± Crossbar

for any size exchange... up to ten thousand lines...

KELLOGG Crossbar

DIAL TELEPHONE SWITCHING SYSTEM

★

Type 7-2

KELLOGG — DIVISION OF I T & T —

KELLOGG SWITCHBOARD AND SUPPLY COMPANY

A Division of International Telephone and Telegraph Corporation

SALES OFFICES: 79 West Monroe Street, Chicago 3, Illinois

KELLOGG CROSSBAR
DIAL TELEPHONE SWITCHING SYSTEM

**INTRODUCTION, FUNDAMENTALS, BASIC UNITS, CIRCUIT PRINCIPLES,
TRUNKING METHODS, OPERATING FEATURES, EQUIPMENT LAYOUT, HOUSING AND FLOOR PLANS**

TYPE 7-2 MANUAL

PRINTED and REPRINTED 1954

KELLOGG SWITCHBOARD AND SUPPLY COMPANY
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
CHICAGO, ILLINOIS

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INTRODUCTION

Kellogg Crossbar. . . .

Communication people have long been confronted with the problem in dial conversion planning of choosing a dial switching equipment affording an economical approach to meet the ever growing problem of community growth.

The Kellogg Crossbar central office equipment presents the solution to this problem.

The switch employed in the Crossbar system is the result of continuous research to make available to the Telephone Industry a dial switching system filling the requirements of all types of initial installations. At the same time provides for an economical and symmetrical expansion to meet unexpected growth so frequently encountered.

The Kellogg Crossbar system:

1. Eliminates many of the weaknesses inherent in other types of dial switching systems.

2. Combines features found in some types of other existing systems but not all present in any one system.

3. Provides features greatly needed in the Independent Telephone Industry but not available in other systems.

FUNDAMENTALS

A telephone system is a network of lines and equipment arranged in such a manner that a subscriber may be connected to another within the area served by that particular system. Earlier dial switching systems established their connections by means of various electrical and mechanical devices.

The Crossbar switch and its associated apparatus have made it possible to develop an entirely new and radically different method of establishing a speech connection between two subscriber's telephones.

This method of connecting two metal bars at the intersection where they cross each other at right angles to establish a conversation path is appropriately called a Crossbar System.

THE CROSSBAR SWITCH

The Kellogg Crossbar Switch derives its name from the assembly of a number of horizontal metal bars extending from left to right known as horizontals and a number of vertical metal bars extending from front to back known as verticals.

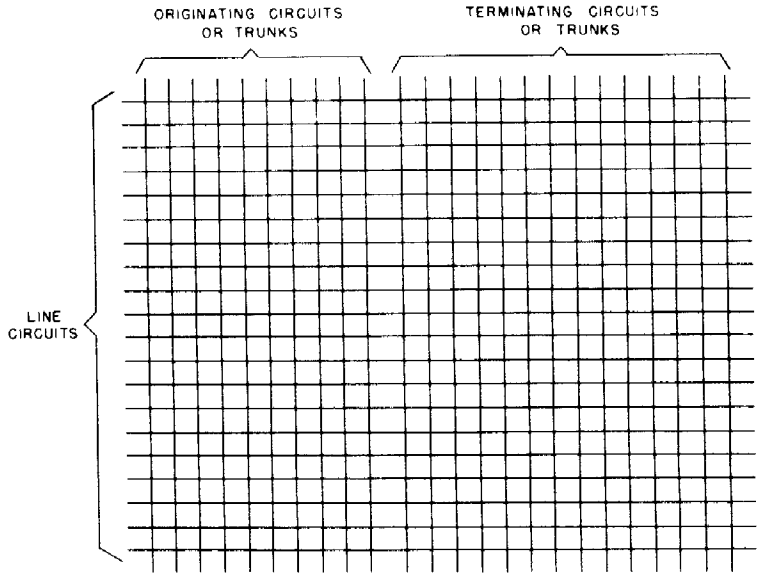
Where the bars cross, a set of contacts made of precious metal are associated with each bar. These contacts are so arranged that a conversation path can be established from one bar to another bar where they cross at right angles.

No connections are made by brushes, wipers or knife blade switches moving over a large number of terminals as commonly found in other switching systems.

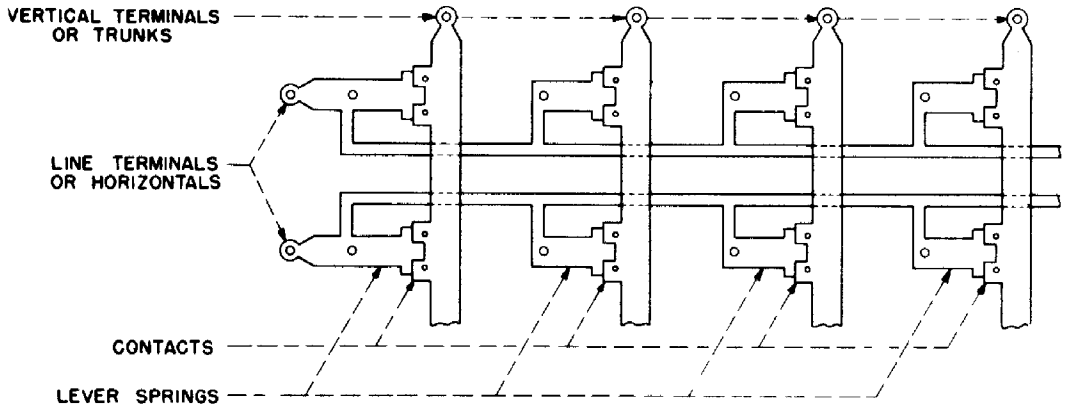
While the Kellogg Crossbar system is available in several types of design to meet varying requirements, this manual covers the Kellogg 7-2 Crossbar system.

The 7-2 system although primarily designed for use in small unattended or medium sized offices is readily expandable to meet any unexpected growth requirements.

As can be seen in Figure 1, horizontal lines cross vertical lines at right angles. By placing contacts at the intersection of these lines and insulating the lines from each other a connection can be established between any two lines. In the illustration it will be observed there are 20 horizontal lines with 10 vertical lines on the left portion and 14 vertical lines on the right portion. By letting the 20 horizontals represent subscriber lines and the verticals represent cord circuits or trunks it can be seen that 10 originating or 14 terminating connections may be handled simultaneously for these 20 lines.



FUNDAMENTAL CROSSBAR DESIGN
FIGURE 1



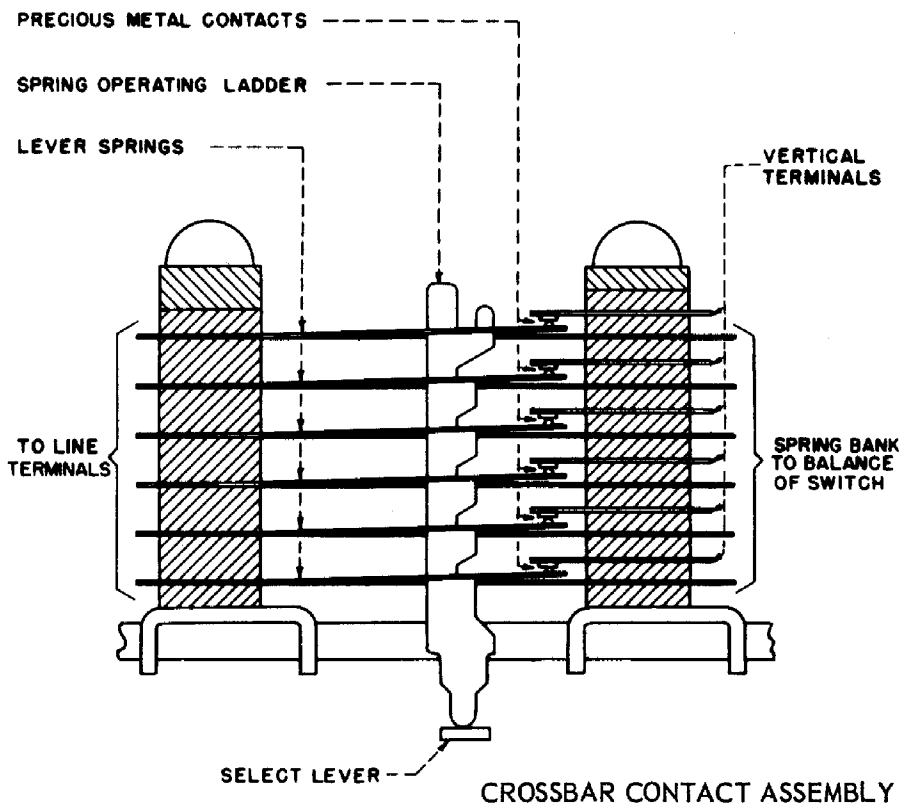
CROSSBAR SWITCH CONTACT SECTION
FIGURE 2

Figure 2 illustrates a contact section of a Crossbar switch showing two horizontal paths and four vertical paths. When one set of contacts as indicated by the arrows is closed, one horizontal and one vertical path are connected.

The Crossbar switch is composed of a number of such horizontal and vertical bars with their associated contacts.

It will be noted there are no heavy parts or mechanisms to be moved, avoiding excessive wear.

In Figure 3 a stack of contacts is shown operated. Connections are established by the rapid and simple operation of a relay armature moving only a few thousandths of an inch and in ten thousandths of a second.



CROSSBAR CONTACT ASSEMBLY
FIGURE 3

To make a connection, upward pressure is exerted upon the Spring Operating Ladder by operation of a relay armature against the Select Lever which will be described later.

Since the conversation path is established simply by the closing of contacts rather than the wiping over of many contact terminals, precious metal can be used for the surface of the contacts, eliminating noise factors inherent in switching systems using base metal contacts.

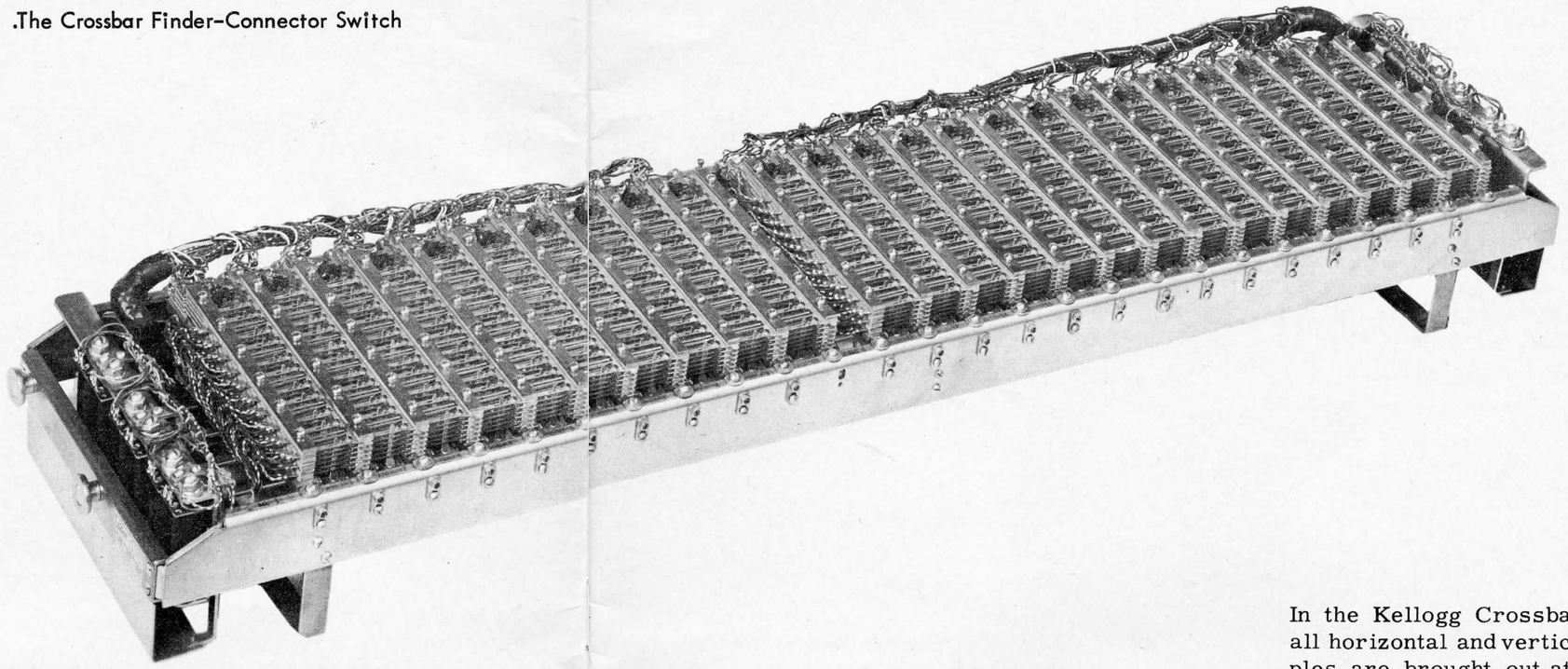
BASIC UNITS OF THE 7-2 CROSSBAR SYSTEM. . .The Crossbar Finder-Connector Switch

The basic unit of the Kellogg 7-2 Crossbar switching system is the finder-connector switch. This switch has a capacity of 20 lines.

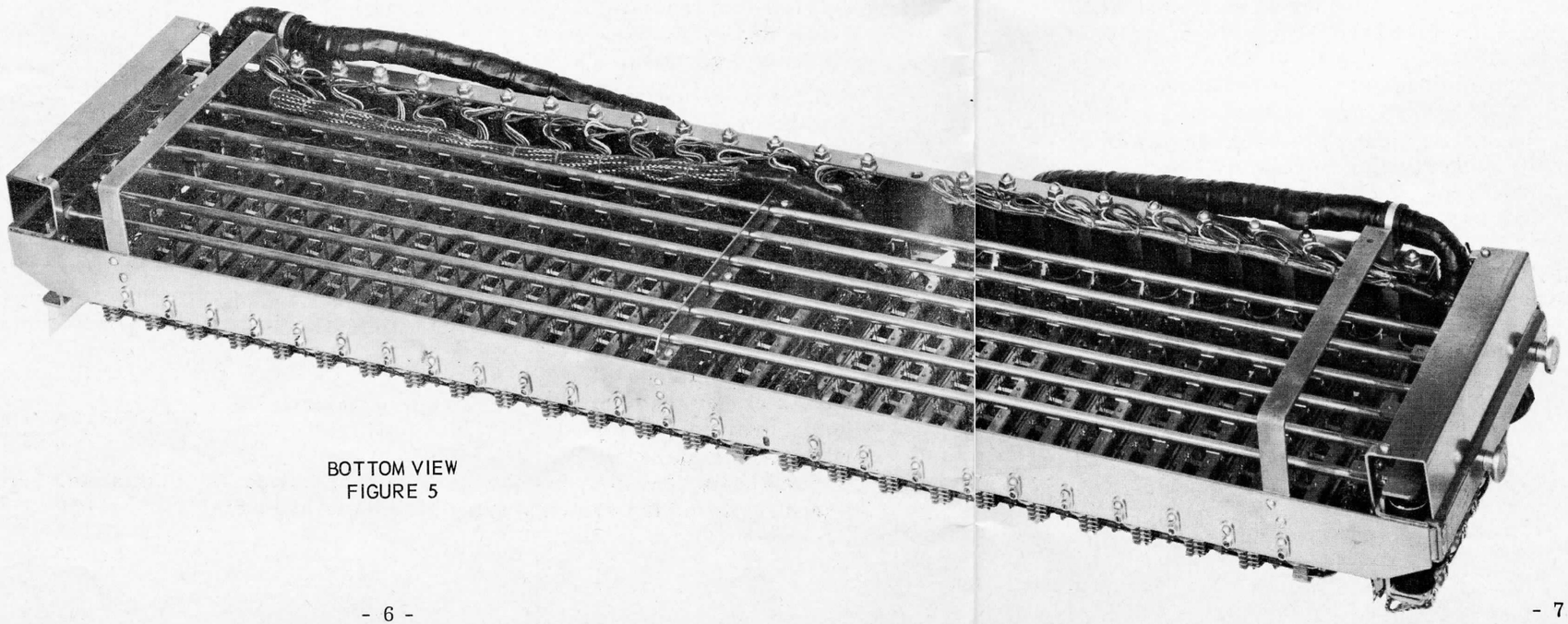
The contact bank, made up of stacked spring bars, is mounted on top of the switch frame. See Figure 4.

The stacks extending from left to right make up the horizontal multiple, each with the tip, ring, and sleeve leads of two line circuits. These horizontals stacked one above the other are referred to as upper and lower horizontals. Those extending from front to back make up the vertical multiple or trunk circuits, with the same tip, ring and sleeve arrangement.

Since the spring bars form the built-in horizontal and vertical multiples, there is no need for soldered wire multiples.



TOP VIEW
FIGURE 4



BOTTOM VIEW
FIGURE 5

In the Kellogg Crossbar switch all horizontal and vertical multiples are brought out at the rear of the switch by short flexible cable, and are attached to the switchboard frame wiring by plug connectors.

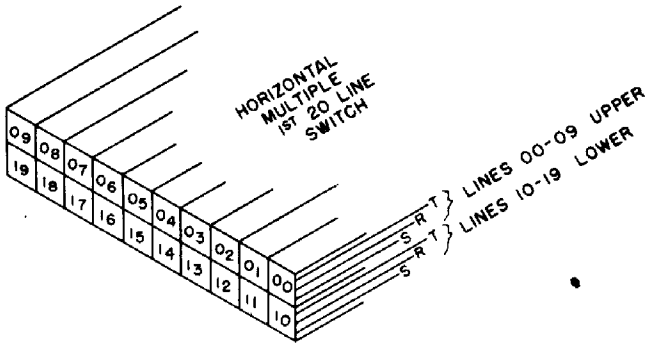
Plug-in type connectors on all Crossbar switches assure added flexibility for rearrangement and easy growth of equipment.

In the bottom view of the Crossbar Switch Figure 5, a number of rods may be seen extending across the switch. These rods are called Select Rods. One rod serves each pair of horizontals. The function of the Select Rod is to prepare the selected horizontal to close contacts with a selected vertical at their crosspoint.

Mounted on the rear of the frame is a row of magnet coils which operate the armature associated with the stacks of vertical bars.

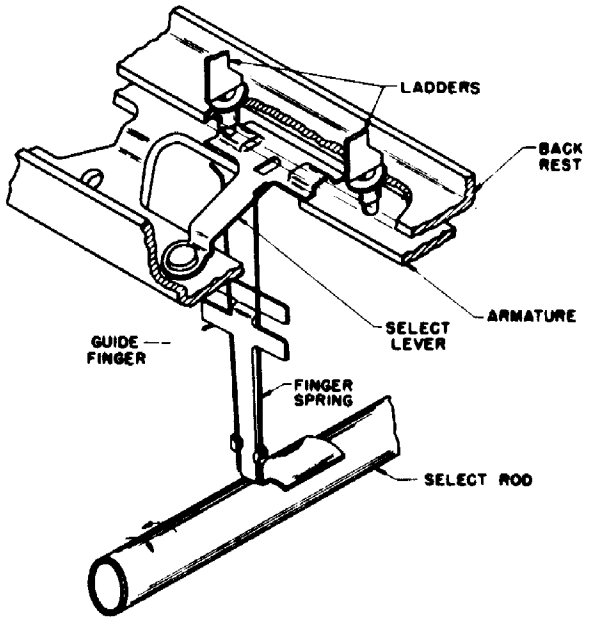
As previously mentioned there are twenty lines on each Crossbar switch. These lines are arranged in ten horizontal rows with two line circuits on each row. The line number assigned indicates whether the line is the upper or lower of the two in a given horizontal. The even tens digit indicates a line located on the upper horizontal, while the odd tens digit indicates a line on the lower horizontal.

The diagram in Figure 6 illustrates the relative bank location of the lines when the Crossbar switch is viewed from the left end.



BLOCK DIAGRAM
UPPER AND LOWER LEVER
LINE LAYOUT
FIGURE 6

To make a selection of a set of contacts requires operation of two Select Rods and a Hold armature. One Select Rod selects the horizontal, the second rod selects the upper or lower line, and the Hold armature of the selected vertical completes and holds the connection.



CONTACT OPERATING MECHANISM
FIGURE 7

When the Hold armature has operated, the Select Rods are released. See Figure 7.

Finger Springs held in place by Guide Fingers are attached to the Select Rods at each vertical. When the Select Rod is rotated in one direction, the Finger Spring moves a Select Lever under the ladder for one set of contacts. When the rod is rotated in the other direction the Finger Spring moves the Select Lever under the ladder for the other set of contacts.

After the Select Lever is in position under the ladder, upward pressure exerted by a Hold armature causes the contacts to be closed.

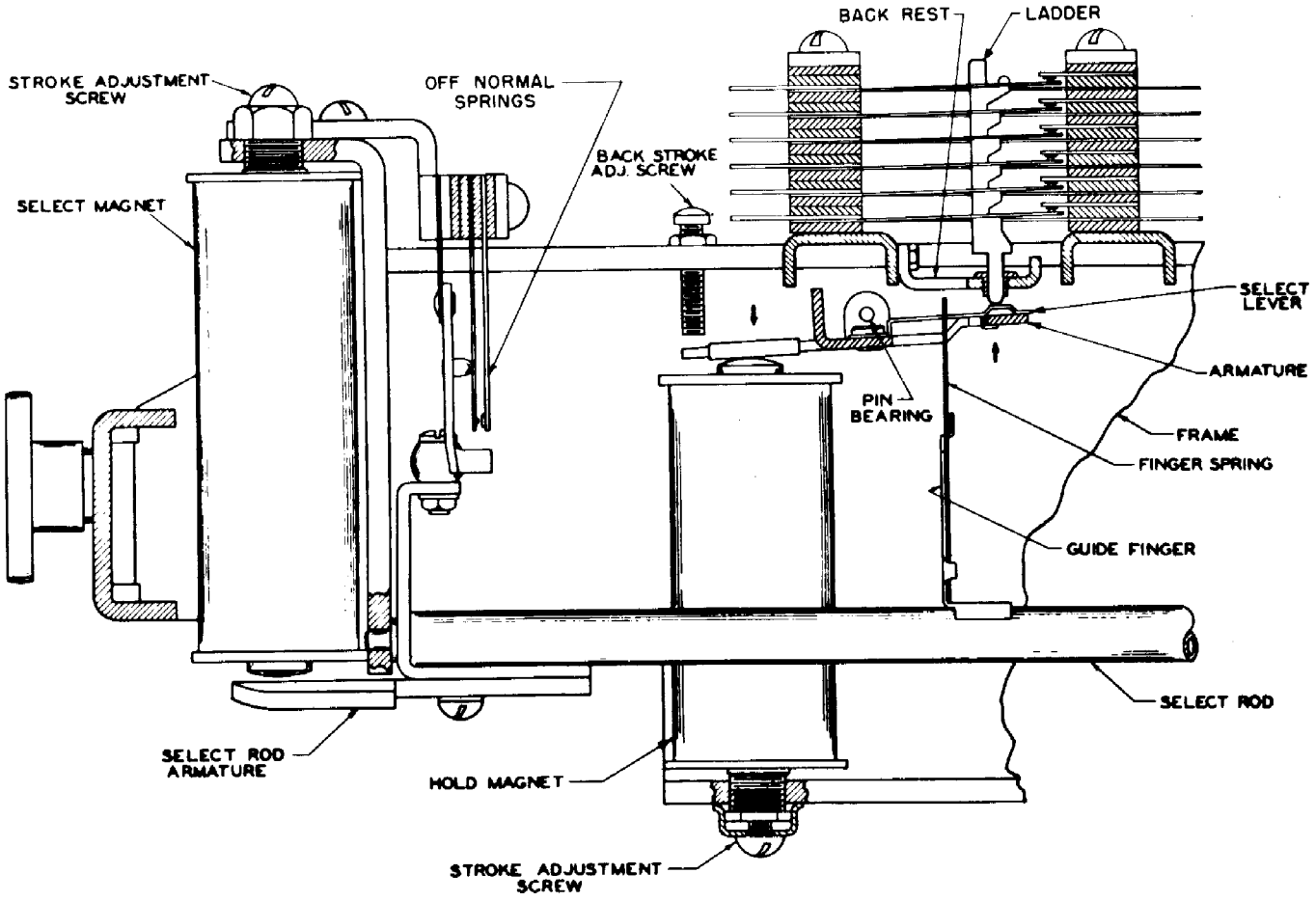
The Hold armature remains operated during the period of the call. See Figure 8.

After the Hold armature has operated, the Select Rods return to mid-position bringing all Select Levers back to normal except the one operated by the Hold armature, thus freeing the Select Rod for another selection with a different vertical.

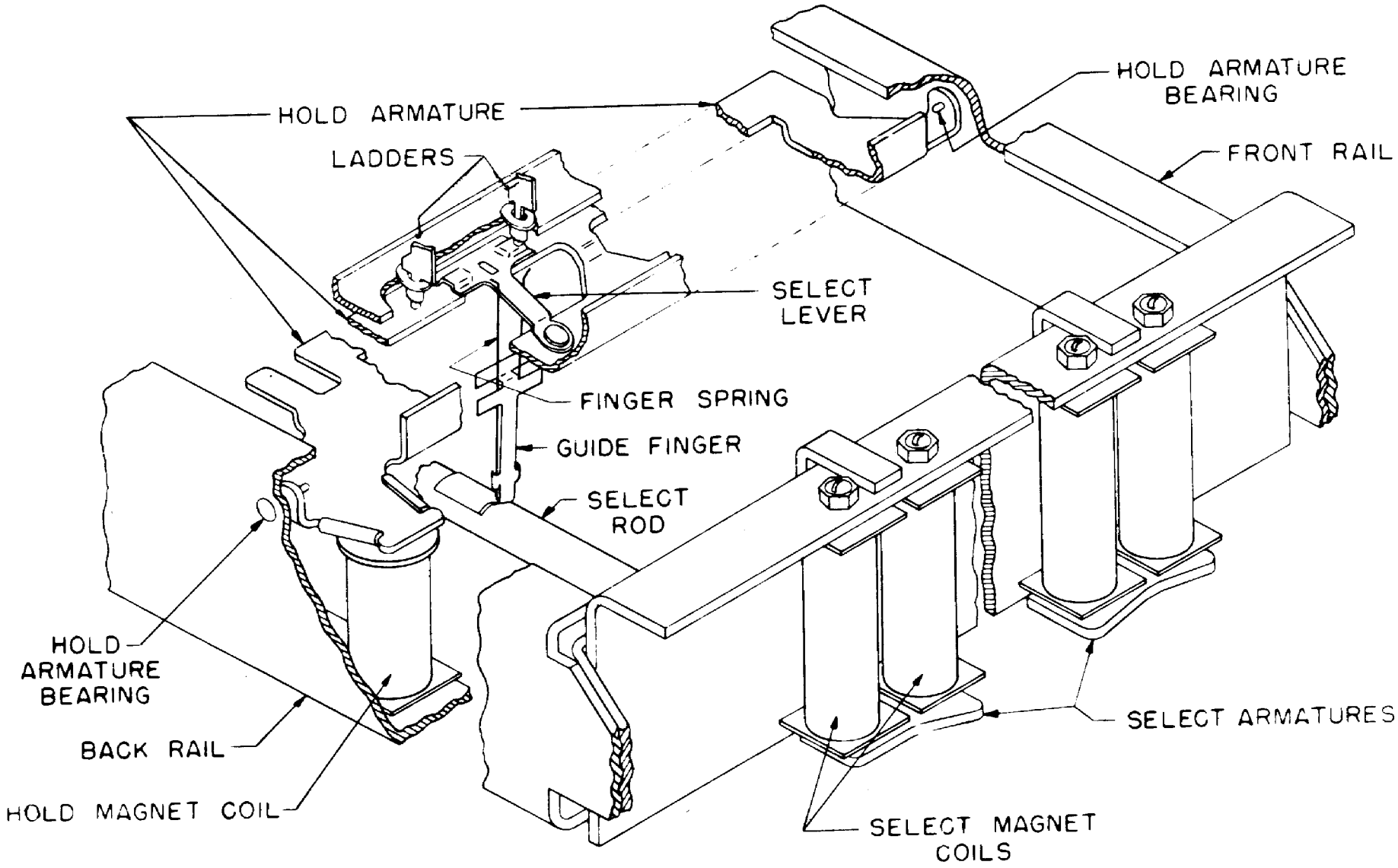
In addition to the regular contact banks of the switch, each vertical is provided with an extra set of contacts which always operate along with the springs at the selected cross-point.

The only movement in a Crossbar switch is the rotation of the Select Rods and the operation of the Hold armatures to close the selected contacts.

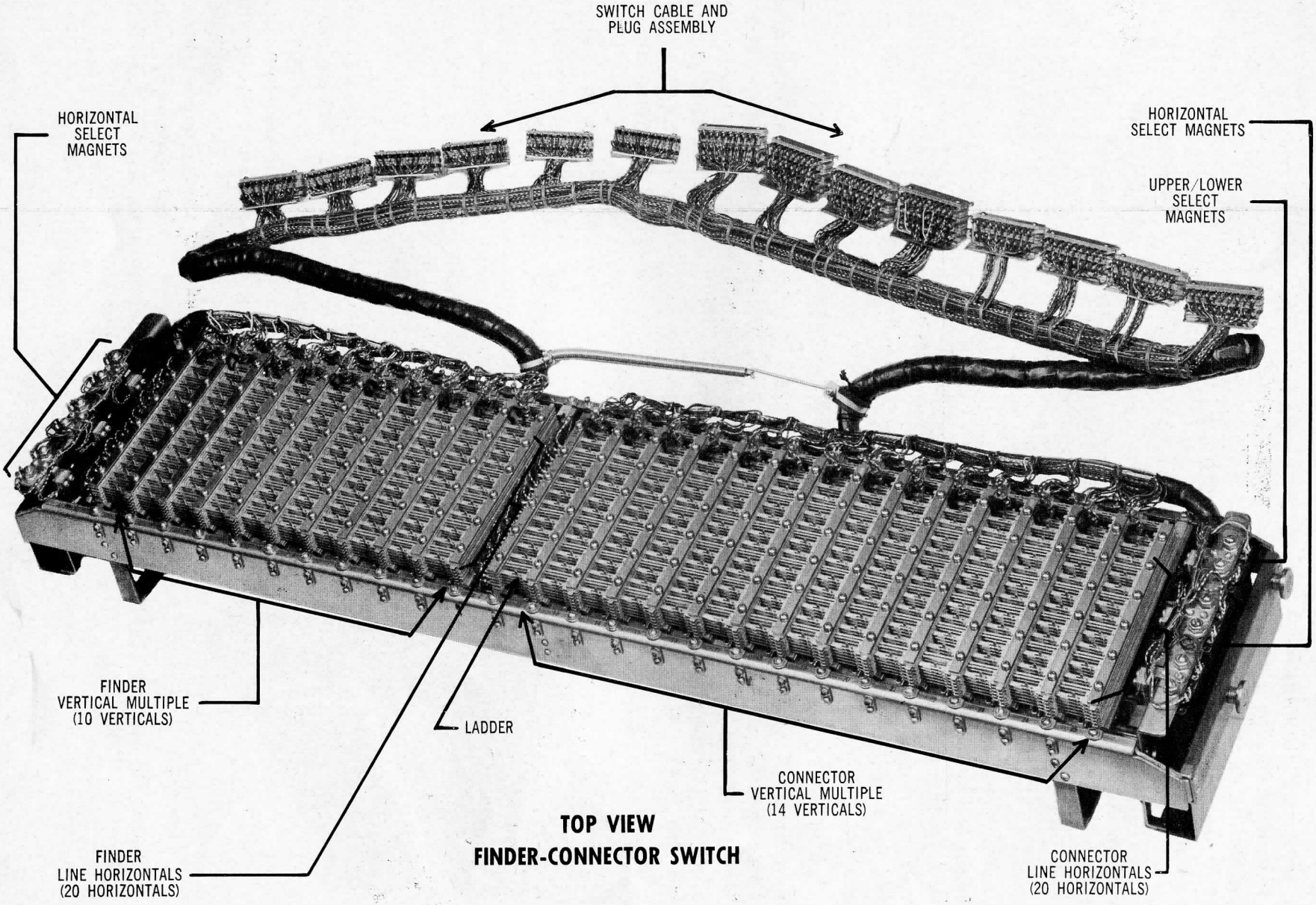
The cut-a-way view in Figure 9 further illustrates the selection and hold mechanism.



TRUNK SELECTING AND
CONTACT OPERATING MECHANISM
FIGURE 8



SELECT AND HOLD MECHANISM
FIGURE 9



TOP VIEW
FINDER-CONNECTOR SWITCH

FIGURE 10

THE MAGNETIC IMPULSE COUNTER

The Magnetic Impulse Counter, Figure 11, is fundamentally a relay with ten two step armatures and their associated contacts. Its function is to register the dial pulses received.

One impulse counter is included in a Selector or Connector for each digit of the dialing plan.

The armatures are arranged to operate in sequence responding to the pulses applied to the counter coil. When the counter is normal No. 1 armature is always in a half operated position. See Figure 12.

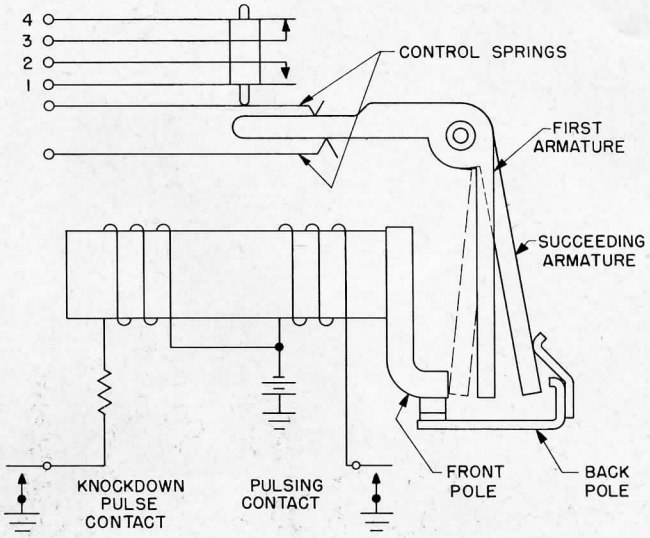
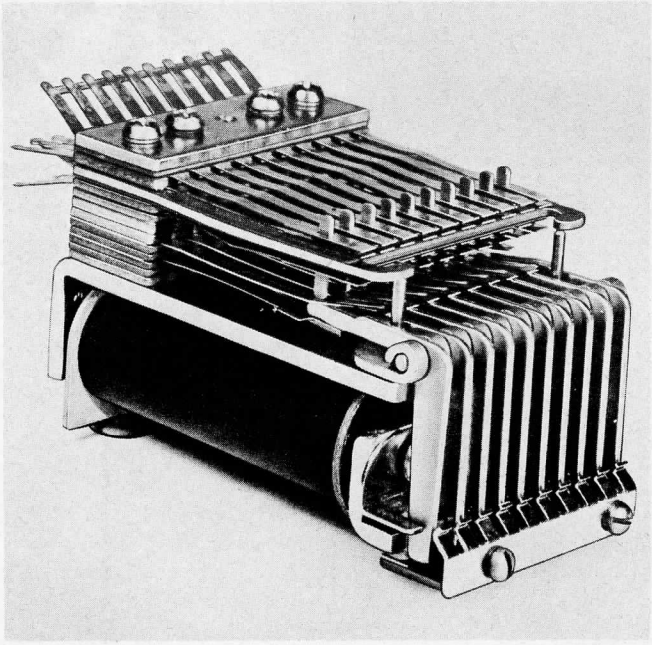


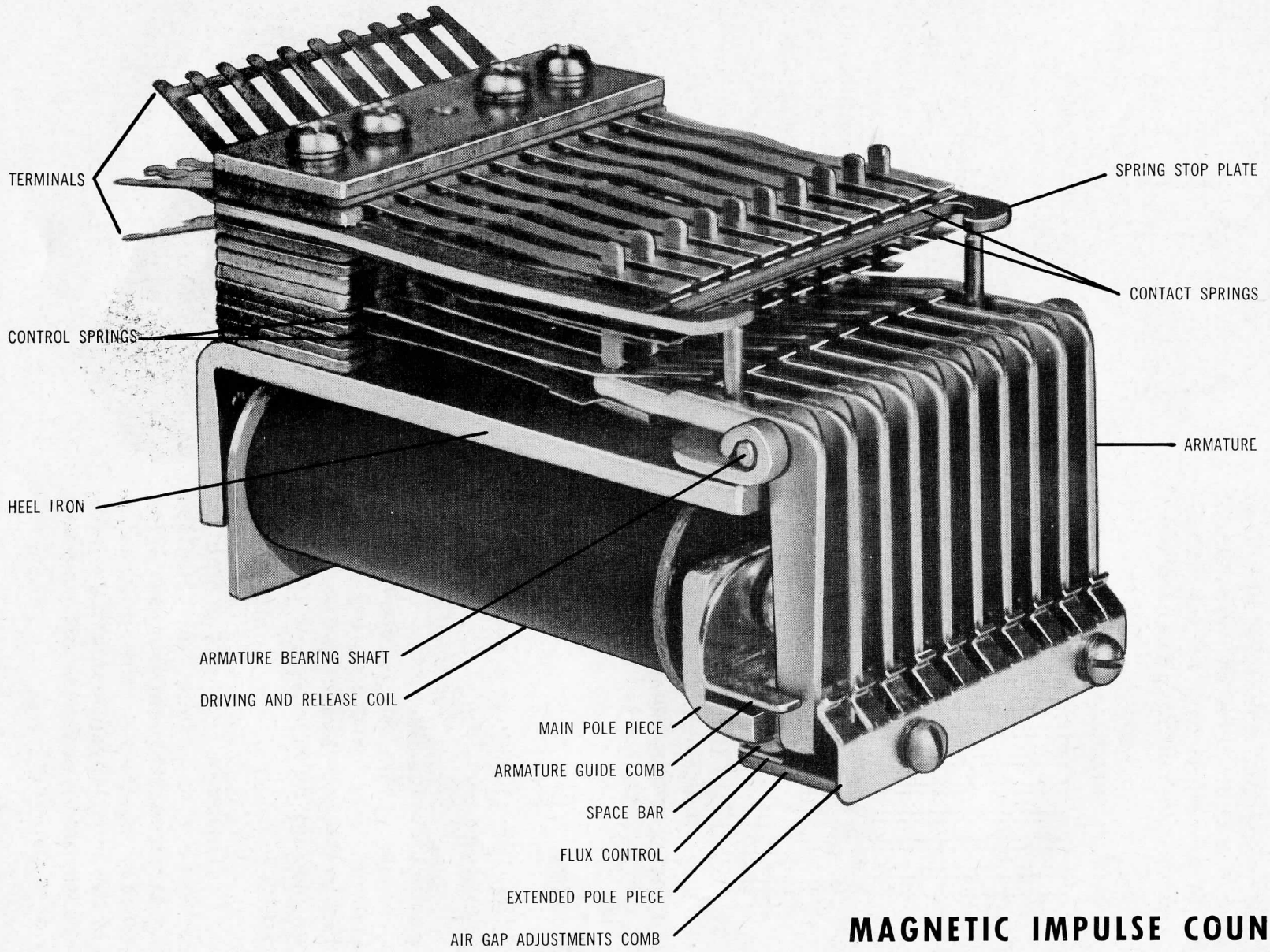
DIAGRAM SHOWING FIRST ARMATURE IN THE HALF-STEP POSITION
FIGURE 12

When a digit is dialed into the counter, the first armature, being in a half-step position, operates on the first pulse and all other armatures are held magnetically to the back pole piece. When the pulse is complete, the residual magnetism of the core holds the first armature operated, and the second armature moves to half-step because the load spring has been raised by the first armature, allowing the lifting spring to move the second armature away from the back pole into half-step position. On the second pulse, the second armature operates fully. Each succeeding pulse operates the corresponding armature. Since the armatures are held by residual magnetism, no current is required to hold the operated armatures.



MAGNETIC IMPLUSE COUNTER
FIGURE 11

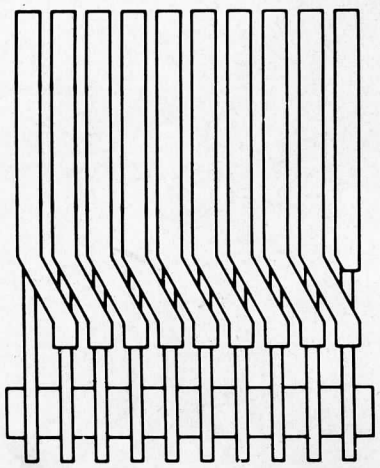
At completion of a call the operated armatures of the counter are released by a momentary closure of current to the release winding. The release winding causes flux of reverse polarity in the core of the counter. This reverse flux neutralizes the residual magnetism which held the armatures operated. Therefore the armatures all restore to their normal positions.



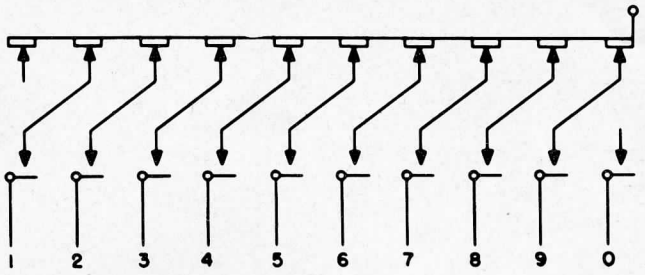
MAGNETIC IMPULSE COUNTER

FIGURE 13

Figure 14 shows the control spring arrangement for holding armatures 2 to 0 inclusive against the back pole piece until the preceding armature has been operated. Since there is no control spring on armature No. 1, its armature remains in half step position when normal.



CONTROL SPRING ARRANGEMENT
FIGURE 14



CONTACT ARRANGEMENT
FIGURE 15

The contact arrangement of the counter is shown in Figure 15. As each armature operates, the upper contact breaks and the lower contact makes. If, for example the digit 5 is registered, the circuit would be closed through the upper contact of armature No. 6 thereby marking the No. 5 lead.

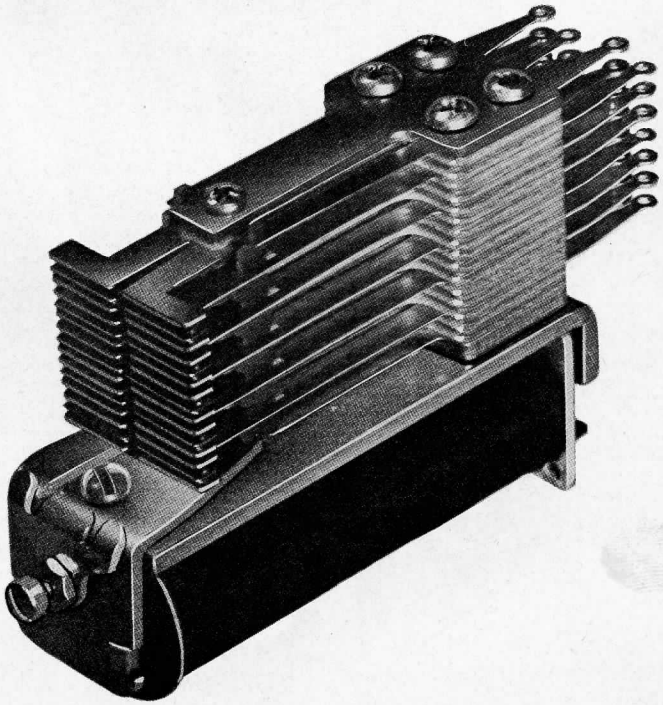
THE 4000 TYPE RELAY

The 4000 Type Relay is a general purpose telephone type.

The contact spring assembly has conventional terminals for soldered wire connections. The entire spring bank is fastened to the heel iron by two assembly screws and may be removed or installed in one piece.

The coil is wound in layers of enamelled magnet wire with a sheet of cellulose acetate between adjacent layers. After the winding operation, the protruding ends of the interleaved insulating sheets are coalesced to seal the coil against entry of moisture.

All contact springs have welded twin bar contacts of precious metal.



4000 TYPE RELAY
FIGURE 16

CIRCUIT PRINCIPLES

The type 7-2 Crossbar system is a straight forward decimal numbering system employing Crossbar switches, Magnetic Impulse Counters, and the 4000 Type Relay.

The use of Crossbar switches for establishing selected paths on a direct access basis may be of interest to technically inclined readers. The following circuit descriptions and illustrations are presented and although necessarily brief, explains the basic operation of 7-2 Crossbar.

FINDER OPERATION

A three relay line circuit is generally furnished in type 7-2 Crossbar offices and consist of line, cut-off, and trouble lock-out relays. A two relay line circuit consisting of line and cut-off relay is available when trouble lock-out is not required.

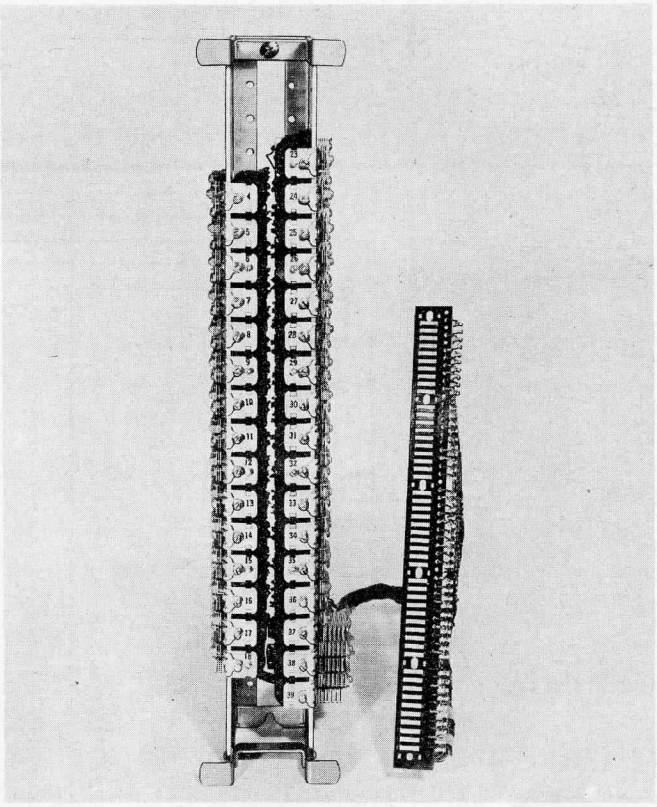
Each group of 100 lines or less is furnished an allotter circuit which performs the function of allotting a different finder to successive calls originating in the hundred group.

The twenty lines served by each finder-connector switch are connected through frame terminals directly to the main frame.

The lines on each switch are grouped in four, five line groups. Those with even tens numbering are in two groups located in the upper horizontals of the switch, those with odd tens numbering are in two groups located in the lower horizontals of the switch.

Figure 18 shows a simplified schematic of a call through the finder portion of the Crossbar switch.

When a subscriber removes the handset,

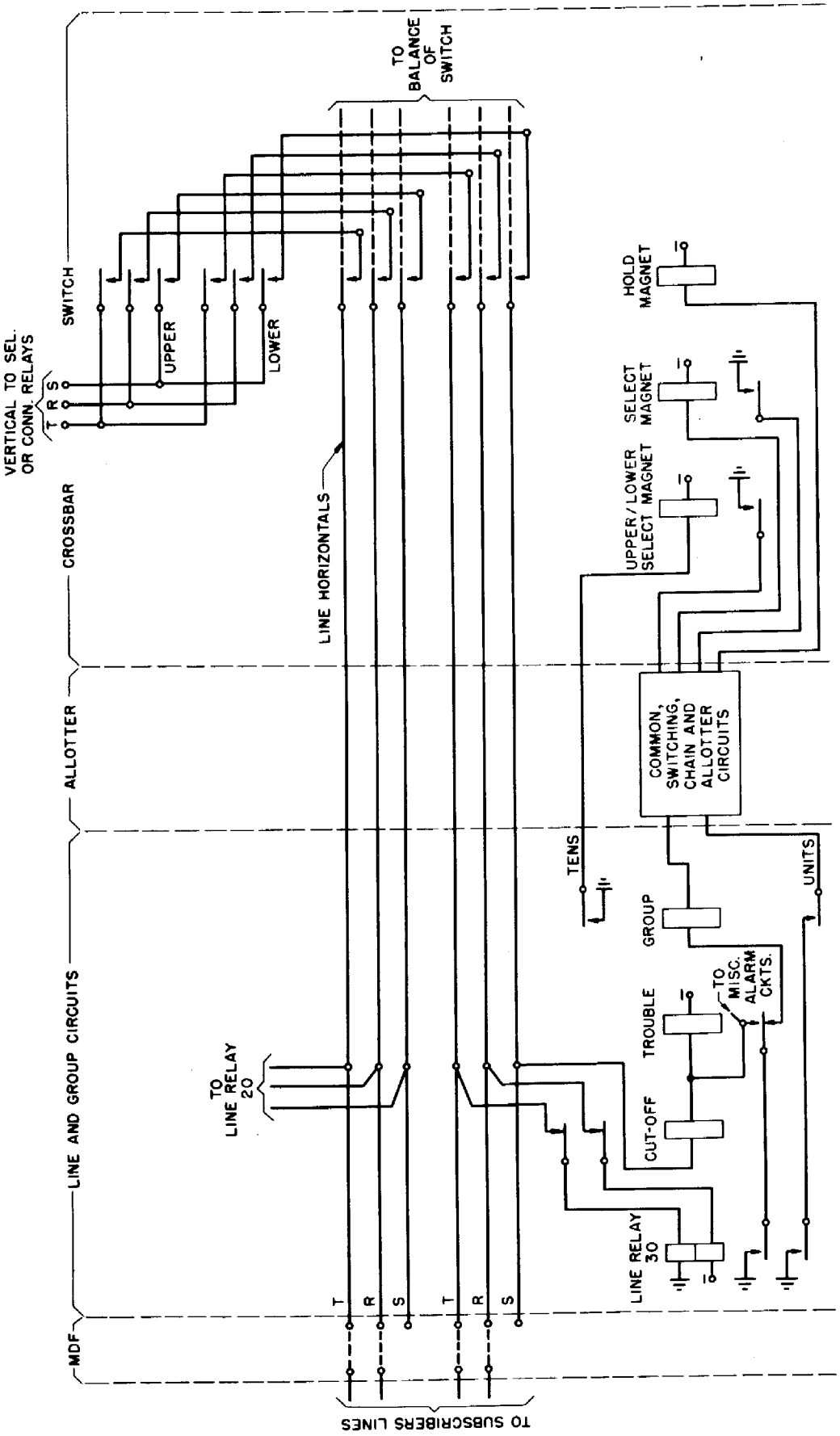


TEN LINE, THREE RELAY LINE UNIT COMPLETELY WIRED AT FACTORY READY FOR MOUNTING. NOTE PRESSURE TYPE TERMINAL STRIP FOR EASE OF INSTALLATION AND ADDITIONS.
FIGURE 17

the line loop is closed operating the line relay in the line circuit.

The line relay operates a group relay associated with the upper or lower five line group in which the calling line is located. This group relay operates to momentarily exclude all other lines from seizing the allotter circuit, and at the same time operates the upper or lower select magnet causing the select rod (referred to as the 6th select rod) to move the select levers under the upper or lower select point as required.

A units relay in the allotter circuit is operated to actuate the select magnet. This select magnet rotates the select rod to the right or left to place the select lever under the horizontal in which the line is located.



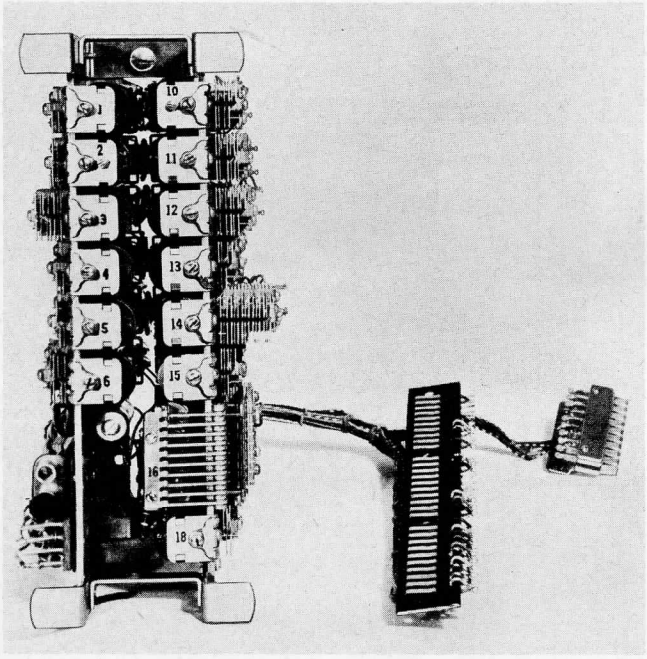
SIMPLIFIED CROSSBAR FINDER SCHEMATIC
FIGURE 18

The group relay operates other relays (not shown) causing the allotter test relays to select the next idle finder (vertical).

After an idle finder is selected its hold magnet operates closing the desired crosspoint. This connects the calling line to a selector or connector.

For the purpose of illustrating the entire sequence, selector operation is shown, although some small offices may not be equipped with selectors.

SELECTOR OPERATION



SELECTOR RELAY UNIT WITH CABLE PLUG
FIGURE 19

The Crossbar selector consists of a group of relays, a magnetic impulse counter to register the digit dialed, and a horizontal of a selector level switch.

When the linefinder has connected the selector to a calling line, the selector line relay operates over the subscriber's loop.

The selector line relay and hold relay operate, connecting ground back over the sleeve lead to operate the line cut-off relay and maintain the operated hold armature of the finder. The allotter is released for subsequent calls.

The selector returns dial tone to the calling party indicating that the selector is ready to receive the dial pulses. As the digit is dialed the selector line relay makes and breaks the circuit to the impulse counter which registers the digit dialed. The series relay operating on the first pulse releases after the last pulse of the digit and extends ground through contacts on the counter to operate the chain relay of the selector. Operation of the chain relay extends a circuit through the counter contact corresponding to the digit dialed, to operate the trunk group relays associated with that digit. At the same time the chain relay completes a circuit to operate a select magnet of the Crossbar switch associated with the trunk level dialed. This select magnet is permanently associated with a particular selector. The test relays select an idle trunk and complete the circuit to operate the corresponding hold magnet. Thus, in combination the select rod and hold magnet cause closure of a crosspoint, extending the call to the next stage.

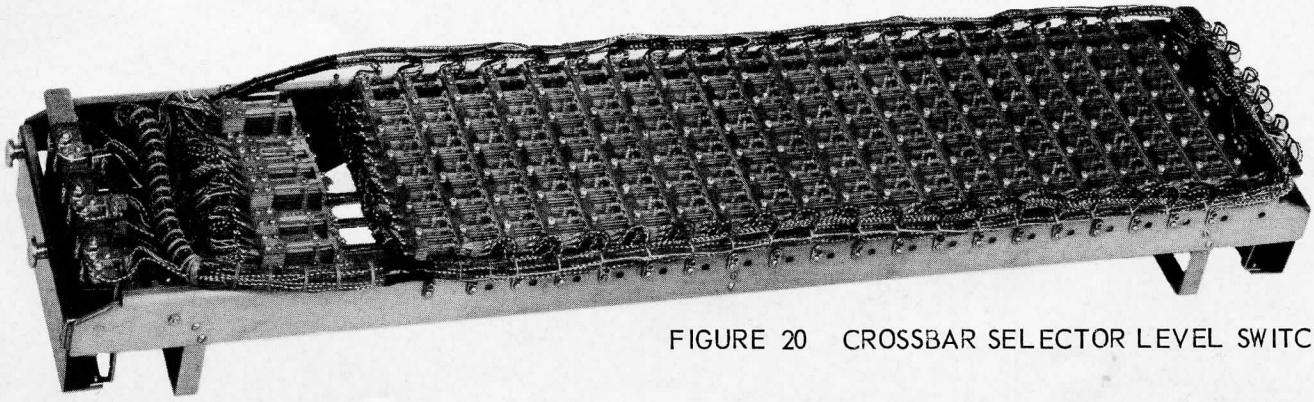
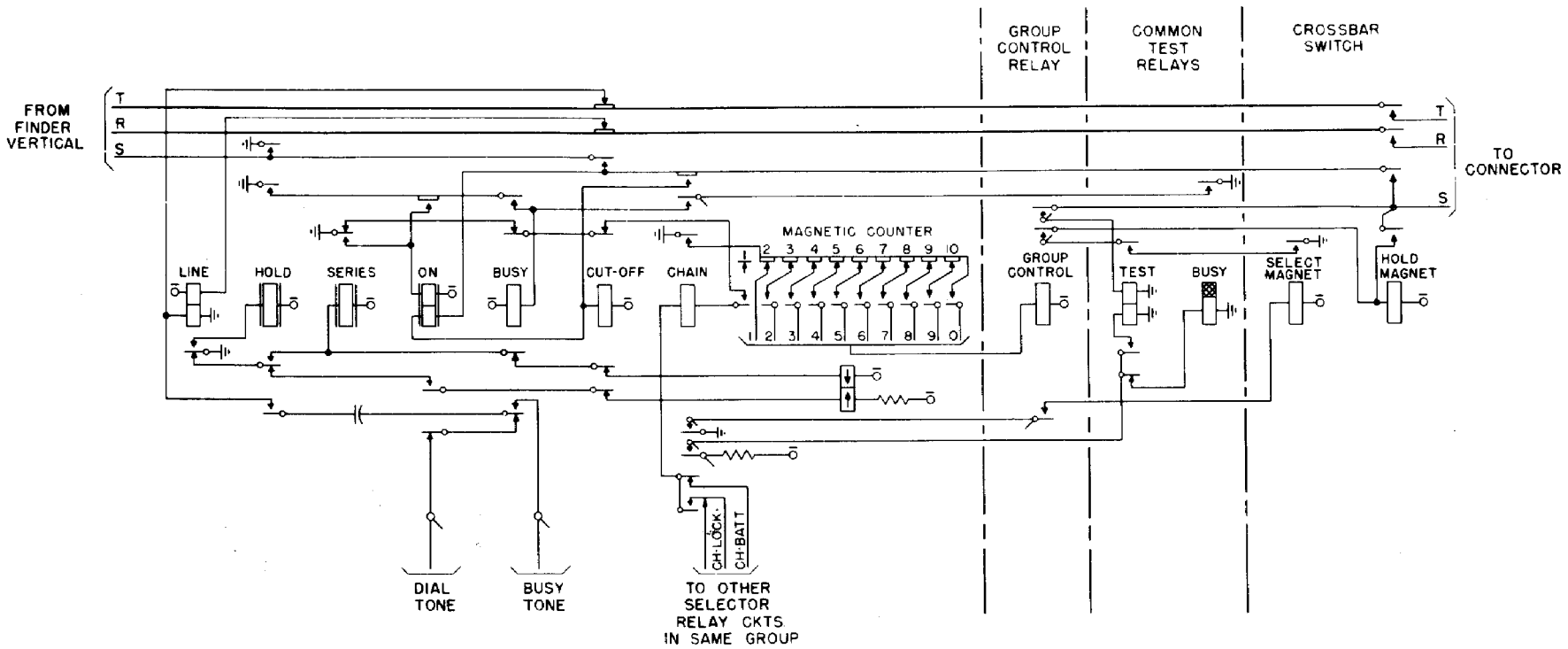


FIGURE 20 CROSSBAR SELECTOR LEVEL SWITCH



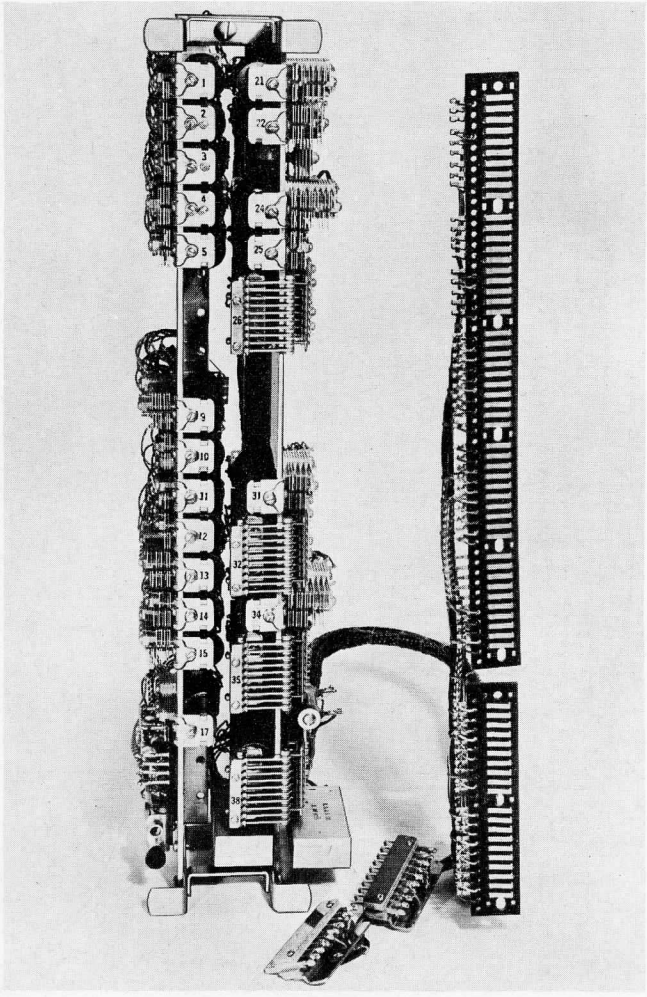
SIMPLIFIED SCHEMATIC DIAGRAM OF
CROSSBAR SELECTOR
FIGURE 21

At the same time the selector cut-off relay operates releasing the chain and test relays making the common test circuit available for the next call.

To illustrate the completion of a call, connector operation is now shown.

CONNECTOR OPERATION

The function of the connector is to extend the tip and ring path of the calling line to the called line and to signal the called station.

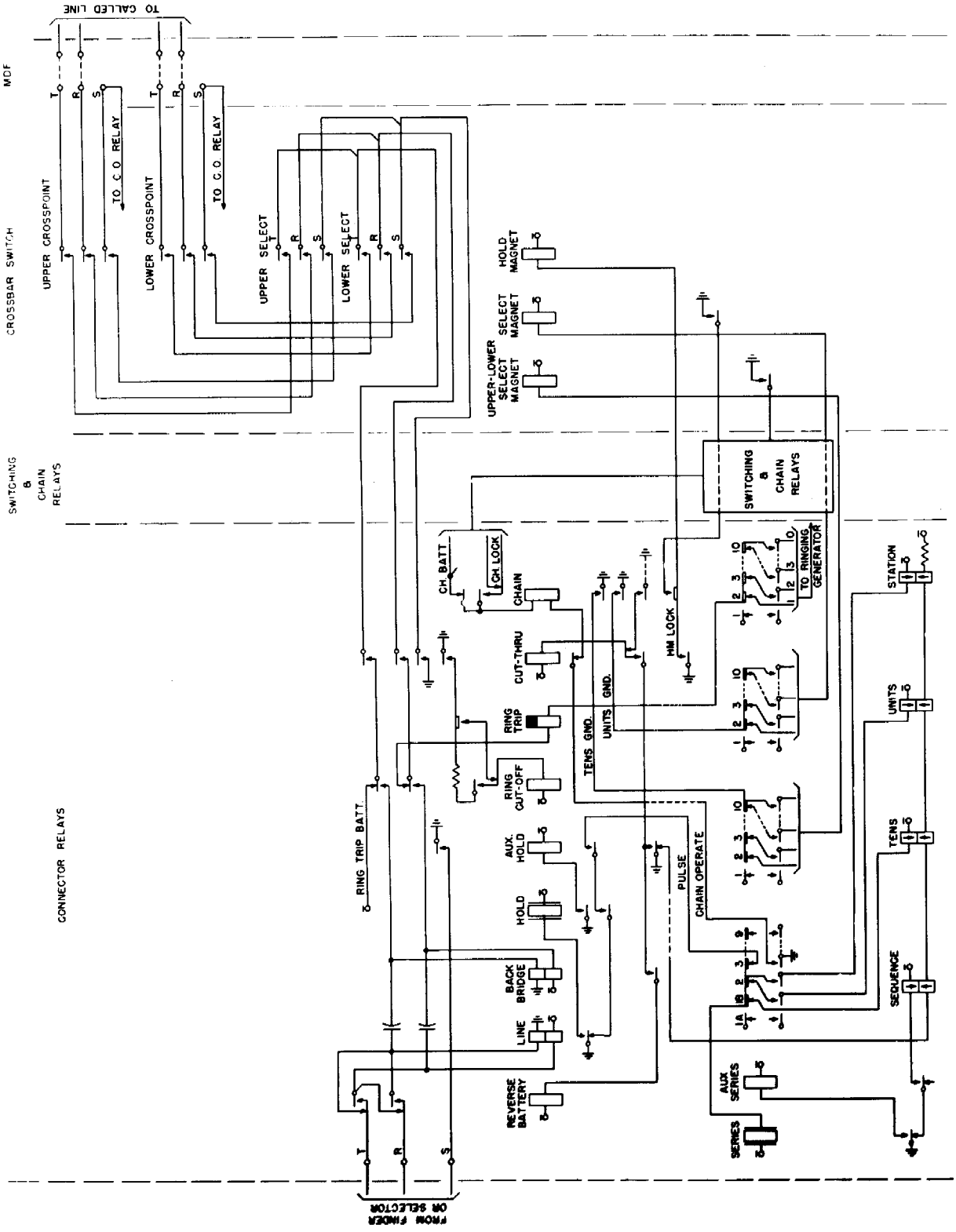


CONNECTOR RELAY UNIT SHOWING CABLE AND TERMINAL ASSEMBLY.
FIGURE 22

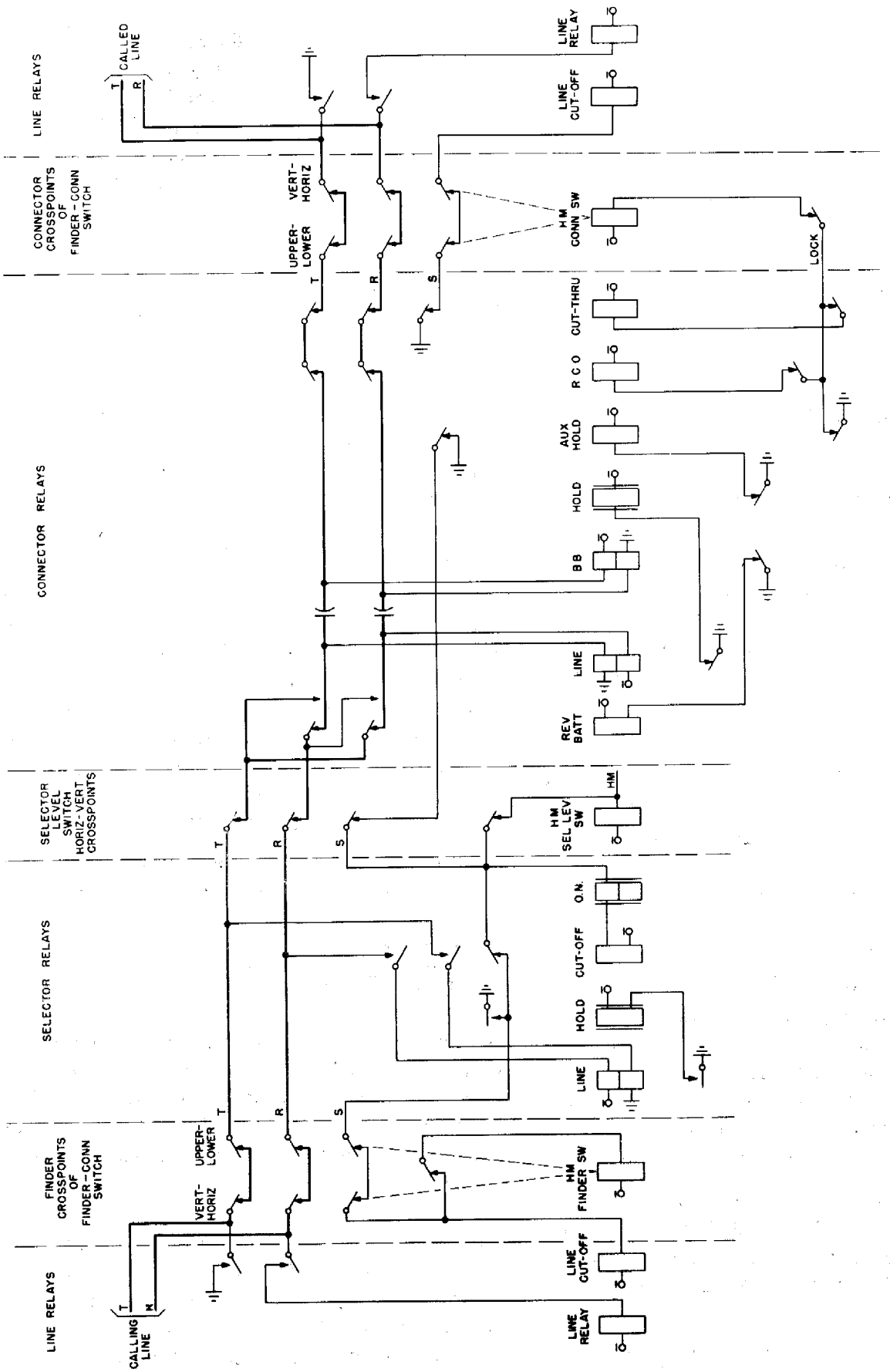
The 7-2 Crossbar connector consists of a group of relays, and magnetic impulse counters.

The connector line relay, see Figure 23 now operates over the subscriber's loop and operates its hold relay. Ground is returned to hold the preceding equipment in an operated condition. The connector is now ready to receive the tens, units and station digits of the called number.

The line relay follows the dial pulses, closing ground to operate the impulse counters via the sequence counter. When the tens digit pulsing period is ended the sequence counter now advances the pulsing path to the units counter where the units digit is then recorded. The sequence counter then steps the pulsing path to the station counter. If a station digit of 1 to 5 is received the circuit completes a path to ring over one side of the line. If a station digit from 6 to 0 is dialed the station counter causes ringing generator to be applied to the other side of the line. At the time the station digit is registered in its counter, the sequence counter advances operating the chain relay which completes a circuit through the marked lead of the tens counter to operate the upper or lower select magnet of the switch serving the called tens group. The operated upper or lower select magnet causes control relays associated with that switch to complete a circuit to operate the units select magnet associated with the wanted line horizontal, through the mark lead of the units counter. The select magnet in operating causes the hold magnet associated with the connector vertical to operate. The hold armature also closes the tip, ring and sleeve contacts at the line horizontal and vertical crosspoints. A cut-through relay operates to connect ringing generator to the tip and ring leads of the idle line and also opens the circuits of the select magnets.



SIMPLIFIED SCHEMATIC DIAGRAM OF
CROSSBAR CONNECTOR
FIGURE 23



SIMPLIFIED CALL - THROUGH SCHEMATIC
FIGURE 24

When the called party answers the ring trip relay operates to transfer the calling line from the ringing circuit to the talking circuit. The reverse battery relay operates, reversing the tip and ring leads to the calling party for supervision and connects a lead to the timing relay for conversation timing.

In the normal testing operation to determine if a called line is busy, a circuit is extended over the sleeve lead to test whether the calling line and called line are the same. If they are the same one, the call is a reverting call and conditions must be established in the connector so that when the calling party hangs up the calling line will be switched to the ringing side of the connector circuit and ringing started on the line. For simplicity the reverting call portion of the connector has been omitted in Figure 23.

EQUIPMENT SELECTION

A major problem in central office engineering is the determination of equipment quantities to be provided.

Telephone traffic of different communities varies considerably. Equipment quantities to provide an adequate grade of service are influenced by the locality calling rate, the conversation holding time and the permissible number of lost calls.

After the traffic data of the exchange have been translated into "unit calls per line" by reference to applicable traffic tables, the quantity of originating and terminating conversation paths, or trunks, in the dial switching equipment is determined.

The two primary considerations then affecting the equipment selection become: one, the capacity of the equipment to handle the traffic load, and two, the cost of the equipment, not only from the standpoint of the original investment, but also the cost of future additions.

The tendency of families to seek suburban homes coupled with the decentralization of factories and shopping centers, often result in great changes in telephone service demands.

In past years it may have been permissible to place dial central office equipment of very limited ultimate capacity in a small community. The unpredictable and at times sudden increase of service demands witnessed points out the necessity of selecting equipment having unlimited growth capabilities.

There will always be a demand for a small dial switching system to serve the initial requirements of the smaller community. And, while there are some limited capacity dial systems manufactured to fill this need, the design of these systems do not readily lend themselves to expansion except at a prohibitive modification expense.

The 7-2 Crossbar system provides for an orderly and economical future expansion.

TRUNKING METHODS -
Offices 100 lines or less.

As previously mentioned the 7-2 Finder-Connector switch is divided into two sections with the originating trunks or finder verticals on one side and the terminating trunks or connector verticals on the other.

On installations of 100 lines or less the finder trunk verticals are wired to the connector relays by means of a short frame cable. It becomes readily apparent that should growth development require, the only change necessary for

purposes of expansion is to remove this cable to permit the insertion of group selection equipment between the finders and connectors.

Figure 25 illustrates the fundamental trunking plan of a 7-2 Crossbar system of 100 lines or less. The connector line horizontal terminals are terminated on the distributing frame.

The finder line horizontal terminals are strapped to the connector terminals at the Crossbar switch plug assembly, allowing any cross connecting of terminals required for traffic adjustment to be made at the plug assembly.

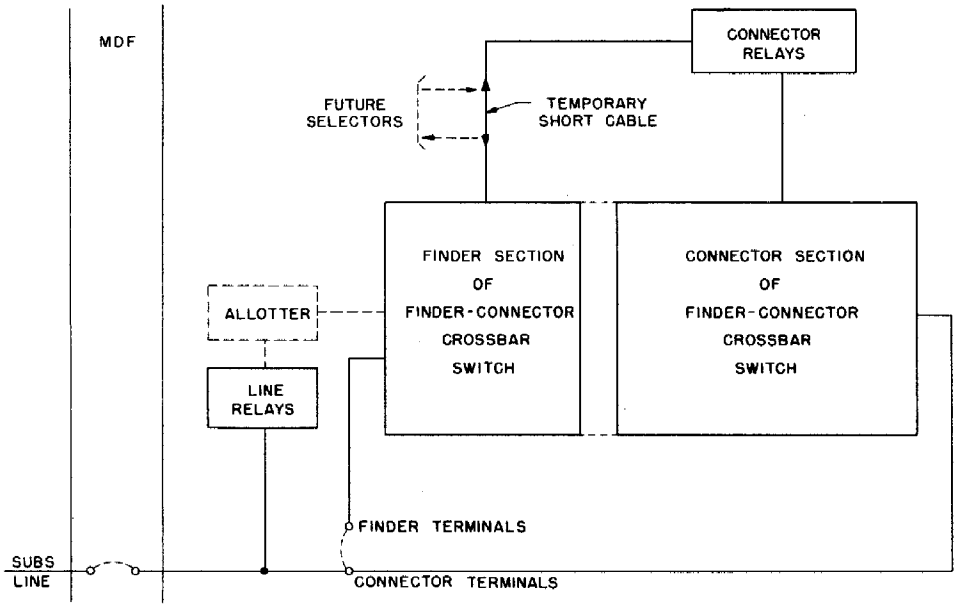
Calls are completed by the subscriber's line relay starting the allotter operation of selecting an idle finder vertical and connecting this vertical with the subscriber's line horizontal. The connector furnishes dial tone to the calling party. Dialing the wanted number then causes completion of a path over the connector vertical and crosspoint to the called line.

Design characteristics of some dial systems under 100 lines necessitates inter-office trunks be terminated on either line equipments or incoming trunk connectors. On one hand reducing the available line equipment by one for each trunk, and on the other, reducing the terminating traffic capacity of the system by one connector for each trunk.

A design feature of the 7-2 Crossbar system now permits a higher terminating traffic capacity by a transfer circuit arrangement which releases the local connector after a trunk connection has been established, thereby freeing it for another call and reducing the number of local connectors required.

In modern telephone planning, it is recognized that even in small initial installations, such as community dial offices, group selection equipment is desirable and often a necessity to provide trunking flexibility.

Nationwide toll dialing and customer toll dialing, area and exchange numbering plans frequently demand the use of 2-5 numbering, necessitating the use of group selectors. Therefore consideration should be given to connecting trunk requirements in order to arrive at a sound decision to omit or include group selectors at the outset to provide an economical and orderly growth.



FUNDAMENTAL TRUNKING PLAN
FIGURE 25

Group selection in the 7-2 Crossbar office is based on a system of decimal numbering with the selector responding to one or more digits to provide a choice of one trunk group out of ten.

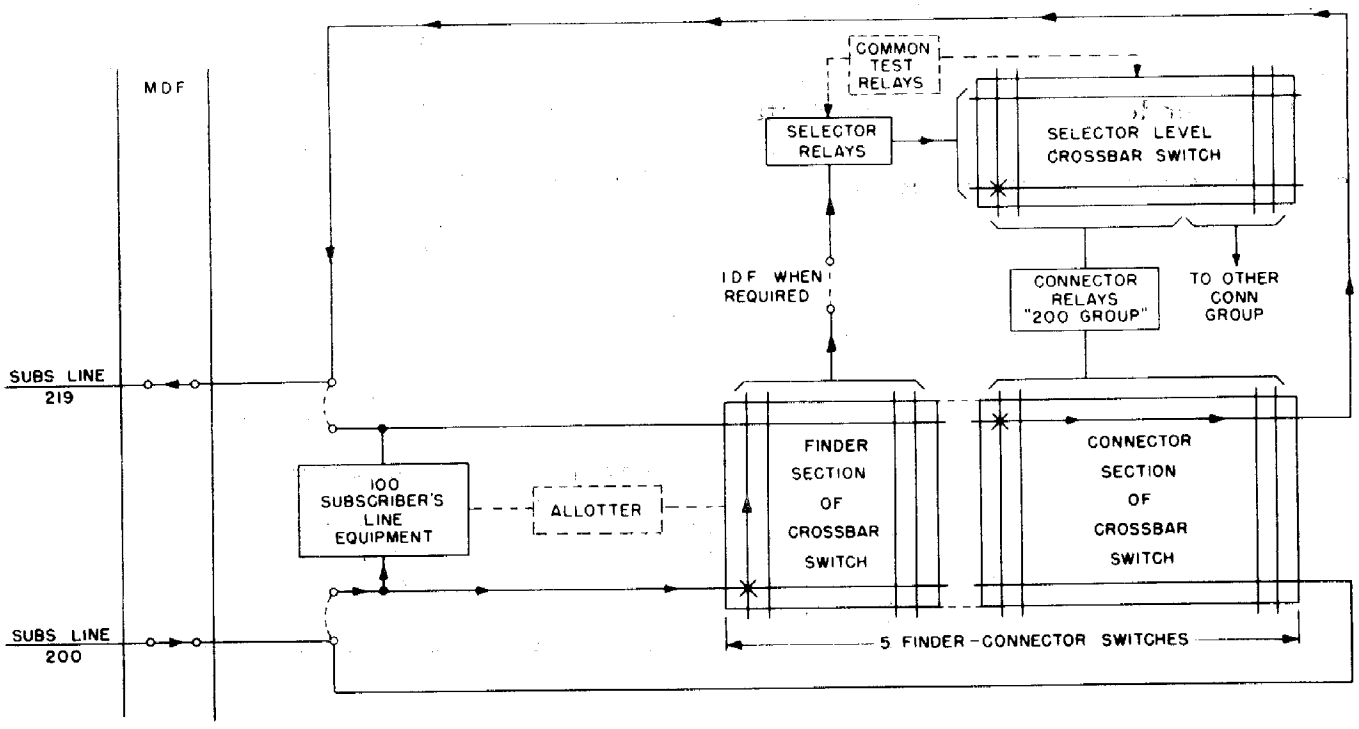
Selector trunking is accomplished by a Crossbar Selector Level Switch composed of 12 horizontals and 20 verticals. Each selector relay unit is directly connected to one of the 12 horizontals. The 20 verticals or trunk paths may be arranged to provide combinations of trunking paths in groups of from 1 to 10 trunks each.

Figure 26 illustrates the principle of group selection.

The block diagram represents a group of 100 lines with both finder and connector multiples terminated on a MDF.

The trunk verticals from the finder section of the Crossbar switches may be connected directly to selector relay units or through an IDF if required.

When the receiver of line 200 is removed, the allotter operation connects the line horizontal to idle finder vertical #1 at the switch crosspoint as indicated by (X). The finder vertical extends the calling path to a selector relay unit which furnishes dial tone. Upon dialing the digit "2", test relays select a vertical associated with an idle connector in the "200" group of lines. The selector level horizontal and vertical crosspoint is made as indicated by (X), extending the call to the connector relays. Upon receiving the tens digit "1", the units digit "9", and the station digit if required, the connector switch crosspoint, indicated by (X) is made.



PRINCIPLE OF GROUP SELECTION
FIGURE 26

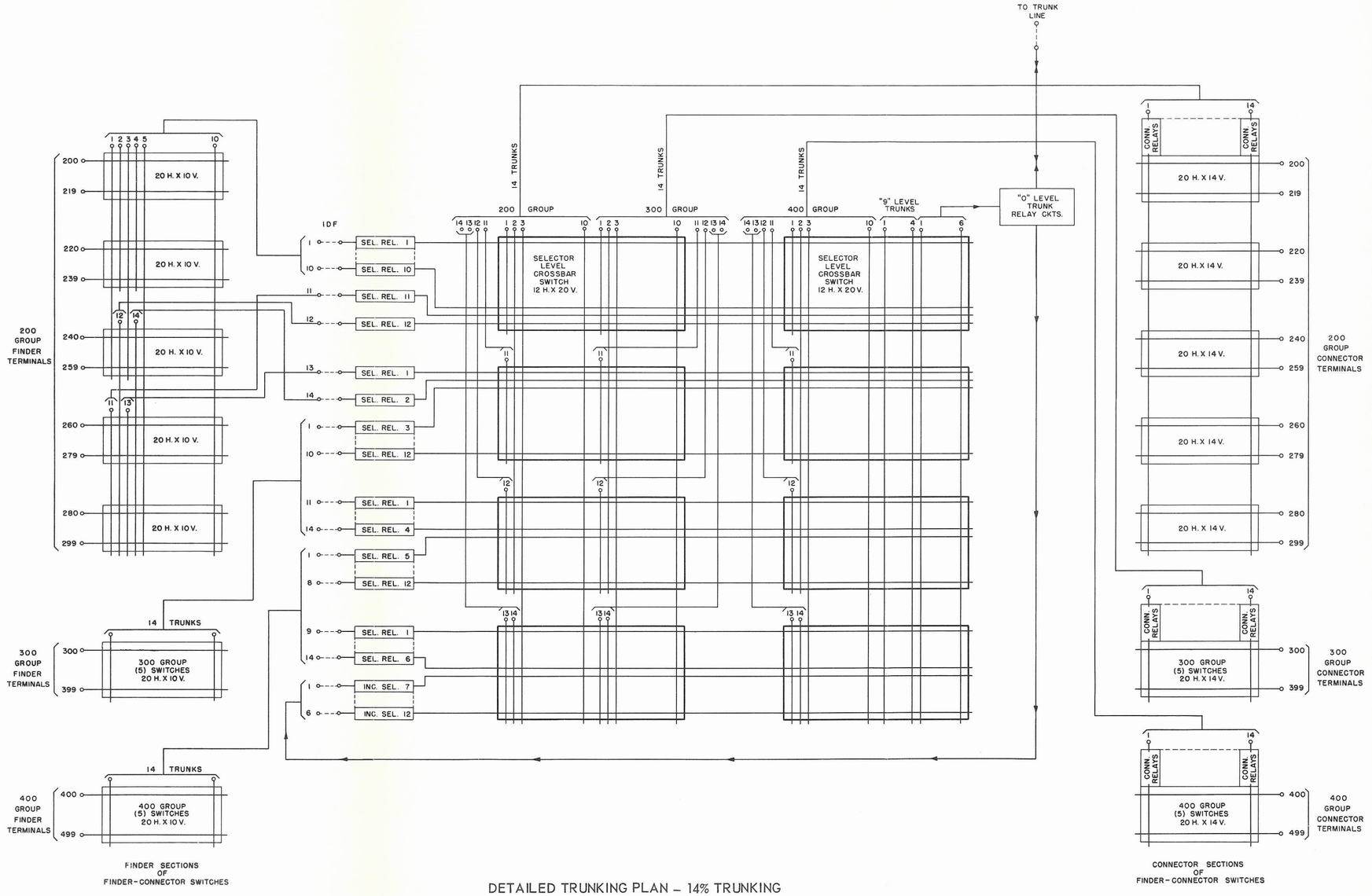
Although previous discussion on the 7-2 finder-connector switch mentions the switch as having 10 trunk verticals, any percentage of trunking up to 50%, may be arranged for originating traffic with the same basic equipment.

Figure 27 shows a detailed trunking plan of a 300 line 7-2 Crossbar system. While under average conditions traffic requirements range from 10% to 15% trunking, a 14% trunking plan is shown.

The first 100 lines designated the "200" line group are shown with the 5 individual 20 line switches. The "300" and "400" line groups are represented by two blocks. It will be noted that by a vertical grading arrangement 14 originating trunks are available to each 100 line group. By the same vertical grading method 14 terminating trunks from the selector level switches become available to each 100 line group of connectors. Calls are routed by a group selection digit of "2", "3" or "4" which directs the call over one of the 14 trunks from any one of the selector level switches to the proper connector group. A typical arrangement of two inter-office trunk groups is included.

Inter-toll dialing together with exchange numbering plans necessitates in some installations the prefixing of certain digits to the normal directory number. Since these digits are not needed for locally originating calls they must be absorbed.

The absorption of unneeded prefix digits is accomplished in the 7-2 Crossbar system by registering them on the selector counter in the usual manner. If the digit is to be absorbed, the counter is released preparing it for the next digit. On receipt of a trunking digit the selector action proceeds to extend the call over the selected trunk group.



DETAILED TRUNKING PLAN – 14% TRUNKING
300 LINES – TERMINAL PER LINE
KELLOGG TYPE 7-2 CROSSBAR
FIGURE 27

INTER-OFFICE TRUNKS

Dial offices generally require inter-connection with other offices for toll recording or extended area service.

There are numerous types of inter-office trunks available to meet varying needs of existing equipment, traffic and economy. There follows a brief description of three of the most commonly used inter-office trunk types.

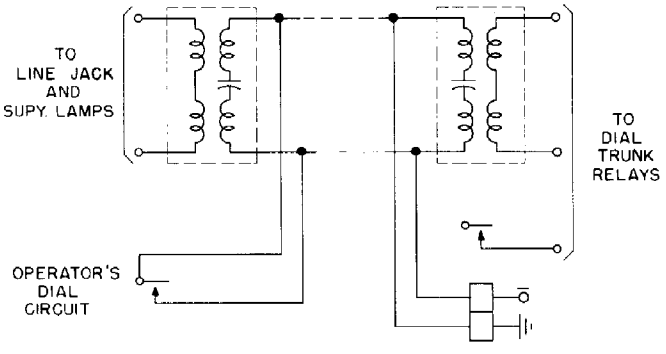
LOOP DIALING TRUNKS: Dial to Manual

Loop dialing trunks require a physical pair of wires for each circuit and are usually specified when the line wire loop resistance does not exceed 1000 ohms.

Figure 28 shows a simplified schematic of a loop dial trunk for operation between a dial office and an operator office. Trunks are also available for dial to dial operation. Outgoing impulse repeaters (trunk circuits) are required on dial trunks.

Supervision on loop dial trunks is accomplished by reversal of battery at the terminating end upon answer.

Loop dial trunks are comparatively simple in operation and are in many cases preferred, unless of course, other considerations dictate the use of other types of operation.

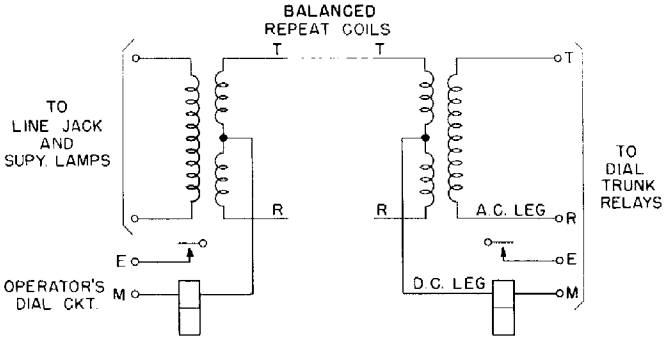


LOOP DIALING TRUNK
FIGURE 28

SIMPLEX TRUNKS: Dial to Manual

The simplex circuit was originally designed to permit transmission of telegraph and voice signals simultaneously over a single pair of wires.

Figure 29 shows a schematic of a simplex trunk for operation between a dial office and an operator office. Such trunks are also available for dial to dial operation between two dial offices. Figure 29 shows dialing in one direction only, that is, from manual to dial.



SIMPLEX DIAL TRUNK
FIGURE 29

It will be noted that for dialing on the simplex this trunk has a ground return circuit with a relatively low resistance. In effect the simplex circuit is approximately 1/4 of the trunk loop resistance.

Simplex trunks may be converted to a phantom group should the need arise.

This type of trunk permits dial pulses and control signals over the ground or "D.C. Leg" without interfering with voice currents on the talking circuit. Care should be exercised in use of simplex trunks if differences in ground potential exist at the two offices.

COMPOSITE TRUNKS: Dial to Manual

Phantom trunks are generally employed to gain a third or phantom circuit with only two physical pairs of wire. Composite signaling on trunks is often preferred because of its flexibility.

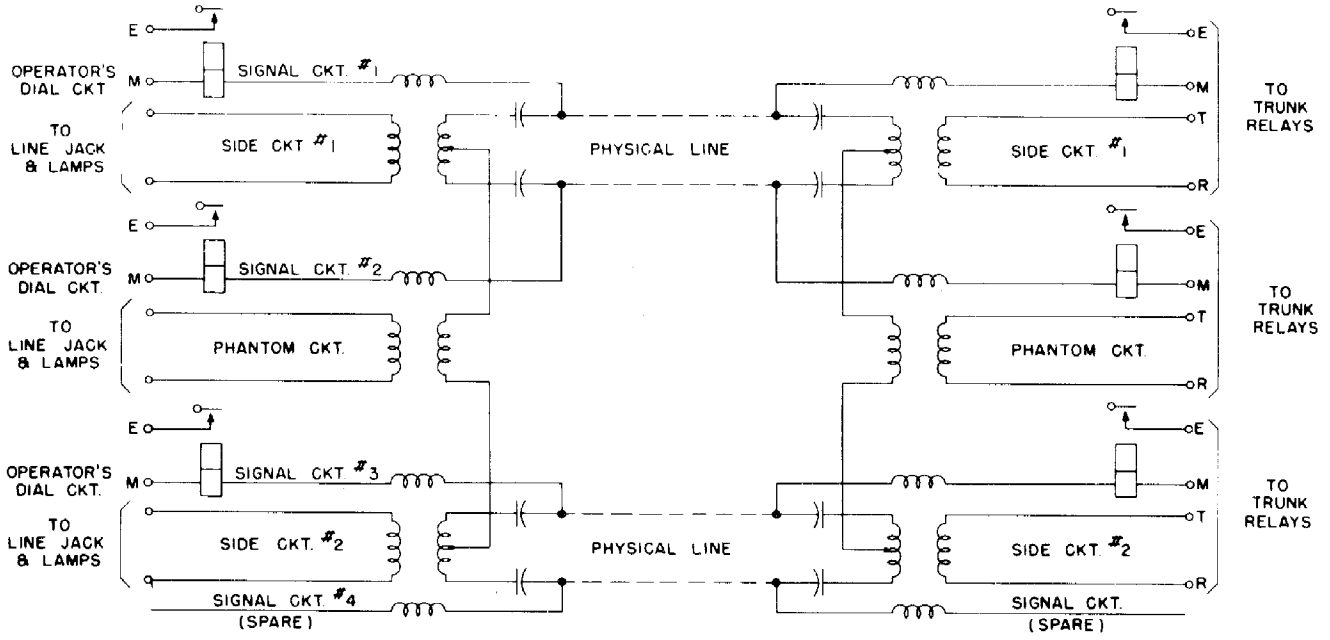
Figure 30 shows a schematic of a composite trunk group for operation between a dial office and an operator office. Composite trunks are also available for dial to dial operation.

A phantom group consists of two physical pairs of wire called the side circuits and the phantom which is derived from center tapped repeating coils. By using composite sets consisting of balanced repeating coils and filter networks on the two physical pairs, three talking circuits and four signaling circuits are obtained.

Since only one signal circuit is required for each of the three talking circuits the fourth signal circuit is available for special use such as alarm signaling. If telegraph or teletypewriter service is to be carried by one of the legs, heavy duty composite equipment is required.

Composite dialing trunks are usually specified where the line loop resistance does not exceed 2000 ohms.

Composite dialing trunks are equipped for duplex signaling operation which permits signaling in both directions at the same time for dialing, holding, and supervision.



PHANTOM COMPOSITE GROUP
FIGURE 30

ONE OR TWO WAY TRUNKS

Generally inter-office trunks are suitable for traffic in either direction. Such trunks are referred to as two-way trunks. Supervision is provided for both way traffic.

Occasionally the need arises to handle traffic in one direction only in which case one-way trunks are provided..

DUAL-FUNCTION TRUNKS

Network considerations may require that traffic be routed to two different destinations via the same trunk. In such cases the trunk is described as a dual function or dual access trunk.

Such trunks, used for both free service and toll traffic have one disadvantage. While carrying free service calls the trunk cannot be available for toll traffic.

Dual function trunks have limited application.

DIAL BACK TRUNKS

Permit operator control of calls between two remote dial offices both of which reach the operator office over the same trunk group.

The operator, in such cases, dials back on the same trunk to cause the dial office equipment to complete the desired selection in the second dial office.

Special engineering consideration is necessary if such arrangements appear to be required, and the restrictions imposed by toll dialing growth should be thoroughly investigated.

TANDEM TRUNKING

Frequently calls are to be handled between two offices which have no direct trunk connection but both of which have direct connection with a third office. This is referred to as a Tandem Office. By the use of a directing digit the call is sent over an idle trunk to the tandem exchange. The switching equipment at the tandem exchange is so arranged that on receipt of the dial pulse a path is marked to an idle trunk directing the call to the desired exchange.

DIAL TRUNK TERMINATIONS

Existing offices in which new dial trunks are to terminate seldom are equipped for the necessary signaling and supervisory circuits.

Trunk termination equipment varies depending upon the types of switchboard and cord circuits involved, and careful analysis is required to assure technical coordination.

FEATURES

With the advent of extended area service and inter-toll dialing the number and complexity of special features required for dial switching systems have greatly increased.

The arrangement of the 7-2 Crossbar is such that special features of many types may easily be furnished. The standard 7-2 Crossbar office contains all of the generally required features of dial switching operation. Each office, due to its location in the area and other factors, may require special features not generally included in the standard equipment, but such features can be furnished with the original installation or added at a later date.

The speed of operation of the Crossbar switch easily meets the high standards of inter-toll dialing or trunk selection of any type without altering the equipment in any way.

The following is a list of operating features which are available with 7-2 equipment. Those indicated by asterisk (*) are special and are provided only where required.

ADDITIONS

Since both finders and connectors are served by the same 7-2 Finder-Connector switch, only one switch need be provided for each 20 line addition until frame capacity is reached.

Additions necessitating the use of extra frames require only one finder-connector frame for each 100 lines with an ultimate saving in floor space.

ALARM INDICATIONS

Alarms are indicated by both visual and audible signals for major or minor troubles, such as fuse blown in finder or connector circuits, permanent signals caused by lines or trouble lockout or power failures.

ALARM SENDING AND CHECKING (*)

May be provided and arranged to extend office alarms automatically to a distant operator over one of the inter-office trunks.

Alarm checking is accomplished by the operator or attendant dialing a special alarm checking number. By tones received the attendant determines if the fault indicated is urgent or not.

ALLOTTER

A circuit arrangement furnished with every 100 line group or less which can be likened to a dispatching service.

Line finders are allotted successively as traffic originates on subscriber lines.

ANSWER SUPERVISION

Supervision on loop trunks is by battery reversal, and on composite trunks by differential relay operation.

BALANCED BATTERY CIRCUIT

Transmission bridges in local equipment are condenser coupled with balanced high impedance battery feed coils of low direct current resistance.

BUSY KEY AND TEST JACK

A busy key and test jack is provided on each regular selector and connector.

BUSY VERIFICATION (*)

Toll operator busy verification connectors may be provided enabling the toll operator to override line busy conditions without ringing.

A predetermined single digit prefixed to the regular directory number permits the toll operator to be bridged across a busy line to determine whether it is busy or in trouble.

COIN BOX (*)

Coin lines may be provided as required. All lines equipped for coin box service are furnished with special identification tone. Generally for reasons of economy coin box lines are arranged for post pay type of operation.

CONVERSATION TIMING

Conversations between local subscribers may automatically be terminated after 6 to 8 minutes. A warning tone is heard one minute prior to disconnection. Reverting calls are not timed.

Conversation timing is not applied to toll calls, but may be applied to inter-office calls over free or extended area trunks.

The conversation timing feature may be disconnected by simply removing a wire in the connector or trunk if desired.

DIGIT ABSORPTION (*)

When required to meet local numbering plans such as 2-5 numbering, any digit or combination of digits may be absorbed in the selector equipment.

Digit absorption is available only in installations requiring the use of selectors.

GRADING

Facilities are provided on all installations for grading of inter-frame trunking so that availability of selectors and connectors may be rearranged to meet changing traffic conditions.

INTERCEPT (*)

Normally the equipment is arranged to return tone to indicate that a user has dialed an inaccessible or unassigned number. However equipment may be provided to intercept calls to disconnected stations and extend them to a dial service assistant. It may be arranged to route intercept calls over regular toll trunks to the operator office if desired.

LINE LOCKOUT

Line lockout is normally provided for all subscriber lines equipped. A line is automatically disconnected from the switches in two to four minutes after seizure if any of the following conditions occur:

(a) Grounded or shorted line
(b) Incomplete dialing
(c) Unanswered calls
(d) Abandoned reverting calls
(e) Receivers incorrectly restored

LOCAL - TOLL DISCRIMINATION

A circuit arrangement which distinguishes a toll call from a local call. It removes time disconnect on toll calls. It is provided in combination local and toll connectors.

LONG LINE ADAPTERS (*)

Where the resistance of certain subscriber lines exceed 1000 ohms loop, long line adapters may be provided.

PAYSTATIONS (*)

See Coin Lines.

PBX GROUPING (*)

Subscribers requiring more than one line to a PBX switchboard or lines to several individual telephones on the same premises may have a single directory number listing.

The lines for PBX service are arranged in groups with a maximum of ten lines each. Since no step-by-step action is used in testing for an idle line, the terminals assigned to a PBX group need not be consecutive. Furthermore, any terminal in the PBX group may be used as the listed directory number for the group.

PBX service is available in two types:

(1) Non-Hunting
(2) Group-Hunting

Non-Hunting PBX service permits two line and three line PBX groups to be assigned within a ten line group not using all available ten lines. Any lines in the ten group not assigned to PBX service may by used for other subscriber service.

Group-Hunting PBX service incorporates the same general features as Non-Hunting. However two or more groups of up

to ten lines each may be tested in succession for an idle line. Should a PBX group require an additional line any unassigned line within the 100 line connector group may be used.

A 100 line connector group may be converted to PBX service at any time by the addition of PBX relays. Offices initially equipped with Non Hunting PBX service may easily be converted to Group-Hunting PBX service by replacing the Non-Hunting PBX relays with a set of Group-Hunting relays.

POWER SUPPLY

Unless otherwise specified a complete power supply unit is included in every installation. The power equipment includes an exchange battery with adequate reserve capacity, self regulating full float charging equipment to assure prolonged battery life, together with all necessary control circuits.

RESTRICTED SERVICE (*)

Originating calls from local lines or free service trunks can be restricted on a basis of five line groups. Restricted service permits any line or group to be blocked from reaching specified trunk groups. Blocked calls receive busy tone as an indication that the call can not be completed.

REVERTING CALLS

Subscribers on the same line may call each other by simply dialing the regular directory number.

After dialing, a distinctive tone is given the calling party, indicating that a call has been dialed to the same line and that the calling party must hang up to allow the called station to be signaled. On answering, the called party also receives the reverting tone. Then the equipment in use to establish the connection is released, becoming available for other calls. Talking battery for reverting calls is furnished by the line circuit.

Reverting calls by special number may also be provided if required.

RINGING TONE

Uniform ringing tone is returned to the calling party at each ringing period.

TEST TRAIN (*)

Equipment may be provided to permit centralized testing by a wire chief at a distant office.

TONE INDICATION

Busy tone will be heard by the calling party if the called line is in use, if no path is available to the called line, or if any unequipped line is dialed and will continue until the calling party hangs up.

On toll calls the equipment is arranged to provide 60 I. P. M. flash and tone for line busy, and 120 I. P. M. flash and tone for all paths busy.

TRAFFIC METERS

An allotter peg count meter is furnished in each 100 group to record the number of originating local calls.

A connector peg count meter is furnished in each 100 line group to record the number of completed and attempted calls.

A finder overflow meter is furnished in each 100 line group to record the number of originating calls lost due to all finders being busy.

An outgoing trunk overflow meter is furnished to record the number of calls to each outgoing trunk group when all trunks in the group are busy.

Selector level overflow meters may also be provided as optional equipment to record the number of calls to each group when all trunks in the group are busy.

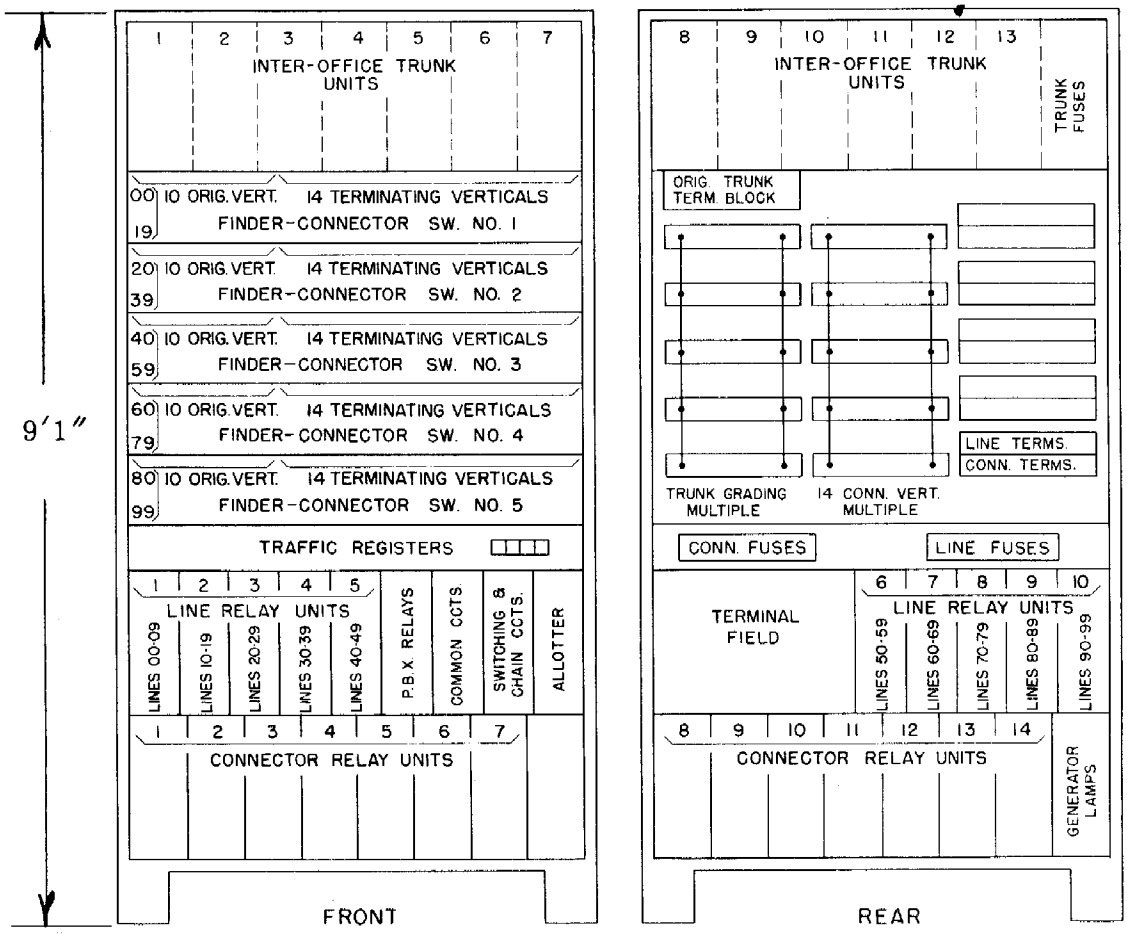


FIGURE 31

FINDER - CONNECTOR FRAMES

Type 7-2 Crossbar is mounted in self supporting aluminum finished steel frames.

Removable metal panels finished in gray Hammertone cover both front and rear of the equipment frames.

Crossbar switches are drawer mounted. Each switch has rollers fixed on both ends to permit it to slide in or out of its position in the frame for easy access and inspection.

Standard frame dimensions are 9'1" in height, 52" wide, and 14" deep.

Frames have a capacity of 100 line equipment and five finder - connector Crossbar switches.

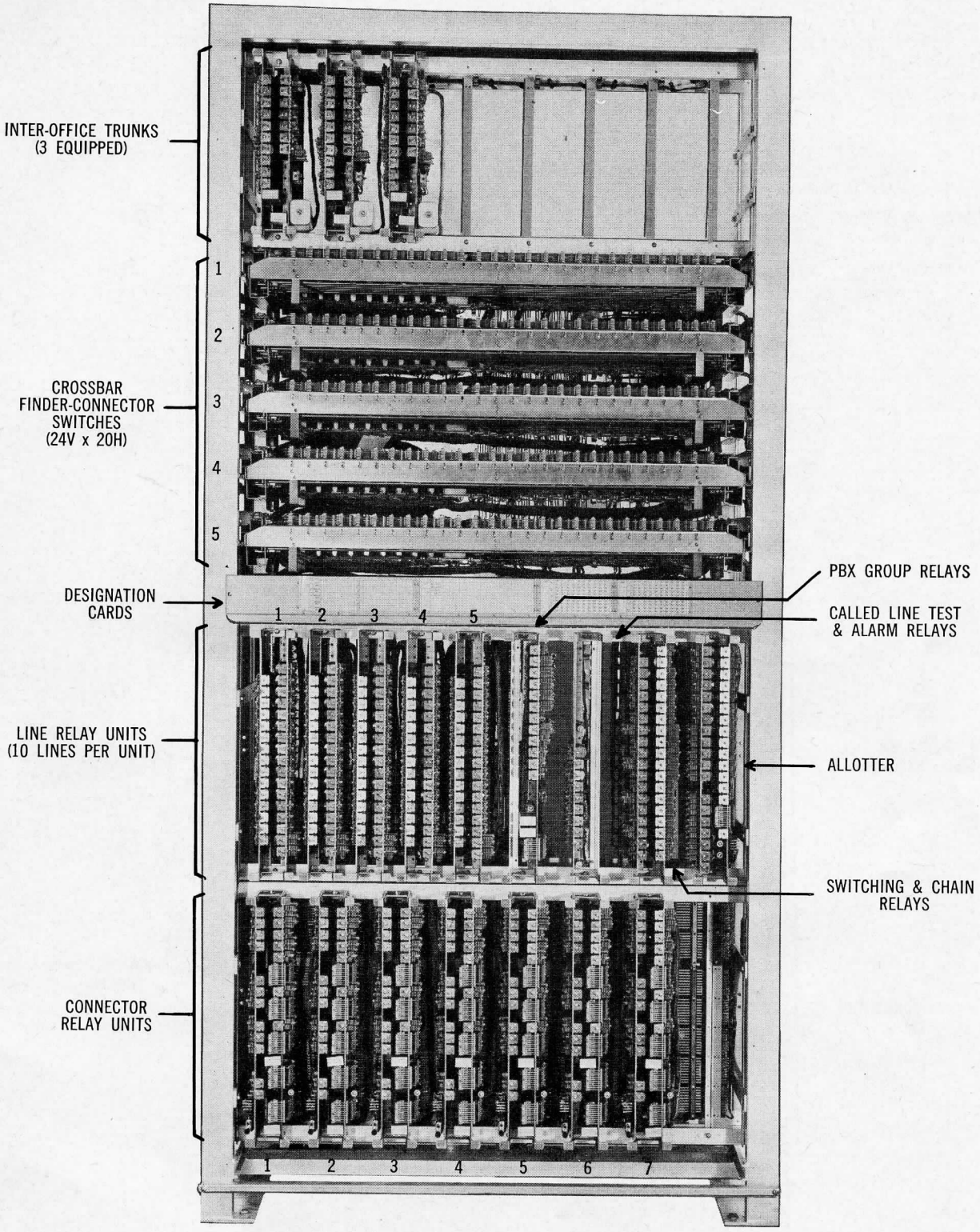
Figure 31 shows the general equipment layout. It should be noted the standard 9'1" frame has a capacity in the upper section to mount thirteen inter-office trunk units, generally saving the cost of a separate trunk frame.

The standard 9'1" frame requires a minimum unobstructed ceiling height of 10'6".

In order to meet conditions in existing central office buildings which do not permit use of the standard height frames, the 7-2 Crossbar equipment may be furnished in 100 line capacity frames 7'7" in height, 52" wide and 14" deep.

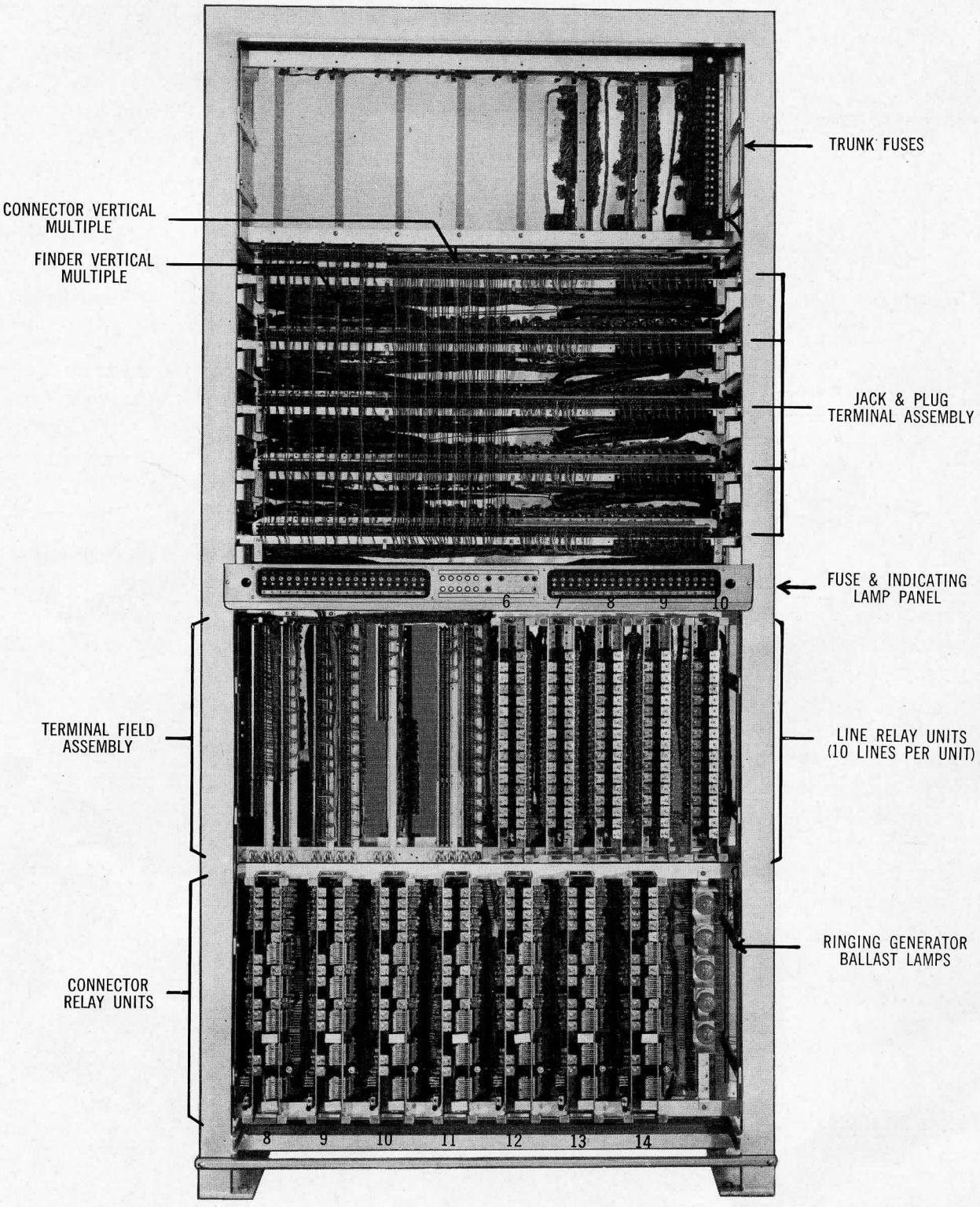
The equipment mounted in the low type frame is identical to that mounted in the standard frame except for the trunk equipment which must mount in a separate frame.

Minimum unobstructed ceiling height for the 7'7" frame is 9'0".



FRONT
FINDER-CONNECTOR FRAME (EQUIPPED)
100 LINE CAPACITY

FIGURE 32



REAR
FINDER-CONNECTOR FRAME (EQUIPPED)
100 LINE CAPACITY

FIGURE 33

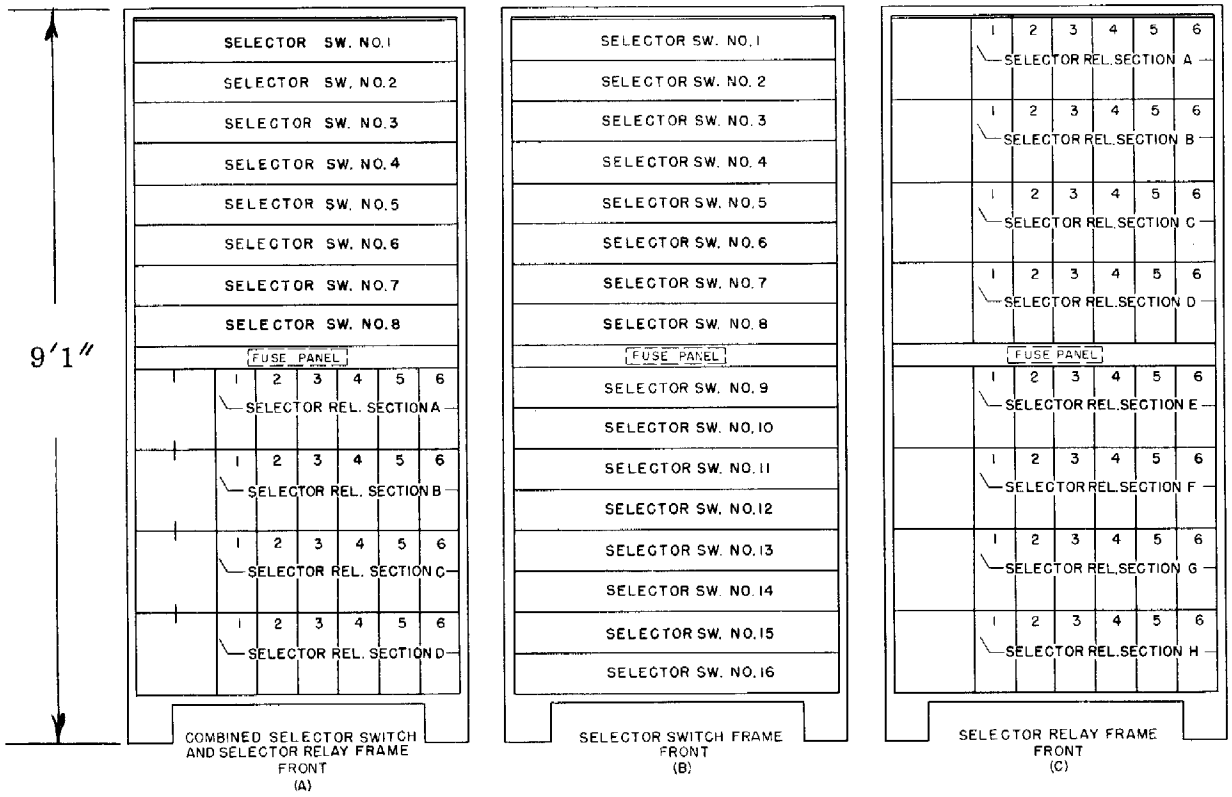


FIGURE 34

SELECTOR FRAMES

Selector equipment requiring one or more selector frames is provided on installations exceeding 100 lines or if traffic requirements demand, such as:

(a) Incoming trunk selectors
(b) Trunk group selection
(c) 2-5 Numbering plans
(d) Through toll dialing plans

Standard selector frame dimensions are the same as shown for the finder-connector frames.

Figure 34 shows the general equipment layout of Crossbar selector equipment frames.

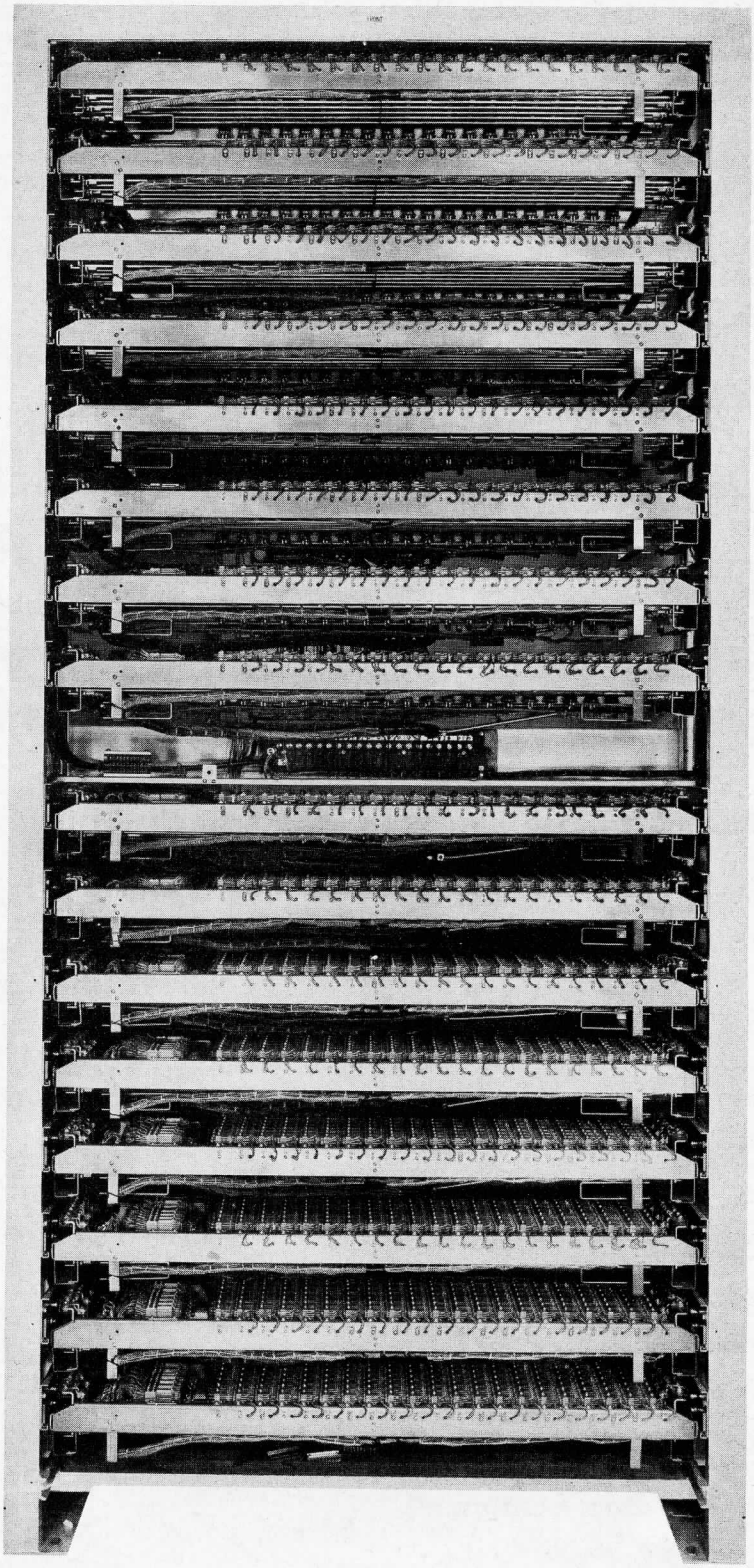
Illustration (A) shows the front view of a combined selector switch and selector relay frame. This frame has a capacity of eight selector switches and forty-eight selector relay units, twenty-four of which are mounted on the rear of the frame. Since the use of this type frame does not readily lend itself to an economical system of growth due to inter-unit cabling problems, use of this frame is generally restricted to installations not to exceed 400 lines ultimate.

Illustration "B" shows a front view of a selector switch frame with a capacity of sixteen selector level switches.

Illustration "C" shows a front view of a selector relay unit frame with a capacity of ninety-six selector units. Forty-eight being mounted on the front, and forty-eight mounted on the rear of the frame.

Selector equipment frames are also furnished in 7'7" in height when required.

On installations using the low type frame, mounting space can be provided for inter-office trunk equipment in selector frames requiring less selector equipment than their mounting capacity.



CROSSBAR SELECTOR SWITCH FRAME
EQUIPPED WITH 16 SELECTOR LEVEL SWITCHES
FIGURE 35

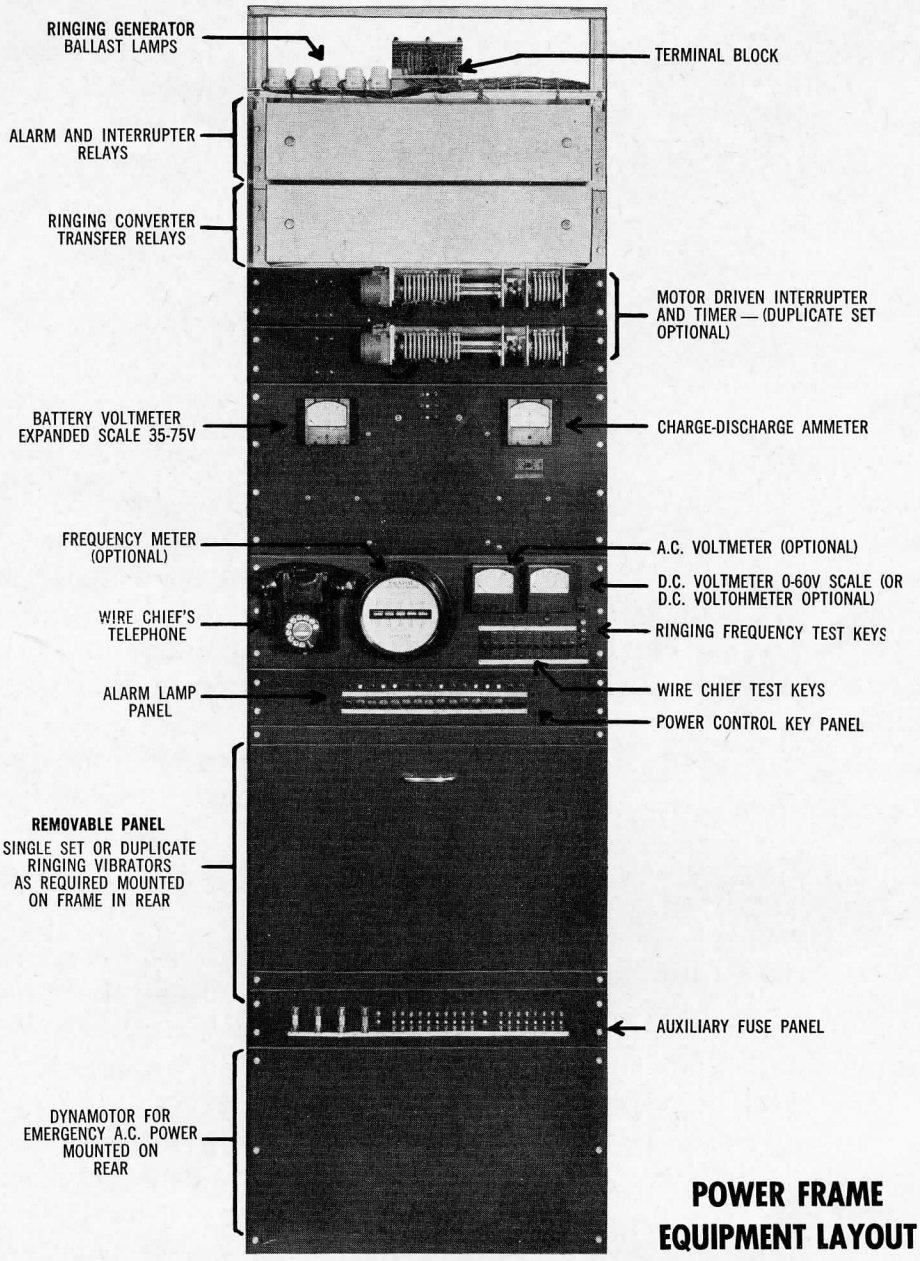


FIGURE 36

POWER FRAME

A power frame is furnished with Crossbar installations containing all of the necessary ringing, battery, and charging control equipment as well as alarm circuits and a wire chief's test panel.

Standard dimensions of the power frame is 9'1" in height, 2'8" wide. Low type power frames can also be furnished if required.

The power frame pictured in Figure 36 shows the general equipment layout of a power frame commonly supplied with Crossbar installations.

Some of the equipment items shown, such as the frequency meter, A.C. Voltmeter and the duplicate interrupter and timer may be omitted where economy is of prime importance.

WIRE CHIEF'S TESTING EQUIPMENT

As will be noted on Figure 36 a standard feature on all Crossbar power frames includes a Wire Chief's test panel and telephone circuit. The Wire Chief's test circuit is operated by the use of cam type keys mounted on the panel.

The test circuit has provisions to test for:

Shorted lines
Ground on tip conductor
Ground on ring conductor
Foreign battery
Line monitor

For installations requiring more extensive test facilities the following optional equipment can be provided.

A. C. Voltmeter
Dial speed indicator
Howler circuit
Ringing frequency meter
Key operated MDF test shoe
Volt-ohmeter

When required a Wire Chief's test turret with all necessary meters and test equipment can be furnished instead of the test panel.

RINGING

The following is a partial list of ringing systems furnished with Crossbar installations.

DECIMONIC RINGING

Decimonic ringing system complete with timer, tone generator, ringing machine supervisory and transfer circuit, K-5 decimonic sub-cycle and emergency pole changer providing 20, 30, 40, 50, 60 cycles ringing current, motor driven ringing interrupter and emergency Dynomotor with automatic switching circuit to provide A. C. supply during commercial power outage.

FIVE FREQUENCY, HARMONIC OR SYNCHROMONIC RINGING

Five frequency ringing system complete with timer, tone generator, ringing machine supervisory and transfer circuit, five frequency duplicate pole changers providing 16, 30, 42, 54, 66 (Synchromonic) or 16-2/3, 25, 33-1/3, 50, 66-2/3 (Harmonic) cycle ringing current, motor driven ringing interrupter and emergency Dynamotor, with automatic switching circuits to provide A.C. supply during commercial power outage.

Four frequency systems may be provided by omitting one of the above frequencies.

SINGLE FREQUENCY CODE RINGING

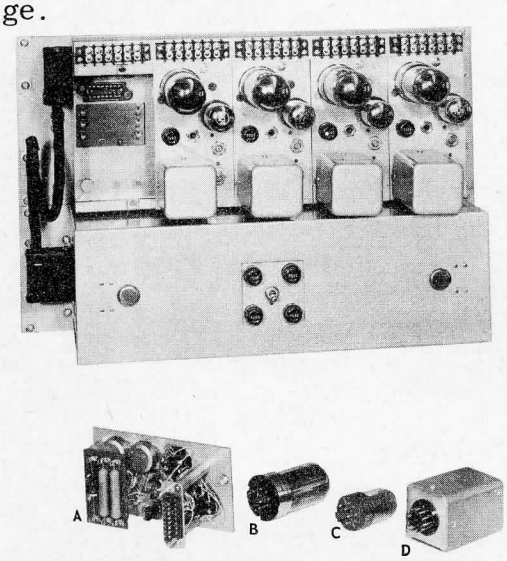
Code ringing complete with timer, tone generator, ringing machine supervisory and transfer circuit, single frequency Sub-Cycle and emergency pole changer providing 20 cycle ringing current, motor driven ringing interrupter, and emergency dynamotor with automatic switching circuits to provide A.C. supply during commercial power outage.

BIASED SELECTIVE OR SUPERIMPOSED RINGING

Biased selective ringing system, complete with timer, tone generator, Sub-Cycle in combination with an external D.C. supply and emergency pole changer, providing 20 cycle positive and negative pulsating ringing current, ringing machine supervisory and transfer circuit, motor driven interrupter and emergency Dynamotor, with automatic switching circuit to provide A. C. supply during commercial power outage.

ELECTRONIC RINGING

Electronic ringing complete with timer, tone generator, ringing machine supervisory and transfer circuit, Kellogg Electronic Ringing Generator furnished in either 4 or 5 frequency arrangements for decimonic, harmonic or synchromonic frequencies, emergency pole changer, motor driven ringing interrupter and emergency Dynamotor with automatic switching circuit to provide A. C. supply during commercial power outage.



ELECTRONIC RINGING GENERATOR
FIGURE 37

Figure 37 shows the plug-in type components comprising the Electronic Ringing Generator with the parts of one ringing frequency removed from the chassis as follows:

A. Oscillator Amplifier
B. No. 6080 Power amplifier tube
C. 6SN7 Oscillator tube
D. Oscillator Network unit

The Oscillator Amplifier chassis are identical for all ringing frequencies.

CENTRAL OFFICE BATTERIES

The size and capacity of the batteries furnished on each installation is based upon the number of equipped lines, the traffic, and the anticipated growth requirements of the community. Sufficient reserve capacity is provided in the event of a commercial power failure. The reserve capacity provided is based upon probable frequency and duration of power outages expected.

The 7-2 equipment will operate satisfactorily on a battery voltage range of from 46 to 52 volts. The use of end cell batteries is not required.

BATTERY CHARGING CONTROL CIRCUITS

All necessary charging control circuits determined by the power requirement of the installation are furnished.

FUSING:

All final feed fuses are of the alarm and indicating type arranged to light a pilot lamp when a fuse operates.

WIRING AND CABLING:

The equipment is assembled in the factory with all frame wiring placed and connected. All equipment is tested and adjusted before shipment. All lines are connected to terminal strips inside the frames. Crossbar switches and relay units are terminated on plug-in type terminal strips and arranged to be placed in their frame spaces and connected simply by a plug insertion.

Machine made cable is provided to connect the terminal strips in the frames to the main frame and for interconnection of equipment frames.

CABLE RACK:

A cable runway is furnished to support inter-frame cables.

MISCELLANEOUS:

Circuit descriptions, wiring diagrams, relay adjustments, and equipment layout drawings are furnished on each installation.

Maintenance tools, including a hand dial test set are furnished.

STANDARD RINGING CODES

For 10-Party Frequency Ringing

Ringing Digit	Side of Line	Ringing Code	Frequency of ringing voltage (CPS) 33-1/3, 30, 30	50, 42, 40	66-2/3, 54, 50	16-2/3, 66, 60	25 Harmonic 20 Synchromonic 20 Decimonic
1	Neg.	1 long	X				
2	Neg.	1 long		X			
3	Neg.	1 long			X		
4	Neg.	1 long				X	
5	Neg.	1 long					X
6	Pos.	2 shorts	X				
7	Pos.	2 shorts		X			
8	Pos.	2 shorts			X		
9	Pos.	2 shorts				X	
0	Pos.	2 shorts					X

For 10-Party Bridged Code

Ringing Digit	Side of Line	Ringing Code
1	Neg.	1 long
2	Neg.	2 short
3	Neg.	4 short
4	Neg.	2 long
5	Neg.	2 long 1 short
6	Pos.	2 short 1 long
7	Pos.	2 short 1 long 1 short
8	Pos.	1 long 1 short
9	Pos.	1 long 2 short
0	Pos.	1 long 3 short

For 8-Party Superimposed

Ringing Digit	Side of Line	Ringing Code	Ring Polarity
1	Neg.	1 long	+
2	Neg.	1 long	-
3	Neg.	2 short	+
4	Neg.	2 short	-
5	Pos.	1 long	+
6	Pos.	1 long	-
7	Pos.	2 short	+
8	Pos.	2 short	-

HOUSING

It should be remembered that dial switching equipment is designed to perform many complex functions. Like all electrical equipment of such a nature it will provide a highly satisfactory service over a long period of time if properly housed and protected.

A reasonable amount of care exercised in the planning stages will pay dividends in later maintenance costs.

Building requirements will vary with geographical location, climate, dust and smoke conditions, salt air and proximity to chemical plants.

If a new building is to be constructed it should be planned to protect the equipment from moisture, dust and fumes. The floor on which the equipment is to be placed should be dry. If a concrete floor or other porous material is planned, it is advisable to cover it with a material such as linoleum or asphalt tile which will help reduce moisture and concrete dusting. Wall and ceiling construction should be such that the inner surface of the room will not tend to dust or collect moisture. Plain surfaces such as finished plaster is preferable to open beams or rough surfaces.

All building alterations should be completed before the equipment is placed to avoid plaster dust, etc., in the vicinity of the equipment.

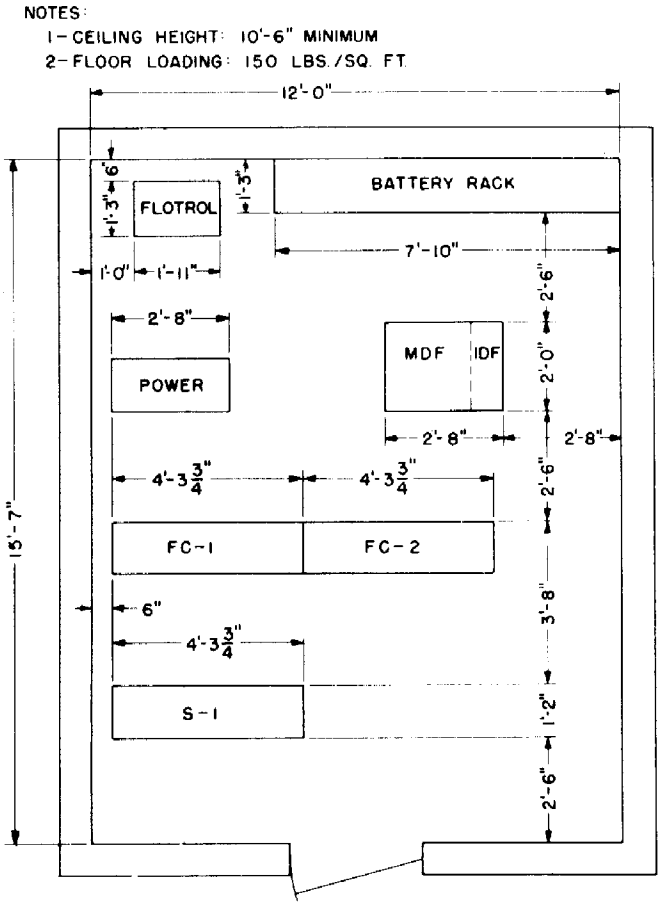
Although Crossbar switching equipment will perform satisfactorily under all temperature conditions some form of ventilation or heating should be provided to prevent excessive moisture condensation, especially in locations where extreme temperature changes are experienced.

The Kellogg Switchboard & Supply Company will gladly assist in planning the equipment housing.

FLOOR PLANS

Floor space requirements for 7-2 Crossbar switching equipment is determined by the traffic load for the number of equipped lines in the initial installation plus some consideration of future equipment requirements to meet growth.

Figure 38 illustrates a typical floor plan for a 200 line 7-2 Crossbar terminal per line installation including Power and Main Frame.



TYPICAL FLOOR PLAN
200 LINE ULTIMATE
TYPE 7-2 KELLOGG CROSSBAR
FIGURE 38

NOTES

1 - CEILING HEIGHT: 10'-6" MINIMUM

2 - FLOOR LOADING: 150 LBS./SQ. FT.

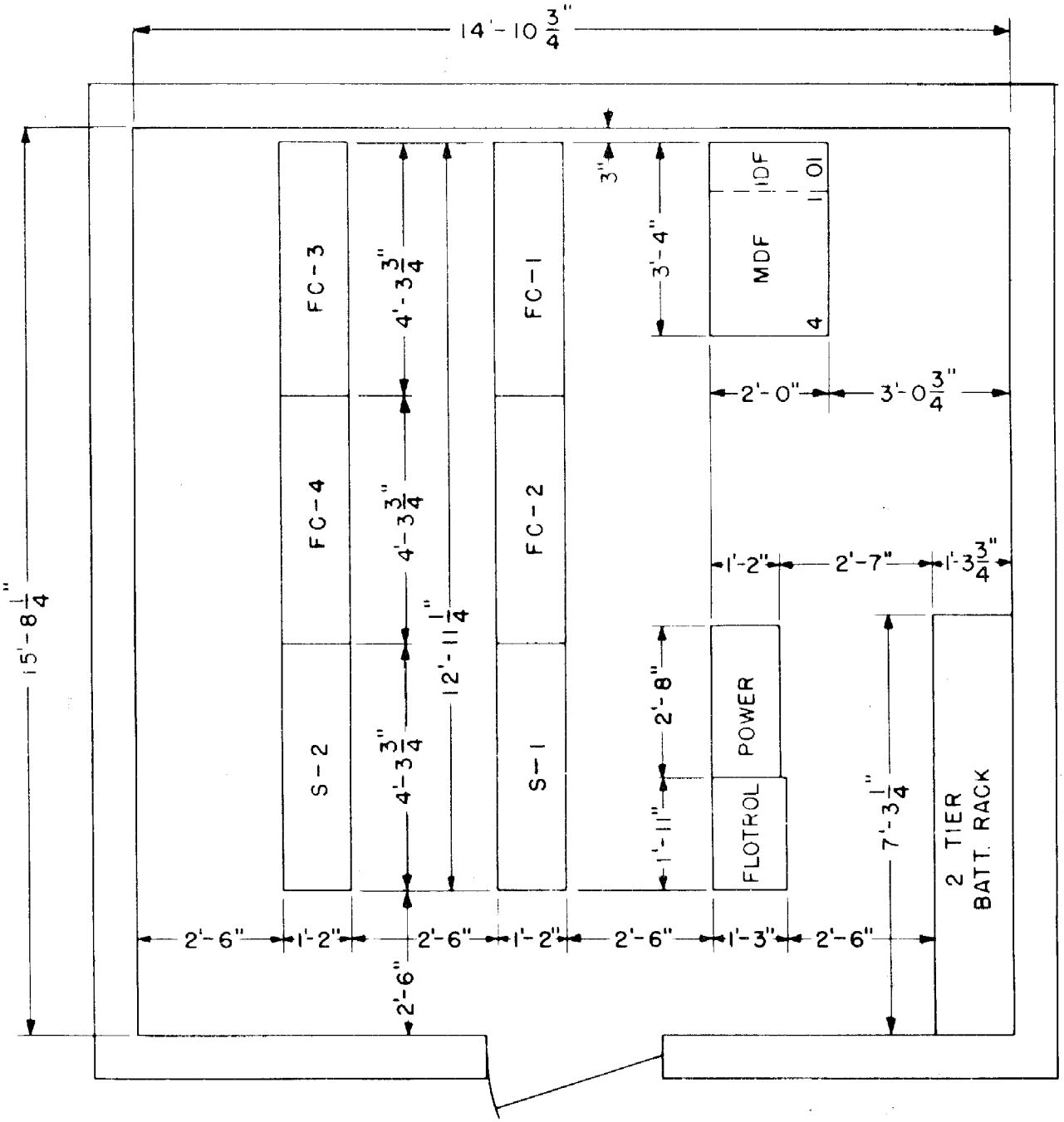


FIGURE 39 ILLUSTRATES A TYPICAL FLOOR PLAN FOR A 400 LINE 7-2. CROSSBAR TERMINAL PER LINE INSTALLATION INCLUDING POWER AND MAIN FRAME.

NOTES:

1 - CEILING HEIGHT: 10'-6" MINIMUM

2 - FLOOR LOADING: 150 LBS./SQ. FT.

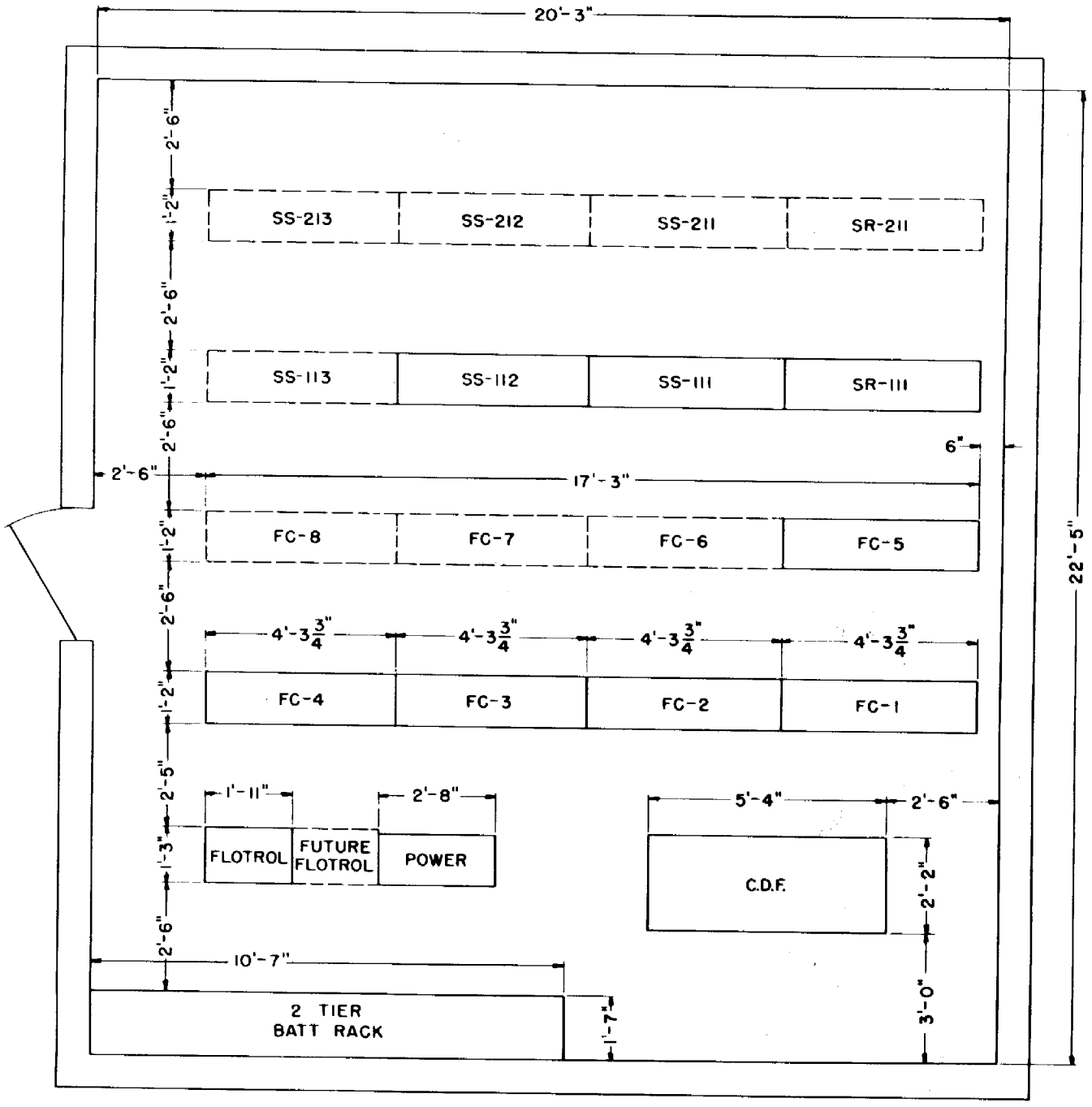


FIGURE 40 ILLUSTRATES A TYPICAL FLOOR PLAN FOR A 800 LINE 7-2 CROSSBAR TERMINAL PER LINE INSTALLATION INCLUDING POWER AND MAIN FRAME.

MAIN DISTRIBUTING FRAMES

Switchboard protection and cross-connection facilities are provided, as required, on a main distributing frame.

Two types of main distributing frames are available:

1. An "A" type frame which has all outside lines terminated on terminal blocks. The switchboard cables are terminated on protectors mounted on the vertical side of the frame.

2. A "B" type frame which has all outside lines terminated on protectors on the vertical side, and all switchboard cables terminated on terminal blocks.

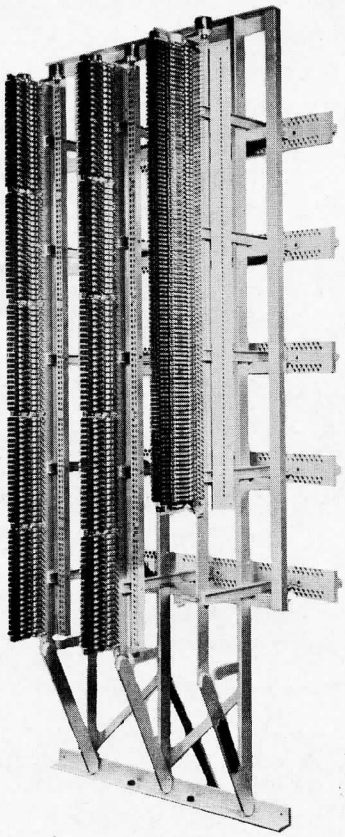
Protector units affording protection against lighting and power currents may be furnished in three types:

1. Carbon lighting arrestors and heat coils.

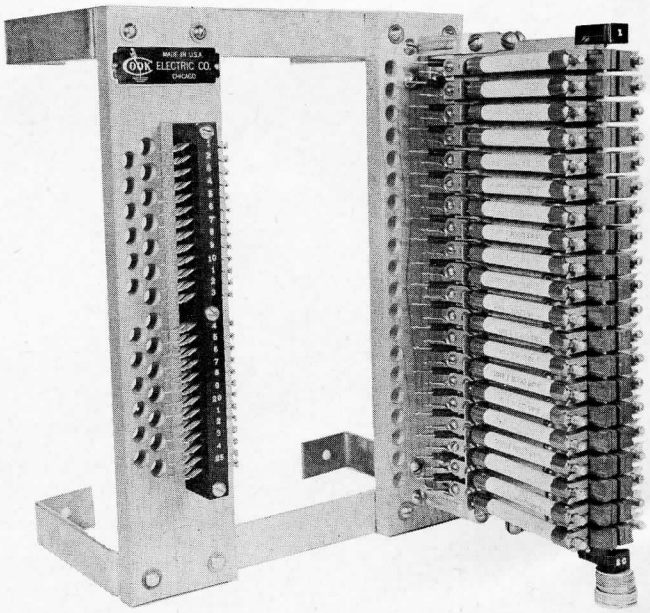
2. Carbon arrestors and fuses.

3. Carbon arrestors, fuses and heat coils.

Main distributing frames may be furnished in either floor mounting or wall mounting. However, wall mounted frames are not commonly furnished for installations ultimately exceeding 100 lines. Figure 41 illustrates both floor and wall types of frames.



MAIN DISTRIBUTING FRAME



WALL DISTRIBUTING FRAME

FIGURE 41