relay for the directory number tens block of an allotted number hunting group.	5
ABT	Allotted Block Test. One relay for the first tens block (directory number or other than directory number) of an allotted number hunting group for each number group frame over which the hunting group is distributed.	5
SA & TBT	Select Advance and Ten's Block Test. One relay per tens block when block select hunting is being used.	10

Where a block select unit or P.B.X. allotter circuit, described below, is provided for a terminal hunting group, it is not necessary to provide A relays for that group.

Terminal Hunting Arrangements

All lines within a terminal hunting group must be confined to the same number group unless a P.B.X. allotting arrangement is provided as described below. The sleeve leads of all lines in the group are brought to the number group frame. The marker tests the leads, starting with the number dialed, and upward numerically through the other lines in the group until an idle line is found. It determines the line link frame location of that line and attempts to establish connection. If the line is found busy at the line link frame location, the marker re-enters the number group and again tests for an idle line. On this trial it tests the lines in the reverse direction. If all lines test busy at the number group frame, or if a line is found busy on a second entry into a line link frame, the marker causes the busy signal to be returned on the connection.

The lines of a terminal hunting group may be assigned anywhere within a number group. Spreading them haphazardly gains no advantage, and can be extremely wasteful of the auxiliary relays described earlier. For example: If there are two line groups of eight lines each, and two lines of each group are assigned to the same four tens blocks, each group would require four SC and three A relays. and each of the four tens blocks would require a TBA relay. A total of 18 relays are thus required. On the other hand, if each group is confined to a tens block, only two SC relays (one per group) are required. In general, it is advisable to contain any terminal hunting group within a minimum number of tens blocks, and to avoid assigning two groups within the same tens block. However, this is, of course, not always possible because of unanticipated growth, avoidance of number changes, etc.

Assigning non-consecutive numbers to a terminal hunting group within the same tens block does not require any additional auxiliary relay. When part of the numbers in a tens block are assigned to a terminal hunting group, the balance may be assigned to non-hunting lines.

Block Select

An arrangement, called a block select unit, is available for large groups which saves marker time in hunting over the test leads of the group and also avoids the provision of A relays for the group involved. Its operation is such that the marker enters the initial (directory) tens block, tests all the lines in that block individually and finding none idle, proceeds directly to a tens block in which an idle line appears. A subgroup idle indication from each line in the hunting group must be obtained from auxiliary line units or a B relay for each line may be added from the number group sleeve busy relay circuit. These relays are provided in blocks of ten and each block may serve only one number group.

When block select hunting is used with either allotted or non-allotted hunting facilities, each tens block beyond the first in which a hunting group appears requires one tens block select circuit (SA and TBT relay). The first tens block in a non-allotted hunting group may contain either one, or more than one hunting group; however, the first tens block of an allotted hunting group can contain only one hunting group. Subsequent tens blocks are limited to one hunting group for both allotted and non-allotted hunting.

Block select hunting is available for both flat and wire spring number group frames.

Studies indicate that block select units are economical when the size of the P.B.X. group is as follows: For lines equipped with auxiliary line circuits, 21 one-way lines or 40 two-way lines; for lines not equipped with auxiliary line circuits, 40 one-way lines or 80 two-way lines.

P.B.X. Allotter

Another terminal hunting arrangement known as P.B.X. allotter may be provided to permit distribution of traffic to P.B.X. lines over several number groups. The P.B.X. allotter will prove useful in offices with large P.B.X.'s in which it is desirable to distribute the load over several number groups or for small P.B.X.'s or other terminal hunting groups which require special treatment in order to reduce the hazard from the failure of a single number group. The use of the allotter helps relieve a possible backup condition caused by several markers waiting for connection to the same number group during periods of heavy traffic to a given P.B.X.

With this arrangement, the marker will enter a number group to reach a line only when a test by the allotter circuit has indicated that one or more lines are idle. The preference for selecting a number group will vary for different markers so that calls will be distributed approximately equal between the number groups.

Since the allotter recognizes an allotted number by observing the thousands, hundreds, and tens digits only of the listed number, all lines in the listed number tens block must be associated with the allotted group to be left unassigned. No other hunting group may appear in any tens block having lines in an allotted hunting group. If the dialed number is associated with an allotted group but is not within the listed number tens block the call will proceed in a manner similar to a non-allotted hunting group, and will terminal hunt only from the dialed number upward and should all lines in that number group be busy there will be no recycling to another number group.

As covered previously, additional relays (AN, ABT) are required when the allotter feature is to be provided.

With flat spring markers the P.B.X. allotter equipment provides for a maximum of ten allotted P.B.X.'s or other terminal hunting groups per marker group with arrangements for allotting three P.B.X.'s over two to eight number groups and seven P.B.X.'s over two or four number groups. Flat spring-type number groups are arranged for not more than four allotted P.B.X.'s per number group. There is no limit within a number group on the number of P.B.X. lines. The allotting feature can be applied to the P.B.X.'s of any two number series of a marker group. However, all number groups over which an allotted P.B.X. is distributed must be in the same 10,000 number series. One P.B.X. allotter circuit will be required for each combined or completing marker. The equipment is located on separate basic and supplementary allotter frames each arranged to serve a maximum of eight combined or completing markers. The supplementary frames are used where it is desired to care for more than four P.B.X.'s on an allotted basis.

With wire spring markers the equipment provides for a maximum of ten allotted P.B.X.'s or other terminal hunting groups per marker group, with arrangements for allotting four P.B.X.'s over two to eight number groups and six P.B.X.'s over two or four number groups. The marker arrangements provide for not more than five allotted P.B.X.'s per number group. There is no limit within the capacity of the number group on the number of P.B.X. lines. The allotting feature can be applied to the P.B.X.'s of six number series of a marker group. However, all number groups over which an allotted P.B.X. is distributed must be in the same 10,000 number series. The equipment is mounted on separate allotter frames, each frame arranged to serve a maximum of four completing markers and ten P.B.X.'s.

Intercepting trunks, free numbers or any terminal hunting group which has a part or all of its lines connected to a make-busy circuit can not use a block select unit or a P.B.X. allotter.

Trunk Numbers

Each incoming tandem trunk (including CAMA) coin or other junctor and intermarker group trunk (subscriber-to-trunk) requires one line link frame appearance, and each incoming intertoll trunk requires two line link frame appearances. A 3-digit trunk number is assigned to each such trunk. In two of the number groups in the office, each of these numbers is cross connected in accordance with the line link frame appearance of its trunk. In the case of a tandem trunk, coin junctor and intermarker group trunk, the cross connection is the same in both number group frames, corresponding to the one line link frame appearance. In the case of an intertoll trunk, one number group has the cross connection for one line link frame appearance, and the other number group that of the other line link frame appearance.

When a call is received on one of these trunks which is to be completed to a trunk on the trunk link frame, the marker obtains the trunk number from the incoming register link frame, or from the out sender link frame in the case of subscriber-to-trunk intermarker group trunks. The marker then enters either of the number group frames where these trunk numbers are assigned and determines the line link frame location of the trunk so that it may establish the connection from that appearance of the incoming trunk. In the case of an intertoll trunk, if the marker is unable to match paths from the location to which it is first directed, it will back off, re-enter the other number group frame and attempt to establish the connection via the other line link frame location.

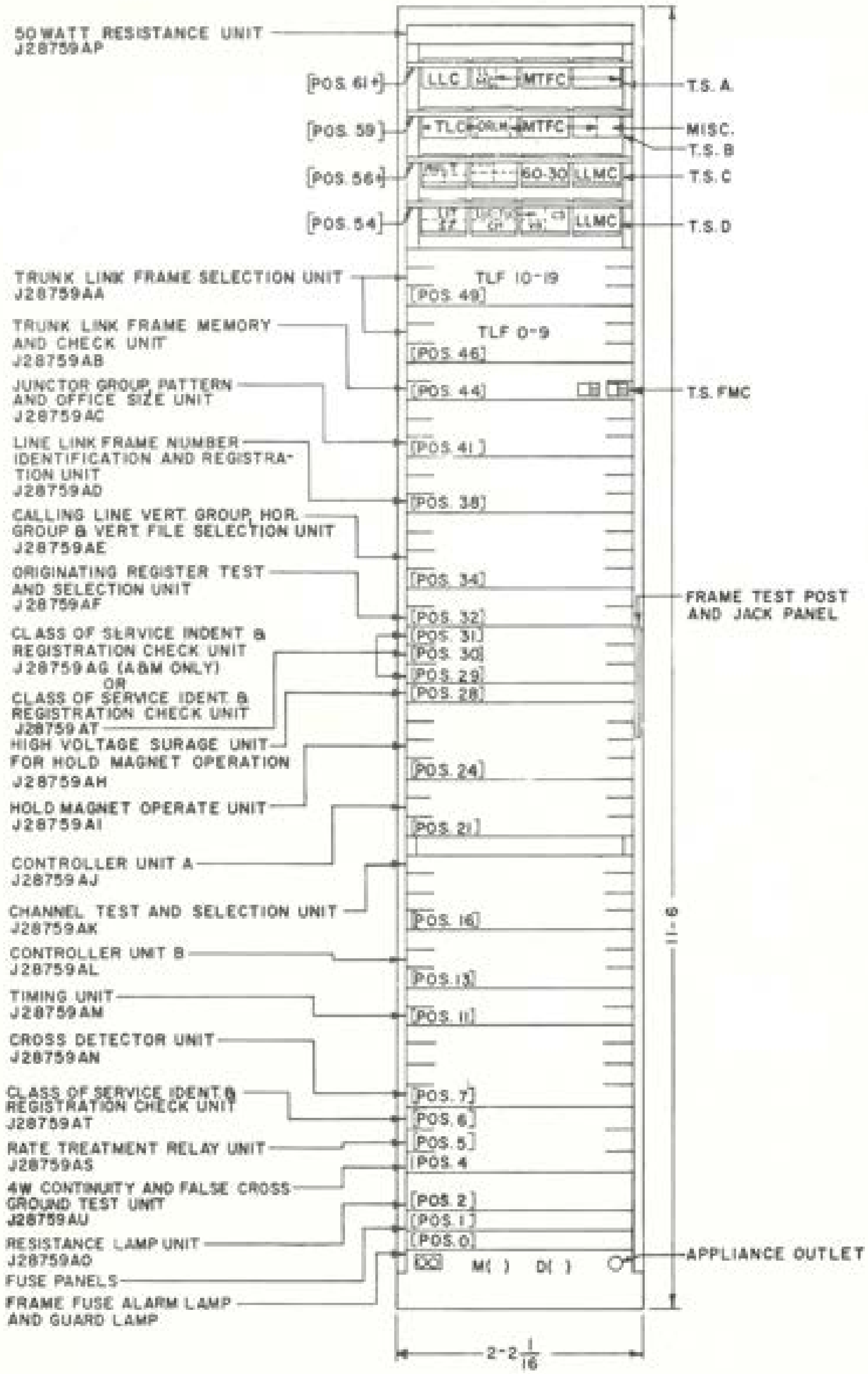
Any two number group frames may be selected for handling the trunk numbers. Each trunk should be assigned the same 3-digit number in each of the two number groups selected for trunk assignments. Once these groups are selected, the markers are wired to use these number groups for calls involving trunk numbers. If there is an appreciable number of trunk numbers, it may be advisable to set aside two number groups to handle only trunk numbers. Prior to issue 31-D of the flat spring marker where trunk number groups are used they can be in addition to the 20 number groups used for subscriber numbers.

Effective with Issue 31-D of the flat spring markers and where wire spring markers are employed the two number groups used for trunk numbers must be included within the 40,000 number capacity of the marker group. When trunk numbers are assigned in number groups where there are also subscriber numbers, the trunk and subscriber numbers can not be mixed in the same tens block. Hence, any tens block containing at least one trunk number reduces subscriber directory numbers by 20 (ten in each of two number groups). It is, therefore, advisable to restrict trunk numbers to as few tens blocks as is feasible.

<u>Number Group Frame Quantities</u>

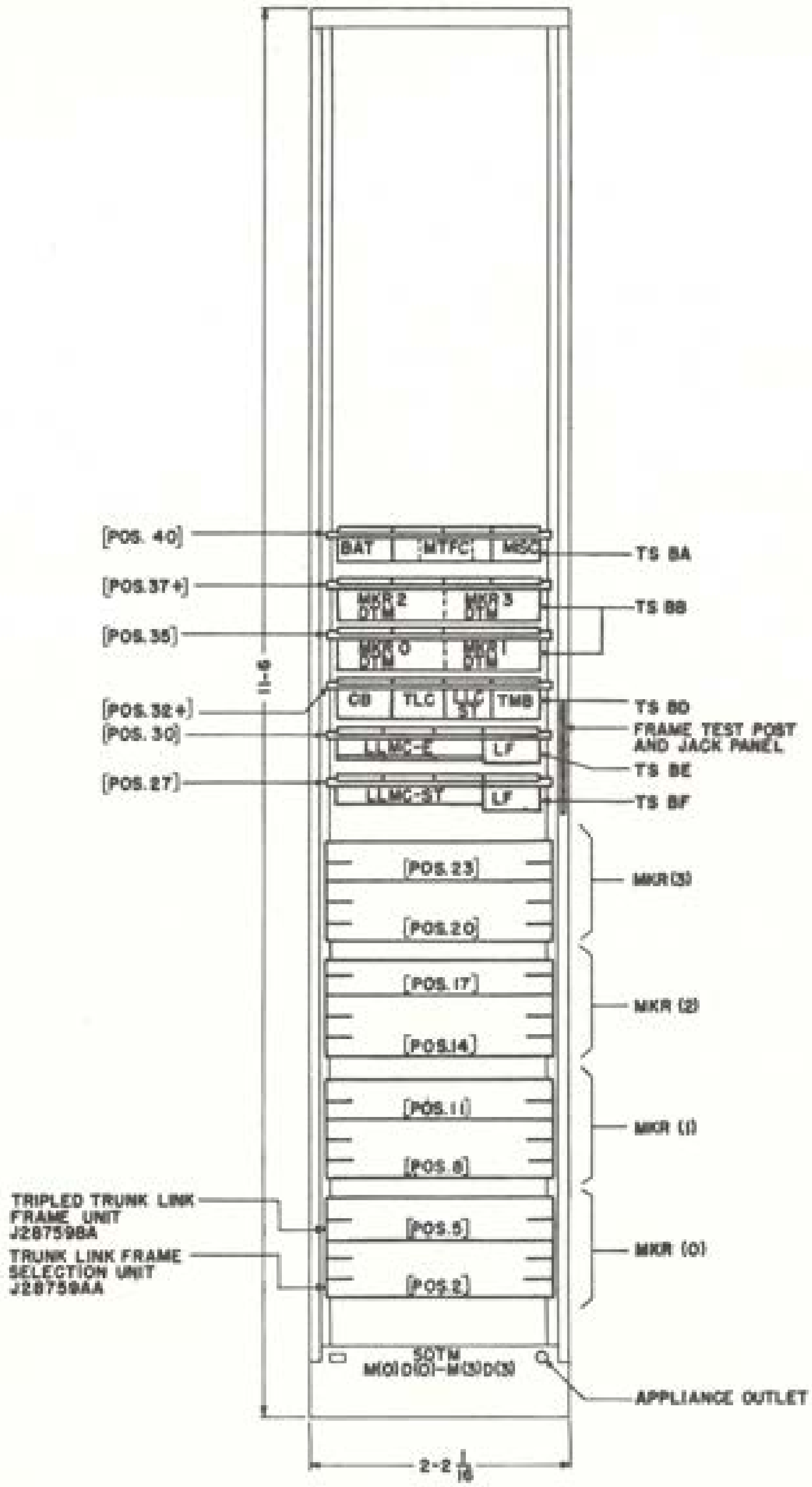
Each number group frame can serve 1000 directory numbers. The quantity to be provided shall be enough to cover the number of main stations to be served, with allowances for utilization margin to probe for loading ceilings, intercepting requirements, P.B.X. growth, physical and theoretical breaks by hundreds blocks, adequate reservations for trunk numbers for incoming tandem and intertoll trunks, etc.

As a general principle, the maximum load carrying capacity of the office is obtained when all number groups are equally loaded. If the number of calls directed to one number group is too high, the number of times that one marker will be required to wait for another marker to release the number group connector is increased with a consequent increase in marker holding time and decrease in marker call capacity. However, the number group holding time is so short that no appreciable interference occurs as long as the number of busy-hour calls to any one number group does not exceed 3000. Hence, it is seldom necessary to consider call carrying capacity when providing number group frames.



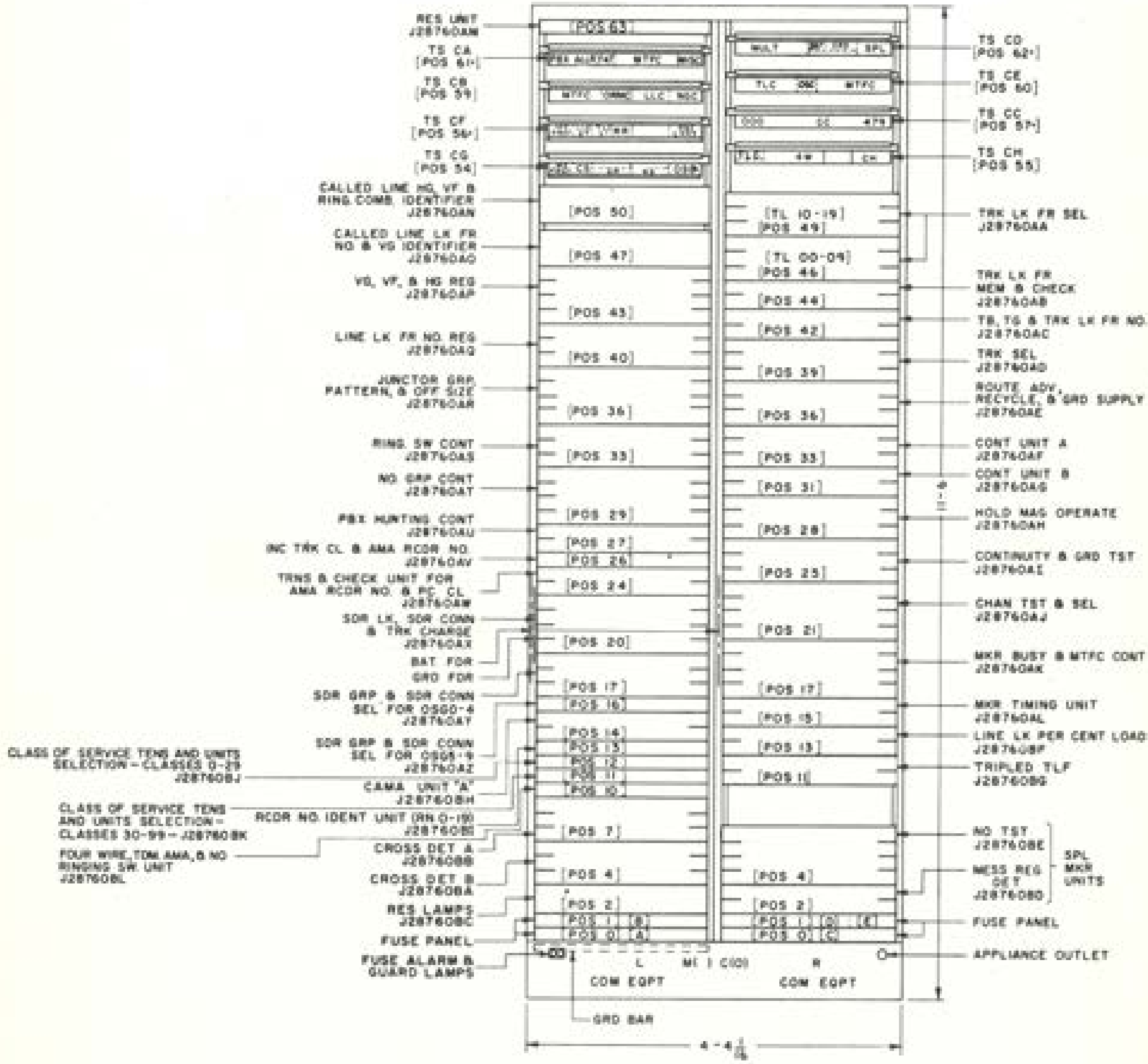
Dial Tone Marker Frame

Figure 4-1



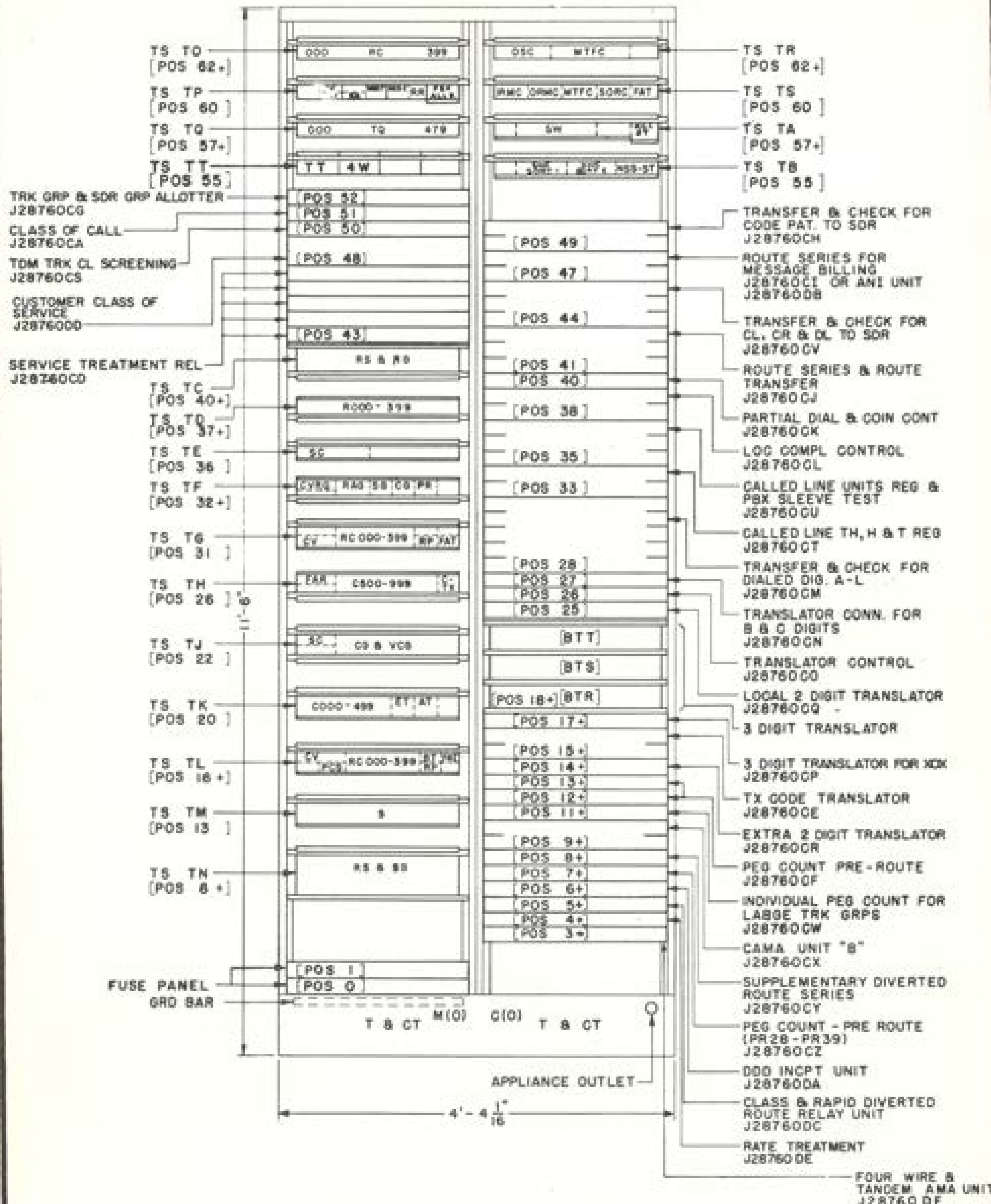
Supplementary Dial Tone Marker Frame

Figure 4-2



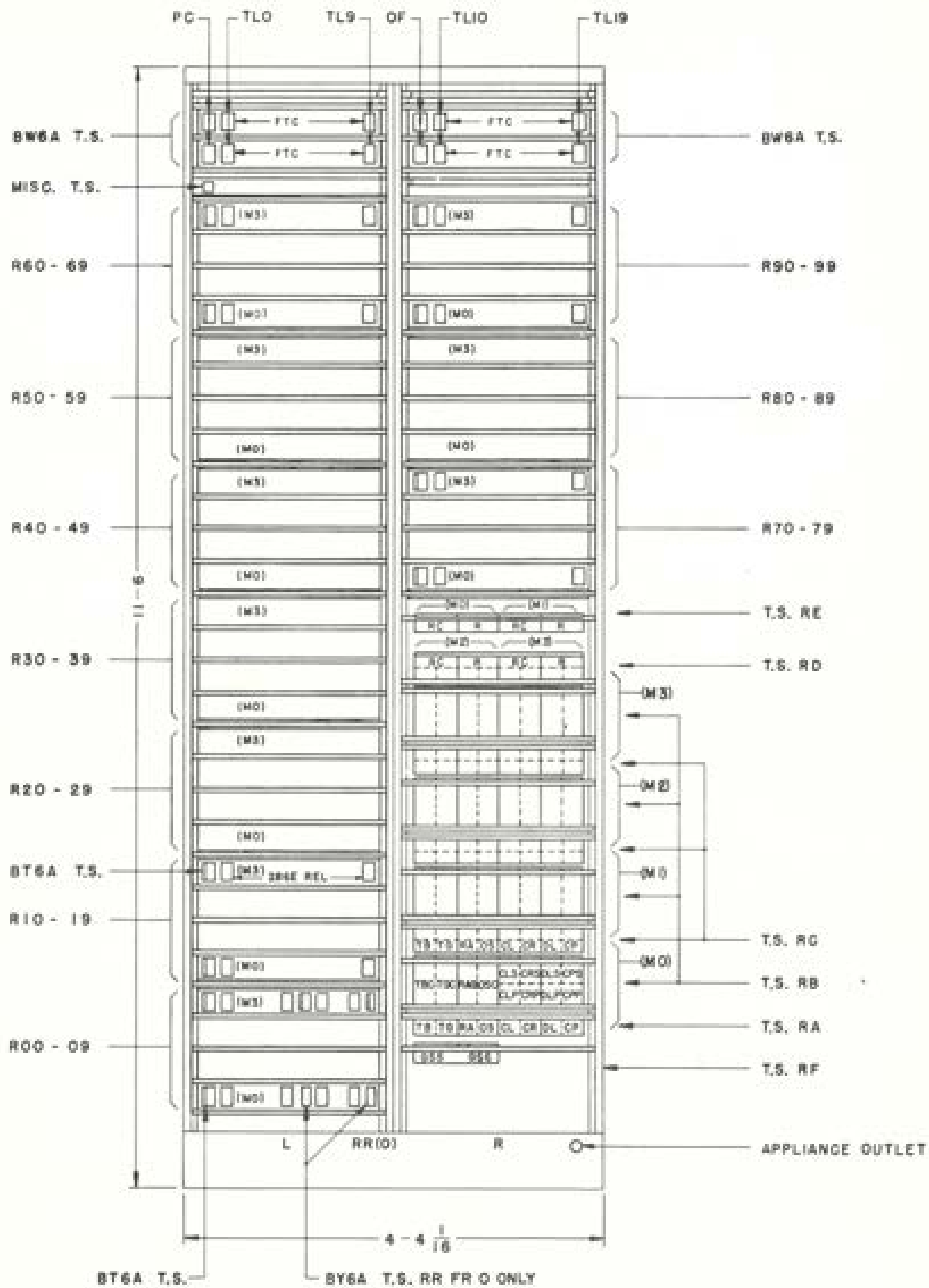
Completing Marker Common Equipment Frame

Figure 4-3



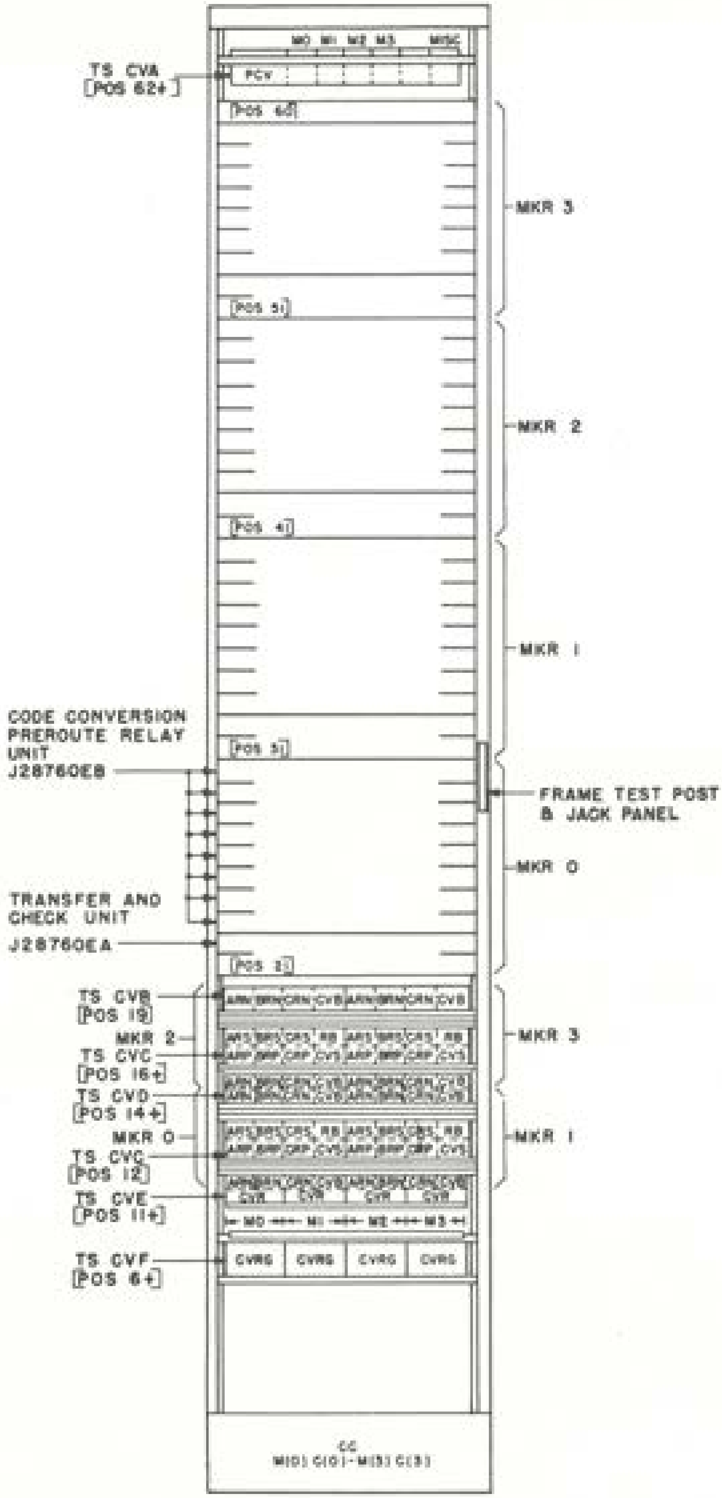
Completing Marker Translator and Code Treatment Frame

Figure 4-4



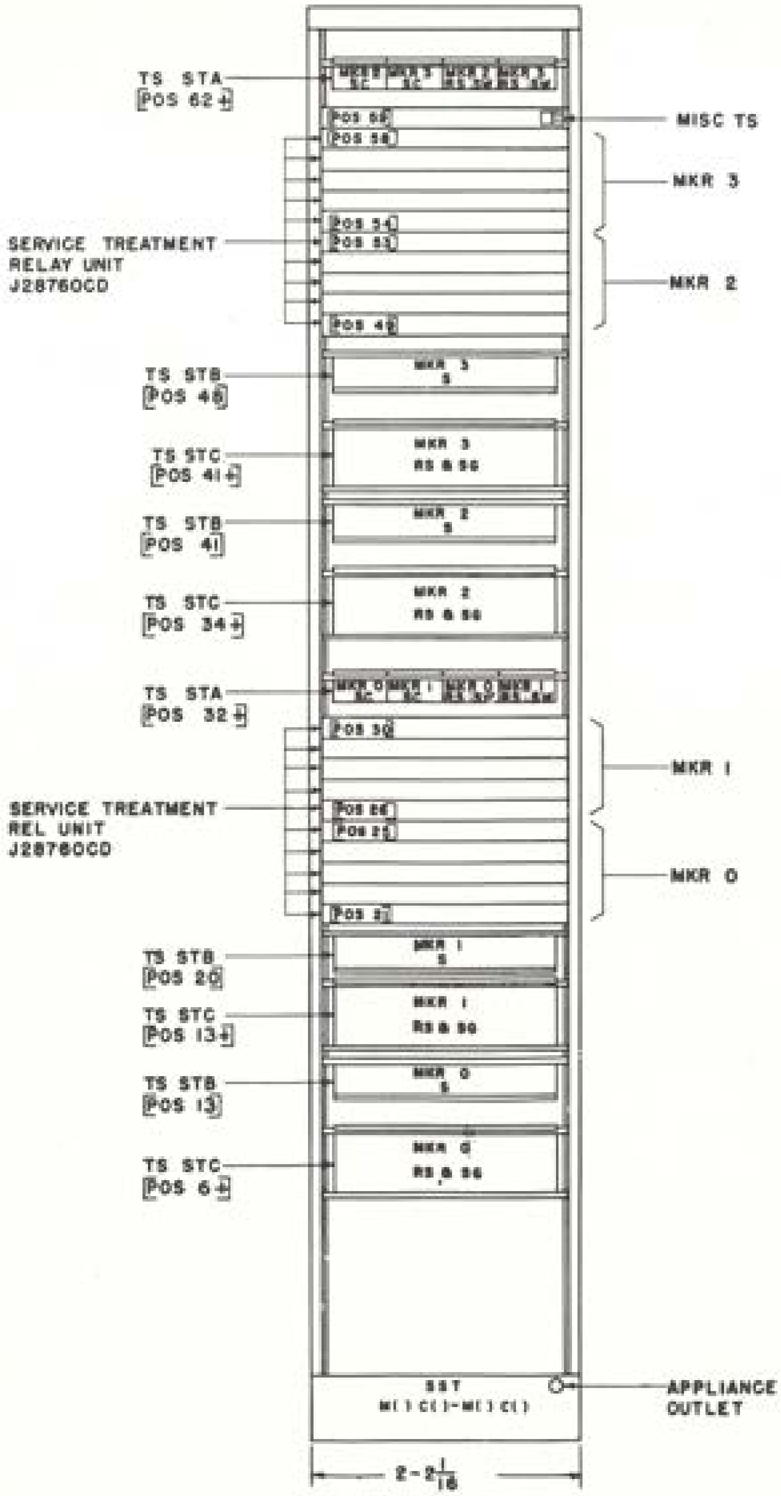
Route Relay Frame

Figure 4-5



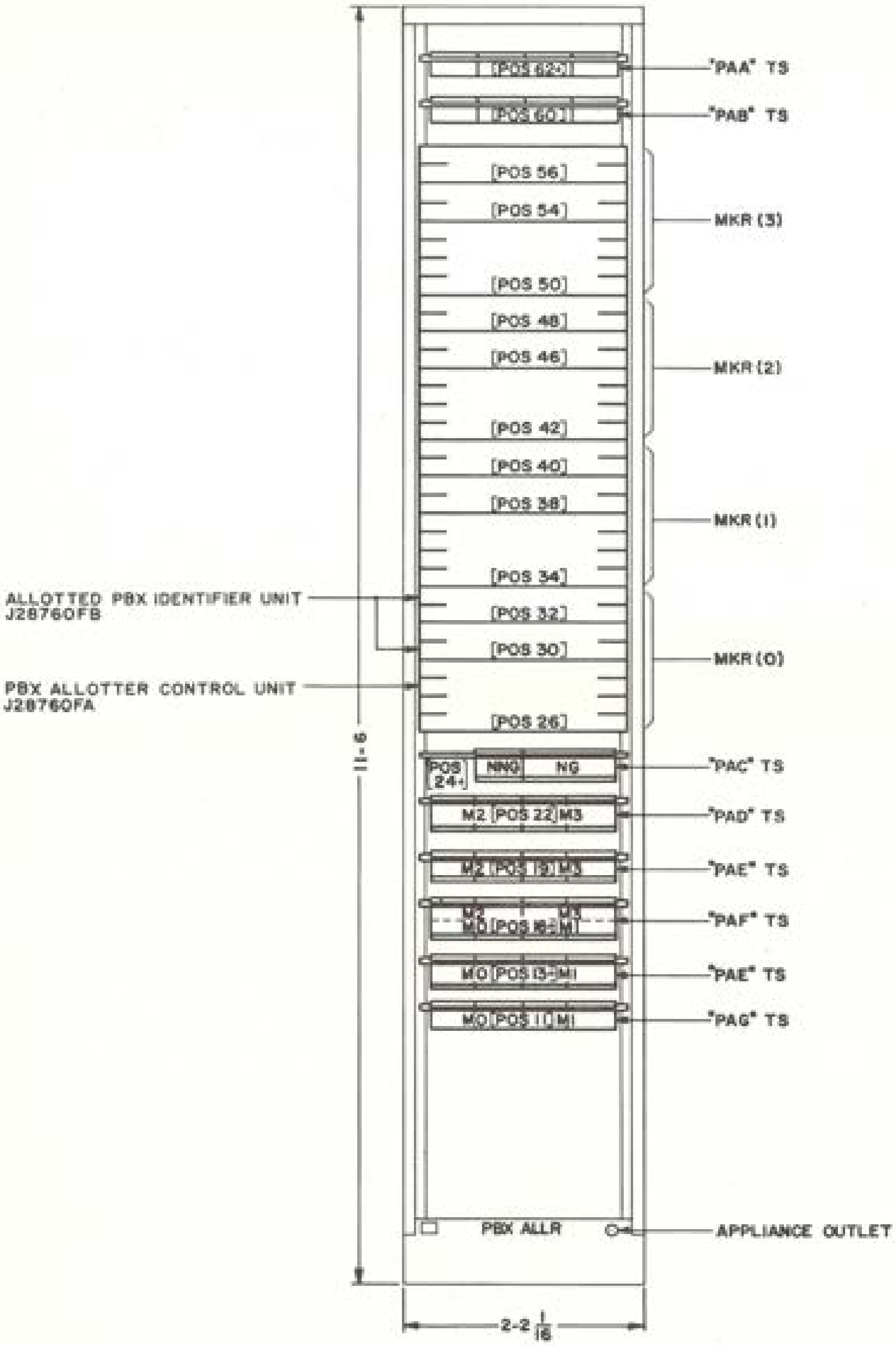
- Code Conversion Frame

Figure 4-6



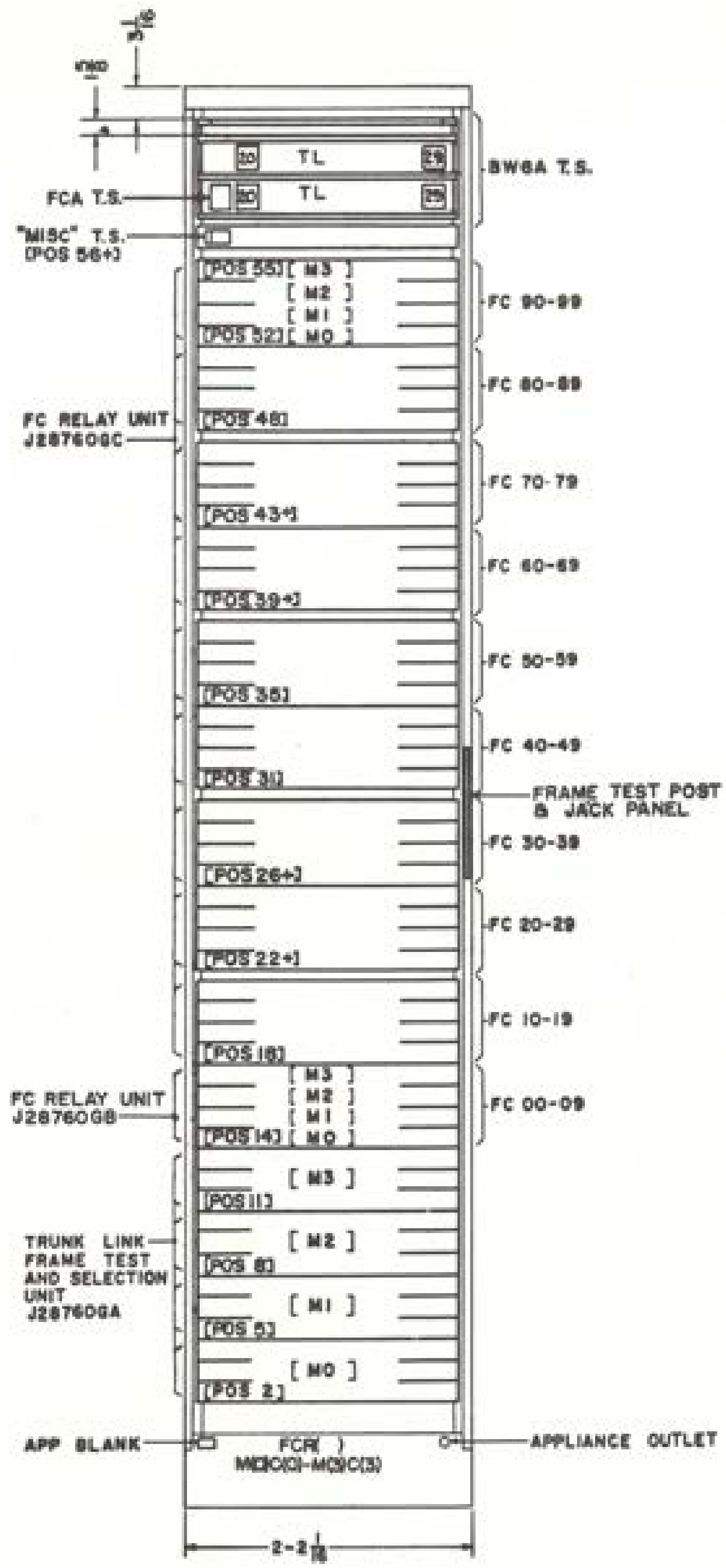
— Supplementary Service Treatment Frame

Figure 4-7



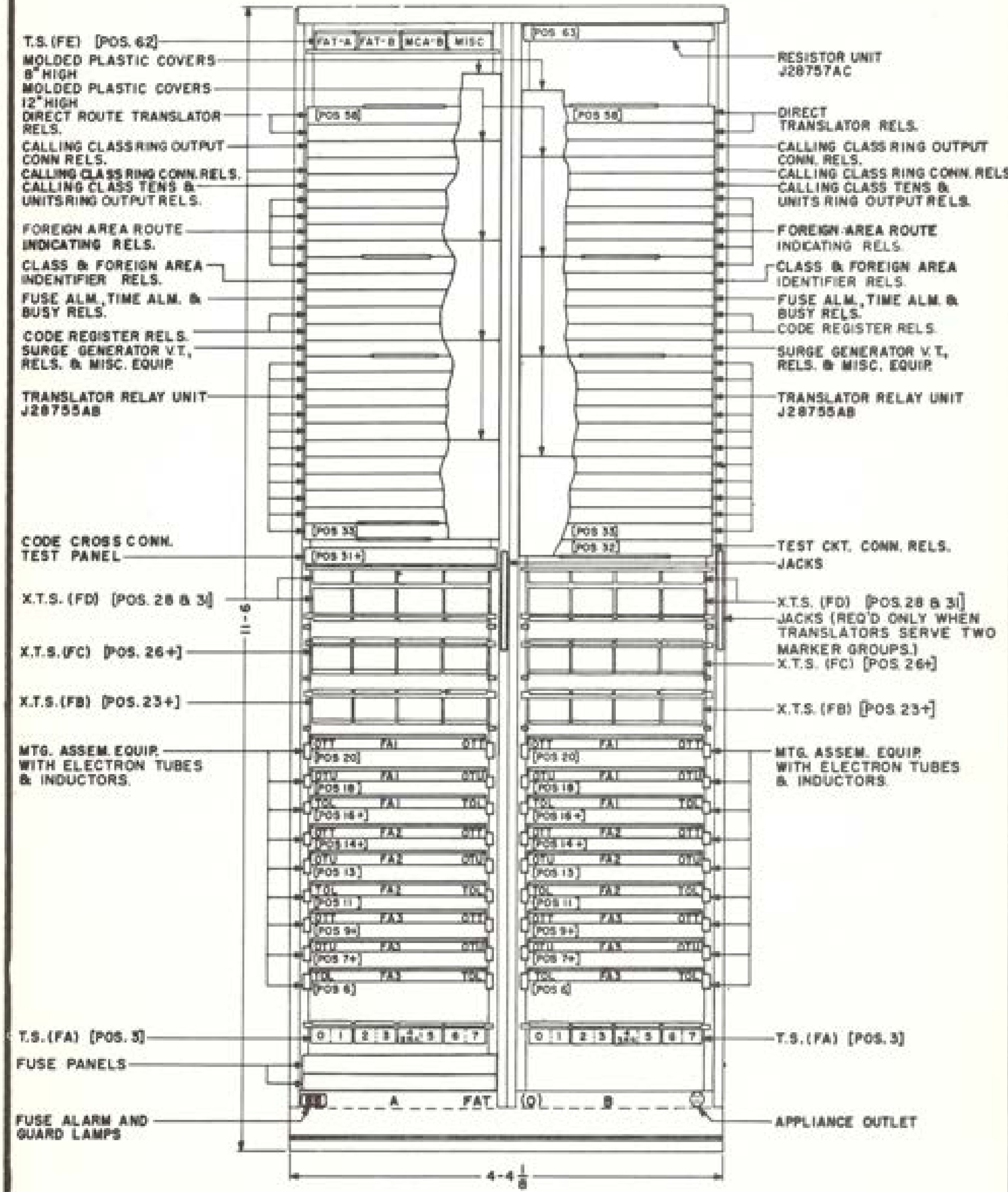
PBX Allotter Frame

Figure 4-8



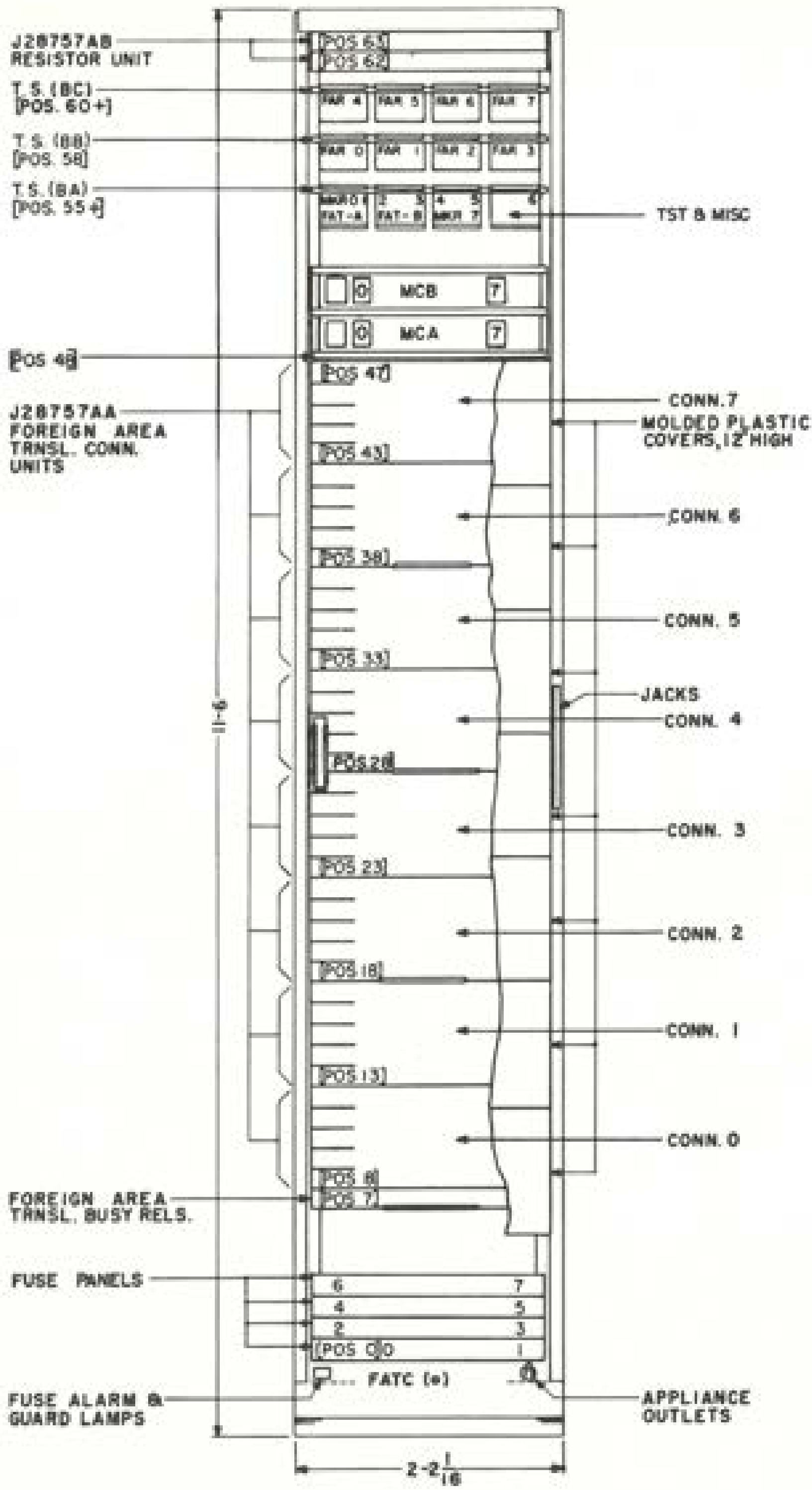
Completing Marker FC Relay Frame

Figure 4-9



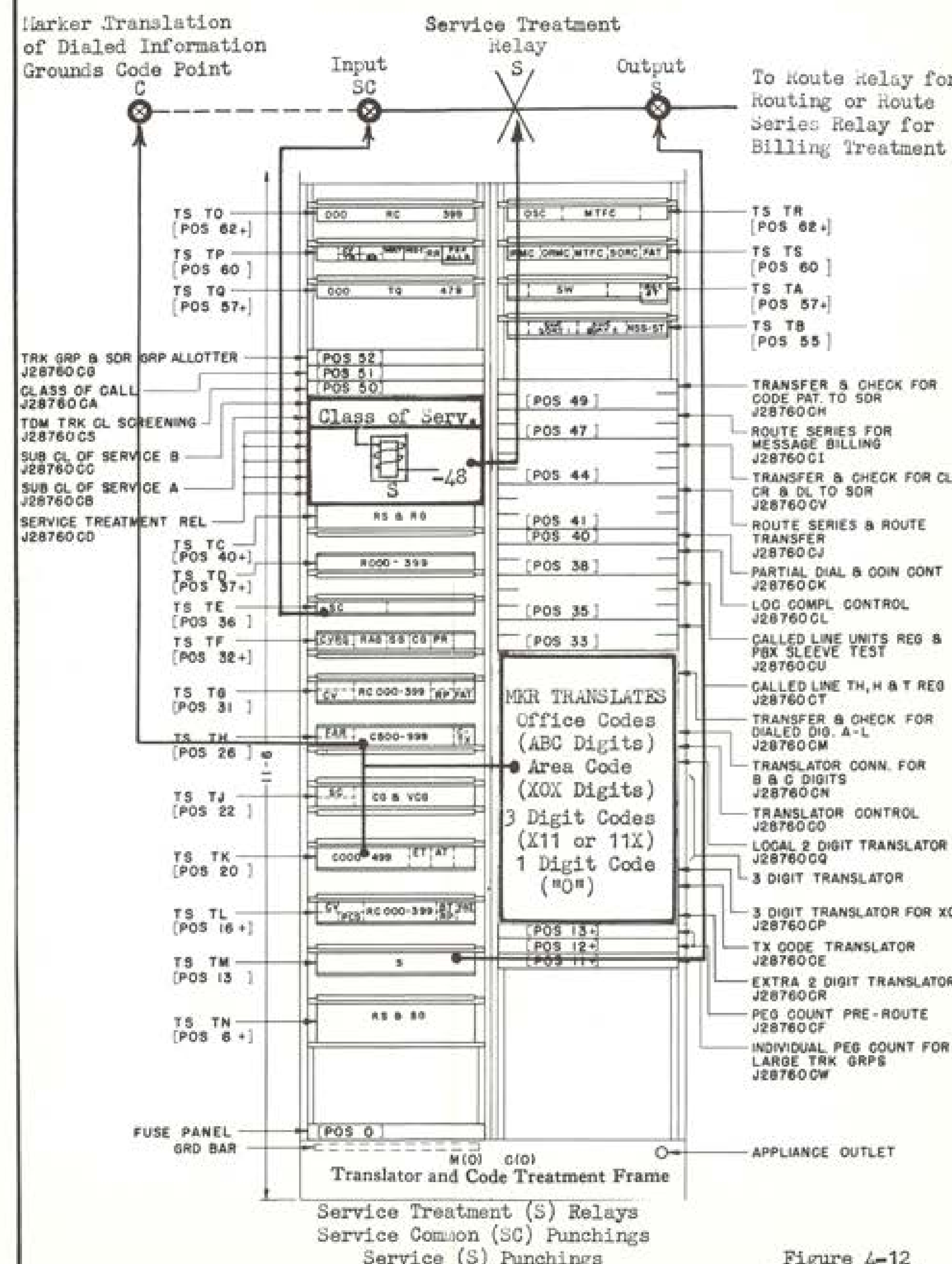
Foreign Area Translator Frame

Figure 4-10



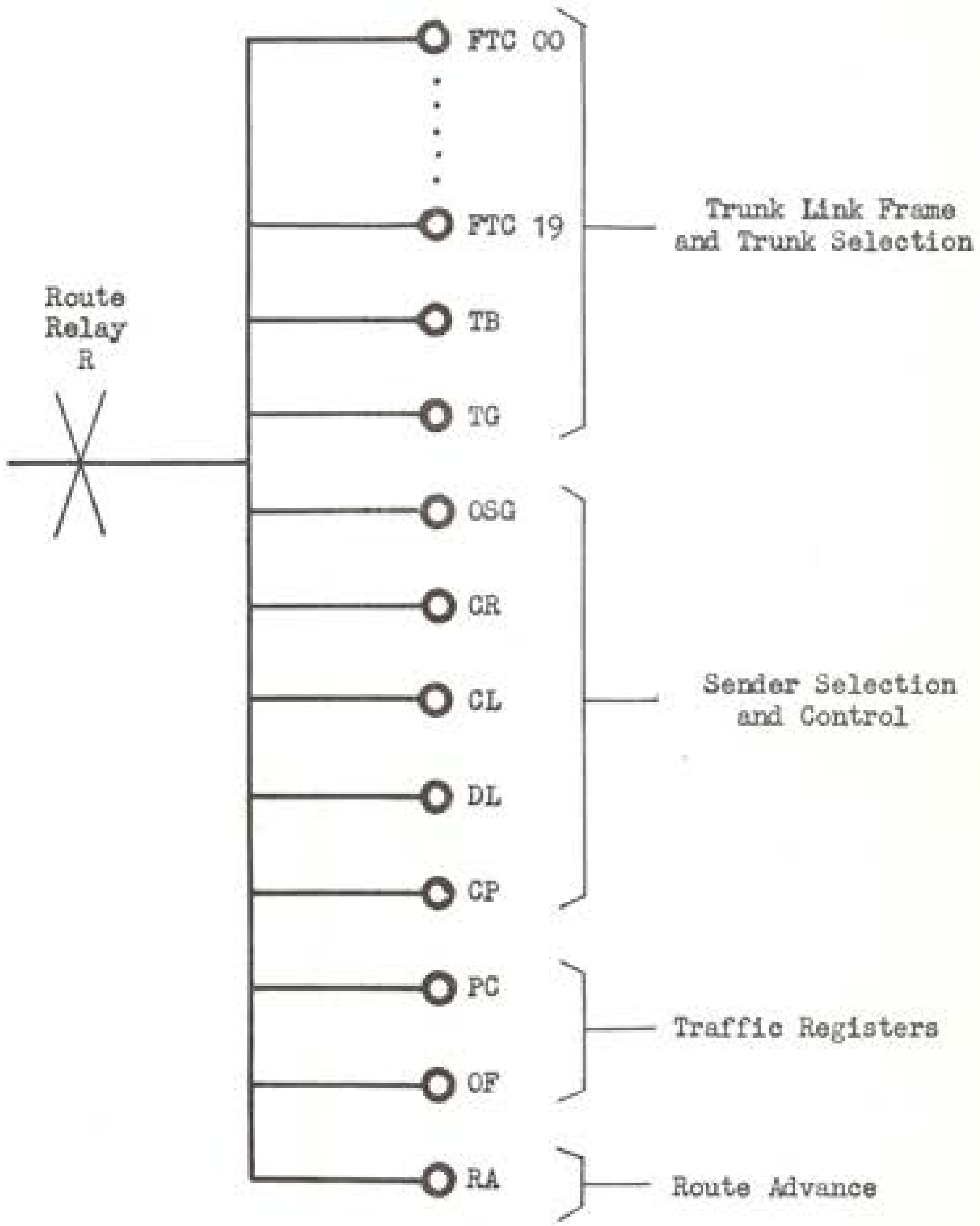
Foreign Area Translator Connector Frame

Figure 4-11



Service Treatment Relay Located Between Code Point and Route Relay

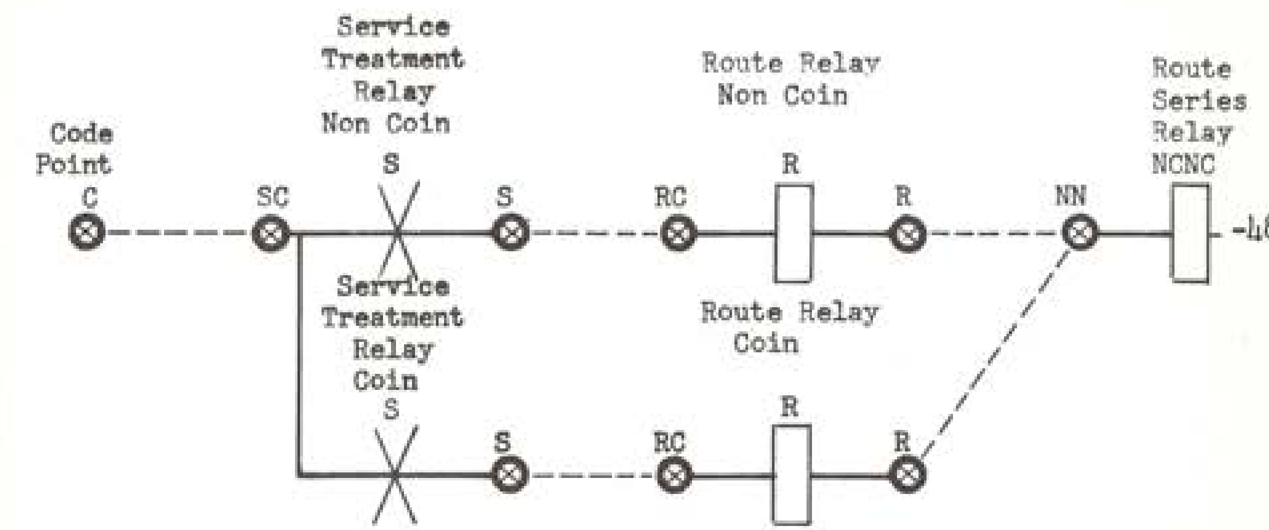
Figure 4-12



Route Relay Functions

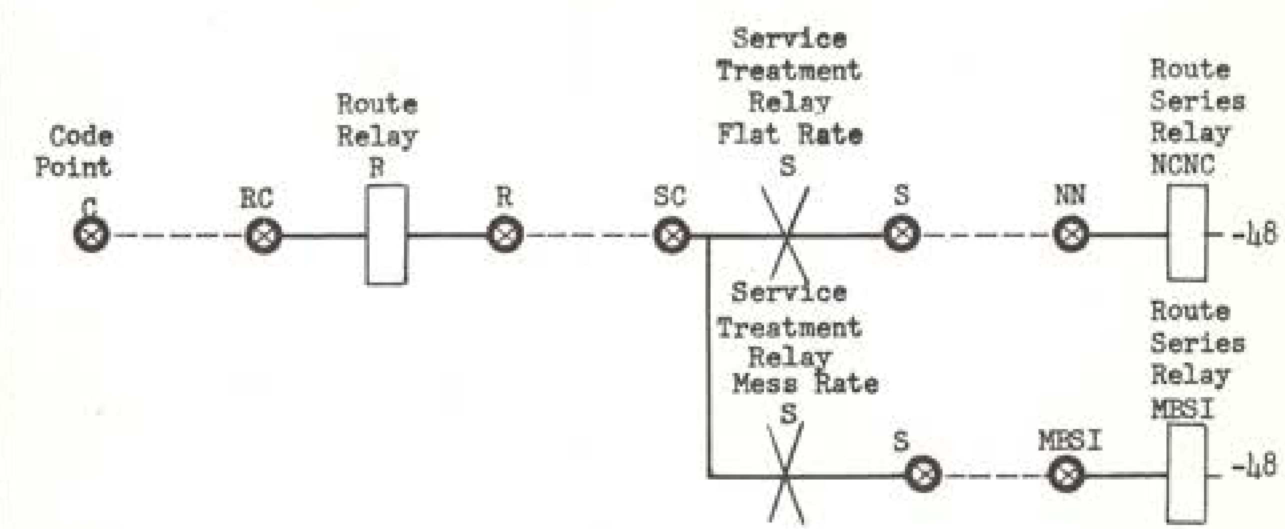
Figure 4-13

SCREENING FOR DIFFERENT ROUTES



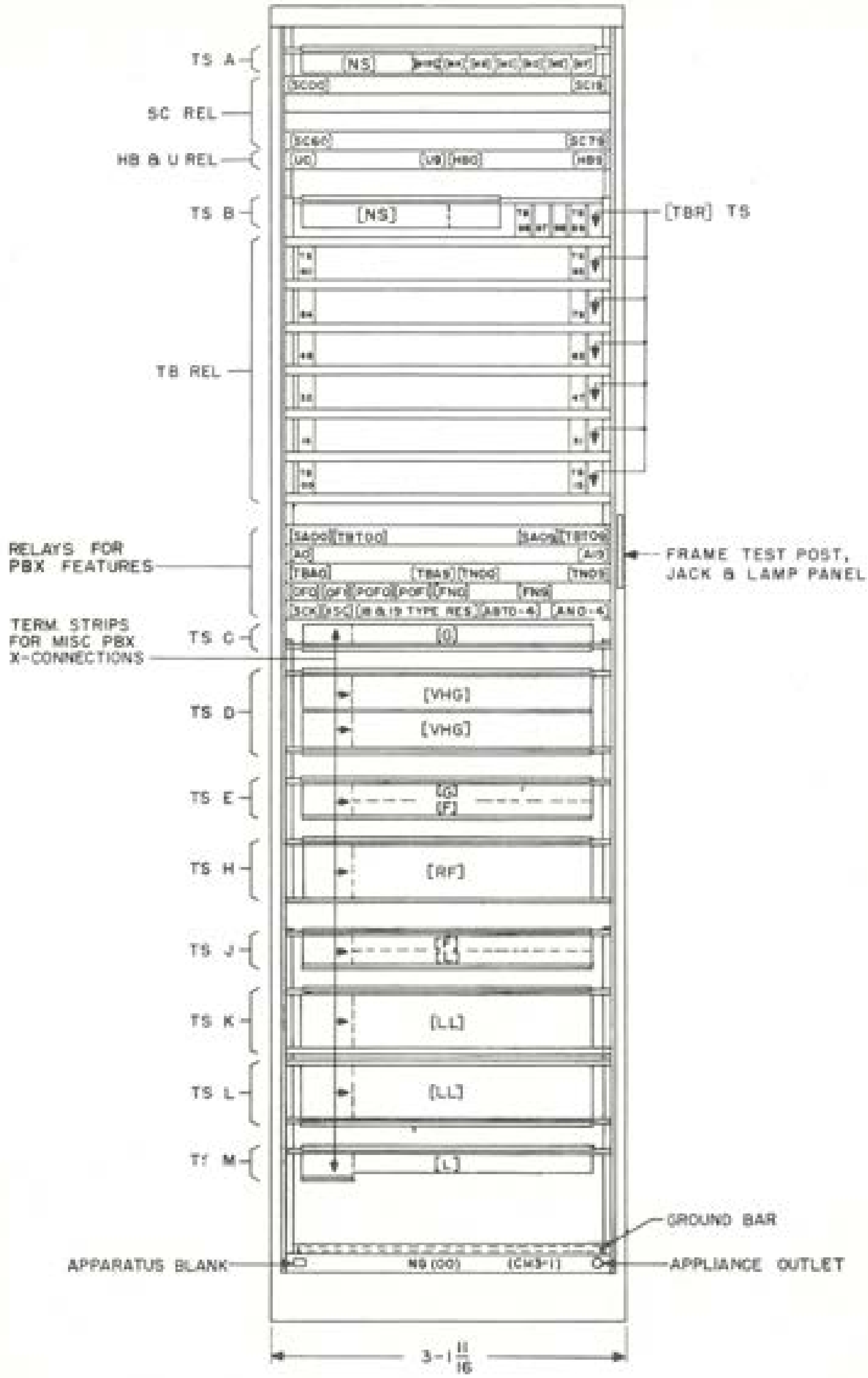
SKETCH A

SCREENING FOR DIFFERENT CHARGE CONDITIONS



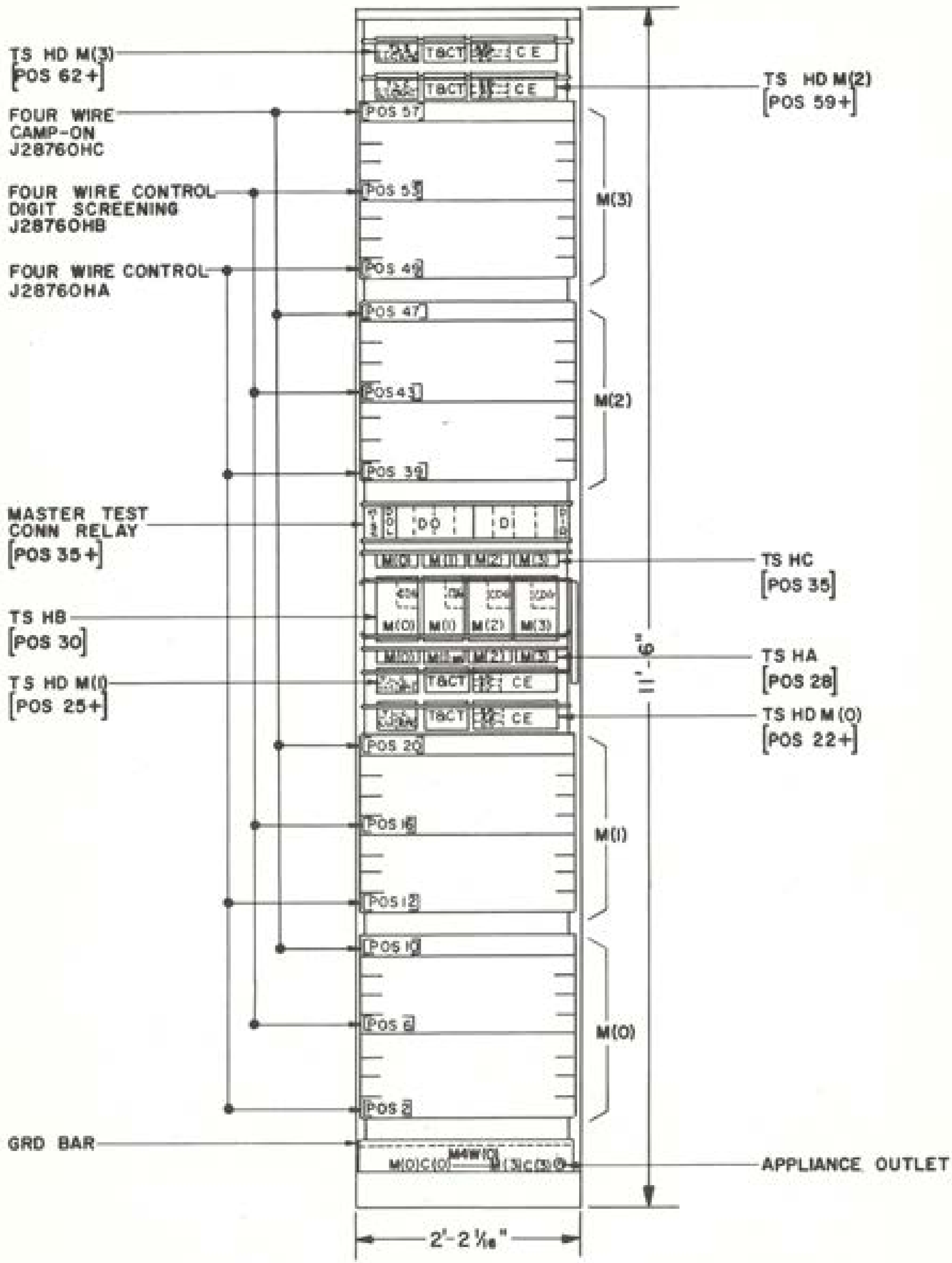
SKETCH B

Figure 4-14



Number Group Frame

Figure 4-15

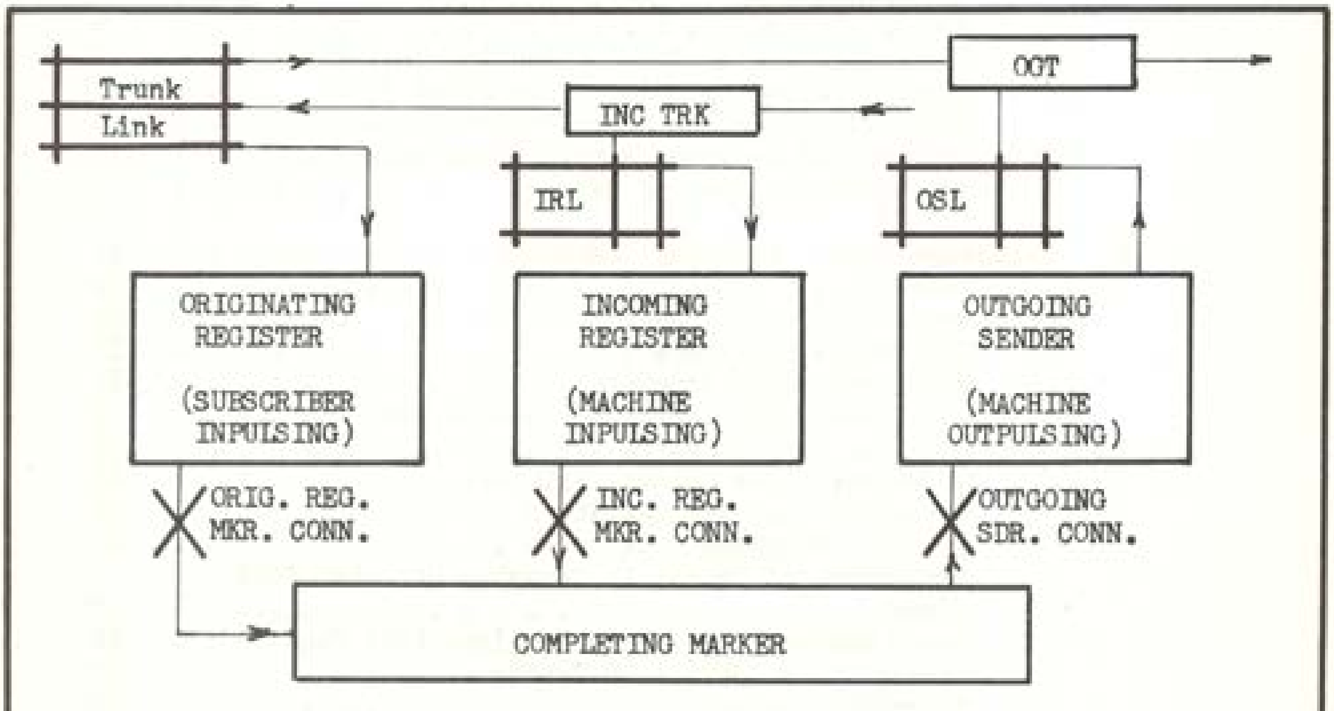


Completing Marker 4-Wire Frame J28760H

Figure 4-16

SECTION V

PULSING PATHS



No. 5 Crossbar Pulsing Paths

Reference and Credits -

Traffic Engineering Practices	-	Originating Register, Pretranslators and Originating Register Marker Connectors - Division D, Sec. 8f
Traffic Engineering Practices	-	Out Senders, Intermarker Group Senders, Sender Link Frames and Out Sender Connectors - Division D, Sec. 8g
Traffic Engineering Practices	-	Incoming Registers, Incoming Register Link Frames and Incoming Register Marker Connectors. - Division D, Sec. 8h

SECTION V - PULSING PATHS

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FIGURES

A. INPULSING PATH - ORIGINATING REGISTERS

General

When a subscriber lifts the receiver to originate a call, the line circuit line relay operates and starts a series of events which result in the establishment of a connection from the calling line, through a line link frame and trunk link frame to an idle originating register circuit. This connection is established under control of a dial tone marker and is known as a dial tone connection. Each register has an appearance on a trunk link frame just as a trunk does and the operation of selecting a register and connecting a calling line to it is much the same as selecting a trunk and connecting a line to it.

While the dial tone marker is in the process of establishing this dial tone connection, it determines and transfers information concerning the identity of the calling line to memory relays in the register circuit. This information consists of the calling line's line link address, class of service, and the line link used in the dial tone connection (the marker will consider this path available when establishing an outgoing connection).

In addition, the dial tone marker informs the register if the calling line is coin, two party, or manual. The register in each of these cases may be required to take special action during its control of the supervisory function.

After the dial tone connection is established, and the dial tone marker releases, the register is ready to receive dial pulses, or touch tone signals from the subscriber. It then transmits "number please" in the form of dial tone to the calling subscriber.

When all digits have been dialed by the customer, or when the originating register "times out" due to partial dial or permanent signal condition, a completing marker is reached through an originating marker connector. The digits of the called number, and the line link address and class of service of the calling line, etc., are transferred to a completing marker which thereafter controls the progress of the call.

In the original No. 5 design, the originating registers included as part of the register circuit the memory relays which stored the calling line information. With the introduction of the wire spring version of the originating register (7-1-55), this memory function was relocated to a new frame, the originating register line memory frame. This section describes the features of the new as well as the old design and includes a section at the end covering additions to existing offices.

Figures 5-1 and 5-2 show the frames involved in the flat-spring and wire-spring version of the subscriber originated inpulsing paths.

Originating Registers (Figure 5-3)

Each originating register frame (wire spring) provides for a maximum of eight registers and is equipped with all of the associated marker connector relays for eleven digits. The horizontal multiple on the multicontact (RA, RB, RC) relays at the top of the frame may be split in one or two places when the registers on the frame are to be associated with two or three originating register marker connectors. Corresponding splits are required in the multiple of the multicontact (RD and RE) relays for this originating register frame on its associated originating register line memory frame.

Features Of The Originating Register

Several features are available in the originating register, and the Telephone Company must specify which should be provided. These features are as follows:

(a) The number of digits for which the register shall be equipped.
(b) Whether or not coin lines will be served. If so, there are several arrangements available. The choices of these options must be coordinated with the coin trunking arrangements.
(c) Whether or not 2-party test shall be provided. This is required if 2-party message rate service is involved, using either message registers or AMA for charging purposes.
(d) Whether service codes shall be of the XII or IIX type.
(e) Whether or not A, or A and B translation shall be provided. This is a simple form of pretranslation within the originating register itself, and its use and limitations are discussed under the subject of pretranslation.
(f) Whether pretranslators will be provided, and if so, at what points a marker will be selected. The meaning of this latter statement, and the use and engineering of pretranslators are also discussed in this section under the heading of pretranslation.
(g) Whether or not code translation is required within the register for completion of a call over a straightforward

trunk to a manual office. This is the ability of the register to call for a marker immediately after receipt of the code. When pretranslators are provided, this feature is not required within the register itself. Otherwise the register may be equipped for manual code translation as follows:

MANUAL CENTRAL OFFICE (C.O.) CODES AVAILABLE FOR NO. 5 OFFICE EQUIPMENT

Manual Code	No. 5 Office Numbering	With Neither A Nor A and B Translation	With A Translation	With A and B Translation
3-digit*	7-digit	1 code only	Any unused C.O. code within the limits of A or A and B digit translation.	

* Three-digit code required even where either A digit or A and B digit translation is provided.

Note: With the above arrangement it is possible, in addition, to use any unassigned XII or IIX service codes as manual office directing codes.

Pretranslation

When all subscriber calls to other subscriber lines consist of the same number of digits, and not more than one manual straightforward code is involved, the originating register can be set to call in the marker as soon as an operator, service, or manual straightforward code has been dialed, or the full digits of the called number have been dialed.

When the number of digits of subscriber dialed calls is variable, or more than one manual straightforward code is required, pretranslation is required. This involves the ability of the equipment to recognize from the central office code the number of digits to expect for the particular call. This will indicate the point at which the originating register should call for a marker. In some cases, it is also necessary to recognize that a particular dialed code may require station delay (party line indication W, R, J, or M).

Simplified forms of pretranslation are available within the originating registers. Where this arrangement meets the requirements it is usually justified in small and medium offices. Since this involves equipment in each originating register, pretranslators may be justified in larger offices. A rough guide as to the economic breaking point is fifty originating registers. Where more involved forms of pretranslation are needed to meet office requirements, separate pretranslators must be provided. No. 5 crossbar offices arranged for direct distant dialing (DDD) require separate pretranslator frames in all cases.

Pretranslation In The Originating Register

Two forms of pretranslation are available within the originating register:

"A" Translation

The initial digit of the code (A digit) determines the point at which the marker will be called in for all codes with that initial digit. An "A" digit translator unit is provided for this feature.

"A and B" Translation

For any three A digits, the point at which the marker will be called in is determined from the combination of the first two digits of the dialed code (A and B digits). Each of the other five A digits (the digits 1 and 0 can never be used in a C.O. code) determines the point at which the marker will be called in for all codes with that initial digit.

Pretranslation By Pretranslator Frame (Figure 5-4)

Pretranslators are called in by the originating register through a connector arrangement as soon as a central office code has been dialed into the register. Through the connector, the register passes the C.O. code to the pretranslator, which determines the point at which the marker will be called in for that code, and passes this indication back to the register. The pretranslator is then released. Each central office code may be translated individually.

When pretranslators are provided, each originating register is equipped with a minimum of three relays for receiving indications from the pretranslator as to when the marker should be called in. One is for calling in the marker after the code only has been dialed, another for a specified number of digits of a fully dialed call (central office code plus the line number), and the third for use when the register is to wait for another digit in addition to a specified number of digits (stations delay). Where required, the registers may also be equipped for one, two, or three other specified number of digits, an optional feature which must be specified by the Telephone Company. One of the settings for a specified number of digits is termed a "basic setting," and should be chosen as the arrangement which will apply to the largest portion of calls. If the pretranslators should fail to function, the originating register will automatically treat all codes in accordance with this basic setting, thus completing a majority of the calls properly.

As an example of the use of pretranslators, assume a combined 6- and 7-digit area, where the majority of the calls are to 7-digit points, some calls require six digits only, some six digits with and without party letters, and others involve manual office 3-digit codes. For this example the originating registers would be equipped for four settings, one more than the equipped minimum. The "basic setting" will be seven digits as it is assumed the majority of traffic is to the 7-digit points. The pretranslators will be arranged for "start indices" as follows: code only; seven digits only (basic setting); six digits only; and six digits plus stations delay.

A pretranslator is capable of handling 15,000 busy-hour calls. However, in order to protect service, a minimum of two should be provided. Equipment arrangements allow a maximum of three. The maximum number of originating registers that may be associated with two pretranslators is 120, and with three pretranslators is 180.

One group of pretranslators may serve two marker groups in the same building, provided the treatments of C.O. codes are identical, and provided three pretranslators will be adequate for the combined traffic of the two marker groups.

Originating Register Line Memory Frame

On a dial tone connection, the calling line location (line link address), and class of service are temporarily stored on memory relays for subsequent use by the completing marker. In the previous design with flat spring relays (Figure 5-1), these memory relays were a part of the originating registers, and the information to be stored was received over forty leads through the equivalent of a multicontact relay per marker on each trunk link connector frame and a multicontact relay per originating register on the originating register frame. This information was passed to the completing marker via the originating register marker connector through a second multicontact relay per originating register on the originating register frame. While forty leads were required for passing this information to and from a register, there were only a few leads between the memory relays and other equipment units of the originating register.

Advantage has been taken of this in the redesign for wire-spring relays by mounting the memory relays and their associated connector relays previously located on originating register and trunk link connector frames on a new frame which is called the originating register line memory (ORLM) frame. This arrangement (Figure 5-2) reduces first cost and floor space since it saves local and switchboard cabling and increases capacities of originating register and trunk link frames.

Each ORLM frame (Figure 5-5) will accommodate the memory and associated connector relays for a maximum of 24 originating registers, 6 trunk link frames and 4 dial tone markers. With the introduction of Centrex, the memory relays on the ORLM frame have been changed. They now are arranged for an indication of 100 classes-of-service as compared to the previous maximum of sixty, and 20 rate treatment indications have been added.

As a general rule, all ORLM frames, except the last will be equipped for the full complement of 24 originating registers, and as many dial tone markers as required, up to a maximum of four. The number of trunk link frames for which each ORLM frame will be equipped will depend upon the assignment of originating register to trunk link frames, and will be influenced by the following considerations:

a) All originating registers on a particular trunk link frame must be associated with the same ORLM frame.

b) All originating registers on the same originating register frame must be associated with the same ORLM frame.

The considerations involved in engineering the ORLM frames can perhaps be best illustrated by taking a specific example. Assume, for instance, an office with 17 trunk link frames and 78 originating registers; for the most equal distribution of registers, there would be 10 TL frames with 5 registers and 7 TL frames with 4 registers. For this distribution, the ORLM frame might be arranged as indicated below:

ORLM FRAME

	0		1		2		3	
	TLF	Reg./TLF	TLF	Reg./TLF	TLF	Reg./TLF	TLF	Reg./TLF
	4	5	4	5	2	5	2	4
	1	4	1	4	3	4	—	—
Total TL Frames	5		5		5		2	
Total Reg.		24		24		22		8

While the above arrangement could be used, it is undesirable from an equipment standpoint in that ORLM frame No. 2 is only partially equipped for originating registers and, because of requirement (b), one of the three originating register frames associated with ORLM frame No. 2 can be equipped with only 6 instead of 8 registers. These objections can be overcome by the arrangement shown below:

	ORLM FRAME							
	0		1		2		3	
	TLF	Reg./TLF	TLF	Reg./TLF	TLF	Reg./TLF	TLF	Reg./TLF
	4	5	4	5	6	4	1	6
	1	4	1	4	—	—	—	—
Total TL Frames	5		5		6		1	
Total Reg.		24		24		24		6

With the above arrangement there would be 8 TL frames with 5 registers, 8 with 4 registers and one with 6 registers. While there is some compromise in the distribution of registers over TL frames, more efficient use is made of available frame space on the ORLM and originating register frames, and some readjustment can be made on the last ORLM frame if desired on the next addition of TL frames to obtain a more equitable distribution.

Originating Register Marker Connectors (Figure 3-8)

When an originating register has received sufficient digits for completing the call, or when the time-out interval has elapsed with no digits received (permanent signal), or with sufficient digits (partial dial), the register is connected to a completing marker through an originating register marker connector (ORMC). Through this connector, the originating register passes all of the necessary information for completing the call to the marker. The register and connector are released when the marker has disposed of the call.

The originating register marker connector frame has a capacity of four connectors and eight completing markers. The connectors are arranged for eleven digits.

A maximum of 20 originating registers may be assigned to a connector, and the maximum number of connectors is twelve. For service protection a minimum of three connectors is recommended.

downloaded from: TCI Library - http://www.telephonecollectors.info - Source: Connections Museum, Seattle, WA

The following restrictions should be considered in the assignment of originating registers to connectors:

(a) An originating register frame has a capacity of eight registers mounted on a double bay and numbered from the bottom up: 0, 1, 2, 3 in the left bay; 4, 5, 6, 7 in the right bay.

(b) Arrangements are available which permit the association of the eight registers on a particular originating register frame with:

(1) One, two or three originating register marker connectors.(Cut strapping between RD & RE relays)

(2) One, two or three trunk link frames.

(c) In making the assignments of registers to connectors, the ultimate arrangement should be considered because it is not feasible to restore the horizontal strapping between multi-contact relays once it has been cut.

(d) If the resulting assignment results in any connector handling more than its rated call capacity, additional connectors should be provided.

(e) A basic ORMC frame is arranged to permit the connection of a maximum of eight markers. If more than four connectors are required, additional basic frames are required for each additional four connectors.

Additions to Existing Offices

It is recommended that U & Y type originating registers be provided on additions only to the extent of filling out existing register frames. For this reason U & Y relay type originating registers will be retained for a period of time as A & M only. For the few such cases that may occur the following additional options must be specified in the traffic order:

(a) Whether more than ten classes of service will be involved.
(b) Whether or not AMA equipment shall be provided in the office.
(c) Whether or not timing for an extra digit is required, a feature called "stations delay."

The wire spring originating registers, together with their associated ORLM frame, may be used for additions to existing jobs and, if spare connector frame space capacity is available on existing frames, may be associated with existing type originating register marker connectors; in the case of additions, however, the following limitations apply:

(a) Originating registers of the wire spring type cannot be mounted on existing U & Y relay type originating register frames.

(b) Wire spring and U & Y relay type originating registers cannot be mixed in the same originating register marker connector.

(c) Wire spring originating registers cannot be assigned to U & Y type trunk link frames.

(d) Originating Registers of the U & Y relay type cannot be assigned to wire spring trunk link frames.

(e) If existing jobs are modified for 10 or 11-digit dialing, the lead capacity of existing originating register marker connectors must be built up by adding auxiliary connector frames of the present type. Accordingly, if wire spring type originating registers are assigned to U & Y type connectors, auxiliary connectors of the U & Y type must be provided for more than eight digits.

B. IMPULSING PATH - INCOMING REGISTERS

General

Any call incoming to the No. 5 crossbar system from an operator or from another dial system (local, tandem or toll) requires the use of an incoming register, whether the call terminates within the office, or switches through the office on a tandem basis. As an exception, calls from one No. 5 marker entity to another No. 5 marker entity within the same building usually utilize intermarker group senders, which act both as the out senders in the first entity and as the incoming registers in the other. As described later in this section, an incoming register is also required for a marker pulse conversion call, and on any call involving a coin junctor, AMA junctor, MR junctor, or operator junctor.

Each type of incoming pulsing requires its own group of incoming registers: dial pulsing (DP), multi-frequency (MF), cordless "B", or revertive pulsing (RP). For the latter type, a group of non-tandem registers will handle calls to the No. 5 office only. A tandem type group must be provided for calls to be switched through the No. 5 office. The tandem group may also handle calls terminating in the No. 5 system. The maximum size of a group is ten incoming registers (including the maintenance register). Depending on the traffic volume it may sometimes be necessary to divide certain types of registers into two or more groups.

An incoming register is associated with the incoming or marker pulse conversion trunk after the trunk is seized by means of a crossbar switch called the incoming register link switch. As described in greater detail later in this section, these switches are mounted on a link frame. Two or three frames may be associated when necessary to provide an incoming register link frame arrangement to serve an MF or DP (non-by-link) register group.

The MF, RP and DP incoming registers employ wire spring relays. The older MF, RP and DP non-wire spring designs are rated "A and M" and should be specified in older offices only to fill out existing non-wire spring type register frames. The cordless "B" registers will remain non-wire spring relay types.

Wire spring and non-wire spring incoming registers cannot be mounted on the same register frame.

TYPES OF INCOMING REGISTERS

The table shown below lists the standard incoming register frame arrangements.

Type of Register	Wire Spring	Non-wire Spring	No. of Registers Per Frame	See Note
Multi-frequency (MF)	X		3	1
Dial Pulse (DP)	X		3	1
Revertive (REV)	X		3	1, 2
Revertive Tandem (REV TAN)		X	2	3
Cordless "B" (CDB)		X	5	2

Note 1: One L.C. Wire spring single bay frame provides for either three multi-frequency registers, three dial pulse registers, or three revertive pulse registers. Only one type of register can be mounted on a frame. (See Figure 5-6)

Note 2: Incoming registers of the non-wire spring revertive (non-tandem) and central "B" type are arranged in any combination on a two-bay frame with capacity for five registers. (See Figure 5-8)

Note 3: Tandem incoming revertive pulse registers handle tandem calls from panel and No. 1 crossbar offices. They are mounted on a single bay frame having a capacity of two registers. These registers will not be redesigned on a wire spring relay basis. (See Figure 5-9)

Dial Pulse Registers (Figure 5-6)

Dial pulse registers may be equipped for either five, eight or eleven digits.

A register group distinguishes between the operational features by a "mark" on the trunk that it is serving. Register groups serving trunks with either or both "TAN" and "TOL" class marks should be specified.

Other features of importance to incoming DP registers which should be specified in the traffic order are: whether or not bylink trunks will be used, and whether or not a variable number of digits will be received over certain trunk groups; the latter can apply only on intertoll and tandem trunks. Table 5-1, page 23, is table of the different types of codes which may be received by DP registers over toll and tandem type trunks and the number of digits required to start the marker.

DP incoming registers may also be equipped with "A" or "A and B" digit translation. This translation is identical to "A" and "A and B" translation in originating registers. This provides for starting the marker or stations delay timer after receipt of the required number of digits, as indicated by the "A" digit alone, or the "A and B" code digits. This arrangement is limited since only three "A" digits can be associated with "B" digits. However, "A" digits not associated with "B" digits can have individual treatment.

When the No. 5 crossbar office serves as a tandem switching point for calls originating in several near-by offices, it may be desirable to permit access from some of these incoming groups to only certain of the outgoing groups, and access from other incoming groups to different outgoing groups. Different screening treatment (maximum 5) may be applied to each class to permit access to certain outgoing trunk groups and not to others. A more complete explanation of marker translation is provided under route relays and allied items. Wire spring design also provides five toll class distinctions for screening purposes.

Multi-Frequency Registers (Figure 5-7)

MF registers always receive a start signal when all digits of a call have been received. The marker is started at this time. MF registers may be equipped for either five, eight or eleven digits. When marker pulse conversion is required, the MF incoming registers must be equipped for all digits that operators may require as well as those required by incoming trunks.

As in the case of DP registers, MF register groups serving trunks with either or both "TAN" and "TOL" class marks should be specified.

MF register groups to be arranged for "11" directing codes or "11X" service codes over tandem trunks should be so specified.

Revertive Pulse Registers (Non-Tandem) (Figure 5-8)

These may handle only calls which terminate in a single marker group. Only the equivalent of the four numerals of a subscriber line number can be received, but the registers may be arranged to recognize high-five or low-five incoming group selection to discriminate between calls to two different number series in the marker group. If this discrimination is required, it must be specified. Even though high-low discrimination is available, separate trunk groups may be used instead to obtain the discrimination.

Cordless "B" Registers (Figure 5-8)

These have the same features described above for incoming RP registers.

Revertive Pulse Tandem Registers (Figure 5-9)

These may handle the traffic for subscriber numbers within the No. 5 office as well as calls to be switched through the office. In some cases, however, it may be more economical to provide separate groups from a distant office, one for the tandem traffic only and the other for terminating traffic only.

These registers are equipped to receive office brush and group selections, which are used to determine the called office, in addition to incoming and final selections which are equivalent to the subscriber's line number. A maximum of 40 "codes" can be received in this manner.

Number of incoming registers

The number of registers, of each type to be provided, is based on the incoming office busy-hour calls requiring the use of a particular type of register. One register per group is usually provided for maintenance purposes in addition to traffic requirements. Only incoming registers with the same type of pulsing may be served by one incoming register link group.

The maximum number of registers that may be provided in one group is ten, including the maintenance register. Therefore, where traffic requirements exceed nine registers of a given type, it will be necessary to divide such registers into two or more groups. The number of incoming trunks which may be associated with a particular type of register is also limited, as discussed below. Where these trunk capacities would be exceeded, it will also be necessary to divide the registers into additional groups.

Incoming Register Link Frames

This description covers the wire spring relay type incoming register link frames. The non-wire spring relay type link frames are rated "Manufacture Discontinued" since the wire spring relay type link frames are completely compatible with the non-wire spring relay type registers and link frames.

There are two kinds of incoming register link frames using wire spring relays. (See Table 5-2) The non-by-link frame (Figure 5-10) may be equipped with eight switches and relays to accommodate 160 trunks and provide access to a maximum of ten incoming registers. One, two, or three frames may be used together as one link group with MF, RP, or DP (without by-link) registers. There is only one design of this frame and no distinction such as auxiliary or supplementary is made. The by-link frame (Figure 5-11) may be equipped with six switches and relays to accommodate 120 trunks to provide access to a maximim of ten incoming DP registers. Only one frame of this kind may be used in a link group and it is limited to serving by-link trunks with or without a combination of trunks not requiring by-link operation.

On the 160 trunk capacity frame, the eight switches are arranged in four horizontal groups. A horizontal group includes the 20 trunks associated with a basic switch (first equipped) and the 20 trunks associated with a supplementary switch. These 20 or 40 trunks bid against each other in the same preference chain for a register. The lower four switches on this frame serve as basic switches and the upper four as supplementary switches. The switches may be equipped in any order desired, except that a basic switch shall be equipped before its associated supplementary switch.

On the 120 trunk capacity frame, the six switches are arranged in six horizontal groups with no switches serving as supplementaries. This frame is designed primarily for use with dial pulse by-link trunks, which are limited to having not more than 20 trunks in a horizontal group. Direct pulse trunks may be assigned to a link frame with by-link trunks if it is not economical to provide separate register groups. Since, in general, for this type of trunk only 120 trunks can be served by ten registers, no provision is made for having more than one frame in a link group.

<u>Assignment of Trunks to IRL Frames</u>

The following limitations govern the general assignment of trunks to the incoming register link frame switches.

(a) All trunks in the same horizontal group (20 or 40 trunks) shall be located within the same group of ten trunk link frames, 0 to 9, 10 to 19, or 20 to 29. This limitation makes it desirable to give consideration initially to whether or not the ultimate marker group will have trunk link frames 10 to 19, or 20 to 29. If only one register link frame of 160 trunk capacity is ultimately required, the four basic switches should be assigned to the 0 to 9, 10 to 19, or 20 to 29 trunk link frame groups, since any supplementary switches added to basic switches must be associated with the same trunk link group. Also, for frames using U- and Y-type relays and where the ultimate number of trunks is less than 200 and the number of trunk link frames is greater than 10, horizontal groups shall be reserved on the basic frame for those trunks associated with trunk link frames 10 to 19, and 20 to 29.

(b) A minimum of two horizontal groups shall be furnished in each incoming register link group. When the number of trunks initially connected to a link frame is less than 40, they shall be divided between the two link switches so that approximately half of each type of trunk or junctor will appear in each of the two horizontal groups. In general, trunks in the same trunk group should be spread over more than one link switch. If two or more register groups are provided for the same type of pulsing, trunks in the same trunk group may be spread over all the register groups if so desired.

(c) Where a dial pulse incoming register link frame is used for both by-link and direct pulse trunks, two horizontal groups are required for the by-link trunks and two for the direct pulse trunks, since both types can not be assigned in the same horizontal group. Each of these two initial sets of two switches will serve up to 40 trunks. For frames using wire spring relays a maximum of six horizontal groups can be provided for each group of registers serving by-link trunks. Where this frame if used, and where groups of trunk link frames (0 to 9, 10 to 19, and 20 to 19) are provided, it is desirable to coordinate the assignment of trunks to the trunk link and register link frames so that the register link switches are used to their greatest capacity. For example, where only a few direct pulse trunks are equipped with a large number of by-link trunks, the direct pulse trunks should not be assigned in both trunk link frame groups, thereby requiring very sparsely used register link switches for both trunk link groups.

(d) Where more than 40 trunks are associated with a link group, a link switch shall be provided for each 20 trunks or fraction thereof. In general, the first frame shall be filled before starting a second frame. Sufficient switch verticals shall be available as spares for any incoming trunks for which locations are reserved on trunk link frames for later additions. In general, the trunks from one trunk link frame associated with a link group shall be assigned in order to the veritcals of one or more link switches before proceeding to the assignment of trunks from the next trunk link frame. However, when a large number of trunks are assigned to one location on only a few trunk link frames for an "overflow" appearance, these "bunched" trunks shall be assigned to individual verticals on the incoming register link switches so that they are distributed over at least two horizontal groups.

(e) Vertical 00 of horizontal group zero (HGO) on the first frame of a link group is reserved as a test vertical for the master test frame. Therefore, no incoming trunk shall be assigned to this vertical.

(f) Two-way intertoll trunks arranged for pulse conversion are assigned two appearances on the link switches, one associated with the switchboard and one with the inward call. Only that register link appearance associated with the inward call requires a trunk number. Where a trunk receives the same kind of pulsing from both the associated switchboard and the connecting office on an inward call, both link appearances will normally be in the same incoming register link group. However, if there are two groups of registers, which incidentally may register different numbers of digits such as seven digits for tandem and four digits for local traffic, it may be desirable to assign one appearance in each register link group.

Trunks Numbers for Tandem and Intertoll Trunks

Each incoming tandem and intertoll trunk requires a LL termination and a trunk number, sometimes referred to as the trunk's directory number, which is used by the marker to enter either of two number groups and obtain the line link frame location of the trunk. This three-digit number is determined by the incoming register from the trunk's location on the incoming register link frame. Basically, each half-switch of the incoming register link frame on which tandem or intertoll trunks are connected is assigned arbitrary hundreds and tens digits, and the switch vertical location of the trunk determines the units digits.

The hundreds and tens digits are equivalent to the tens block in the two number groups to which the marker looks for the line link frame location. Because two number group appearances are provided for service protection reasons, each ten trunks assigned trunk numbers will use twenty directory numbers. Since these tens blocks can be used only for trunk numbers, it is advisable to concentrate trunk numbers into as few tens blocks as possible to avoid wasting directory number capacity of the office. This is accomplished by concentrating tandem and intertoll trunks on as few half-switches as feasible, and in some cases of using the same hundreds and tens digits on more than one half-switch in the same or different link groups. When the latter arrangement is used, the detailed assignment of trunks to verticals for these half-switches must be specified to avoid trunk number duplication. There is no restriction to filling in the other switch verticals with non-tandem type trunks. As only two number groups may serve trunk numbers in a marker group, all future tandem and intertoll trunk numbers as well as intermarker group (subscriber to trunk)

trunk numbers should be considered when directory numbers are reserved. It may be more economical to provide spare number group capacity than to change subscribers' numbers at a future date.

Marker Pulse Conversion Trunks

Each marker pulse conversion trunk requires an incoming register link appearances in an MF register group, and also an appearance on an out sender link switch. The incoming register association is required to receive the MF pulses from the switchboard keyset. When all digits are received, they are transferred to a marker which in turn transfers them to the appropriate type of out sender for outpulsing.

Intertoll Trunks

An intertoll trunk which pulses into the No. 5 crossbar system must have an appearance on an appropriate (DP or MF) incoming register link switch. If it is a two-way intertoll trunk, it may also require an appearance on an out sender link switch. If it is a two-way intertoll trunk requiring marker pulse conversion, it will require two incoming register link switch appearances and an out DP sender link switch appearance. One of the incoming register link appearances will be for the marker pulse conversion calls. The other will be for the incoming traffic from the intertoll trunk, which may be with a DP incoming register (two-way DP type trunk), or with an MF incoming register (incoming MF outgoing DP type trunk). In the latter case, the two appearances may be on the same link switch, on different switches with access to the same register group, or on switches with access to different groups of registers where more than one MF incoming register group is available.

Junctor Trunks

Coin junctors, AMA junctors, and MR junctors are both outgoing and incoming trunks. A subscriber's call is outpulsed on to the junctor trunk as an outgoing interoffice call, but the trunk in effect loops back into the office as an incoming tandem trunk, with the call re-entering the office as a new call. The outpulsing utilizes an out sender, and when the call re-enters the office it utilizes an incoming register. Hence, each of these junctors requires an incoming register link switch appearance.

Operator junctors are classed as either incoming tandem or toll class trunks, and hence, each requires an incoming register link switch appearance.

Assignment Flexibility

Occasionally, it may be necessary to change the association of certain incoming trunk groups from one register group to another. This may occur, for example, in the case of trunks from a manual office to be cut over to dial within the engineering period of the No. 5 job. If the manual office has dials on the switchboard, the trunks require association with dial pulse incoming registers. Assume that the manual office is to be cut over to No. 1 Crossbar with customer dialing to the No. 5. The trunks must then be associated with revertive pulse incoming registers after cutover. These cases are reviewed with the Telephone Company Engineering Department so that the reassociation can be made at cutover without the necessity of providing trunk relay equipment for both the manual and dial basis, since the same trunk relay can usually be used for both types of pulsing.

Incoming Register Marker Connectors (Figure 3-8)

When an incoming register has received sufficient digits for completing the call, or when the time-out interval has elapsed with no digits received (permanent signal) or with insufficient digits (partial dial), the register is connected to a completing or combined marker through an incoming register marker connector (IRMC). Through this connector, the incoming register passes all of the necessary information for completing the call to the marker. After the marker has performed its function, the marker, connector and register are released.

A maximum of 20 incoming registers may be assigned to a particular connector. In some cases this limitation may require the provision of more connectors than the initial estimate.

The number of incoming registers of each register group assigned to each IRMC shall be specified by the Telephone Company. The following limitations apply in specifying this association:

a) Wire spring relay type registers (MF or DP) are mounted on single bay frames accommodating three incoming registers of the same type. If the three registers on one frame are assigned to the same connector, the multi-contact relay strap wire multiple is not cut and switchboard cable is run from one of the associated terminal strips to the marker connector frame. The three registers on one frame, however, may be assigned to two different incoming register marker connectors by splitting the multi-contact relay strap wire multiple. Careful consideration should be given to the location of the split between registers in different connectors since it is not feasible to reconnect the strap wire multiple. When additions are made, no change can be made in the location of the split. Switchboard cabling is simplified and splitting of strap wire multiple is avoided if all registers on a frame are assigned to the same connector.

b) Non-wire spring relay type incoming registers are mounted five or less to a frame and are numbered 0 to 4. Partially filled frames are equipped from the top down (4 to 0). A particular frame may mount registers of only one type of pulsing or any mixture of types. The five registers on a frame may be cabled to either one or two IRMC's, with a split only between registers 2 and 3 or between 3 and 4. As an exception, incoming revertive pulse tandem registers are mounted two per frame and the registers on each frame must be assigned only to one particular connector.

Because of the possible widespread effect of incoming traffic congestion - backups in other central offices and tandem systems - it is generally advisable to avoid "tight" engineering of IRMC's. In this connection it is recommended that a minimum of two connectors be provided.

Non-wire spring registers and intermarker group senders may be assigned to the same connector with wire spring registers. However, if this is done, certain wire spring type relays must be provided in the connectors serving these registers and senders.

Intermarker Group Senders

The primary considerations regarding the engineering of intermarker group senders are covered under outpulsing. However, since they act as the out senders in one marker group, and also as the incoming registers in the other marker group, those factors specifically pertaining to their incoming register functions are covered here.

The trunk numbers for tandem type trunks (subscriber-to-trunk trunks) are determined as follows: The units digit of the number of the trunk link frame on which the trunk is terminated in the called marker group is the hundreds digit of the trunk number. Hence, when several such trunks are "bunched" on a trunk link frame, they have a common hundreds digit. Each trunk of this type has two vertical appearances on a sender link switch, one of which is the regular appearance for associating the trunk and the intermarker group sender. The other, called an "auxiliary" appearance, is wired to a terminal strip on the sender link frame in such a manner as to provide an indication of the tens and units digit of the trunk number. The assignment of trunk numbers should, of course, be carefully coordinated with those of trunks associated with incoming registers in order to avoid duplication and to conserve tens blocks in the number groups.

Intermarker group senders must have access to markers in the terminating marker group through incoming register marker connectors (IRMC). They may use the same IRMC as those serving incoming registers but separate connectors are preferable from a maintenance standpoint. This is not a circuit requirement, however, and in some marker groups it may be economically desirable to assign intermarker group senders in combination with incoming registers to the same marker connectors. All groups of intermarker group senders whose traffic is into one marker group may use the same IRMC's regardless of whether the traffic originates in one, or more than one other marker entity in the building.

A one bay frame (Figure 5-12) provides for four IMG senders with or without AMA and each is arranged for either eight or eleven digits. Multi-contact relays at the top of the frame connect the IMG senders to outgoing sender connectors in the originating marker group and to incoming register marker connectors in the terminating marker group. On IMG sender frames multi-contact relays are always equipped for four senders and eight digits. Additional relays are ordered for the four sender capacity frame when digits exceed eight or when AMA is provided. The multiple between multi-contact relays may be split between any two IMG senders to provide the required traffic load from sender connectors in the same marker group or to incoming register connectors in the terminating marker group.

TABLE 5-1

CODES RECEIVED BY DP INCOMING REGISTERS FROM TOLL AND TANDEM TYPE TRUNKS AND NUMBER OF ADDITIONAL DIGITS WHICH MAY FOLLOW

TOLL TYPE TRUNKS

Type of Code		Number of Additional Digits
Local (A - 2 to 9) (B - 2 to 9) (X - 0 to 9)		4 or 5
		or
		0 to 5
TX Operator 11	(X - 1 to 9) (X - 0 to 9)	0
Operator and Plant 1	(X - 0 + 2 to 9) 1	0
Intertoll 1	(X - 0 + 2 to 9) (X - 0 + 2 to 9)	0
Trunk	and	or
Group 0	(X - 0 to 9) (X - 0 to 9)	0 to 8
Area	(X - 2 to 9) 1 (X - 0 + 2 to 9)	0 to 8
	or	or
	(X - 2 to 9) 0 (X - 0 to 9)	7 or 8

TANDEM TYPE TRUNKS

	Type of Code	Number of Additional Digits
Local	(A - 2 to 9) (B - 2 to 9) (X - 0 to 9)	4 or 5 or 0 to 5
*Service	(X - 2 to 9) 11	0 to 8
*Area	(X - 2 to 9) 1 (X - 0 + 2 to 9) and (X - 2 to 9) 0 (X - 0 to 9)	0 to 8 or 7 or 8
"11" Foreign Area Directing	11 (A - 2 to 9) (B - 2 to 9) (X - 0 to 9)	4 or 5 or 0 to 5
One Digit	(C - 0 to 9)	4 or 5 or 2 to 5
Two Digit	(B - 2 to 9) (C - 0 to 9)	4 or 5 or 1 to 5

* Tandem type trunks must give the same treatment to service and area type codes.

Notes: Where "4 or 5" appears it means the register can be arranged to start the marker after 4 digits or after 4 digits plus one stations digit. When the latter arrangement is used and the stations digit is dialed the marker will be started immediately but, if not dialed, the marker will be started after a 3-5 second interval.

Where "7 or 8" appears the arrangements available are the same as "4 or 5" except that 7 or 8 digits must be received.

Where "0 to 5" and "0 to 8" appears it means the register can be arranged to start the marker under control of the repetitive 3 to 5 second inter-digital timer after the third digit is registered. In these cases, the marker will always be started 3 to 5 seconds after dialing has stopped except when a full complement of digits is registered in which case the register will start the marker immediately.

Where "0" appears it means the register will start the marker immediately after the code is registered.

TABLE 5-2

INCOMING REGISTER LINK GROUP ARRANGEMENTS

USING WIRE SPRING RELAY FRAMES

TEN REGISTERS MAXIMUM

Frames	No. of Sws/Fr	Trks/ Sw	Trks/ Fr	Trunk Total	Capacity/IRL GP Tandem-Type TK	Type of Pulsing
1, 2, or 3	8	20	160*	480	320	MF
1, 2, or 3	8	20	160*	480	160	DP (Non-by-link)
1	6	20	160*	120	120	DP (By-link with or without Non-by-link)

* One trunk appearance in each link group is assigned for the master test frame.

Type of Register Group	Total Trunk Capacity (1)		Tandem-Type Trunk Capacity	
Dial Pulse - By-link Trunks	99	(2)	99	(2)
	199	(3)	199	(3)
- Non-by-link Trunks	399		200	
- By-link & Non-by-link	159	(4)	99	(4)
Trunks Combined	259	(5)	199	(5)
Multi-frequency	599		400	
Revertive Pulse	599		None	
Revertive Pulse Tandem	199		199	
Cordless "B"	199		None	

(1) One link vertical is required for automatic monitor.

(2) Using basic frame only.

(3) Using basic and 1st auxiliary frames.

(4) Using basic and supplementary frames.

(5) Using basic, supplementary and 1st auxiliary frames. All by-link trunks and all tandem-type trunks are restricted to switches on the basic and 1st auxiliary frames. When a supplementary frame is provided, the switches must be omitted on the horizontal level corresponding to the horizontal level of switches serving by-link trunks on the basic frame.

C. OUTPULSING PATH - SENDERS

General

The basic function of senders in the No. 5 crossbar system is to transmit information received from the marker via sender connectors to a terminating office via sender links and trunks, for the control of the switching equipment in that office. Out-senders are used to transmit such information to offices in distant buildings or to offices of a type other than No. 5 cross-bar in the same building, while intermarker group senders transmit such information to other No. 5 entities in the same building. Out senders are also used to transfer the necessary information from markers to AMA transverters on all calls involving AMA charging in the No. 5 office. They are also used for marker pulse conversion calls for coin, AMA and MR junctor calls and for control purposes on through switched calls to straightforward trunks. No. 5 offices serving as CAMA centers also require the provision of CAMA senders. Senders are not required on non-AMA intra-office calls, on outgoing calls to straightforward trunks, on outgoing calls to operators, or on calls to certain miscellaneous trunks such as tone trunks.

The transmission of the necessary information to other offices by out senders is in the form of pulses. Four types are available for supplying the proper type of pulsing; dial pulse (DP), multi-frequency (MF), revertive pulse (RP) and panel call indicator (PCI). Each type of outpulsing requires its own group or groups of out senders. Where no digits need be outpulsed on AMA calls of the intraoffice type, an out sender is required for AMA purposes. Any type of out sender except PCI may be employed for this purpose.

The maximum size of a group is ten out senders including maintenance. As described later in this section, it is sometimes necessary to divide certain types of senders into two or more groups. Where more than one group of a particular type is provided, all trunks of a particular non-allotted trunk group must be associated with only one of the sender groups. The allotting of large trunk groups to more than one sender group is covered under trunks. With allotted groups, the two subgroups of trunks may be associated with different sender groups.

Dial Pulse Senders

Dial pulse senders (Figure 5-13) are arranged to register from one to eleven digits and to outpulse one to eleven. In non-AMA offices where the initial one, two or three digits are never outpulsed the sender need not be arranged to register these digits, otherwise all digits are transferred to the sender whether or not they are outpulsed.

Any number of initial digits from one to six may be deleted from outpulsing. Digit deletion in senders is accomplished by route relay cross connection and the provision of delete relays in the sender.

Dial pulse senders may be arranged to prefix the digits "11" or one, two or three arbitrary digits (0 to 9, inclusive). Deletion and prefixing of digits are independent functions of the sender. Thus, prefixed digits may be in addition to or in place of digits received from an originating or incoming register.

Dial pulse senders may also be arranged to outpulse at a rate of either ten or twenty pulses per second.

Multi-Frequency Senders

MF senders (WS) (Figure 5-14) have exactly the same capabilities as DP senders with respect to the registration, deletion, prefixing and outpulsing of digits.

Revertive Pulse Senders

Revertive pulse senders (Figure 5-15) are capable of pulsing into panel offices or No. 1 crossbar offices. They can not be used to pulse into crossbar tandem offices since they are not equipped to send forward office brush and group selections. These senders transmit only four numerical digits of the number and are arranged, non-optionally, to transmit high and low incoming group selections.

Panel Call Indicator Senders

This type of sender (Figure 5-16) is used to complete to manual offices, to panel sender tandems equipped with panel call indicator equipment, or to crossbar tandem offices equipped with PCI senders for CAMA. This sender may not be used for intra-office AMA calls.

PCI senders are capable of registering a maximum of eight digits. The office code digits may be deleted from outpulsing in their entirety as determined by route relay cross connections.

The digits "11" may be used as a prefix to central office codes to indicate an office in a foreign area. This information is passed by the PCI sender to the AMA transverter for charging purposes but is not outpulsed and is not within the eight digits that may be registered. This feature is also available for RP senders.

Intermarker Group Senders

On a call from one No. 5 marker group to another No. 5 marker group in the same building an intermarker group trunk is used. This type of trunk is associated with an intermarker group sender (Figure 5-12), which receives information from one marker group and transmits it to another marker group.

Intermarker group senders may be arranged to record from five to eleven digits for transfer to the terminating marker group and for transfer to the transverter on AMA calls. All digits of a call are transferred into the sender from the marker in the originating office. In a six or seven digit local numbering plan area the senders may be arranged to identify the called office by means of the C digit, the BC digits or the ABC digits of the office code.

The marker gains access to a sender on an outgoing call via out sender connectors. The intermarker group trunks and senders are associated with each other on regular out sender link switches. Therefore, most items concerning the engineering of intermarker group senders have been covered here, but a few items pertaining to their functions as incoming registers in the called marker group are covered in the section on inpulsing.

Number of Senders

The number of senders of each type provided for Traffic is based on the office busy-hour calls requiring the use of the particular type of sender involved.

The maximum number of senders that may be provided in one group is ten, including maintenance. Therefore, where traffic and maintenance requirements exceed ten senders of a given type, it will be necessary to divide such senders into two or more groups.

Out Sender Link Frames

An out sender link frame (Figure 5-17) has the capacity for mounting ten sender link switches. Each such link switch is a 200-point crossbar switch with a maximum of twenty trunks terminated on the verticals. The senders appear on the horizontals, and are multipled to all the switches whose trunks are served by the sender group involved. The trunks from only one trunk link frame can be terminated on a particular link switch. The trunks from one trunk link frame may be associated with a maximum of six sender link switches and hence, there is a maximum of 120 trunks per trunk link frame that can have access to senders of all types including intermarker group senders.

It is desirable that each trunk link frame have the same sender link switch arrangement. An example of the form in which this might be specified is as follows:

Outgoing sender link switches for each trunk link frame shall be arranged for trunks as follows:

SWITCH VERTICALS ASSIGNED

Link Switch	MF	DP	PCI	REV	DMC	TOTAL
1st			6	14 (1)		20
2nd	12				8	20
3rd		10		10 (2)		20

(1) Has access to revertive pulse sender Group 1.
(2) Has access to revertive pulse sender Group 2.

The first step is to obtain the average number of trunks (including spare) per trunk link frame by types of pulsing. Allowance is then made for spare sender link switch verticals for assignment flexibility and to anticipate future changes in pulsing which may occur. This subject is discussed in more detail later in this section. After these data are obtained, assignment of trunks to individual sender link switches should be made in such a way as to obtain the most economical use of these switches. Frequently, trunks involving two different types of pulsing will be assigned to the same sender link switch. The switch vertical requirements must be apportioned in such a way that they total twenty, which, in most cases, will involve providing somewhat more spare than actually required. This process is called splitting of switches and is discussed in more detail later in this section.

If trunks of a given type of pulsing are served by more than one sender link switch (such as the revertive pulse trunks shown in the example) they may be served by one or more sender groups. If served by more than one sender group, the arrangement is indicated as illustrated in the example.

The senders of a group should be divided as evenly as possible between the upper and lower halves of the link switch horizontals. For example, if there are seven senders in a group, three should be assigned to any of the horizontals 0-4 and four to any of the horizontals 5-9. This split provides Subgroups A and B of a sender group required for assignment to out sender connectors as described later.

More Than Twenty Trunks per Trunk Link Frame, Served by Same Sender Group.

For this condition, the trunks served by a sender group must be spread over two or more link switches.

Splitting of Switches

It would often be wasteful of switches if the trunks on a switch could have access to only one group of senders. To overcome this, the link switches can be split as follows:

Split the horizontal strappings between any two verticals, and assign one sender group to the horizontals on the left side of the switch, and a different sender group to the right side. The trunks are correspondingly assigned to the verticals on the left or right side.

Two examples are pertinent:

(1) If the trunks per trunk link frame requiring access to two sender groups are eleven and five trunks, respectively, a link switch could be split between the thirteenth and fourteenth verticals, thereby assigning thirteen verticals to one type of trunk and seven to the other (Figure 5-18 example 1). One switch suffices for the two sender groups, with spare verticals for trunk growth in each case.

(2) If the trunks per trunk link frame requiring access to two sender groups are eleven and twenty-five trunks, respectively, two link switches must be used (Figure 5-18 example 2). One switch might be split as above, with the eleven trunks assigned to one side, and five of the larger group to the other side. The balance of the larger group is assigned to the other link switch.

Intermarker Group Senders and Trunks

Intermarker group senders are treated the same as any other senders. However, tandem-type intermarker group trunks (subscriber-to-trunk trunks) require two vertical appearances on the same sender link switch. One is a regular appearance for normal association of the trunk and sender; the other is an "auxiliary" appearance whose use is for determining the trunk number in the called marker group. All "auxiliary" appearances should be located at the extreme right portion of the switch.

Marker Pulse Conversion Trunks

Each marker pulse conversion trunk requires an out sender link appearance for association with an out sender of the proper type--DP or RP. These trunks may be spread over not more than one RP and two DP sender groups. Each trunk also requires an appearance on an MF incoming register link frame. These appearances are required so that the MF pulses from the switchboard can be stored in the incoming register, then transferred to the marker, and then in turn transferred to the out sender for outpulsing.

When a marker pulse conversion trunk is also used for traffic switched through the office from intertoll trunks, one sender link switch appearance will care for the association with an out sender required for either condition.

Where a marker pulse conversion trunk requires association with an out sender only because of marker pulse conversion, an appearance is also required on a trunk link frame in order to return an overflow signal when all senders are busy. All such trunks on a trunk link frame may have a bunched appearance. It is the usual practice with bunched trunks to concentrate them on a few trunk link frames. However, these marker pulse conversion trunks require individual sender link switch appearances. It is, therefore, desirable to spread the trunks evenly over all trunk link frames and then bunch those assigned to each trunk link frame on one appearance.

Intertoll Trunks

An intertoll trunk requires an appearance on an appropriate (DP or MF) sender link switch if access is obtained to the trunk via the No. 5 equipment and outpulsing is involved, or if it is a marker pulse conversion trunk. If it is a two-way intertoll trunk, it will also require either one or two incoming register link switch appearances.

Junctors

Coin junctors AMA junctors and MR junctors are both outgoing and incoming trunks. A subscriber's call is outpulsed onto the junctor as in any outgoing interoffice call, but the trunk in effect loops back into the office as an incoming tandem trunk with the call re-entering the office as a new call. The outpulsing utilizes an out sender, and when the call re-enters the office it utilizes an incoming register. Hence, each of these junctors requires an out sender link switch appearance.

Operator junctors are incoming tandem trunks and hence do not require association with an out sender.

Flexibility Arrangements

In allocating trunks to the sender link switches, some space should be left within each grouping for growth or load balance reassignments. Normally, a few verticals will be sufficient. Where the office characteristics are not expected to change materially, trunk growth will be taken on new trunk link frames and hence will not materially affect previous sender link switch arrangements. Certain factors can be foreseen, however, future changes in type of pulsing, or a material growth of intermarker group trunking should be taken into consideration in allocating trunks to the switches and may make it desirable to order additional switches to anticipate these changes.

The trunk equipments are cabled to terminal strips on the sender link frames, and cross-connected from there to the verticals of the link switches. Hence, there is some flexibility for reassigning trunks within a frame.

Out Sender Connectors

When a marker seizes a trunk requiring association with an out or intermarker group sender, the trunk and sender are associated through the link switch, and the marker gains access to the out or IMG sender through an out sender connector (Figure 3-12). Through this connector, the marker passes all the necessary information for completing the call to the sender, after which the marker is released. A pair of connectors serves any and all types of senders.

Out sender connectors are furnished in pairs. The number to be provided is primarily a function of the traffic volume. Each connector is restricted to a maximum of 3000 busy-hour calls in offices with flat spring completing markers and 6000 calls in offices with wire spring markers. However, because of other limitations the following steps should be observed except in a minimum case where only two connectors will be adequate.

As described previously, each group of senders is divided into Subgroups A and B. One subgroup is assigned to one connector of the pair on a frame, the other subgroup to the other connector.

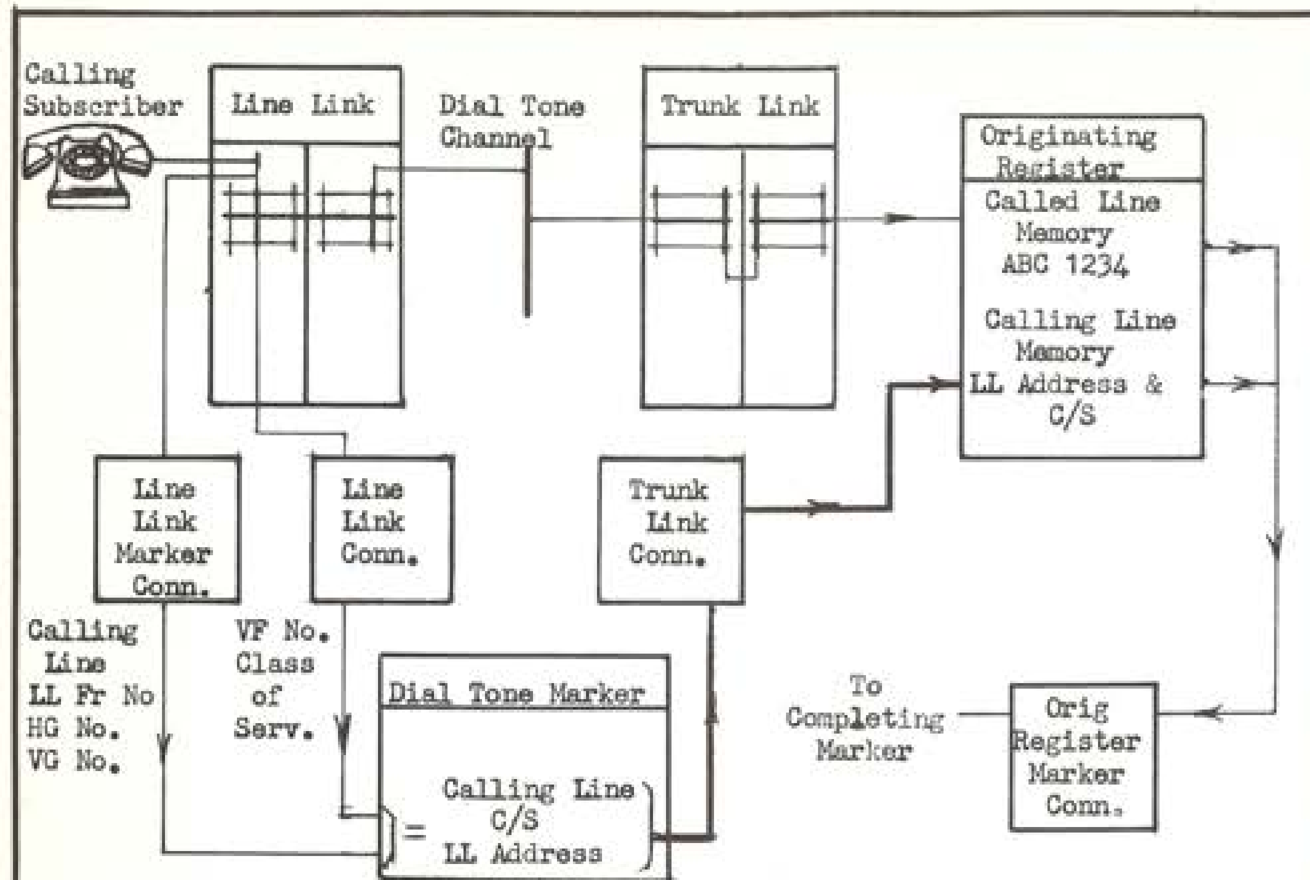
Obtain a preliminary estimate of the number of connectors by dividing the total calls requiring the use of senders by 3000 or 6000 as required. Round this figure up to the next full even number.

Estimate the calls per sender for each sender group. The maintenance sender is not counted.

Assign the senders to the out sender connectors, observing the fact that subgroups are divided between the two connectors on a frame, and attempting to provide an arrangement so that all connectors carry approximately the same number of calls. No connector may exceed the 3000 or 6000 call capacity. In this step, assign all senders, including maintenance, but using the estimate of calls as determined in the previous paragraph.

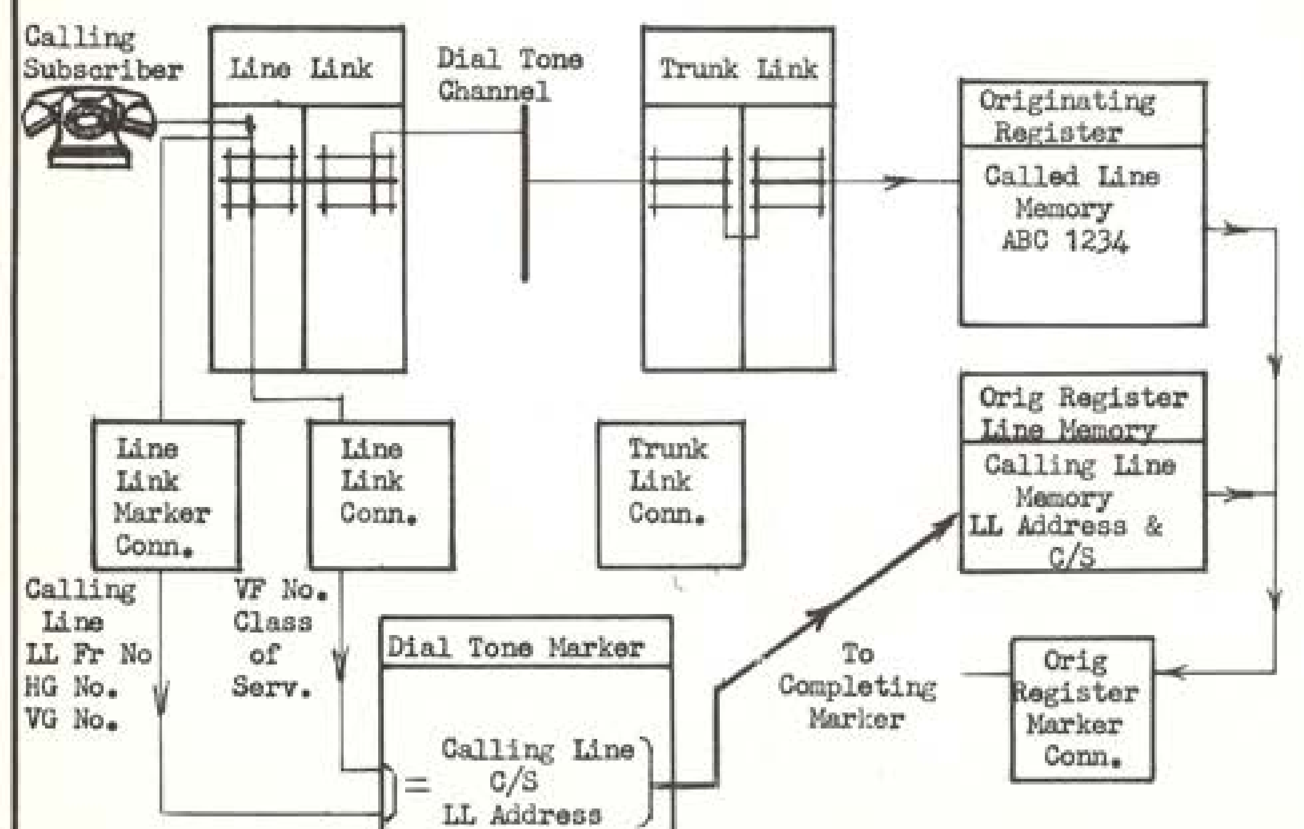
A maximum of thirty senders or four groups of senders may be assigned to one pair of connectors, fifteen to each connector.

In some cases, it may be necessary to increase the first estimate of the number of out sender connectors to meet these requirements.



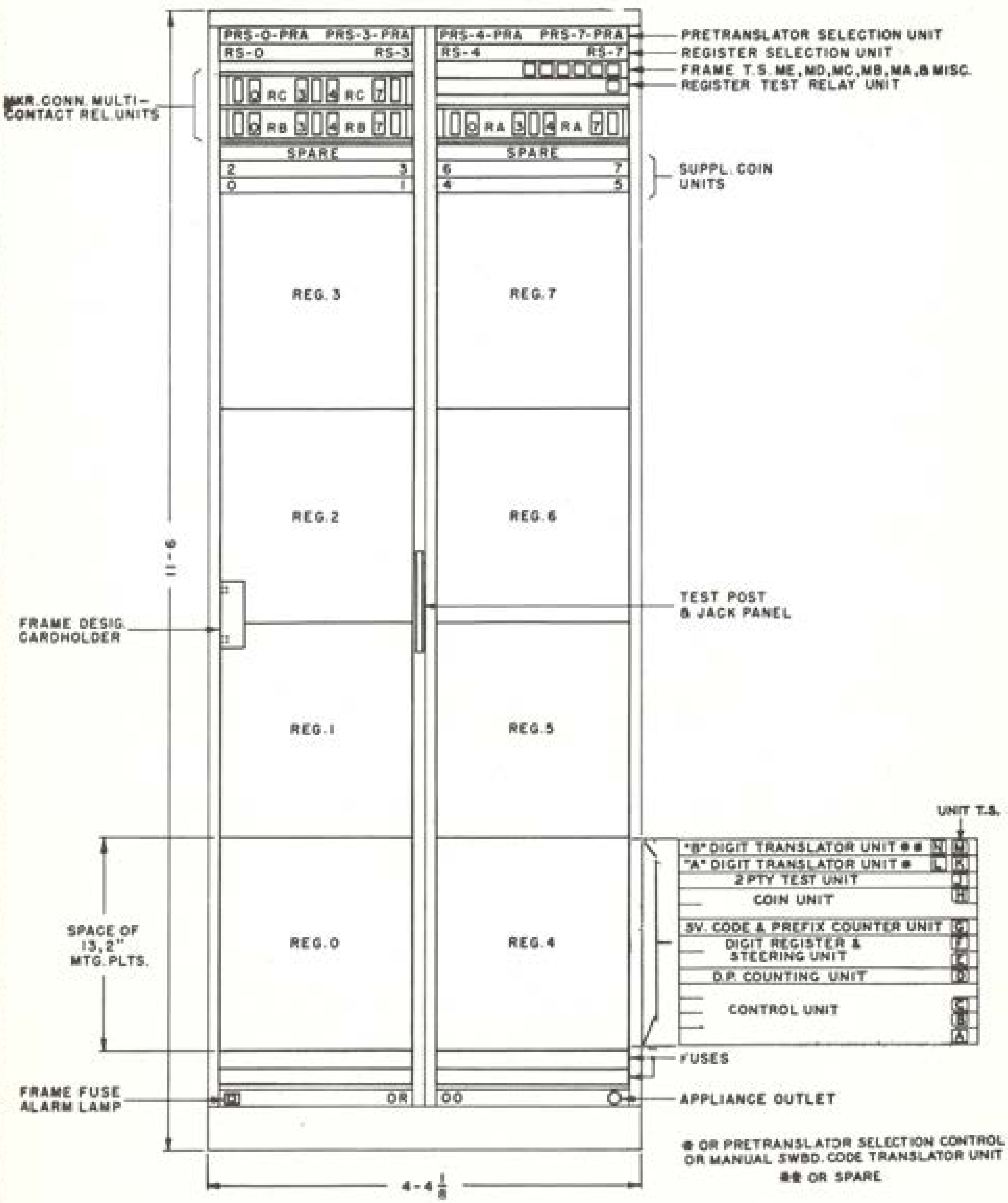
Originating Register (Flat Spring)

Figure 5-1



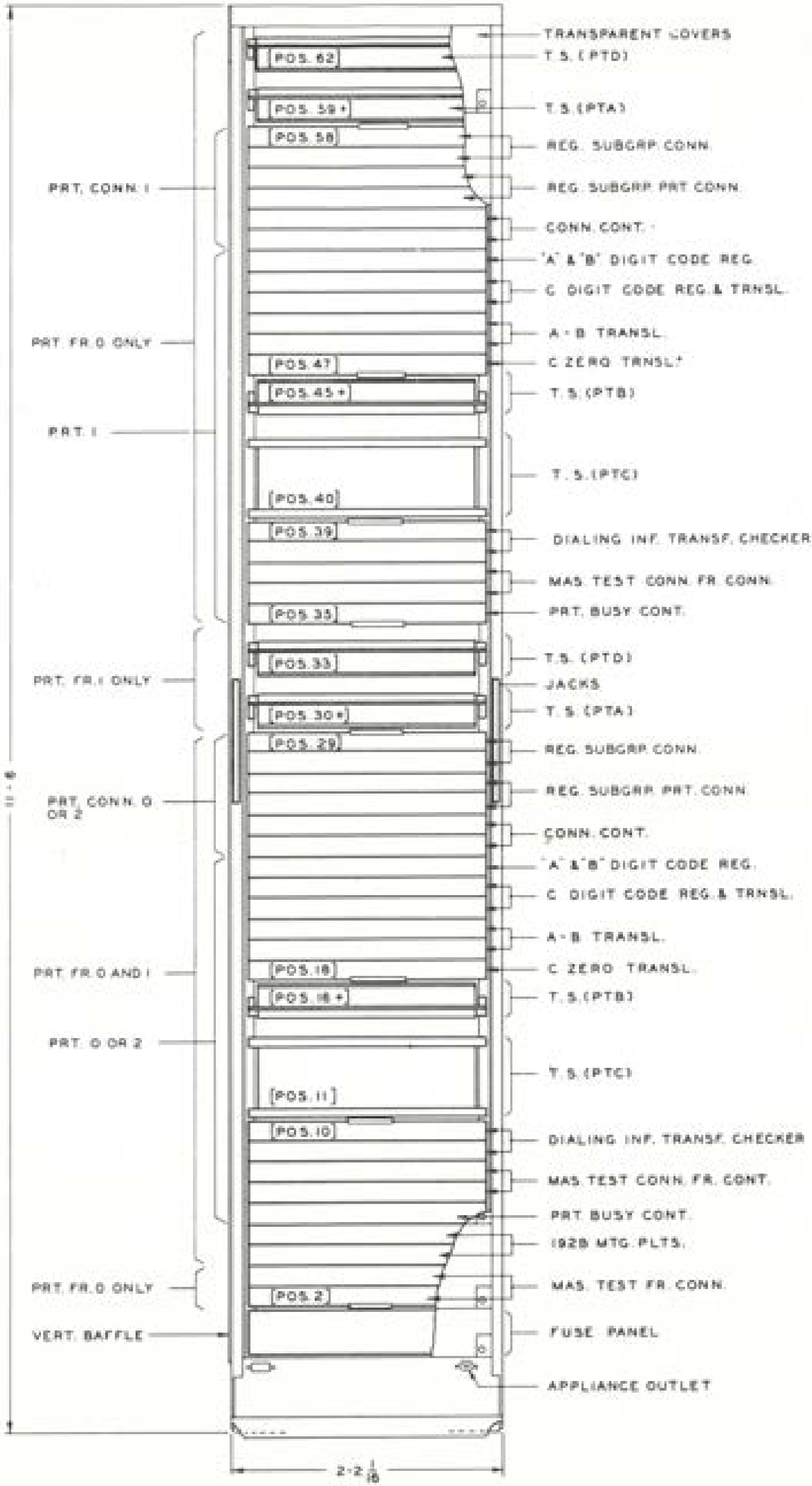
Originating Register (Wire Spring)

Figure 5/2



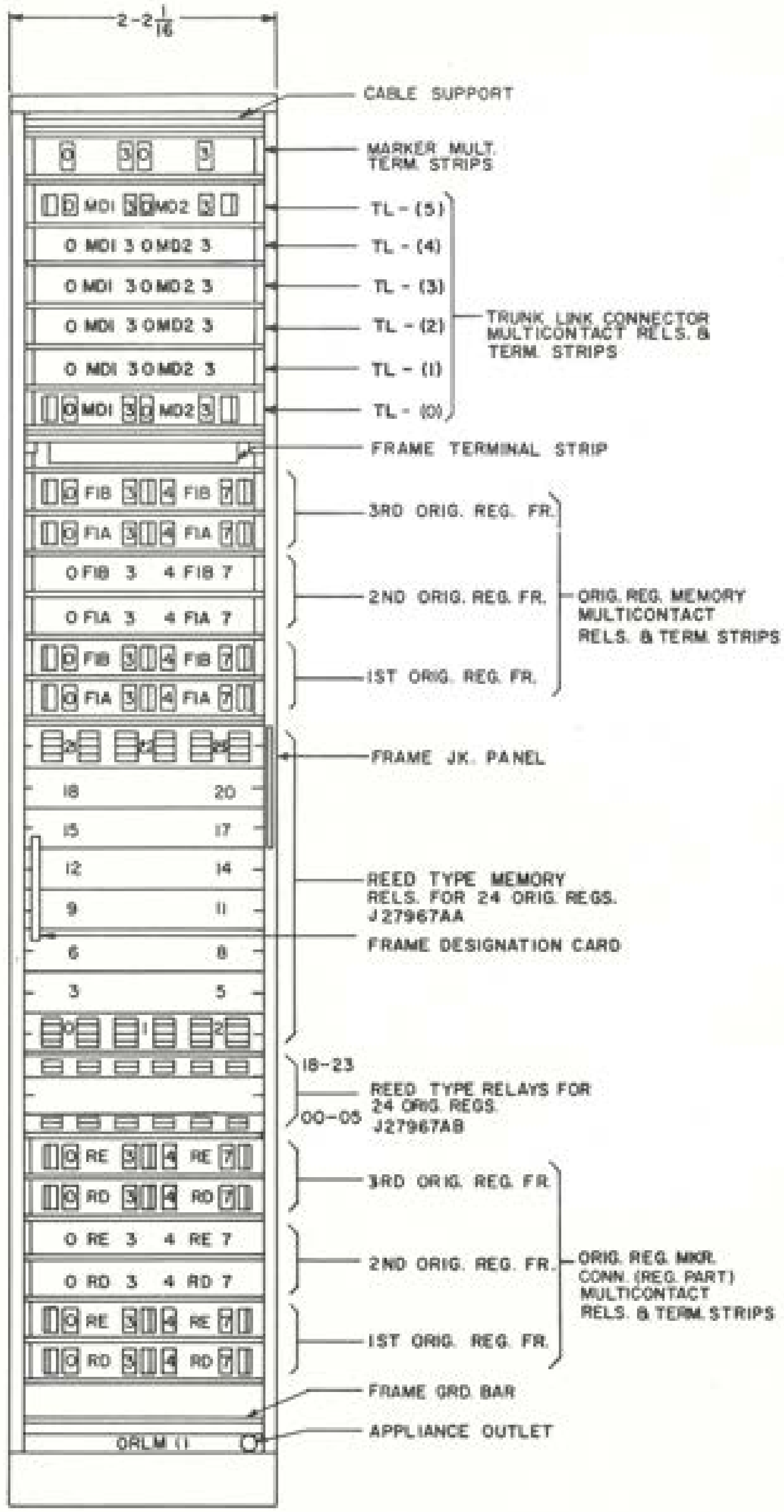
Wire-spring Relay Originating Register Frame

Figure 5-3



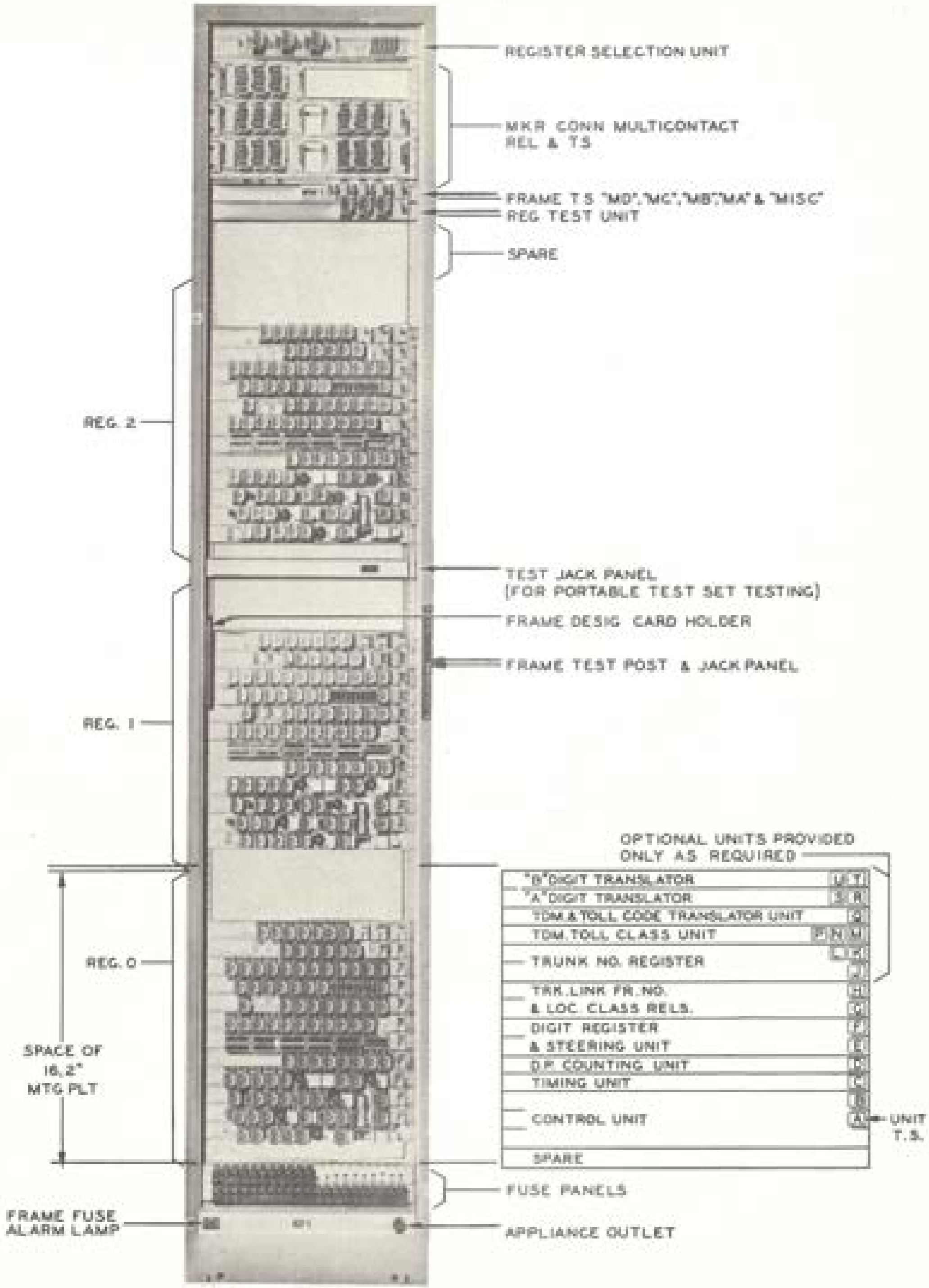
Pretranslator Frame

Figure 5-4



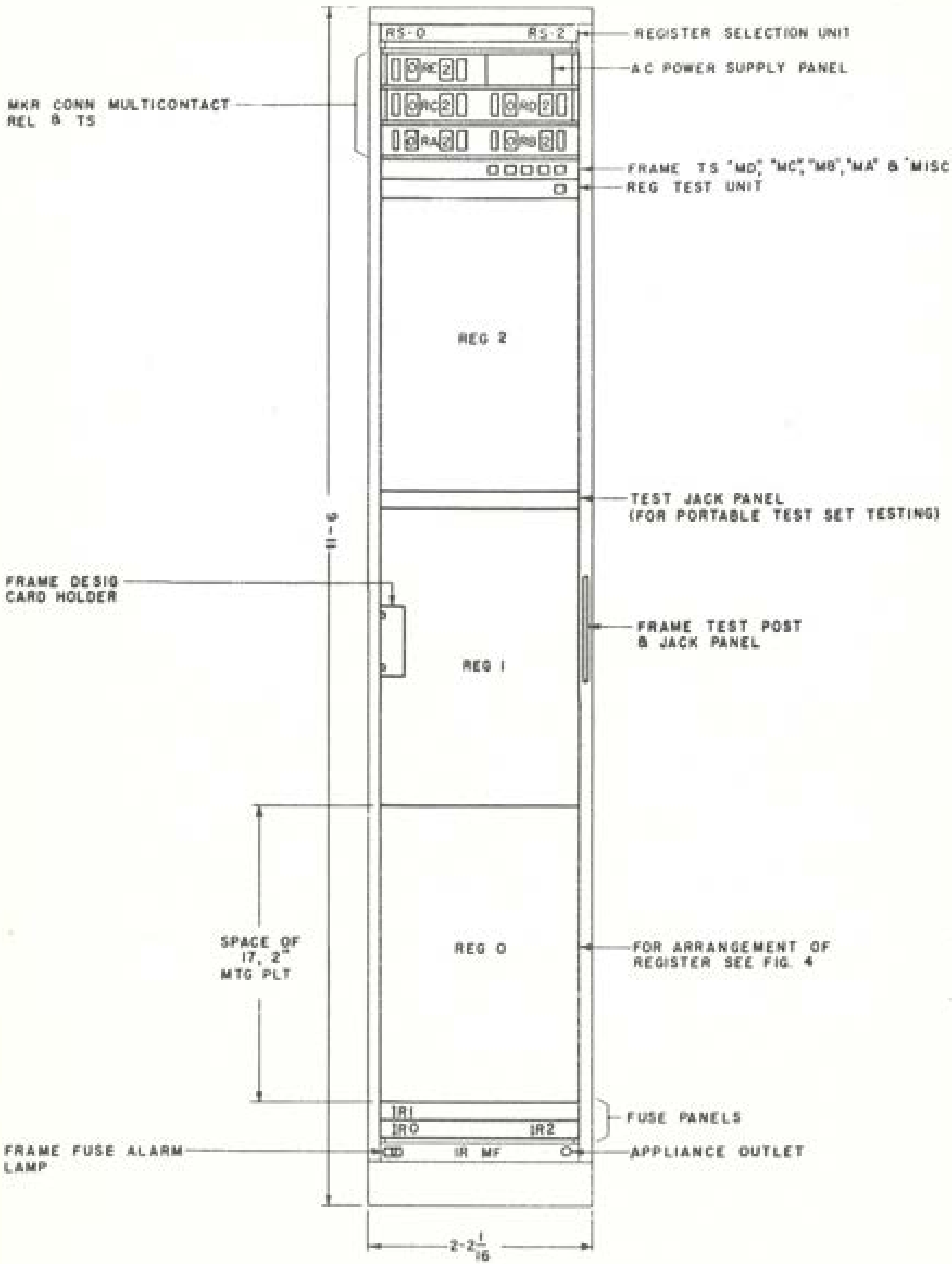
Originating Register Line Memory Frame

Figure 5-5



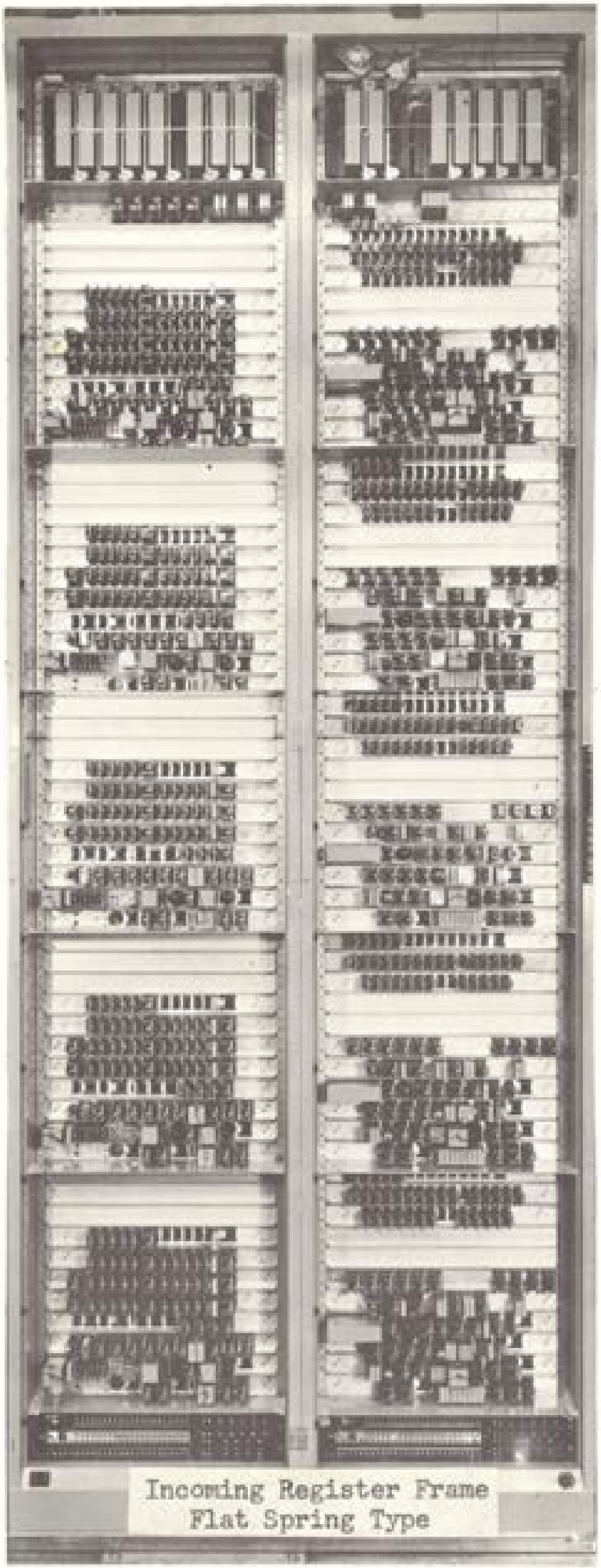
Incoming Register Frame
For Dial Pulse registers

Figure 5-6



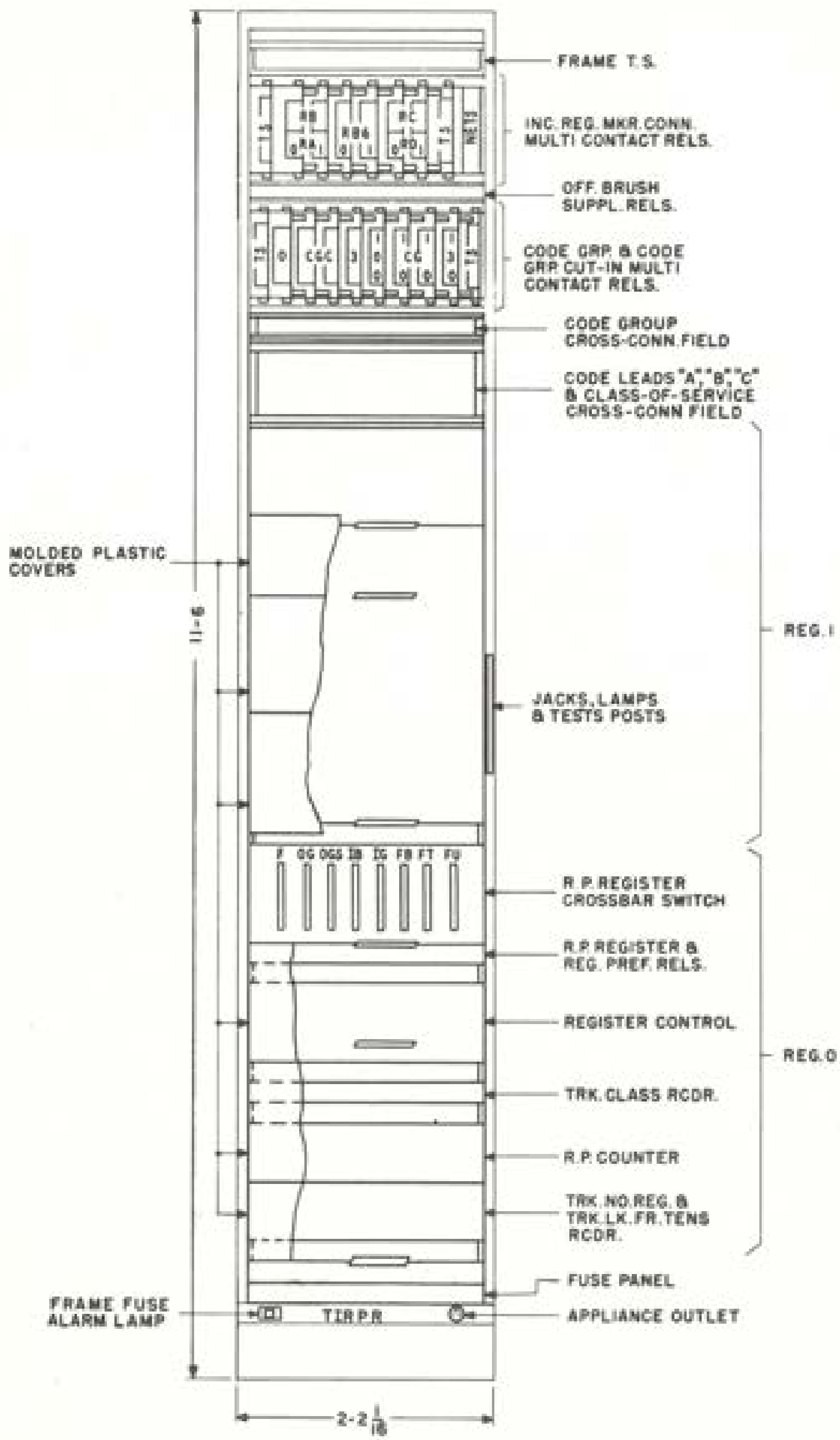
INCOMING MULTIFREQUENCY
REGISTER FRAME

Figure 5-7



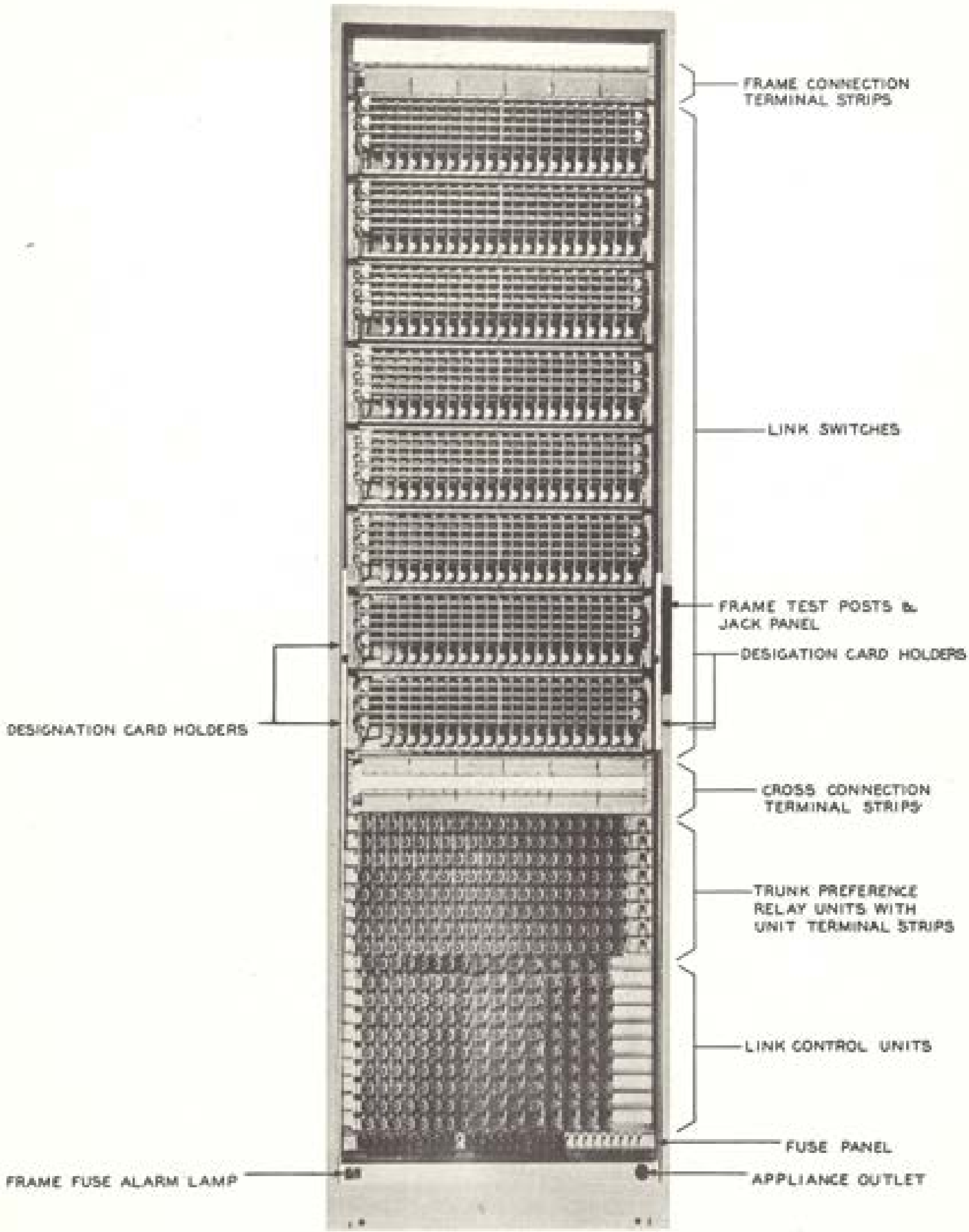
Incoming Register Frame
Flat Spring Type

Figure 5-8



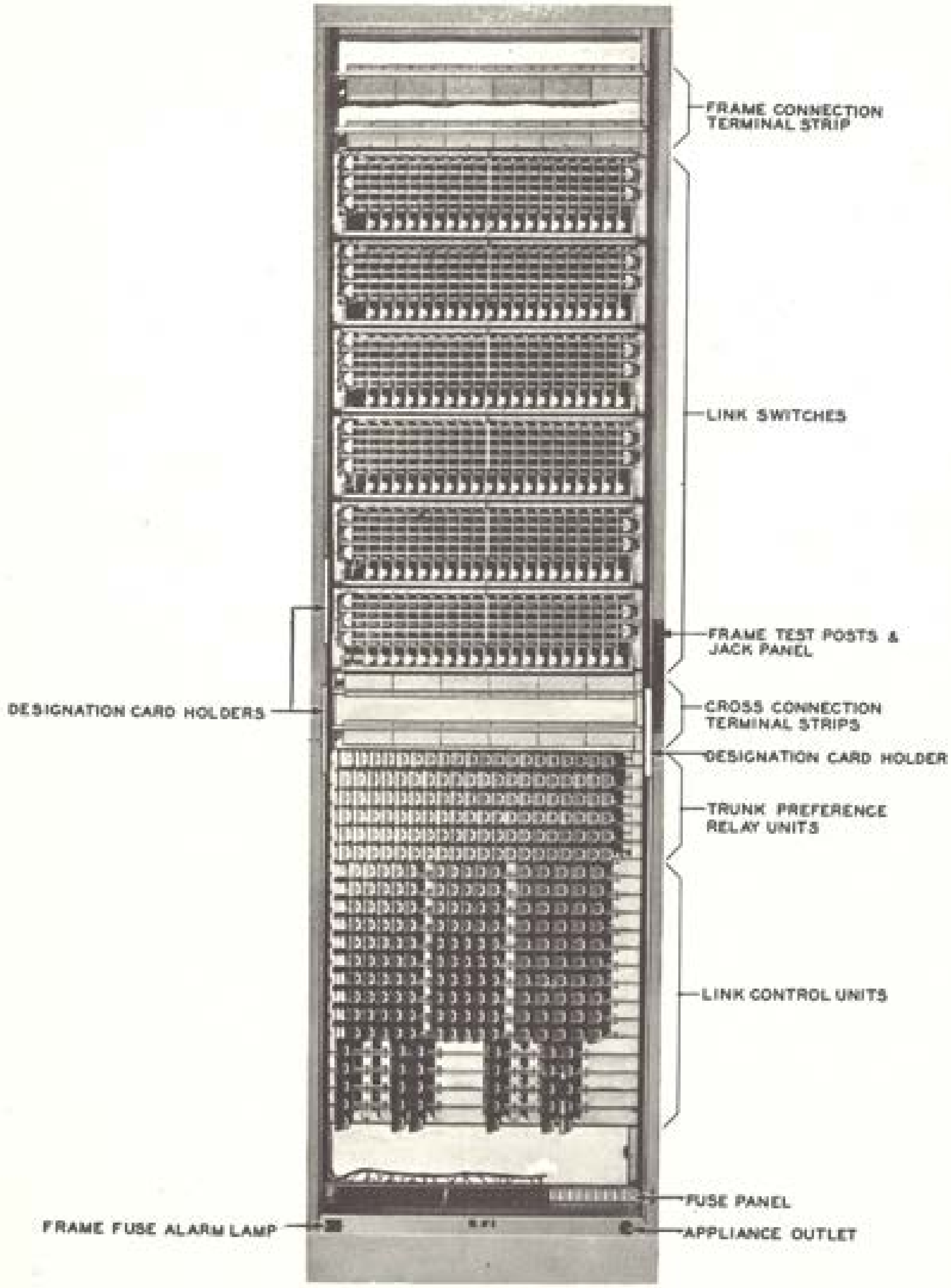
Tandem Incoming RP Register Frame -

Figure 5-9



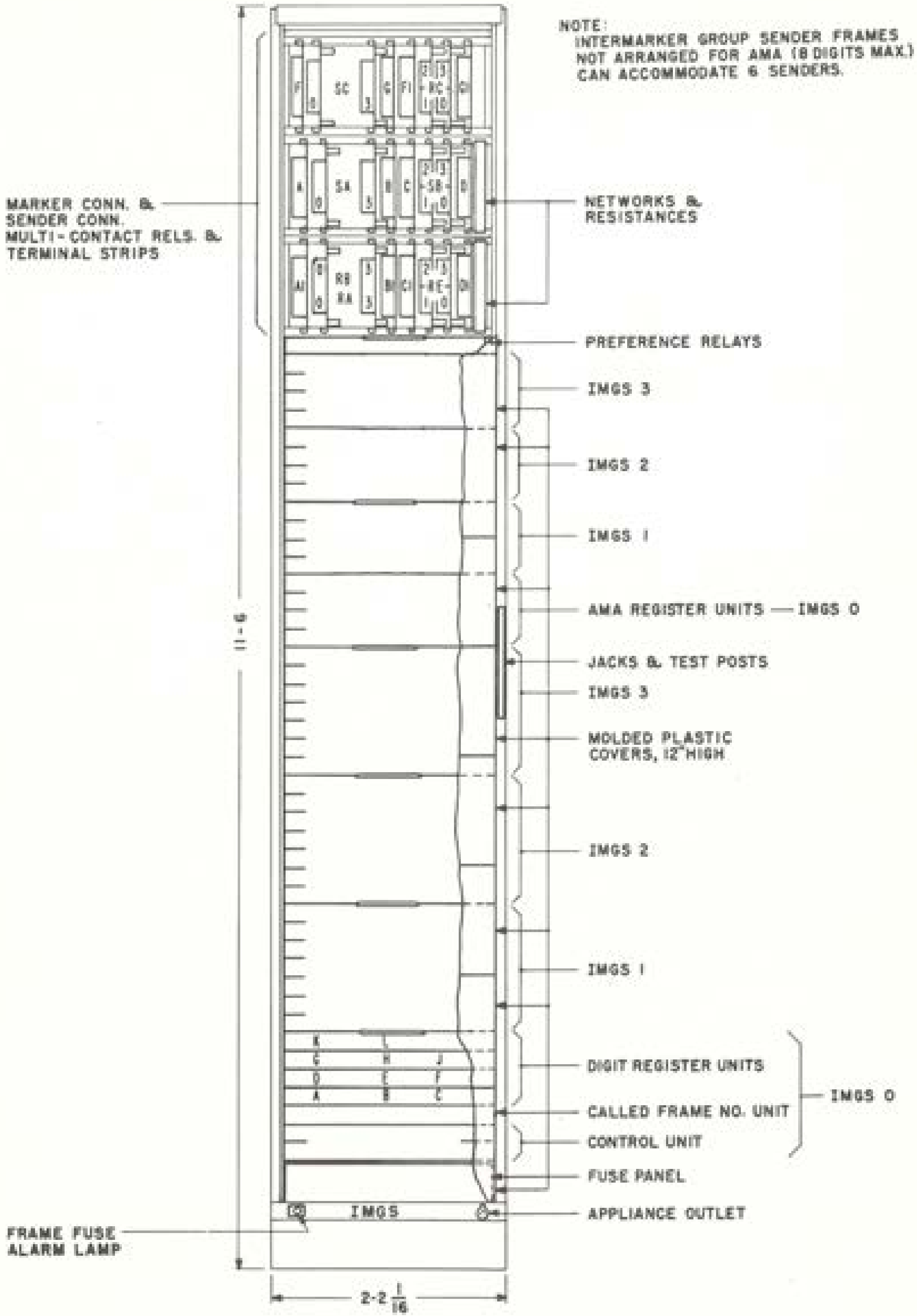
Wire Spring
Incoming Register Link Frame
Non-By-Link

Figure 5-10



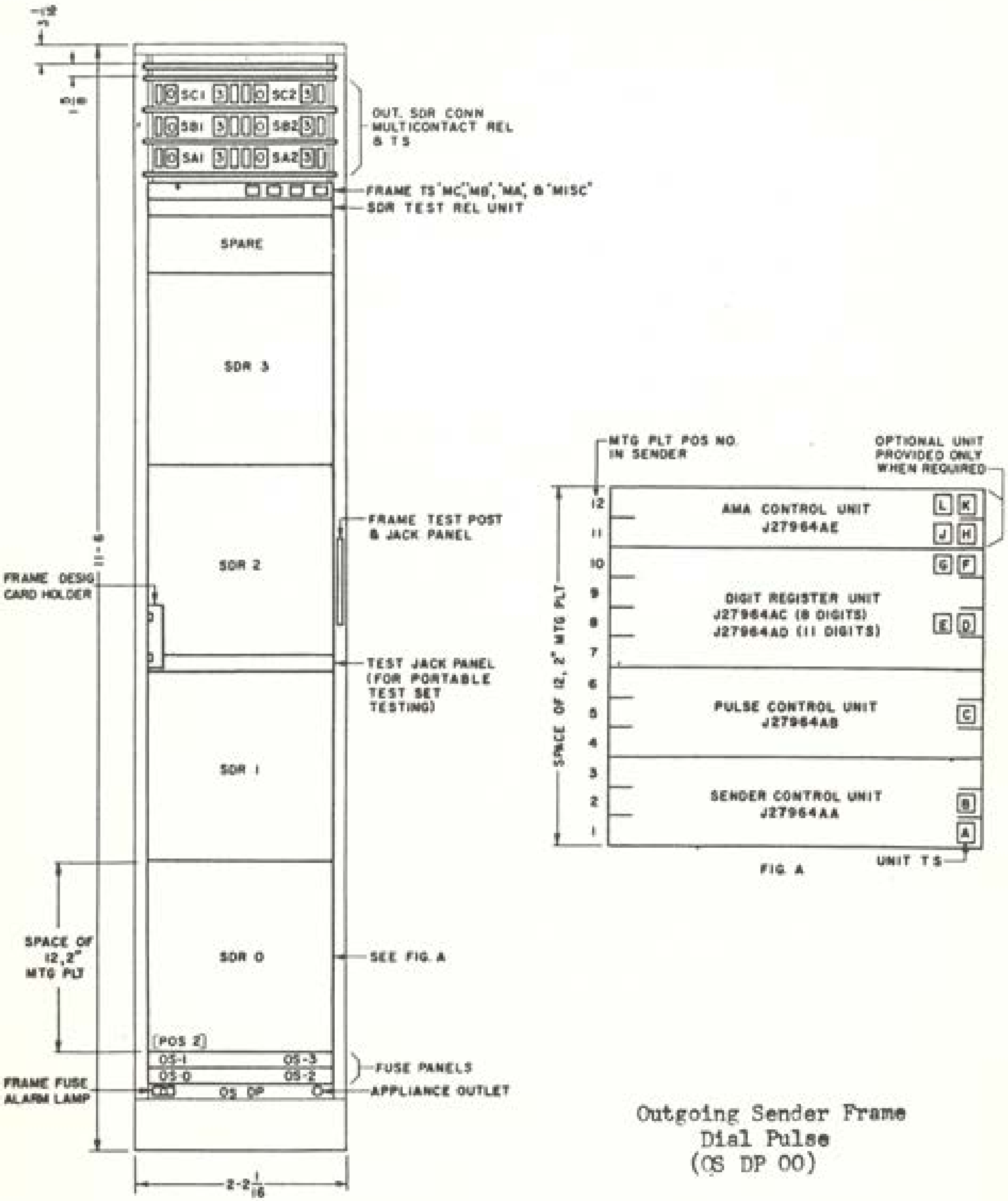
Wire Spring
Incoming Register Link Frame
By-Link

Figure 5-11



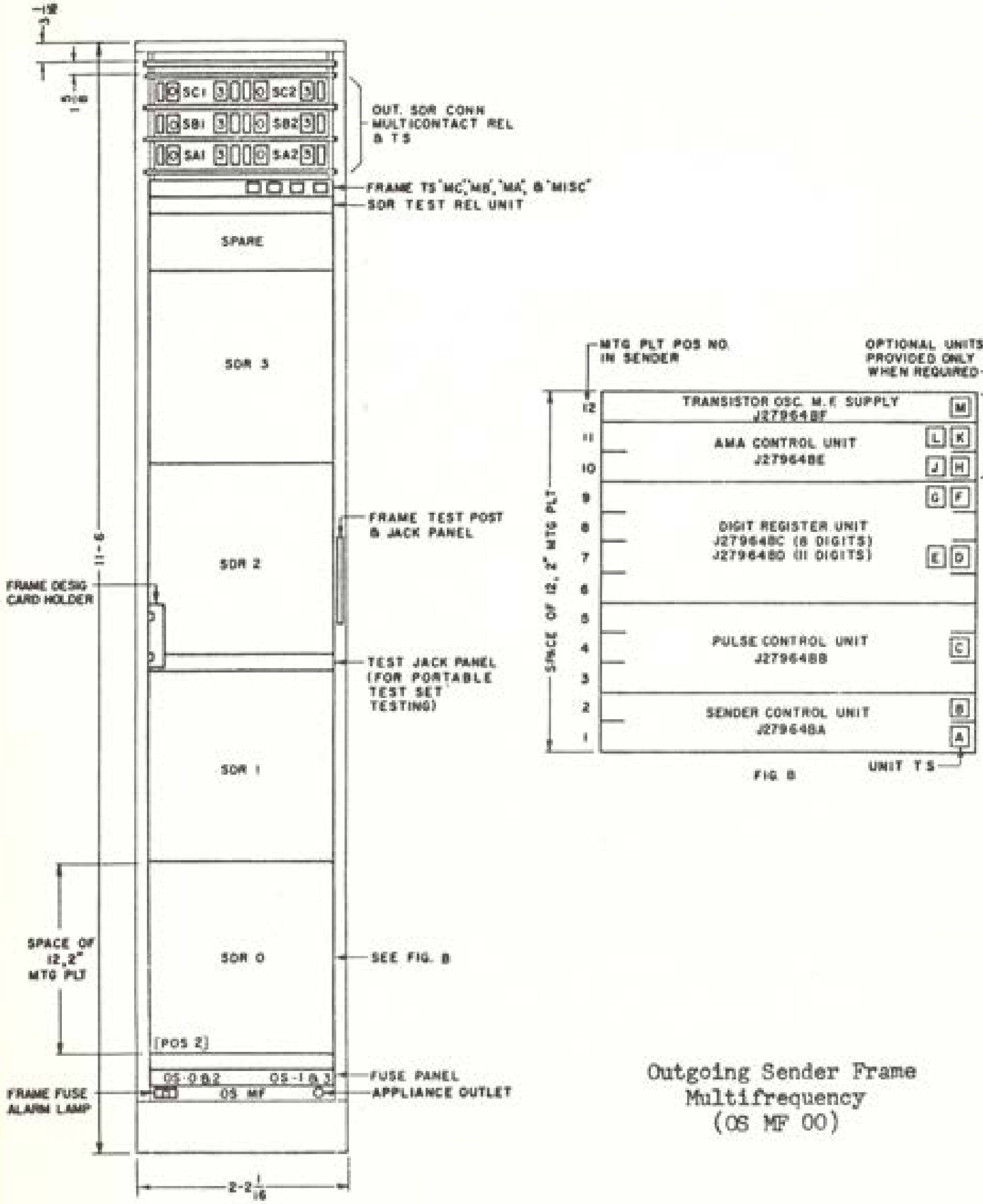
Intermarker Group Sender Frame

Figure 5-12



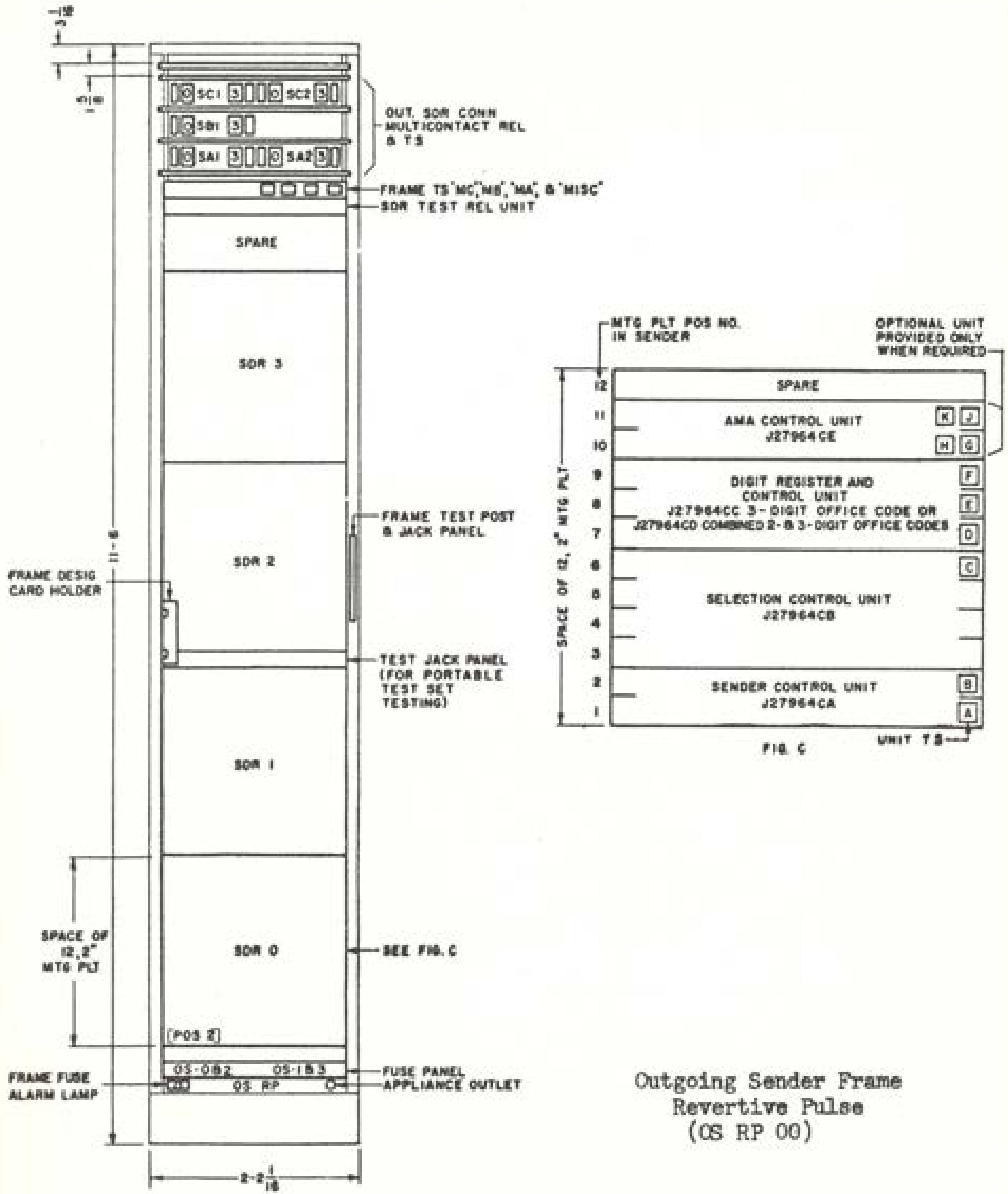
Outgoing Sender Frame
Dial Pulse
(OS DP 00)

Figure 5-13



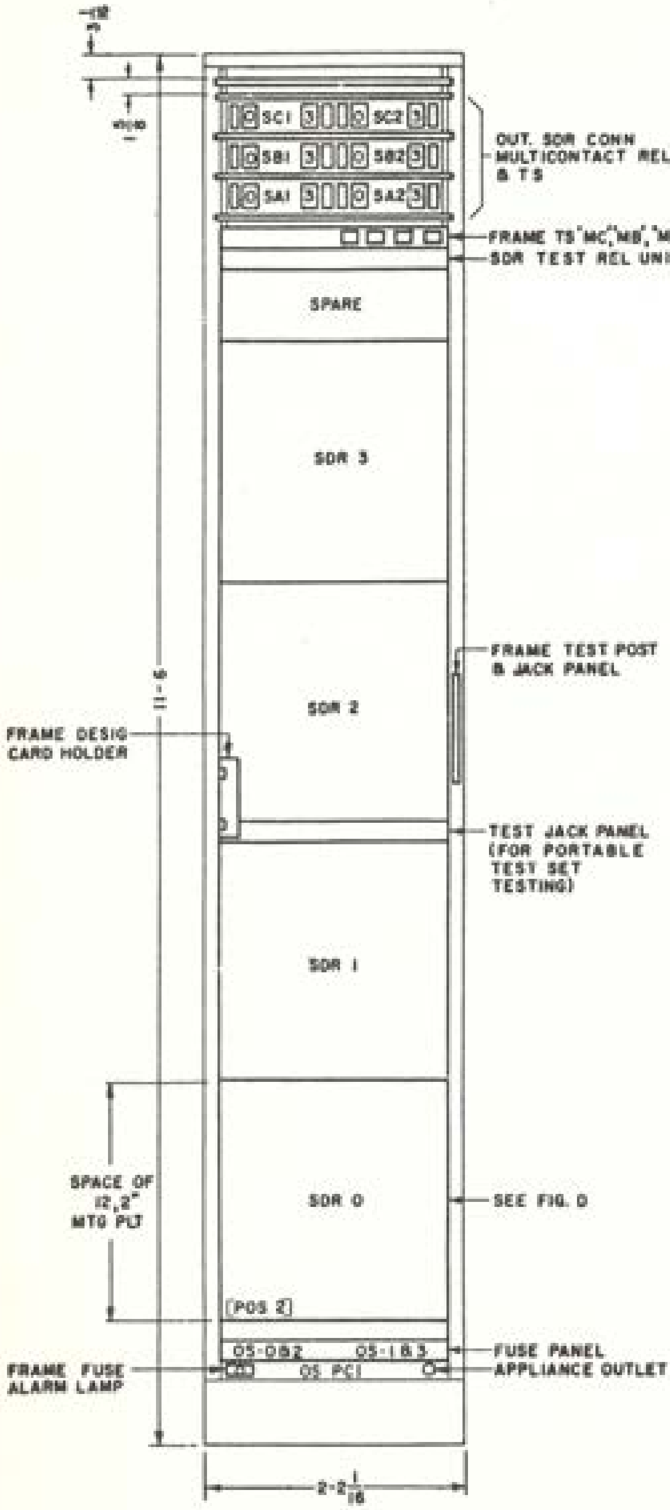
Outgoing Sender Frame
Multifrequency
(OS MF 00)

Figure 5-14



Outgoing Sender Frame
Revertive Pulse
(OS RP 00)

Figure 5-15



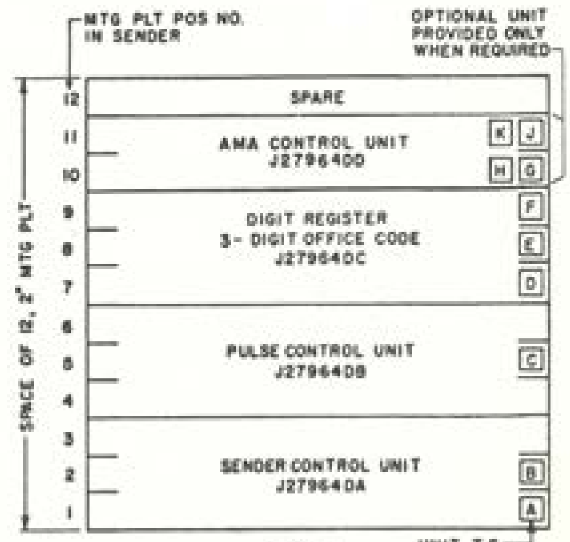
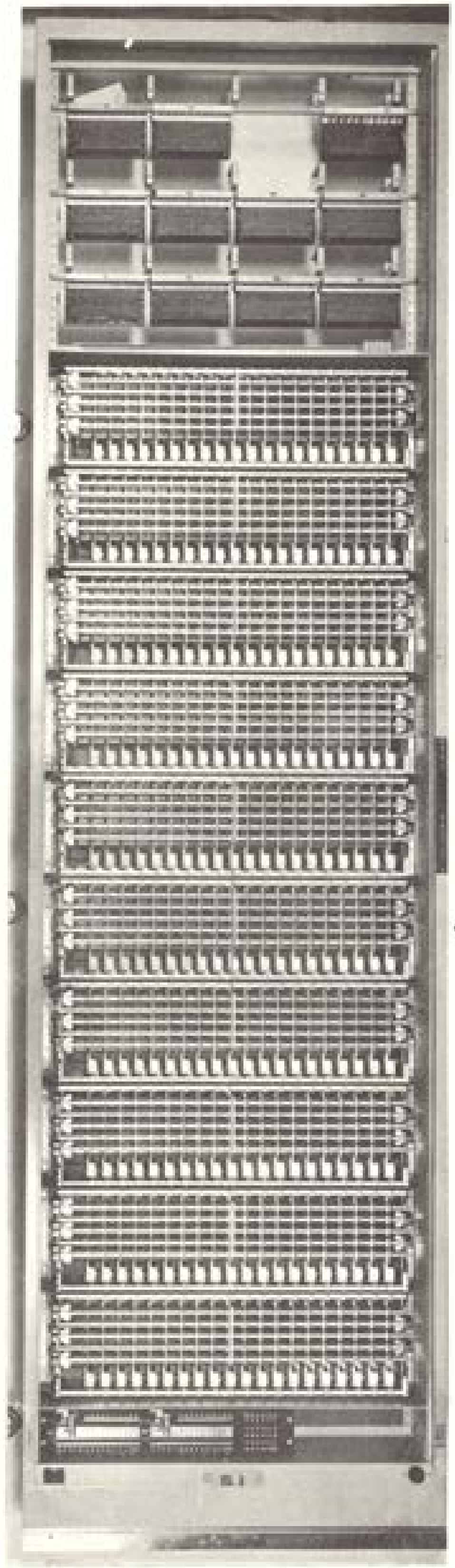


FIG. D

Outgoing Sender Frame
Panel Call Indicator
(OS PCI 00)

Figure 5-16

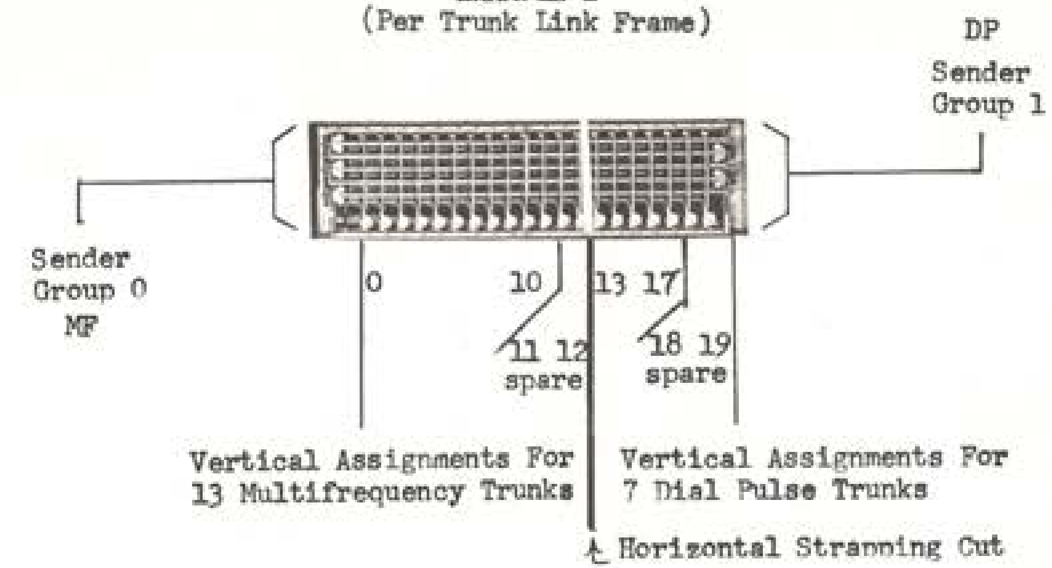


One to Six Crossbar Switches Assigned For Each Trunk Link Frame

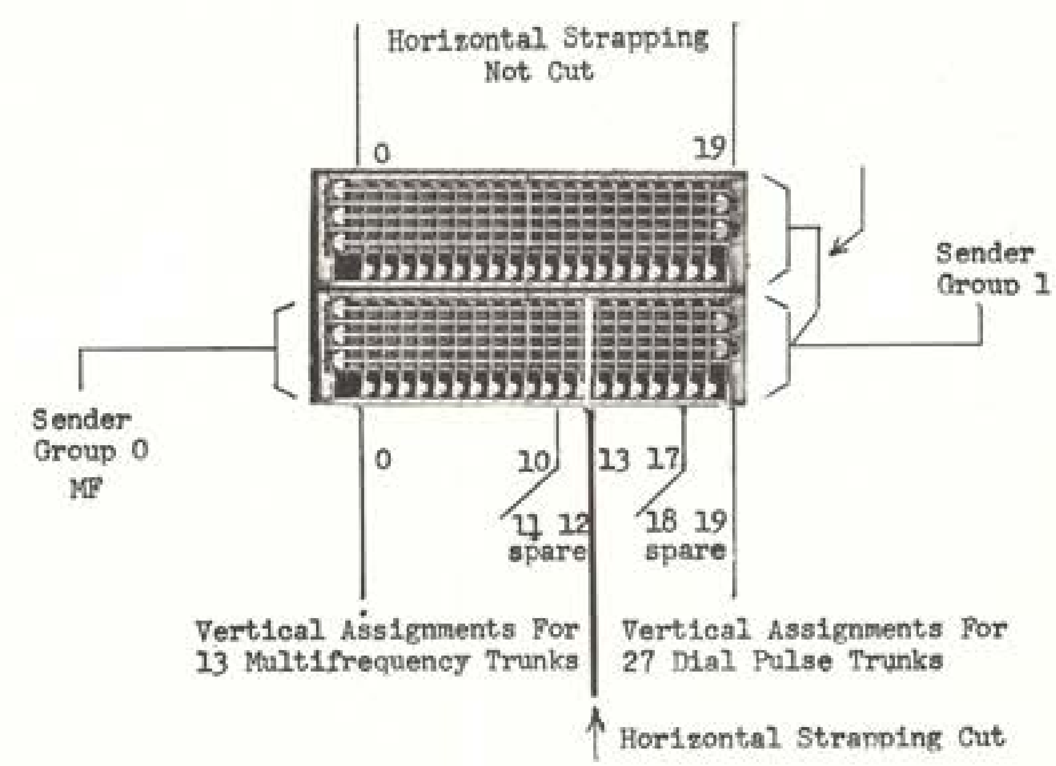
Outgoing Sender Link Frame

Figure 5-17

EXAMPLE 1
(Per Trunk Link Frame)



EXAMPLE 2
(Per Trunk Link Frame)

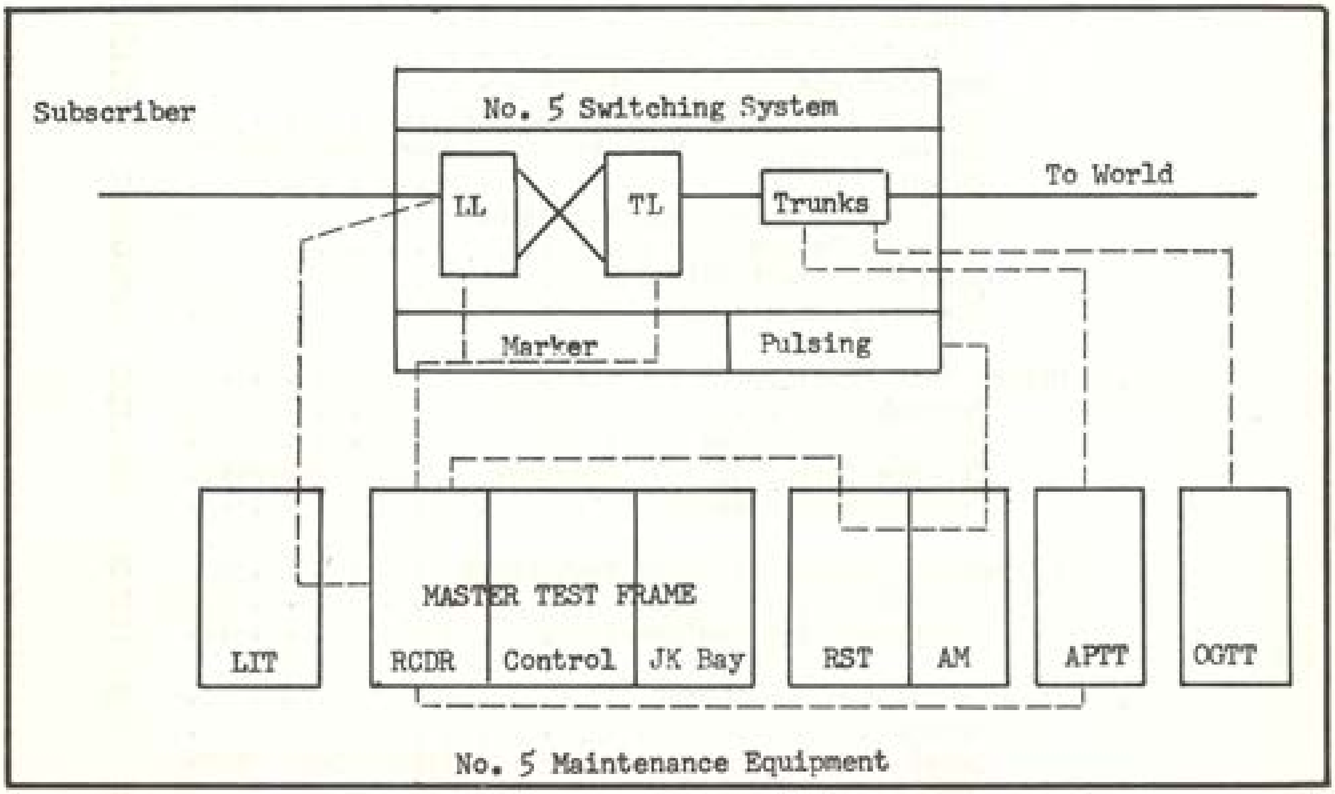


Trunk and Sender Assignment
Outgoing Sender Link Frame

Figure 5-18

SECTION VI

MAINTENANCE FACILITIES



<u>Reference and Credits</u> -

Maintenance Facilities For The No. 5 Crossbar System -
O. H. Williford - BLR 7-50

Alarm System For No. 5 Crossbar - C. E. Germanton - BLR 8-49

Interoffice Transfer of Alarms In No. 5 Crossbar -
C. E. Germanton - BLR 8-49

Bell System Practices - Equipment Engineering -

No. 5 Crossbar - Master Test Frame - J23252 iss. 9
No. 5 Crossbar - Automatic Progression Trunk Test Frame -
J23450 iss. 1
No. 5 Crossbar - Line Insulation Test Frame - J23650 iss. 2
No. 5 Crossbar - Alarm Equipment - J28353 iss. 4
Common Systems - Manual Outgoing Trunk Test Frame - J98501 iss. 4

SECTION VI - MAINTENANCE FACILITIES

FIGURES

SECTION VI

MAINTENANCE FACILITIES

A. MASTER TEST FRAME

General

In a No. 5 central office, practically all the controls for maintenance equipment are concentrated in one maintenance center called the master test frame. The equipment includes primarily a trouble recorder, a master test circuit, and a jack bay. In addition, there is available on an optional basis an automatic monitor circuit for testing pulsing equipment. Here also are means for extending the alarms to a distant office during unattended periods.

The trouble recorder functions automatically to keep a punched-card record of troubles that occur on service calls, both for the major part of the central office equipment and for the associated outside cable plant as well. See Figure 6-21.

The master test circuit provides for simulating service calls under controlled conditions. This aids the maintenance personnel in the final diagnosis of an indicated trouble condition, and also permits insurance tests to be made of those parts of the central office equipment that do not have access to the trouble recorder. It also permits tests to be made of subscribers' line and outgoing trunk conductors, and associated incoming trunk circuits in distant offices. This includes a rapid test for continuity and polarity of out-going trunks.

The automatic monitor checks on a sampling basis the performances of the pulse-receiving equipment of all register circuits, and the pulse-sending equipment of all senders, and causes the trouble recorder to make records of irregularities disclosed.

The alarm extension facilities can keep an attendant at a remote central point informed of the occurrence of each trouble, and indicate to him its classification as to urgency of corrective action.

Automatic recording of trouble is aided by the nature of the No. 5 system wherein markers become associated with all major circuits in the process of establishing connections. Self-checking features, which are basic elements of markers, also check the associated circuits, and where faults are detected, they are recorded. Markers become associated with line circuits for originating and terminating calls when checks for continuity and the absence of false ground are made, and through associated senders on outgoing calls they receive indications of open outgoing trunks. Such failures are recorded on the trouble recorder when encountered. Under key control, the trouble recorder may also record the identity of lines on which permanent signals occur.

The automatic monitor is provided to disclose irregularities in the pulsing features of registers and senders. Its circuit consists essentially of pulse-receiving equipment and two sets of digit recording relays. It associates itself automatically with registers on service calls and records on one set of recording relays the digits pulsed into the register by the subscriber, and on the other set, the digits passed from the register to the marker. It similarly associates itself with senders, and on one set of recording relays records the digits sent to the sender by the marker, and on the other set, the digits pulsed out by the sender. With both senders and registers, after pulsing is completed, the two sets of monitor recording relays are compared, and if mismatch occurs, the trouble recorder is caused to make a record of the details of the call. This record includes the identity of the associated line or trunk, since some types of failure might be due to faulty line or trunk conditions. One monitor circuit cannot, of course, monitor all calls, but it works continuously, and over a period checks a substantial percentage of the calls each register or sender handles.

The No. 5 system is designed to permit a degree of unattended operation and therefore, it is expected that there will be scheduled periods when an office is attended and others when it is not. Since the trouble recorder is automatic, it will record troubles which occur while the office is unattended as well as while it is attended. Also, during the unattended periods, alarms will be transferred to an attended office, and the severity codes available permit the nature and seriousness of the trouble to be readily appraised. A repair man would at once be dispatched to the unattended office should any serious trouble arise, but normally the troubles will not be of a nature to require immediate attention.

When the maintenance force returns to the office at the next maintenance period, the punched cards stored in the trouble recorder give details on the troubles that have arisen, and thus they can readily be located and remedied. For this purpose the master test circuit is available. Its control panels carry keys and push buttons to permit the markers, registers, senders, and trunks to be selected as desired for a test call, and lamps on the control panel indicate the progress of the call. The automatic monitor can also function as a test circuit, and will be called in by the master test circuit in testing registers and senders. Troubles occurring in the major circuits while under test will be registered on the trouble recorder. The trouble recorder may also be controlled to give a record of the establishment of test calls which complete satisfactorily to supplement lamp signals. Start and release control of this master test circuit can be extended to any point in the office where a maintenance man may wish to observe the performance of the equipment under these conditions.

While the office is attended, the master test frame is the observation and control point for the office. Here progress lamps display continuously the flow of traffic through the office, and an experienced man can often tell by the pattern of these lamp flashes in space and time whether or not all is well in the office. Audible and visual alarms will indicate the occurrence of irregular conditions in either the inside or outside plant under operating conditions. Individual circuit make-busy jacks are also concentrated on the jack bay, so that circuits with indicated troubles can be quickly isolated from service. Access by the master test circuit to circuits plugged busy is not prevented.

Both the trouble recorder and master test circuit are designed for use with automatic message accounting equipment where this is provided. It is necessary only to add a small relay unit to the master test circuit to adapt a master test frame for automatic message accounting maintenance. The trouble recorder is also designed for automatic testing of subscriber lines for low insulation resistance. Subscriber lines can be tested automatically when desired by the line insulation test frame, and the trouble recorder will record the identity of lines found to have less than an established minimum insulation resistance.

The possibility of unattended operation for extended periods of time lies in no small measure in the many operating safeguards that have been built into this system. The extensive use of second-trial and alternative-choice features prevents localized troubles from interfering with the completion of calls through the office, and circuits have been designed to prevent the pyramiding of trouble that has sometimes occurred under overloads in previous switching systems. These designs include a more liberal provision of timing intervals in the markers. This permits timing the switching functions in smaller increments, thus providing less circuit delay when failure is encountered, and advance by timeout is required. Every precaution has been taken to localize trouble when it does occur. The more extensive use of double contacts, the elimination of relay types and contact combinations that have required abnormal maintenance in previous experience, as well as a more liberal use of contact protection, greatly contribute to the freedom from trouble in the No. 5 office.

Recorder Bay (Figure 6-1)

The recorder bay is equipped with the trouble recording perforator, associated relay unit, the plant register unit, a fuse panel, and frame terminal strips. The perforator is mounted on a plug-in basis by means of ten 20-conductor plugs for control leads and one power supply plug for 48 volt DC. The plant registers are mounted directly above the perforator so they may be read from the floor without the use of a ladder. A MF receiving unit and a MF receiver connector unit may also be mounted on this frame, if specified for test set testing of MF senders in conjunction with the sender test units which are mounted on the control bays.

Two panels containing apparatus for the line load control and dial tone speed indicating circuits may be mounted above the plant register unit.

The general functions are described in the following paragraphs:

Recorder Bay Circuits

(a) The trouble recorder control and test circuit, comprised of one J-coded unit on this bay with its associated keys and lamps on the control bay, provides facilities for controlling the operation of and testing the card perforator. As previously mentioned, all trouble and test records are automatically recorded on punched cards by means of a perforator.

This perforator is capable of punching 1080 indications on a printed trouble record card. The 1080 positions on this card are adequately designated to indicate to a maintenance man the significance of a perforation in one of these positions. Each trouble ticket contains several perforations, indicating the particular equipment in trouble and the associated frames and circuits involved in the call up to the time the trouble occurred. In AMA offices, the time the trouble occurred (in day of the month, hour, and minute) is also indicated. Since the perforator punches a maximum of 120 holes at one time, it requires nine steps to scan the entire 1080 indications. Of course, the card is not necessarily perforated in each of these steps. Markers, transverters, pretranslators, and AMA recorders gain access to the perforator through the MTF connector.

The trouble recorder control and test circuit is connected between the MTF connector and the perforator. Cross-connection facilities are provided on the trouble recorder control and test unit to limit the number of troubles the perforator will accept within a given time interval.

(b) The plant register circuit provides registers and counters which furnish the plant maintenance force with an accumulative record of the number of troubles and test calls to which the central office equipment is subjected. The equipment, consisting of one J-coded unit, is mounted on this bay. Registers are furnished to indicate the number of:

(1) Entries recorded on the trouble perforator.
(2) Troubles detected by each marker.
(3) Stuck senders.
(4) Calls observed by the automatic monitor with a separate register for incoming, outgoing, and originating calls.
(5) Failures detected by the automatic monitor with a separate register for incoming, outgoing, and originating calls.
(6) Marker second trial failures.
(7) Transverter second trial failures.
(8) Marker ground test failures.
(9) Troubles detected in AMA equipment.
(10) Coin supervisory time-outs.
(11) Pretranslator first and second trial failures.
(12) Incoming register link release failures.
(13) Troubles detected by the line insulation test circuit.

(c) Line load control is an arrangement for insuring service on certain essential lines by denying originating service temporarily to other lines during an overload. This is accomplished by the operation and release of line load control relays, in all line link frames, under control of the line load control circuit. The dial tone speed indicating circuit is for use in giving a visual indication as to the number of subscribers originating calls which must wait more than three seconds before receiving dial tone. As a further aid in administering the line load control feature, an office load meter is provided which will indicate approximately the total office 48-volt current drain and therefore give an indication of the total traffic load. The key and lamp equipment for these circuits is located on two apparatus mounting panels on this frame. The first panel contains the office load meter and keys and lamps for both circuits, the second is required for line load control in offices with over 40 line link frames. All other equipment is miscellaneous relay rack mounted.

(d) The function of the MF receiver is to convert incoming a-c signals in the voice range into d-c signals on which the associated circuit operates. The MF receiver unit on this frame is required in conjunction with the sender test circuit when that circuit functions with MF senders.

Control Bays (Figure 6-1)

The control equipment is mounted on a double-bay frame. Each bay is equipped with jack, key, and lamp panels, a writing shelf, frame terminal strips, and various relay units. A fuse panel is provided in the right bay. The relay units for the trunk test and the optional units for test set testing of registers and senders are located in the left bay and those for the master test control, voltmeter test, and telephone circuits in the right bay. All of the control keys and lamps for these circuits and for automatic montior, register, and sender test, auxiliary signal, incoming register test, sender test, and trouble recorder circuits are located in the jack, key, and lamp panels. The stile casings on these panels are equipped with engraved designation strips so that keys and lamps associated with any particular circuit may be readily identified.

Control Frame Circuit

(a) The master test control circuit.

1) To make tests of the marker, transverter, and connecting circuits.

2) To control the setting up of tests to be made by the automatic monitor, the sender test circuit, and the trunk test circuit.

3) To verify line cross connections in the number group and AMA translator.

4) To set up connections to any line for voltmeter tests.

5) To test pretranslators and intermarker group senders.

(b) The MTF trunk test circuit, in connection with the master test control circuit, may be used for testing practically all kinds of trunks that have trunk link frame appearances and for making certain tests on coin supervisory circuits. The relay equipment, consisting of three units, is mounted on the left bay, and the keys and lamps are located on the right bay. Trunk selection and testing is accomplished on a manual basis. The sequence of tests is controlled by the operation of keys, and the success or failure of the trunk circuit to meet the test is determined by the testman observing lamps and listening in the receiver of the MTF telephone circuit.

This circuit may also be used in conjunction with the portable register test set, the master test control circuit, the trouble recorder circuit, a telephone set, and the precision pulse generating test set to test DP originating registers. In this application, a 3-conductor belt line connected to the trunk test circuit has jack appearance at this frame and at each of the originating register frames. The register test may be connected to the trunk test circuit at any of the jack appearances by means of a 3-conductor plug-ended cord which is provided with the test set.

(c) The test circuit for incoming registers and CAMA senders is used in conjunction with the portable register and CAMA sender test set, the trouble recorder, the precision pulse generator test set, and a telephone test set to test DP, RP, and MF incoming registers. The same combination of circuits, less the precision pulse generator, is used to test central B incoming registers.

This circuit is also used in conjunction with the master test control circuit and the portable register and CAMA sender test set to test CAMA senders. Three units associated with this circuit are mounted on the left bay, and four rotary-type switches, for register selecting, are located on the right bay. The same register and CAMA sender test set is used for testing originating and incoming registers and CAMA senders. It is a portable set contained in a metal box which may be attached to the step of a rolling ladder. A multiconductor belt line connected to the test circuit for registers and CAMA senders has appearance at this frame and at each of the register and CAMA sender frames.

The register and CAMA sender test set may be connected to the test circuit for incoming registers and CAMA senders at any of the jack appearances by means of a multiconductor cord provided with the test set. Keys for controlling application of tests and lamps for indicating progress are located on the test set.

(d) The sender test circuit, under control of the portable sender test set and in conjunction with the master test control circuit, provides facilities which may be used to test features and operation of DP, RP, MF, and PCI senders. The relay equipment consists of eight units located on the left bay and one located on the recorder bay.

The sender test set is a portable set contained in a metal box which may be attached to a step of a rolling ladder. A multiconductor belt line connected to the sender test circuit has appearance at this frame and each of the sender frames. The sender test set may be connected to the sender test circuit at any of the jack appearances by means of multiconductor cords provided with the test set.

The master test control circuit is used to select the sender to be tested and the conditions required for test and progress are simulated principally by the manipulation of keys in the sender test set.

(e) The voltmeter test circuit is used primarily for applying various tests to subscriber lines and outgoing trunk conductors. The equipment, consisting of part of one unit and the associated keys and lamps, is located on the right bay.

This circuit also provides facilities for applying howler tone to subscriber lines in an off-hook condition. It gains access to these lines and trunk conductors by means of patching cords plugged into test jacks of permanent signal holding trunks, common overflow trunks, outgoing trunks, and plugging-up lines.

The master test control line test and trunk test circuits have direct access to the voltmeter test unit so that its facilities are available for tests originated by these circuits.

(f) The telephone key and lamp circuit provides telephone facilities between the test frame and various other points in the same and distant offices. Keys, lamps, and part of one unit, comprising the equipment, are located on the right bay. This circuit also enables the testman to listen on trunk connections set up through the trunk test circuit and on subscriber lines and other circuits connected to the voltmeter test circuit through the master test control line test circuit.

Keys for connecting the telephone circuit to various tie lines, trunks, and local station lines can be furnished with or without the holding feature, as required. Provision is made for 11 of these keys, in addition to one always furnished, for connecting the telephone to the local frame line circuit. One tie line or trunk requiring the holding feature or two not requiring the holding feature can be connected to each key.

(g) The auxiliary signal circuit provides an audible signal at this frame to indicate an incoming call on one of the tie lines or trunks terminating on the MTF control bays. The signal can be cut off by the operation of a cutoff

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key or tied into the office alarm system to bring in a minor alarm by the operation of a night alarm key. The equipment, consisting of one mounting plate of relays, is mounted on a miscellaneous relay rack frame, and the associated bell or buzzer and keys are located on this frame.

(h) The line insulation test control circuit provides a lamp at the master test control bay which, when lighted, indicates to the maintenance force that line insulation testing is in progress. Under this condition, test calls which use the no-test connector should be avoided as they may cause the line insulation test control circuit to time out.

(i) This frame also contains jack, lamp, key, and switch equipment only for the following circuits.

(1) The MTF jack, lamp, and key circuit.
(2) The trouble recorder control and test circuit.
(3) The automatic monitor, register, and sender test circuit.

(j) The test circuit is arranged to function with the automatic monitor, register, and sender test circuit in the testing of the ANI features of MF senders. In addition, the test circuit is arranged to test ANI transverters and perform line verification using ANI transverters.

Jack Bay (Figure 6-1)

The jack bay is equipped with two jack, key, and lamp panels; ten mounting plates of relay equipment for the jack, lamp, and key circuit and the continuity and reversal test circuit; two fuse panels; and five frame terminal strips.

Jack Bay Circuits

(a) The MTF jack, lamp, and key circuit is actually a collection of miscellaneous test, make-busy jack, lamp, and control circuits. The equipment consists of two jack, lamp, and key panels, ten mounting plates of apparatus located on this frame, four strips of jacks, three strips of lamps, and one key located on the recorder bay. This circuit, by the use of progress, identification, busy, alarm, and guard lamps, provides a visual indication of the operating condition of the office showing equipment in use or in trouble at any instant. In addition, make-busy jacks are provided here for removing from service practically all major circuits in the office.

(b) The continuity and reversal test circuit provides a means for making rapid tests of continuity and polarity on the tip and ring leads of idle outgoing trunks which have their test and make-busy appearances on this frame. This circuit, consisting of two relays, a buzzer, and lamp, is connected to the trunk conductors on a patch basis by means of the outgoing trunk test jacks. It functions with any standard interoffice outgoing trunk, with the exception of special service and recording completing trunks.

Automatic Monitor Bay (Figure 6-2)

The automatic monitor bay is equipped with various relay units, several multicontact relays, a fuse panel, and frame terminal strips. While the relay units are used principally for monitoring of senders and registers, they are also used in conjunction with the units on the register and sender test bays for test purposes.

Register and Sender Test Bays (Figure 6-2)

The register and sender test bays are equipped with various relay units, several multicontact relays, a fuse panel, frame terminal strips, and one 6- by 80-inch and one 20- by 80-inch terminal cross connecting type terminal strip.

Auxiliary Register and Sender Test Bay (Figure 6-2)

The auxiliary register and sender test bay is equipped with various relay units, a fuse panel, frame terminal strips, and is used in offices with RP senders and registers or PCI senders.

Automatic Monitor, Register, and Sender Test Frame Circuit

(a) The automatic monitor is used to check the pulsing performance of incoming and originating registers and outgoing senders. It is part of the automatic monitor, register, and sender test circuit. These functions have been combined into one circuit in order to avoid duplication of equipment, as certain features use equipment common to both functions.

The automatic monitor frame contains 25 units which function with the monitor. The associated keys and lamps are located on the control bay. This circuit connects at random to in-service registers and senders and compares the numbers received by these circuits with the numbers transmitted by them. If these numbers do not agree, a trouble card is perforated identifying the circuit in trouble and giving other information relative to the trouble.

A ten-step allotter circuit permits apportioning and monitoring among incoming and originating registers and outgoing senders in 10 per cent steps. These percentages may be readily varied by making simple cross-connection changes. If no call is received by the monitor for a period of one minute, the allotter advances to the next step. By the operation of certain keys, the monitor can be made to associate itself with only incoming registers, originating registers, or outgoing senders, or can be made to monitor exclusively on any one register or sender.

(b) The register and sender test portion of the automatic monitor, register, and sender test circuit is used for testing outgoing senders and originating and incoming registers, except revertive tandem incoming registers. The equipment consists of 30 units on the register and sender test bays and 17 additional units on the auxiliary register and sender test bay for testing revertive registers, senders, and PCI senders.

Associated keys and lamps are located on the control bay. With the aid of the master test control circuit, any particular sender or register can be selected and tested. Satisfactory completion of any test such as 2-party, coin, pulsing, AMA, etc., is indicated by an OK lamp. Failure of a test lights a trouble lamp and, where desirable, causes a trouble card to be perforated. Progress lamps are also provided to help locate the trouble.

(c) The MF receiver on the frame is used by the automatic monitor, register, and sender test circuit when that circuit functions with MF registers or senders.

Line Verification Test Equipment

(a) The line verification test equipment permits verification of cross connections associated with subscriber numbers on the number group frames, class-of-service cross connections on the line link frames, and the cross connections associated with line numbers on AMA translator frames. It duplicates but does not replace the line verification features of the master test control circuit. It is located separately to permit cross connections to be verified in connection with the completion of service orders without interfering with other uses of the MTF. The design provides for this equipment to function with one or two MTF and, therefore, tests can be made of cross connections located in one or two marker groups.

(b) The 48-volt battery and ground is furnished to the relay unit through a terminal strip at the top of the unit by means of loose wire from the relay rack fuse panel and ground bar. Battery and ground for the switch panel unit is furnished from the relay unit through the interunit terminal strips. Connections to associated circuits are made with switchboard cable via the MTF control bays except the 130 volt, "VG", and "PCT" leads which are cabled directly to the PRTD frame, AMA transverters, and traffic register cabinet, respectively.

When the switch panel unit is mounted on the relay rack with the relay unit, connections between these units are made by means of jumpers between the adjacent interunit terminal strips. When the switch panel unit is not located on the relay rack, switchboard cable is used instead of jumpers. When the switch panel unit is located on the growing end of the MDF, sufficient slack should be allowed and stored on the top of the MDF for future maximum frame extension.

(c) Marker and transverter line verification tests can be made separately or the circuit can automatically proceed to make a transverter line verification test following the completion of a satisfactory marker line verification test.

Results of the cross-connection tests are indicated by means of lamps. Under certain conditions, however, it may be found desirable to have a permanent record of a verification. For such cases, a feature is included which causes a trouble recorder card to be produced. The rotary switches on the switch panel unit provide means for registering the office designation, the subscriber number, the location of the line on the line link frame, the class of service, and the ringing combination assigned to the line.

The keys are provided for setting the circuit for selecting the marker group and the marker and transverter to be used for the tests, for registering the talking charge condition to be checked, for obtaining a trouble recorder card, and for starting and restoring the verification circuit.

Test Set Testing

In small No. 5 crossbar offices where there are only a few senders and registers it is not economically feasible to install the register and sender test bay, and the associated automatic monitor bay for testing these units. Testing is on a manual basis using portable test sets. A sender test set is available for testing senders. A register and CAMA sender test is used for testing incoming registers, originating registers and CAMA senders.

The Sender Test Set

The sender test set is a portable set used in conjunction with the sender test circuit, the master test control circuit, and a signal receiving circuit for testing dial pulse, revertive pulse, multifrequency pulse, and panel call indicator senders. It controls the test, indicates the progress of the test, and the number outpulsed by the sender. Two 20-conductor cords are furnished with the test set for connecting it to the sender test circuit. Jack appearances for cord connection are furnished on the master test frame control bay and on each of the sender frames having any of the senders listed above. The sender test set is contained in an aluminum case approximately 10 inches long, 8 inches wide, and 6 inches high with cover. Apparatus is mounted on a panel in the lower part of the test set case. The test set may be attached to a rolling ladder step by fastening it to the side of the ladder with a strap.

The Register and CAMA Sender Test Set

The register and CAMA sender test set is a portable set that may be used in conjunction with the incoming register test circuit, the trouble recorder, a telephone set; and the pulse generating test set for testing dial pulse, multifrequency pulse, and revertive pulse incoming registers. It may also be used in conjunction with the incoming register test circuit, a telephone set, and the trouble recorder for testing central B revertive incoming registers. One 20-conductor cord is furnished with the test set for connecting it to the incoming register test circuit for testing incoming registers. Twenty-conductor jack appearances for cord connection are furnished on the master test frame control bay and on each of the incoming register frames.

The register test set may also be used in conjunction with the trunk test circuit, the master test control circuit, the trouble recorder, a telephone set, and the pulse generating test set for testing dial pulse originating registers. One 3-conductor cord is furnished with the test set for connecting it to the trunk test circuit for testing originating registers. Three-conductor jack appearances for cord connection are furnished on the master test frame control bay and on each of the originating register frames.

The register test set is contained in an aluminum case approximately 12 inches long, 9 inches wide, and 7 inches high with cover. Apparatus is mounted on a panel and on an associated mounting plate; both are mounted in the lower part of the test set case. The test set may be attached to a rolling ladder step by fastening it to the side of the ladder with a strap.

B. OFFICE TEST FRAME

General

The Office Test frame has been developed as a substitute for the Master Test frame in smaller No. 5 crossbar offices. This double-bay frame together with the present standard jack, lamp and key circuit comprises the complete maintenance center. Not only have equipment and installation costs been significantly reduced through the use of this arrangement, but nearly one-half of the present maintenance center requirements for floor space have been saved.

As of this writing the Office Test frame is applied only in the 980 line package office. It will, however, be used in offices at least in the range of 500 to 3000 lines.

The initial planning in connection with the application of the office test frame in the 980 line package office has included arrangements to permit and facilitate an in-service transition to the Master Test frame should this be required because of growth conditions. The application of the Office Test frame will prove economical in any given office for a period as short as two years. Substantial savings will accrue for any interval longer than two years.

With the present design of the Office Test frame, its capacity is limited to 5-trunk link frames and two markers of each type, dial tone and completing. Provisions have been made for dial pulse and multifrequency (2 out of 6) signaling only. Test facilities are included for LAMA but not for ANI; however, the need for these test features is recognized and they will be made available at the earliest possible date. Features are included to adequately test a small toll center.

Equipment Features

The Office Test frame consists of two circuits, the Trouble Indicator and Connector circuit and the Test circuit, mounted on a standard 11' - 6" sheet metal, box-shape frame (see Figures 6-3). The frame has a total lateral width of 4' 4-1/8" and is divided into two bays, each arranged for 23" mountings. The frame comes equipped with an appliance outlet, fuse panel, miscellaneous jacks and lamps, terminal strips, etc. Each bay has a fold-down type writing shelf and mounting space is available for line load control lamps. Plant administration registers are also included in the frame. A cross connection field is provided for associating connector relay contacts with the display lamps of the Trouble Indicator. Control panels containing lamps, jacks and keys are mounted in each of the bays. The circuit for each multifrequency receiver and oscillator is an individual plug-in unit using an octal plug.

Trouble Indicator and Connector Circuit Features

This circuit serves as a substitute for the standard trouble recorder. It contains connector relays for connecting trouble leads to the display lamps from markers, transverters, recorders, master timers, and pretranslators.

The lamp circuit uses NE-5 neon glow tubes which are triggered with a voltage of 165 volts and sustained at 117 volts. Rectifier circuits are used to obtain the required voltage. Circuits bidding for the indicator obtain access to it by operating one of the relays in a preference chain. A display is released by opening the 165 volt supply through the operation of the RLS key or by a release signal sent from the alarm sending circuit. If the requesting circuit is unsuccessful in an attempt to seize the Trouble Indicator, a display lost indication is registered identifying the circuit making the attempt.

The left half of the lamp panel gives equipment locating information and the right half contains call progress lamps arranged in sequence chart form. Form E-4872 (Figures 6-4), provided for recording Trouble Indicator displays, is a reproduction of the Trouble Indicator lamp designations.

Test Circuit Features

The Test circuit provides a means of originating and terminating test calls on a call-through basis. Operation is identical to that of regular service calls. Test calls can be directed to specific pieces of equipment by means of a make busy control circuit that makes idle, undesired equipment appear busy momentarily while releasing the desired equipment for selection.

Keys and lamps (Figures 6-5) are provided for applying and observing various test conditions on originating, incoming and terminating test lines. An amplifier and speaker are included for audible monitoring of test calls. Pulsing can be controlled by a built-in pulse generator or multi-frequency supply, a dial mounted on the control panel, or by a handset patched to a remote location. Sender out-pulsing can be checked by a dial pulse counting circuit or by multi-frequency receivers contained in the Test frame.

Facilities are included for testing P.B.X. hunting lines, for controlling class of service indications, for testing LAMA features, and for making reverting call tests. All components of the standard No. 5 crossbar central office can be tested by the Test circuit as well as associated LAMA equipment.

C. AUTOMATIC PROGRESSION TRUNK TEST FRAME

General

The automatic progression trunk test frame (Figure 6-6) provides facilities for the automatic testing of trunks to panel, crossbar, step-by-step, and tandem offices, and intra-office and intermarker subscriber-to-subscriber trunks. The sequence of tests made on an individual trunk and the automatic progression from one trunk to another is accomplished by information stored in the form of perforation on teletypewriter tape. The latter is fed through a teletype transmitter-distributor which is used to read the tape and to transmit the information to register and steering relays which control the test and progression features.

The test circuit has a line link frame appearance in each marker group served and is connected to the trunks by means of regular service linkages using the marker for this purpose. When all the tests recorded on a particular tape have been made, a lamp is lighted indicating to the maintenance man that a new tape should be substituted or the same tape rerun with different key settings. Repeat tests and particular circuit tests may be made manually without the aid of tape by using a 10-button key set and other keys, as required.

By means of a teletypewriter reperforator under the control of a 10-button key set located on the test frame, perforations on a two-out-of-five basis are entered on teletypewriter tape for subsequent use in controlling the automatic operation of the test frame. The reperforator is also used to duplicate existing tapes that have become worn or damaged. These are run through the transmitter-distributor which, with the COPY key operated, actuates the reperforator to reproduce the perforations on new tape.

Teletypewriter Equipment

The teletypewriter equipment is mounted on a steel table measuring 36 inches in height, 31 inches in width, and 25 inches in depth. On the top of the table is the transmitter distributor together with a tape winder and a tape unwinder. The unwinder permits the tape to be read from the inside of the coil, that is, in a forward direction, thus avoiding the necessity of rewinding.

The reperforator which is used only when producing new tapes or when reproducing existing tapes is located on a sliding shelf which may be pulled out for maintenance access and to replenish the tape supply. Also mounted on the shelf is a tape winder. In the lower portion of the table is a drawer for the storage of tapes used in the operation of the frame and for a supply of unperforated tape.

The preferred location of the test frame is in the maintenance center, with the teletypewriter table placed nearby against the wall facing the test frame.

D. LINE INSULATION TEST FRAME

General

The Line Insulation Test Frame is a one bay sheet metal frame. It is equipped with a fuse panel, control panel, frame terminal strips, and various relay units as shown in Figure 6-7.

A control circuit connects the test circuit successively to the subscriber lines, except for lines found busy and certain lines which, when tested, would produce false trouble records or cause interference with service. It causes line insulation resistance faults within a selected range, as indicated by the test circuit, to be recorded by the trouble recorder or by a teletypewriter at a distant test center. Access to subscriber lines for testing is obtained through the line link frames using the line link connector multiple associated with one of the regular markers which is held busy during the testing period but is automatically restored to service if required by traffic. Facilities are provided for automatically starting the circuit by means of a time switch.

Detailed Description of Line Insulation Test Operation

The line link frame connector multiple used for test is wired from the line link frames to the marker by way of the test control circuit. The multiple of a dial tone marker may be used for this purpose Upon the start of a test by local or remote control, the marker whose multiple is intercepted is automatically made busy. Approximately, 75 leads in this multiple which are required for testing are cut into the test control circuit for direct control of the line link frames.

The test control circuit is arranged to generate the equipment locations of line groups (five lines associated with a line link frame LG relay) in succession, and to connect to these groups by means of a multiple of the line link frame start leads and the HG and VGB leads of the frame multiple. When a group is connected, its five verticals are tested for busy and for the pass-by condition imposed on these which would cause interference as described later.

An idle line link is selected and the first line to be tested is closed through the link and the no-test vertical to the test control circuit. While the test of this line is being made, the frame is held with the select magnet for the link operated. When the test on the first line is completed, its hold magnet is released and checked down, whereupon the hold magnet for the next line to be tested is operated. The no-test hold magnets on the line link frame and in the no-test connector remain operated between the tests of successive lines. This process continues, until the test has progressed through the group except that the line link frame is released while a record of a line trouble is being made. Also, if a false indication of trouble is detected due to an off-hook condition occurring after the frame is seized or due to a plugged up line, the frame is momentarily released to prevent undue interference with service and such appearances of trouble are not recorded.

The test starts at the first line group (horizontal group 0, vertical group 0) of the first line link frame, and progresses to the corresponding line group of the next frame, etc. On successive cycles through the frames the vertical group count is increased until all lines in horizontal group 0 of all frames have been tested. The other horizontal groups are then tested in a similar manner. Provision is made on an optional basis for taking care of different sizes of line link frames in the same marker group.

The selection of line groups is rotated throughout the frames as mentioned above in order to prevent undue interference with traffic at any one frame, and to prevent heating of the frame connector relays.

If a no-test junctor is found busy, the test will progress to the next frame. It is probable that only a few lines will be passed in this manner as upon reseizure of the frame on successive cycles the no-test call will ordinarily have been released, again making the junctor available. If a line link frame is made busy, it will be skipped.

The tests will be temporarily suspended and the marker restored to service if an all markers busy condition obtains for a short period.

The test circuit uses the same level on the no-test connector that is assigned to the master test control circuit. A lock-out feature is provided and preference is accorded to the master test control circuit, if it should require the use of this level.

The line link appearances of toll and certain other trunks must not be tested as this procedure would cause interference with service and with the tests. As previously mentioned, dial PBX lines, certain test lines, and blank number trunks are passed by as they would produce false records. The verticals associated with these circuits may be skipped in either of two ways as follows:

(a) For each such vertical, a pigtail resistance is connected between the 2T and RB1 (battery) terminal of the line relay. This does not interfere with marker operation. The test control circuit, however, tests for this battery as a signal to skip the vertical.

(b) Two PBX classes of service are provided for each case, one for manual PBX lines and the other for dial PBX lines. The marker accords the same treatment to these classes. The test control circuit, however, has access to the dial PBX class lead and skips the associated lines. Toll trunk terminations and all other verticals which are not to be tested are associated with the dial PBX class so that they may also be passed by.

Either or both of the above means may be provided. The first may be preferable in offices having only a few verticals which must be skipped, and the second in offices which have a large number of such verticals. It will be noted that the second arrangement requires the assignment of toll trunks, etc, to certain vertical files, which is not efficient except for fairly large groups. However, the number of verticals so treated can be increased by the inclusion of information, intercept, and other trunk circuits which do not produce false trouble indications. Such circuits may be tested or skipped, as desired.

Local control by means of keys is provided in all cases. One of nine keys is used to start the circuit in accordance with the desired combination of range and type of test. Remote control can be provided on an optional basis by means of the test trunk and selector circuit used to connect to permanent signal holding and plugging up lines. The 0 level on the selectors is used for LIT purposes. Terminals 1 to 9 of this level are used to start the test. Terminal 0 provides access to the control circuit for monitoring purposes and for restoring the LIT frame to normal. While monitoring, tone signals indicate whether the test is in progress or if it has stopped due to trouble. The tone signal connected to terminal 0 is also connected to the particular start terminal 1 to 9 used, to indicate that the circuit has responded to the start signal, and so that the type of test called for can be verified by dialing the terminal again.

After one of these terminals has been dialed for the above purposes, the selector may be restored and used for its regular functions without affecting the status of the LIT circuit.

Lamps are provided for indicating circuit off-normal, type of test and range, temporary suspension of test, and trouble in the test circuit or frame circuits which would cause the test to stop. Such a trouble condition will also actuate the minor alarm which will be extended to a distant maintenance center when the alarms are transferred.

An off-normal lamp at the MTF indicates to the maintenance force that no tests or maintenance work should be performed on the marker removed from service by the line insulation test frame, and that no test calls should be made which would unduly hold the no-test connector to the exclusion of this circuit. Four plant registers are provided to count the number of completed test cycles made under various test conditions.

One LIT frame is provided for each marker group. This will permit the lines associated with two or more marker groups in one building to be tested at the same time. Each test frame is capable of testing approximately 12,000 lines per hour.

General Description of Traffic Count Operation

The line insulation test control circuit is arranged to make five types of traffic count. These are line link office count, frame count, and horizontal group count; and trunk link frame count and horizontal group count. In each case, the links are tested for a busy condition and the number found busy is recorded on traffic registers for engineering purposes.

Office count covers all of the line link frames in the marker group. The frame counts are made on ten line link frames or five trunk link frames at a time, and the horizontal group counts on one link link or trunk link frame.

Some of the circuit features used for line insulation testing, such as the means provided for obtaining access to line link frames and for obtaining access to line link frames and for testing links for a busy condition, are also used for traffic count. Other features, such as those involved directly in the testing of lines and in recording line insulation defects, are not required.

Control relays are provided which rearrange certain internal connections in the circuit, as required, for the various types of traffic count. Manually operated switches are also provided for selecting the frames to be tested for the frame and horizontal group counts. The circuit is prepared for traffic count operation by setting these switches, if required, and by the operation of one of five keys at the test frame, corresponding to the type of count to be made. This causes the required control relays to operate.

The counting process may thereafter be started and stopped under control of a key at the traffic register rack. The results of the count are recorded by ten traffic registers as described in the following paragraphs. An additional register is used to record the number of completed test cycles. The time allowed for a cycle is 3 minutes, regardless of the number of frames involved. Ordinarily, several cycles will be made in one run. After completion of a run, the circuit is restored by means of the RN key at the frame.

Office count provides information which may be of use in the engineering of additions. The frame and horizontal group counts may be used for obtaining data for loading the line link and trunk link frames and the horizontal groups thereof.

Line Link Office Count

For this type of count, the line insulation test control circuit connects to the sleeve leads of the ten line links associated with horizontal group 0 of the first line link frame, this connection being established through the line link frame connector multiple of the associated marker as for line insulation testing. These links are tested for a busy condition. The ten registers referred to above are in this case directly associated with the link-busy test relays and correspond to link positions 0 to 9 in the horizontal group. Registers associated with links found busy are operated simultaneously upon operation of the busy test relays. The circuit then proceeds to horizontal group 0 of the second line link frame, tests the links, and causes registers corresponding to busy links to score as above. This process continues until horizontal group 0 of the last frame has been tested. On each frame seizure, the ten registers are operated in accordance with the busy conditions encountered.

In order to obtain the over-all cycle time of 3 minutes for all horizontal groups of all frames, which is desirable as it approximates the holding time of a conversation, an 18-second timer is provided to mark the start times for successive horizontal groups. Ordinarily, considerably less than 18 seconds will be required to test through one horizontal group of all frames. During any remaining time, the associated marker is restored to service and the frame awaits the start signal for the next horizontal group.

The links of horizontal group 1 of all frames are tested as described above for those of horizontal group 0, and the remaining horizontal groups are tested in a similar manner, the test of each group being started 18 seconds after the start of the previous group. If, due to unusual conditions, more than 18 seconds should be required for one horizontal group, the next one is started immediately and the total cycle time is increased accordingly.

Upon the completion of a cycle, the cycle register is operated. Additional cycles are made as long as the start key at the traffic register rack is left operated. Upon the release of this key, a cycle in progress will complete but no further operations take place.

The total link busies for the marker group are obtained by adding the scores on the ten registers. The CCSs for the marker group can be determined from this figure in conjunction with the number of cycles made.

Line Link Frame Count

This count is made on a group of ten (or less) line link frames, the frames to be tested being selected by a manually operated switch. The links of horizontal groups 0 to 9 of the ten frames are tested as described for line link office count, successive horizontal groups through these frames being started at 18-second intervals.

The ten registers in this case, however, are associated, respectively, with the frames under test (0 to 9, 10 to 19, etc). In testing each horizontal group of a frame, the register associated with that frame is scored a number of times equal to the number of links found busy. The registers therefore record the total number of busy links on a per frame basis. Additional cycles are controlled as described for line link office count.

Line Link Horizontal Group Count

In this case, only one line link frame is tested at a time, the selection of this frame being controlled by manually operated switches. The ten registers are associated, respectively, with the ten horizontal groups of the frame and record the total link-busy conditions per horizontal group. These groups are tested at 18-second intervals. Additional cycles are controlled as previously described.

Trunk Link Frame Count

This is similar to line link frame count. Only five frames are tested at a time, however, as there are twice as many links per frame. Both the left and right links of each horizontal group are tested before the circuit proceeds to the next frame.

Registers 0 to 4 are associated, respectively, with frames 0 to 4 or 10 to 14, and registers 5 to 9 with frames 5 to 9 or 15 to 19.

Access to the trunk link frames is obtained by means of the trunk link frame connector multiple for the marker associated with the line insulation test control circuit.

Trunk Link Horizontal Group Count

This count is similar to line link horizontal group count. The left and right links of each horizontal group, however, are tested before the circuit proceeds to the next group.

Registration Test

A registration test feature is provided to check that the circuit functions properly in recognizing and counting busy links, and to assist in clearing trouble. The link-busy conditions are simulated by means of keys, and the results of the tests are recorded by a register at the test frame.

E. MANUAL OUTGOING TRUNK TEST FRAME

General

The manual outgoing trunk test frame is available for testing outgoing trunks. It consists of a test frame and one or two adjacent jack frames. The test circuits are located in the test frame and the trunks to be tested appear as trunk and make-busy jack circuits in the jack frames. Connections between the test equipment and the trunks is made with patching cords in the jack frame.

Test Frame (Figure 6-8)

The test frame equipment consists of the conventional key, jack, and lamp panel together with a pigeon hole and writing shelf unit. Above and below is located the associated relay equipment. The battery supply is furnished through fuses located on the master test frame. A frame local cable is provided for interconnecting the equipment units in the frame. The various tests are set up by operating the necessary keys in the test circuits.

Test and Make-Busy Jack Frame

The equipment in the jack frame consists of two jack panels each having a capacity of 2000 jacks. These comprise the test and make-busy jacks of the outgoing trunks to be tested. Common jacks associated with the test circuits in the test frame are also provided on these jack panels and so located that they can readily be patched by means of cords to any one of the test and make-busy jack circuits.

In No. 5 crossbar offices, the test and make-busy jacks are always cabled to the distributing frame and then cross-connected to the associated outgoing trunks. The jacks are therefore arranged in numerical sequence numbered bottom up and designated with the office name at which they terminate. The jack bay for these offices is therefore available with one jack panel where an ultimate of 1000 jack circuits is required or with two jack panels for an ultimate of 2000 jack circuits per frame.

F. ALARM SYSTEM FOR NO. 5 CROSSBAR

Theory

To give warning of conditions that might adversely affect telephone service, Bell System Telephone offices have alarm systems which indicate by both audible and visual means the equipment in trouble. The indicators are so arranged that a maintenance man, regardless of what part of the building he might be in at the time, can find his way to the equipment with a minimum of effort.

Alarm systems used previously in crossbar, and in the later panel and toll offices, have achieved this objective by using a system of bells, chimes, and colored lamps strategically placed whereby the floor, the main aisle, the aisle, and finally the circuit in trouble are indicated. In the No. 5 crossbar system, the same result is achieved but with a simplicity of design that makes possible economies in manufacture, installation, and job engineering. The components for the system are fabricated in the shop, and only a minimum of cabling is required to complete the system on the job.

Components do not depend on the types or number of circuits requiring alarm, and the special engineering required for each installation is reduced to a minimum. For any one building, the entire alarm equipment consists of a small aisle pilot unit having a red and a white lamp and two relays; a cluster of four lamps--red, white, yellow and green--for each main aisle; a vertical lamp holder near the exit door having one lamp for each of the other floors in the building; a panel having a six-inch vibrating bell, two telephone ringers with distinctive gongs, and a large tone bar or chime signal; and relay control equipment consisting of one two-inch mounting plate for each floor of the building. Of the group of four lamps in each main aisle, two--the red and white--are the MAIN AISLE PILOTS that indicate trouble in some tributary aisle. The other two--green and yellow--are the OTHER FLOOR lamps, which indicate the existence of trouble on one of the other floors in the building.

A hypothetical central office layout indicating the positions of these lamps is shown in Figure 6-9, and an aisle pilot unit in Figure 6-10. In addition to these lamps, there are individual lamps mounted on various switching and equipment frames that indicate the particular bay, panel, or circuit in which the trouble has arisen. Whenever a trouble arises that lights one of these individual lamps, an aisle pilot for that aisle, the main aisle pilot on that floor, and the exit lamps on all the other floors also light, and an audible signal is sounded on the floor where the trouble has occurred. Lighting of the OTHER FLOOR lamps, and giving audible signals on other floors, is optional, and depends on whether or not a grouping key on each floor is operated. When these keys on all floors are operated, any trouble will also light the OTHER FLOOR lamps on all floors except that on which the trouble has occurred, and will sound the audible alarm on these floors. With the grouping keys all operated, a maintenance man on any floor will hear the alarm when trouble arises anywhere in the building.

By looking at the OTHER FLOOR lamps, he can tell whether the trouble is on the floor he is on or on some other floor, since an OTHER FLOOR lamp will be lighted only when the trouble is on another floor. If one of the latter lamps is lighted, he will go to the exit, and the particular exit lamp lighted will indicate the floor on which the trouble has arisen. These exit lamps are arranged in a vertical row with one socket for each floor, the top representing the top floor and so on down. On each floor no lamp is in the socket for that floor, and thus the floor on which the trouble exists may be determined from the position of the lighted lamp relative to the socket that has no lamp. After he reaches the floor where the trouble has occurred, the main aisle and aisle pilots will guide him to the proper aisle, and the lighted individual lamp on the frame will indicate the equipment causing the alarm.

The circuit by which the proper lamps are lighted when trouble occurs is indicated in Figure 6-11. When trouble arises, the local lamp will be lighted and battery through a resistance will be connected to lead A at the left of Figure 6-11. A connection to this same lead will be made for all troubles of same grade, major or minor, arising in that aisle. Battery on this lead operates the AP relay, thus lighting both the aisle pilot lamp for that aisle and the main aisle pilot lamp and operating the FL relay. The operation of this latter relay connects ground to the exit lamp multiple and thus lights all the exit lamps for that floor, sounds the audible signal on that floor and also connects ground to the grouping key. If the grouping key on any floor is operated, the audible signal will sound and the OTHER FLOOR lamp will light on the floor above. Conversely, an alarm on the floor above will sound the audible signal and light the OTHER FLOOR lamp on this floor. If all the grouping keys are operated, audible signals will sound and OTHER FLOOR lamps will light on all floors except the floor on which the trouble occurred.

Switching-trouble alarms are arbitrarily divided into two categories called major and minor alarms, and there is a circuit like Figure 6-11 for both types. Each circuit has lamps of a particular color associated with it. For major alarms, the individual circuit or fuse panel lamp, the aisle pilot, and the main aisle pilots are red, while for minor alarms, the corresponding lamps are all white. The OTHER FLOOR lamps are yellow for major alarms and green for minor alarms.

A distinction is also made in the audible signals; for major alarms the audible signal is a tone bar operated by a relay interrupter, while for minor alarms it is a telephone ringer. The exit lamps, which are all amber, serve for both types of alarms, and are lighted by the FL relay of both the major and minor alarm circuits.

The main power supply equipment is usually all located in the basement, and since it does not require a series of locating lamps, provided by the circuit in Figure 6-11, it has its own alarm circuit providing both major and minor alarms. It is tied in with the Figure 6-11 circuit, however, to the extent that for major alarms it lights the yellow OTHER FLOOR lamp and rings a six-inch gong on all floors whether or not the grouping keys are operated. For minor power alarms, it lights the green OTHER FLOOR lamp and rings the regular minor alarm bell on one of the floors which was arbitrarily designated as the floor from which power alarms are supervised. Of course, the grouping keys will also transmit minor power alarms to the other floors. For either major or minor alarms, it lights a separate amber exit lamp on each of the switching floors.

Also not part of Figure 6-11 are the alarms from the fuses that supply the alarm circuits themselves. A failure of one of these fuses rings a specially toned telephone bell on each floor, but no pilot lamps are lighted except in the alarm control equipment unit, since the blown fuses might prevent the pilot lamp from lighting and thus no dependence could be placed on them. The location of the alarm control equipment is always known to the maintenance man, and thus the sounding of the specially toned bell is sufficient to indicate where the trouble has occurred.

Since in a 10,000-line central office there are about 15,000 fuses that may give an alarm, they are potentially the source of the greatest number of alarms. Experience has shown, however, that fuse alarms are of comparatively rare occurrence.

Alarm type telephone fuses connect the individual circuits to a common power bus, and when they blow, they establish a connection from the power bus to an alarm bar. This arrangement, together with a commonly used type of circuit to connect the alarm bar to the fuse panel lamp and the alarm system, is shown in Figure 6-12. Lead A connects to lead A of Figure 6-11. Such an arrangement has been used for many years, but it has been necessary heretofore to limit the number of fuse panels that can be connected to the same aisle pilot relay-relay AP of Figure 6-11. This is because with a number of simultaneous alarms, the current through the winding of the AP relay is the sum of all the individual alarm currents, and as a result with many simultaneous alarms, the relay not only overheats but may reduce the voltage across the lamps below the point for satisfactory illumination. By a careful selection of the type of lamp, the relay winding, and the two resistors in the lamp circuit, however, the permissible number of simultaneous alarms has been so greatly increased that all restrictions on the number of fuse panels have been removed. The panel lamps, indicated in Figure 6-12, are always red since blown fuses in this system are arbitrarily classed under major alarms.

Telephone offices require a number of power supplies other than 48-volt battery, and heretofore a relay has been used for each panel for each type of supply since the panel lamps had to be lighted through relay contacts. For the No. 5 crossbar alarm system, however, the arrangement indicated in Figure 6-13 is employed. It is known as the "pilot fuse" method since it employs a fuse in the regular 48-volt section of the panel as both a relay and indicator to give the alarm when a fuse in any other part of the panel blows.

Five types of power supply besides 48-volt battery are shown in Figure 6-13, and the alarm contact or stud for each of the fuses in these five sections of the panel is connected to a separate pilot fuse in the 48-volt section of the panel. When a fuse blows and connects its particular power supply to its alarm stud, the pilot fuse is placed directly in series between the 48-volt battery and the other power supply. As a result, the pilot fuse blows and gives an alarm in the regular manner.

Some circuits, such as the marker or transverter, have a large number of fuses since it is not desirable to design them with a single fuse large enough to carry the entire load. However, should even one fuse blow, the effectiveness of the circuit is impaired and since the circuit is involved in a large percentage of the calls handled by the office, it is of the utmost importance not only to indicate an alarm if a fuse blows, but also to prevent the circuit from being selected for further use until the defective fuse is replaced. For such circuits, therefore, the arrangement shown in Figure 6-14 is employed.

A relay is connected in shunt with the panel lamp, and if any fuse blows, not only will the regular alarm be actuated, but, in addition, the relay will operate and make this circuit busy. The relay has practically no effect on the fuse alarm, and thus does not affect the high reliability of the original arrangement. If a failure should occur in the wiring to the relay or in the relay winding, or if the adjustment of the relay is faulty, the regular fuse alarm in the system is still operated.

In addition to fuse alarms, many circuits are arranged to indicate other types of trouble, particularly an inability to complete functions within a reasonable time. To measure such time intervals, a capacitor-timed cold-cathode-tube circuit is usually employed. One type of circuit is shown in Figure 6-15. When the circuit is selected, relay ON operates and remains operated during the entire in-use time. This removes the ground connection from capacitor C and allows it to charge from the 130-volt battery through the P resistance, the winding of relay TA, and resistance R. As the capacitor charges, the voltage between the control anode and the cathode increases. When this voltage is high enough to cause ionization, current will flow between the main anode and the cathode, thus operating relay TA. The operation of TA in turn operates relay AL, which lights a local alarm lamp and connects battery to lead A, which in turn connects to lead A of Figure 6-11. Through circuit components not shown in Figure 6-15, relay ON is then released, thus releasing TA, stopping the flow of current through the tube, and restoring the circuit to its original condition. Relay AL has locked itself in, however, and will remain operated to remember the trouble until it is manually released.

Another common source of alarms is the trouble recorder, since each time a trouble record is made, an alarm is given. These also are classified as major and minor, and light indicating lamps leading to the master test frame.

Since the No. 5 system was designed to serve small as well as large areas, it was planned to extend the alarms a large portion of the time to off-premises personnel. It has been necessary, therefore, to provide for transferring the alarms to a distant office where a maintenance force will always be available. All the alarms, therefore, are connected to an alarm sending circuit, which is indicated in both Figures 6-11 and 6-15. The alarm sending and receiving circuits, which are capable of identifying as many as seventy distinct types of trouble, will be described in a succeeding chapter.

Alarm Equipment

The alarm equipment for a No. 5 crossbar office comprises main aisle, frame aisle, and exit pilot units; alarm grouping key and lamp units; audible alarm panels; and mounted on an alarm frame, several relay control units. In addition, and augmenting the standard alarms, the following may be provided as required: auxiliary alarm, emergency alarm, alarm sending, alarm receiving, extension alarm, and distinctive tone units.

The alarm frame is a standard single-bay frame with common equipment consisting of a frame jack panel, a miscellaneous terminal strip, and one fuse panel with 70-type ABS fuses for one floor and one power room. There are two different equipment arrangements for this frame; one (Figure 6-16) covers alarm equipment for a building with a maximum of six floors, and one (Figure 6-17) covers alarm equipment for buildings of ten floors. The units equipped on these frames are provided in accordance with job requirements.

Details of Units

(a) The Main Aisle and "Other Floor" Pilot Lamp Unit consists of a lamp mounting with four lamps: two lamp (red and white) for indicating major and minor alarms on the floor on which the unit is mounted, and two lamps (yellow and green) for indicating that a major or minor alarm exists on some other floor. This unit also includes mounting devices for fastening to a superstructure bar or to a stringer of a cable rack. This unit requires wiring, which is not included, to connect it to the unit terminal strip of the nearest frame aisle pilot unit.

(b) The Frame Aisle Pilot Unit is a metal box-type assembly arranged for mounting on an end guard. It contains two lamp sockets, two control relays, and a unit terminal strip, all surfaced wired, and two lamps which protrude from the front face to indicate major and minor alarms.

It is necessary to mount these units on the end guards before the end guard is fastened to the frames at the end of the aisle.

For any office, the total number of aisle pilot units required is always equal to the number of frame aisles.

(c) The Exit Pilot Lamp Unit is a lamp mounting with a capacity of four S-type lamps. This unit will provide for three switching floors and one power room, or for four switching floors. One lamp represents a power room and the other lamps represent each of the other floors. For multifloor buildings, it may be necessary to provide additional units. A lighted lamp indicates that a trouble exists at the location represented by the lamp. The unit includes lamp mounting, sockets, lamps (amber colored), and devices for mounting unit on wall or column. Floor designations are stamped on the unit.

(d) The Alarm Grouping Key and Lamp Unit consists of a key and associated lamp, closed in a metal box, which is arranged for fastening to a wall or column. It is intended to be mounted by the installer according to instructions from the Telephone Company.

This key and lamp circuit is associated with an alarm grouping relay (SW) which provides for grouping the alarms of unattended floors with those of an attended floor. Only one lamp per unit is required, and it is equipped to the position corresponding to the succeeding floor number. The lamp is lighted when the key is operated and indicates that the alarms for that floor have been grouped. One unit per floor, except last and power room, is required when facilities for alarm grouping are provided.

(e) The Audible Alarm Panel consists of an alarm bell panel equipped with tone bar signal, subsets, and signal bell. The panel is also arranged to accommodate a subset (SA) to provide for toll service alarms, and a signal bell (B) to provide code signaling on major alarms when alarm grouping is provided. The apparatus on the panel shall be inter-connected and wired into the alarm system by the installer.

A maximum of five of these panels may be provided for each floor.

(f) The Power, ABS Fuse and Floor Alarm Control Unit is a three mounting plate unit. This unit mounts on the alarm frame and includes the equipment for:

1) Controlling the power fuse alarms for one or two power rooms.
2) Controlling the ABS fuse alarm and alarm lamp which is located on the unit.
3) Controlling the alarm equipment located in a switchroom when required.
4) The interrupter for the tone bars of the office.
5) Controlling the main aisle pilots, "other floor" pilots, exit pilots and audible floor alarms for the first floor.

(g) The Floor Alarm Control Unit is a single mounting plate unit, mounting on the alarm frame. This unit contains equipment for controlling the main aisle pilots, "other floor" pilots, exit pilots, and audible floor alarms, for one floor other than the first, requiring these alarms.

(h) The Alarm Grouping Unit is a one-mounting plate unit mounting on the alarm frame. It provides means for code signaling on major alarms when the alarms of various offices in the same building are arranged to be grouped. One unit is arranged for equipment for two floors.

(i) The Alarm And Transfer Unit For N1 Carrier Equipment is a one mounting plate unit, mounting on the alarm frame, and arranged for equipment for two aisles and two floors. It is provided for connection of N1 carrier circuit alarms to the No. 5 crossbar alarm system and arranged for transfer of these carrier alarms to the alarm sending circuit on a distinctive tone basis.

(j) The Exit Pilot Lamp Control Unit is a one mounting plate unit mounting on the alarm frame and arranged for eight sets of equipment. One set of equipment is required for one floor or one power room.

Application of Alarms to No. 5 Equipment on Floors With Other Systems

When No. 5 crossbar equipment is located on the same floor with equipment of other systems, the No. 5 equipment shall always be alarmed in accordance with its own alarm specifications. From an alarm standpoint the area assigned to the No. 5 equipment shall be treated as a separate floor.

If any cross aisle within this area contains frame aisle pilots for both the No. 5 and some other alarm system, separate main aisle pilots shall be provided for each system. These pilots shall be mounted in different locations in the main aisle so that their locations can be used to indicate the alarm system with which they are associated.

Where No. 5 and common systems equipments requiring alarms are located in the same frame aisle, frame aisle pilots for only one of these systems shall be provided. Auxiliary aisle pilot relay units shall be furnished as required to tie together the alarm leads of both systems.

Interoffice Transfer of Alarms

At least part of the time, such as nights and week-ends, many No. 5 crossbar offices are maintained by off-premises personnel. An alarm transfer circuit is available for transferring the alarms in unattended offices to a center where a maintenance force is available. This circuit consists of an alarm sending unit in the unattended office connected via only two inter-office conductors to an alarm receiving unit in the attended office.

A considerable amount of information must be transferred via this alarm transfer circuit. The design of the circuit provides seventy different types of alarm conditions. In addition, it is possible to enable the transfer circuit from the receiving end whenever transfer has been neglected at the sending end.

It is also possible to determine whether the transfer has been enabled even if no alarm condition existed, and to release locked in temporary alarms so as to determine whether or not the trouble condition is of a continuing nature.

Another feature of the alarm transfer circuit is that any failure in the transfer circuit will not result in a no-alarm signal, or will not signal an alarm of less importance than that existing at the time. If the cable conductors are opened or grounded, for example, if a fuse blows, if a contact fails due to dirt, or if a wire is broken off, an alarm will be sounded, while if an alarm is being transmitted it will be changed to a more important class if possible but never to a less important one.

At the sending end of the system, positive or negative 130-volt battery or open circuit may be applied to each of the two transfer leads under control of relays. At the receiving end of the system, each transfer lead connects to one side of the winding of a three-position polarized relay; the other side of each winding is grounded. Since each relay has three positions, there are nine combinations of positions for the relays taken together.

These relays control a circuit which causes a specific lamp to light and an audible signal to sound for each of eight of the combinations. The ninth combination with no lamp or audible signal is used to indicate that the circuit is in good working order. One of the eight lamps and audible combinations is used to indicate a failure in the alarm circuit itself. This leaves seven indications to be associated with various types of trouble conditions that may arise in the particular office that is being supervised.

Besides these two relays, a telephone receiver is bridged across the circuit through a repeating coil, and at the sending end provisions are made for applying any of ten possible tone or click combinations, which may be superimposed on the D-C current through the transfer leads. These combinations are shown in Figure 6-18. For each of the seven alarm positions of the relays, therefore, there are ten possible tones. There are thus seventy possible trouble conditions that may be given in addition to the signals for transfer-circuit failure and for the all-clear condition.

A simplified schematic of this transfer arrangement is shown in Figure 6-19, where the relays are in the positions they assume when no alarms are being transferred. Relays FA, L, L1, and A are operated at the sending end, while at the receiving end polarized relay T is operated to its positive position and relay R to its negative position. Under these conditions, the D-C signal relays and the tone and click circuit are disabled, and thus alarms arising in the office are not transferred.

When the alarms are to be transferred to the distant point, the transfer key TR is operated, thus releasing the A relay. This supplies enabling battery to both the tone and D-C relay circuits and disables all audible alarms in the local office, but makes no other changes so long as there are no alarms to be transferred. Should a maintenance man now listen at the receiver at the maintenance center, he would hear a low tone, which in conjunction with the no-lamp condition would indicate that a transfer had been made, that the circuit was in good working condition, and that there were no alarms. When alarms occur, they operate relays in the D-C and tone signal circuits to send the proper signals to indicate the type of trouble existing.

When the maintenance man returns to the unattended office, he releases key TR. This causes lamp TR to light. Then he momentarily operates the reset key RS. This operates relay A which locks itself in through the transfer key, extinguishes lamp TR, removes battery supply from the tone and D-C relay circuits, and enables the local audible alarms. The extinguishing of TR lamp is a check that relay A operated and remained locked after RS was released.

It is not sufficient, however, to provide only for sending the required alarms. Every possible contingency must be foreseen and provided for. One obvious one is that the maintenance man might neglect to operate the transfer key when he left the No. 5 office. Under such conditions, the transfer may be accomplished from the receiving circuit by operating the AR key at the extreme right of Figure 6-19. A maintenance man at this point would know that the transfer had not been made by absence of tone when he listened on the telephone receiver, and knowing from the schedule of non-attendance at the distant No. 5 office that transfer should have been accomplished, he would at once operate key AR. This opens the transfer circuit and thus releases relay L which in turn releases relay L1. The release of L1 in turn releases relay A and thus effects the transfer.

When transfer has been accomplished in this manner from the receiving end, the TR lamp at the sending end will be lighted through a back contact of relay A and the TR key. When a maintenance man returns to the No. 5 office, therefore, this lighted TR lamp will show that transfer was made from the receiving end, and he will momentarily operate the RS key to reoperate relay A and thus enable the local alarms. When relay A operates, the TR lamp will be extinguished.

Key AR need be operated only momentarily since once relay A has released, it will not be reoperated by closure of L1 because normal connection to the winding of A is made through one of its front contacts. Once released, relay A can be reoperated only by operation of the reset key RS.

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The primary function of key AR, however, is to open momentarily the locking paths for all memory relays--in this way determining whether some alarm received is of a temporary nature or whether it continues or recurs. Examples of the former are a trouble recorder seizure, momentary failure of the regular power service to the building, or an overload of the switching equipment such as may result from a flurry of calls in case of a fire in the neighborhood. The slow-release relays L1 and AR in Figure 6-19 insure that the locking leads LK are not opened if relay L releases momentarily when the alarm signals change, and that these leads do not remain open continuously in case of a cable failure.

Since there is always the possibility of two or more alarms occurring simultaneously, and since only one alarm can be transferred at a time, it has been necessary to associate preference circuits in the tone and D-C signal circuits to select only one of possibly several alarms for transfer. Under such conditions, it is desirable to select the most important alarm, that is, one requiring the most prompt attention. The nine possible combinations of conditions that can occur on the transfer leads to the maintenance center are thus arranged in a preference sequence as shown in Figure 6-20, where the importance decreases from left to right. At the extreme right is the normal condition, indicating that the transfer circuit is normal and that no alarms are being transferred. At the extreme left, on the other hand, are the conditions that would exist if the power fuses on the alarm circuit had blown, or if the transfer leads were open. Since, under this condition, no alarms at all would be transferred, this is the worst condition possible. Between these two extremes are the seven conditions used for various classes of alarms.

These seven alarm conditions have been so selected that should an open occur in either of the transfer leads, the resulting alarm indicated at the receiving office would be of a more serious nature than the alarm existing when the trouble occurred. This is shown in Table I.

TABLE I---CHANGE IN ALARM GIVEN IF EITHER TRANSMITTING LEAD IS OPEN.

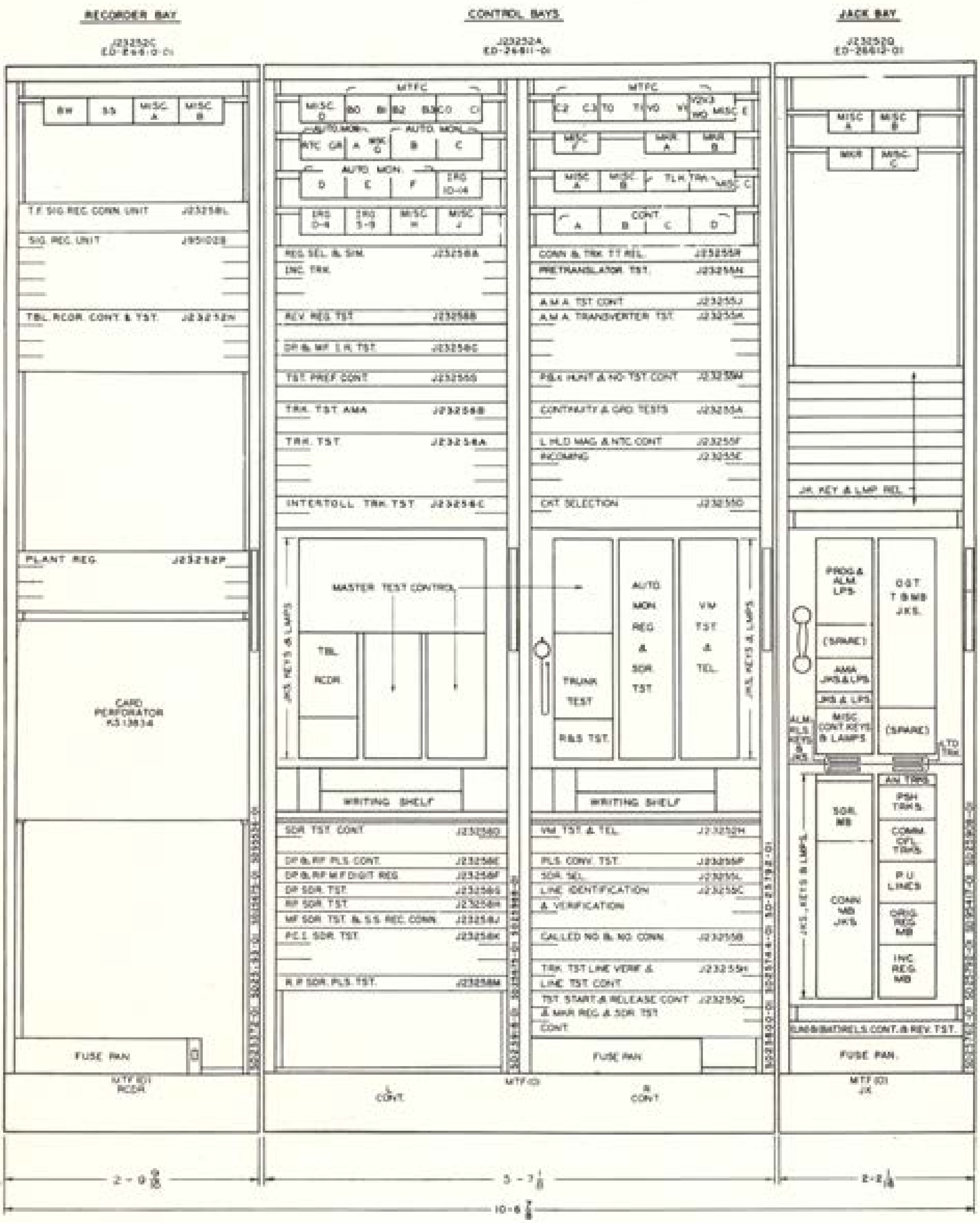
	T	R
0	6	3
1	4	7
2	4	3
3	8	-
4	-	8
5	6	7
6	-	8
7	8	-
8	-	-

At the left are listed the various classes from zero to eight, corresponding to Figure 6-20. The next column to the right indicates the alarm class that would result were the tip lead opened, while the third column indicates the alarm that would result were the ring lead open. A dash indicates that no change occurs, since the battery signal has already been removed from that lead. It will be noticed that in all cases the importance of the alarm is either unchanged or increased, but is never decreased by the opening of the circuit.

The absence of tone would give a clue if this trouble is caused by severance of a conductor. However, the trouble may be due to dirty contact or a broken wire, in which case the tone may still be audible. A factor of safety resides in the fact that any alarm which is transmissible over one lead is severe enough, unless of short duration, to warrant dispatching a maintenance man to investigate its cause.

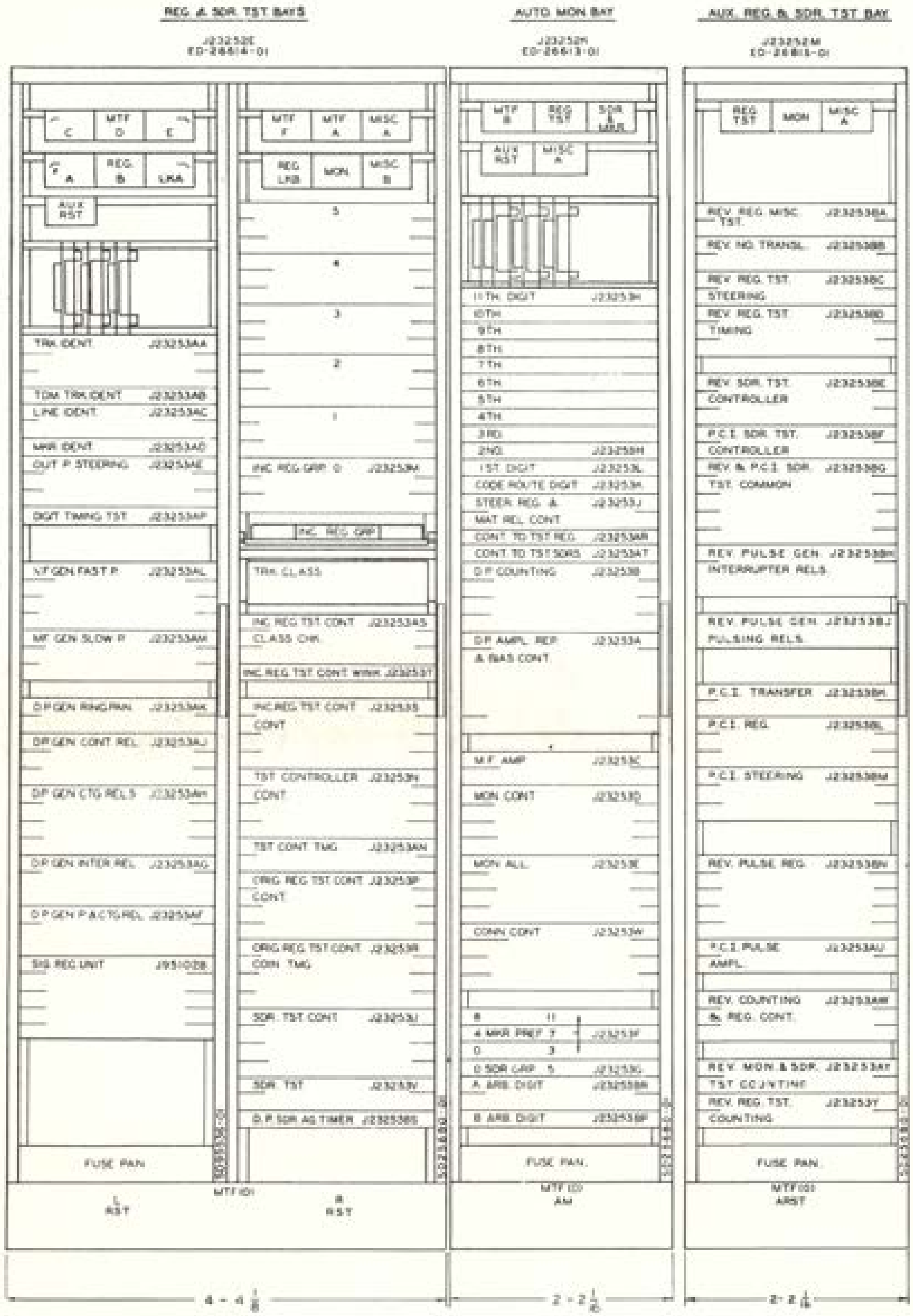
If while relay A is operated, a momentary break should occur that would release it, the transfer of alarms becomes enabled and the audible-alarm devices in the building are disabled. This feature does not appear desirable at first glance but the alternative--to disable the transfer under a similar failure condition--would be dangerous, since the alarm signals would then not reach any maintenance people. The present arrangement insures that in case of such trouble, the alarms are transmitted to the distant point where maintenance personnel are always in attendance. In addition, the pilot lamps at the originating point will light, which, without the audibles, will be indication of an alarm sending circuit failure.

At the receiving end of the transfer arrangement, the lamp and audible signals remain locked-in, even if the received signal has been retired. If the signal should be changed before attention can be given, all lamps and audibles remain locked-in. In addition to the alarm release key already referred to, there is an audible cutoff key which, when operated, will silence the audible and extinguish the lamps unless an alarm signal is still in effect, in which case the corresponding lamp remains lighted. If the alarm signal is subsequently replaced by the normal signal, the lamp is extinguished and the circuit is again normal. If, however, the lamp signal is changed, the original lamp is extinguished, a new lamp lights, and the audible is sounded.



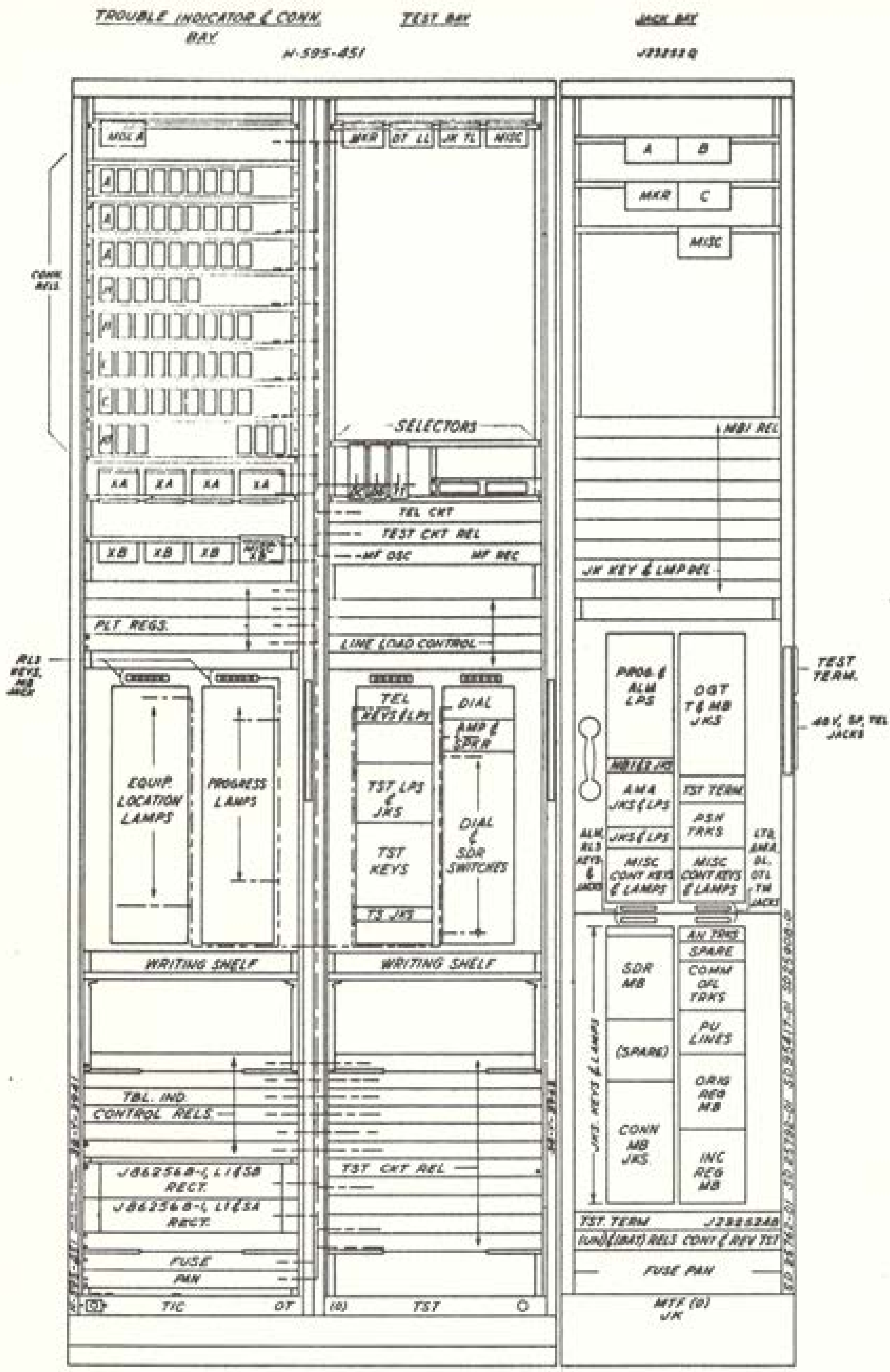
Master Test Frame

Figure 6-1



Register and Sender Test and Automatic Monitor Frames

Figure 6-2



OFFICE TEST FRAME AND JACK BAY-EQUIPMENT

Figure 6-3

OFFICE	DATE	TIME
TROUBLE ANALYSIS		
TROUBLE FOUND		
DATE CLEARED	TIME	BY

MKR	TV	REC	TVG	DR 0 1 2 3 / EVG	RD / RA	IPA / TGT	DNK / FCG	FT / LR	FAK / DCK	PI / FS	CI4 / PO	CI3 / AMA	CIF A / GTS	CI2 / OV	CI1 / BN	MXT	
ET / FRT	A / TRS	B / XLH	CBS	D / FNB	E	BSP / 2TR	TPT / TP	RPT / RP	CT: 0 1 2 4 7	CU: 0 1 2 4 7							

FU: 0 1 2 4 7 | VG: 0 1 2 4 7 10 | HG: 0 1 2 4 7

VF: 0 1 2 3 4 | FUT/TH: 0 1 2 3 4 5 6 7 8 9

VGT/HN: 0 1 2 3 4 5 6 7 8 9 10 11

HGT/T: 0 1 2 3 4 5 6 7 8 9 | VFT/OFF: 0 1 2 3 4 | OSG: 0 1 2 | SSA | SSB

CS/RST: 0 1 2 3 4 | RCT: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

TB: 0 1 2 3 4 5 | CN: 0 1 2 3 | CN/RG/S: 0 1 2 3 4 5 6 7 8 9

FS/TLR: 0 1 2 3 4 | TF/RN: 0 1 2 4 7 | LC/U: 0 1 2 3 4 5 6 7 8 9

LV: 2 3 4 5 6 7 8 9 | CH: 0 1 2 3 4 5 6 7 8 9 | RLR | HR

TS: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

A: 0 1 2 4 7 | B: 0 1 2 4 7 | C: 0 1 2 4 7 | CI/T D: 0 1 2 4 7

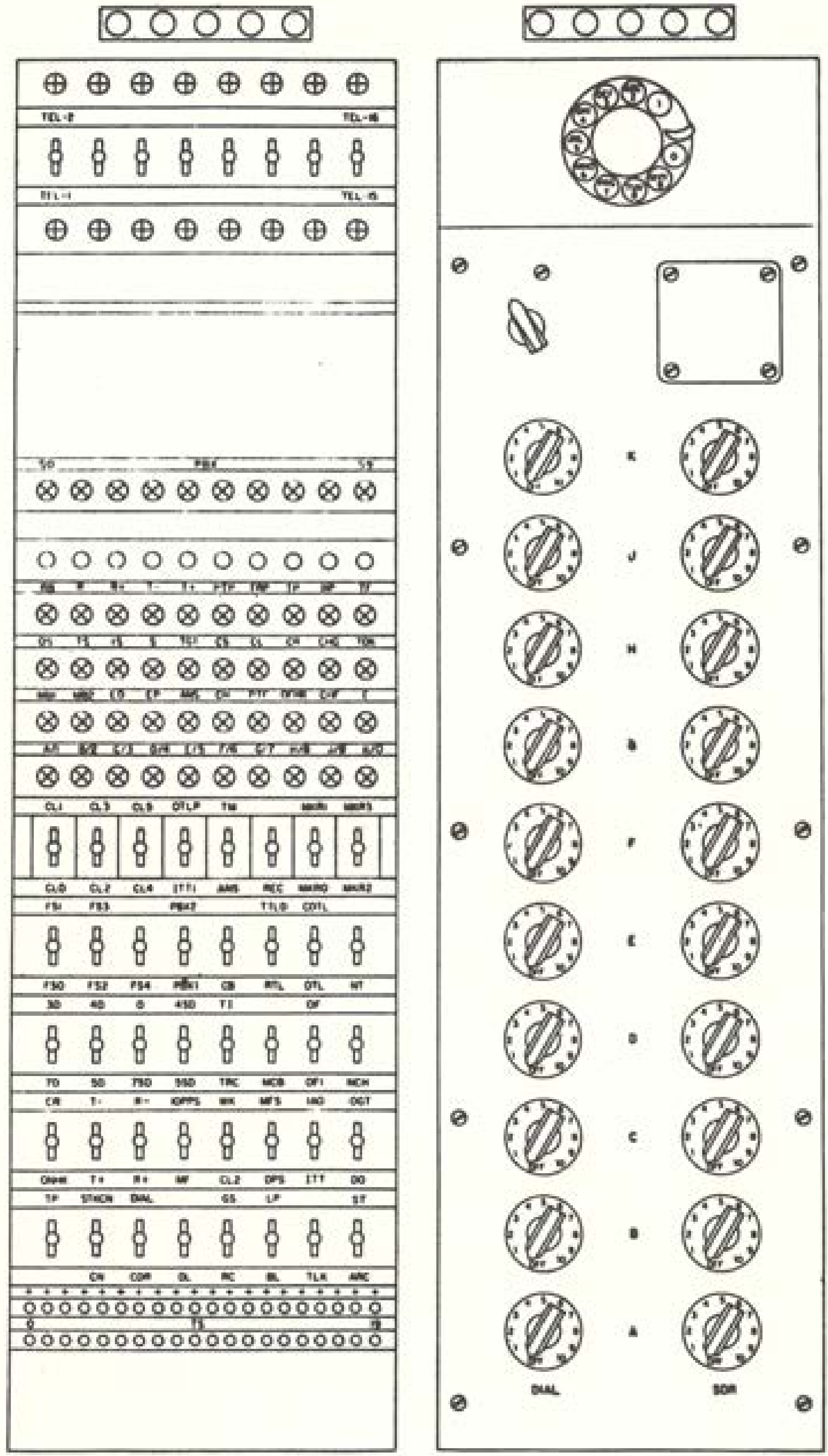
E/A': 0 1 2 4 7 | F/B': 0 1 2 4 7 | G/C': 0 1 2 4 7 | H/D': 0 1 2 4 7

J/E': 0 1 2 4 7 | K/F': 0 1 2 4 7 | CI/U L: 0 1 2 4 7 | XPI XTI XUI XTC XTL GS: 1 2 3 4 5

MB: 0 1 2 4 7 | CM: 3 A B C | SD | PCK | PRL | RLK | PTR | JG: 0 1 2 3 4

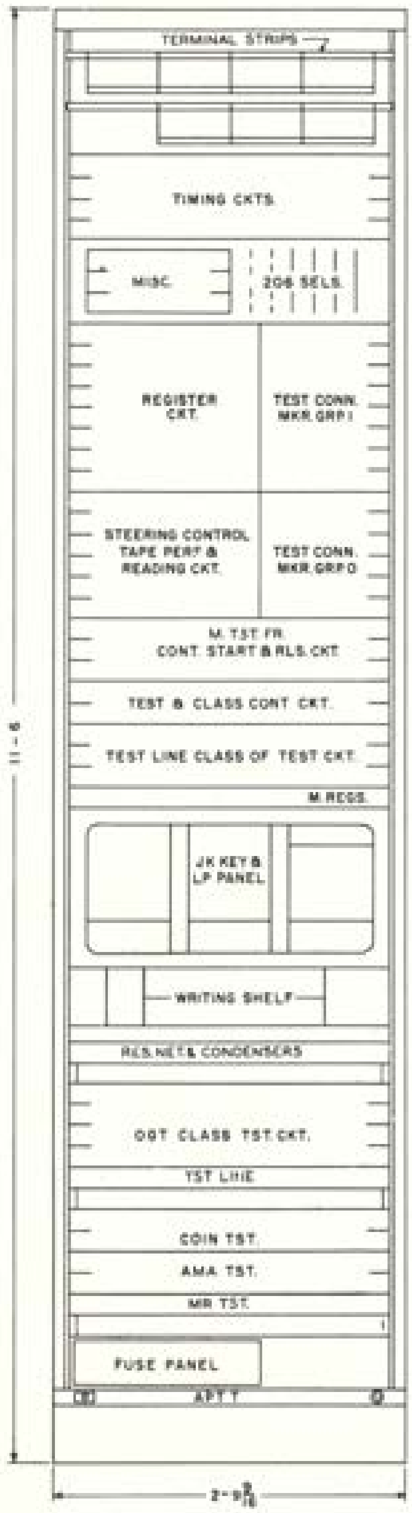
TROUBLE INDICATOR DISPLAY

Figure 6-4



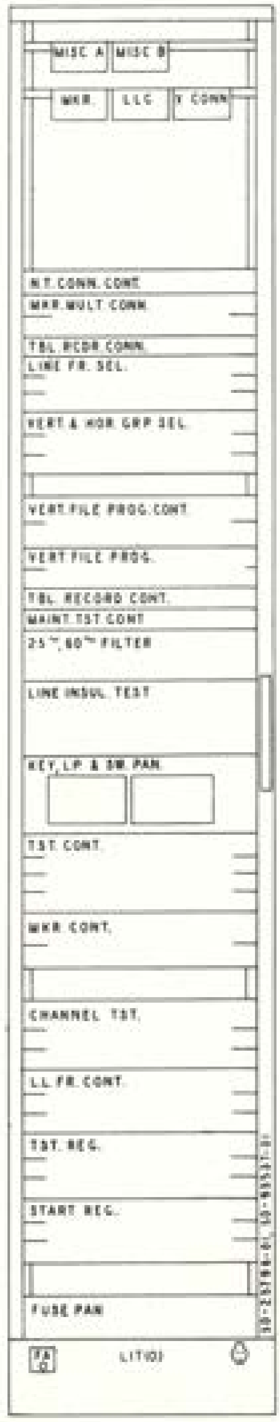
TEST CIRCUIT CONTROL PANEL

Figure 6-5



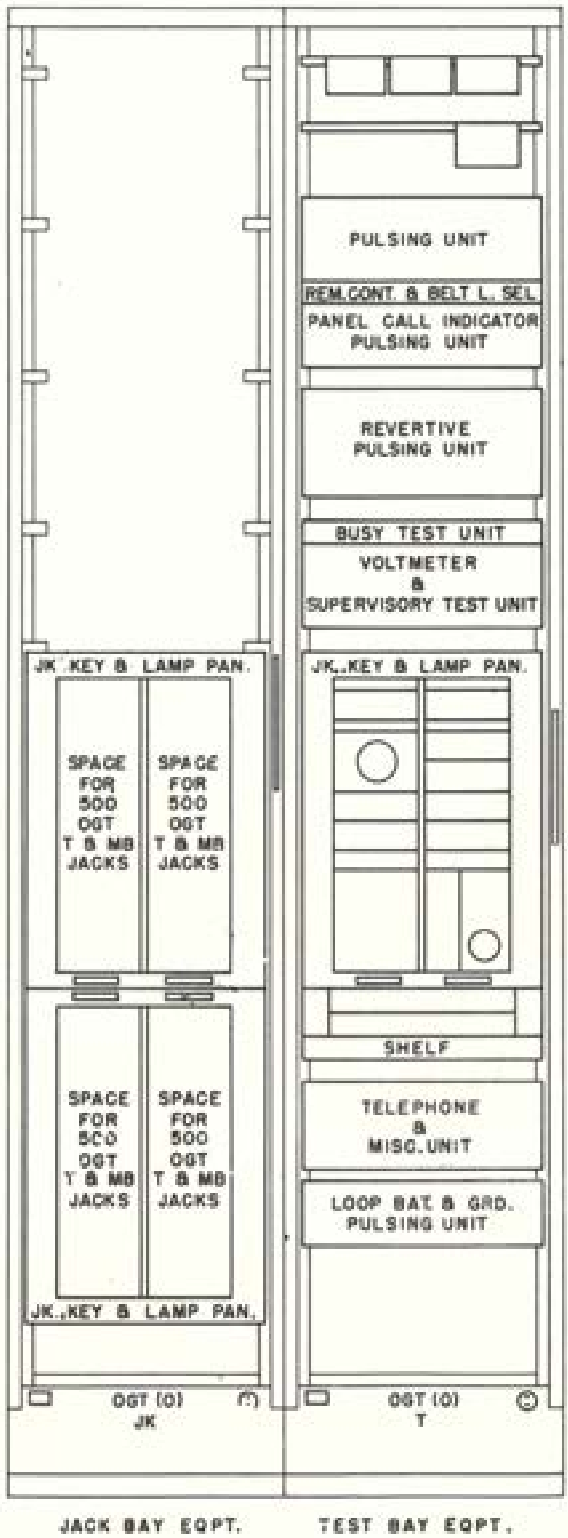
Automatic Progression Trunk Test Frame

Figure 6-6



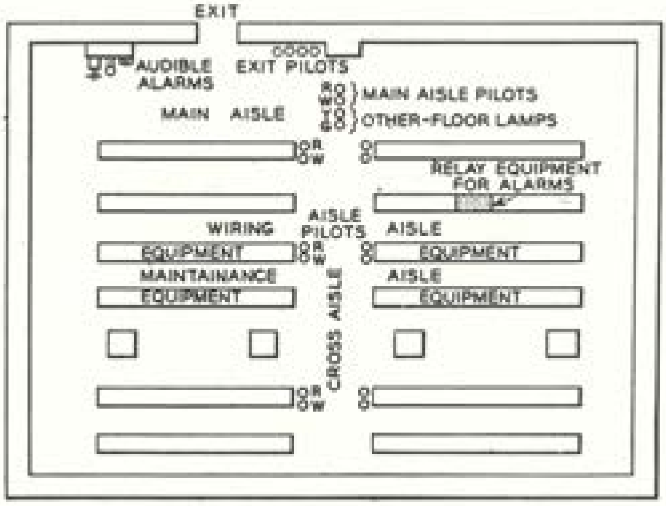
Line Insulation Test Frame

Figure 6-7



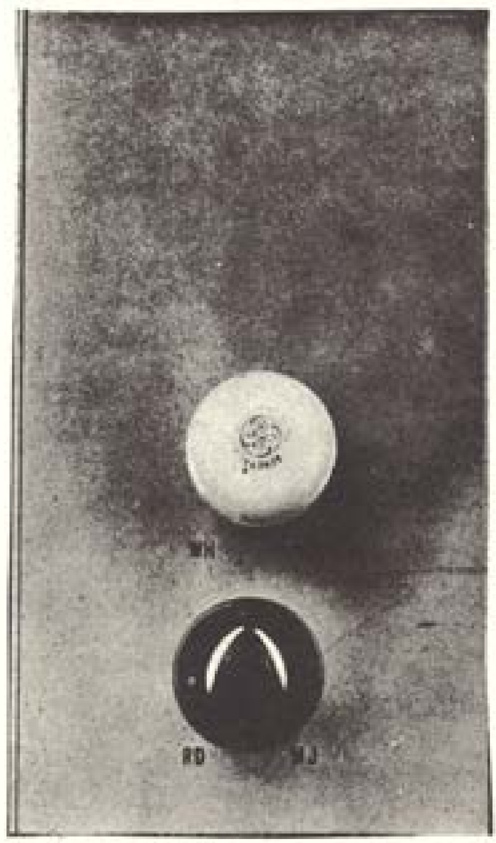
Outgoing Trunk Test Frame

Figure 6-8



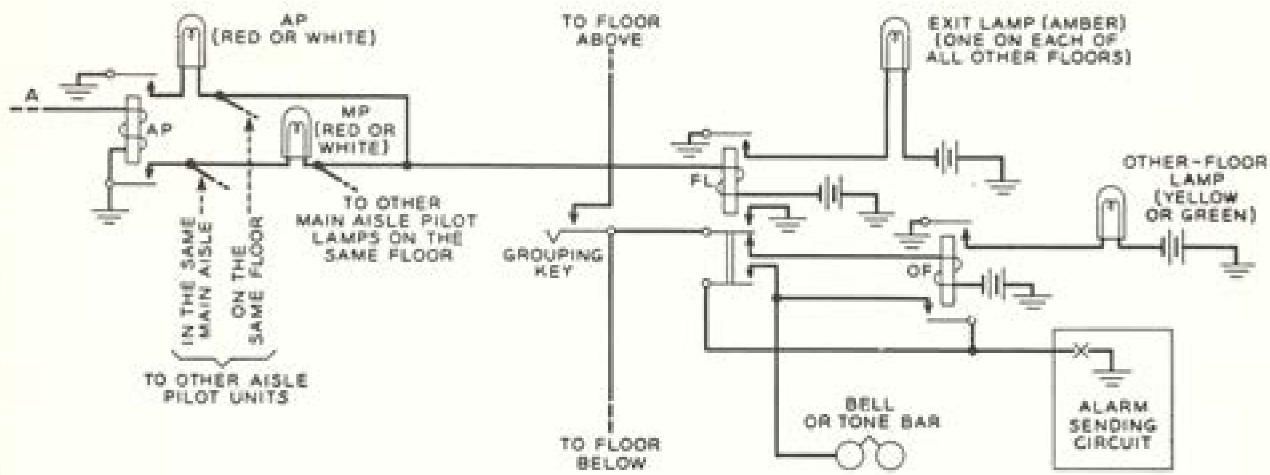
Arrangement of alarm pilots in a hypothetical central office

Figure 6-9



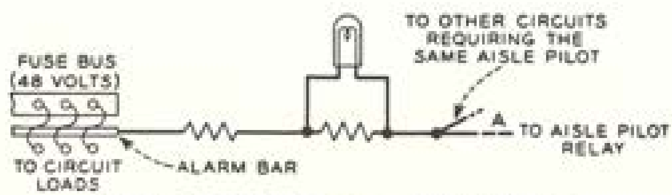
-The aisle pilot unit used in the No. 5

Figure 6-10



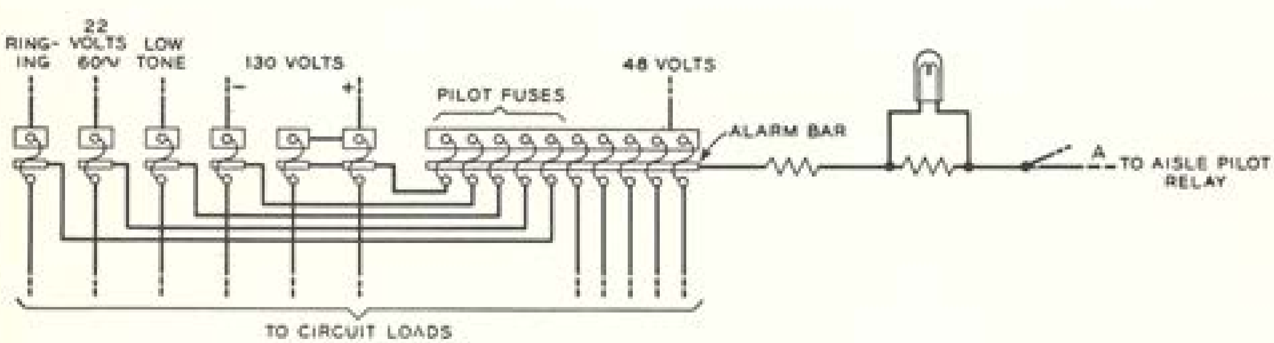
-Simplified schematic of the alarm circuit for No. 5 crossbar

Figure 6-11



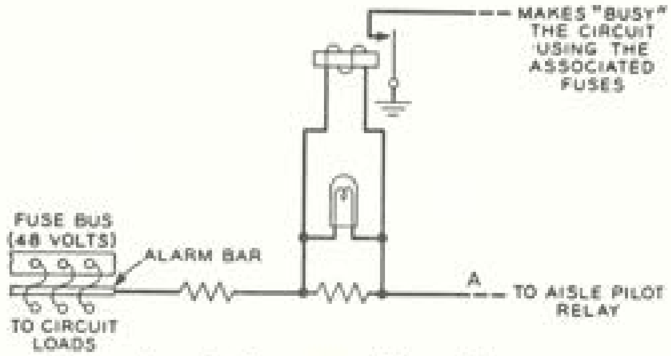
The standard fuse alarm arrangement

Figure 6-12



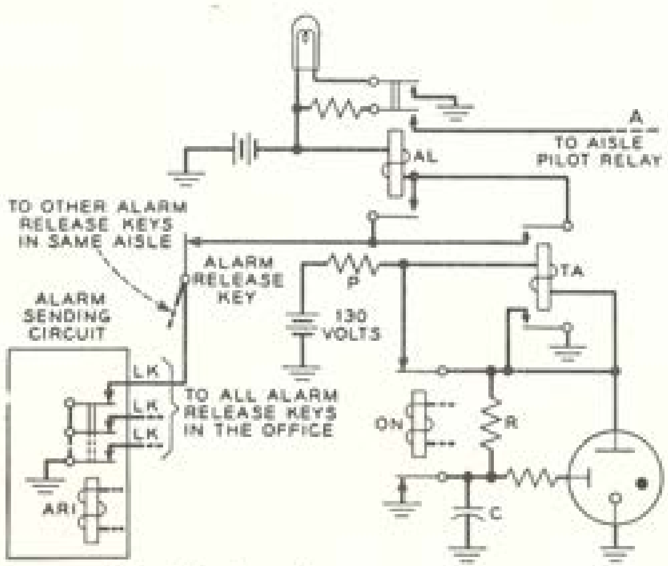
-Pilot fuse alarm system employed where more than one type of power supply is required

Figure 6-13



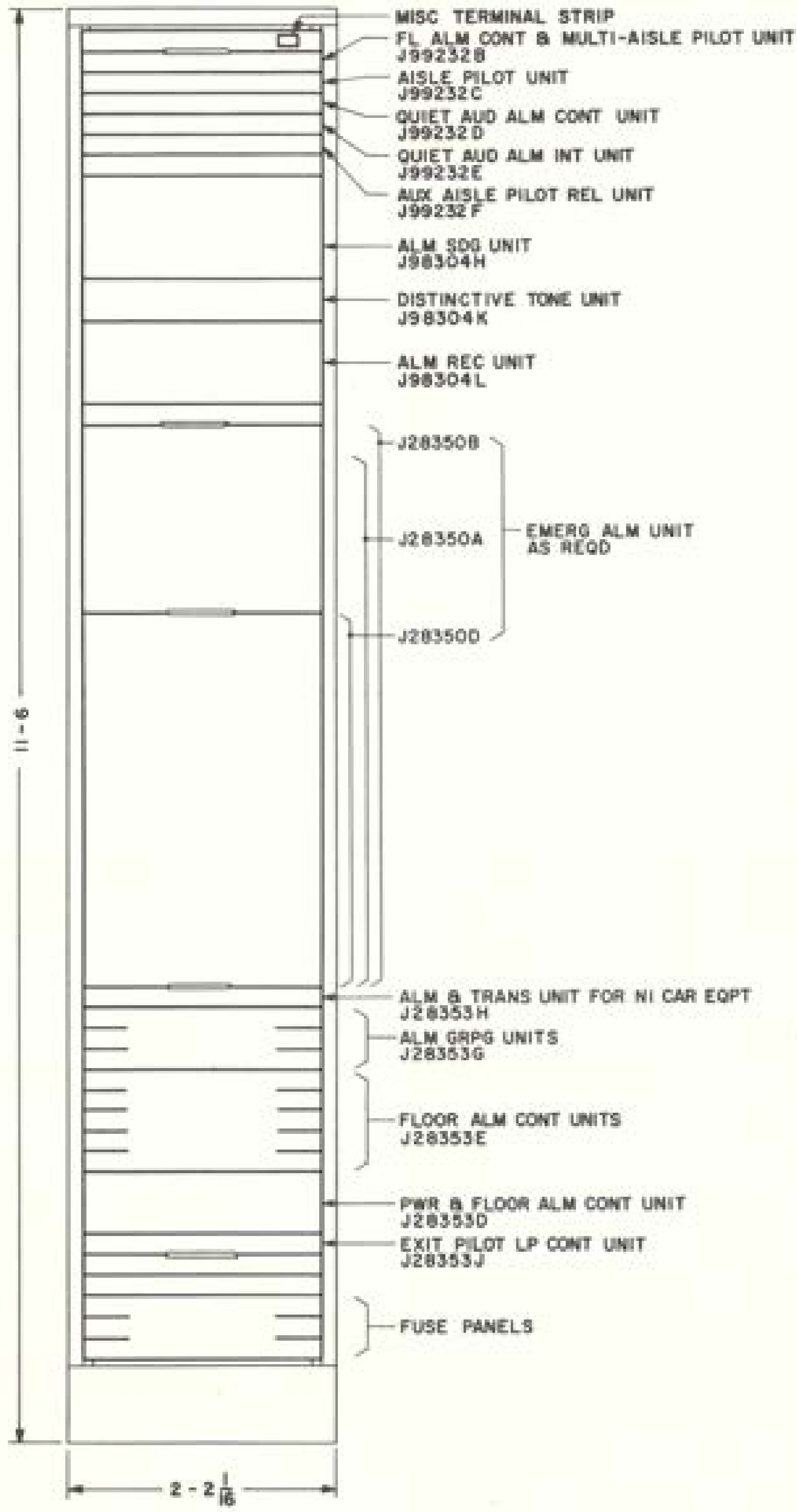
A make-busy type of fuse alarm

Figure 6-14



A typical time alarm

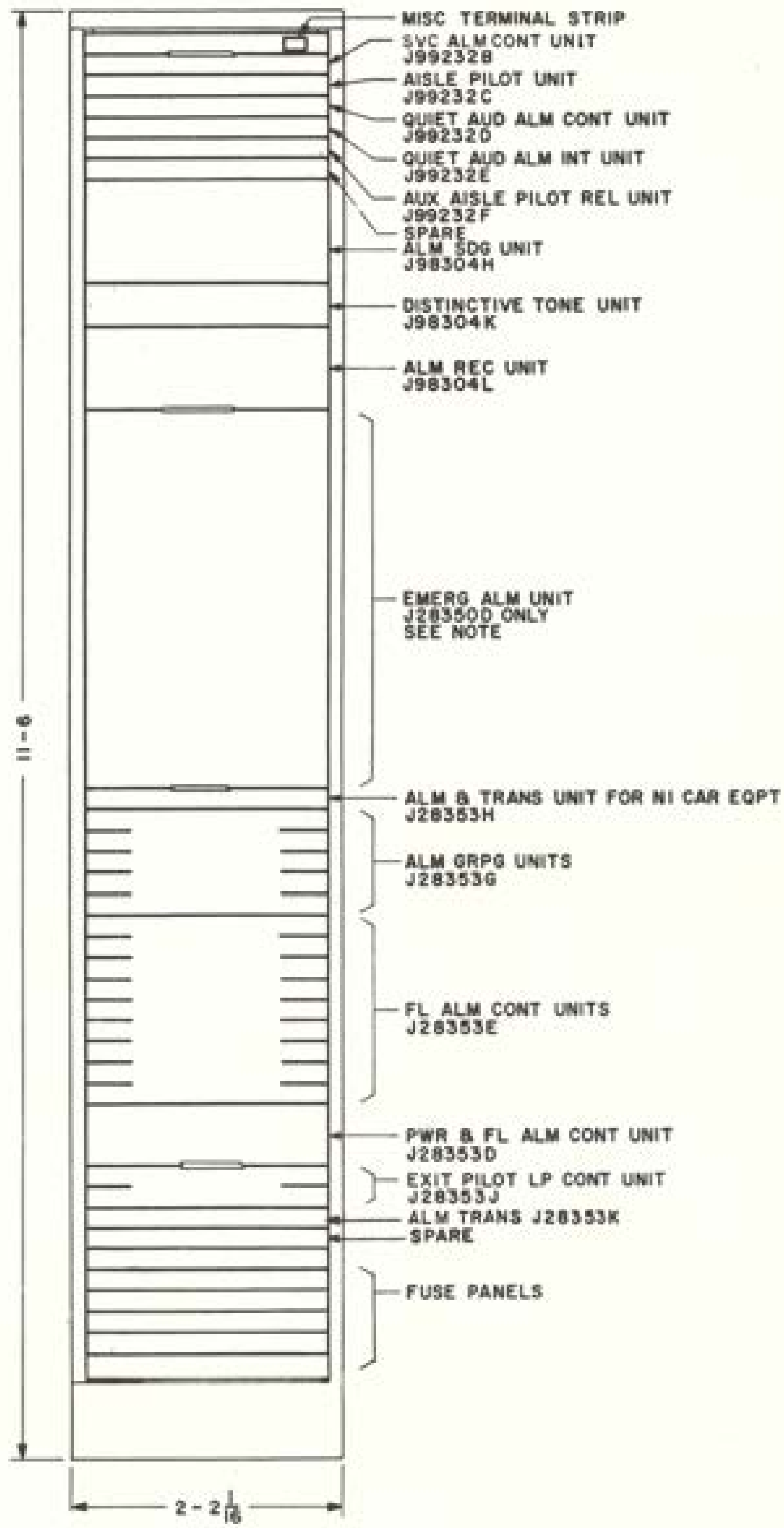
Figure 6-15



Alarm Frame - Typical Equipment For Maximum Six Floors

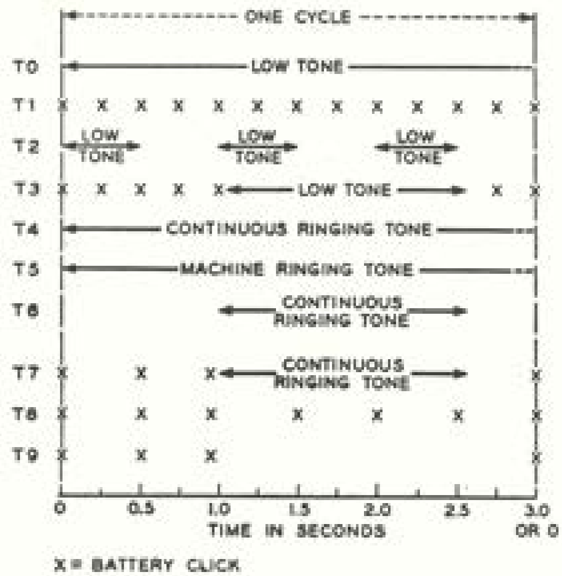
Figure 6-16

NOTE:
WHEN EMERGENCY ALARM UNIT PER J28350A OR B IS REQUIRED, UNIT IS MOUNTED ON A MISC RELAY RACK PREFERABLY NEAR THE ALARM FRAME.



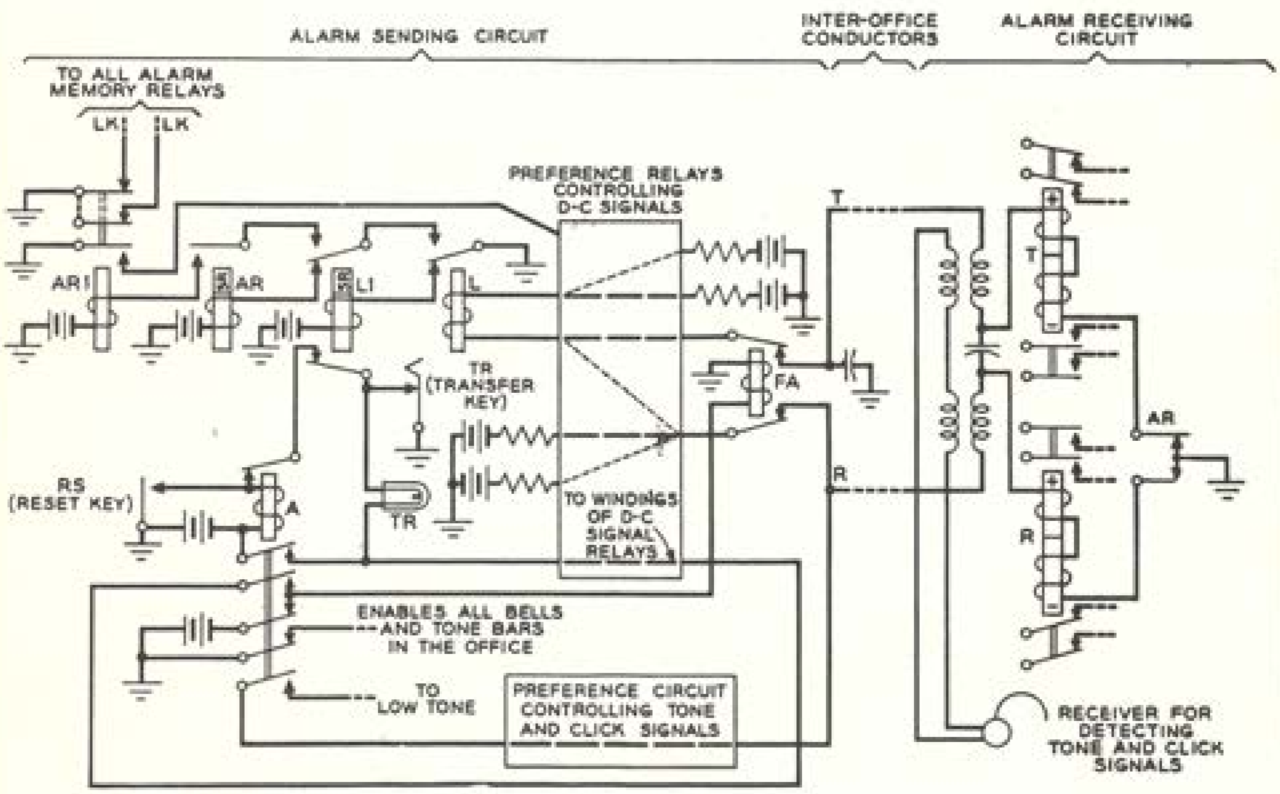
Alarm Frame - Typical Equipment For Maximum Ten Floors

Figure 6-17



-*Tone and click combinations*

Figure 6-18



-*Simplified sketch of the alarm sending and receiving circuits*

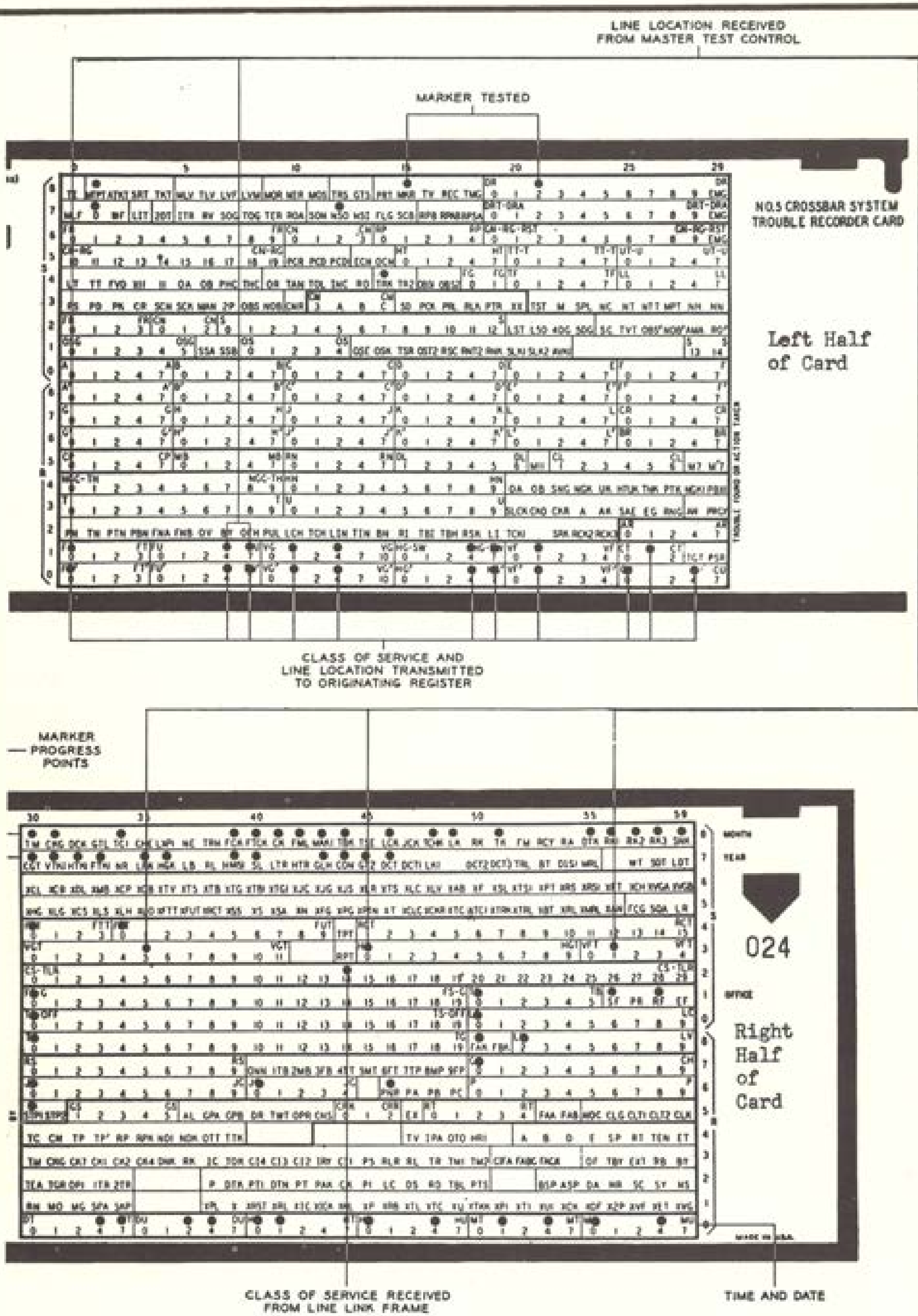
Figure 6-19

LEAD	ALARM CONDITION								
	ALARM TRANSFER FAILURE	TROUBLE RECORDER SEIZURE		ALARM					NORMAL
		1 ST TRIAL	2 ND TRIAL	MAJOR POWER	MAJOR SWITCHING	PERMANENT SIGNAL	LOAD	MINOR	
T	OPEN	–	OPEN	–	OPEN	+	+	–	+
R	OPEN	OPEN	–	–	+	OPEN	+	+	–
	8	7	6	5	4	3	2	1	0

DECREASING SEVERITY ⟶

-D-c signal combinations

Figure 6-20



No. 5 Crossbar System Trouble Recorder Card

Figure 6-21