THE NO. 1 CROSSBAR DIAL TELEPHONE SYSTEM

Telephone Systems Training

COURSE: CENTRAL OFFICE EQUIPMENT

LESSON NO. 5

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Western Electric Company
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Equipment Engineering Branch *Training Section*

Western Electric Company, Inc.
Hawthorne Works
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This lesson is issued to describe the general features of the No. 1 Crossbar Dial Telephone System. Information contained herein is to be used for training purposes only.

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BIBLIOGRAPHY

Bell System Publications.

Section 1. History and Development.

Experience gained in connection with the development, manufacture, installation, and maintenance of existing Panel and Step-by-Step dial telephone systems, has culminated in the development of another dial system. This most recent achievement of the Bell Telephone Laboratories in the telephone communication field is known as the No. 1 Crossbar dial system, which employs the principle of the relay in the design of its mechanism.

During the period of the World War I, the Panel dial system reached the stage in its development where a definite manufacturing program was outlined, and trial equipment for three central offices was ordered and installed. During this same period, development work was initiated in connection with another mechanical telephone system (coordinate system) which embodied ideas taken from the peg type manual telegraph switchboard in use about 1880. Operating features included a system of vertical and horizontal wires, so arranged in a framework, and controlled by groups of vertical and horizontal magnets, that one vertical and one horizontal wire out of the complete arrangement could be caused to make contact and complete a particular path through the frame. A series of such frames were required to complete calls from one subscriber to another. Development work on this new type of equipment was abandoned during World War I. In the post-war period the Bell System was faced with a shortage of operators who were required to operate the manual switchboards in general use at that time. As a result of this shortage of operators and to continue the Bell System policy of continued improvement in telephone service, it was decided to adopt the Panel dial system for all new installations in the larger cities. The Panel dial system was adopted because it was in its final stages of development, and the immediate need for a mechanical system made it desirable to begin manufacture and installation as soon as possible.

All activity was then centered on the further development, manufacture and installation of the Panel dial system. Along with this development, arrangements were made with the Automatic Electric Company whereby the Bell System would manufacture and install Step-by-Step dial equipment. A few years later, development work was started on a new system (the No. 1 Crossbar dial system) which would eliminate the unattractive features of both the Panel and Step-by-Step dial systems. The anticipated advantages of the Crossbar over the Panel dial system include: (1) elimination of power-driven equipment with a few minor exceptions; (2) reduction in number of parts; (3) reduction of maintenance costs; (4) twin precious metal contacts, minimizing circuit failure due to corrosion and dust and increasing conductance resulting in better transmission; and (5) the straight line production method of manufacture resulting in lowered manufacturing costs. The crossbar switch, composed of relay-like spring combinations arranged in units of vertical columns and horizontal rows, under control of vertical and horizontal magnets, provides practically all switching functions necessary in completing connections.

The first No. 1 Crossbar dial system central office unit was installed on a trial basis for the New York Bell Telephone Company in Brooklyn, New York, being placed in active service in early 1937. A great many central office unit equipments have been installed throughout the Bell System in the years up to 1946. These include units in New York City; Lynn, Massachusetts;

Washington, D.C.; Chicago, Illinois; Seattle, Washington; Detroit, Michigan; and Alameda, California. A total of approximately 19,174 frames were provided to service 862,000 subscriber lines during the years 1937 to 1946. The schedule for 1946 will include 10,944 frames and 492,000 lines, and for 1947, 23,750 frames and 900,000 lines.

The equipment so far installed has given satisfactory service. The Bell Telephone Laboratories are continuing development work on the system, redesigning the original equipment and adding many new features so as to provide the best possible service to the telephone subscriber.

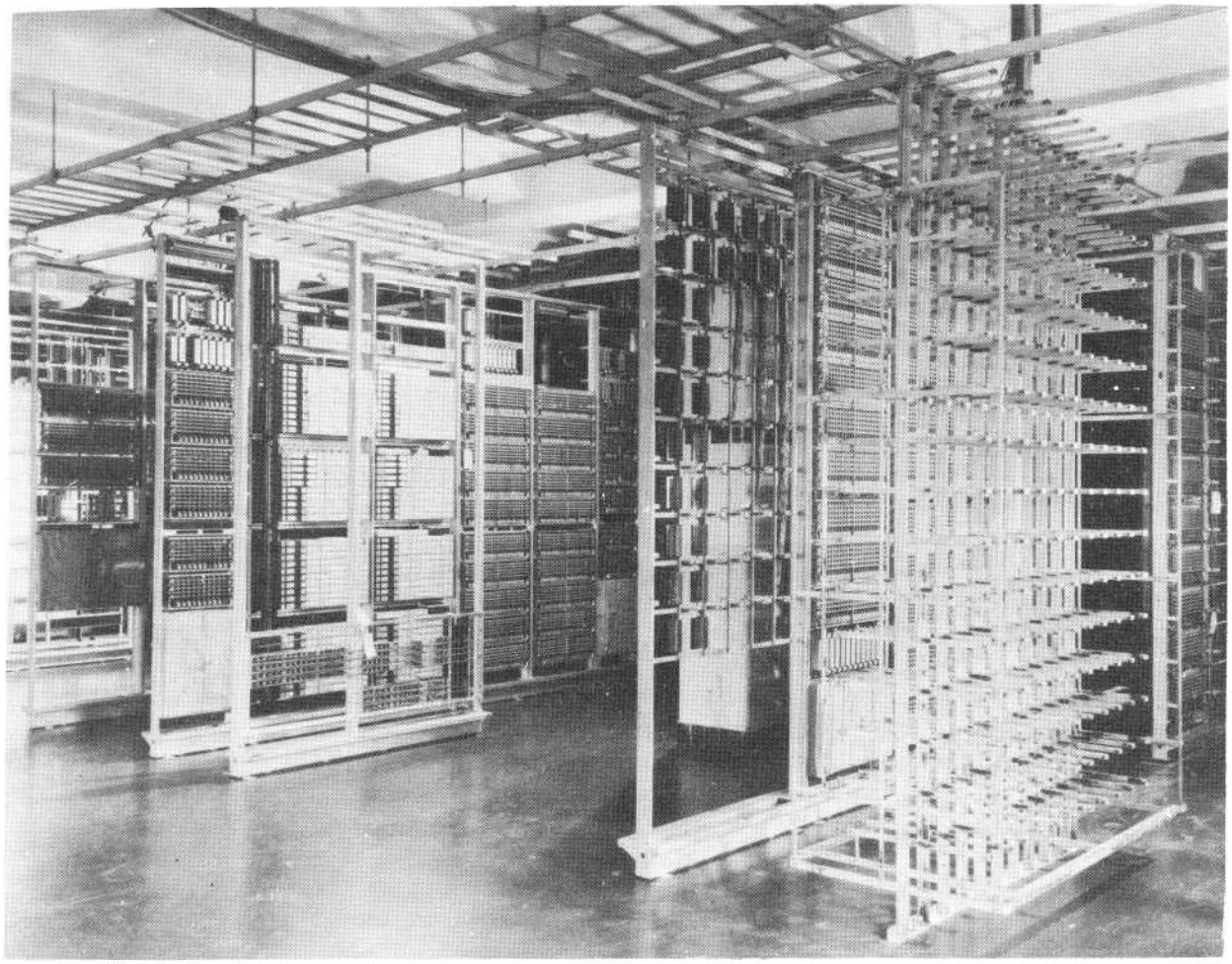


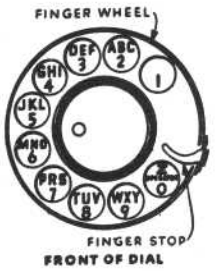
Fig. 1 Typical Frames - No. 1 Crossbar Dial System

Section 2. The Principles of Dial Switching

The function of any telephone system is to connect the lines of any two of its subscribers so that they can talk over the electric circuit thus established.

In a manual telephone system the subscriber orally transmits the number he desires to an operator who selects the number for him and connects his line to the line of that number; or who, in larger systems, connects the line with a trunk to a distant office and repeats the number desired to another operator who completes the connection to the called line. In a dial system the operator is entirely eliminated in so far as regular calls are concerned, but the sequence of operations is somewhat similar, with the operations being performed by electro-mechanical switches.

Since an electro-mechanical switch cannot respond to the voice of the subscriber as an operator can, each subscriber equipment includes a "dial" (Fig. 2), by means of which he transmits electrically the number he is calling. Actually, when the dial is operated by a calling subscriber, the electric circuit between the subscriber and the central office is opened and closed a certain number of times, depending on the digit or letter dialed. For example, if number 4 is dialed, the circuit is opened and closed 4 times, thus generating 4 pulses, which transmit definite information to the mechanical equipment in the telephone office.



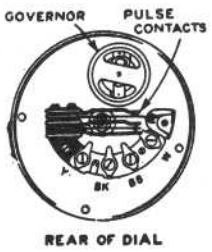


Fig. 2 Dial

The simplest form of a dial telephone system (Fig. 3A) would be some form of an electro-mechanical switch electrically connected to the subscriber line, the selector arm of which, would, by means of an electro-magnet, be moved one step each time the circuit of the subscriber line was broken and made by the operation of the dial. This would enable the sub-scriber to connect his telephone to any one of a group of telephones by a single rotation of the dial. By dialing one (1), the telephone connected to the first contact of the switch would be selected; by dialing two (2), the telephone connected to the second contact would be selected. As many telephones could be selected at the one switch as there were digits on the dial. Zero is the tenth and last digit on the dial, and when the dial is rotated from the zero finger hole, ten dial pulses are sent out and the telephone connected to the tenth contact of the switch would be selected.

More telephones could be reached by the subscriber with the use of additional switches arranged as in Fig. 3B. Here the first rotation of the subscriber dial sends out pulses which cause the selector arm of the first switch to move and connect to a path, called a trunk, to a second switch. The second rotation of the dial operates the selector arm of the second switch. To insure that the second switch is operated by the second rotation of the dial and the

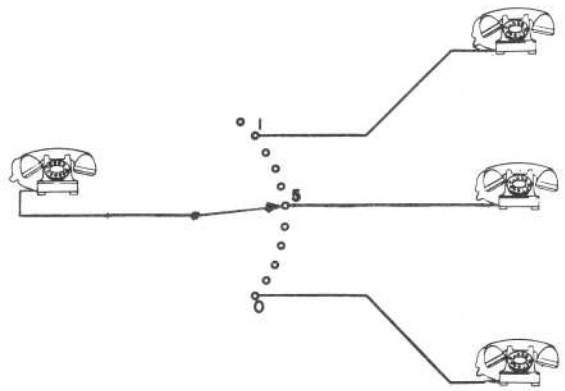


Fig. 3A

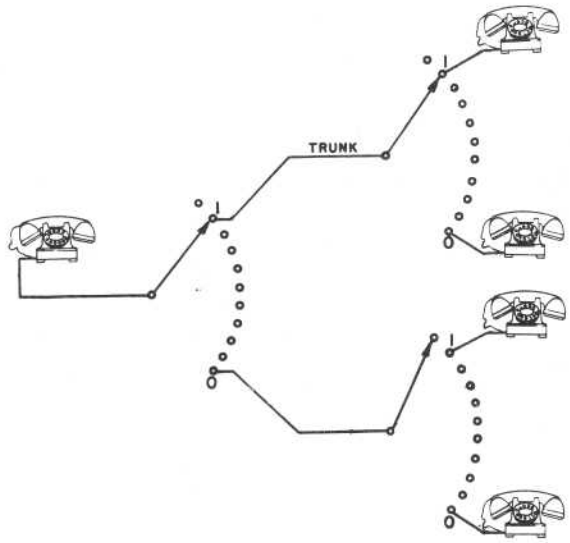


Fig. 3B

first switch not moved, a slow release relay is included in the circuit. This relay is so slow that it will not release between the rapid pulses produced by the dial, but does release in the pause which ensues when the subscriber reaches for the second pull of the dial. This slow release relay involves a fundamental principle of dial telephone systems.

The two arrangements thus far described allow for only one telephone to originate calls to any of the others. In order that the other telephones may originate calls also, it is necessary to equip each telephone with a selector switch of its own. During the time that the subscriber is not using his telephone this switch of course would be idle.

This condition can be eliminated by introducing a switch known as a "line finder". One of these switches is provided for a group of subscriber lines, the lines being connected to the terminals of the switch bank. The switch is so designed that when a subscriber lifts his receiver, the selector arm automatically rotates and finds the calling subscriber line terminal in the bank and makes contact with it. This connects the subscriber line to a first selector switch, via the line finder, and the operation of the dial causes the called line to be selected the same as in the system described above. Fig. 3C represents a complete telephone system, which operates on this principle. The system includes a line finder switch which connects the calling subscriber line in circuit with one of the first selector switches. The first selector switches are shown connected by means of trunks, to second selector switches. After the line finder switch has connected the calling subscriber telephone to the selecting equipment, the first selector, under control of the first dialing, selects a trunk to the office wanted (it may be the same office in which the calling subscriber line is connected). The trunk connects to a second switch, in the called office, which is controlled by the second dialing to select a trunk to the group of telephones wanted. This group of telephones is connected to a third switch known as a connector switch. The third dialing causes one of these lines to be connected to the selected trunk, completing the connection between the calling and the called telephones.

An additional feature is illustrated in Fig. 3C. It will be noted that there are two trunks between office "A" and office "B" and that these trunks are multipled to both the selector switches shown. Thus, two subscribers

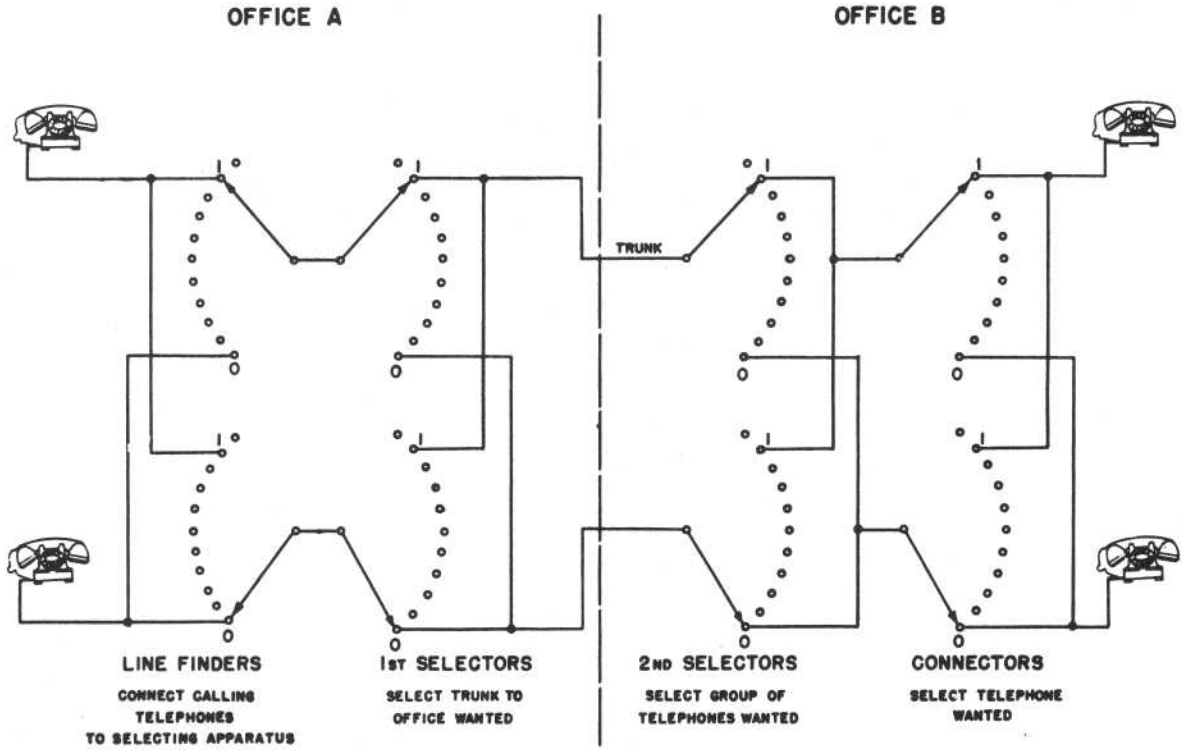


Fig. 3C

may at the same moment talk from office "A" to office "B", but this requires an additional feature in the selector switch. It must be so arranged that if it is moved by a subscriber dialing to a trunk which is already in use, it will automatically move to the next trunk. This feature is known as "trunk hunting" and is characteristic of dial telephone systems of this type. In such systems, the number of trunks in any group over which a selector can hunt is generally limited to ten by the mechanical limitations of the switch and the numerical system employed in dialing. Where more than ten trunks are required, they must be divided into two or more groups, each of which does not exceed ten.

If all trunks in one of these small groups become busy, a selector hunting in that group will not be able to complete the call, although there might still be idle trunks in other groups. Could all of these trunks be put in one group so that each selector could hunt over all of them it would always be possible for every selector to complete a call so long as any trunk was idle. One group of twenty trunks will in this way handle more than twice as much traffic as a group of ten trunks. Where a large number of trunks is required to each office, the advantages of equipment so constructed that the selectors can hunt over large groups of trunks are apparent. The realization of this, coupled with the fact that trunking systems in the larger cities are necessarily complex, was largely responsible for the development of the panel dial type selector consisting of brushes attached to a rod moving over banks of subscriber or trunk terminals.

The panel dial system equipment is so constructed that the selector may hunt over a group of trunks as large as ninety if desired or this may be split up into groups of 5, 10, 20, 30, etc., so as to supply the proper number of trunks for efficient service.

It is necessary to abandon direct control by the subscriber dial when trunk groups of over ten are used or when a bank of terminals is divided into a variable number of trunk groups with a varying number of trunks in each group. The time interval required in moving the selector over a group of 90 trunks might be so great that it will exceed the interval between the dialing of two digits, and the second digit would be dialed before the first had been registered in the selector. If a selector were choosing the fourth group of trunks in a bank, it might be necessary for it to jump 10 trunks at the first step, 20 in the next, and possibly 40 at the third.

In addition to the abandonment of direct control, it is necessary in such a large and complicated installation as that required in a large city to abandon also numerical selectors so that any group of trunks in an office may be associated with any dialing combination which may be desirable from a traffic standpoint. Having abandoned direct control and numerical selection, the digits which the subscriber dials have no direct relation to the groups of trunks with which the various combinations of these are associated.

The Panel dial system provides a system of selectors, switches, and relays, arranged in proper combinations, which will receive the dialing from the subscriber, record it, and decode it in such a way as to operate certain combinations of these, which will in turn control circuit closures, to complete calls from one subscriber to another subscriber.

The Crossbar dial system, designed to replace the Panel dial system, consists essentially of crossbar switches and multi-contact relays instead of Panel dial selectors and sequence switches. The crossbar switch is the principle switching element, consisting primarily of horizontal and vertical members, each under magnet control. A large number of contact combinations are available with this arrangement, by means of which one of a number of paths may be selected and established through the switch unit. A path is completed when a vertical point is connected to a horizontal point, the number of these "cross-points" available being determined by the number of horizontal and vertical members.

Crossbar switches and relays are arranged on various frameworks in such a way that any subscriber in an exchange area may call any other subscriber, simply by dialing the number of the party being called.

Fig. 4 shows the sequence of equipment involved in completing a call through a No. 1 Crossbar dial central office. The line, district, office, and incoming link, district junctor, and incoming trunk frames carry the talking connection, while all remaining frames are used only in completing the call to the point where the two subscribers may start conversation. Each frame is equipped with numerous circuits, so that several conversations may be carried on at the same time. If the traffic requires, additional frames are added, providing additional circuits or paths, by means of which other calls can be handled.

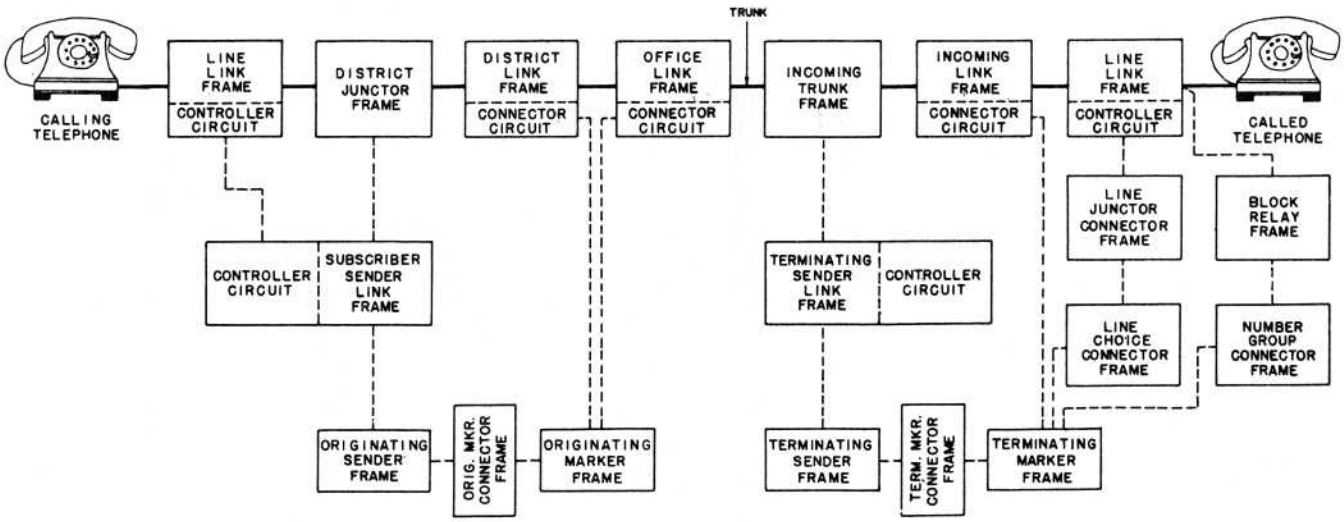


Fig. 4 Path of Call Through a No. 1 Crossbar Dial Central Office

Section 3. Equipment.

The crossbar switch (Figs. 5, 6, and 7) is the principle switching device used in this system and may be described as a selective two stage multi-unit relay. The component parts of the switch include five horizontal bars, each equipped with a number of flexible wire fingers and each bar under the control of magnets, which, when energized, impart a rotary motion to the bars and fingers either in a clockwise or a counter-clockwise direction. These parts are known as the selecting elements of the crossbar switch.

Fig. 5 Crossbar Switch (Rear)

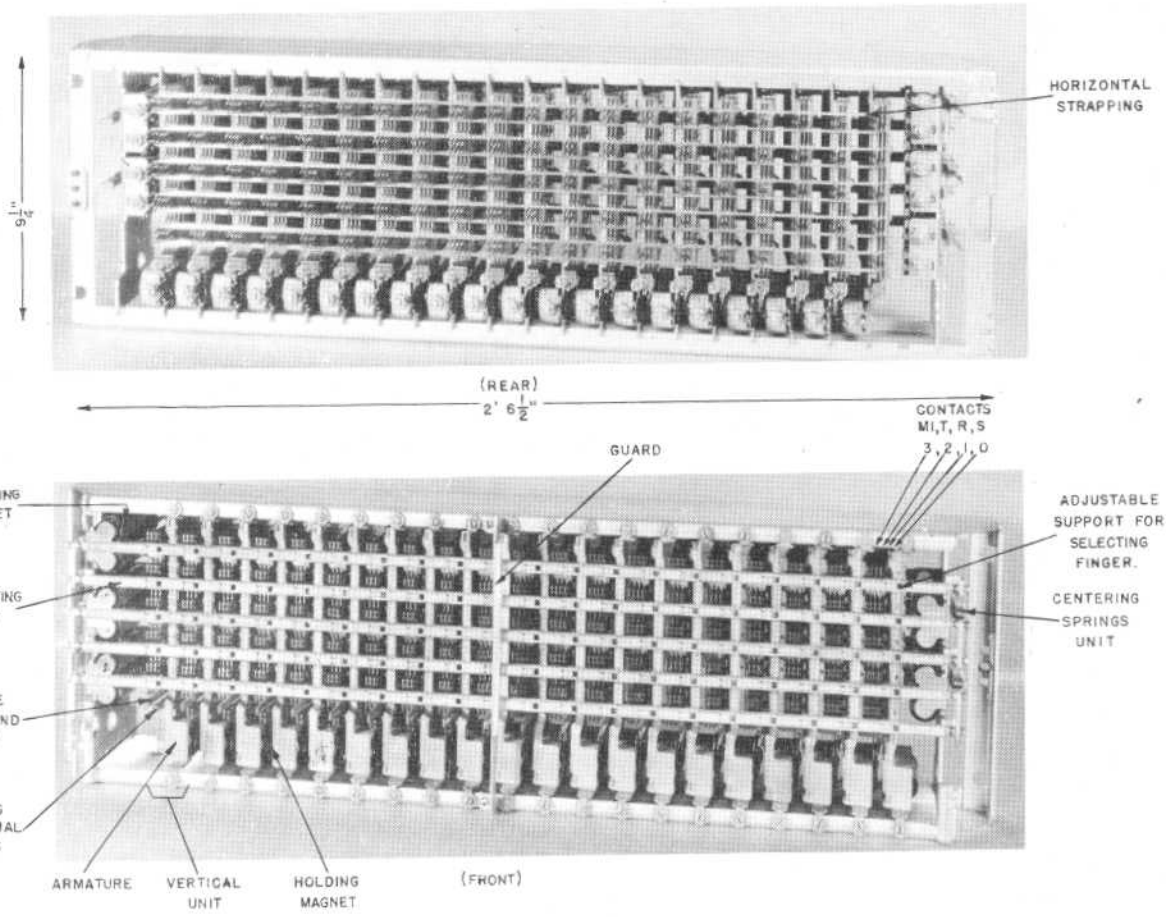


Fig. 6 Crossbar Switch (Front)

The switch is also provided with a number of vertical unit assemblies, each having 10 sets of relay-like contact springs (Fig. 8). Each set consists of 3, 4, 5, or 6 pairs of normally open or "make" contact springs. One spring of each pair is a fixed spring consisting of a projection of an insulated vertical metal strip made in the shape of a comb. This strip extends from the top to the bottom set of contacts of a vertical row. A wiring lug is provided at its lower end and projects to the rear. At the lower end of

these strips and facing the front is another projection which serves as a jack for test and make busy purposes. This metal strip thus provides a continuous and self-contained multiple within the vertical unit assembly for alternate vertical rows of spring contacts. The remaining or mate spring of each pair is individual and is insulated from the other springs. These mate springs extend to the rear of the switch for wiring purposes. The soldering terminals, in addition to being arranged for individual wiring, have notched projections to permit the use of bare wire strapping where it is desired to multiple the individual contacts of two or more vertical units horizontally.

Individual springs have forked ends, each prong being equipped with a precious metal contact, while the projections on the common metal strip, representing the fixed or stationary spring of a pair, are solid and mount two precious metal contacts, thus providing twin contacts for each circuit closure.

Each vertical unit assembly also includes a "holding" magnet located at the lower end of the unit and a long vertical armature, known as the holding bar, in front of and extending to the top of the unit, and pivoted so as to rotate under control of a magnet and restoring spring.

The operation of either the selecting or the holding magnets alone do not actuate the contact spring assemblies, since it requires a two-stage operation to effect contact closure at any crosspoint. First, a selecting magnet must be operated and kept energized until the holding magnet of the desired vertical unit is operated, after which the selecting magnet may be

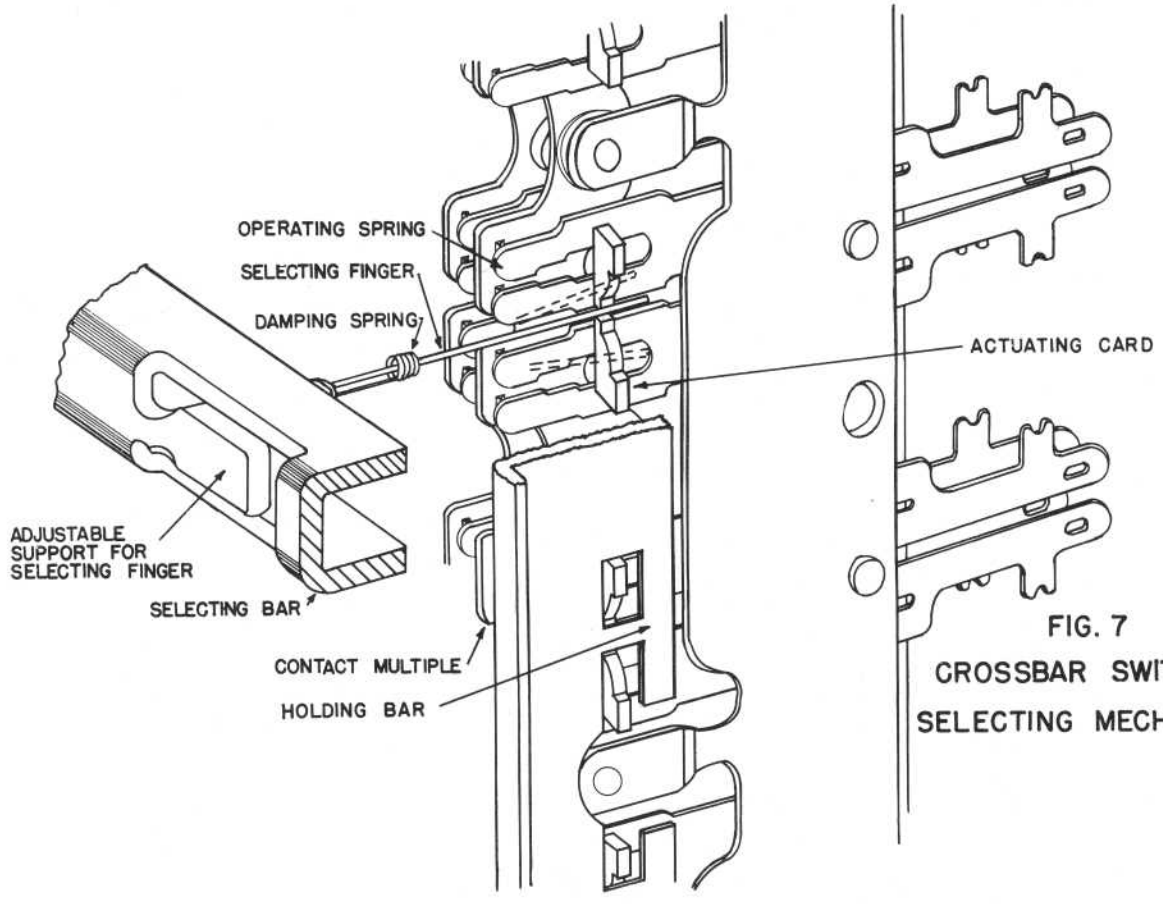


FIG. 7
CROSSBAR SWITCH
SELECTING MECHANISM

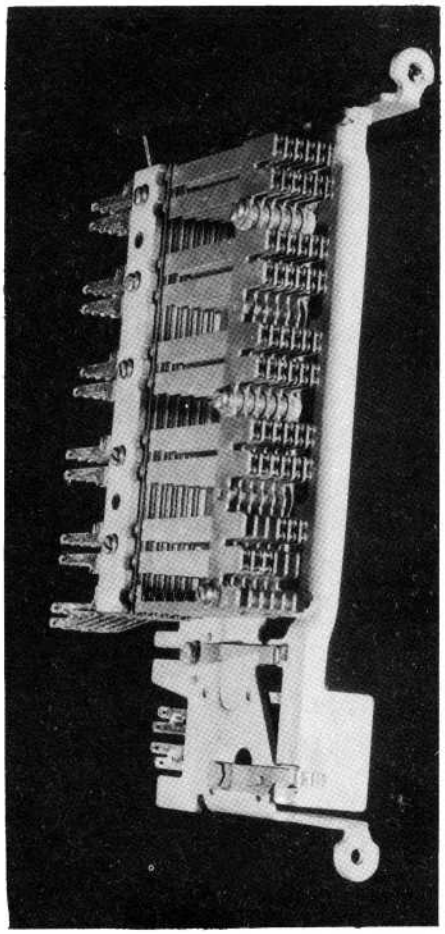


Fig. 8 Vertical Unit

released. The holding magnet must, however, remain energized throughout the duration of the contact closure. Each spring assembly is equipped on the right with an actuating card which is constructed to act as a stop and limit the up and down travel of the selecting fingers. With the switch normal, one selecting finger is at rest in a horizontal position and midway between each pair of spring assemblies. The selecting fingers also occupy positions in a vertical plane in between the actuating cards and the holding bars of the various units so that on the operation of the selecting magnets, the fingers are free to travel up or down within the limits of the stops mentioned and come to rest in the same horizontal plane as the actuating cards and in between the actuating cards and the holding bars. The selecting magnet must remain energized until a holding magnet is operated so that the selecting finger will be trapped and cause the selected spring assembly to close its contacts. On the release of the selecting magnet the finger remains locked at the operated cross-point, but due to the flexible nature of the finger the selecting bar is permitted to return to normal, and it may again be operated when it is desired to select any of the other cross-points, which are under the control of the same selecting bar, with the exception of that particular spring assembly, which is adjacent to the spring assembly already operated and located on the same vertical unit.

The switch is also equipped with "off normal" spring assemblies, as required, which are associated with the selecting and holding magnets, and function like those of relays. These springs are operated whenever the associated magnet is energized; are individual to the respective magnets, and are not dependent on the two-stage operating cycle described.

The crossbar switch framework is 9-1/4" in height and is provided in three lengths - 20-1/2", 30-1/2", and 34-1/2" - which mount either 10, 19, or 20 vertical units. The 10 vertical unit switch is known as a 100-point switch and is made in 3, 4, 5, and 6 wire-sizes. The wire-size or classification indicates the number of spring pairs or combinations at each cross-point; for example, a 100-point, 4-wire switch includes 100 cross-points, each of which consists of 4 spring pairs. The 19 vertical unit switch is a 190-point, 5-wire arrangement, while the 20 vertical unit switch is designed in two lengths, one 30-1/2" and the other 34-1/2" long. The 30-1/2" length switch is a 200-point, and either 3 or 4-wire; while the 34-1/2" length is a 200-point, 6-wire switch.

Crossbar switches are classified under the following codes:

Codes				Vert.	Cross-	Wire
Orig.	Replacing			Units	Points	Size
300	304	314	324	10	100	3,4,5,6
301	305	315	325	20	200	3,4
302	306	315	325	19	190	5
303	307	315	325	20	200	3 and 5
308		318	328	20	200	6

The multi-contact relay (Fig. 9) resembles in design the vertical unit of the 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 structure may, therefore, be used as two independent relays, or when desired, may be used as one relay by multipling the two windings of the coils.

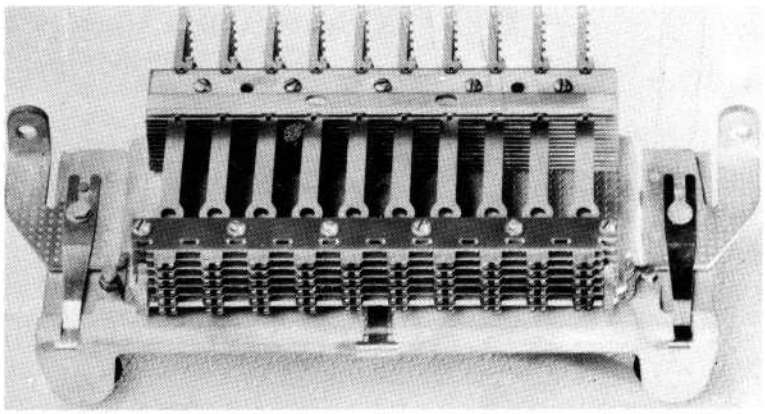


Fig. 9 Multi-contact Relay

The spring nests consist of normally open or "make" contacts with all springs brought out individually at the front and rear. In energizing a magnet all springs under control of that magnet are operated and the contacts are closed. All springs have split ends and twin contacts.

The multi-contact relay is available in four spring capacities, namely, with 30, 40, 50, and 60 pairs 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 and occupies a mounting space of approximately 2" x 11". A tight-fitting can cover slips over the spring pile-ups, leaving the magnets and armatures exposed.

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

A change in the design of the multi-contact relay to use shorter contact springs has resulted in a series of new codes being assigned. Multi-contact relays, old and new, are coded as follows:

Code		Old and New Codes Identical		
Old	New	Wire Size	Spring Capacity	Coil Resistance
245-A	263-A	6	60	275w)
B	B	4	40	275w) Arranged for
C	C	3	30	275w) Horizontal
D	D	5	50	275w) Strapping
E	E	6	60	120w)
254-A	264-A	5	50	275w(Arranged for
B	B	6	60	275w(Individual Wiring

The multi-contact switch (Fig. 10) is used wherever it is desired to switch a number of leads manually, as in transferring from one controller circuit to another. It is essentially the multi-contact relay with the magnets omitted and replaced by a lever or key for actuating a plate which takes the place of the armature. This switch is designed in two types, 216-A and B, one with a single lever which will operate all spring sets (60 pair) and another type having two levers, each of which controls one-half of the spring sets as in the case of the multi-contact relay. The 216-A is the only type in production with soldering terminals arranged for individual wiring only.

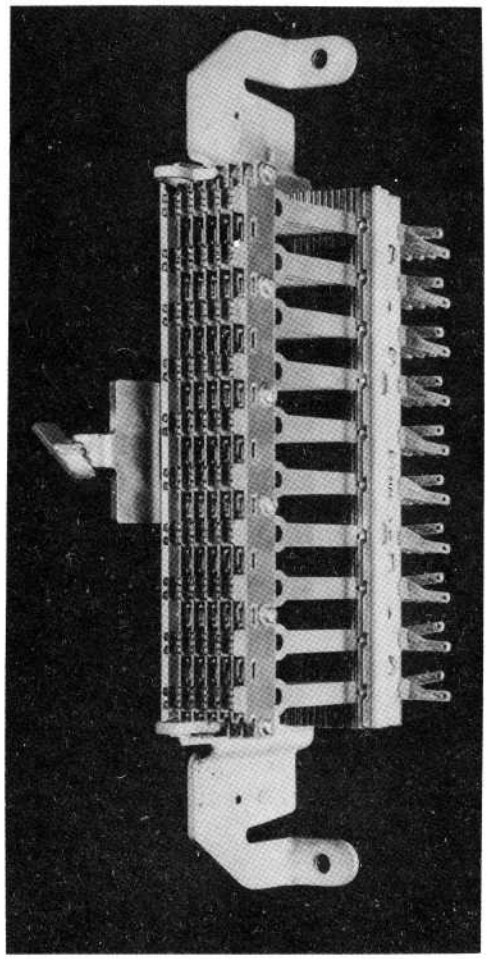


Fig. 10 Multi-contact Switch

The "U" type relay (Fig. 11) is a new and improved general purpose relay, designed with a heavy and very efficient magnetic structure, which will permit the equipment of a large number of contact springs, up to a maximum of 24. The springs are equipped with twin contacts, and the relay has characteristics which make it remarkably free from contact chatter. The front ends of the core, armature, and adjusting nut are chromium plated to reduce any tendency of the armature to "stick" and fail to

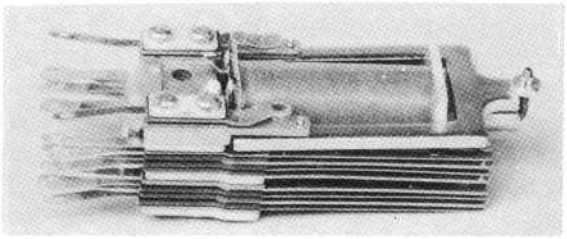


Fig. 11 "U" Type Relay

release. The coil is of the "form wound" type, each winding layer separated by a sheet of cellulose acetate, while the spool head ends are practically hermetically sealed.

A cable well type terminal strip (Fig. 12) is incorporated in a number of the relay rack mounted units. It mounts like an "R" or "U" type relay and is provided with wiring terminals front and rear. The rear terminals line up with the relay terminals and are used to terminate the local cable connections, while the front terminals also afford a means for terminating the switchboard cable. The recessed portion or "cable well" is used for disposing of the cable wires or "skinners", thus obviating the necessity of forming and sewing the leads that are connected to the terminal strips by the installer (Fig. 13). Other features include the accessibility of the terminals for testing purposes and relieving wiring congestion at the rear of the frames.

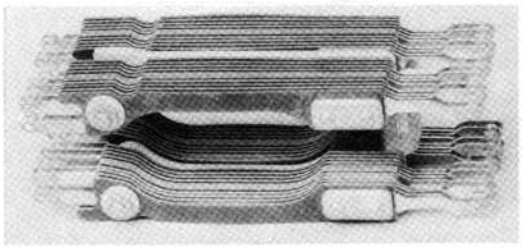


Fig. 12 224-A Cable Well Terminal Strip

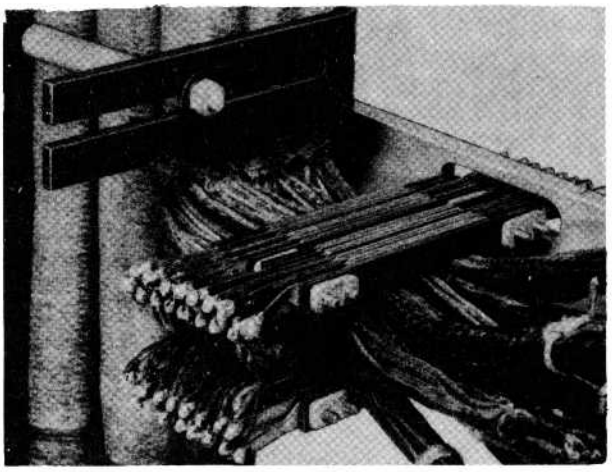


Fig. 13 224-A Cable Well Terminal Strip Installed

A terminal strip, 216A type, for use with crossbar switches (Fig. 14) has been developed for use when it is desired to connect a switchboard cable not only direct to terminals of the crossbar switch but also to local cable wiring, as in the case of the secondary bay of the line link frame where a switchboard cable is used for connecting the vertical units for each group of 20 district junctor circuits and the associated controller circuit leads to the district junctor grouping frame. This strip consists of one horizontal row of twenty single-sided punchings, each of which is provided with two notches.

Fig. 14 216-A Terminal Strip

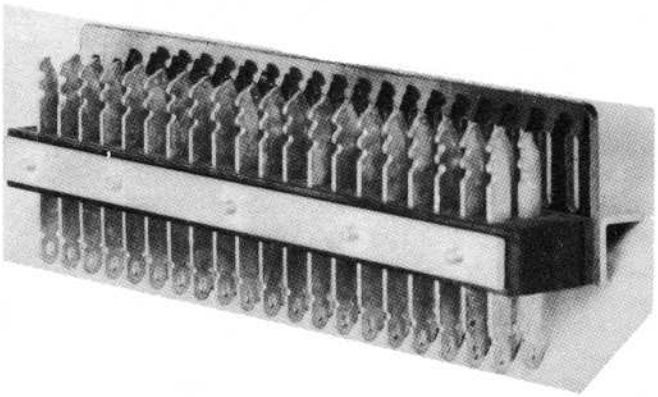


Fig. 15 219-A Terminal Strip

The 219-A type terminal strip (Fig. 15) differs from the 216-A type in that it consists of 40 double-sided punchings, arranged in two horizontal rows of 20 each. The ends of the punchings projecting to the rear are single-notched, while those projecting toward the front are provided with a hole and a notch. This type strip is used on equipment units which require a certain amount of common strapping, and also in cases where several of these units are mounted on the same bay and require interconnection.

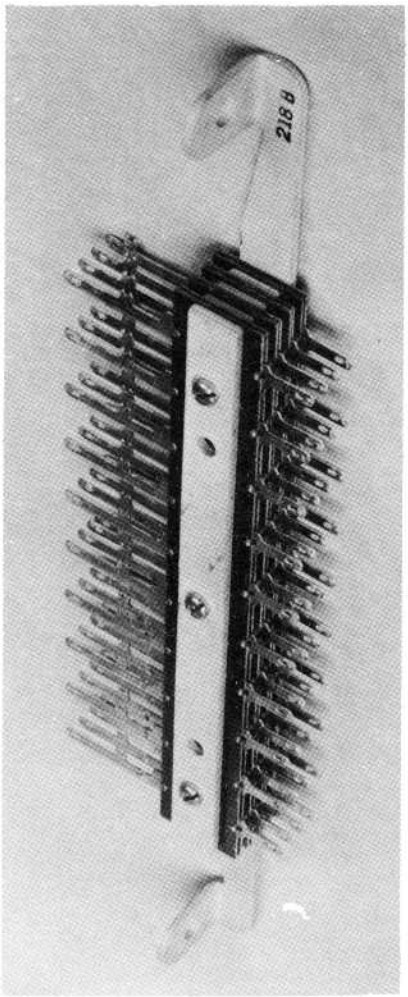


Fig. 16 218 Type Terminal Strip

The 218 type terminal strip (Fig. 16) consists of 10 sets of punchings arranged one above the other in a metal framework, and each punching is insulated from each of the others in a set as well as from all other sets. The strip takes the same mounting as a multi-contact relay and is available in the 3, 4, 5, or 6-wire sizes to correspond to the various types of multi-contact relays. Punchings extending toward the front and rear may be used to terminate either local or switchboard cable. The rear end of the punchings are provided with staggered, notched projections to which horizontal strapping may be terminated, which multiples like contacts on a horizontal row of multi-contact relays with which the terminal strip is associated.

The 203-A type terminal strip (Fig. 17) consists of a bakelite base into which are moulded 16 U-shaped double-ended terminals, both ends of each terminal projecting out the same side of the strip. The base clamps into a 28-B metal bracket, which may be attached to another framework. This strip is used in terminating either local or switchboard cable on various types of miscellaneous unit equipments.

Fig. 17 203-A Terminal Strip

The 207-B terminal strip (Fig. 18) consists of five horizontal rows of punchings, 80 punchings across, which are arranged in four sections, 100 punchings per section, and each is insulated from each one of the others. A metal framework holds the assembly of punchings and insulators together and provides mounting space for wooden fanning strips above and below the punchings. Individual punchings extend both front and rear. The application of this type terminal strip is found in the cross-connecting field in the markers.

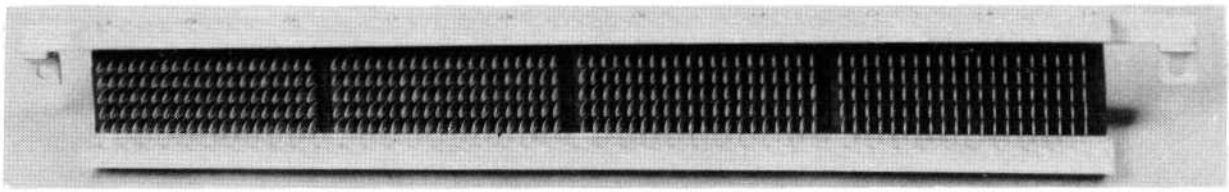


Fig. 18 207-B Terminal Strip

The 208-A terminal strip (Fig. 19) is made up of two horizontal rows of punchings, extending front and rear, 80 punchings per row. Each punching is insulated from all others with insulators and punchings assembled and held together by a metal framework. A wooden fanning strip mounts on the framework in such a way as to be associated with the front punchings. This terminal strip is provided in the cross-connecting field of the markers.

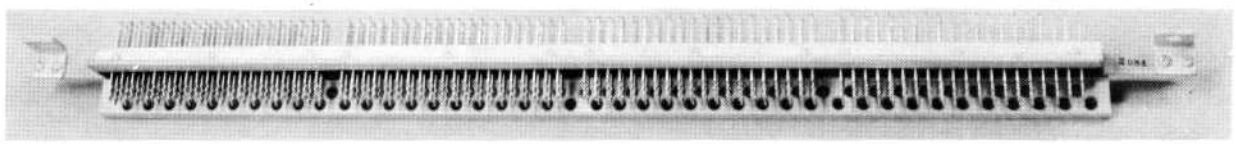
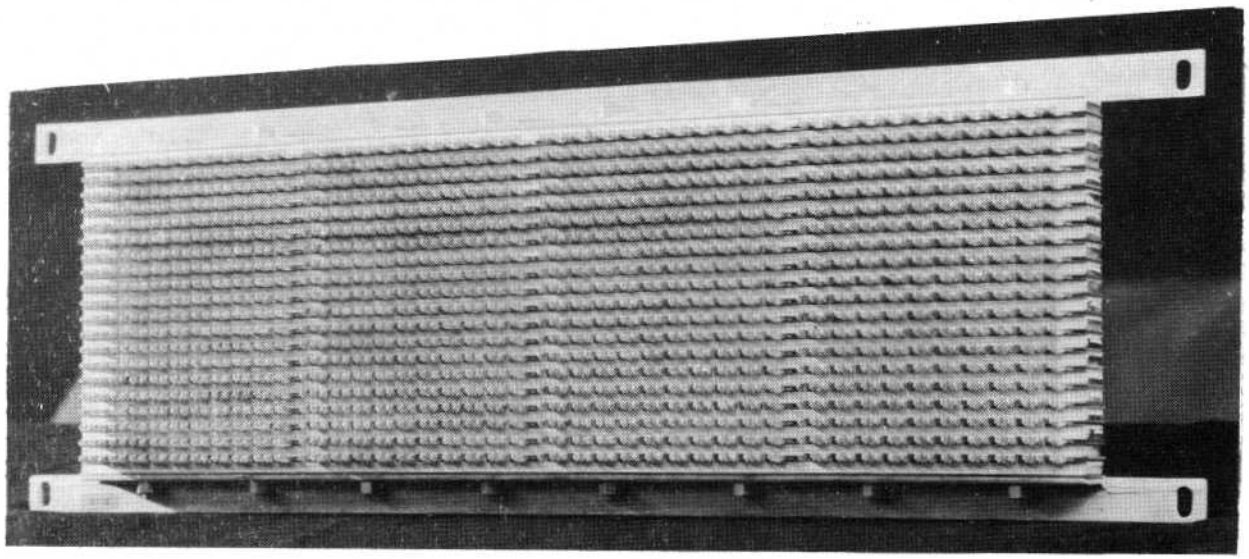
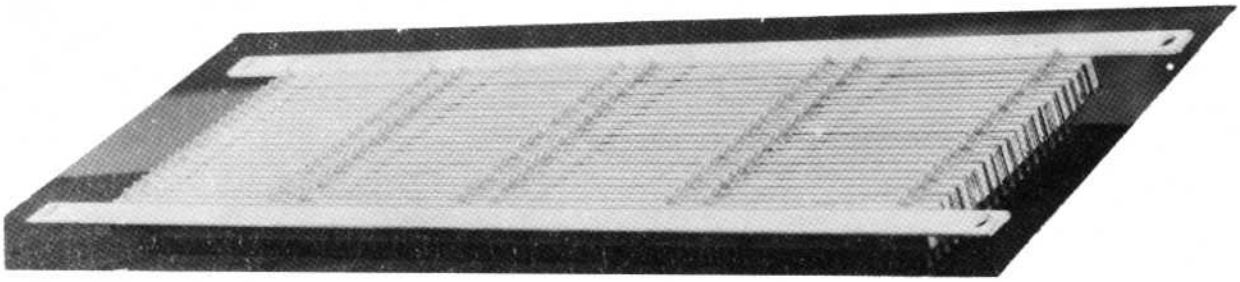


Fig. 19 208-A Terminal Strip

The 209-B terminal strip (Fig. 20) is of the decoder type. A metal strip is arranged with 20 common punchings projecting toward the front and spaced equi-distant one from the other, while two punchings project to the rear, one at either end of the metal strip. Four of these strips make up one horizontal row, with a total of 20 rows making up one terminal strip. Each row is insulated from the next, and each sectional strip is insulated from its adjacent one. Aluminum bars are placed between the horizontal rows, acting as spacers and providing rigidity to the complete strip after assembly in a metal framework. Sections in a horizontal row may be made common in any combination simply by strapping together adjacent punchings on the rear. This terminal strip is also used as a cross-connecting strip in the markers.



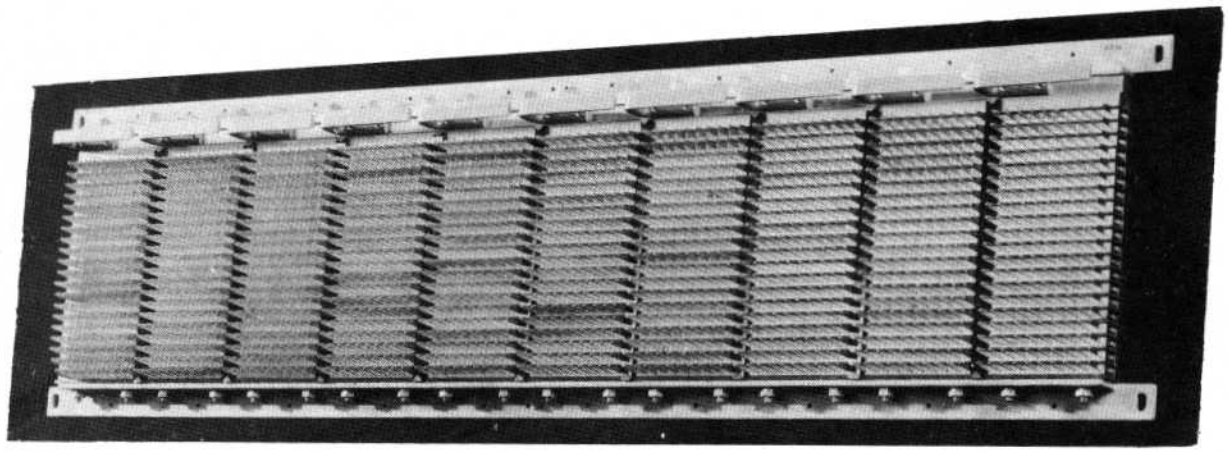
Front



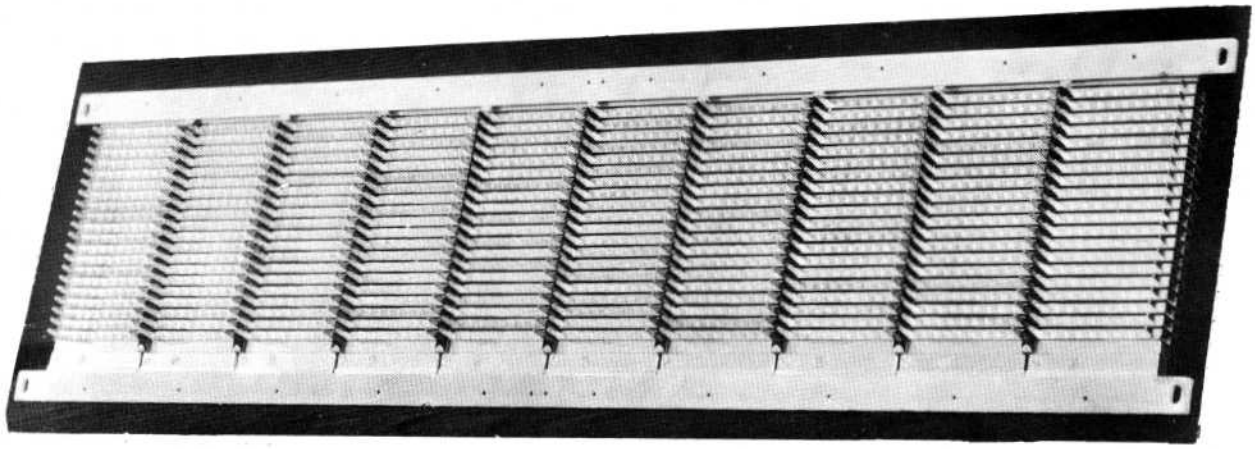
Rear

Fig. 20 209-B Terminal Strip

The 221-B terminal strip (Fig. 21) is similar in structure to the 209-B. Metal strips with 10 common punchings projecting toward the front and two toward the rear are arranged 10 to a horizontal row, with 20 rows making up a terminal strip. The complete terminal strip is thus made up of ten sections, which may be multiplied together in any combination by strapping adjacent punchings on the rear. This terminal strip is used in the cross-connecting field on the block relay frame.



Front



Rear

Fig. 21 221-B Terminal Strip

The 222-A terminal strip (Fig. 22) consists of individual punchings, insulated one from the other, arranged in five horizontal rows, 100 punchings per row. The punchings project both front and rear and are assembled together with the insulators in a metal framework. Fanning strips are not included in the completely assembled strip. It is used as part of the cross-connecting terminal strip equipment in the block relay frame.

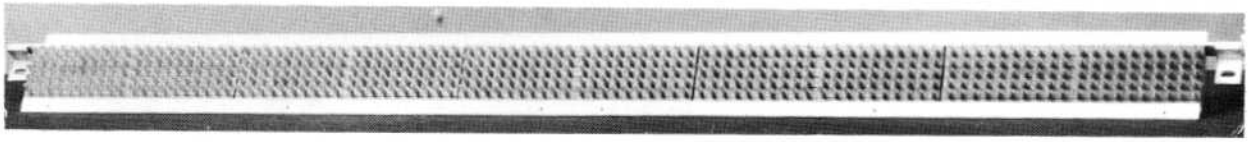


Fig. 22 222-A Terminal Strip

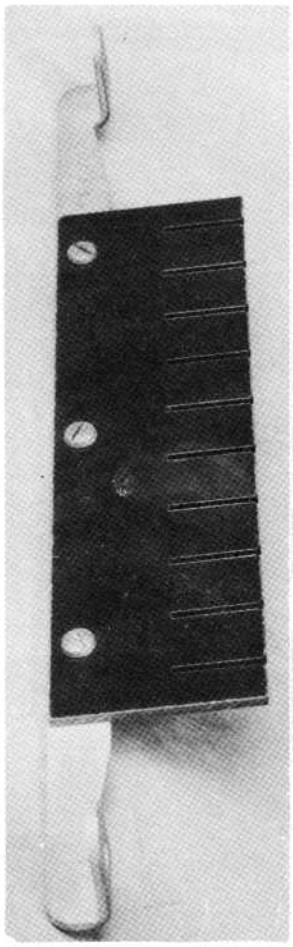
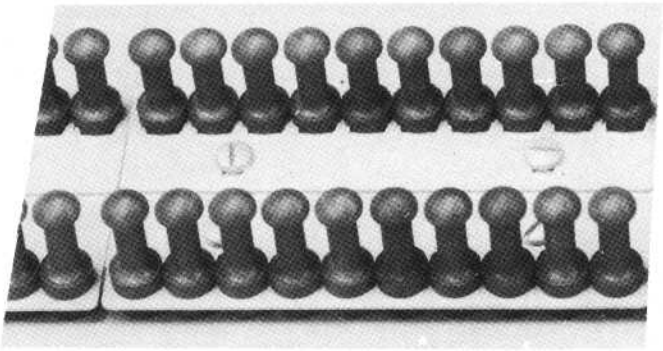


Fig. 23 Multiple Wiring Locating Strip

A multiple wiring locating strip (Fig. 23) consists of a strip of phenol-fibre, 1-3/4" x 6 1/4", which is slotted on one edge with ten slots, each 3/4" deep. The phenol-fibre strip is attached to a metal framework which takes the same mounting as the multi-contact relay. When multi-contact relays are not equipped in all positions on a frame or unit, the horizontal strapping is provided for all unequipped positions and held in place by inserting the strap wires in the slots by levels. This arranges strap wires in an orderly manner and prevents trouble conditions in associated circuits when the wires are insulated with spaghetti-type insulation.

The 17-A type fanning strip (Fig. 24) is part of the block-relay frame equipment and consists of a double row of hard-rubber bars mounted in a metal framework adjacent to each other and so arranged that they will revolve individually. The space between the two rows, approximately 2", is used as a well to run straps from one terminal strip punching to another without running the strap at an angle.



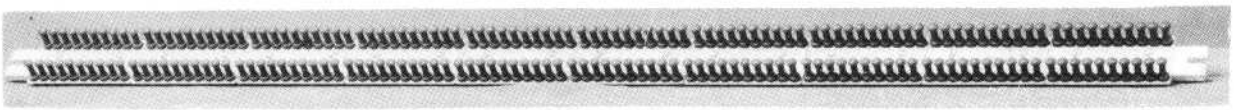


Fig. 24 17-A Fanning Strip

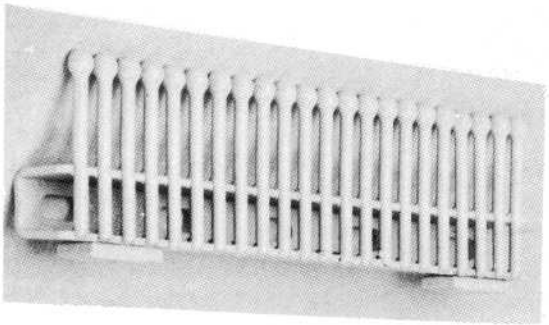


Fig. 25 Fanning Strip

Another type of fanning strip is illustrated in Fig. 25 which is used in the cross-connecting fields on the markers, to provide a means of running strap wires between terminal strips vertically as far as possible.

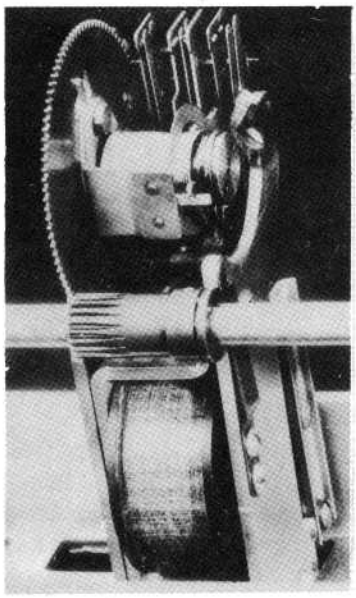


Fig. 26 Timing Unit for Local Calls

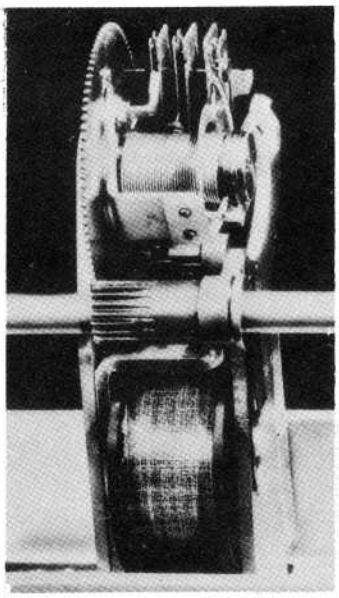


Fig. 27 Timing Unit for Coin Calls

New plugs for use with the crossbar switch and the multi-contact relay include "make-busy" and "test" types. A "make-busy" plug inserted into the lowest spring assembly in any vertical unit of a crossbar switch grounds the holding magnet causing it to operate. Another type of "make-busy" plug is used with the multi-contact relay to ground any one of the springs on the row farthest away from the armature. A "test" plug is furnished when it is desired to make connections to the common multiple springs of the vertical units of crossbar switches for testing purposes.

Electrically operated timing devices (Figs. 26 and 27) are furnished for overtime charging on message rate and coin box calls. These timing devices are mounted on a mounting plate which is part of the equipment on associated district junctor units. The timers are operated by means of magnetically controlled start clutches which are associated with a steel shaft (Fig. 28) driven by a 22-v A.C. Telechron motor. This timing equipment is

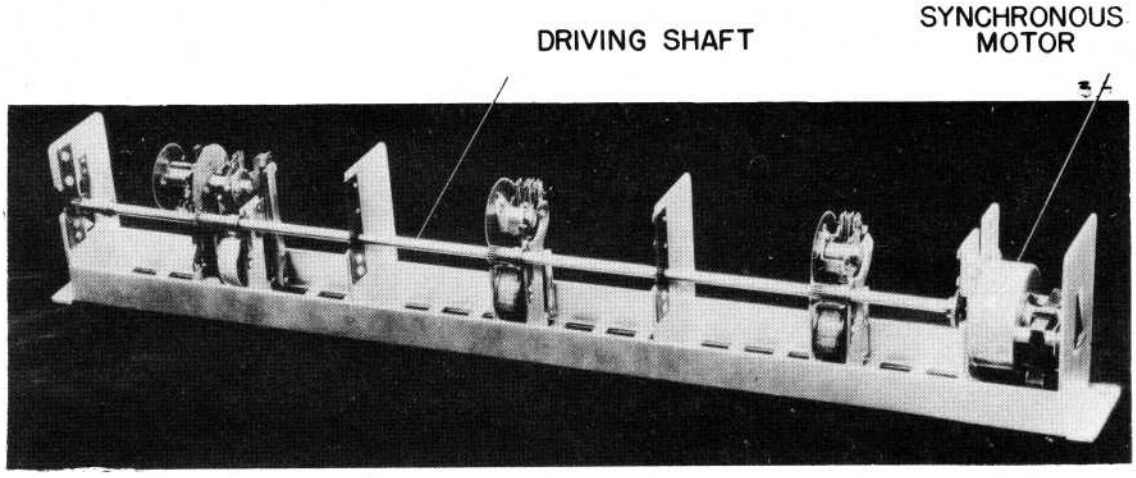


Fig. 28 Illustration of Mounting

arranged to check all calls at the end of an initial five-minute interval and make an additional charge for every additional five-minute period beyond the initial. If the charge is made on a message register basis, the timer sets the equipment to operate the message register once for each overtime period. If a call is originating from a coin box station, the timer sets the circuit to signal the calling party one-half minute before the initial five-minute period is up so that the subscriber may have one-half minute in which to complete the conversation or insert another coin in the coin box. At seven seconds after the initial five-minute period a circuit will test for a coin in the coin box at the calling station, and if one is there, will retire with no action taken; if the test finds no coin in the coin box and the parties are still talking, the talking path between the two subscribers is opened, and the calling subscriber is connected through to an operator at the DSA board. The operator at the switchboard notifies the calling party of the overtime condition.

In metropolitan areas, where telephone circuits (subscriber lines and trunks) are installed in cables entirely underground, protection equipment at the incoming end of these circuits at the central office is not required. The regular protector mounting has been replaced with a new type jack arrangement called the line jack (Fig. 29). A group of such jacks is shown in Fig. 29. Each jack has two pairs of spring contacts which normally close the tip and ring of a cable pair to the tip and ring of the associated central office circuit. Each set of springs is opposite another set on the other side of the jack and each set serves one cable pair. Incoming circuits connect to terminals on one side of the jack and cross-connecting jumpers to the other side. Springs are equipped with precious metal contacts, thus providing for better transmission. A plug guide is provided to insure proper insertion of plugs. A test and a dummy plug are shown in place in Fig. 29. Test plugs are provided for patching central office and cable circuits to a testing station, while inserting a dummy plug disconnects the cable pair from the inside circuit (equivalent to removing heat coils or dummy heat coils from protector mounting). Another type test plug is used to check cable pairs during installation or in case of cable failure. A reversing plug reverses the tip and ring connection to the line when properly inserted. A gang type plug opens 10 pairs at a time and is used principally in case of cable failure. A guard serves as a marker for important circuits to prevent accidental insertion of a plug. A shield is also available which completely covers the front end of a jack when extra protection is required.

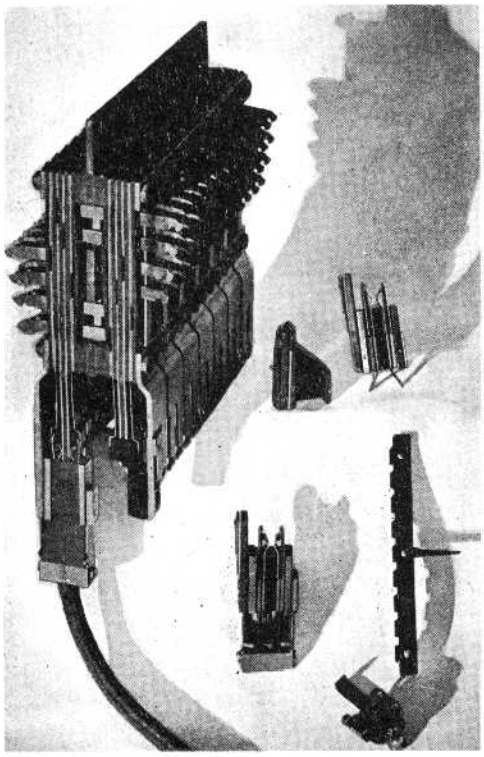


Fig. 29 Line Jack and Associated Equipment

Substituting the new jacks for protector mountings will appreciably reduce the floor space required where protector blocks are not needed; with the new jack arrangement, twice as many circuits can be accommodated in the same space.

Crossbar dial equipment is assembled in complete frames, adjusted, wired, tested, and shipped to the place of installation from the Hawthorne Works.

Fig. 30
275A and 276A Relays

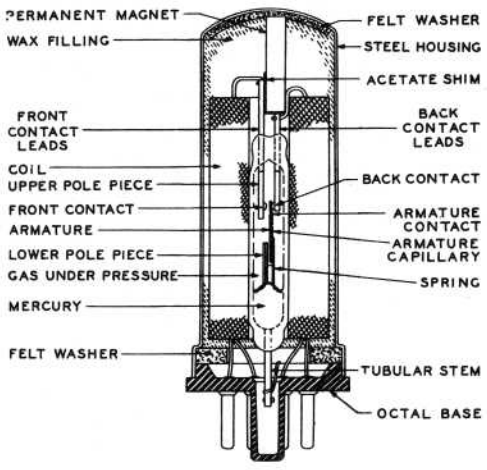


Fig. 31
Cross Section of a 276 Type Relay

The 275 type relay (Fig. 30) consists of a 218A mercury switch surrounded by a winding coil and assembled in a metal vacuum tube shell equipped with an octal type vacuum tube base. The relay features high-speed non-chattering contacts capable of carrying relatively high currents and a representative use is in control circuits such as markers to quickly operate two or more multi-contact relays simultaneously.

The 218A mercury contact switch (Fig. 31) consists of an armature and two sets of contacts enclosed in a glass tube filled with hydrogen gas under 250 pounds pressure. The armature is a small piece of permalloy attached to a supporting spring and equipped with a contact arm. This arm normally rests against the back set of contacts which are made of non-magnetic material. The front contacts are attached to supports of magnetic material forming the upper pole pieces. The magnetic path through the switch includes these upper pole pieces plus the armature and the lower pole piece and when the coil is energized the armature is moved to the upper pole piece. The contact arm moving with the armature leaves the back contacts and comes to rest against the front contacts. Between the contact arm and the back contacts a drop of liquid mercury is gradually stretched until unable to bridge the gap any longer when it will fall away from the contacts and drop down to the bottom of the glass tube. When the contact arm has traveled far enough that the mercury on the arm and the front contacts joins, a new drop is formed which electrically bridges the gap until the contact arm comes to rest against the front contacts. Non-chattering break

and make conditions in associated circuits are thus attained. A small amount of liquid for wetting the contacts is stored at the bottom of the glass tube and travels to the contacts through a small hollow tube through the armature by capillary action.

The 276 type relay differs from the 275 in being provided with a small permanent magnet attached to the front contact supports to increase its sensitivity and to permit it to operate and release within close limits of current flow.

No readjustment of the 275 or 276 relay can be made after manufacture and therefore no maintenance can be applied other than replacing a defective relay. These relays are preferably mounted in a vertical position but may be mounted as much as 30° from the vertical without affecting their characteristics. Due to the high pressure of hydrogen gas in the glass tube of the 218A switch, no attempt should be made to disassemble the 275 or 276 relay in the field.

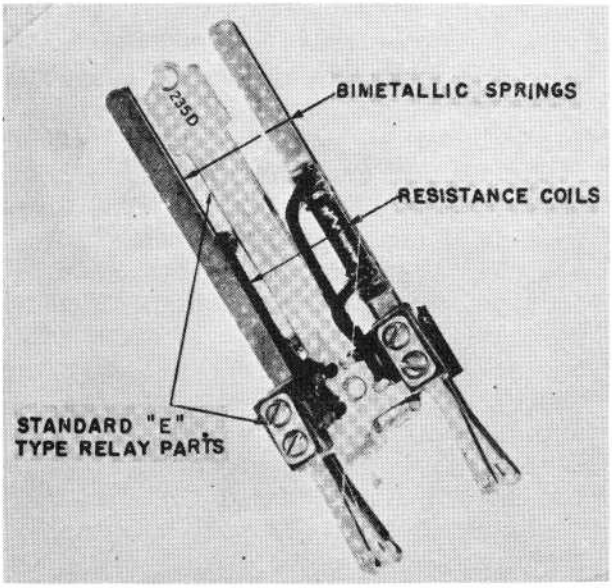
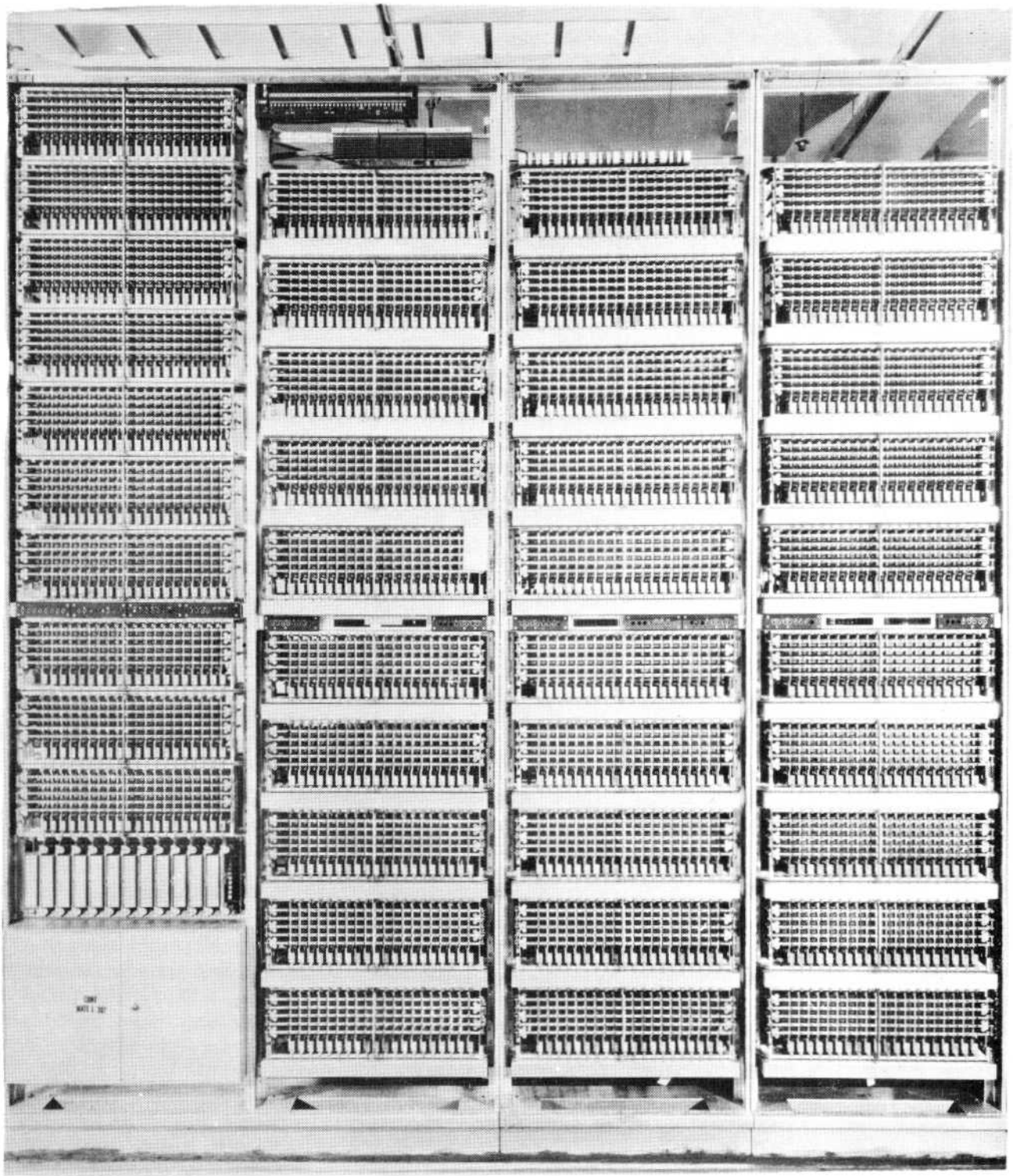


Fig. 32 - 235 Type Thermal Relay

The 235 type relay (Fig. 32) is a thermal relay being operated by the heat resulting from a current flow instead of by the magnetic effect of that current. The relay is mounted on an E-type core with standard provisions for mounting on a 1 3/4 inch mounting plate with optional individual or complete strip covers. The relay is arranged to operate in time intervals from 3 to 25 seconds when 45 to 50 volts is applied to the heater. The rated time intervals apply when a cooling period of 2 minutes is allowed between operations. The relay consists of 1 or 2 pairs of bi-metallic springs secured in a pileup to the E-type core at one end and carrying contacts at the other end. A heater winding is placed around one spring of the pair and when current is applied to the heater, that spring is deflected and causes its contact to make with the stationary contact on the other spring. The use of similar bi-metallic springs for both contacts provides compensation for changes in room temperature since both springs are similarly affected, and the space between the contacts which determines the timing remains unchanged.



Secondary Primary Primary Primary

Basic Unit Supplementary Bays

Fig. 33 Line Link Frame - Individual Message Rate, Flat Rate or Coin

Section 4. Frames

Frames are of the "single-sided" type, 11' 6" in height and of varying widths. Angle framework members are used with the short flanges of the angles placed parallel with the rear plane of the frames, with the equipment mounted on the front surfaces of the flanges and between the two upright angles. This mounting arrangement has several advantages. Framework members are placed in space hitherto wasted; space at the rear of the equipment is left unobstructed for wiring and cabling purposes; permits extension of horizontal strapping across two or more bays if required; rear wiring forms may be maintained in a vertical plane independent of whether the equipment units are mounted on the front or the rear of the angle flanges.

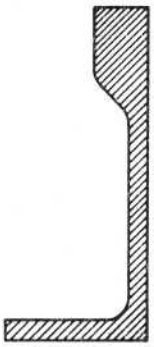


Fig. 34 Cross Section of Bulb Angle

A new bulb-shaped angle (Fig. 34) has been designed to obtain upright members of sufficient strength to support the equipment without a waste in floor space. A sanitary sheet metal base with self-contained ladder guards is welded to the framework, eliminating guard rail assembly on the installation job, and providing a convenient location for the armored cable supplying frame service outlets. The framework construction at the top of the frame consists of two angles placed horizontally across the uprights and welded to them. This construction provides means for attaching the supporting superstructure and cable racks without the necessity of drilling mounting holes in the top details. Many of the frames will be provided with a perforated channel attached horizontally to the uprights and approximately midway between the top and bottom of the framework. This detail keeps the spacing of the two uprights as nearly parallel as possible and provides supports for miscellaneous frame circuit equipment, such as lamps, keys and jacks. End guards of sheet metal have been designed to correspond to the construction of the frame base.

1. Line Link Frame

Line Link Frames are furnished as a Basic Unit plus one or more Supplementary Bays. The basic unit will serve up to 190 lines, and more lines may be added 100 at a time in supplementary bays. The basic unit can serve up to 100 total of simultaneous incoming and outgoing calls, and when the 190 lines are not of sufficient calling rate, supplementary bays of lines up to ~~590~~ 690 total are added to build up to the 100 call maximum density.

The basic unit for Individual Message Rate, Flat Rate and Coin classes of service consists of two bays. The left, or secondary bay as viewed from the front (equipment) side, mounts ten crossbar switches, some controller relay equipment enclosed in a front casing, twelve multi-contact relays, terminal strips, and two jack, key and lamp panels mounted horizontally near the center of the bay. The right or primary bay mounts ten crossbar switches, one standard mounting plate equipped with nineteen line and four control

connector relays per crossbar switch, terminal strips, one mounting plate equipped with condensers and resistances, fuse panel, and jack, key and lamp panels mounted horizontally near the center of the bay. The first supplementary primary bay mounts ten primary crossbar switches, and 20 line and four control connector relays per crossbar switch. The second supplementary primary bay duplicates the equipment contained in the first supplementary bay.

Line link frames serving two-party message rate lines will include the same general type of equipment except that the primary and secondary crossbar switches will be of a different type.

The subscriber line capacity of the Basic Unit primary bay is reduced from 200 to 190 because ten line verticals (the "0" left vertical of each switch) are assigned for "no-test" purposes. Supplementary primary bays have a capacity of 100 or 200 lines per bay, depending upon whether 100-point or 200-point crossbar switches are used. The maximum number of supplementary primary bays will never exceed 3, providing for a maximum of 690 lines per line link frame.

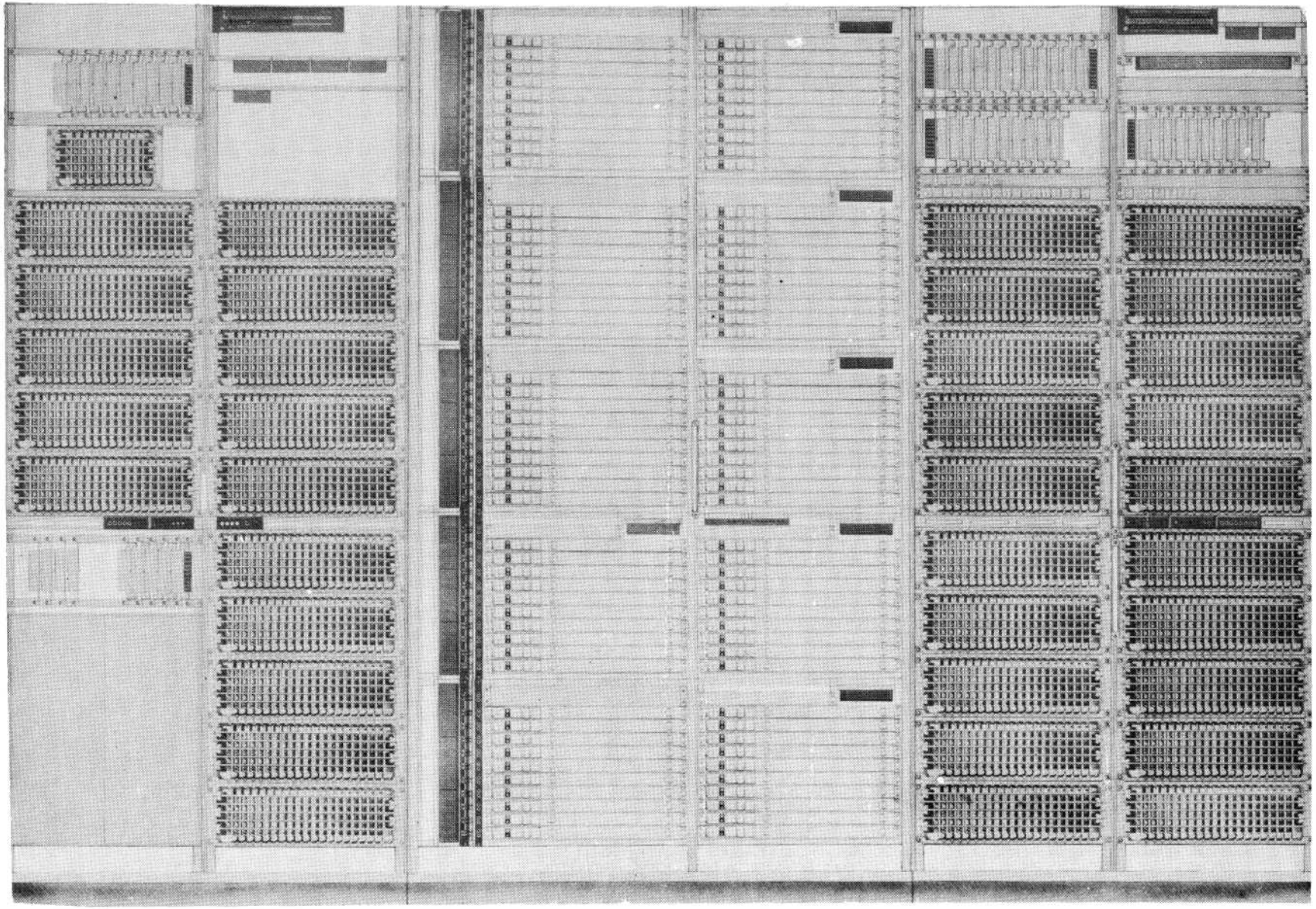
The secondary crossbar switches in the flat rate, individual message rate, and coin type of frame are each equipped with ten 4-wire and ten 3-wire vertical units, the 4-wire units on the right half of the switch and the 3-wire on the left half. The former provide 100 switching paths to district junctors and are used for originating calls, while the latter, which also provide 100 switching paths, are used for terminating line junctors from incoming link frames for terminating calls. The two-party message rate line link frame provides for a 5-wire primary switch arrangement and a 3-wire 5-wire combination in the switches in the secondary bay. This type of line link frame requires 5-wire originating circuits because separate "M" leads must be carried to each of two message registers associated with the two parties on the same line.

2. District Frame Group

The district frame group includes three frames: district junctor, subscriber sender link, and district link. The frames in this group are all individual frame units which form an integral equipment unit when installed in the central office (Figs. 35 and 36). The grouping of these three frames provides an economical wiring arrangement in that the connecting circuits can be included in the frame local forms rather than providing these connections by means of frame to frame switchboard cabling. The frames are installed, subscriber sender link frame on the left, district junctor frame in the center, and district link frame on the right, looking at the equipment side.

a. District Junctor Frame

The district junctor frame, the center frame of the district frame group, mounts the relay equipment which (1) furnishes talking battery to the calling subscriber line, (2) maintains supervision over the call after the subscriber sender and originating marker have released, (3) times local calls, (4) supervises multiple charging on local or zone calls, (5) controls (A) collection or return of a deposited coin, and (6) (B) operation of the proper message register of message rate lines on charge calls. It is divided into two framework bays. Relay units, each mounting the equipment for 20 district junctor circuits, are so arranged that an individual unit mounts across



Subscriber Sender Link Frame | District Junctor Frame | District Link Frame

Fig. 35 District Frame Group

both bays, with the frame capacity providing for the mounting of five of these units, one above the other. These district junctor units are available in five types (20 junctor circuits per unit, arranged in two groups of 10 circuits each); namely, (1) non-coin, (2) coin, (3) key pulsing, and (4) two-party message rate. The non-coin junctor units are universally wired to serve with single, two-party, or four-party flat rate lines and individual message rate lines. The message rate and coin junctor units are wired for local overtime charging, with the associated equipment being provided only when ordered by the Telephone Companies. In addition to the local overtime charging feature the same type of junctor unit may also be arranged for registering calls completed to zones beyond the local area.

b. District Link Frame

The district link frame, the frame on the right in the district frame group, consists of two bays, a primary bay on the left and a secondary bay on the right. The primary bay equipment consists of 10 primary crossbar switches, a maximum of 22 multi-contact relays, and two mounting plates for miscellaneous relays. The secondary bay provides space for mounting 10 secondary crossbar switches, 10 multi-contact relays, miscellaneous terminal strips, a fuse panel, a mounting plate for miscellaneous relays, three spare relay mounting plates, and jack, key, and lamp panels.

The crossbar switches associated with this frame are 200-point, 3-wire with the horizontal strapping on the secondary switches cut at the mid-point so as to provide 200 3-wire outgoing paths over which a call may reach the office link frame on which the outgoing trunks to the desired office destinations are located. District junctor circuits are wired to the primary switches on this frame while the secondary switches are associated with office junctor circuits which are used to carry the connection to the office link frame. The multi-contact relays provide means for connecting the test leads of the various paths through and out of the frame to the originating marker so that the marker may test and select idle paths to connect a district junctor circuit through to a particular office link frame.

The 200 outgoing paths to the office link frame from the secondary bay of the district link frame are spread out over all the office link frames in the office according to a definite plan. The distribution of these outgoing paths to the various outgoing office link frames will vary with different central offices dependent on the number of district link and office link frames provided.

All calls completed in a crossbar system must be trunked through office link frames. This arrangement is somewhat different from the plan followed in the panel system where the outgoing trunks may appear on either the district selector frame or an office selector frame.

c. Subscriber Sender Link Frame

This frame, the left frame in the district frame group, provides facilities for connecting any one of a group of 100 district junctors to any one of a group of 100 subscriber senders. The subscriber sender link frame is divided into two bays, primary on the right and secondary on the

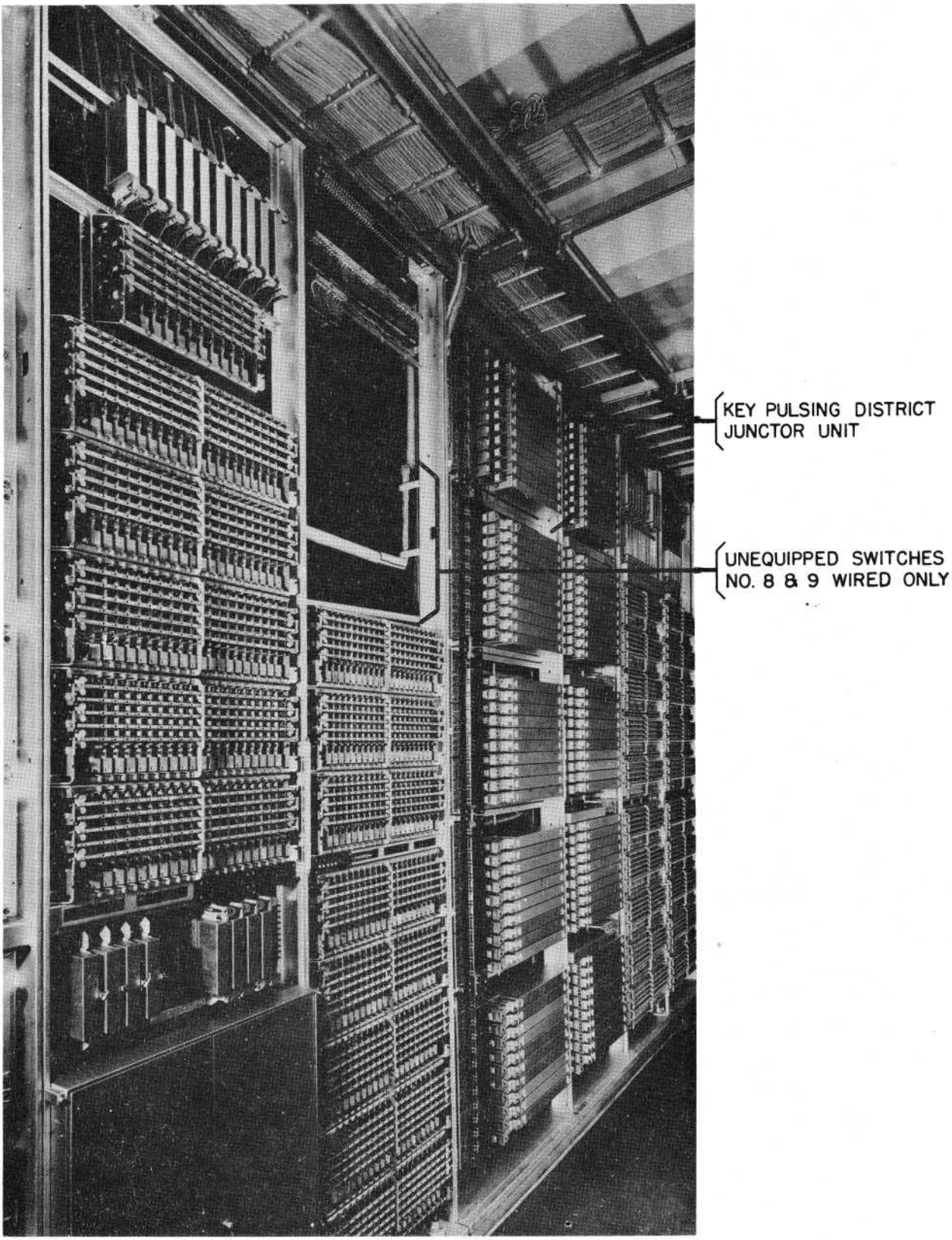


Fig. 36 District Frame Group.

Subscriber sender link primary switch positions 8 and 9 not equipped when key pulsing district junctors are provided in top unit.

left, looking at the equipment side. The equipment in the primary bay includes 10 primary crossbar switches, terminal strips, a fuse panel, and jack, key, and lamp panels. The secondary bay provides space for mounting five secondary crossbar switches, one crossbar switch used for testing purposes, a maximum of 15 multi-contact relays, four manually operated multi-contact switches, a controller circuit consisting of "U" and "Y" type relays on mounting plates inclosed in a front casing, miscellaneous terminal strips, and jack, key, and lamp panels.

District junctor circuits are connected to the 10 primary crossbar switches and subscriber senders are connected to the five secondary crossbar switches. Both primary and secondary switches are of the 200-point, 4-wire type, with links providing connections between the two. The crossbar switch provided for testing purposes is of the 100-point, 6-wire type which provides the medium for connecting district junctors to an associated district junctor test frame.

The main purpose of the equipment on this frame is to connect a district junctor circuit to an idle subscriber sender circuit. When such a connection has been accomplished the sender causes a dial tone to be transmitted back to the calling subscriber line, to indicate that dialing may be started. The information which the subscriber provides through dialing the number he wishes to call is registered in the selected sender. Dependent on this registration, the sender passes information to the originating marker which in turn then is able to set up a connection to an outgoing trunk to the called office.

3. Office Link and Office Extension Frame

The office link frame is a two bay structure (Fig. 37), similar to the district link frame, consisting of a primary bay on the left and a secondary bay on the right. The primary bay provides mounting space for 10 primary crossbar switches, multi-contact relays (a minimum of 6 and a maximum of 16), two mounting plates for miscellaneous relays, and jack and lamp panels. The secondary bay contains 10 secondary crossbar switches, a maximum of 20 multi-contact relays, two mounting plates for mounting miscellaneous relays, condensers, and resistances, terminal strips, a fuse panel, and jack and lamp panels.

An office extension frame is sometimes used in conjunction with an office link frame. It is made up of a single bay containing 10 secondary crossbar switches, five multi-contact relays, a terminal strip, two mounting plates for mounting miscellaneous relays, condensers and resistances, and a jack and lamp panel. The extension frame is preferably located next to the secondary bay of the office link frame with which it is associated. This arrangement eliminates the necessity of providing switchboard cable which would be necessary if the extension frame was located elsewhere. Whether or not extension frames are provided will be determined more or less by traffic conditions. If extension frames are provided, it is necessary to make the same provision for all office link frames in the central office unit.

The office link frame primary crossbar switches are of the 200-point, 3-wire type while the secondary switches are 200-point, 4-wire. The horizontal strapping of the primary switches is split in the middle while the secondary

switch horizontal strapping may be altered to meet the trunking requirements of the office. Office junctor circuits are cabled to the primary switches and outgoing trunk circuits are connected to the secondaries. The function of the office link frame is to connect a particular office junctor to an outgoing trunk circuit through link connections between primary and secondary switches.

The office link and extension frame secondary switches are always of the 4-wire type, the fourth wire being necessary for testing and control purposes when 4-wire trunk circuits are involved. The majority of outgoing trunk circuits are 3-wire, the exceptions including recording completing trunks, trunks to desks, etc. The fourth contact pair of each cross point is always provided and wired to the originating markers to allow for either 3 or 4-wire outgoing trunk circuits.

4. Originating Sender Frame

The originating sender frame (Fig. 38) is of unit type construction with a capacity for mounting five subscriber or key pulsing sender units (Fig. 39). Under ordinary conditions the two different types of sender units

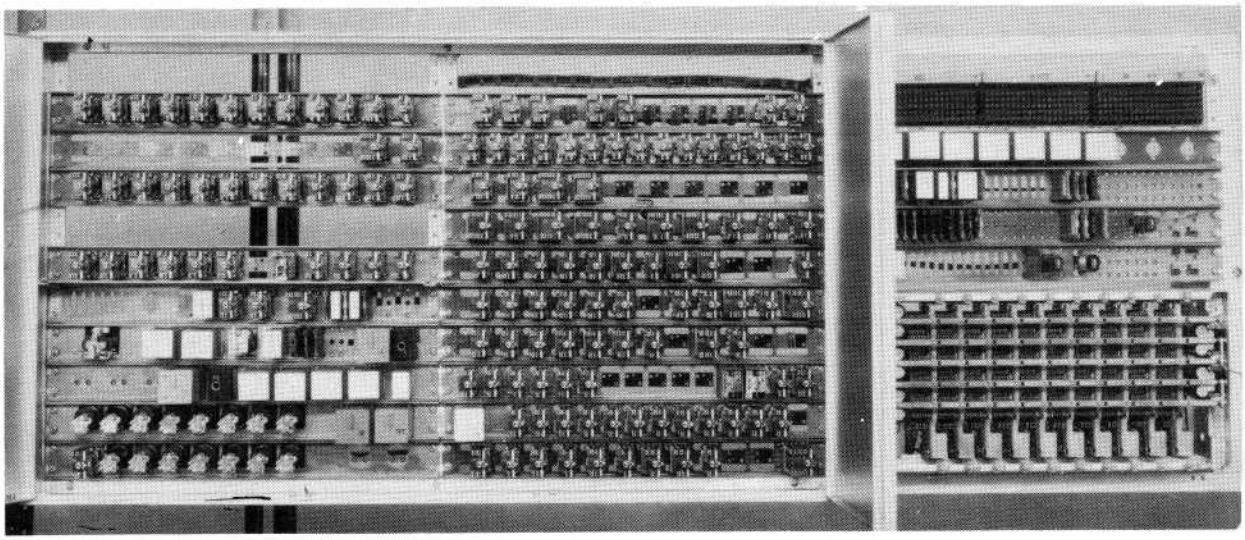
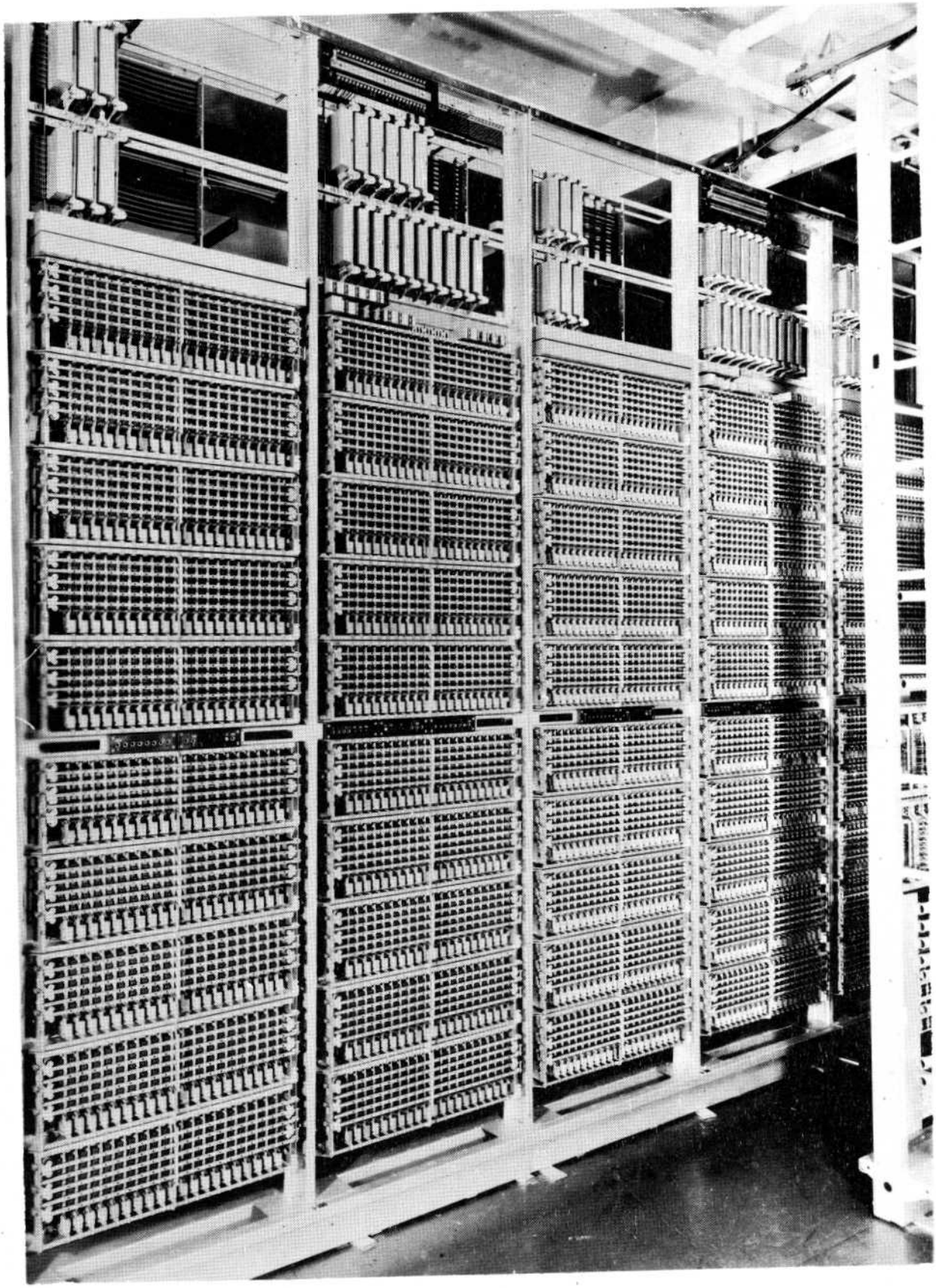


Fig. 39 Subscriber Sender Unit

are kept separate on individual frames, that is, a frame will mount five subscriber sender units or five key pulsing sender units. The only exception to this may be encountered on jobs where an odd number of senders of each type may not completely fill separate frames. In such a case it is permissable to mount two different types of senders on the last frame. The sender frame mounts in addition to the five sender units a fuse panel, miscellaneous terminal strips, and a jack and lamp panel. Space for the jack and lamp panel is provided between the second and third sender units, counting from the bottom.

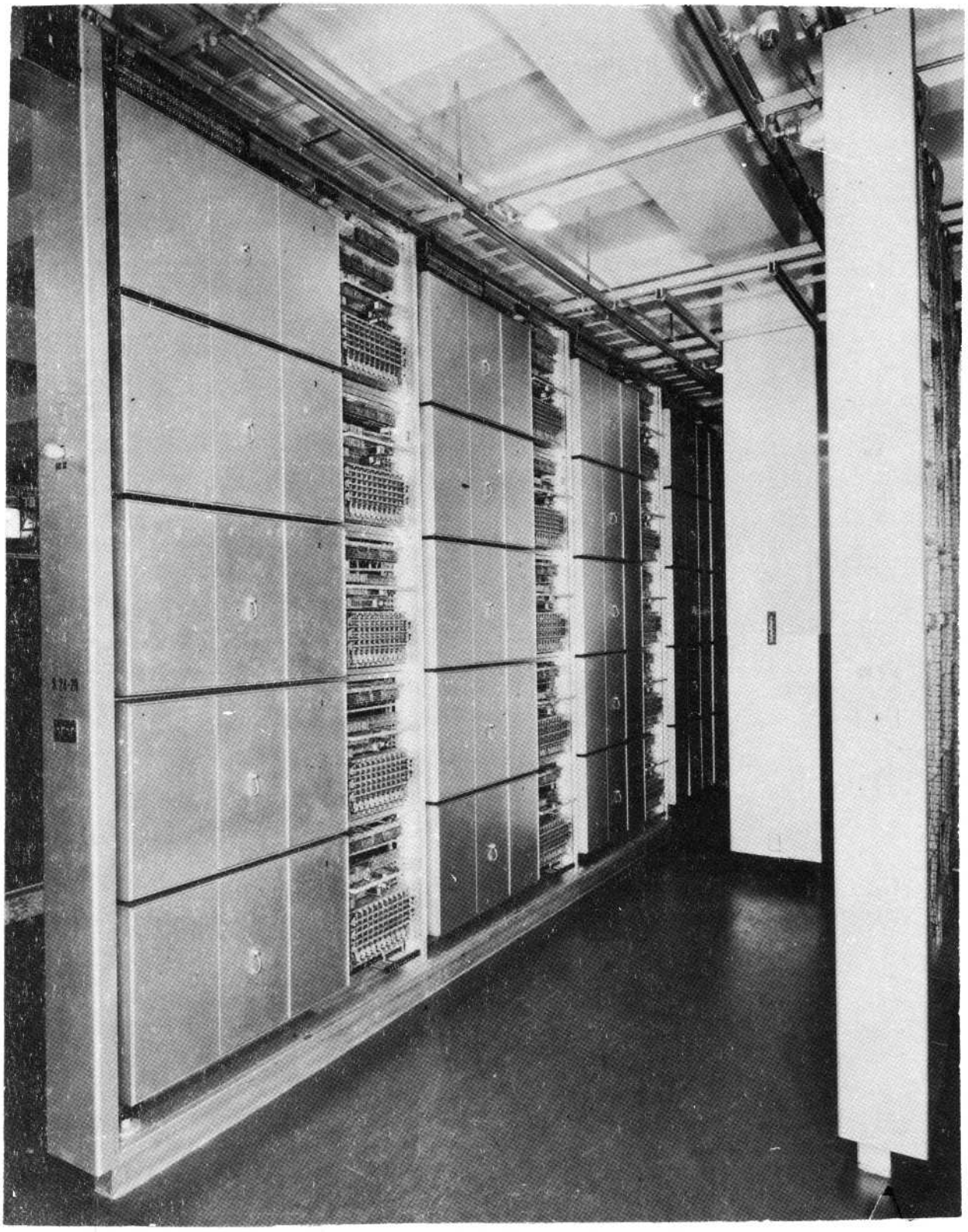
A subscriber sender unit provides equipment for one sender circuit, consisting of relays, condensers, resistances, a 10 vertical crossbar switch,



Primary Secondary

Frame 0 Frame 1

Fig. 37 Office Link Frames



Frame 24 Frame 25 26

Fig. 38 Originating Sender Frames

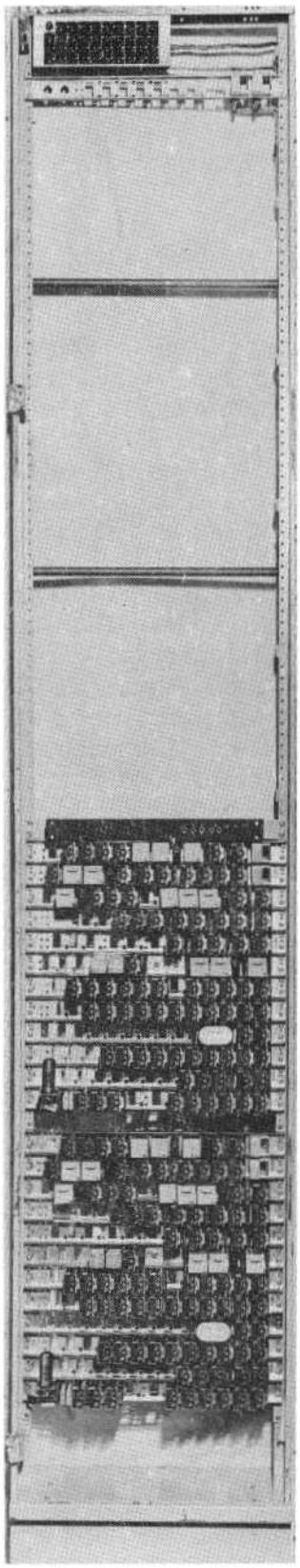


Fig. 40
Auxiliary
Sender Frame

AS-0

and miscellaneous terminal strips. The relays, condensers and resistances are mounted on mounting plates which are arranged in three individual vertical rows in the sender unit. Those mounting plates equipped with relays are enclosed with a front and rear dustproof casing. The key pulsing sender unit is similar to the subscriber sender unit, except that the crossbar switch is omitted. Sender units of either type are approximately 2 feet in height and 5' 6" in width.

For district junctor access, subscriber senders are wired to subscriber sender link frames and key pulse senders to key pulse sender link frames. Both types of senders are cabled to originating marker connector frames for marker association. Subscriber senders, when equipped for direct distance dialing, must also be wired to auxiliary sender link frames for access to auxiliary senders.

5. Auxiliary Sender Frame

The auxiliary sender frame (Fig. 40) is of unit type construction with a capacity of four auxiliary sender units (Fig. 41) and a minimum of two frames required per sender group of (min) four to (max) ten auxiliary senders. The frame also mounts a fuse panel and terminal strip mounting plate at the top, plus a jack panel at the center.

An auxiliary sender unit provides equipment for one sender circuit consisting of four relay units totalling twelve 2 by 23 inch mounting plates which are furnished on all jobs, plus a one plate optional unit. The sender unit is enclosed in front and rear casings and measures 2 feet 2 inches high by 1 foot 11 inches.

Auxiliary senders are wired to auxiliary sender link frames for connection to subscriber senders serving direct distance dialing calls. The auxiliary sender accepts the ninth and tenth digits from the subscriber, then multi-frequency pulses the entire ten digits forward to the next toll switching point.

6. Auxiliary Sender Link Frame

The auxiliary sender link frame is of unit type construction with a capacity of ten auxiliary sender link units, plus five plates of common equipment and a fuse panel at the top and a jack panel at the center of the frame.

The auxiliary sender link unit contains a 200 point 6 wire crossbar switch and one plate of relay and miscellaneous equipment.

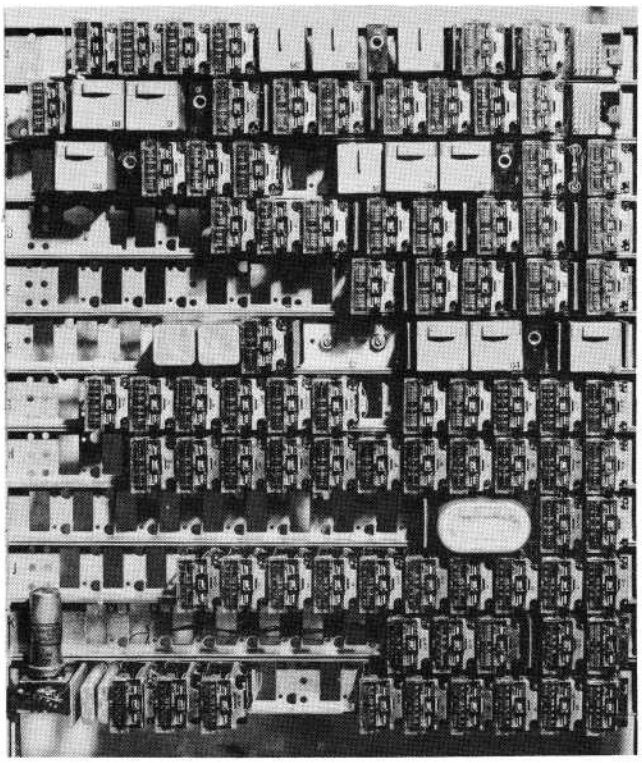


Fig. 41
Auxiliary Sender Unit

An auxiliary sender link unit serves to link the (max) ten senders of one subscriber sender sub-group to the (max) ten auxiliary senders of one auxiliary sender sub-group. A minimum of four link units is equipped per frame.

7. Originating Marker Connector Frame

The originating marker connector frame (Fig. 42) is a single bay frame with a capacity of three connector circuits. Each connector circuit consists of multi-contact relays (minimum 22 and maximum 36), control and alarm circuit relays mounted on mounting plates arranged in two vertical rows and located at the bottom of the frame, the jack panel located between the first and second connector circuits, a fuse panel, and terminal strips. All equipment mentioned, with the exception of the multi-contact relays, is common to all connector circuits of a frame.

The multi-contact relays in a marker connector are arranged in two horizontal rows and from a circuit standpoint are divided into two groups, one group being associated with subscriber and key pulsing senders, while the other group is associated with originating marker circuits. Each originating marker in the central office is multipled to two multi-contact relays per marker connector circuit. Since the minimum number of originating marker circuits provided in any office is three and the maximum number is eight, the minimum number of marker relays provided in the marker connector circuit will be six and the maximum number will be 16. Each marker connector circuit also has associated with it a maximum of eight subscriber plus key pulsing sender circuits, or a maximum of 10 subscriber sender circuits. Each sender circuit requires two multi-contact relays in the marker connector circuit which means that the marker connector circuit will be equipped with a minimum of 16 and a maximum of 20 sender multi-contact relays.

Sender sub-groups are in all cases individual to marker connector circuits so that the number of marker connector circuits required in a central office will be determined by the total number of sender sub-groups (maximum of 10 senders per sub-group). The originating marker circuits in a central office must be common to all of the originating marker connector circuits, requiring, therefore, a marker multiple between the connector circuits upon any one frame as well as between all marker connector frames.

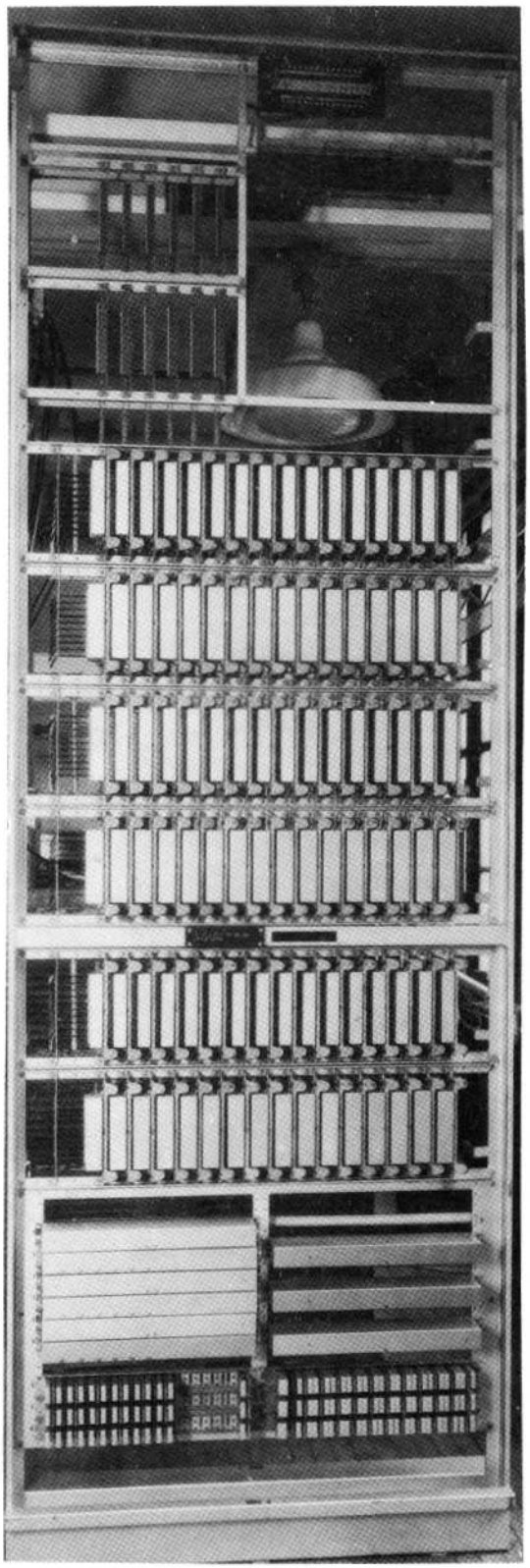


Fig. 42 - Originating Marker Connector Frame

The purpose of this frame is to connect originating senders to originating markers. Thru it, each sender has access to every marker in the office and the duration of the connection is the marker holding time of approximately a half-second.

8. Originating Marker Frame

The originating marker frame (Fig. 43) is a multi-bay single sided frame consisting of a double bay common equipment unit and several single route relay bays. The double bay common equipment unit is provided for all jobs and consists of relay equipment in the left bay arranged under three front and rear casings, plus several terminal strips mounted in the upper part. The second bay of this unit--the bay on the right--provides mounting space for five horizontal rows of multi-contact relays, several cross connecting type terminal strips, a number of other types of terminal strips, a fuse panel, and jack and lamp panels. Route relay bays are added to the right of the common equipment unit in such numbers as are required for the particular job. This bay contains a maximum of five horizontal rows of multi-contact relays and several cross connecting type terminal strips. The multi-contact relays are divided into lower and upper halves, each half providing terminals for the circuits of one route relay. This bay provides for a maximum of 50 multi-contact relays or 100 route relays. The number of these bays which must be provided for the originating marker will be determined by the number of codes which must be arranged for within the area in which the marker is to serve. The maximum number of bays is held at eight, which will provide for a maximum of 800 routes. In some localities calls may be completed between two different areas by direct dialing, one subscriber to the other. Under such conditions an additional route relay bay to provide the proper route relay equipment is added to the originating marker frame. This added route relay bay is located at the left of the common equipment unit.

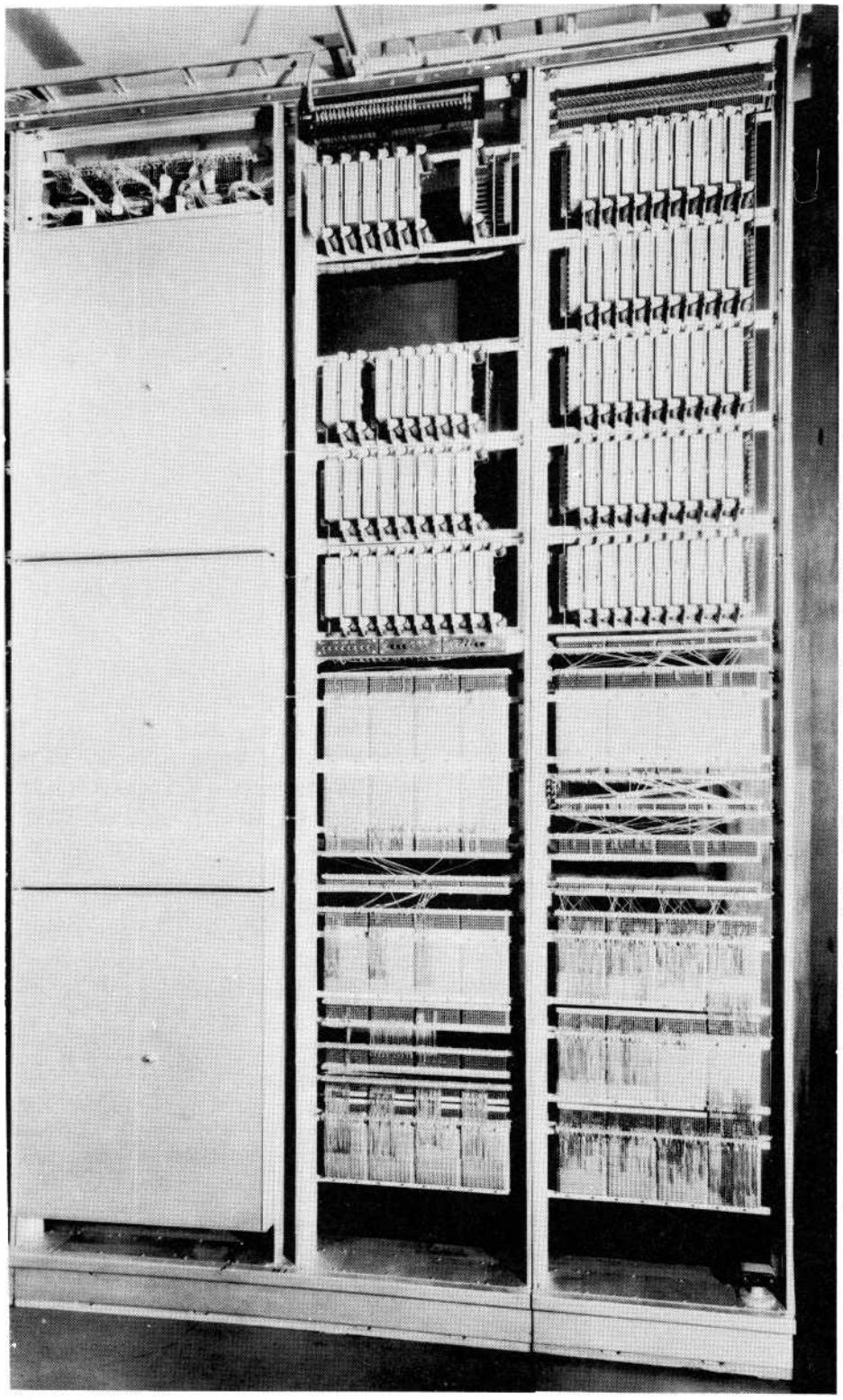


Fig. 43 Originating Marker Frame

The originating marker frame performs two main functions: one a decoding function, the other a marking function. Information on an office code dialing is relayed to the marker by the sender, and by decoding this office code information the marker is able to locate and select an idle outgoing trunk to the terminating central office. The marking function consists of testing for and selecting idle paths (link and junctor) through the district and to and through the office link frames. The marker also furnishes information to the district junctor circuit to control talking selection, zone charge, and party information; and also returns certain information to the sender so that selections over the outgoing trunk path may be taken care of.

9. Incoming Frame Group

This frame group forms part of the terminating equipment in a central office and includes three frames (Fig. 44): the incoming trunk frame in the middle, the incoming link frame on the right, and the terminating sender link frame on the left, looking at the equipment side of the frames. The frames in this group, just as in the district frame group, are all individual frames which form an integral equipment unit when installed in the central office. This grouping of frames provides an economical wiring arrangement, eliminating individual frame to frame switchboard cable.

a. Incoming Trunk Frame

This frame mounts the equipment for the various types of incoming trunk circuits required for the central office. Trunk circuit equipment is arranged by units; a maximum of 20 circuits per unit and each unit arbitrarily divided into two groups of 10 or less trunks, the equipment for one group mounted in the lower half of the unit and that for the other group in the upper half. Each incoming trunk frame provides mounting space for five such units. The circuits in the first unit on a frame provide for incoming trunk groups 0 and 1, the second unit for groups 2 and 3, the third unit for groups 4 and 5, etc. The maximum trunk capacity for this frame is 100.

The incoming trunk unit mounts the equipment for a maximum of 20 incoming circuits on two vertical rows of mounting plates, 10 per row. Each mounting plate takes care of the equipment for one incoming trunk circuit. The only exception to this is in connection with toll incoming trunk circuits which require additional equipment for proper transmission facilities, and as a result two mounting plates must be provided per circuit, thus limiting the capacity of a toll incoming trunk unit to 10 toll incoming trunk circuits. Each unit also provides mounting space for terminal strips, jack and lamp panel, fuse panel, and one mounting plate for miscellaneous relay equipment which is common to all of the circuits in the unit. There are many different types of incoming trunk circuits which may be arranged in any combination within a particular unit, providing they are grouped in 10's; that is to say, any group of 10 within a unit must be the same type of trunk circuit. The five main types of circuits include full selector, B switchboard, toll, dial pulsing, and MF or key pulsing. If an incoming trunk frame has less than 100 trunk circuits associated with it, as in the case where one of the units may be a toll trunk unit, the practice is to provide an additional number of toll trunk circuits on a supplementary incoming trunk frame. These circuits are cabled to the regular incoming trunk frame, bringing the regular frame capacity up to its maximum of 100.

Another type of incoming trunk frame is provided when 160 trunk incoming link frames are specified for a job, which is designated as an auxiliary incoming trunk frame. Equipment corresponds to that on the

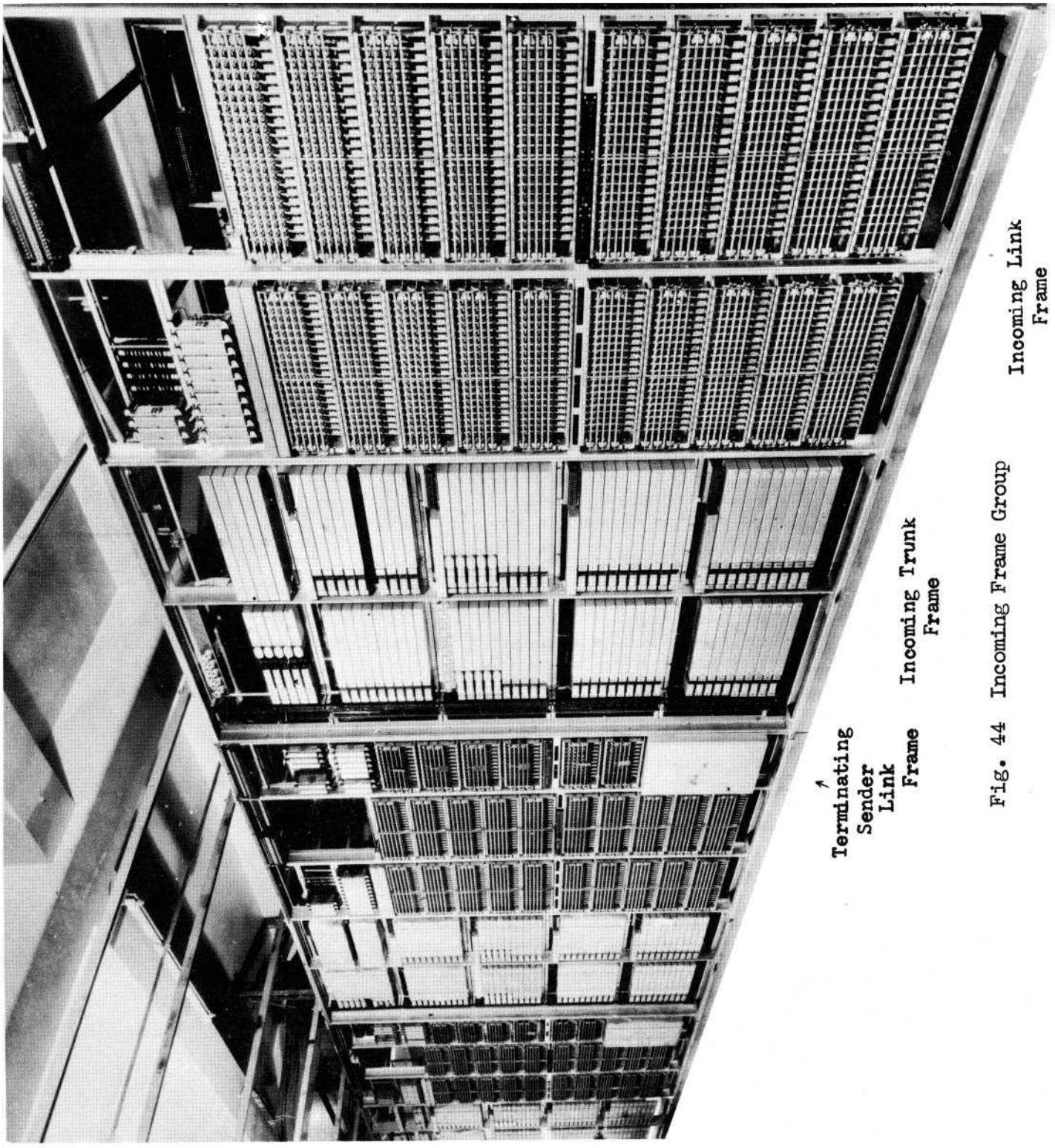


Fig. 44 Incoming Frame Group

regular trunk frame, with facilities provided for 100 trunk circuits, which are served by an adjacent auxiliary terminating sender link frame in so far as sender access is concerned. Association with incoming link frames is obtained by cabling the auxiliary trunks to the frames located with the regular incoming trunk frame, in quantities required to complete the load on the incoming link frame.

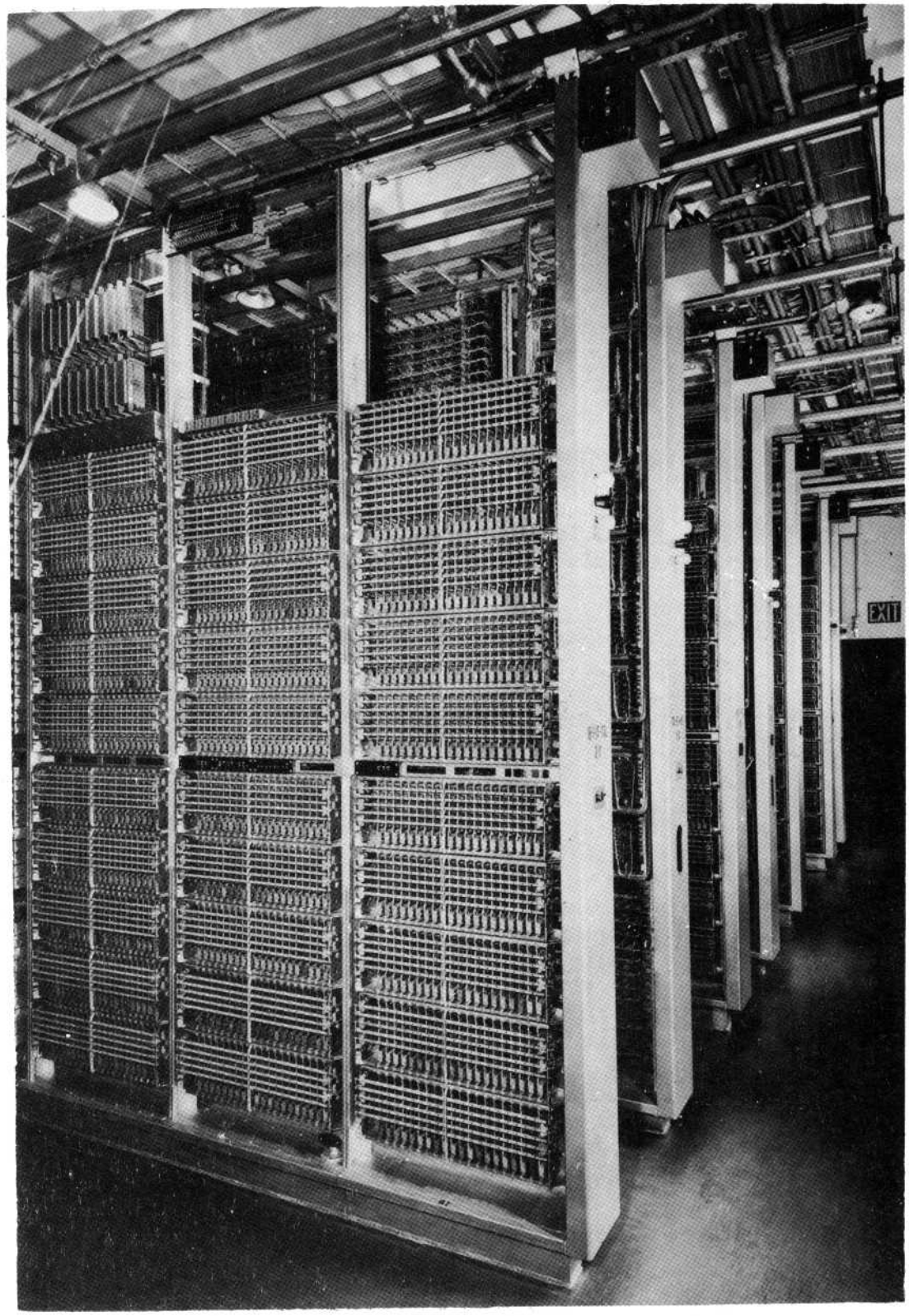
The supplementary incoming trunk frame is a duplication of the regular incoming trunk framework, providing additional mounting space for trunk circuits for which there is no mounting space on the regular frame but which must nevertheless be associated with it. The supplementary incoming trunk frame is located as near as possible to the regular incoming trunk frames, the most suitable location being that which will provide for the shortest amount of cabling between the two types of frames.

The incoming trunk frame provides facilities for mounting the trunk circuit equipment which furnishes talking battery to the called subscriber, maintains supervision over the call after the terminating sender and terminating marker have released, provides the proper type of ringing current to the called line, and transmits busy tone to the calling line if the called line is busy.

b. Incoming Link and Incoming Extension Frames

The incoming link frame (Fig. 45) is a two-bay framework--the left or primary bay providing space for mounting ten 20-vertical, 6-wire crossbar switches, multi-contact relays, and four mounting plates for miscellaneous relays; the right or secondary bay containing ten 200-point, 3-wire secondary crossbar switches, multi-contact relays, terminal strips, fuse panel, and key, jack and lamp panels.

Incoming trunk circuits are wired to primary switch levels, a maximum of 16 trunks to a switch and 160 to a frame. Trunks are provided in pairs, designated as "even" and "odd", each pair being wired to the six make springs of a level. Level numbers 2 to 9 inclusive are associated with trunks, while levels 0 to 1 are associated with a link and are used in differentiating between the even or odd trunk of a pair connected to the same level. The operation of a crosspoint on any level connects the trunks to the brass strip multiple of the particular vertical involved, from which either the even or odd trunk is connected to the link by operation of either the 0 or 1 level select magnet. Thus any one of a maximum of 160 incoming trunks may be closed through to any one of 200 link connections, which completes a connection to a secondary switch. Two hundred line junctor circuits outgoing from incoming secondary switch verticals to line link frames are available for selection so that any particular call may have access to all line link frames. Incoming link circuits originate on primary verticals and



Pri. Link Sec. Sec. Extension

Fig. 45 Incoming Link and Extension Frame

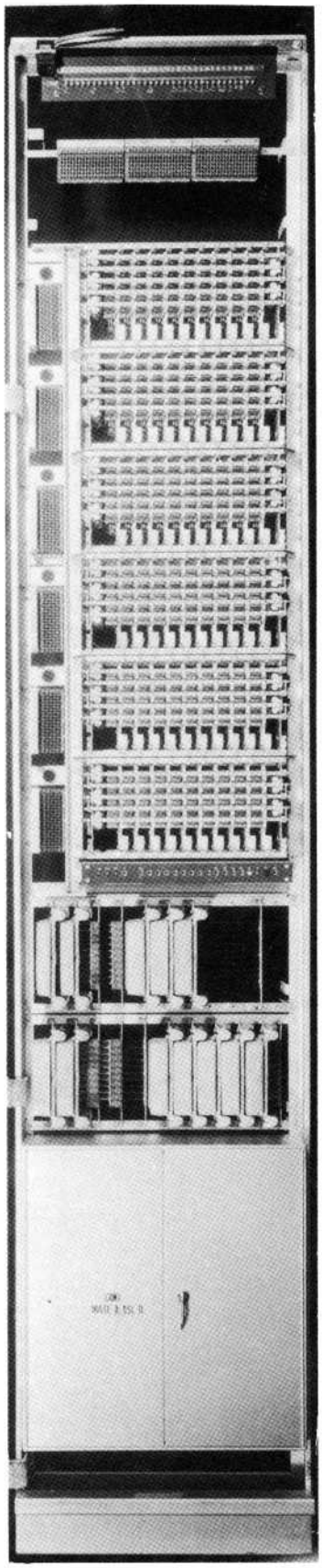


Fig. 46 Terminating Sender Link Frame

terminate on secondary levels, while line junctor circuits are associated with secondary verticals.

The purpose of the equipment on this frame is to provide an idle path from any one incoming link frame to any one of the line link frames in the office so that any one of a maximum of 10,000 subscriber lines may be reached by an incoming trunk circuit. The path between an incoming trunk circuit and a subscriber line involves the setting up of a connection between primary and secondary switches in the incoming link frame, the link connection in the primary and secondary switches in the line link frame, and a line junctor connection between the two.

Central offices having low calling rates require more than 10 incoming link frames as well as more than 10 line choices. Incoming extension frames are then added to each incoming link frame to increase the line junctor capacity (Fig. 45). The extension frame is a duplicate of the regular secondary bay of the incoming link frame and is always installed to the right of its associated secondary bay.

c. Terminating Sender Link Frame

This is a single bay frame (Fig. 41) containing three 100-point primary crossbar switches (upper), three 100-point secondary crossbar switches (lower), multi-contact relays, a jack and lamp panel, terminal strips, a fuse panel, and a controller circuit with its associated equipment on mounting plates enclosed with a front casing. This frame is associated both with incoming trunk and sender circuits. A large number of different types of trunk circuits may be connected to it which may have access to four different types of sender circuits.

The purpose of the equipment on this frame is to select an idle sender of the proper type and connect it to the incoming trunk circuit which is involved in the call. When the terminating equipment is common to two central office units, this frame has added functions in providing an indication to the sender as to which of the two offices the call should be completed to.

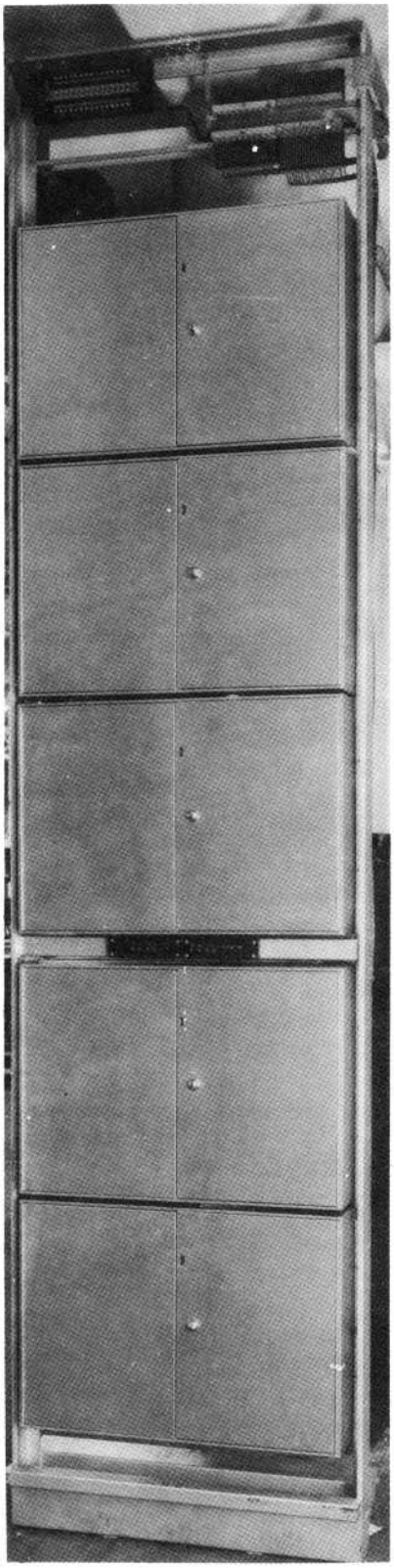


Fig. 47 Terminating Sender Frame

A terminating sender link frame is always associated with an incoming trunk or auxiliary incoming trunk frame, being designated as an auxiliary terminating sender link frame when associated with an auxiliary incoming trunk frame.

10. Terminating Sender Frame

The terminating sender frame is a single-bay structure arranged to mount five sender units, a fuse panel, terminal strips, and jack panels (Fig. 47). Sender Units enclosed in front and rear casings are made up in five different types: Full Select (FS), B, Central B, Dial Pulse (DP) and Multi-Frequency Pulsing (MF) senders. On any one sender frame, various combinations of these may be provided except that no more than three shall be other than Full Select, and the remaining two or more shall be Full Select senders. The future replacement of senders other than Full Select type with Full Select senders will be made much more convenient if the Full Select senders are mounted in the upper portion of the frame. All types other than Full Select should be divided approximately equally over all the sender frames.

The (1) full selector sender (Fig. 48) is used on all calls being completed to a crossbar subscriber from either another crossbar subscriber or from a panel subscriber. This sender receives the called number from the originating sender in the calling office on a revertive pulse basis. These pulses representing the called number are registered as cross-points on the 6-vertical crossbar switch which is part of the equipment in this sender unit. The sender eventually passes information on the called number to the terminating marker which controls completion of the connection to the called subscriber station. This sender unit, in addition to the crossbar switch, also contains five mounting plates of miscellaneous equipment, such as "U" and "Y" type relays, condensers, resistances, etc.

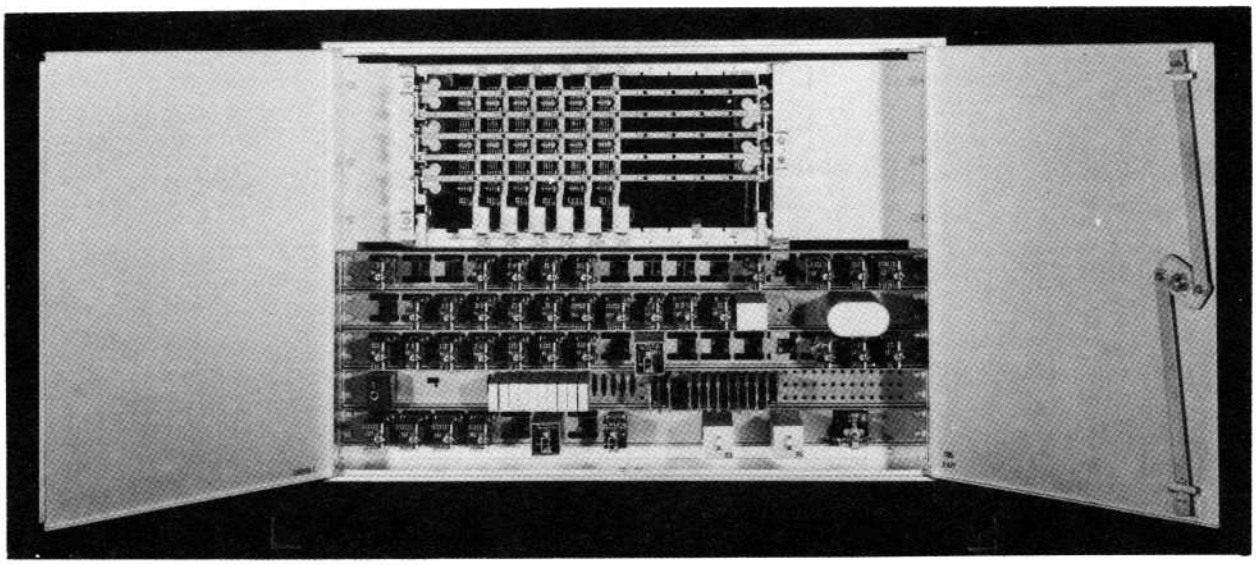


Fig. 48 Full Selector Sender Unit

The (2)a "B" sender, which consists of relays, condensers, and resistances is used in connection with completing calls from a manual to a crossbar subscriber. In this type of call the call distributing "B" operator at the crossbar office receives the numerical code of the called subscriber from the manual operator in the originating office, and transfers this information to the "B" sender by keying up the number on the keyset in her position.

"B" senders are associated with "B" position finder units. These finder units consist of a maximum of five 206-type selector switches and some miscellaneous relay equipment. These units should be part of the equipment mounted on the associated terminating sender or terminating sender link frames, but due to lack of space they are provided as part of the equipment on the terminating marker connector frame. Each one of the finder units provides for a maximum of five "B" senders and a maximum of twenty call distributing "B" positions. Its function is to select an idle "B" position and connect it to the particular "B" sender that is being used on a call.

The (2)b central "B" sender is used in connection with manual traffic in a similar manner to the "B" sender with the exception that it functions with a central call distributing "B" switchboard and associated sender in a distant office. This type of sender also consists of miscellaneous equipment, including relays, condensers, and resistances.

The (3) dial pulsing sender is provided in crossbar offices which do not have a "B" switchboard for terminating traffic from manual switchboards equipped with dials. In an area of this character, where the manual operator actually dials the called number into the crossbar terminating equipment, the "B" board operator is not required. This type of sender also consists of miscellaneous relays, condensers, and resistances.

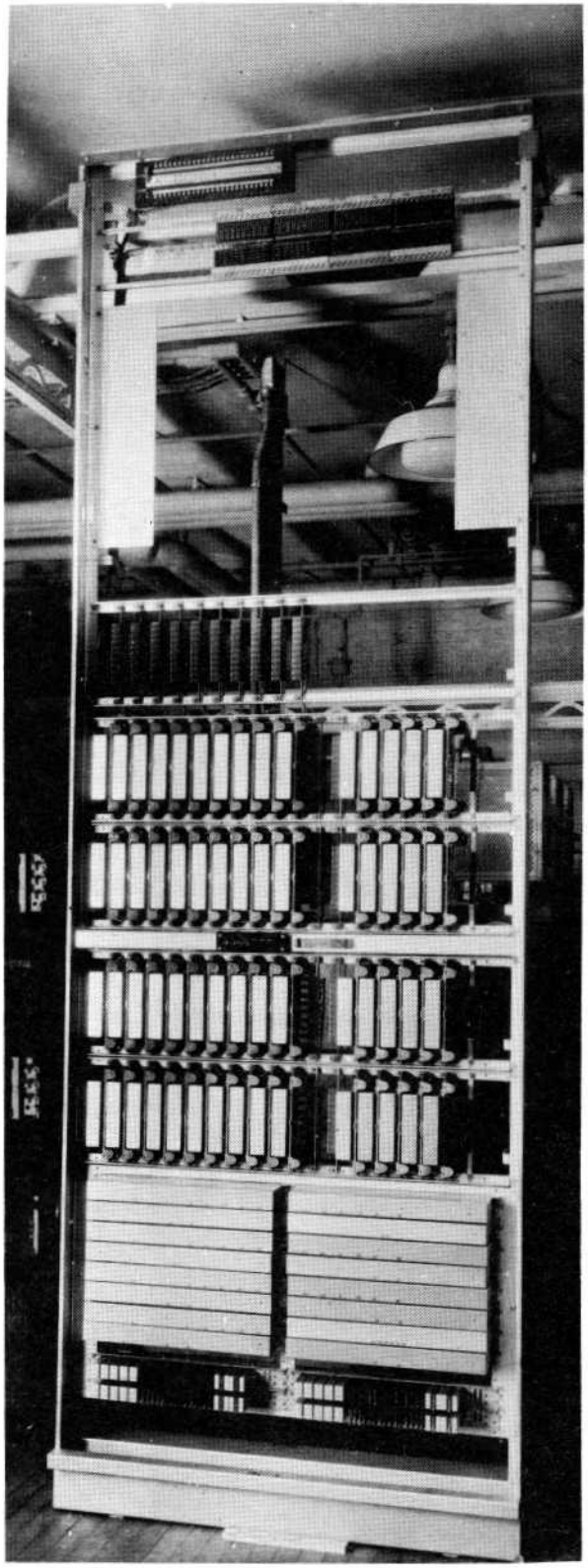


Fig. 49 Terminating Marker Connector Frame

The MF terminating sender is used to complete calls incoming from offices equipped with either MF outpulsing senders or switchboard positions such as Toll and D.S.A. The terminating X B - 1 office may be in the local area or some foreign one. The MF sender includes miscellaneous relays, condensers, resistances and an associated multi-frequency receiver unit.

11. Terminating Marker Connector Frame

The terminating marker connector frame is a one bay structure (Fig. 49), having a capacity for four marker connector circuits, associated control and alarm relay equipment common to these circuits, and a maximum of two B-position finder units. The frame equipment also includes a fuse panel, eight terminal strips, and a jack panel.

A marker connector circuit consists of a single horizontal row of multi-contact relays, the number of which will vary with the number of terminating markers and with the number of senders associated with each connector circuit. The minimum number of multi-contact relays will be seven, with a maximum of 15. These multi-contact relays which make up a connector circuit are arranged in two groups, the group on the left being associated with markers while the group on the right is associated with senders. One multi-contact relay is provided for each marker as well as one for each sender.

The purpose of these terminating marker connector circuits is to select an idle terminating marker and associate it with the sender that is being used in setting up a connection to a subscriber. The number of marker

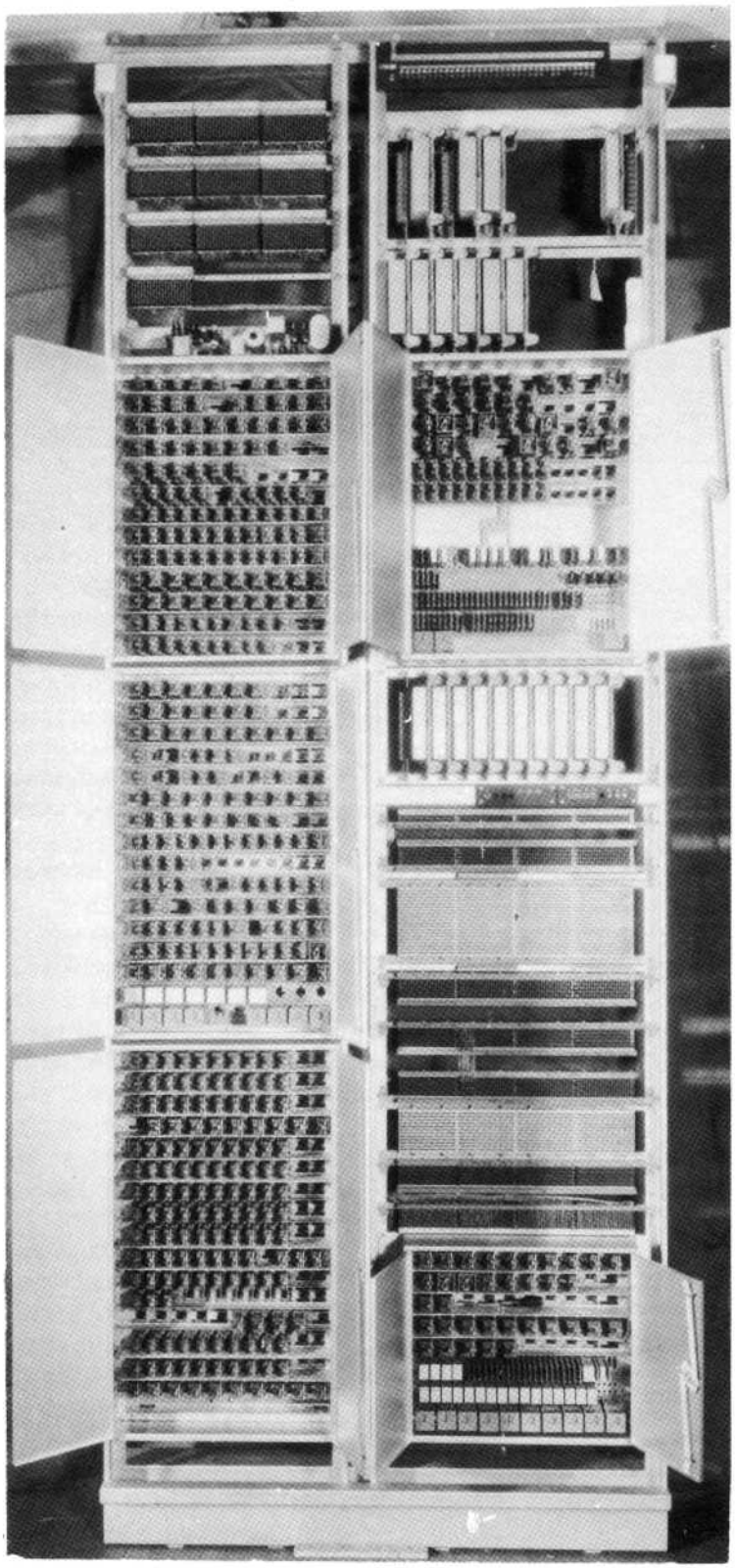


Fig. 50 Terminating Marker Frame

connector circuits which are provided in a central office unit will be determined by the number of senders which are provided. While senders are individual to marker connector circuits, terminating markers are common to all marker connector circuits. Terminating markers are cabled to a set of crossbar type terminal strips located just above the top connector circuit in the frame and then from punchings on these terminal strips are wired in local frame cable to the marker relays in each of the connector circuits. The markers are also multipled from connector frame to connector frame by means of switchboard cable.

12, Terminating Marker Frame

The terminating marker frame consists of two bays (Fig. 50), mounting equipment for one marker circuit. The left bay provides mounting space for "U" and "Y" type relays, condensers, and resistances arranged in three groups of mounting plates, each enclosed with a front and rear casing. One mounting plate is provided in the upper portion of this bay for miscellaneous equipment with space above this plate reserved for twelve terminal strips. The right bay provides mounting space for another group of relays, condensers, and resistances enclosed in a front and rear casing, multi-contact relays arranged in three horizontal rows, fuse panel, several terminal strips arranged for cross connecting purposes, jack, key, and lamp panels, and if required, a second group of relays, resistances, and condensers, also enclosed in a front and rear casing.

The terminating marker receives the number of the called subscriber from the terminating sender, translates it into relay settings by means of which it controls the establishment of connections through the incoming and line link frames to the called subscriber. The marker in its first operation tests the called line for a busy or idle condition; if it finds a busy condition the incoming trunk circuit is set to return a busy signal to the calling line; if the called line is found idle, then the marker proceeds to test for and select idle paths through the terminating equipment, which are required to complete the connection from the incoming trunk circuit to the called subscriber line. These test and control functions of the marker are provided through its various test and control relay groups.

The number of terminating markers provided in any central office unit will vary from a minimum of three to a maximum of ten, the number actually provided being dependent on traffic conditions.

The group of control relays located in the lower portion of the right bay are furnished only on two of the markers provided for any central office unit. This control equipment is provided to serve in connection with number checking, no test, and no hunt calls. For example, if five markers are provided for a particular job, markers 0 and 1 are equipped with this special control unit.

A feature is incorporated in the terminating marker to provide for traffic control to a particular directory number. A jack panel arrangement is located in the space occupied by number checking equipment on one of the markers which is not arranged for handling special calls. One of these jack panels is provided per marker group and is wired common to all markers.

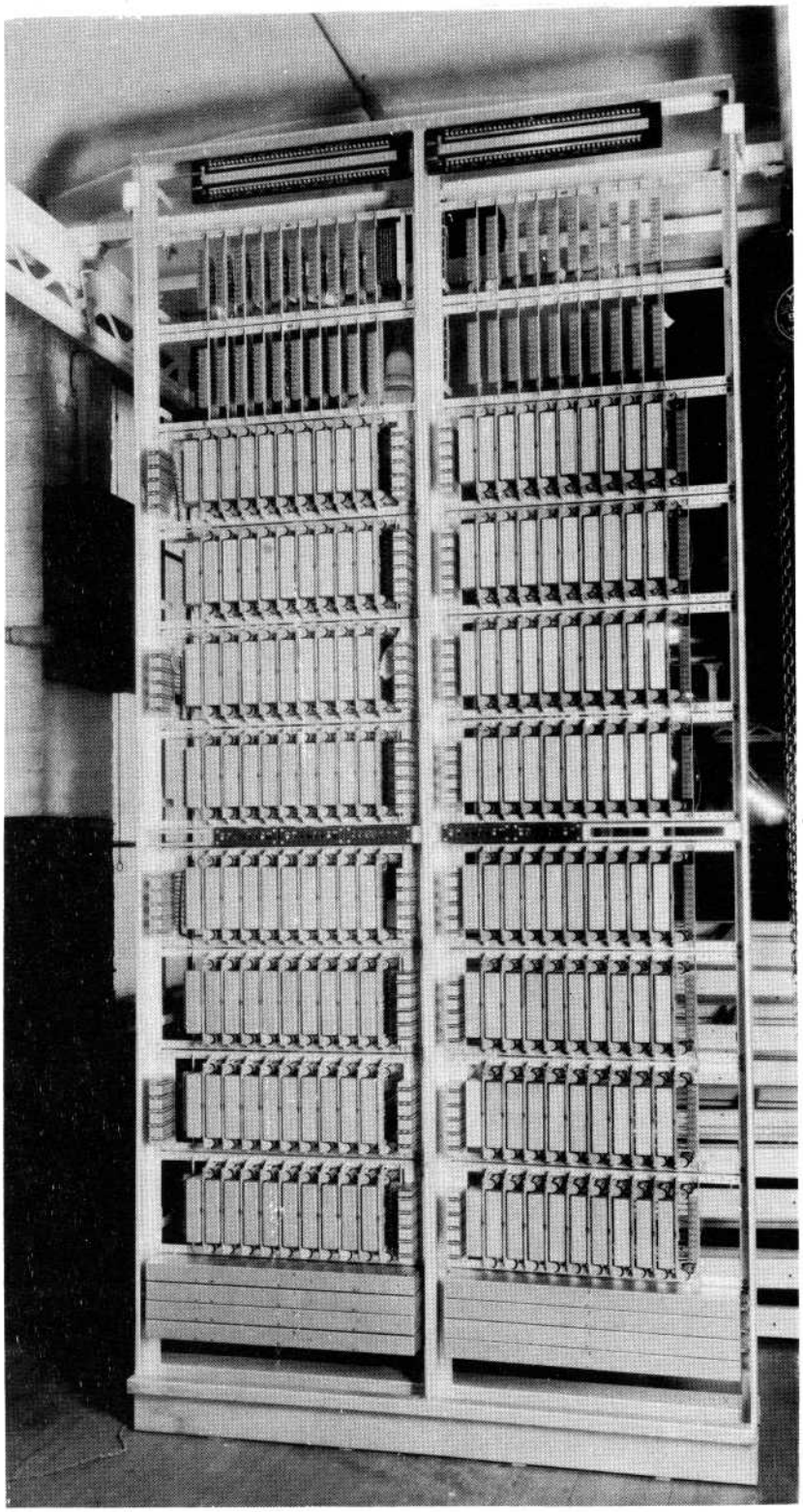


Fig. 51 Number Group Connector Frame

13. Number Group Connector Frame

This frame is a single-sided two bay framework (Fig. 51), available in two widths, one serving a maximum of ten markers and the other a maximum of six. Each type of frame provides mounting space for four number group connector circuits.

The left bay of this frame contains a fuse panel located at the top of the frame, a double row of crossbar type terminal strips (a minimum of three pair and maximum of ten pair), eight horizontal rows of multi-contact relays (a minimum of three and maximum of ten relays in each row), contact protection equipment in the form of condenser-resistance combinations arranged on short mounting plates, installed on the left of the bay for alternate rows of multi-contact relays and on the right of the bay for all rows of multi-contact relays, and four mounting plates of control circuit relays located in that part of the bay below the multi-contact relays.

Equipment in the right bay of this frame is a duplicate of that in the left bay with these exceptions: contact protection equipment is mounted only at the left of each horizontal row of multi-contact relays.

Each horizontal row of multi-contact relays has associated with it either one or two crossbar type terminal strips. It provides a terminating point for horizontal strap wire which multiples like contacts throughout the relays in any horizontal row.

Jack, key, and lamp panels are mounted in each bay between the fourth and fifth horizontal rows of multi-contact relays.

The 10,000 directory numbers which may be associated with any central office are arranged in number groups consisting of consecutive directory numbers, as many of these consecutive numbers being associated with a number group as will provide a traffic condition of 1,000 busy hour calls. Number groups may be increased or decreased in increments of 100, the minimum consecutive numbers in any one number group being 100 while the maximum number may be 2500. For each number group thus provided, one number group connector circuit must be equipped on the number group connector frames.

14. Block Relay Frame

This frame is a one bay structure (Fig. 52), the top half containing four welded framework assemblies, each equipped with ten multi-contact relays, three terminal strips, and a short mounting plate (mounted in a vertical position) equipped with two "U" type relays, a fuse panel and three miscellaneous terminal strips. The lower half of the frame provides space for mounting several cross connecting type terminal and fanning strips which are used as a common cross connecting field to provide miscellaneous information to the marker so that the call may be completed to the proper destination.

The multi-contact relays are designated as TB (Twenty Block), each relay closing through three leads for each of 20 consecutive directory numbers. The relays are arranged in four horizontal rows, ten relays per row. Two hundred consecutive directory numbers can thus be provided for on one relay row, with the four rows on one frame taking care of a total of 800

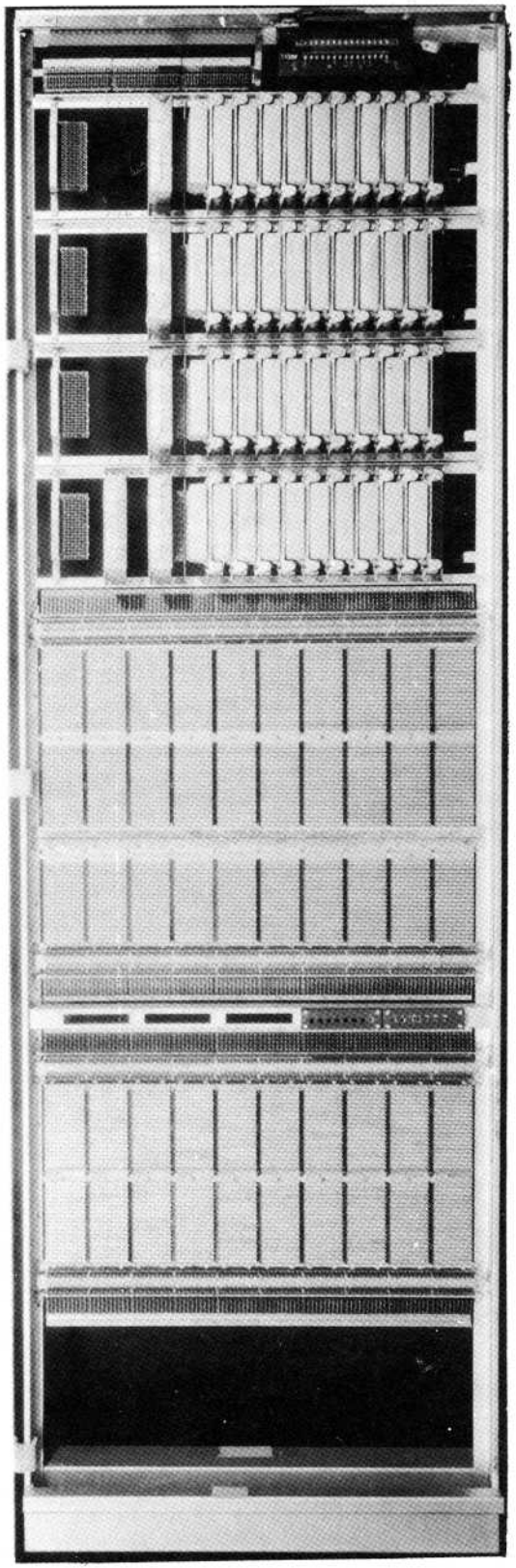


Fig. 52 Block Relay Frame

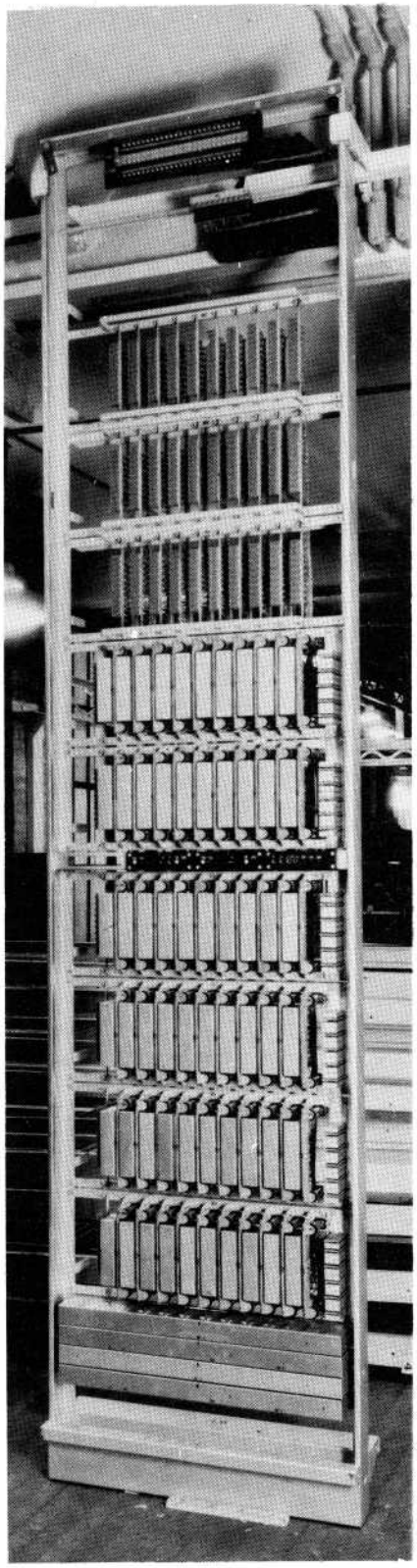


Fig. 53 Line Choice Connector Frame

consecutive directory numbers. The three leads carried through for each directory number are designated as NS (Number Sleeve), NF, and NC. The NF and NC leads are carried through the local form to punchings on the rear of several of the cross-connecting type terminal strips located in the lower portion of the bay, while the NS lead for each number is cabled to the vertical terminal strips located on the line distributing frame. The NS lead is used by the marker in making "line tests", while NF and NC leads are used to return information to the marker.

Block relay frames are provided for each central office on the basis of one frame for each block of 800 consecutive directory numbers, which would mean that in a 10,000 line unit the minimum number of block relay frames would be 13. Some central offices require "extra numbers", for which provision must be made by the addition of more block relay frames.

15. Line Choice Connector Frame

This frame is a one bay arrangement (Fig. 53), available in two widths; the larger for use in offices requiring from 7 to 10 terminating markers, and the smaller for offices requiring from 3 to 6 terminating markers. Either type of frame contains a fuse panel and a single terminal strip located at the top of the frame, 3 horizontal rows of crossbar type terminal strips (a minimum of 3 and a maximum of 10 strips per row), 6 horizontal rows of multi-contact relays (a minimum of 18 and a maximum of 60), terminal strips, condensers, and resistances. Four mounting plates are located in the lower portion of the frame which provide mounting space for miscellaneous "U" type relays. Jack and lamp panels are also located in the middle portion of the frame. Each one of the six horizontal rows of multi-contact relays contain from 3 to 10 relays depending upon the number of terminating markers associated with the central office unit and a combination of condensers and resistances equipped on a short mounting plate which is mounted in a vertical position on the right-hand side of each of these assemblies.

This frame mounts the equipment for two line choice connector circuits, one of which is required for each line choice. Each circuit consists of three horizontal rows of multi-contact relays, the maximum number of these connector circuits provided in any central office unit being limited to 20.

The purpose of the equipment on this frame is to provide facilities for connecting a large number of leads from the marker to both line link and line junctor connector frames which will provide the terminating marker with means to eventually select an idle path between the incoming trunk circuit and the called subscriber line.

16. Line Junctor Connector Frame

This is another of the one bay frameworks (Fig. 54), made up in only one width but which may be used in conjunction with either type of line choice connector frame. It provides space for mounting a fuse panel, a terminal strip, 96 multi-contact relays, a jack panel, and four mounting plates equipped with condensers and resistances.

The 96 multi-contact relays are arranged in 8 horizontal rows, 12 relays per row. Two of these horizontal rows of multi-contact relays make up one line junctor connector circuit, with a frame capacity for 4 such circuits.

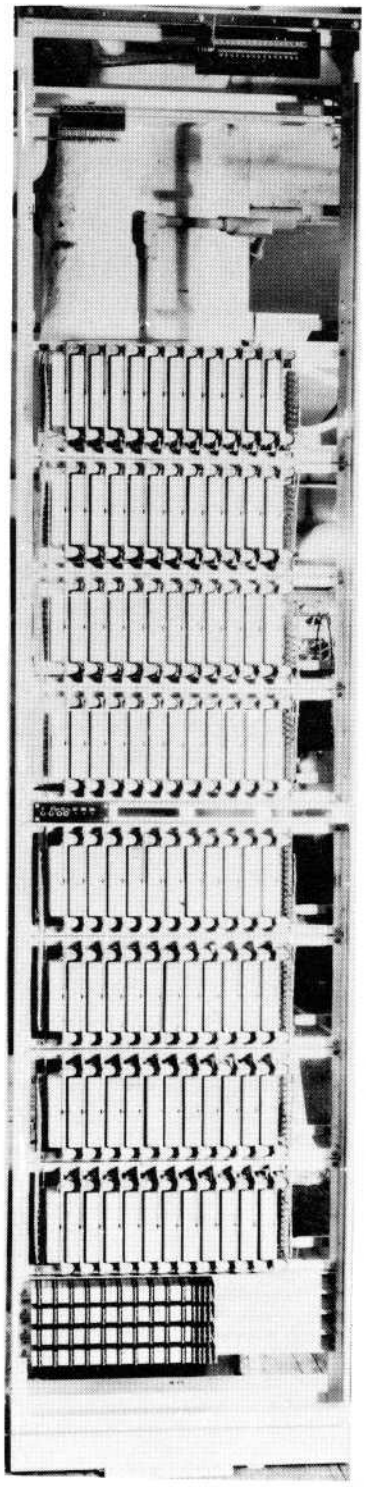


Fig. 54 Line Junctor Connector Frame

The purpose of the equipment on this frame is to provide connecting paths to the marker for testing and selecting an idle line link and an idle line junctor circuit in the proper groups. It operates in conjunction with the equipment on an associated line choice connector frame.

17. Key Pulsing Sender Link or Coin Supervisory Link Frame

This is a two bay framework (Fig. 55) with duplicate equipment in each bay, including a fuse panel, terminal strips, either one or two, 200-point primary crossbar switches, two 200-point secondary crossbar switches, 7 multi-contact relays, a jack and lamp panel, and a controller circuit with its miscellaneous equipment mounted on seven mounting plates enclosed in a front casing.

When used as a key pulsing sender link frame, key pulsing district junctor circuits, key pulsing incoming trunk circuits, or key pulsing outgoing trunk circuits are wired to the levels of the two primary switches located in the left bay, and multipled to like levels on the primary switches located in the right bay. The horizontal strapping on the two primary switches in both bays is so arranged that the frame will provide for a maximum of 100 incoming circuits. Each incoming circuit is an 8-wire circuit, therefore, requiring two horizontals for its termination on the switch. The secondary switches have the horizontal strapping split in the middle with key pulsing sender circuits wired individually to pairs of levels, one on each of the two halves of a switch. Sender circuits are not multipled between the two bays, thus providing a frame capacity for a maximum of

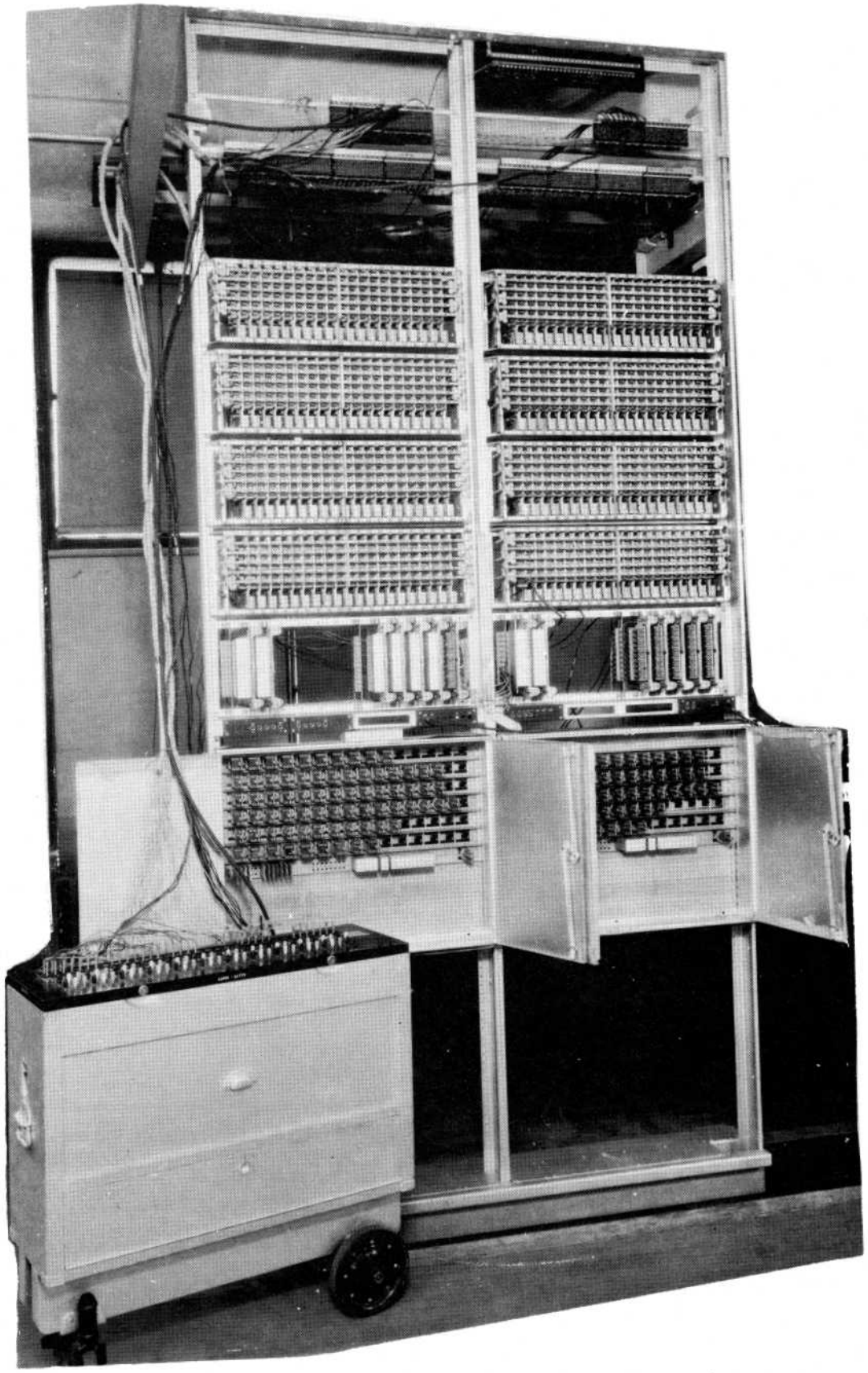


Fig. 55 Key Pulsing Sender Link or Coin Supervisory Link Frame with Test Set

forty senders. The incoming trunk circuits have access to the senders through link connections which originate on primary verticals and terminate on secondary verticals; in other words, the link spread is from primary vertical to secondary vertical.

When this frame is used as a coin supervisory link frame, the same equipment will provide for 100 coin district junctor circuits and 40 coin supervisory circuits.

This frame serves the purpose of associating a district junctor or trunk circuit with an idle key pulsing sender or a coin district junctor circuit with an idle coin supervisory circuit.

Additional miscellaneous equipment, arranged in several small units and directly associated with the operation of this frame, is mounted on miscellaneous bays and cabled to the associated key pulsing or coin supervisory link frame. This miscellaneous equipment consists of select, release relay, and time alarm units.

18. Grouping Frames

a. District Junctor Grouping Frame

This is a double-sided distributing frame (Fig. 56) with arrangements for mounting terminal strips in a vertical position on one side and horizontally on the other side. The framework is made up in the shop of verticals which are shipped individually to the various jobs, with terminal strips mounted by the installer according to job specification. The size of the frame will vary with the job and may be specified in 11, 17, or 21 vertical arrangements, with the verticals on 6-1/2" centers.

District junctor circuits are cabled to the vertical side of this grouping frame from their line link frame appearances, while the relay equipment associated with each junctor circuit is cabled from its location on the district junctor frame to the horizontal side. Proper distribution of district junctors to line link frames to provide for variable traffic conditions is obtained by means of jumper connections between the vertical and horizontal side of the grouping frame.

b. Office Junctor Grouping Frame

This frame consists of two single-sided bays (Fig. 57) located end to end for all installations, each bay being approximately 4 feet in length. Each one of these bays consists of an arrangement of 5 vertical upright square bars providing a mounting arrangement for 10 terminal strips per bar. A maximum of 50 terminal strips can be mounted in each of the two bays, the mounting arrangement of the strips being such that looking at the front side of the frame the fanning strip of each terminal strip will be at right angles to the length of the grouping frame.

Distribution of office junctor circuits between district link and office link frames is provided for by this frame. Office junctors are cabled from their originating end at district link frames to front punchings on terminal strips in the grouping frame, while office junctor

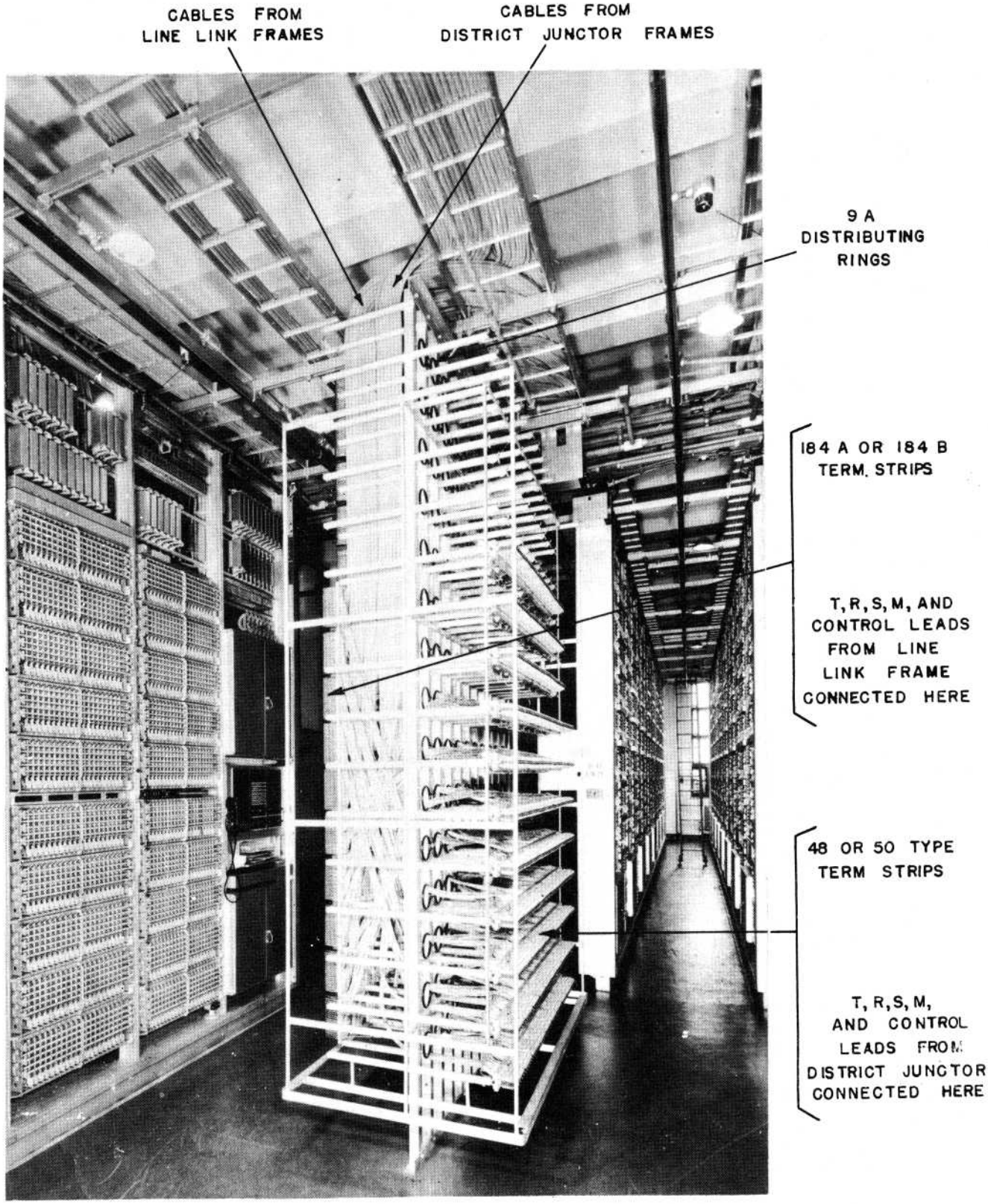


Fig. 56 District Junctor Grouping Frame

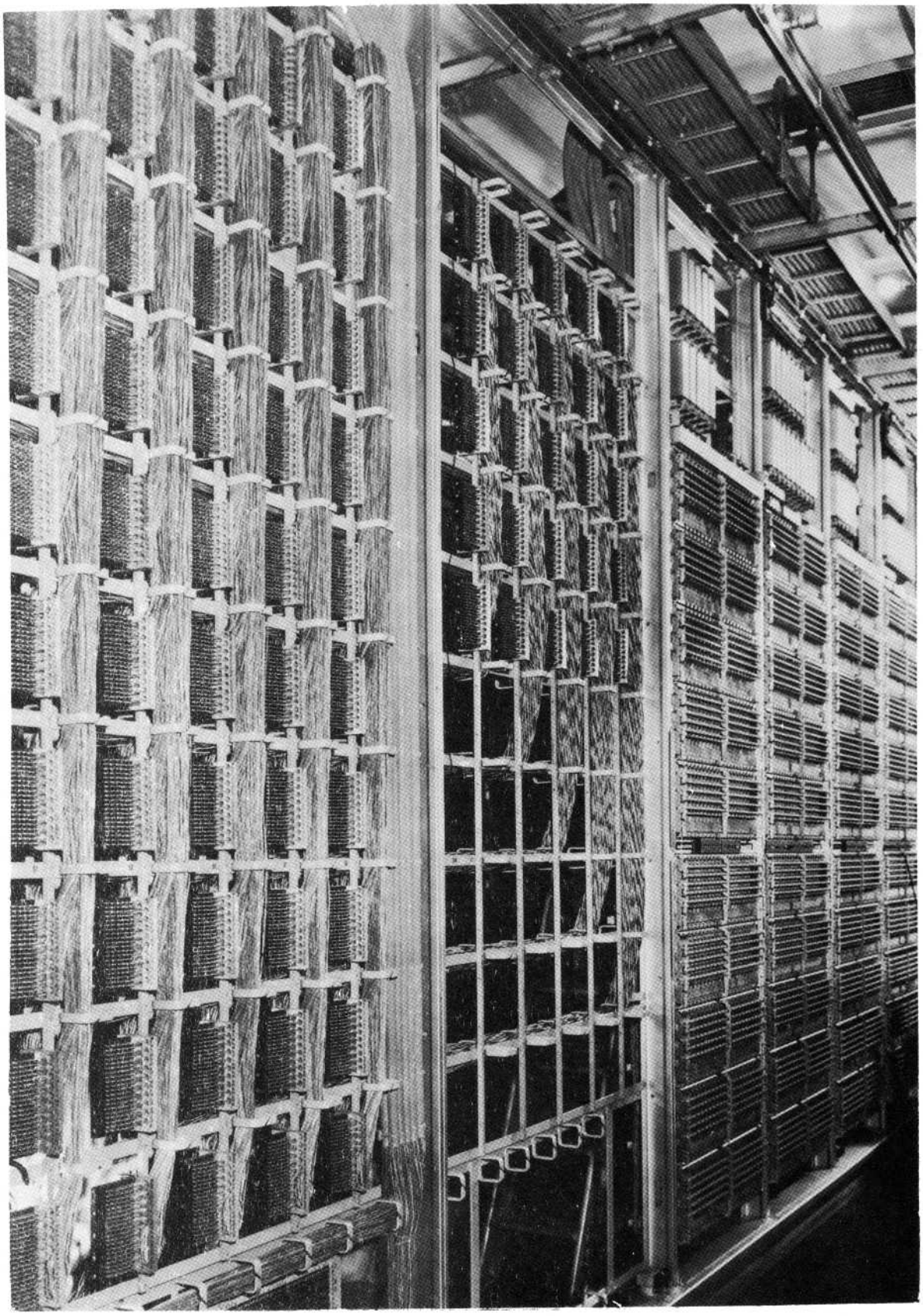


Fig. 57 Office Junctor Grouping Frame

Fig. 58 Line Junctor Grouping Frame

circuits from the office link frames are cabled to rear punchings of these strips. The distribution of the junctor circuits between district and office link frames is made according to information provided by junctor assignment charts, which will vary with the number of district and office link frames installed in the central office unit.

Space is provided in the lower portion of each of the grouping frame bays for mounting three terminal strips which provide a means of fusing the two hold magnets on each end of a junctor with only one fuse. This fusing is accomplished on the district end of the junctor which eliminates operating troubles which might result with separate fusing at each end.

When the number of district and office link frames provided in an office is less than 20, a certain amount of jumpering is required between punchings on opposite sides of the terminal strips in this grouping frame.

c. Line Junctor Grouping Frame

This frame is provided in either a one or two bay size, depending upon the size of the central office (Fig. 58). The arrangement of the framework and the terminal strips are exactly the same as explained for the office junctor grouping frame with this exception, that no cross-connecting type of terminal strips are ever provided in the lower portion of the bays.

The proper distribution of line junctor circuits, which connect incoming link frames with line link frames, is provided for by this frame. Line junctor circuits from incoming link frames are cabled to punchings on terminal strips on the front of the frame, while junctors from line link frames are cabled to punchings on terminal strips on the rear of the frame.

Each incoming link frame in an office must have access to all line link frames, so that any incoming trunk circuit may be connected to any line located on any line link frame in the office. The distribution of line junctor circuits between incoming link and line link frames will vary with the number of frames. The line junctor grouping frame provides a point at which flexibility may be obtained in the proper distribution of these line junctor circuits. Assignment charts are available which provide the proper arrangement of junctors for any size central office. When the number of line link frames in an office is 40 or under and the number of incoming link frames is 10 or under, only one junctor grouping bay is required, while if these same frames are over 40 or over 10 in number, then the double bay arrangement is required.

A certain amount of jumpering is required between punchings on the front and rear of the terminal strips when the number of incoming link and line link frames is less than the maximum. As additional frames are added, either incoming link or line link, the distribution plan for connecting junctor circuits must be rearranged. This is accomplished by replacing part of the jumpers with regular switchboard cable.

19. Line Distributing Frame

This framework is single-sided (Fig. 59) consisting of 55 welded vertical assemblies bolted on 8" centers to base, intermediate, and top horizontal angles, which provide mounting space for a maximum of 648 terminal strips. The upper portion of the frame is arranged for mounting terminal strips in 8 horizontal shelves, while the lower portion provides space for mounting 55 verticals, each of which provides mounting space for 4 terminal strips. Connections between the horizontal and vertical positions of the frame are made by means of jumpers run from the front of the frame only. An open, "V" shape, tubular distributing ring, insulated with a gray vitreous enamel finish, is provided to facilitate the running of cross-connecting jumpers.

Subscriber line sleeve and message register leads (LS, M or S1, S2, M1, M2) are cabled from line link frames to terminal strips in the upper or horizontal portion of the line distributing frame, while directory number sleeve and message register leads (NS, M) are cabled to the lower or vertical portion of the frame. By means of jumper connections, any subscriber line may be associated with any directory number. Subscriber lines may be relocated on a different line link frame to satisfy traffic conditions with the line retaining the same directory number just by changing the jumper connection at the line distributing frame. For two-party message rate subscriber lines, an additional message register lead (M2) is required for the second party.

When a Telephone Company desires a flexibility of message register service, a block of terminal strips may be located in the horizontal portion of the frame in that space available for miscellaneous equipment on which the cabling from the message register rack may be terminated. One-wire jumpers may then be run from these terminal strips to the "M" terminal of the subscriber number terminal which requires message register service. This arrangement permits full flexibility in assigning message registers as required to any subscriber number, or in other words, the message register number does not necessarily have to coincide with the subscriber number. When message registers are cabled direct to the vertical terminal strips, it is necessary that the register number and subscriber number coincide.

Additional equipment on the frame includes a number of jack mountings, cord and plug assemblies, and connecting blocks. This equipment provides a battery connection, frame line circuit, means for checking and testing message registers, PBX line make busy, battery and ground test connections, and signaling battery.

This frame is designed to be located parallel to and facing the same frame aisle as the block relay frames, which provides the most economical cabling arrangement between these two types of frames. One line distributing frame must be provided for each group of 10,000 subscriber lines. If terminating equipment is made common to two central office units, two line distributing frames must be provided, one for each unit, and installed back to back and as near as possible to the block relay frames. Installing the two frames back to back requires the least amount of floor space and assures the shortest length of jumper required when jumpering between frames.

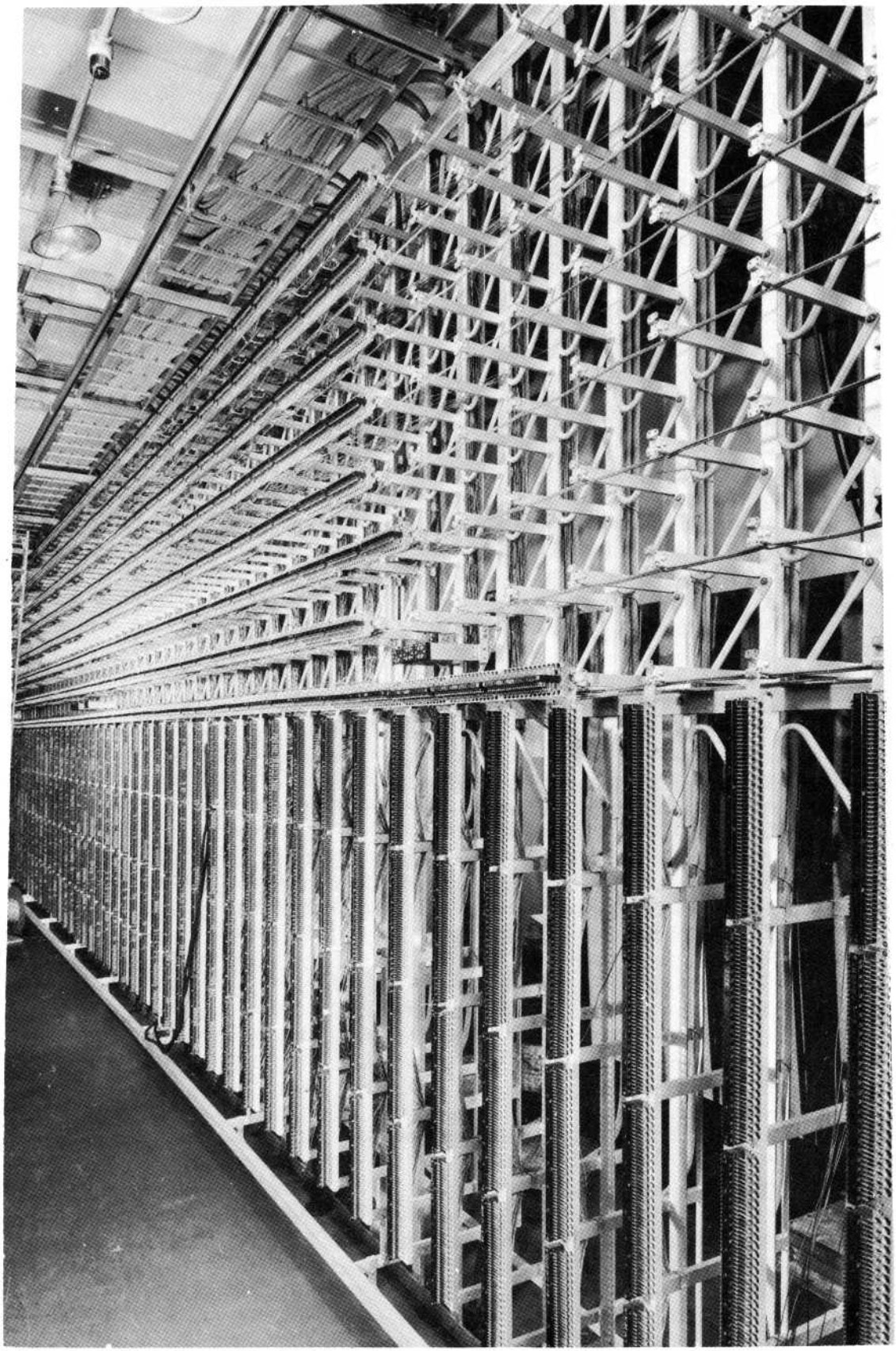


Fig. 59 Line Distributing Frame

20. Office Interrupter Frame

This is a one bay framework arranged to mount reciprocating bar type interrupters together with an AC-DC duplex motor, motor fuse box, shaft, drive, and bearings. No local cable is provided on this frame due to the fact that the number of interrupters required for different jobs is variable and that there is only a small amount of frame wiring. The number of interrupters mounted on one frame is limited to 24, which may all be of the 165 type. If both 165 and 166 types are required, the division between the number of each type should be such that the 166 type is less than half of the total. When all the interrupters on one frame are of the 166 type, the total should not exceed 17.

A minimum of four office interrupter frames is provided for each crossbar central office unit.

Cable rings are provided for switchboard cables incoming to the frames. Leads from the switchboard cable to interrupter contacts are run through special fanning rings which are mounted on the back of the interrupter mounting bars. The use of this type of fanning ring provides a support for the cable arm and eliminates the necessity of sewing.

The interrupter frames provide interrupted current to nearly every crossbar frame in a central office required for timing circuits, etc. These leads are run in separate switchboard cable with the frame to frame association such that if trouble is encountered from the interrupter frame no more than 25 per cent of the associated equipment is put out of service at any one time.

21. Zone Registration Equipment

This equipment consists of zone registration district connector (RDC) frames, zone registration control (RC) frames, and zone registration timing interrupter (RT) frames which provide a means of automatically timing calls made between zones which would otherwise require the services of an operator for the purpose. It can be arranged to time calls to any number of zones up to a maximum of 5 and to handle the initial as well as the overtime charge for all classes of service except coin. This is accomplished by operating the register of the calling subscriber line as many times as required, depending upon the initial and overtime rate as well as the duration of the call. All coin service subscriber lines completing calls to lines in other zones require the service of an operator at the DSA switchboard for charging and timing.

a. Zone Registration District Connector Frame

This is a single bay frame with mounting space for a maximum of twelve, 200-point, 4-wire crossbar switches, together with a fuse panel and a jack and lamp panel (Fig. 60).

District junctor circuits, which are wired for zone and overtime charging, are cabled to the verticals of the switches in this frame, while the zone registration circuits are cabled to the switch horizontals. The frame capacity provides for 240 district junctors and 100 registration circuits. The number of these frames required will depend on the zone traffic conditions.

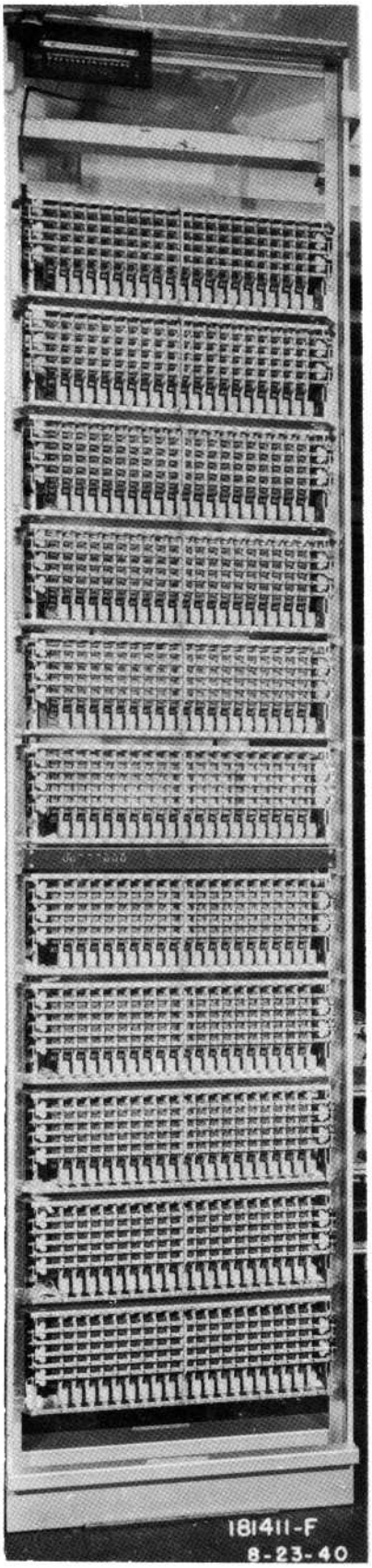


Fig. 60 Zone Registration District Connector Frame

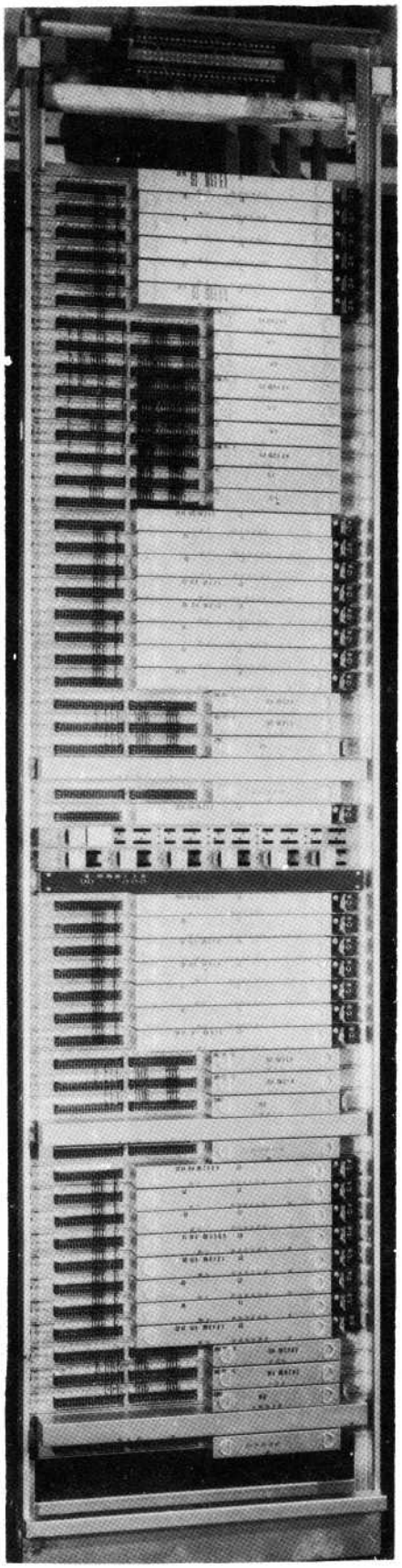


Fig. 61 Zone Registration Control Frame

b. Zone Registration Control Frame

This is also a single bay framework (Fig. 61) which provides mounting space for the following circuits arranged on a unit basis:

Type of Unit	Mounting Plates Per Unit	Circuits Per Unit
Zone Registration	1	1
Control	3	1
Common group connector	1	1
Individual group connector	1	1
Zone connector	1	4
Group busy equipment	1	7

The capacity of the frame is 60 mounting plates with the miscellaneous units consisting of relays, resistances, condensers, etc. The control unit tests for and selects an idle zone registration circuit which in turn provides the district junctor circuit with the necessary information for making the proper message register charge to the calling line. The zone registration circuit has associated with it the timing interrupter circuit which provides the timing feature required for timing both the initial and overtime periods of the call.

The other miscellaneous unit equipments mounted on this frame are provided as required, dependent on the multiple arrangement of the zone registration circuits on the district connector switch horizontals.

c. Zone Registration Timing Interrupter Frame

This frame is also a single-bay arrangement providing mounting space for a maximum of fourteen timing interrupter units, each of which has a capacity for sending timed interruptions to a maximum of five zone registration circuit units.

The timing interrupter units consist of a maximum of five 209-A type selector switches, miscellaneous relays, condensers, resistances, and a telechron motor. Each unit is also provided with a terminal strip for making interconnections between timing units and zone registration circuits. The telechron motor is provided to operate the selector switches under control of the interrupter relays. The rotation of these switches will then control the opening and closing of various circuits during definite time intervals to provide a check on both initial and overtime talking periods.

These timing interrupter units may be mounted as part of the equipment on the zone registration control frame on such jobs where the amount of equipment does not require the second bay.

22. Service Observing Jack Panel

The service observing jack panel is a one bay framework with a cord and plugshelf arrangement at a convenient height from the base (Fig. 62). The space below the plugshelf provides room for the cords and is enclosed front and rear with a metal casing. The space above the plugshelf provides a jack field varying in capacity and easily accessible to the plug-ended cords

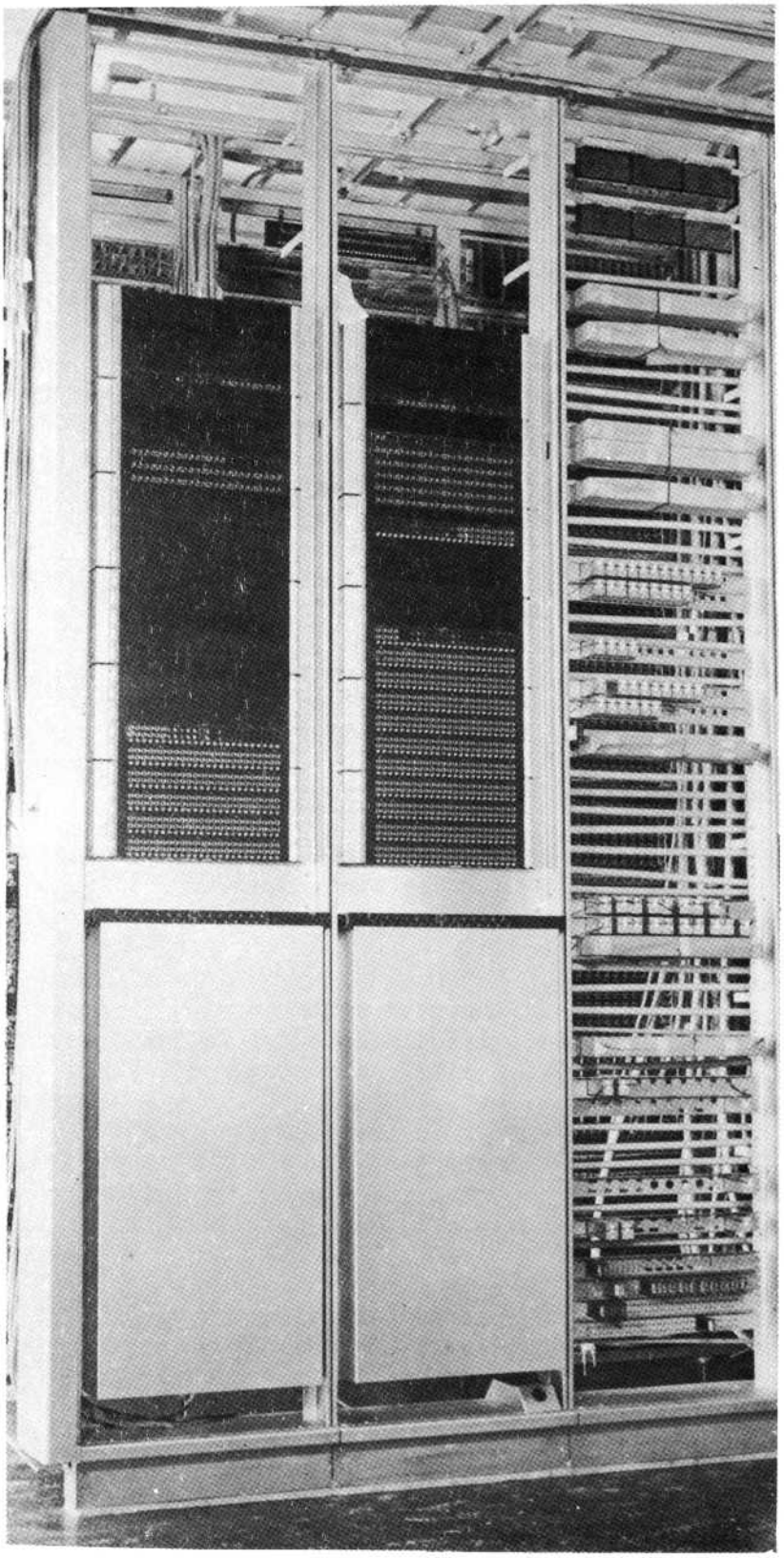


Fig. 62 Service Observing Jack Panels (Left)
Floor Alarm Frame (Right)

in the plugshelf. This field is divided into 3 jack groups: one for service observation, another for call through tests, and the third for "A" switchboard cord monitoring. Space is provided at the top of the frame for mounting 3 mounting plates for miscellaneous relay equipment which is associated with the cord monitoring jack field. A designation strip is mounted on the front part of the plugshelf for numbering the plug-ended cords and for designating the types of service with which they are associated.

The service observing jack field, located just above the plugshelf, provides for a maximum of 180 double jacks on which service observing trunks are terminated from line link frames. These trunks on the other end connect to SO (service observing) jacks located in the jack panels on all line link primary bays. The distribution of these service observing trunks is such that 2 trunks are available for service observing on a vertical line link group of 100 subscriber lines. Ten double jacks in the upper row of this jack field are cabled through the main distributing frame to the DSA board where they terminate as outgoing trunk jacks in the face of the board. These circuits are used by an operator at the "A" board in conjunction with a No. 6 service observing set which may be patched to any of the jacks in the patching panel by plugging the patching cord into the proper outgoing trunk jack. Connection of any service observing trunk to any line link frame may be made by means of a patching cord at the service observing jack panel. The upper row of jacks also contains a group of 5 double jacks, which are designated L-EXT, which are provided for complaint observation when circuits in this panel must be extended to those in another panel located at some distant point.

The next jack field in the upper portion of the bay consists of nine rows of single jacks of which a maximum of 180 jacks, located in the first 7 rows, are associated with call through testing. These jacks, designated TL, are cabled to a line link frame terminating on TL jacks located on these frames. One TL jack is provided on each line link primary bay per each 100 subscriber lines. The upper row of jacks in this field contains 24 single jacks (designated TS), twenty of which are cabled to call through test sets and the other four provided for special tests in connection with line message registers. The call through test set can then be connected to any non-working vertical unit on any line link frame merely by patching between TS and TL jacks in this field.

The third jack field contains five rows of single jacks, each of the first four rows containing 20 designated as "A" jacks while the fifth row contains 24 designated as "B" jacks. The "B" jacks are wired to the relay equipment located just above and then cabled to the main distributing frame at which point they are cross-connected to answering jack circuits which terminate at the "A" board monitoring position as a jack and lamp. The "A" jacks are cabled to those cord circuits which are to be monitored on in the "A" board.

The plugshelf has a capacity of 39 plugs which may be connected to either dialing observing line circuits, PBX service observing line circuits, or complaint observing line circuits. These connections terminate on associated equipment located on the miscellaneous relay rack, from which point they cable to either a No. 7, No. 9, or No. 10 service observing desk from which all line and complaint service observations are made.

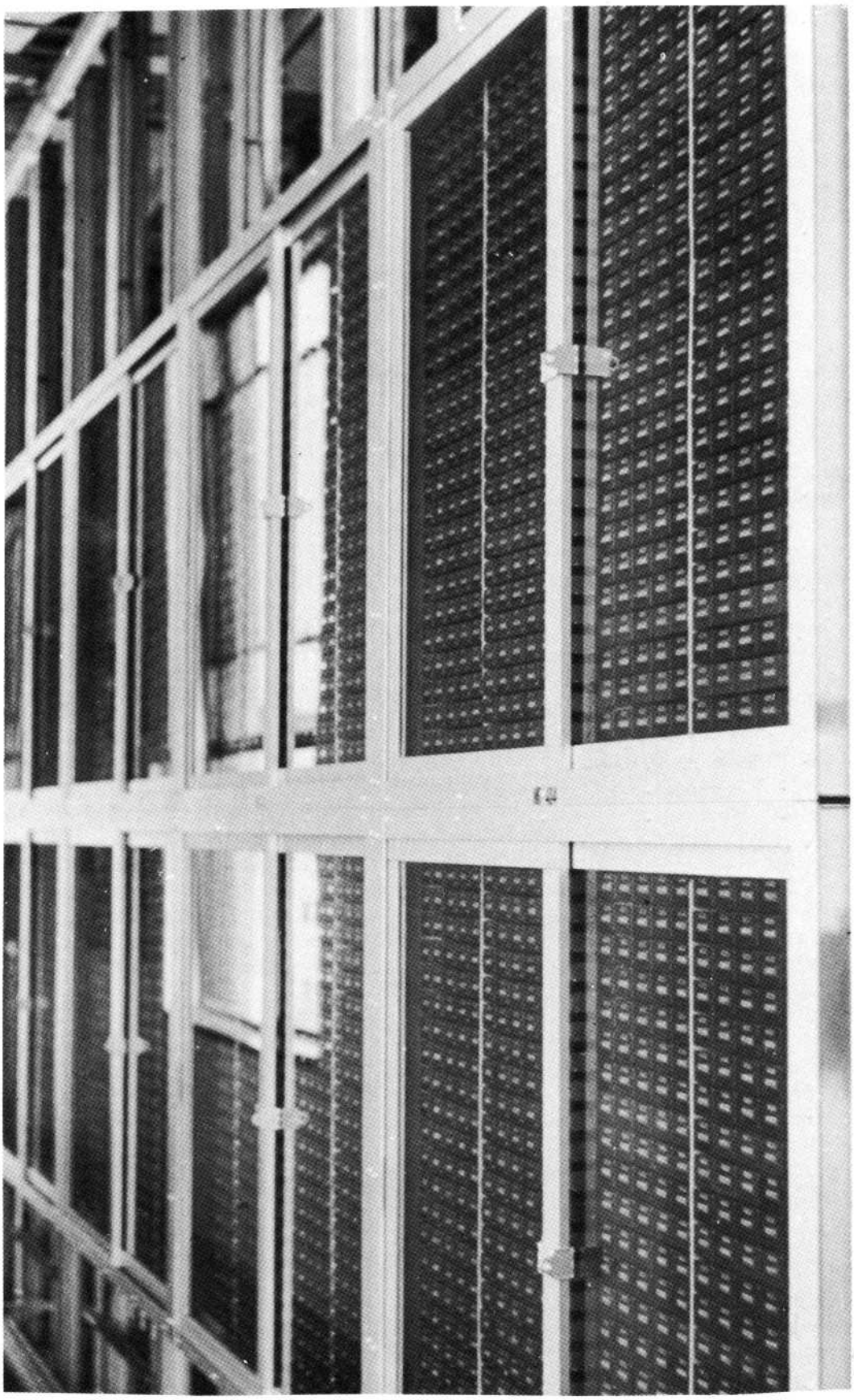


Fig. 63 Message Register Racks

If more than 39 cords are required in a central office, a second jack panel is provided which, if possible, is installed adjacent to the first panel. With this arrangement the jack field in the first panel will provide outlets for both sets of cords. If a second panel is installed in some other location, the jack field must be duplicated and in multiple with that in the first panel. If on the other hand the capacity of the jack field is to be increased, then two or more jack panels may be furnished and located adjacent to and in line with one another. The cords in the original panel will reach the jack field in adjacent bays to either right or left.

23. Message Register Rack

This rack is a two bay framework (Fig. 63) providing space for mounting 50 mounting plates per bay.

Ten message registers are mounted on each mounting plate with the framework and cabling so designed that one mounting plate may be moved forward at any time for the purpose of inspecting or cleaning the mechanism of the registers. The capacity of the message register rack is 1,000 registers, 500 per bay.

The rack may be furnished with or without casings. If casings are provided, it is standard practice to furnish two complete casings for each rack, one for the lower and one for the upper portion. Each casing is composed of a front half and a rear half, the former being equipped with glass panels, while the latter is metal.

The lower portion of each bay provides mounting space for miscellaneous equipment which includes: test line equipment (jacks, lamps, relays, condensers, resistances, and a buzzer), talking line equipment (jacks), battery and ground supply (jack), and recorders' talking lines (relays, resistances, and condensers).

The individual message registers are cabled to the line distributing frame either to the vertical subscriber number terminal strips in 100% message rate central offices or to message register terminal strips located in the miscellaneous portion of the horizontal side of the line distributing frame. With this latter arrangement, registers may be cross-connected to subscriber numbers on the vertical terminal strips in central offices where such full flexibility is desired.

These message registers register the total number of successfully completed calls originated by associated subscribers; at certain definite intervals, message register readings must be taken so that the subscriber may be billed properly. These readings or recordings may be made either visually or photographically. Visual recording is performed by a reader who is in communication with a recording clerk over a recorder's line circuit. Photographic recording is accomplished by actually photographing a certain number of registers with the use of a special camera. Cameras are available for photographing 10 or 25 registers at any one time. Negatives are developed and prints furnished to the Billing Department.

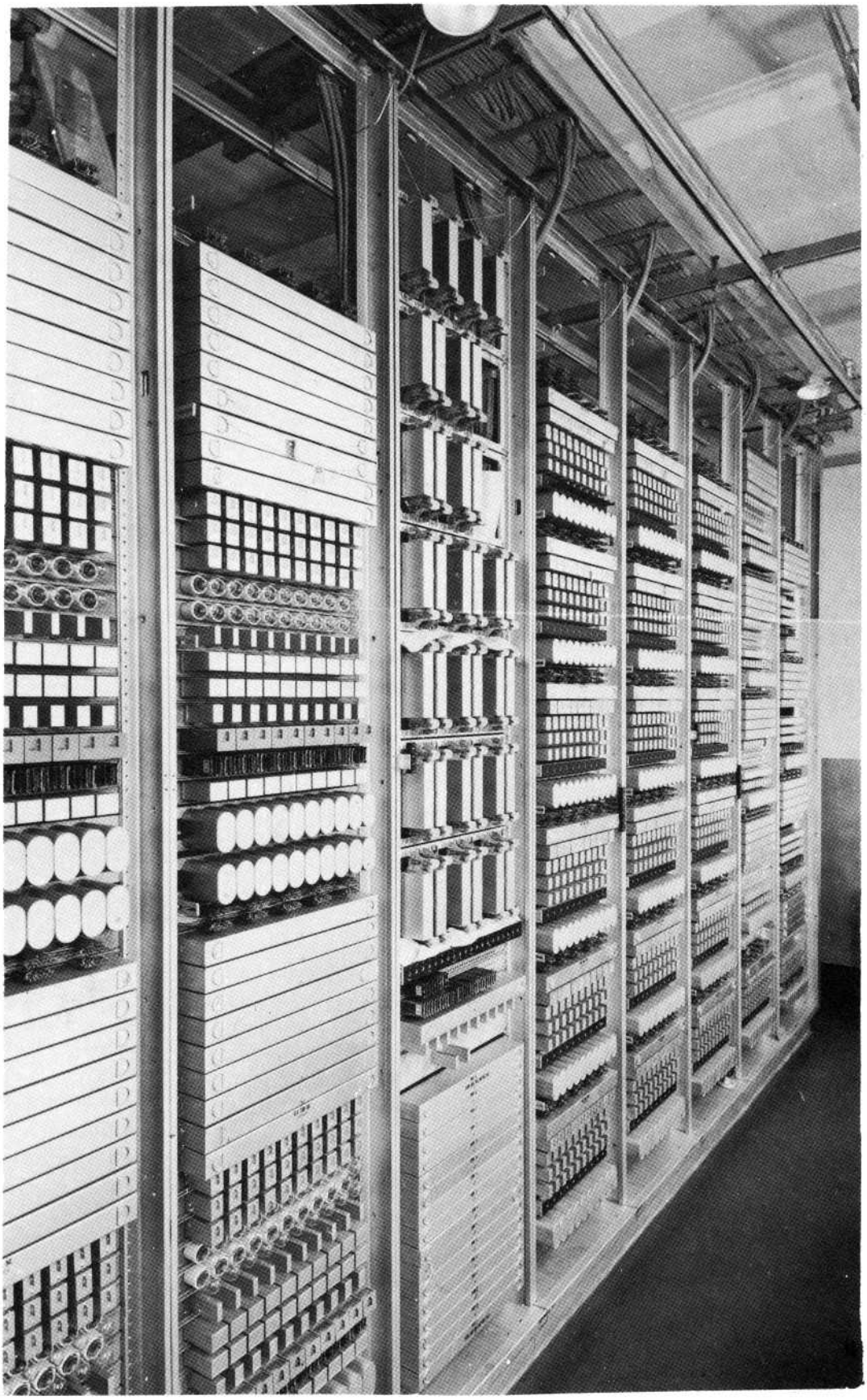


Fig. 64 Relay Racks

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24. Miscellaneous Frame

This frame consists of a single bay arranged for a capacity of 63 2" mounting plates, each 20-1/2" long. These bays provide mounting space for miscellaneous equipment units which for the most part are directly associated with and actually part of equipment associated with other frames. The reason for mounting units of this type on miscellaneous bays is due to the fact that mounting space is not available on the regular frames. These miscellaneous units consist of relays, condensers, resistances, terminal strips, and crossbar switches, and include the various sender selector units, coin supervisory units, number checking links, key pulsing number checking senders, no-test connector switches, key, jack and lamp panels, miscellaneous current supply units, subscriber sender link emergency control unit, a line link emergency controller unit, or a terminating sender link emergency controller unit - under certain conditions, and a fuse panel.

The arrangement of these various units on the miscellaneous frames is determined by consideration of such facts as the amount of equipment required, the floor plan, the relation of these frames to the associated equipment, future additions to the office, etc. For example, in order to minimize possible service reactions, subscriber and terminating sender selector units are spread over a minimum of 3 bays and for the same reason key pulsing sender and coin supervisory selector units, and coin supervisory units are spread over a minimum of 2 bays.

Miscellaneous frames in 1, 2, or 3 bay arrangements are distributed over the floors of a central office building so that a minimum amount of switchboard cabling will be required to associate this miscellaneous equipment with other frames. In many instances a single miscellaneous bay may be located at the end of each of several lineups, while in one or two cases it may be advantageous to combine 2 or 3 bays in one location.

25. Relay Racks

A relay rack is a one bay framework consisting of two bulb angle uprights and a bent steel base 10" wide, which permits lining up the rack with other crossbar frames in the same lineup (Fig. 64). Relay racks may be drilled for mounting different sizes of mounting plates, the one arranged for 1-3/4" x 23" plates having a capacity of 69 plates mounted one above the other.

In order that terminal strip equipment mounted on a relay rack does not project out beyond the guard railing, a 224 type terminal strip has been adopted for general use which makes relay rack units self-contained within the limits of the guard rail.

Equipment mounted on relay racks may be by individual mounting plates or by combinations of mounting plates arranged in unit assemblies. This unit type equipment includes miscellaneous incoming trunk circuits, outgoing trunk circuits, time alarm circuits, test trunk circuits, etc. Switchboard cabling terminating on relay rack equipment is brought down the rear of the right-hand upright of the bay and the butted cable carried through insulated openings in the cable-well type terminal strip mounting plate of each unit to the front of the terminal strips where the cable leads are soldered to the strip punchings. Local cables within the rack itself are connected to the rear punchings of a terminal strip and brought to the relays on the wiring side in the usual manner.

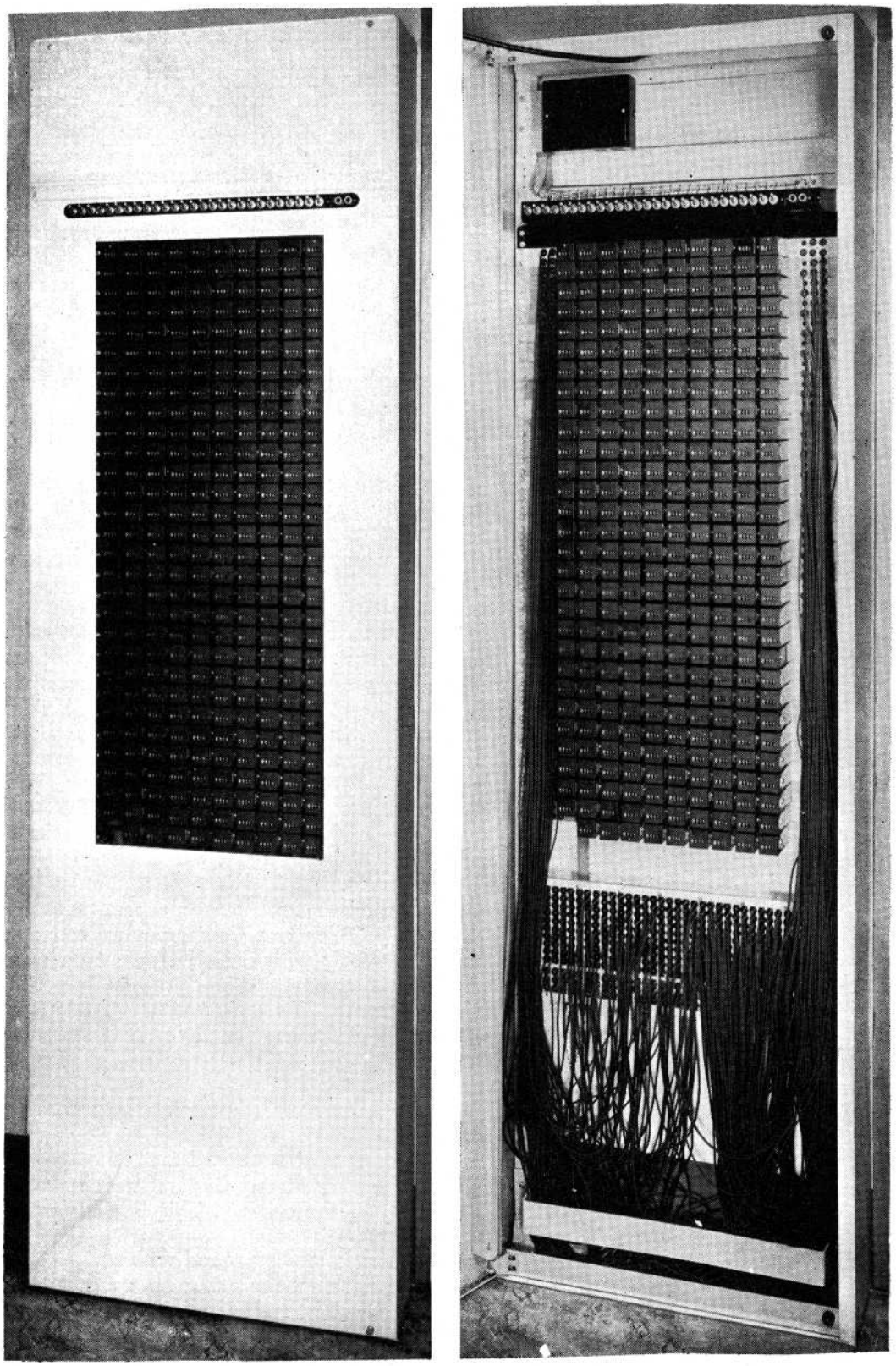


Fig. 65 Traffic Register Cabinet

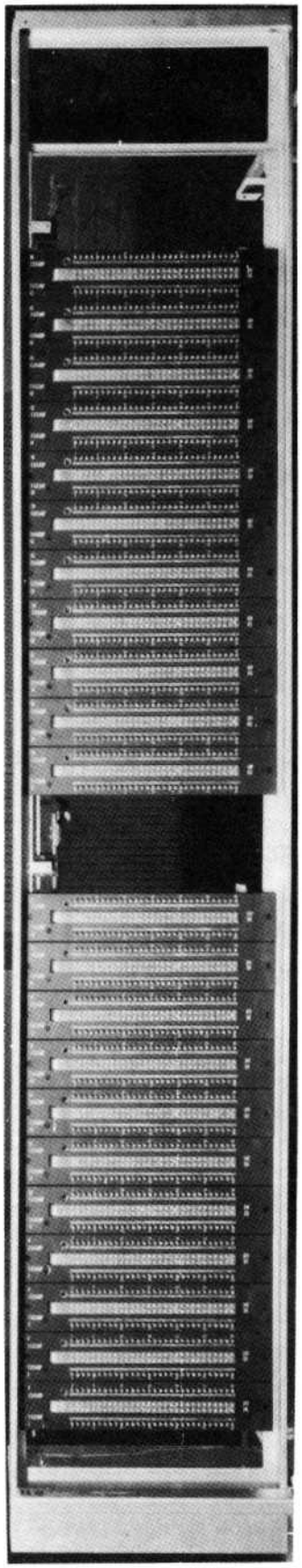


Fig. 66 Fuse Board

Occasionally unit equipment not specifically designed for the crossbar system is provided for use in a central office. These units will not mount on a standard crossbar relay rack and, as a result, adapters must be furnished.

Fuse panels and resistance lamps associated with relay rack equipment units are concentrated and mounted on standard relay rack bays which are called fuse boards. Fuse panels on the fuse boards provide for fusing the battery leads associated with the various units. Resistance lamps are a part of the ringing supply circuits. Fuse boards (Fig. 60) , while ordinarily located at the end of relay rack lineups, may under certain conditions be located centrally with respect to small lineups of relay racks.

Talking battery filters are located on the top of each fuse bay serving the talking battery fuse panels in that bay. Bays having less than 10 amperes talking battery drain may be connected to filters located in an adjacent bay providing there is enough excess filter capacity available there.

In general, there are no restrictions on the arrangement or layout of equipment on relay racks except for cabling convenience, keeping like equipment together, and locating mountings containing jacks, keys, or lamps at convenient heights from the floor.

26. Traffic Register Equipment

Traffic register equipment includes a traffic register rack, a traffic register relay rack, and a traffic register distributing frame. Provision is made on these frames for mounting the equipment necessary for obtaining overflow, group busy, peg count, delay, and load registration data on the various circuits in a crossbar central office.

a. Traffic Register Rack

A register rack is a supporting framework held to the floor by means of bolts in the base angles. It consists of a number of relay rack type bays, each bay providing a capacity for a maximum of 400 registers (Fig. 65). When magnetic counters must be accommodated, they are located at the bottom of the first and second register bays which results in reducing the register capacity of each of the bays, 30 registers for each 4 of the counters. If only one register bay

is provided on the job, all magnetic counters must, of course, be located at the bottom of the one bay.

Traffic registers are always of the same type and are mounted on mounting plates (10 per), which in turn are attached to the rack framework. The lower portion of the bay or bays, which are provided, furnishes space for locating the following equipment when specified: key mountings equipped with battery keys, associated with traffic register circuits used in connection with line link frame equipment; a second key panel equipped with battery and ground keys which are associated with traffic register circuits on frames other than line link frames; a direct recorder's talking line circuit or a dialing recorder's talking line circuit, depending upon whether the recording is done on an individual office basis or when centralized recording is employed; a pair of telephone jacks in a jack mounting to be located at the bottom of each register bay; one test battery supply circuit per bay; and when subscriber line overflow register equipment of the plug and jack type is specified, space is provided for mounting one jack panel for each 4 subscriber line overflow register circuits. A plug holder is mounted near the jack panel, one being required for each 8 equipped register circuits which serves as a receptacle for the plugs required as part of the jack panel equipment. Subset equipment is suitably mounted at the head end of the traffic register rack lineup.

Registers are numbered from left to right in succession, while the magnetic counters provided in any bay are numbered successively from 0 to 3 on each bay and in addition take the tens, hundreds, and thousands digits of the registers which they replace. For example, if a register bay is equipped with 4 magnetic counters and the maximum of 370 traffic registers, the counters would be numbered 4000, 4001, 4002, 4003, while the traffic registers would number 4030 to 4399.

The jack panel, which may be provided for subscriber line overflow registration, consists of five horizontal rows of jacks arranged in four horizontal sections, each of which is associated with a registration circuit. The upper four rows of jacks in a section are designated as TH, H, T, U, which provide a means of plugging up any subscriber number for this type of traffic registration; the lower row of jacks are designated as OS, which provides a means for office selection where the registration circuits are common to more than one central office unit. Each section of the jack panel consists of the same type of equipment which will allow for overflow registration on a number of subscriber lines at any one time.

Traffic register racks may be located in the operating room, in the terminal room, or in the wall separating the two rooms. If located in the operating room, casings are provided, glass in front and metal in rear, and all unequipped portions of the bay provided with dummy mounting plates or apparatus blanks.

b. Traffic Register Relay Rack

In general, one or more relays are associated with each traffic register. The equipment making up these register circuits is arranged in standard units and located on the traffic register relay rack. The relay equipment is permanently cabled directly to the various frames which it serves, with the exception of some trunk busy and trunk peg count circuits

which require flexibility between the relays and the frames, and to the vertical side of the traffic register distributing frame for cross-connecting to the registers.

In laying out the traffic register relay rack bay equipment, it is desirable that all circuits of one type be grouped; for example, the equipment for all peg count circuits should be grouped together. This is desirable from a maintenance standpoint and will also facilitate cabling with the traffic register distributing frame. When the relays associated with register circuits of one type occupy less than one mounting plate, they may be grouped on a single plate with like relays for other circuits, otherwise the relays for each type of circuit should be confined to separate mounting plates.

c. Traffic Register Distributing Frame

The new single-sided type of distributing frame is generally specified which has the terminal strips arranged vertically in the lower half and horizontally in the upper half (See Fig. 59). The relay equipment of the register circuits is cabled to the vertical side of the distributing frame, while the traffic registers are cabled to the horizontal side. Jumper connections between vertical and horizontal sides of this distributing frame can then associate any traffic register with any register circuit. This flexibility will facilitate changes in traffic assignments during the time interval in which equipment is being manufactured and installed as well as for the arrangements of the equipment due to additions. With this cross-connecting arrangement between registers and circuits, any register can be associated with any circuit and the reassignment of the registers can be accomplished simply by changing the jumper connections on the distributing frame. Each four verticals will generally provide facilities for cross-connecting 800 registers.

27. Floor Alarm Frame

This is a one bay frame arranged to mount the alarm relay equipment required for an average crossbar office (Fig. 62). Typical frame equipment layouts for the floor alarm frame show 52 plates of relay equipment for use in offices having manually operated power plants, while for use in offices having 301-C power plants they show 56 plates of relay equipment. Two rows of terminal strips are provided at the top of the frame for terminating the frame local cable and to provide strapping facilities for the association of alarm equipment in accordance with job requirements. Ordinarily, one alarm frame will meet the requirements for four floors of crossbar equipment which may serve one or more central office units. If the capacity of one alarm frame is exceeded an additional frame may be added and conveniently located.

A floor alarm cabinet (Fig. 67) is furnished for each floor and located as per Telephone Company specification, preferably near the chief switchman's desk or the maintenance center. This cabinet contains signal guard lamps for major frames, trouble lamps for miscellaneous frames and circuits which are not equipped with pilot lamps and alarm keys. These lamps and keys are associated with frames and frame equipment located on the same floor. Guard lamps are provided, one per type of frame or circuit on a floor, which function in connection with frame or circuit fuse alarm equipment.

For instance, if an alarm circuit is closed due to the operation of a fuse, an audible alarm will be heard, a lamp on the fuse panel will light, and a guard lamp in the floor alarm cabinet will also signal the blown-fuse condition. Removal of the operated fuse by a maintenance man will silence the audible alarm and extinguish the frame fuse alarm lamp, while the guard lamp in the alarm cabinet will remain lit until the frame circuit has been equipped with a new fuse. This feature provides a check-up on the replacement of operated fuses.

The power alarm cabinet is equipped with power alarm signal lamps, guard lamps, and keys and is mounted on the wall or column in the power room of central offices provided with manually operated power plants. In offices with 301-C power plants the alarm equipment is furnished as part of the power equipment and is mounted on the power board (Fig. 68). In offices with manually operated power plants where the ringing equipment is located in a terminal room away from the rest of the power equipment, a power alarm cabinet containing the ringing machine alarm lamps and keys is furnished on the same floor.

The alarm bell panel (Fig. 67) is of metal, wall or column mounted, providing space for mounting 2 subsets, 1 tone bar signal, and 1 bell. This equipment is normally arranged to give an audible signal in a case where trouble occurs in the equipment located on that floor. The relative seriousness of the trouble condition is indicated by the character of the audible signal. The tone bar (D) indicates a major alarm; one subset (MN) a minor alarm; and the other subset (AB) an alarm battery supply failure. A continuous vibrating stroke of the bell (PF) indicates a major power room alarm, while a repeated (60 per minute) single stroke indicates a power failure of lesser importance. Two alarm bell panels are generally furnished and installed at either end of the main cross aisle, on all floors with the exception of the basement, where only one panel is provided and located centrally. Aisle pilot lamps (Fig. 64) are placed at the end of a frame aisle to indicate trouble conditions on the frames in that particular aisle. The brackets which hold the lamp sockets are mounted on the frame end guard extending slightly into the aisle so that the lamps are visible from the ends of the main cross aisle. Aisle pilot lamps are of 4 different colors: red, green, white, and amber; each one indicating a different class of trouble. The red lamp (inside frosted) indicates a fuse alarm; the green lamp (clear glass) and the white lamp (inside frosted) indicate time alarms; while the amber lamp (clear glass) indicates a trouble condition registered in the test frames. In addition to these lamps main cross-aisle pilot lamps (Fig 64) are provided at each end of a cross-aisle where frame aisle pilots are furnished. Main cross-aisle pilot lamps include one of each of the following colors: red, green, white, amber, and yellow; the first 4 of which provide the same indications as those on the frame aisles, while the yellow lamp indicates a case of trouble on a floor other than on the one on which it is located.

Exit pilot lamps (Fig. 69) are provided at each exit on all the floors of a telephone building to indicate the floor on which a trouble condition occurs. On a particular floor one exit pilot lamp is provided for each of the other floors; for example, on the second floor of a building, yellow exit pilot lamps would be furnished for the basement, first floor, third floor, etc., omitting the second.

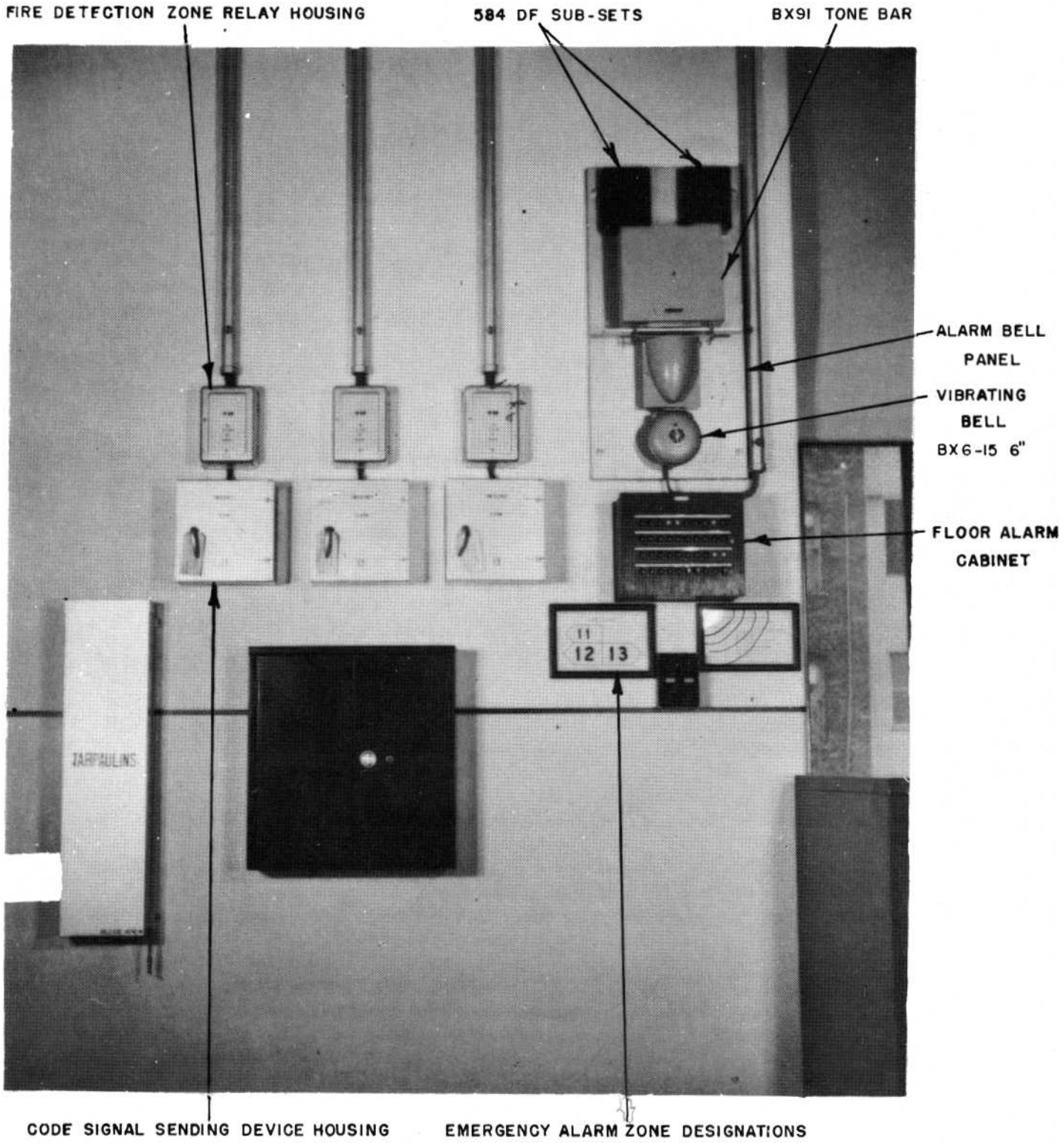


Fig. 67 Floor Alarm Cabinet and Alarm Bell Panel

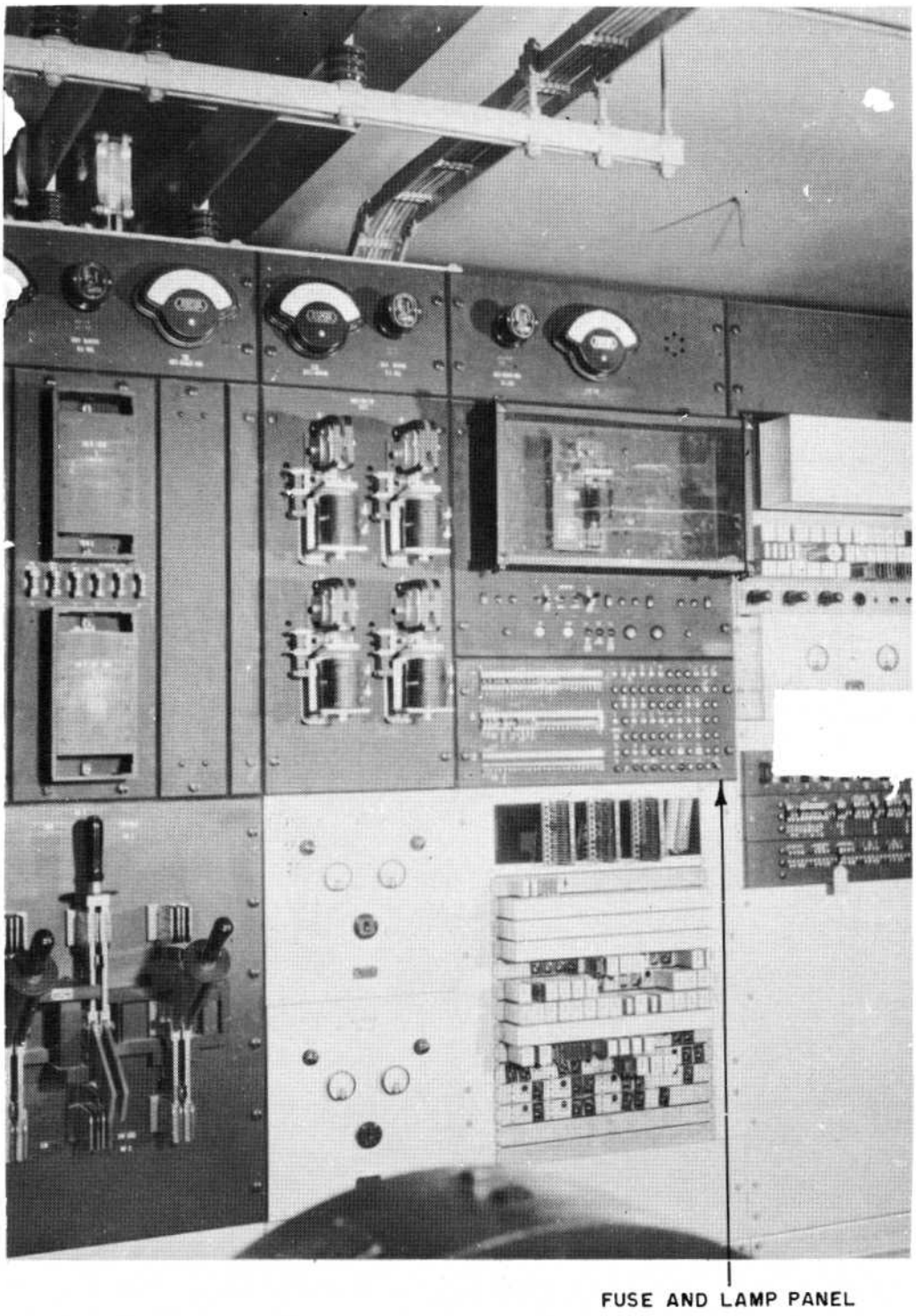
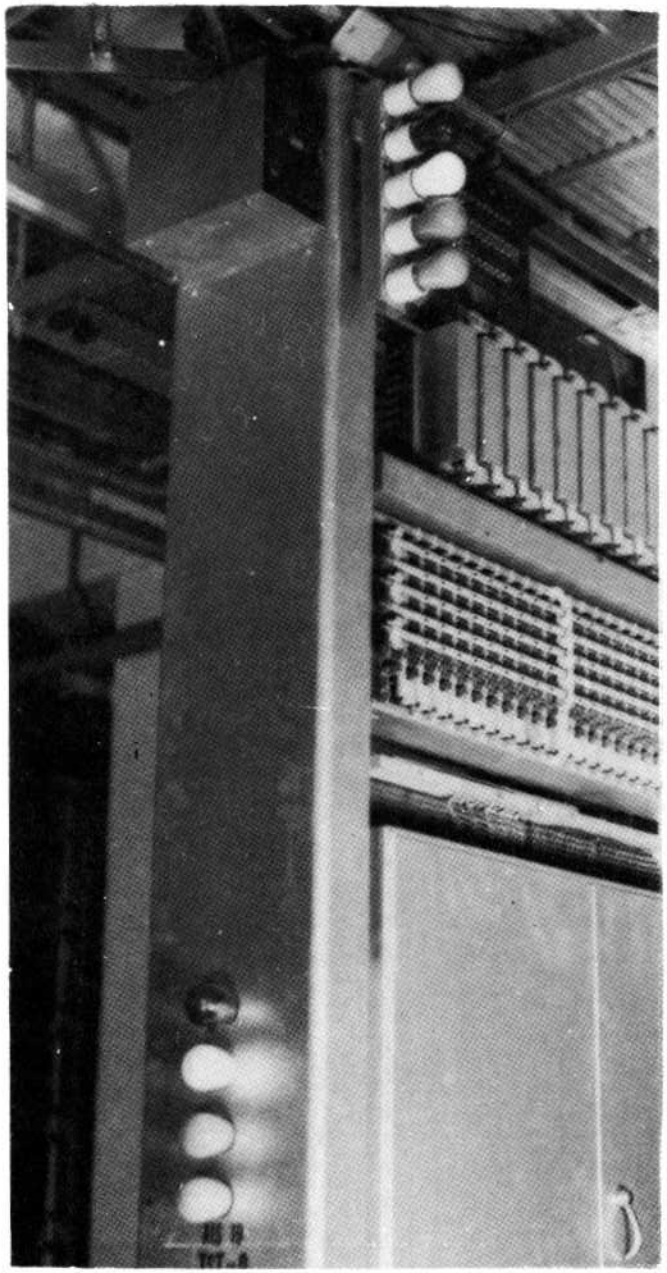


Fig. 68 Power Alarm Panel



Main Cross Aisle and Aisle Pilot Lamps

Exit Pilot Lamps

Fig. 69

28. Emergency Alarm System

Signaling and automatic fire detection is available, with or without codes, for use in crossbar offices to serve as a means of summoning assistance to a particular part of a telephone building in case of an emergency. In general, two systems are available: (1) arranged for automatic code signaling with or without fire detection, and (2) not arranged for automatic code signaling with or without fire detection equipment.

The alarm system with code signaling is available in two capacities, one of 20 code sounding and 30 code sending devices maximum, and the second of 40 code sounding and 50 code sending devices maximum. A code sending device must be specified for each fire zone in a telephone building (Fig. 67) so that the small and large capacity units will take care of 30 and 50 zones, respectively. Sounding devices are distributed throughout the building as required without regard to the zoning. The size or number of fire zones is determined by the shape of the building and the interior arrangement of walls or partitions. Codes or zone numbers are arbitrarily assigned and may be a combination of 1, 2, or 3 digits. A 2-digit code is the one generally assigned, the first digit indicating the floor and the second, the zone area in which the alarm is originated.

Sounding devices consist of either horns, gongs, or bells which are located throughout the area served. These locations should be near the ceiling and out in the open away from ventilating ducts or other equipment which might obstruct the sound. They should also be kept toward the interior of the building away from windows so as to minimize disturbance to adjacent properties. If horns are provided, they should be so installed that the direction of their output will give complete coverage for the area which they serve.

Code signal sending devices with or without remote control are required per zone and located within the limits of or near the zone served. The equipment for a code signal sending device is provided so that a particular code of pulses will be generated which will cause the sounding devices to indicate the number of the associated zone. In sending a code the sounding of each signal is of 1/2 second duration with a silent period of 1/2 second between signals of a given digit; the silent period between digits of a given code is of 2 seconds duration; while the silent period between the end of one code and the start of its repeat is 5-3/4 seconds. The completion of the sounding of the code is known as a cycle with the sending device operating through four cycles, three "repeats" and the original before automatically stopping. There is also a one second minimum silent period before the sending device sends the first signal. Thus, the code 1-4 requires 42-1/2 seconds to complete its four cycles and the code 4-9-2 would require 88-1/4 seconds to complete its four cycles.

Station boxes are fire alarm type switches encased in metal housings so arranged that the manual operation of the switch causes the code signal sending device to function. This alarm system is designed to be both non-interferring and successional. Should two or more alarms be sent in simultaneously or nearly so, one sending device will send its code and automatically shut out all other sending devices so that there will be no overlapping of signals and resultant confusion in alarms. By successional is meant that

should two or more alarms be sent in simultaneously or nearly so, one sending device will send its code immediately while the others await their turn.

Miscellaneous test and control equipment required by the system is designed to mount on a framework enclosed in front and rear casings. This unit mounts on a standard crossbar bay framework generally located in the maintenance center. Equipment includes miscellaneous relays, condensers, fuse panel, alarm lamps, and a special type of multi-contact relay. Emergency alarm equipment may be designed to include alarms coming in from distant unattended offices. Such an arrangement registers a trouble condition at a central point so that a maintenance employee may be rushed to the unattended office.

The automatic fire detection system consists of a fusible resin core solder wire covered with a loose red indicating braid which is attached to cable forms and racks on the various crossbar frames as required. The wire is connected in a closed circuit or loop throughout the entire building with a relay in the battery lead and another relay in the ground lead. The contacts of these relays are connected in series with the station zone loop. A trouble condition is indicated by the release of one or both of these relays which open the station loop and operate an alarm, thus giving the location of the disturbance. Fire detection wire is always specified for certain types of frames while on others only at the direction of the Telephone Company. On ordinary crossbar frames the fire detection wire is run horizontally through the middle of the frame and again across the top of the frame; the wire in all cases being well insulated from the iron framework. On distributing and junctor grouping frames it is generally applied to each horizontal shelf with the level on the bottom shelf serving to protect the vertical terminal strips which may be located in the lower portion of the frame as in the case of the line distributing frame.

Single zone or manually operated systems are also available which will require much less miscellaneous equipment but will serve as an emergency alarm system in units located in smaller areas.

29. Test Frames

Crossbar central office equipment includes a certain number of test frames which with one or two exceptions are located in a single lineup. The location of these test frames is designated as the "maintenance center."

Test frames are provided in such type and quantity so that all frame circuits may be tested for trouble indications. In some cases a test frame may be associated with the circuits on only one type of crossbar frame while in others one particular test frame may serve the circuits on several different types of frames.

The test frame is designed so that regular operating circuits may be selected and checked for proper operation by simulating actual service conditions with the equipment located on the test frames. Test frame circuits are also arranged to provide facilities for checking any particular circuit to which they have access, or the setup on the test frame may be such that one or more tests may be associated with a large number of circuits in succession. When trouble is encountered in a circuit under test,

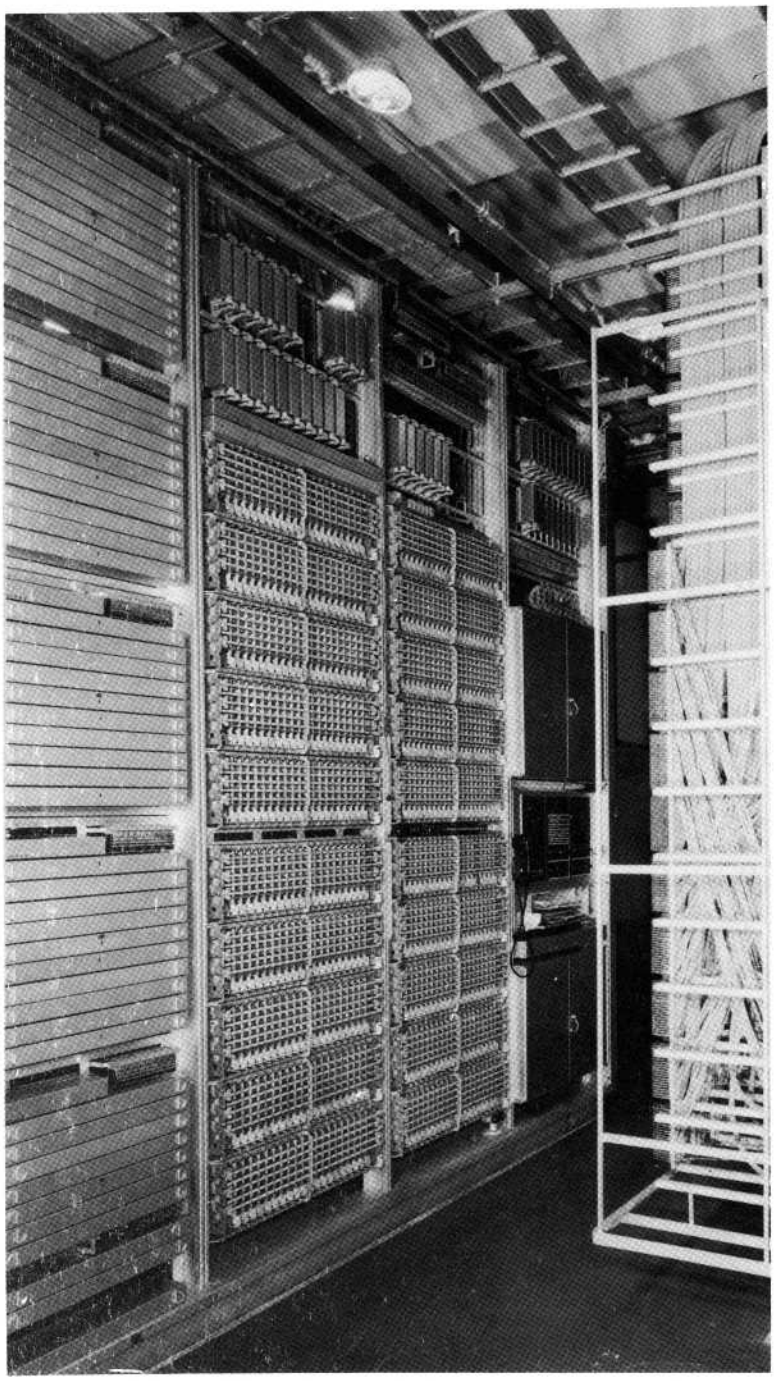


Fig. 70 District Junctor Test Frame (Right)

the test frame will stop at that point and close through audible and visual alarms, which will notify the maintenance man of a trouble condition. The particular lamp indication on the test frame will provide the maintenance man with information on the number of the circuit and frame involved, and also the condition of the circuit at the time the trouble condition was encountered.

The routine testing of the crossbar circuits in the central office provide means for detecting trouble conditions which otherwise would have to be picked up as regular calls were being set up. If trouble conditions can be remedied in the regular equipment, it means that the efficiency for regular service is greatly increased.

a. <u>District Junctor Test Frame</u>

This test frame is a single bay framework providing mounting space for a fuse panel, terminal strips, multicontact relays, 206-type selector switches, relays, registers, timers, key and lamp panel, a writing shelf, and ticket receptacle (Fig. 70). Some of this equipment is mounted on mounting plates which in turn are located on the bay and covered with a casing.

This type of frame is arranged to test a maximum of 2,000 district junctor circuits, of which 1,000 may be coin junctors, in any one originating marker group. In order that the switchboard cabling between this test frame and the frames containing circuits to be tested may be kept to a minimum, it should be located as closely as possible to the district junctor and district junctor grouping frames. For this reason this test frame will very seldom be part of the frames in the maintenance center.

The test circuit selects junctors individually or by groups for test purposes, makes repeat tests if desired, passes or waits for a busy junctor, times out and indicates trouble, generates dial pulses, tests as many as four different classes of calls (free, charge, operator, and zone) any or all of which may be arranged for by proper cross connection, tests the supervisory relays in the junctor circuit for correct operation under extreme conditions, checks for opens or breakdown condition in the transmission condensers, tests for proper operating conditions in connection with initial and overtime charging on two-party message rate lines, makes various checks on coin junctors such as polarity of the coin current provided for refund or collect and tests a junctor circuit for various class conditions such as free call, operator call, local charge, zone charge, and tip party charge.

A 100-point crossbar switch mounted on the subscriber sender link frame is used in conjunction with the equipment on the district junctor test frame to associate the test circuit with any one of the 100 district junctors wired into the sender link frame. Associated wiring is reduced to a minimum by mounting this crossbar switch on the sender link frame rather than on the district junctor test frame.

The test circuit of the district junctor test frame may be operated by remote control from any one of the district junctor frames. This remote control arrangement requires cabling from the test frame to each district junctor frame, at which point the circuit is jack-ended. A 32-A test set, which consists of one push button type key is attached to a plug-ended cord. This key can be patched to the test circuit through one of the jacks in any one of the district junctor frames. This remote control setup for controlling the action of the test circuit allows the maintenance man to visually check the operation of any particular district junctor circuit and control the test action by steps. This equipment is only furnished when specified by the Telephone Company.

b. Originating Sender Test Frame

This test frame is a two bay framework (Fig. 71). The left bay is equipped with two groups of "U" and "Y" type relays, each encased with a front and rear casing, ten 206-type selector switches mounted in a horizontal row, two horizontal rows of multi-contact relays, and four mounting plates for miscellaneous relay equipment. The right bay provides mounting space for a fuse panel in the upper portion of the frame, a maximum of two 200-point crossbar switches, some miscellaneous terminal strips, a group of "U" and "Y" type relays enclosed with a front and rear casing, a mounting plate equipped with several registers, a key and lamp panel, ticket receptacle, writing shelf, and in the bottom of the

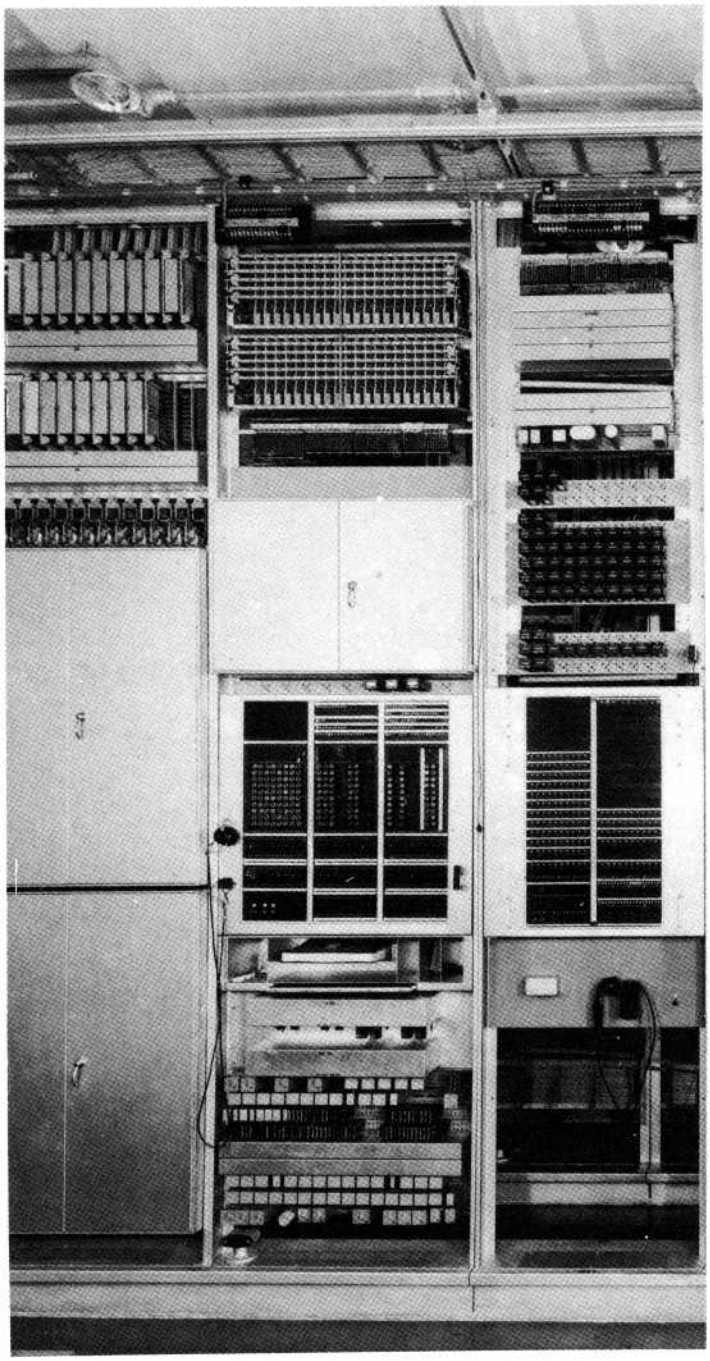


Fig. 71 Originating Sender Test (Left) and Sender Make Busy (Right) Frames

bay another group of relays, resistances, and condensers which make up a relay type interrupter circuit. This particular space is provided for the interrupter circuit to facilitate maintenance and to provide a location that is as free from vibration as it is possible to obtain. The relay equipment mounted in the left bay makes up the test circuit for testing subscriber senders while the relays in the upper portion of the right bay are associated with the testing of key pulsing senders.

This test frame has a capacity of 20 test sub groups of subscriber and key pulsing senders, with the equipment so arranged that this capacity can be increased to 30 sub-groups by means of an auxiliary originating sender test connector unit which is mounted on the sender test connector frame. These test sub-groups may consist of a maximum of ten subscriber senders or of a maximum of five key pulsing senders, the sender sub-groups always corresponding to like link sub-groups.

Sender sub-groups are cabled to the levels of the crossbar switches, one level serving one sub-group. One crossbar switch will then serve ten sender sub-groups or a maximum of 100 sender circuits. Connection is made from the test circuit to particular sender circuits by closing certain cross-points on the crossbar switches.

The test frame equipment is arranged on a circuit unit basis, that is, as far as practical, each separate function of the test circuit is provided for in a separate self-contained circuit unit. Some of the tests that can be made are as follows:

Audible tests of dial and disconnect tone.

Generates dial pulses for dialing into subscriber senders.

Simulates maximum and minimum line, pulse speed conditions.

Tests the sending of revertive and call indicator pulses.

Tests all the operating features of the senders plus associated auxiliary senders when arranged for direct distance dialing.

Tests the following operator class calls: "0" operator, full selector calls to 3 digit operator, restricted code, blank code, and permanent signal.

Records and checks the information which the sender under test transmits to the marker.

This sender test circuit is arranged to automatically test sender circuits. It may be connected to any particular sender for one or more tests or the arrangement may be such that one particular test may be placed on a number of senders in succession, or any number of tests may be placed on any number of senders in succession. When the test circuit encounters trouble on any of its tests it automatically stops at that point, closes circuits for both visual and audible alarms and can only be started again by the maintenance man.

The sender test connector frame, a single bay framework, is installed to the right of the originating sender test frame when required. It provides mounting space for an auxiliary originating sender test connector unit in the lower portion. The auxiliary originating sender test connector unit contains a 200-point crossbar switch, two terminal strips, three mounting plates of miscellaneous relay equipment, and ten multi-contact relays which when provided will increase the capacity of the originating sender test frame from 20 to 30 sender sub-groups.

c. Sender Make Busy Frame

This is a single bay framework (Fig. 71), containing a fuse panel, three terminal strips, a maximum of 200 trouble recording registers, a key and lamp panel, a mounting board arranged to mount a subset, induction coil, handset mounting, a buzzer or bell, and a group of mounting plates equipped with miscellaneous relays.

In general, there are three different types of sender make busy frames: one for use in offices where the subscriber senders are arranged for monitoring at the DSA switchboard; a second for use in offices where the subscriber senders are arranged for timed release with permanent signal trunks, vacant code trunks, and coin supervisory circuits terminated at the DSA switchboard; and the third for use with

timed release senders in offices not equipped with a DSA switchboard. With this latter arrangement, jacks and lamps associated with permanent signal, coin supervisory, coin vacant code, coin station ringer test, and coin test trunks to the local test desk are located in the sender make busy frame. Test trunks from the local test desk and a test circuit are provided for use in testing subscriber lines on calls routed to miscellaneous trunks as listed, and for testing coin lines on calls that cannot be released by the coin supervisory controller circuits.

Individual sender make busy jacks provided for subscriber, key pulsing, auxiliary, and number checking senders are used to remove a defective sender from service. Group busy jacks are also provided for subscriber, auxiliary and key pulsing senders so that all senders in a link sub-group can be made busy in the event of trouble development in the group or associated equipment. Group busy jacks are also provided for coin supervisory controller circuits so that all the coin supervisory circuits appearing in a link sub-group can be made busy. Trouble registers are provided to register the number of times line link controller circuits, subscriber sender link controller circuits, key pulsing sender circuits, and coin supervisory controller circuits are in trouble. Another group of registers are associated with subscriber, key pulsing and number checking sender link groups to indicate the number of "stuck sender" conditions. Link alarm lamps are provided in this frame so that trouble conditions in line link and subscriber sender link controller circuits may be indicated at a central point.

A telephone circuit similar to that furnished for maintenance desks and frames is provided with the sender make busy frame. Key-ended trunk and tie-line circuits are furnished so that the attendant may transact necessary business with the various other desks and switchboards in the building.

The sender make busy frame is in all cases located adjacent to its corresponding originating sender test frame because of its close association. The number of senders served by each of these frames is always the same and since their functions are more or less closely related the location of these frames adjacent to each other is the logical arrangement.

d. Terminating Sender Test Frame

This test frame consists of a single bay and contains a fuse panel, a maximum of ten multi-contact relays, a 206-type selector switch, one 200-point crossbar switch, miscellaneous terminal strips, "U" and "Y" type relays encased in front and rear casing, a mounting plate equipped with several registers, a key and lamp panel, a ticket receptacle, a writing shelf, and a second group of miscellaneous relays located in the lower portion of the bay with front and rear casings (Fig. 72).

This test frame is designed to function with 20 "B" positions and ten link sub-groups of terminating senders. A link sub-group consists of a maximum of ten senders which may be all full selector, all "B", or combinations containing both full selector and "B" senders.

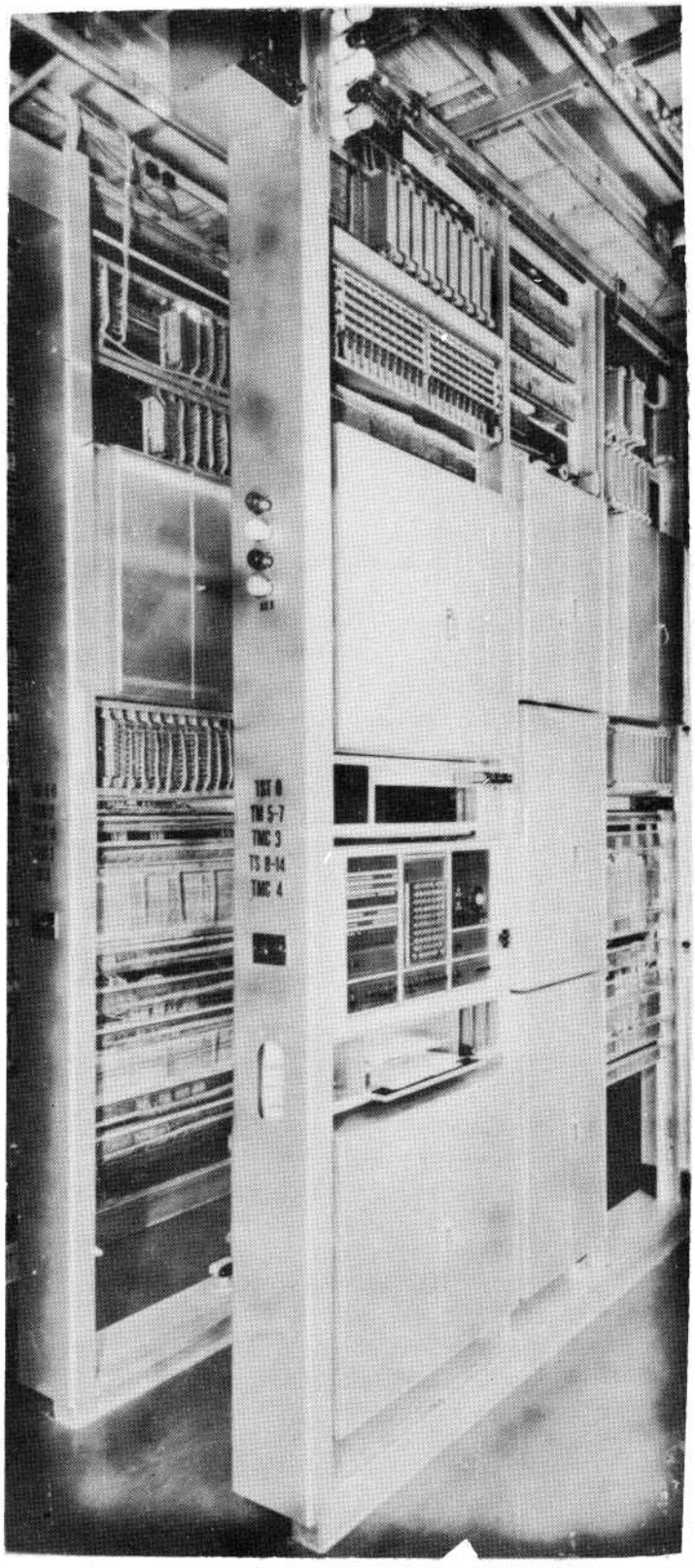


Fig. 72 Terminating Sender Test Frame (Left)

The capacity of the frame may be increased from 10 to 20 sub-groups of senders by providing an auxiliary terminating sender test connector unit which is located in the upper portion of the sender test connector frame provided for that purpose. This auxiliary unit consists of three mounting plates of miscellaneous relay equipment, three terminal strips, one 200-point crossbar switch, and ten multi-contact relays.

The test circuit has access to senders through a connector circuit which consists of a 200-point crossbar switch and multi-contact and "U" type relays, and to the "B" positions by means of two 206-type selector switches. One level on the crossbar switch is required for each sub-group of ten or less terminating senders.

In operation, senders may be tested individually or any number may be tested in succession. Single tests may be made and repeated or a number of tests may be made and repeated on any sender or group of senders. When trouble is encountered the test frame stops, brings in both audible and visual alarms which will notify the maintenance man that the test circuit requires attention.

The test frame equipment is arranged in circuit units which function to check the complete operation of the sender equipment.

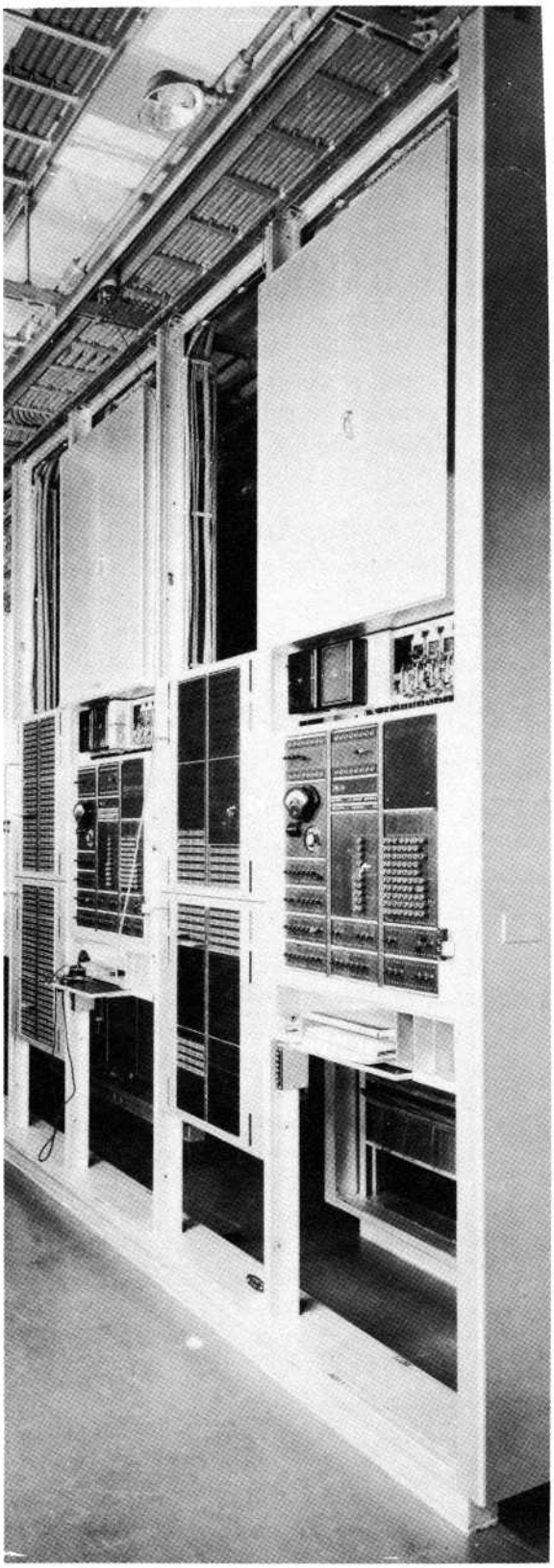


Fig. 73 Outgoing Trunk Test Frames

e. Outgoing Trunk Test Frame

This test frame consists of a minimum of two single bay frameworks which may be increased, depending upon the number of central office units in the building served by the frame. The left bay is called the test bay while the right is known as a jack bay (Fig. 73).

The jack bay provides mounting space for test and make busy jacks which are arranged in two panels, each having a maximum capacity of 1,000 jack pairs. Two horizontal rows of jacks are mounted in a jack mounting with the test and make busy jacks associated with one outgoing trunk circuit located in a vertical file. Space in the jack panel is assigned for 400 outgoing trunks per pair of office link frames in all cases. The 200 outgoing trunks appearing in the left field comprise the even marker test groups while the 200 in the right field include the odd marker test groups. Such an arrangement eliminates the need for a revision in the jack field equipment in cases where split levels on office link frames are converted to non-split and extension frames are added. These jacks are cabled either direct to the office link secondary switches or to the HMDF. If both panel and crossbar equipment are provided in an office and the outgoing trunks are common, the jacks in the test bay may be cabled to a distributing frame if cabling economy is to result from this procedure. Several jack mountings, each equipped with a maximum of four jacks, are also provided on this bay by means of which various test circuits may be patched to particular outgoing trunk circuits.

The test bay equipment includes three miscellaneous terminal strips, relays, resistances, and condensers located on 21 mounting

plates encased with a front casing, a miscellaneous mounting assembly (for locating subsets, buzzers, and a transformer), four 206-type selector switches, a key and lamp panel, a ticket receptacle, a writing shelf, one mounting plate for miscellaneous equipment, a jack mounting providing jacks for a frame telephone circuit, outgoing trunk telephone circuit, etc., and space in the lower portion of the bay for a terminating sender test selection unit which is specified on jobs where terminating senders are to be tested from the outgoing trunk test frame.

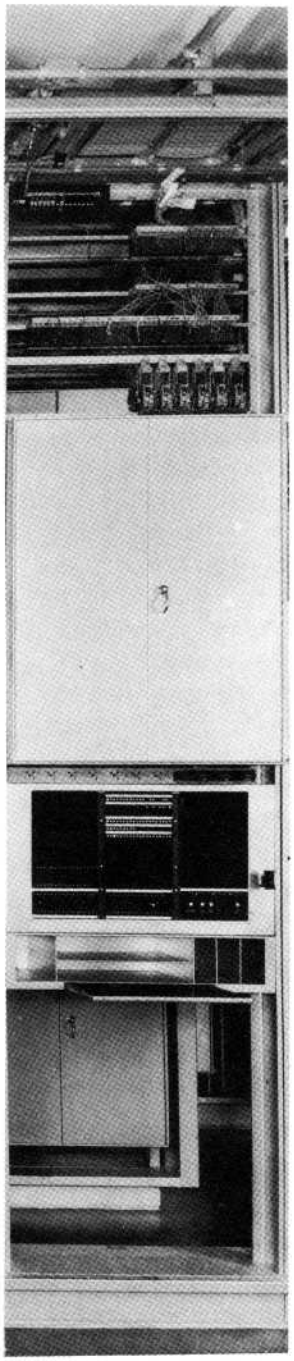


Fig. 74 Incoming Trunk Test Frame

The outgoing trunk test frame is used for testing all of the trunks outgoing from the office link secondary switches. These tests include voltmeter tests, insulation breakdown, routine testing of subscriber lines, etc. Provision is also made for the testing of incoming trunks from panel, tandem, toll, manual, and other crossbar offices. Connection to these incoming circuits is made by means of patching jack equipment located on the associated incoming trunk frame.

f. Incoming Trunk Test Frame and Incoming Trunk Test Connector Frame

This test frame consists of a single bay (Fig. 74) which provides mounting space for a fuse panel, several terminal strips, 206-type selector switches, registers, a key and lamp panel, ticket receptacle, a writing shelf, and a group of relays, condensers, and resistances arranged on 20 mounting plates, enclosed in a front casing.

The incoming trunk test frame is arranged to automatically test the incoming trunk circuits, including such tests as continuity and reversal of polarity, operation test of supervisory relays, etc. The test circuit obtains access to trunks for test by means of a connector which is located on an incoming trunk test connector frame.

The incoming trunk test connector frame consists of a single bay. A maximum of five test connector units may be mounted on this bay, each unit consisting of one 200-point crossbar switch, one mounting plate of "U" type relays, and two terminal strips arranged to provide a cross connecting field. Each one of these units has access to a maximum of 200 incoming trunks, any one of which may be associated with the incoming trunk test frame for test. The standard location for these two frames in an office is in the maintenance center with the test connector frame preferably at the right of the incoming trunk test frame.

g. Originating Trouble Indicator Frame

This frame is a single bay structure (Fig. 75) with space provided for mounting the following equipment: a fuse panel, ten terminal strips, miscellaneous relay equipment arranged on 17 mounting plates encased in a front casing, a mounting plate for locating a clock and a maximum of 16 trouble record registers, a key and lamp panel, a ticket receptacle, writing shelf, and additional miscellaneous relay equipment on 13 mounting plates enclosed in a front casing.

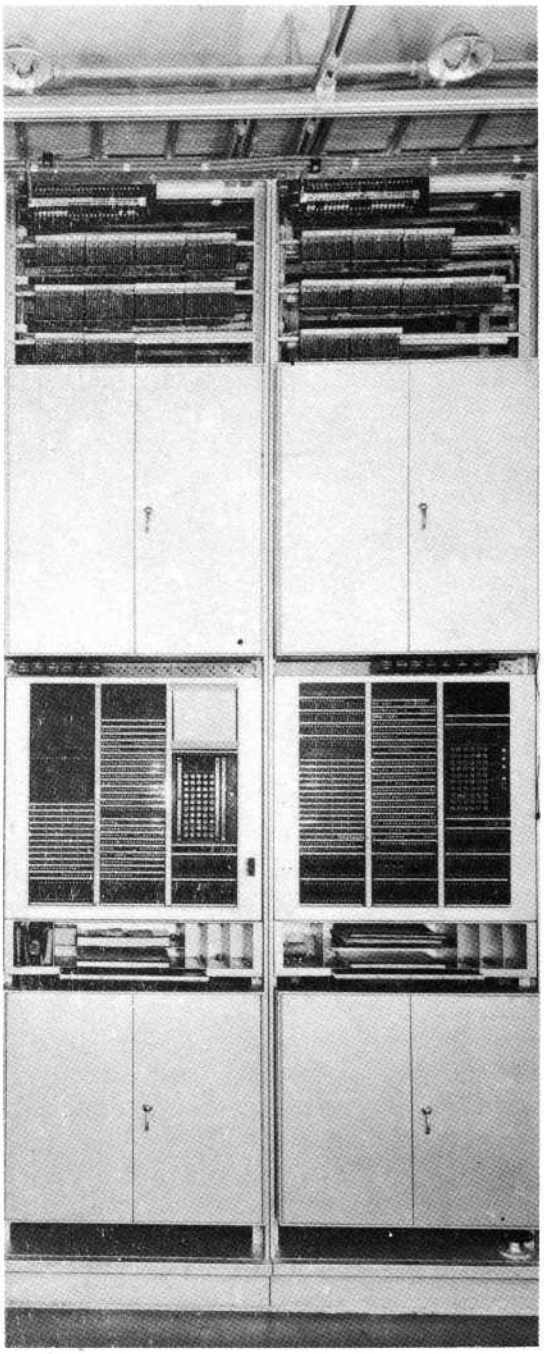


Fig. 75 Originating (Left) and Terminating (Right) Trouble Indicating Frames

The key and lamp panel assembly accommodates the various keys, jacks, indicating lamps, and designation strips required for two originating marker groups, each group consisting of a maximum of eight originating markers. Each marker group may be associated with a maximum of 30 originating marker connector circuits. Indicating lamps are provided for marker, marker connector, district and office link frames. Connector sender position lamps also form part of the lamp equipment located in the key and lamp panel. Make busy jacks are provided for making originating markers busy to all or to any particular originating marker connector, making the trouble indicator frame busy to originating markers, and for taking senders associated with the same originating marker connector out of service.

This trouble indicator frame is a combined maintenance and test frame used in a crossbar central office to facilitate the location of troubles in and to check the operation of the originating markers. The indicator frame takes a record of the information set up in a marker when it fails to complete its functions in a prescribed length of time. When it is used as a test frame, a test call is set up in the marker causing it to perform all of its functions and provides a record of the resulting translations in the progress of the test call. The results of such a test call are registered as lamp signals in the trouble indicator frame.

The equipment on the originating trouble indicator frame is connected to the other associated frames by means of switchboard cables which terminate on the terminal strips located in the top of the test frame.

h. Terminating Trouble Indicator Frame

This indicator frame is a single bay structure (Fig. 75), providing mounting space for a fuse panel, 10 terminal strips, 17 mounting plates of miscellaneous relays enclosed in a front casing, a mounting plate equipped with a 1-A electrical clock and a maximum of 10 trouble record registers, a key and lamp panel, ticket receptacle, writing shelf, and 13 mounting plates of miscellaneous relays enclosed in a front casing.

The indicator frame is designed to function with a maximum of 10 terminating markers, 18 terminating marker connectors, 100 terminating senders, 10 number checking senders, 20 incoming link frames, 25 number group connectors, and 20 line choice connectors. When two or three light traffic central office units are installed in the same building and one indicator frame is made common, the total number of terminating marker connectors may be increased from 18 to 20 with the maximum quantity of the other items remaining the same as stated above.

This frame may be used either as a maintenance or test frame. As a maintenance frame it takes a record of the information set up in the terminating marker when the marker fails to complete its function during a specified time when handling a regular subscriber to subscriber call. When used as a test frame a test call may be set up in a terminating marker allowing the marker to complete its functions and then taking a record of the progress of the test call.

The terminating trouble indicator frame receives information provided by the marker on indicating lamps which form part of the equipment in the key and lamp panel. Busy indication lamps are also provided for terminating markers, terminating marker connectors, terminating senders, incoming link frames, number group connectors, and line choice connectors. Hold jacks and trouble lamps are provided for number checking and terminating senders. Identification lamps are provided for each terminating sender selector unit. Make busy jacks, located in the key and lamp panel, provide a means of busying out various circuits.

The test circuit on this frame is arranged to register information from only one terminating marker at any one time. When the information has been registered both the audible and visual alarm circuit is closed which notifies the maintenance man of a trouble condition. If a second marker should want to write up information on the indicator frame before the trouble registration from the first marker has been cleared, a lamp indication would indicate to the maintenance man that a second marker had also been in trouble. From the lamp indication on the indicator frame, a maintenance man is able to locate the cause of the trouble within the limits of one or two particular circuits.

i. Zone Registration Test Frame

This is a single bay framework containing a fuse panel, three terminal strips, a maximum of six 100-point crossbar switches, one mounting plate equipped with condensers, resistances, message registers, and a timer, three mounting plates of "U" type relays, a key and lamp panel, ticket receptacle, writing shelf and 13 mounting plates of miscellaneous relays enclosed in a front casing.

This test frame with its associated equipment is able to provide testing features for a maximum of 300 zone registration circuits, which are reached by the test frame through the six 100-point crossbar switches, each switch being associated with 50 circuits. An additional 300 registration circuits may be associated with a second registration test frame in which case the two test frames are installed on a home and mate basis and arranged with an emergency transfer feature by means of which the entire 600 circuits can be associated with either of the test frames. This emergency feature is of special value on occasions when one of the test frames may be out of service due to a trouble condition.

The test circuit in this test frame provides for making the following tests on registration circuits:

Simulates the marker.

Checks busy conditions, including the automatic pass feature.

Times the busy and trouble time intervals.

Checks initial and overtime periods.

Counts the number of message register pulses for each charge.

Checks the current used for the operation of the message register, both for minimum value of current and minimum duration of pulse.

j. Talking Battery Supply Filter

A filter consists of two dry electrolytic condensers, a retardation coil, and two 15 ampere "Saf-To Fuse" units (Fig. 76), mounted on a metal panel, which in turn is fastened to the cable rack stringer over the particular frame with which the filter is to be associated. This equipment will filter signal battery current to provide a satisfactory talking battery supply. Each incoming trunk frame and each district junctor frame in an office must be provided with this filter equipment, for on a telephone connection between any two subscribers the district junctor circuit provides talking battery to the calling line and the incoming trunk circuit does the same for the called line.

Two 35-type alarm fuses are required for each filter, which are located on associated junctor or trunk units. These fuses bridge the Saf-To Fuse units located on the filter so that the operation of a 15 ampere fuse will also operate the 1-1/3 ampere 35-type fuse, thus

giving an alarm and providing an indication that the associated filter condenser has failed.

The filter is rated at 10 amperes but will carry current greatly in excess of this without injury to the apparatus, but with increasing load there is a corresponding drop in the filter efficiency.

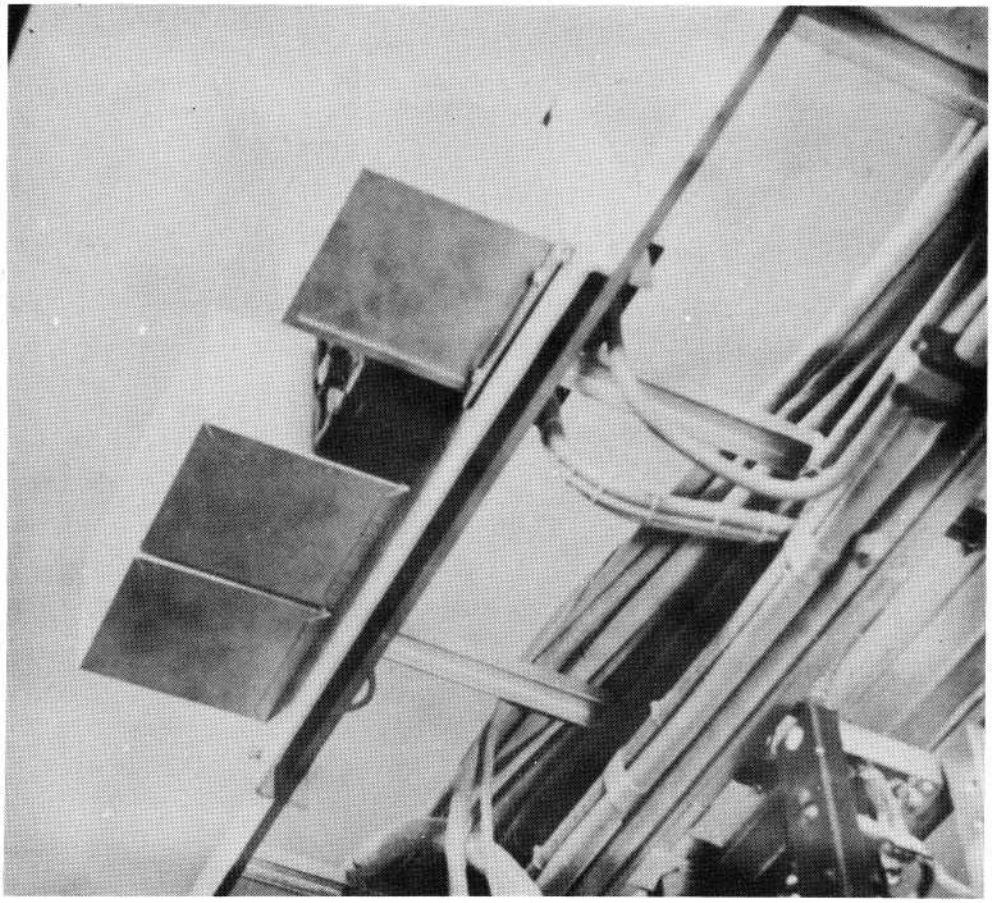


Fig. 76 Talking Battery Supply Filter

30. "A" Switchboard No. 15-D

This switchboard is available in two framework heights, 7' 8-1/2" and 6' 2", with the upper sections of nine panel width and three position keyshelves per section. The low type board (Figs. 77 and 78) is also available in single or two position sections. Positions may be equipped as follows:

Special service.
Combination (special service and intercepting).
Sender monitor and intercepting.
Observing.
Call distributing "B".

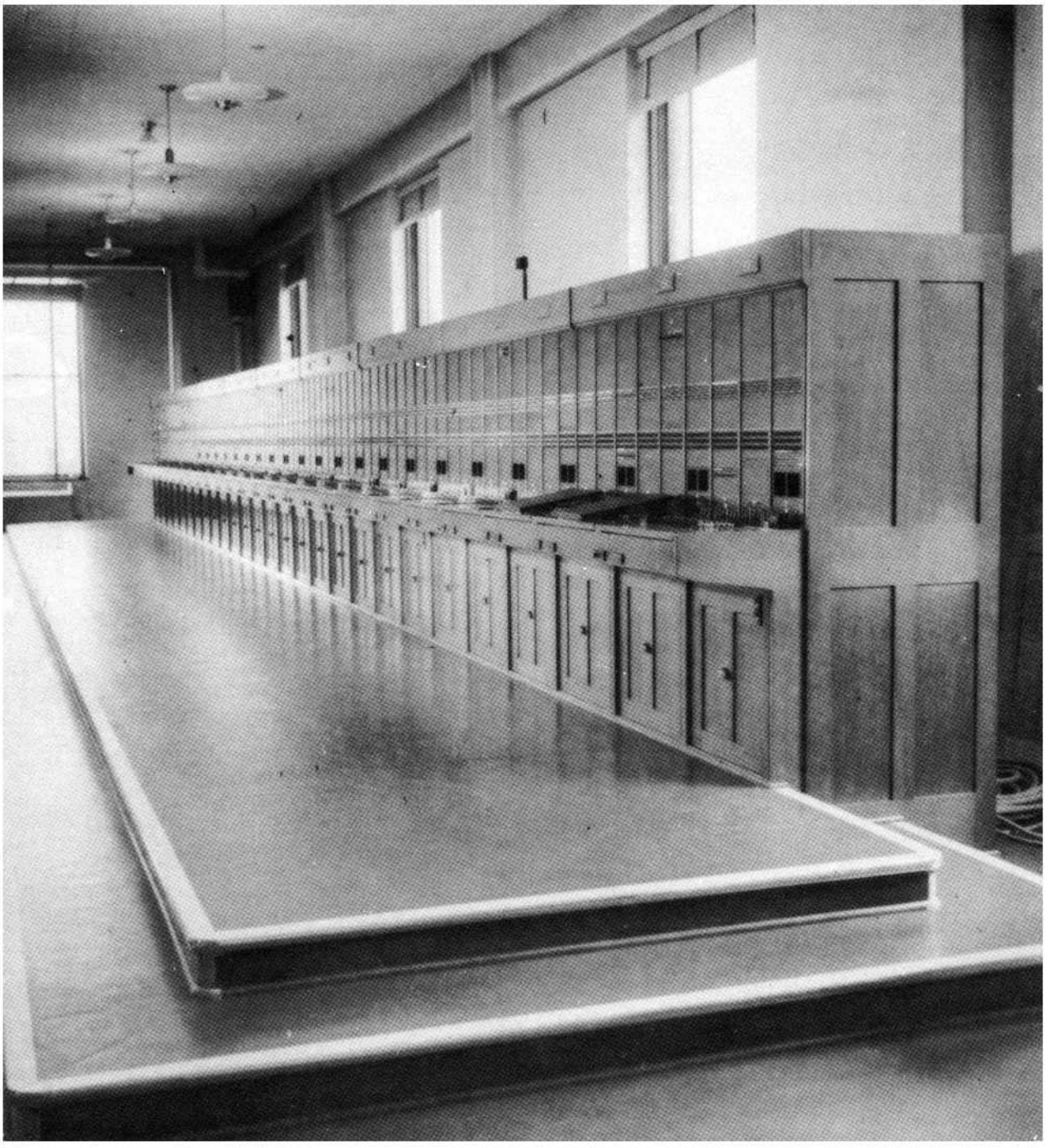


Fig. 77. Dial System A (DSA) Switchboard

Keyshelves are provided in 12 and 15 cord circuit capacities, with the relay equipment for 12 circuits mounted in the rear of the position, and that for the remaining three, on the relay rack. Positions handling toll traffic may be equipped with a maximum of two recording completing trunk circuits, and either a position clock or a calculagraph. The calculagraph is mounted on a separate shelf, which is put in place between pairs of positions, so that two operators may use the timing device in common.

Special service positions handle special service traffic including toll (AB and long distance), revertive calls, service complaints, calls for assistance in an emergency, calls to stations which do not answer or are persistently busy, and number checking on toll calls. In all of the above cases the subscriber is instructed to dial "0" or "Operator," the one exception being on long distance toll calls, in which case special code "211" should be dialed to connect the calling subscriber directly to the toll office. The call reaches the operator over a special service trunk selected by the regular dial originating equipment, which terminates in an answering jack and lamp in the switchboard. The operator answers by plugging the answering end of a cord circuit into the proper answering jack, and completes by (a) plugging the calling end into an outgoing trunk jack which routes the call over a trunk to the "B" board, where the "B" operator receives the proper information for completing the call, or (b) plugging into a jack associated with a trunk circuit which has access to dial completing equipment and obtaining the called number by key-pulsing direct from her position. Where all originating traffic requiring toll tickets is handled by the DSA board, the completion of calls to toll points beyond the limits of "A" board toll is provided for through trunks to "toll tandem" at the nearest toll center. Where long distance calls are not handled directly by the DSA board, a subscriber dialing "0" instead of "211," will be connected to the regular outward toll board in the toll center, over a recording completing trunk. Short haul or AB toll calls are completed by the special service operator over direct toll trunks to the destination of the call. Calls involving service complaints are routed to proper destinations over special trunks. The special service operator will in cases of emergency complete a call for a subscriber by the use of DSA board equipment. Verification of a busy condition on a subscriber line for a calling party can be made by the DSA special service operator by using special "no test" equipment. A call from one subscriber to another subscriber on the same party line is handled by the special service operator with special circuits provided for this feature. Automatic checking of calling subscriber numbers for toll call charging if specified, is taken care of by the special service operator setting up the toll connection. Before completing the toll connection, the operator operates a number checking key, then sets up the calling subscriber number on her keyset, the pulses generated being registered in a number checking sender circuit. A terminating marker completes a loop connection involving the sleeve of the calling subscriber line and all circuits set up into the DSA board. If the calling line and number correspond, a number checking lamp in the keyshelf of the DSA position will burn steadily as an "O.K." check; if the line and number do not correspond, the lamp will flash, indicating a no-check condition.

Combination positions are equipped for special service and intercepting service. Special service provisions are the same as explained for special service positions. Intercepting service involves the interception

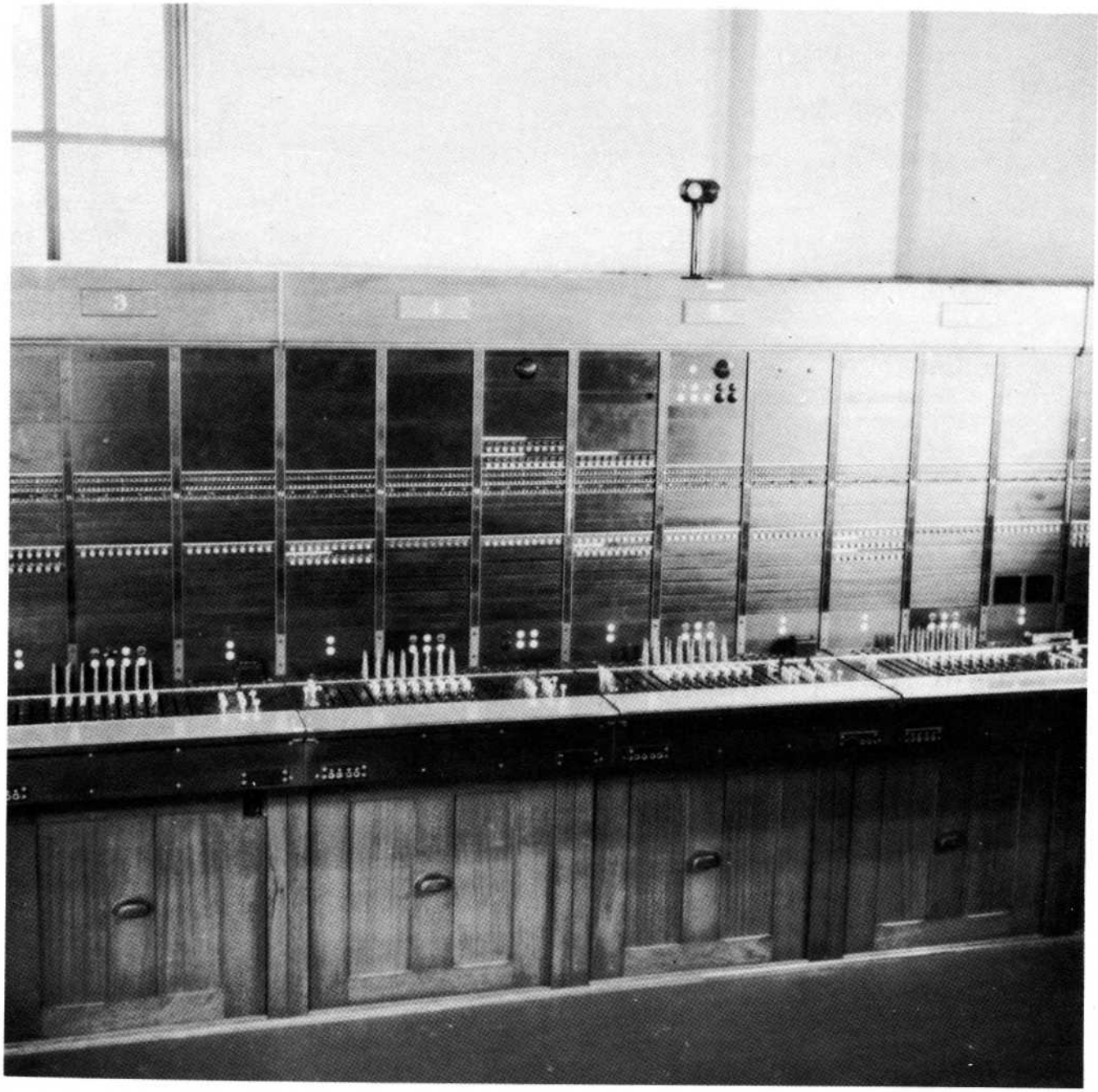


Fig. 78 Dial System A (DSA) Switchboard
Special Service Position

of calls being completed to vacant line terminals, to changed and disconnected numbers, to numbers being denied service, and to numbers whose associated lines are out of service due to a trouble condition. To provide for this service, an intercepting position circuit is required together with additional cord circuit equipment, the latter mounted on the relay rack. There are two general types of intercepting service, regular and trouble, each of which is further subdivided into local and toll. Calls which cannot be completed to subscriber lines due to denied service, line out of order, vacant number terminal, changed number, etc., are intercepted and routed to the intercept operator at the DSA board, who informs the calling line of the inability to complete the call.

Sender monitor positions are provided when the DSA board is serving a crossbar office which is equipped with subscriber senders arranged for sender monitoring. If subscriber senders encounter trouble in their operation when trying to set up a regular connection between two subscribers, the sender monitor operator is called in on the connection, and requests the calling subscriber to disconnect and dial again. The particular sender circuit involved can then be made busy, and the trouble condition cleared.

Observing positions involve one position, usually at the end of a DSA board lineup. Observing equipment in this position will always be only a small portion of the total, the remaining equipment involving other miscellaneous DSA board features. Observing equipment includes display indicators in the keyshelf which are associated with key monitoring cord circuits and used by the monitoring operator to monitor the key pulsing operations of the other DSA board operators and of the call distributing "B" (CDB) board operators. By putting up the proper connections, the monitoring operator can observe on any DSA or CDB board position, listening in on the conversation, and receiving the number keyed up at the position and the call-progress indications on the display indicators in her keyshelf.

Call distributing "B" positions may be included in a DSA board lineup if it is feasible to combine the two for regular operation, or one position may be included so that for night operation calls coming into a regular CDB board can be transferred to the CDB position in the DSA board lineup, with all "A" and "B" board service handled by one operator.

Occasionally when a manual central office is to be replaced by a crossbar central office unit, a number of subscribers may refuse the dial service. Such lines are connected to the DSA board for originating service, and the DSA board operator completes their calls for them through her DSA board equipment. Such lines are called dial terminated manual lines, for which special dial terminating manual line equipment is provided which is located on relay rack mounted units and cabled to the MDF and the DSA board. When one of these subscribers originates a call, the dial terminating manual line equipment operates to indicate a dialing of "0" to the subscriber sender, and the call is routed through the originating equipment in exactly the same manner as if the calling subscriber had actually dialed "0".

DSA switchboards are always required and associated with a crossbar central office unit. In heavy traffic areas, one DSA board may serve a number of units in the same building. In a light traffic area, one DSA board

may serve a number of units located in separate buildings. Whatever arrangement is provided, it is necessary that the customer should always have DSA board service available.

31. Call Distributing "B" Switchboard

The call distributing "B" switchboard (Fig. 79) is made up of two-position sections. The top of the unit slopes from rear to front at an angle of approximately 10 degrees, providing mounting space for a keyset, several lamps, and miscellaneous individual keys. A cable turning section is provided at the head end of the lineup of switchboards, the top of which furnishes mounting space for "calls waiting" lamps. Position equipment in the form of relays, resistances, and condensers are mounted within the section framework.

Calls from manual subscribers, from DSA switchboard operators, from local test desk positions, etc., are completed by the CDB switchboard operator. Incoming calls are routed into the crossbar terminating equipment over particular types of trunk circuits. The incoming trunk circuit involved on a call of this type indicates to the terminating sender link frame that a "B" sender is to be selected. The "B" sender then causes the "B" position finder to provide the next idle "B" position. Two zips of tone are then sent to the originating end of the call as an indication that the called number may be passed to the CDB operator. The "B" operator, on receiving the number, keys it up on her keyset, registering the number in the "B" sender. The "B" sender then calls on a terminating marker connector to provide an idle terminating marker. As soon as the keyed-up number has been registered in the sender, the "B" position is detached from the call and its equipment returns to normal, awaiting another incoming call. The terminating marker completes the call in the usual manner.

The central "B" switchboard uses the same section as the regular CDB board, and is designed to serve a number of individual central office units in urban areas where the amount of switchboard traffic is light. A new central "B" sender must be provided to work with the central "B" board, which consists of a "terminating part" and a "switchboard part." The latter part acts on the originating end of a call, while the terminating part is required in the central office of the called number.

32. General

The depth and spacing considerations for crossbar frames in a telephone central office building are considerably less exacting than in other systems due to the design and arrangement of the equipment on the frames. The placing of the equipment between, rather than projecting from the front or rear of the uprights, has resulted in a reduction in the permissible depth of the frame. Since all crossbar equipment is mounted on single-sided frameworks the frames are placed in paired rows, (Fig. 80). With this arrangement the least frequently worked on, or wiring sides of the frames, are placed opposite each other, with the more important equipment sides of two rows facing a common aisle, thus permitting the minimum width wiring aisle. Such an arrangement provides accessibility for maintenance and affords economy of space.

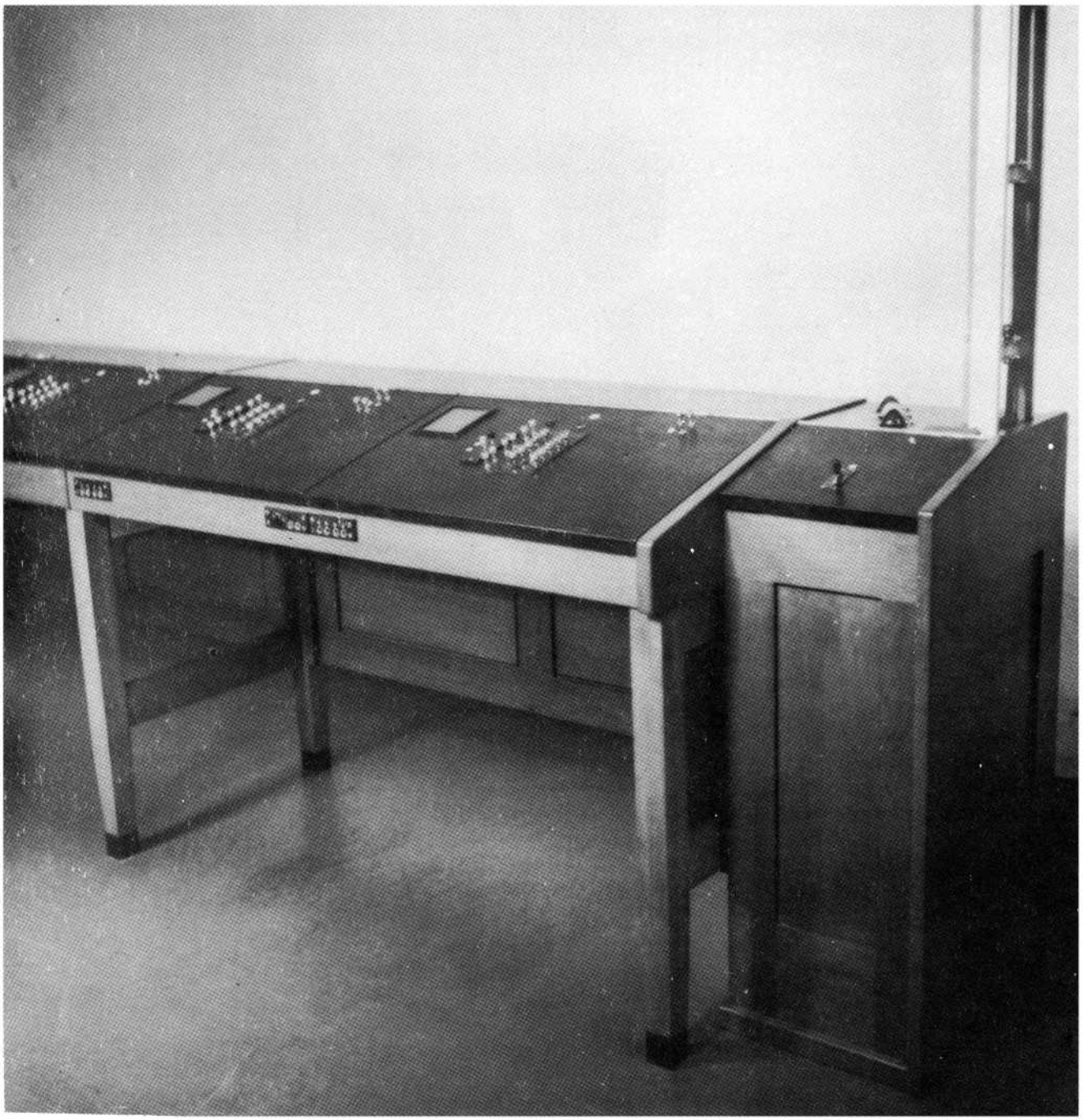


Fig. 79 Call Distributing "B" Switchboard

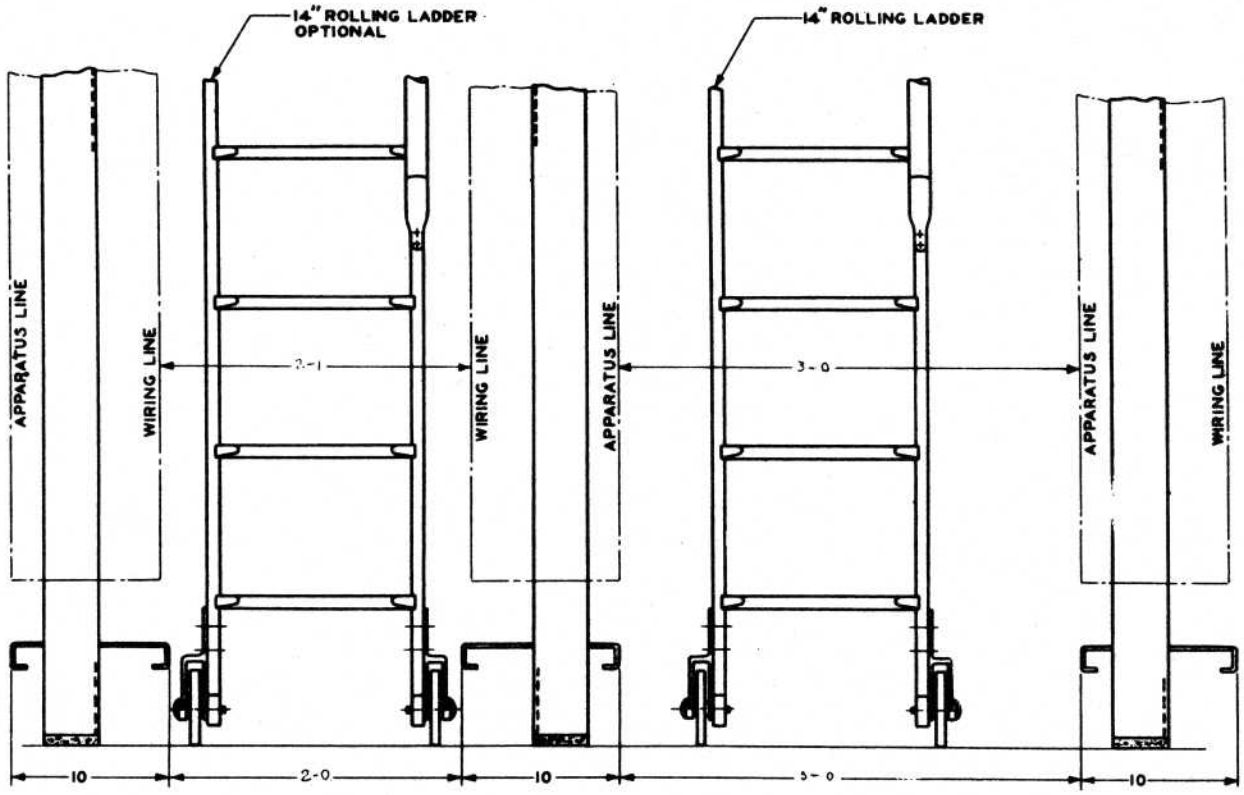


Fig. 80 Width and Spacing of Crossbar Dial Frames

Section 5. Operating Features

Dial systems in general use today all employ mechanical motion for the various switching functions; this motion being controlled by magnetically operated ratchets or by power-driven rods or shafts, to impart rotary or linear action. The Crossbar dial system also employs mechanical motion for the switching function, but this motion has been greatly reduced so as to be comparable to that required to close or open contacts in telephone relays. Power-driven equipment in this system will include only the power machines, reciprocating bar interrupters, and the timing mechanisms used for the timing of calls.

The crossbar switch is the principle switching device employed in the Crossbar dial system, and by means of various arrangements and combinations of this switch, various traffic and circuit requirements can be met. Crossbar switches are also employed as registers in the originating and terminating sender circuits, vertical units being used for registering the impulses for each digit dialed.

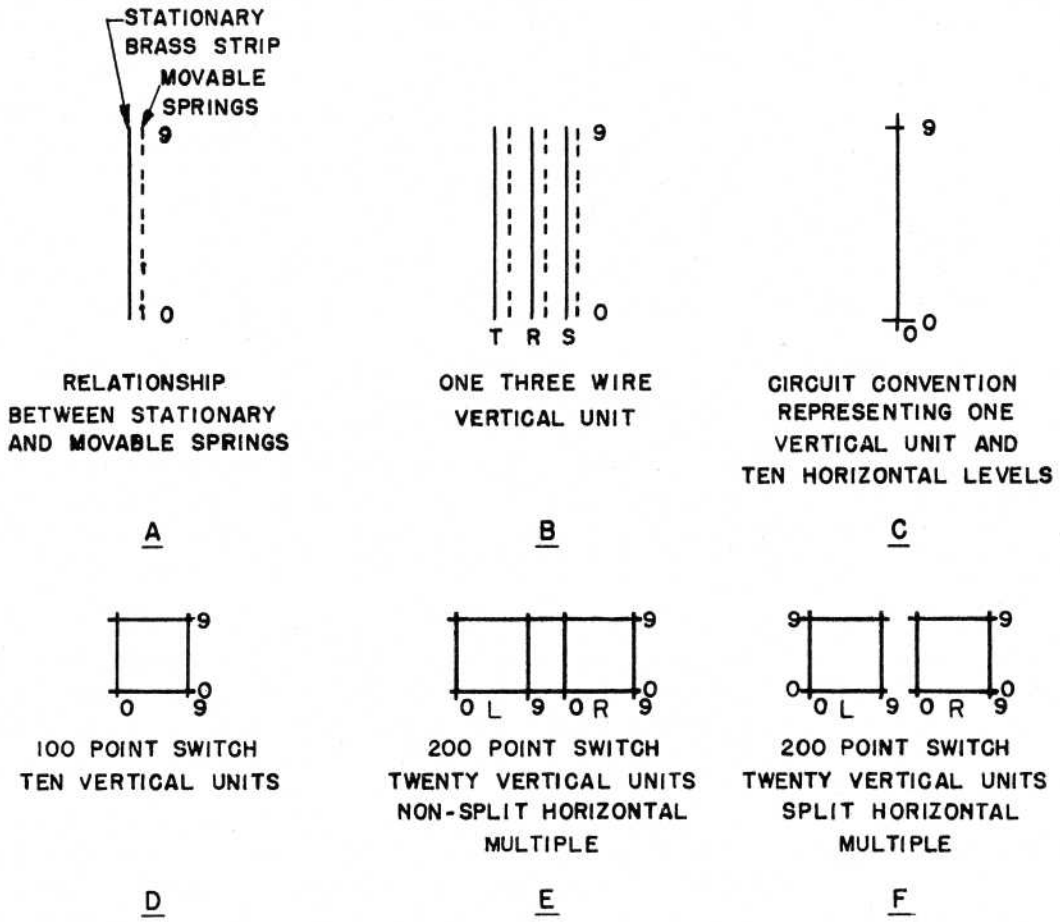


Fig. 81

CROSSBAR SWITCH CONVENTIONS
EQUIPMENT VIEW

1. General Trunking Plans

The crossbar switch vertical unit consists essentially of 10 levels of spring combinations, each level containing either 3, 4, 5, or 6 spring pairs. Each spring pair in a level is made up of one movable and one stationary spring arrangement, the movable springs being individual and the stationary springs being represented by a vertical brass strip which is common to the spring pairs in a vertical file. Fig. 81-A shows this relationship, with Fig. 81-B representing a 3-wire vertical unit, which required 3 spring pairs per level. Fig. 81-C diagrams the circuit convention used to represent one vertical unit with its associated 10 levels, the levels numbering from 0 to 9, bottom to top, with the first and last levels only shown.

Fig. 81-D represents a 100 point crossbar switch, with the first and last of its 10 vertical units and the first and last of its 10 horizontals or levels shown. Vertical units in a 100 point crossbar switch are designated 0 to 9 from left to right, looking at the equipment side. The 10 levels of each vertical unit are shown multiplied horizontally, so that leads wired individually to the vertical units could have access to leads wired to any one of the 10 levels, by the proper coordinated operation of the associated selecting and holding magnets. Such a multiple strapping arrangement across the 10 vertical units of an entire crossbar switch, provides for a 10 to 10 ratio of paths between vertical units and levels.

A 200 point crossbar switch consists of 20 vertical units, which will have common access to any one of 10 levels, if the levels are strapped common to all verticals (Fig. 81-E). The 20 vertical units in a 200 point crossbar switch are numbered 0 to 9 L for the 10 on the left, and 0 to 9 R for the 10 on the right half of the switch. Levels are numbered 0 to 9, bottom to top. With this arrangement, a 20 to 10 ratio of paths from vertical units to levels would be possible.

The multiple field of any crossbar switch may also be divided into two or more sections by omitting or cutting the strapping between any two vertical units, which is called a split horizontal multiple. Fig. 81-F shows a 20 vertical unit (or 200 point) crossbar switch with the horizontal multiple split or cut between the 10th and 11th vertical units, providing two equally alike multiple field sections or trunking fields, each section of the switch having a 10 to 10 ratio of paths from the vertical units to the levels.

Fig. 82 represents schematically one vertical unit, with incoming T, R, and S leads wired to levels and outgoing T, R, and S leads wired to verticals; or incoming circuits to make springs and outgoing circuits to the common stationary strip. Levels 0 and 9 are shown, with associated select magnets, and the hold magnet for the particular vertical unit.

A circuit may be connected to either the vertical or the horizontal multiple of the switch. The connection used is dependent on the advantages of one over the other from traffic, circuit, and equipment points of view. The trunking capacity of an individual switch is limited to 10, which can be increased to 20 by splitting the horizontal multiple. To further increase the trunking capacity and to provide a more efficient trunking network, the crossbar switch is used in a tandem arrangement in each of the major link frames.

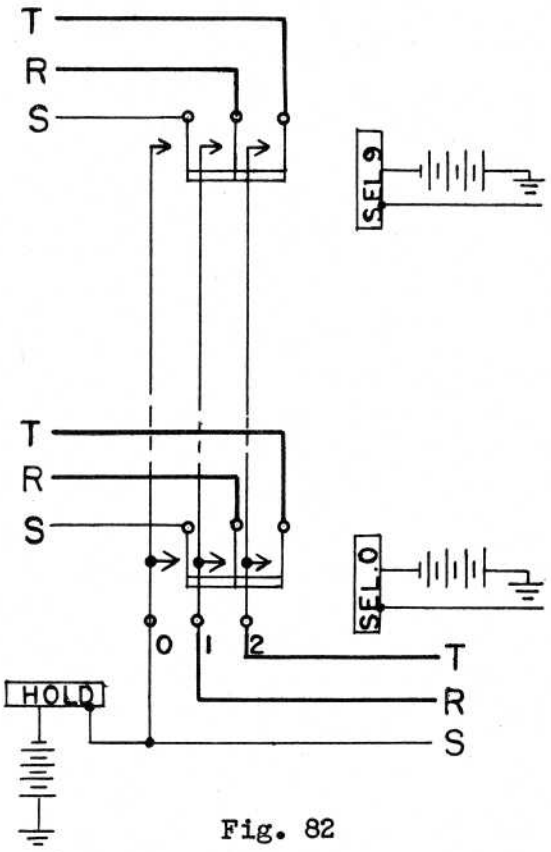


Fig. 82

SCHEMATIC OF ONE VERTICAL UNIT

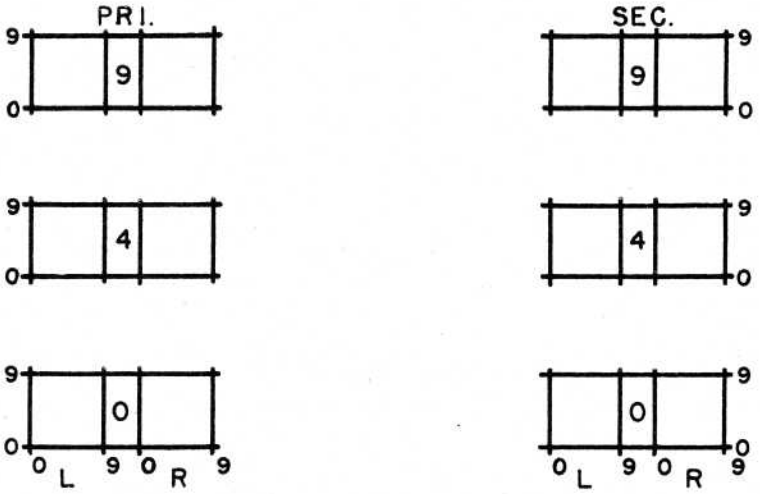


Fig. 83

TANDEM OR PRIMARY-SECONDARY
GROUPING ARRANGEMENT
OF CROSSBAR SWITCHES
ON FRAMES

The tandem grouping of switches shown in Fig. 83 is the standard arrangement for the majority of crossbar frames. Referring to Fig. 83, two vertical files, each mounting 10 crossbar switches, are placed side by side on a two-bay framework. The switches in each vertical file are numbered 0-9 bottom to top, and the vertical units in each switch are numbered 0-9 (L) for ten vertical units on the left and 0-9 (R) for the ten vertical units on the right for 200 point (or 20 vertical unit) switches. The usual designation of switches is "primary" for the left file and "secondary" for the right, although on some frames this is reversed. These "primary" and "secondary" designations do not necessarily indicate the functional use of the switches in any operating association. In the subscriber and terminating sender link frames, the ratio of "primary" to "secondary" switches is different as mentioned above, for the former 10 to 5 and for the latter 3 to 3. The use of crossbar switches in such a tandem arrangement provides a means of saving equipment by increasing trunking efficiency through the use of large trunk groups, and of increasing the flexibility of the equipment.

The paths between the primary and the secondary switches within a particular frame are referred to as "links", while the inter-frame connections, with one exception, are called "junctors." The inter-frame path between office link and incoming trunk frames is the exception, and is referred to as an outgoing trunk from the office link end, and as an incoming trunk from the incoming trunk end.

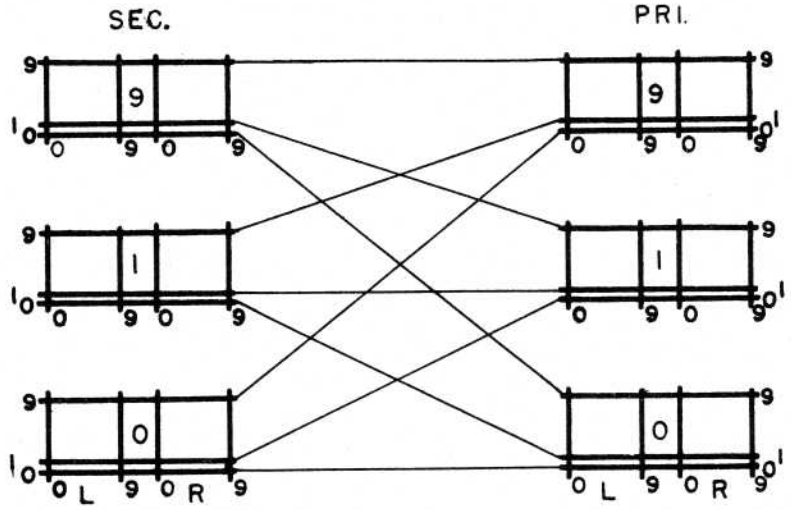


Fig. 84

LINE LINK FRAME

PRIMARY-SECONDARY LINK SPREAD

Fig. 84 illustrates the linking arrangement employed between primary switch horizontals or levels and secondary switch horizontals or levels on the line link frame. The method of connection is termed a "spread," and in the case of the line link frame, the spread is from "horizontal to horizontal," that is, from primary switch levels to secondary switch levels. Levels 0 to 9 on originating unit primary switch 0 are connected to the 0 levels of secondary switches 0 to 9; levels 0 to 9 on originating unit primary switch 1 are con-

nected to the 1 levels on secondary switches 0 to 9, etc.; levels 0 to 9 on originating unit primary switch 9 are connected to the 9 levels on secondary switches 0 to 9. With such a link spread, any subscriber line connected to any primary vertical unit will have access over one link connection to each of 10 secondary switches, which are associated with 100 district junctor and 100 line junctor circuits, the former routing traffic out of the frame and the latter routing traffic into the frame. District and line junctor circuits can be grouped very efficiently, with a small number of groups serving a comparatively large number of subscriber lines.

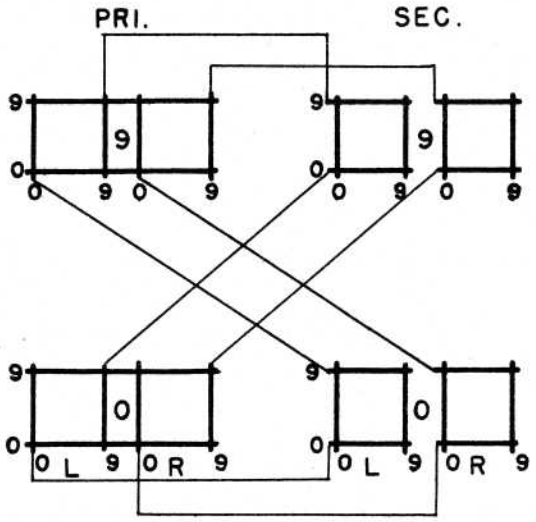


Fig. 85

DISTRICT AND INCOMING LINK FRAME

PRIMARY-SECONDARY LINK SPREAD

The district link frame contains 10 primary and 10 secondary crossbar switches which provide paths from district junctor circuits to office link frames, and outgoing trunk circuits. District junctors terminate on district link primary switch horizontals, 10 junctors per switch, or a total of 100 junctors per district link frame, which are served by 200 district links (connections between primary and secondary switches). These links originate on primary switch verticals (20 per primary switch) and terminate on secondary switch horizontals or levels. To provide for the termination of 200 links on secondary levels, it is necessary to split the secondary horizontal multiple strapping in the middle, so as to provide two groups of levels per switch, 10 levels per group. District link secondary verticals are associated with outgoing office junctor circuits, which terminate on office link frame primary switch verticals. Fig. 85 represents the primary-secondary spread of district link connections. The 0 to 9 L verticals of primary switch 0 are spread over the 0 levels of left-half secondary switches 0 to 9; verticals 0 to 9 L of primary switch 1 are spread over the 1 levels of left-half secondary switches 0 to 9, etc., and verticals 0 to 9 L of primary switch 9 are spread over the 9 levels of left-half secondary switches 0 to 9. Right verticals on primary switches are associated with right-half secondary switch levels following the

same slip as explained for left verticals and left-half switches. This link spread method provides any one of a maximum of 100 district junctor circuits with access to any of the office junctor circuits leaving the secondary switches of a particular district link frame.

Office junctor circuits connect together district link and office link frames, following a junctor distribution plan which is dependent on the number of district and office frames provided. Distribution is such that the maximum number of 200 office junctors leaving any district link frame, are spread over all office link frames as evenly as possible, which provides access to any group of outgoing trunks on any office link frame, over any one of a particular group of office junctors. Office junctors are cabled through an office junctor grouping frame which provides flexibility for their distribution when additional frames are added.

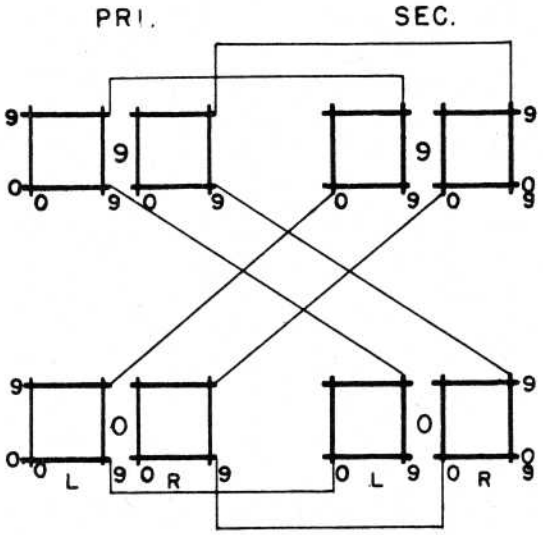


Fig. 86

OFFICE LINK FRAME

PRIMARY-SECONDARY LINK SPREAD

The office link frame contains 10 primary and 10 secondary crossbar switches, with office junctors cabled in to primary switch verticals and outgoing trunks to secondary horizontals or levels. By means of primary-secondary links, an incoming junctor circuit may be connected to a particular outgoing trunk circuit. Primary switches under any condition have the horizontal multiple strapping split in the middle so as to provide two sets of levels per switch. Secondary switches may vary the splitting of the horizontal multiple strapping to meet different job conditions; the multiple may be continuous to provide for a maximum of 100 outgoing trunks per frame; it may be split in the middle to provide for a maximum frame capacity of 200 outgoing trunks; or individual levels may have the multiple strapping split to provide for a maximum capacity of 120, 140, 160 or 180 outgoing trunks. Trunks are arranged in "marker test groups" of 40 trunks each, which are cabled to a pair of office link frames, and divided 20 trunks to the even frame of the pair, and 20 trunks to the odd frame. The 20 trunks on any

office link frame which are associated with a test group are distributed over the 10 secondary switches, two trunks per switch. Pairs of office link frames always include consecutive frame numbers, the even-numbered frame always the first of the pair, as frames 0 and 1, 2 and 3, etc. With this arrangement, office link frames are always provided on an even number basis. Office links, connections between primary and secondary office link frame crossbar switches, originate on primary horizontals and terminate on secondary verticals (Fig. 86).

Levels 0 to 9 on left-half primary switch 0 are spread out over the 0 L verticals of secondary switches 0 to 9; levels 0 to 9 on left-half primary switch 1 are spread out over the 1 L verticals of secondary switches 0 to 9 etc.; and the 0 to 9 levels of left-half primary switch 9 are spread out over the 9 L verticals of secondary switches 0 to 9. Right-half levels of primary switches 0 to 9 are spread over the R verticals of secondary switches 0 to 9, in exactly the same manner as explained for the left-half combination. This link spread arrangement allows any office junctor circuit on a particular office link frame to have access to any outgoing trunk circuit on the frame, the ratio of junctors to links to trunks being 200 to 200 to 200 or 1 to 1 to 1.

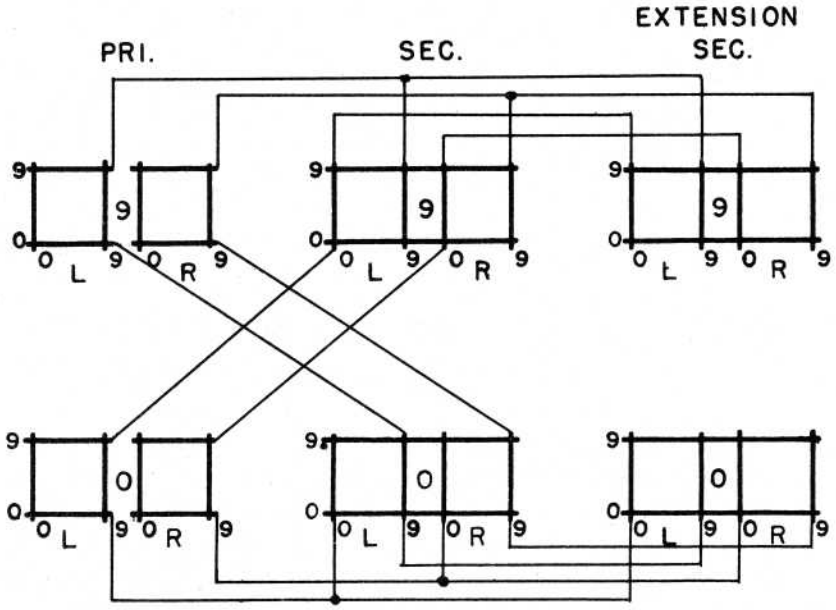


Fig. 87

OFFICE LINK AND OFFICE EXTENSION FRAME

PRIMARY-SECONDARY LINK SPREAD

When the requirements are such that more than 10 office link frames are required, it is necessary to add an office extension frame to each regular frame. The extension frame duplicates the equipment in the regular secondary bay, but the horizontal multiple strapping is not cut on either the regular or extension secondary switches. This keeps the trunk capacity of both frames to a maximum of 200. Office links are extended from regular secondary verticals to extension verticals (Fig. 87) in other words, they are in multiple. While this set-up does not increase the trunk capacity, it does increase the efficiency of the links, in that each link has access to twice as many trunks.

The incoming link frame contains 10 primary and 10 secondary crossbar switches, with a maximum of 160 incoming trunk circuits connected to primary levels and 200 line junctor circuits connected to secondary verticals. Horizontal strapping on primary switches is continuous on levels 2 to 9 inclusive, while the strapping on secondary levels is cut in the middle. Horizontal strapping is not provided on primary switch levels 0 and 1. The incoming primary-secondary link spread is the same as for the district link frame (see Fig.85) except that the primary switches are strapped as shown in Fig.88.

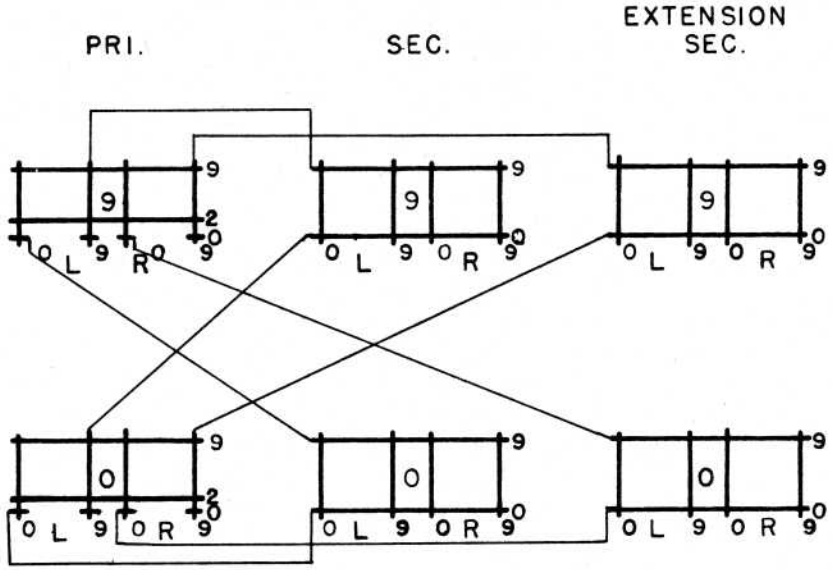


Fig. 88

INCOMING LINK AND INCOMING EXTENSION FRAMES

PRIMARY-SECONDARY LINK SPREAD

Incoming extension frames are provided for each incoming link frame when the total exceeds ten. Incoming link frames are then paired, with common line junctors, with the paired combinations referred to as "incoming groups." In each incoming group, 200 line junctors are multipled through the two incoming link frames, and 200 line junctors are multipled through the two extension frames, thus providing a total of 400 line junctors serving the maximum of 320 incoming trunks. With incoming groups, all secondary crossbar switches are provided with continuous horizontal multiple strapping. The 200 link connections from primary verticals are spread over the regular and extension secondary levels, primary 0 to 9 L to regular secondary levels, and primary 0 to 9 R to extension secondary levels, following the same general plan as outlined for the district link spread (Fig. 88). With such a link spread, any trunk on levels 2 to 9 of any primary switch will have access to any line junctor on any secondary switch vertical on either the regular or the extension secondary.

Subscriber sender link primary switch verticals are associated with district junctor circuits, and subscriber sender link secondary levels are associated with subscriber sender circuits. These associated circuits are 8-wire circuits so that with 4-wire switches, verticals and levels must be

paired, to provide 8-wire paths thru the frame. On primary switches, the horizontal strapping is continuous, while on the secondary switches, the strapping is cut in half or quartered, depending upon job conditions. Subscriber sender link connections between primary and secondary switches, originate on primary levels and terminate on secondary verticals, with levels and verticals provided in pairs, so that each link will close thru an 8-wire circuit.

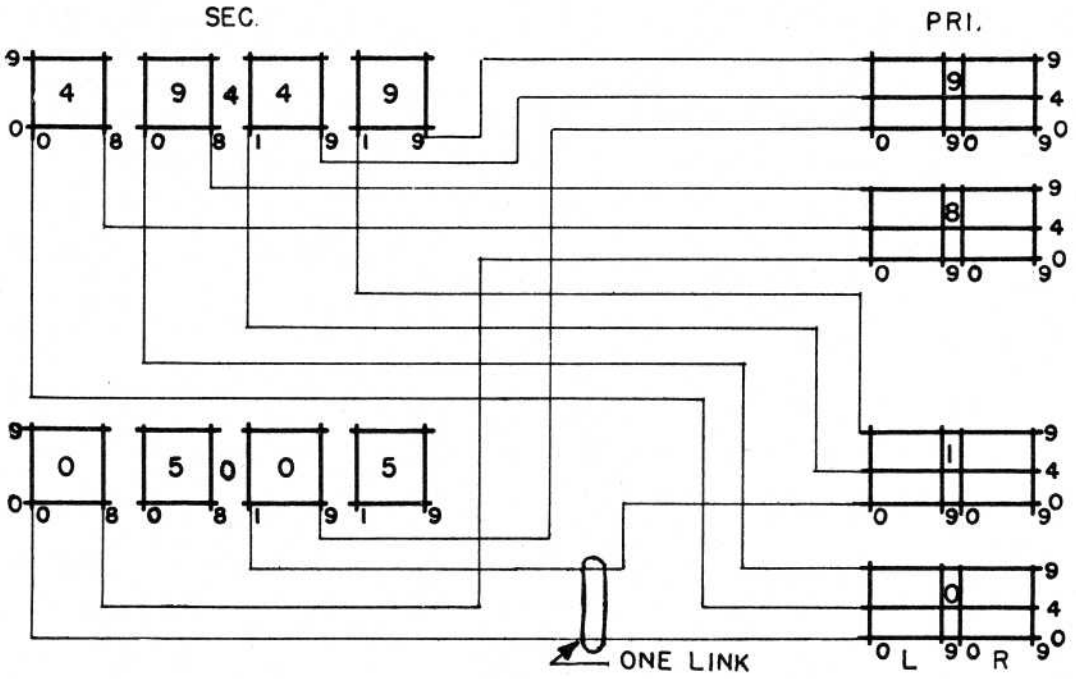


Fig. 89

SUBSCRIBER SENDER LINK FRAME

PRIMARY-SECONDARY LINK SPREAD

If we assume a job condition that requires 10 sub-groups of subscriber senders (100 senders) the horizontal strapping on the 5 secondary switches will be split as shown in Fig. 89, thus providing 20 sets of 10 levels each which are common to 5 verticals. Sets of levels and associated verticals are paired as shown in the sketch; quarter switches numbered 0 and 0, 1 and 1, etc., are paired and known as half switches. Levels on primary switches are paired on adjacent switches, as 0 levels on switches 0 and 1, 4 levels on switches 0 and 1, etc. The link spread is so arranged that the 10 links originating on primary switches 0 and 1, terminate on verticals of each of the 10 secondary half switches; that is, the link originating at the 0 levels of primary switches 0 and 1 terminates on verticals 0 and 1 of secondary half switch C; the link originating at levels 1 of primary switches 0 and 1 terminates on verticals 0 and 1 of secondary half switch 1, etc. A maximum of 50 links are thus provided between primary and secondary switches, which serve to associate any one of a maximum of 100 district junctor circuits with any one of a maximum of 100 subscriber sender circuits. This ratio of 100 junctors to 50 links to 100 senders is satisfactory due to the difference in holding time between junctors and senders. Under certain conditions, primary switches 8 and 9 are not equipped, which reduces the number of links to 40, and the number of junctors to 80 on the particular frame.

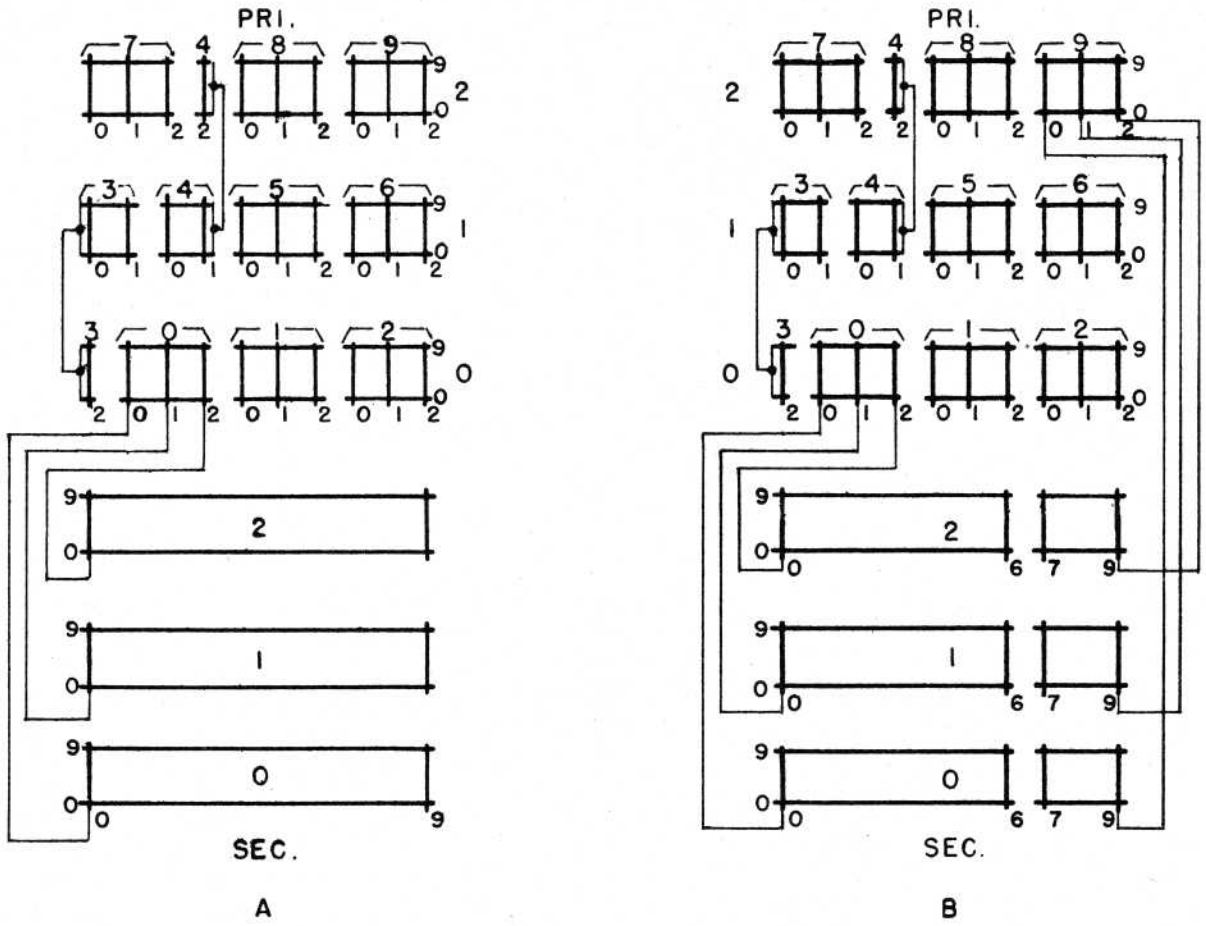


Fig. 90

TERMINATING SENDER LINK FRAMES

PRIMARY-SECONDARY LINK SPREAD

The terminating sender link frame provides mounting space in a single bay for 3 primary and 3 secondary 100 point 6-wire crossbar switches, with incoming trunk circuits wired to primary levels and terminating sender circuits to secondary levels. Horizontal strapping on the 3 primary switches (Fig. 90-A and B) is split into ten sections, each of which is served by 3 primary verticals. This arrangement provides for a total of 100 levels, divided into 10 sets of 10 levels each. Secondary switches as shown in Fig. 90-A provide for common horizontal strapping across the 10 verticals of each switch, thus providing for a maximum of 30 senders, which are arranged in 6 sub-groups of 5 senders each. Two different types of senders may be provided, but each subgroup must contain only senders of one type. Fig. 90-B shows the horizontal strapping on the secondary switches split between the No. 6 and No. 7 verticals, providing two sets of levels per switch, each of which may be associated with two different types of senders. Fig. 90-A then is specified where not more than two different types of senders are furnished, and Fig. 90-B when a maximum of four different types of senders may be provided. The primary and secondary switches are connected by means of 30 links, which originate on

primary verticals and terminate on secondary verticals. The link spread (Figs. 90-A and B) is such that the 3 links from one primary switch are spread over the 3 secondary switches, one link per secondary switch. For example, vertical 0 of primary switch 0, section 0, connects to vertical 0 of secondary switch 0; vertical 1 of primary switch 0, section 0, connects to vertical 0 of secondary switch 1, while vertical 2 of primary switch 0, section 0, connects to vertical 0 of secondary switch 2. In other words, primary switch section number and secondary vertical number correspond, while the primary vertical number and the secondary switch number are the same. With this link spread, any one of a maximum of 10 incoming trunks has access to a maximum of 10 senders over one link connection.

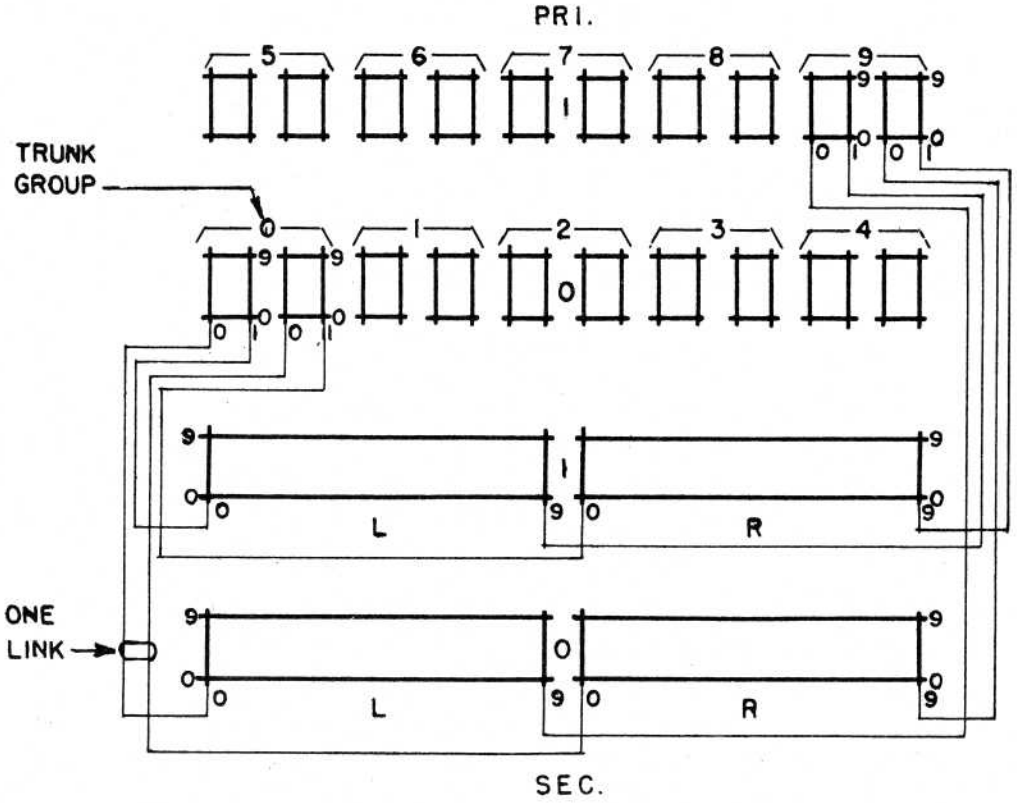


Fig. 91

KEY PULSING SENDER LINK FRAME OR COIN SUPERVISORY LINK FRAME

PRIMARY-SECONDARY LINK SPREAD

The crossbar frame which may serve as either a key pulsing sender link or coin supervisory link frame mounts as part of its regular equipment, four 200 point, 4-wire primary switches and four 200 point 4-wire secondary switches, which are arranged in two groups, 2 primary and 2 secondary switches per group. The horizontal strapping on the primary switches is so cut that two adjacent verticals are associated with one set of 10 levels, that is, each switch is represented by ten sections. Incoming circuits are wired to

primary section levels and key pulsing sender or coin supervisory circuits to secondary levels, and inasmuch as these circuits require 8 wires, verticals and levels must be paired for each. Horizontal strapping on secondary switches is split in the middle to provide two levels per sender circuit. Link connections between primary and secondary switches total 20 per switch group or 40 for the two groups. The link spread (Fig. 91) is from primary vertical to secondary vertical, and involves two cross-points at both the originating and terminating ends of the link. Verticals 0 of the two halves of primary switch 0, trunk group 0, are wired to the 0 verticals of the left and right halves respectively of secondary switch 0; verticals 1 of the two halves of primary switch 0, trunk group 0, are wired to the 0 verticals of the left and right halves respectively, of secondary switch 1, etc. This link spread arrangement allows any incoming circuit on the primary switches to have access to any circuit on the secondary levels.

2. Circuit Features

The marker circuit is the nucleus of the Crossbar dial system and forms the basis of a new method of circuit operation and control for establishing connections through a dial office. This arrangement may be described as a centralized and coordinated method of control in which the circuit network used for establishing connections through the various units of equipment is separate and distinct from the talking and signalling circuits. There are two types of markers; one is called the originating marker and handles the originating traffic; the other type is called the terminating marker and it functions on terminating calls. The purpose of the markers is to decode the dialed pulses as recorded by the senders; to test and select paths to and through the various frames and to outgoing trunks to other offices; and to establish the connections within the Crossbar office by operating the selecting and holding magnets of the crossbar switches involved in setting up the connections. In other words, the markers are in command of and control the major switching frunctions, serving as the directing and supervising mechanisms in the system, until the desired connection has been established.

Two sender circuits are employed in completing a connection; a subscriber sender functions on the originating end of calls to register the dial pulses and provide the originating marker with the necessary information for establishing connections through the district link and office link frames, and to outgoing trunks from the office link frame; a terminating sender supplies the terminating marker with the necessary information for completing the connection through incoming and line link frames to the called station.

Control circuits form part of the line link and various sender link frame equipment. These circuits perform functions very much the same as the markers in setting up the connections through the frames to which these circuits have access. The essential difference functionally between the control circuits and the markers is that the control circuits are individual to a frame or a group of frames forming a trunking channel, while the markers are common to a central office unit.

The Crossbar dial system is designed to handle but one call at a time through any frame. The average time required to set up a call will be approximately the same as required in the Panel dial system.

Self-testing circuits and "second trial" features, together with the twin precious metal contacts for all circuit closures, are expected to greatly reduce the number of calls which might not be completed due to "blocked" or "faulty" connections within the switching mechanism.

The Crossbar dial system offers a flexibility providing a greater latitude in the provision of facilities for handling telephone traffic than in any of the other dial systems. This is made possible by the use of separate senders and markers for the originating and terminating portions of calls, and also by the fact that the markers are capable of independently decoding and translating the information recorded by these senders.

Section 6. Method of Operation (Fig. 93)

When a subscriber originates a call by lifting the handset at his station, his line is closed to a primary vertical on a line link frame in the central office which serves the area in which he is located. The controller circuit of the line link frame then functions to definitely locate the line originating the call, first in a horizontal group of lines, then in a vertical group of lines, and then the individual vertical unit to which the line is connected. While this action is progressing the line link controller circuit is connected to a controller circuit on a subscriber sender link frame and these two circuits working together select an idle district junctor circuit and an idle subscriber sender circuit and associate them with the calling line. As these selections are completed the two controller circuits act together to complete the operation of select and hold magnets on line link primary and secondary and subscriber sender link primary and secondary crossbar switches, the operation of which close certain contacts called "cross-points" on these switches. The closure of these cross-points completes a path to the subscriber sender which causes a dial tone circuit to be closed through to the calling subscriber line as an indication that dialing may be started.

A subscriber number includes two letters and a numeral for the office code plus four numerical digits. The three digits of the office code always consist of the first two letters of the central office name plus a numeral while the number may consist of any combination of four numerical digits. The operation of the dial by the calling subscriber generates a series of current pulses called dial pulses, the number generated being dependent on the letter or number dialed. For example, dialing the letter "A" which corresponds to the number 2 slot on the dial will generate 2 pulses; dialing the letter "N" which corresponds to the number 6 slot on the dial will generate 6 pulses, etc.; in other words, the size of the number dialed will indicate the number of generated pulses. These dial pulses are registered in the subscriber sender circuit as cross-points on a 100-point crossbar switch. When the subscriber sender has received all the pulses associated with the three digits of the office code, an originating marker connector circuit is called upon to select and provide an idle originating marker circuit. When this has been accomplished the subscriber sender transmits certain types of information to the marker which include: (1) the office code dialed, (2) the district frame number involved in the call, (3) class of service of the calling line, etc. With this information registered, the marker then performs a decoding and a marking function. An idle outgoing trunk to the called office is selected under control of the marker. Idle links are then selected in both the district link and office link frames and matched up with an idle office junctor circuit, the three circuits representing a channel. When these selections have been completed the marker controls the setting up of "cross-points" in district and office link primary and secondary crossbar switches which closes the previously selected district junctor circuit through these frames to the outgoing trunk circuit just selected for use on this call.

The outgoing trunk selected by the originating marker becomes an incoming trunk when it reaches the terminating equipment in the called central office. The incoming trunk terminates on an incoming trunk frame which mounts the relay equipment associated with the trunk and is extended through local wiring to a level on an incoming link primary crossbar switch and to one level

on a terminating sender link primary crossbar switch. Incoming trunks on the incoming link frame consist of 3-wire circuits while on the terminating sender link frame they include 6 wires.

While this action has been taking place in the terminating equipment, the calling subscriber is dialing the called subscriber number, the dial pulses of which are being registered as cross-points on the crossbar switch which is part of the equipment in the originating sender. As the hundreds digit is dialed and registered in the originating sender, the trunk circuit is closed through to the terminating equipment, causing the terminating sender link controller circuit to function and select an idle full selector sender and attach it to the incoming trunk circuit associated with this call. Dialed information registered on the crossbar switch in the originating sender is now transmitted on a revertive pulsing basis and registered on another crossbar switch in the terminating sender. The number of pulses transmitted for the first two digits of the called subscriber number will be dependent on the digits. As the third digit of the called number is registered, pulses are immediately transmitted in the same manner, and as the fourth and last digit registration is completed the same process is again repeated. At this point in the completion of the call the calling subscriber has completed dialing and the called subscriber number has been registered in the form of cross-points on a crossbar switch in the terminating sender located in the called central office. The originating sender and subscriber sender link, having at this time completed their function in connection with this call, disconnect and return to normal. The originating marker connector and originating marker circuits which were associated with this call were returned to normal after the call had been extended from the district junctor circuit to the outgoing trunk circuit. The average holding time of a marker and marker connector circuits is about three-tenths of a second per call while that of originating senders and subscriber sender links is 12 to 15 seconds.

When the terminating sender has received complete information on the number of the called subscriber, it calls upon a terminating marker connector circuit to provide an idle terminating marker. Information on the called subscriber number, together with the number of the incoming trunk frame on which the incoming trunk circuit is located that is being used on this call, then is transmitted to the marker by the sender. The marker then by means of its number group circuit locates this number as a particular one in a maximum of 10,000 subscriber numbers that it has access to in this central office unit. Translation consists of locating the number in a group of 100 to 2500 consecutive numbers, then in a block of 100 consecutive numbers, then in a block of 20 consecutive numbers, and finally as a particular number in a 20 block.

The maximum of 10,000 subscriber numbers which may be associated with any one central office unit are arranged in number groups, each number group containing a block of consecutive subscriber numbers which will provide a traffic condition of 1,000 busy hour calls. Number groups may contain as few as 100 consecutive subscriber numbers or as many as 2500 consecutive numbers, which may be either increased or decreased in increments of 100. For example, if consecutive subscriber numbers 0000-0799 would provide a traffic condition of 1,000 busy hour calls, then this group of numbers would be placed in number group No. 0; if consecutive numbers 0800-1199 would provide the same traffic conditions, then this group of consecutive subscriber numbers would be placed in number group No. 1, etc. After translation the marker connects to

the proper number group connector circuit which contains the subscriber number and then causes a 20 block relay to operate on the block relay frame to close through to the line distributing frame the sleeves to 20 consecutive numbers. Two other leads on the 20 block relay associated with this number are connected to terminal strip punchings in the cross connecting field on the block relay frame, which will return information to the marker on the location of the subscriber line associated with this subscriber number, the type of ringing current to be provided, etc. The NS (number sleeve) lead of the called subscriber number is connected to a vertical terminal strip punching on the LDF (line distributing frame) from which point it is extended to a line sleeve lead located on a horizontal terminal strip punching on the same LDF. Number sleeve and line link punchings are connected together by means of jumper wires. Line sleeve punchings on the LDF are cabled to sleeve terminals on line link primary switch vertical units. This jumper arrangement at the LDF provides a flexible arrangement for changing line and number association at will. The marker tests the called line associated with this particular directory number by checking the associated sleeve lead. A ground condition on the sleeve will indicate to the marker that the line is busy, and as a result the marker will set the incoming trunk circuit to provide and return a busy signal to the calling subscriber. If the sleeve of the called line is not grounded, an idle line condition is indicated to the marker, which then proceeds to test for and select idle links in both the line link and incoming link frames, and test for and select an idle line junctor circuit connecting these two frames together. These tests and selections are made by the marker in conjunction with additional equipment mounted on the line choice and line junctor connector frames. The marker then controls the closing of cross-points on incoming and line link primary and secondary switches. With the closing of these cross-points the incoming trunk circuit transmits ringing current through the ringer of the called subscriber station and the terminating sender link, terminating marker connector, terminating marker, number group connector, block relay, line choice connector and line junctor connector disconnect from the call and return to normal. The talking path through the equipment in the originating office includes line link, district junctor, district link and office link frames; while in the terminating office, an incoming trunk, an incoming link, and a line link frame are required to close through the talking path. The talking path provided for any call involves only a very small part of the total equipment on these frames.

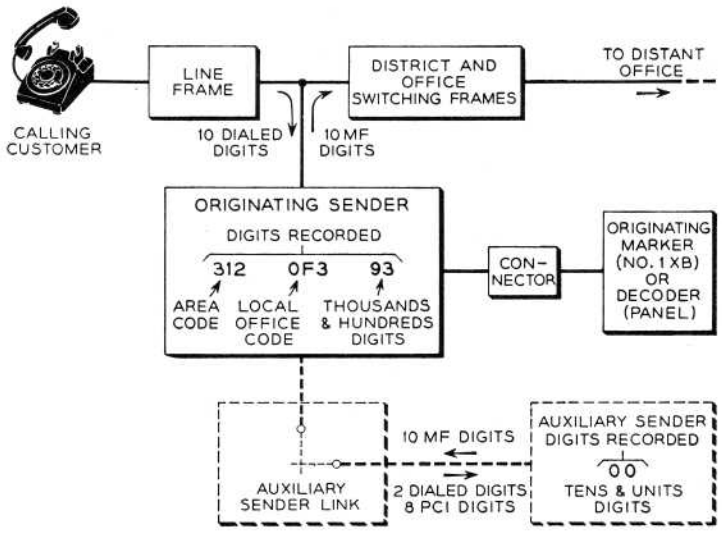


Fig. 92 Block Diagram of Auxiliary Sender Applied to Panel or No. 1 Crossbar Central Office

When the talking parties disconnect, the equipment which has been in use on this call will all restore to normal.

Direct distance dialing by customers requires that a three digit area code be prefixed to the seven digit local telephone number assumed in the action thus far. An auxiliary sender (Fig. 92) provides the added capacity for digits 9 and 10. Area codes have a zero or one for a second digit and upon receipt of this, the subscriber sender prepares to call in an auxiliary sender. Actual connection is held off until after the seventh digit has been dialed, at which time the subscriber sender signals the auxiliary sender link for connection to an idle auxiliary sender thru two cross-points on a sender link switch. Dialing of the eighth digit into the subscriber sender completely fills it, and it prepares to call indicator pulse its eight digits forward to the auxiliary sender. Dialing of the ninth and tenth digits into the auxiliary sender causes it to initiate action over the outgoing trunk which results in attachment of a multi-frequency register at its remote end, usually the next toll switching point. Upon receipt of the signal from the remote register to go ahead, the auxiliary sender trips the call indicator display unit of the subscriber sender causing the first eight digits to be call indicator pulsed from subscriber sender to auxiliary sender. Immediately upon receipt of each of these first eight digits the auxiliary sender multi-frequency pulses them forward to the remote toll switching point. After the eighth digit has been received and pulsed forward the auxiliary sender refers to the remaining ninth and tenth digits previously dialed directly into it and multi-frequency pulses them forward, completing the transmission of digits. The auxiliary sender and sender link release. The subscriber sender advances the district junctor to talking condition and releases itself and the subscriber sender link.

Section 7. Power

The purpose of the telephone power plant is to furnish electrical energy, of the required character and in proper amount, and available one hundred per cent of the time.

In order to meet the vital need of ever-ready power it is necessary in telephone power plants to arrange for some primary power source which is usually a commercial electric service from outside. The services are investigated with care to determine their reliability and, wherever possible, two services connected to different generating stations or systems are brought into the telephone building. In those cases where a single service only can be secured a local means of charging such as an engine generator set may be provided as a reserve for this service.

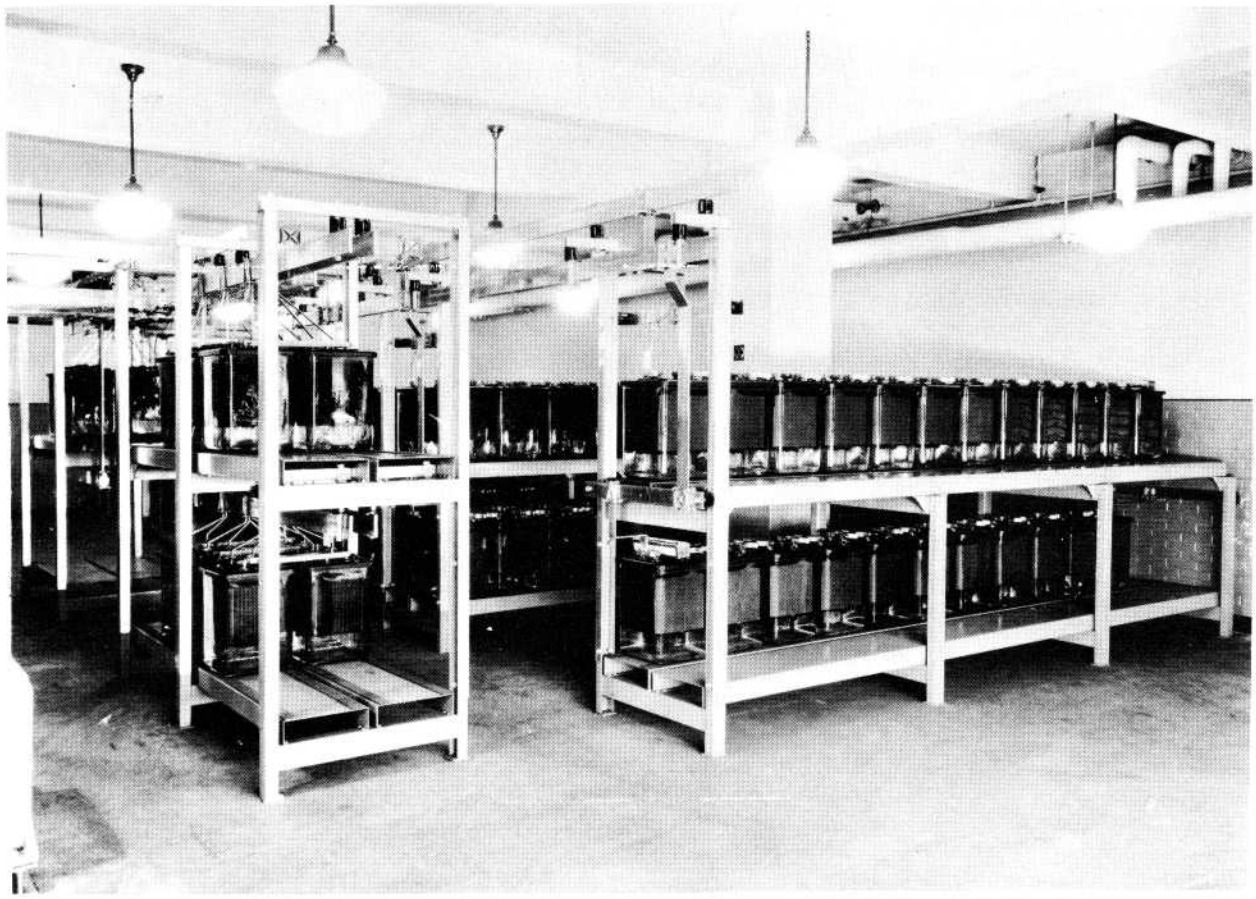


Fig. 94 - Storage Batteries

Even with the best commercial power services, short interruptions are experienced; therefore it is necessary to provide another source which shall be available at all times to operate the central office during temporary failures of the outside service. This is accomplished by the use of a storage battery (Fig. 87) of sufficient capacity to carry the load of the office during failure of the source of power supply, the battery being continuously connected to the circuits so that no interruptions occur. Common practice and experience have resulted in batteries of certain sizes being

provided, these sizes being sufficient to carry the exchange load for intervals ranging from a few hours to several days, depending upon conditions. The present practices have been successful in maintaining continuous power supply, and central offices generally throughout the country have given service even during periods of storm, fire or other calamities.

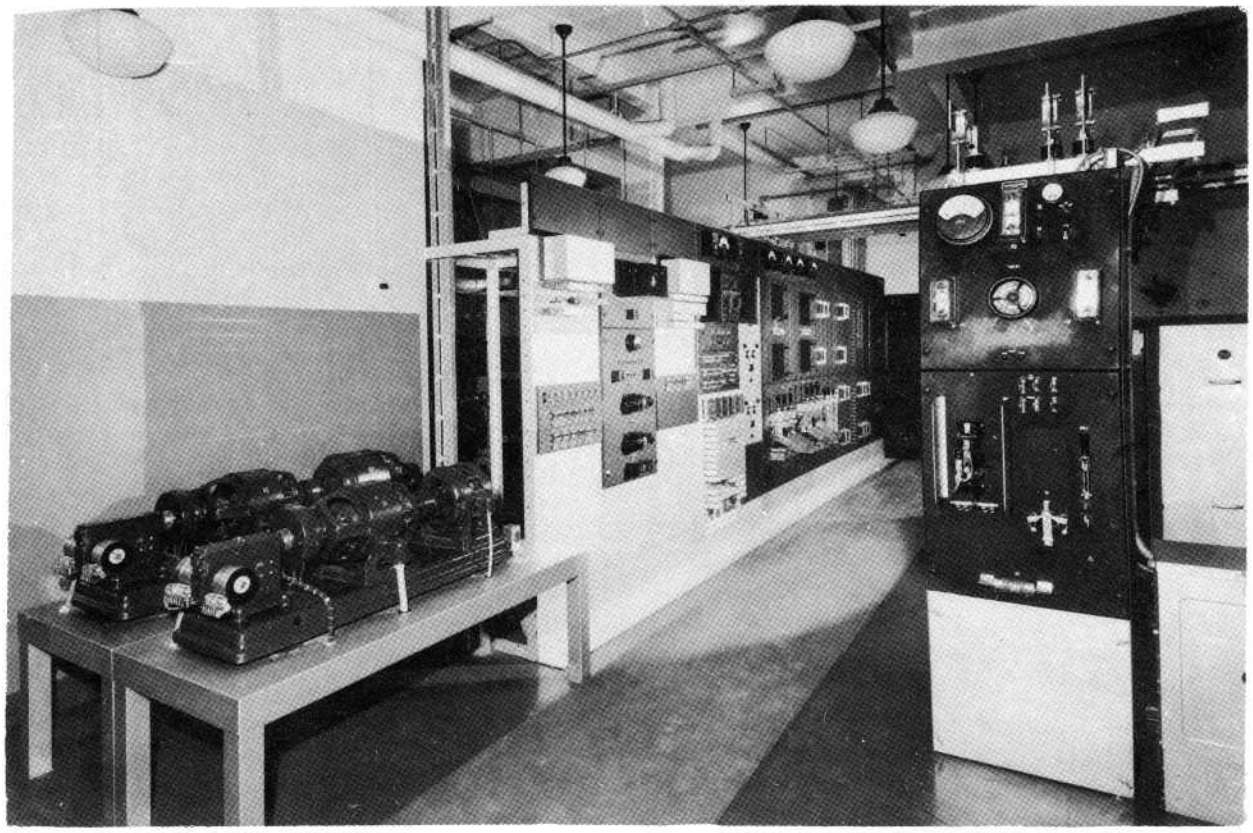


Fig. 95. - 301C Power Plant

The 24 and 48 volt power plant equipment for Crossbar dial offices is similar to the equipment now furnished for Panel and Step-by-Step dial offices.

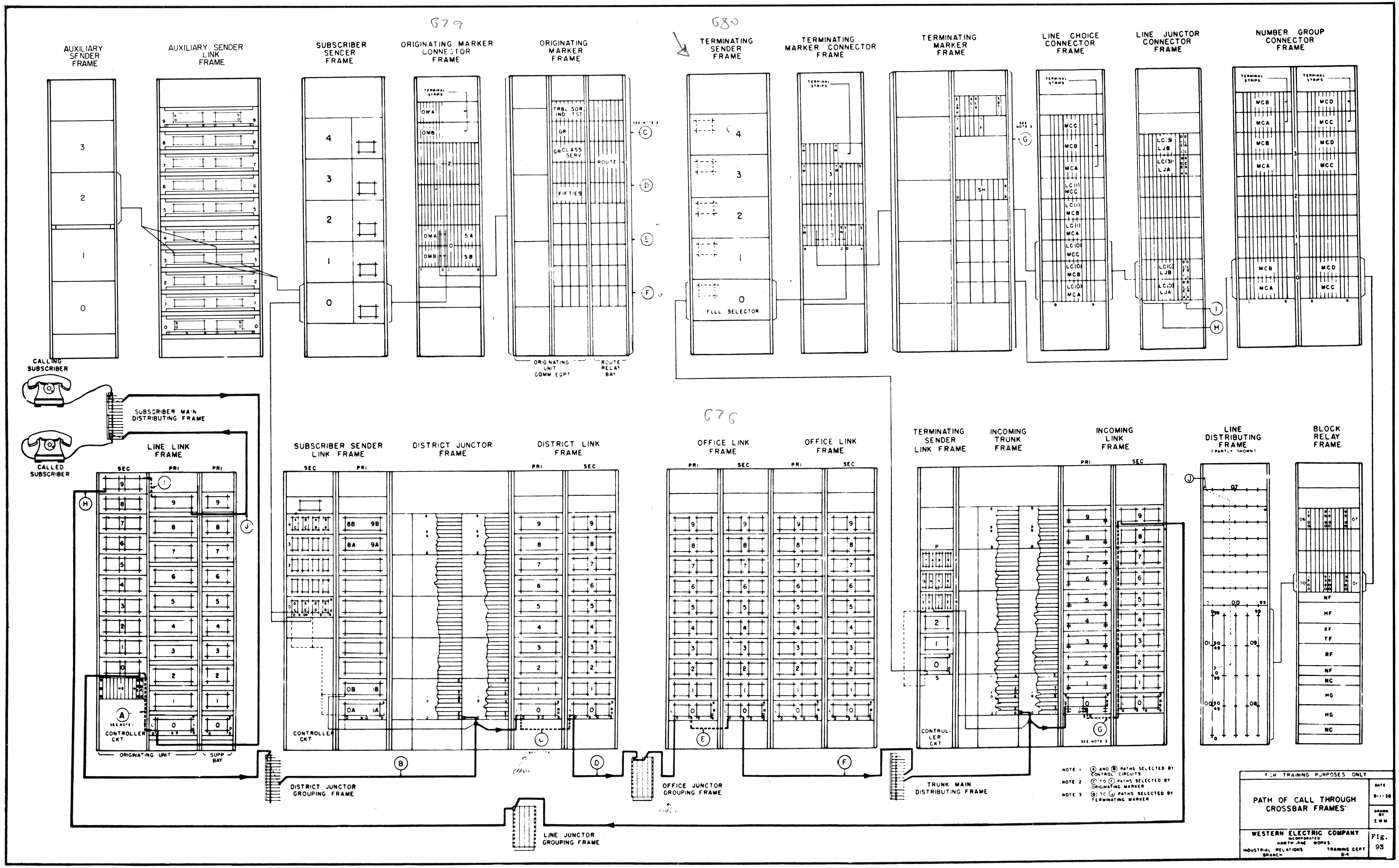
Forty-eight volt potential has been adopted for both the talking circuits and operation of the equipment, and on account of the large number of holding magnets involved in the crossbar switching circuits, the 48 volt drain is heavy. Fuses usually mounted on the centralized battery distribution fuse boards are located in small fuse boxes, installed on the end guards of the various rows of frames.

The 301C power plant (Fig. 88) is standard for central offices having a current drain up to 2000 amperes; for offices having a drain in excess of this amount the 320A power plant is furnished.

A simplified a-c d-c and superimposed ringing power plant has been developed which employs one ringing potential for both individual and party line offices and which provides an increased ringing range. The associated ringing control equipment, and a duplicate set of generators supplying 135 cycle a-c power together with automatic switching means, is mounted on a self-contained framework. This equipment is known as the 803C ringing power plant.

A small 22 volt a-c transformer supplies the power for the telechron motors associated with the call timing devices. A small 11-15 volt a-c transformer is used with the district junctor condenser test circuit. A 24 volt positive d-c current rectifier with automatic transfer facilities and a dry cell reserve is used with the terminating marker for the no test circuit, number checking circuit and non-hunting feature.

Power equipment, such as ringing sets and charging motor generator sets, is in many cases duplicated to provide extra equipment which may be used in case of failure on the part of that ordinarily supplying power to the central office.



FOR TRAINING PURPOSES ONLY

PATH OF CALL THROUGH CROSSBAR FRAMES

WESTERN ELECTRIC COMPANY INCORPORATED HAWTHORNE WORKS
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DATE 9-1-38 — DRAWN BY EWM — Fig. 93