SWITCHING SYSTEMS MANAGEMENT

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1.00 GENERAL

The step-by-step dial system was one of the very early automatic systems to be developed. Step-by-step equipment consists of the following basic elements:

Line finders

Selectors

Connectors

Line equipment serves to connect a calling party to the switch train. The switch train, consisting basically of step-by-step selector switches, extends the calling party's connection to the connector group which serves the called party. Connectors complete the connection to the called party's line.

Since step-by-step selectors respond directly to dial pulses, the numbering plan and trunking design are virtually inseparable. Because of this relationship a careful selection of dial central office codes as well as careful design of the step-by-step equipment is absolutely necessary. These factors become increasingly important as operator and customer distance dialing are extended.

Several types of step-by-step systems are available. Each is designed to meet the special needs of a particular type of community. Naturally, the smaller offices do not, in all cases, require the refinements and complexities which are necessary in large step-by-step offices. In this subsection, No. 1 step-by-step and No. 350A step-by-step equipment will be covered. The chief difference between the No. 1 step-by-step equipment and the No. 350A step-by-step equipment is that the No. 350A equipment is arranged for unattended operation. Switch shelves and trunk equipment for the 350A and the No. 1 offices are identical except that arrangements have been standardized for the 305A equipment to permit the mounting of two or more varieties of switches on the same shelf.

2.00 THE PATH OF A CALL (Figure 1)

The path of a call in a step-by-step office is built up as the code and numerals of the desired number are dialed by the calling customer. Assume the customer is calling 625-4097. This number is composed of two parts, the office code and called station number. The first three numbers comprise the office code; the remaining four numerals comprise the station number. This type of numbering is known as "all number calling" (ANC). When the receiver is removed by the calling customer, the line finder functions to connect the customer's line to a first selector. At this point the customer receives dial tone. The dial tone is a signal to the customer to begin dialing. As the customer pulls the dial around to the dial stop and releases it, a number of electrical impulses are transmitted to the step-by-step equipment as the dial returns to its normal position. For the purpose of illustration, consider a 7-digit office not equipped with digit absorbing selectors (they will be discussed later). In this particular case, the pulses resulting from the dialing of the first number (6) cause the first selector to step up to the corresponding level and then to select an idle trunk to a second selector. When the second number (2) is dialed the second selector will step up to the corresponding level and select an idle trunk to a third selector. When the office numeral (5) in the office code is dialed the third selector will step up to the corresponding level and select a trunk to a fourth selector. When the first numeral (4) of the called number is dialed the fourth selector will step up to the level corresponding to the numeral dialed and select a trunk to a fifth selector. When the second numeral (0) of the called number is dialed the fifth selector will step up to the level corresponding to the numeral dialed and select a trunk to a connector. When the third numeral (9) of the called number is dialed the connector will step up to the level corresponding to the numeral dialed. When the fourth numeral (7) of the called number is dialed the connector will rotate horizontally until it reaches the terminal corresponding to the last numeral of the called number.

The train of selection through the switches is a progressively built-up connection. The switches are selected in sequence and held by the calling station until disconnection. The last switch in the train is called the connector because in makes connection to the called customer's line. When this connection is made the called station is rung and the audible ringing signal is returned over the line to the calling station from the connector. When a path or station busy is encountered, overflow or busy tone is returned to the customer. When the receiver is replaced at the calling station the equipment is released and restored to normal.

On calls for assistance, information, toll, repair service, and the like, the calling customer

reaches an operator by dialing a designated code. Selection of the proper trunk is normally made by switches especially arranged for this purpose. On calls involving an assistance or toll operator, the equipment is released and restored to normal only when both the operator and customer have disconnected.

Numbers for which calls are to be intercepted are cross connected on a distributing frame to trunks terminating at intercepting positions, or on recorded announcements.

3.00 DESCRIPTION OF A STEP-BY-STEP SWITCH

3.01 *General*

Before continuing further with our explanation of the step-by-step equipment it seems necessary to explain in some detail the components of the step-by-step switch, the basic element of the step-by-step dial system. The step-by-step switch is used in one form or other at nearly every stage in the completion of a call through a step-by-step system. In order to aid in explaining its composition and function, it has been broken into three basic components: the relay assembly, the stepping mechanism, and the multiple bank.

3.02 *The Relay Assembly and Stepping Mechanism (Figures 2 and 3)*

The relay assembly contains the relays for operating the stepping magnets; controlling supervision; furnishing ringing, busy, and overflow signals; for supplying talking battery; etc.

The stepping mechanism contains the springs, ratchets, pawls, and magnets required for the vertical and rotary operations of the switch shaft and associated bands and/or commutator wipers. The wipers are attached to the switch shaft and are used for extending the calling path in the switch train.

3.03 *Multiple Banks (Figures 4 and 5)*

Bank terminals in the multiple bank are provided on the basis of the talking and supervisory paths required for a given call. All line finder and trunk finder banks have two contacts per terminal for each bank level as shown in Figure 5. Selector and connector banks have two contacts per terminal on the lower or line bank and one contact per terminal on the upper or sleeve bank per Figure 21. The sleeve bank is also equipped with two contacts per terminal when a control path is required. There are ten terminals per bank level arranged in a semicircle with a maximum of ten bank levels.

The tip and ring leads comprise the talking and dialing path. The sleeve lead provides the busy test, and holds the various switches operated. The control lead is used to control certain special operations such as start of ringing.

A 200 point line finder switch bank has three groups of 100 terminals and is equipped to serve 200 lines. The multiple bank, which is shown in Figure 4 has 100 tip and ring terminals in the lower line bank, 100 tip and ring terminals in the upper bank and 200 sleeve contacts in the sleeve bank. The 100 lines in the lower line bank secure sleeve control from the 100 bottom contacts of the sleeve terminals in the sleeve bank and 100 lines in the upper line bank secure sleeve control from the 100 top contacts of the sleeve terminals in the sleeve bank.

A 100 point line finder switch has two banks of 100 terminals. However, it accommodates only 100 circuits (tip and ring on the lower bank and sleeve and control on the upper bank). A selector switch bank looks much like a 100 point line finder switch.

The 100 terminals of all multiple banks have a standard numbering arrangement. The levels from bottom to top are numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. In like manner, the terminals from left to right are numbered 1, 2, 3, 4, 5, 6, 7, 8, 8, 9, 0, as shown in the following table:

01	02	03	04	05	06	07	08	09	00
91	92	93	94	95	96	97	98	99	90
81	82	83	84	85	86	87	88	89	80
71	72	73	74	75	76	77	78	79	70
61	62	63	64	65	66	67	68	69	60
51	52	53	54	55	56	57	58	59	50
41	42	43	44	45	46	47	48	49	40
31	32	33	34	35	36	37	38	39	30
21	22	23	24	25	26	27	28	29	20
11	12	13	14	15	16	17	18	19	10

Connected to multiple bank terminals may be either customers' lines or numbers, intraoffice switching path, interoffice trunks, operator trunks, or test lines.

3.04 *Operation of Step-by-Step Switch*

The multiple bank shown in Figure 6 has ten levels of ten terminals each. Mounted vertically before it is the shaft. Mounted on the shaft is a bank wiper. The vertical and horizontal (or rotary) magnets are also shown.

The vertical magnet controls the vertical movement of the shaft and wiper.

The rotary (or horizontal) magnet controls the rotary movement of the shaft and wiper.

The brush can be directed to connect with a terminal in one of four ways:

(a) Line Finder Hunting — Each line finder switch has an associated commutator to the right of the multiple bank and the shaft has an extra wiper connected to it, called the commutator wiper. These are shown in Figure 7. Line finder hunting takes place as follows:

A calling customer lifting his receiver energizes his terminal in the line finder group, which in turn places a ground condition on the associated commutator level segment. At the same time, an associated start circuit operates to start the shaft of the first choice line finder switch hunting for the grounded level. When the grounded commutator segment is reached the shaft's upward movement is stopped. Then, the bank wiper is rotated to the energized terminal. If the first choice line finder is busy, since lines are multipled over more than one switch, the operation described above takes place on the second choice line finder, or the first available line finder switch in the group.

(b) Selector Trunk Testing — The first series of pulses step up the selector to the dialed level and then the wiper rotates and tests automatically to select an idle trunk, as follows:

The selectors, in subsequent portions of the switching train, operate in much the same fashion as line finders except that the vertical movement of the shaft is controlled by the operation of a vertical magnet under the direction of the customer's dial, and the horizontal motion is controlled by the rotary (horizontal) magnet which causes the shaft to rotate in search of the first idle trunk or path instead of an energized terminal.

(c) Connector Terminal Selection — The first series of pulses step up the shaft to the dialed level. The second series of pulses rotate the wiper to the desired terminal, as follows:

The connectors operate in the same manner as selectors in locating the desired level, but the connector shaft moves horizontally to reach the called terminal in accordance with the number of pulses transmitted when the calling customer dials the last digit of the called number. (Rotary and level hunting will be discussed later.)

4.00 LINE FINDERS

4.01 *General (Figures 8 and 9)*

The purpose of the line finder is to connect a calling line to a first selector after the removal of the receiver by the customer, and to make the calling line test busy for incoming calls. These functions are also performed by line switches. (See Appendix II.) Advantages of line finders as compared to line switches are that the line finder reduces the likelihood of double connections, has considerably greater flexibility, requires less space and are more economical.

4.02 *Line Finders (Figure 10)*

The line finder consists of a framework on which is mounted a shaft, magnets, relays, and in most cases three sets of banks. It is basically the same as the step-by-step switch which was described earlier. The shaft is free to move in a vertical direction and also to rotate through a limited arc about its own axis. The vertical movement, controlled through the vertical magnets, causes the wipers which are attached to the shaft to rise to the required bank level and the rotary movement, controlled through the rotary (horizontal) magnets, sweeps the wipers over the terminals of that level.

4.03 *Line Finder Groups (Figures 8 and 9)*

Line finders are arranged in groups of various sizes. Within a given group, each line finder is directly associated by wiring with a particular first selector. Line finders are segregated into classes which vary in accordance with circuit functions required by a particular class of service. Normally separate classes of line finders are maintained for flat rate, message rate individual, message rate 2-party and coin. When it is not necessary that the operator identify given classes of service, one from the other, by means of a lamp cap or designation strip, several classes may be routed over a single "operator" trunk group. Line finders are mounted on line finder frames of two sizes, 11' 6" high or 9' 0" high. There are various sizes and combinations of line finder groups which may be mounted on these two types of frames. Within each frame, line finders are located on shelves. Each line finder frame normally has the capacity to mount two bays, one of line finders and one of associated line equipments. Within a framework of line finder frames and shelves, line finders are arranged in groups known as 200 point or 100 point finders. A 200 point line finder group normally consists of two shelves of line finders with 8, 10, or 15 line finders on each shelf, thus providing line finder groups with a capacity of 16, 20, or 30 line finders and 200 line equipments. A 100 point group consists of one shelf mounting, 10 line finders and relay equipments to accommodate 100 line equipments. Since a minimum of one test terminal per bank is required only 198 lines may be connected to a 200 point line finder group and a maximum of 99 lines may be connected to a 100 point line finder group. Line finders are normally numbered from left to right beginning with the lower shelf. On an initial installation the maximum capacity of switches or line equipments need not be provided. In such a case, a definite pattern of installation is followed in order to assure balanced traffic distribution. The amount of equipment provided in any given line finder group is governed by the estimated usage of the customers it is designed to serve.

4.04 *Types of Line Finders*

There are two types of line finders available to serve the various classes of service.

(a) The regular line finder is used for all classes of service except 2-party message rate and where no distinction is required between the classes of service assigned in a line finder group.

(b) Regular line finders provided with normal post springs are required for discrimination between two classes of service. They are used in conjunction with a first selector to transmit a class of service tone to an operator trunk, or to deny service to one or more first selector levels from one of two classes of lines assigned in the same line finder group. Lines which require discrimination are assigned by levels, ten lines per level on the 100 point line finder and 20 lines per level on the 200 point line finder. These lines, in the case of the 200 point line finder, are allocated ten each to the correspondingly numbered levels of the upper and lower line banks.

(c) The 2-party message rate line finder is a 4-wire line finder which is not arranged to provide class discrimination.

4.05 *Class of Service Limitations of Line Finder Groups*

Because of the varying requirements and the limitations explained above, line finder groups generally serve only one class of service. With the extended and restricted area service lines are usually segregated in separate groups. Segregation by groups is sometimes not economical and in this case mixing of more than one class may be necessary. This usually occurs where there are only a relatively few lines of one class or when it is necessary to provide for other unusual circumstances.

When it is desirable, classes may be mixed but the following points must be considered:

(a) Flat rate and message rate individual or 2-party may be mixed. When this is done all line finders must be connected to message rate trunks. All assistance calls from both flat rate and message rate lines must be ticketed unless a discriminating line finder, which provides tone identification is used, or unless the switchboard at which the operator group terminates is equipped to operate subscriber message registers.

(b) Flat rate and dial postpayment coin may be mixed. When these classes are mixed, it

is necessary that discriminating line finders be used and all lines in the group must have the same service area.

(c) Message rate individual and message rate 2-party may be mixed. When this is done, all line finders must be connected to 2-party message rate trunk circuits.

(d) Extended and restricted service area lines may be mixed. When this is done, it is necessary to use discriminating line finders and restricted service first selectors. A 4-wire first selector is required to transmit a class of service tone to the operator trunk to discriminate between extended and restricted calls and all lines must be of the same class. A combination of flat rate and individual message rate may be mixed, if tone indication to the operator is not required to distinguish between these two classes.

4.06 *Number of Lines and Line Finders per Group*

As was mentioned above, the number of lines and line finders per group is limited by physical and traffic load considerations. The 200 point line finders are equipped with 200 line terminals, two of which are used for test purposes. This leaves a maximum of 198 lines that can be used to terminate customers' lines. For line finders of the 100 point type the same situation exists, that is, one of the terminals is required for test and, therefore, only 99 customers' lines may be terminated. It should be remembered that in the case of both the 200 point and the 100 point type it may be necessary to increase the number of test terminals by at least one for traffic purposes such as dial tone speed, etc. Under some conditions it is conceivable that more than one terminal would be necessary for traffic test purposes. Generally, it is advisable to reserve some additional terminals to provide room for movement of lines.

All lines of any line group appear in the multiple banks of each line finder in the group so that any line finder in the group can connect any line circuit in the group to its associated selector. Each group of line finders and associated line equipments is divided into subgroups in order that calls may be handled more efficiently.

4.07 *Multiple Banks (Figure 11)*

Three multiple banks with 100 sets of double terminals and a set of vertical terminals or commutator segments are provided for each 200 point line finder. The tip and ring of the first 100 lines (00-99) appear in the lower line bank and the second 100 lines (100-199) appear in the upper line bank. The sleeve leads for both 100 groups appear in the sleeve bank. These banks are usually referred to as the lower line bank, upper line bank, and sleeve bank, but sometimes are called lower, middle, and upper banks, respectively. The vertical commutator segments are located at the right side of the switch between the upper line and sleeve banks. Figure 11 shows how these terminals are arranged and how the 200 line relays are connected to the banks of a switch. The bank wiring of the first and second choice line finders in any subgroup is identical but the lower numbered line finder, if idle, will always operate first.

The standard wiring of the multiple banks used in the step-by-step dial system is such that line 1 is really line 01, that is, up ten and in 1. Line 02 is up ten (see Figure 34) and in 2. Line 55 is up 5 and in 5 and line 11 is up 1 and in 1. Line finder banks are "slipped" and as a result the only place in which the terminals of a line finder multiple bank appear in the usual or normal position are for example switches 1 and 11 in a 20 type finder group.

4.08 *Function of the Line Finder*

The line finder shaft is equipped with three sets of horizontal wipers. One set is required for each multiple bank. Each line finder shaft is also equipped with a commutator wiper wired to one of the relays in the line finder. As the shaft moves upward, the commutator wiper passes over the commutator segments. The commutator regulates the vertical motion of the shaft and determines at which level the horizontal or wipers will cut in. The 10th commutator segment is permanently grounded so that should a line finder in hunting not find a ground on a lower numbered commutator segment, it would be stopped at the 10th level and cut in there even though the call which was started has been abandoned. There is also a contact which closes when the horizontal wipers pass beyond the ten terminals on the 10th level so that on an abandoned call, or on a false ground that may start a line finder hunting, a line finder will go to an imaginary 11th terminal (rotary step) on the 10th level and will then return to its normal or idle position.

It is important in the step-by-step system that a line finder and its associated first selector be connected to the calling line and ready for the customer to start dialing, as soon as possible, after he takes the receiver off the hook. For this reason, in a typical group of 20 line finders and 200 lines, the line relays are wired to the line finder banks in such a manner that two finders called "home finders" are first and second choice respectively for a particular subgroup of 20 lines, third and fourth choice for another subgroup, fifth and sixth choice for still a different subgroup and so on until they become 19th and 20th choice for the final subgroup. Thus, in any subgroup two calls may be handled at the same time by these home finders going only to the first level. This results in a good speed of dial tone, and minimum wear of the line finder switches. Additional traffic in any subgroup will be handled by a line finder from the next subgroup, in which case the search must be to the second or higher level.

The principal functions of the line finder include finding the customer's line in a group of 200 lines appearing on the line finder bank and to extend the tip, ring and sleeve leads of the line directly to a first selector. In addition, the line finder must extend ground to the sleeve of the associated line relay in order to make the line test busy to incoming calls. The line finder must maintain its operated position under the control of the succeeding switch, such as the first selector, so that when, the first selector releases it, the line finder will return to normal. The line finder also must advance the start lead to the next choice line finder and open the multiple chain circuit under the following conditions:

(a) When for any reason a line finder is removed from the shelf.

(b) A line finder goes to the 11th rotary step.

(c) A line finder is made busy at a test jack.

(d) A line finder has seized a line, or

(e) When the associated selector is made busy or removed.

Line finders must also provide an alarm on certain troubles. In addition, the line finder must return to normal when a call is abandoned except when a call is held by an operator. The line finder must return to normal when it fails to find the line. The line finder must provide a means for making routine tests, operating of all line finders busy registers (ATB's) if all of the line finders in the group are busy, and may operate a peg count register each time the line finder restores to normal. The line finder and the first selector form a link.

4.09 *Path of a Call – Dial Tone (Figure 12)*

When the customer lifts his receiver from the hook a line relay is operated and an idle line finder, normally the home finder, starts hunting for the line; first in a vertical direction under the control of the vertical magnet and commutator to find the level on which the line appears, and, then, in a rotary direction under the control of the rotary magnet in order to find the particular calling line. Vertical stepping is effected by a pawl actuated by the vertical magnet. This pawl engages the teeth of the vertical ratchet lifting the shaft one step at a time. Rotary stepping is performed in a similar manner by having a pawl., actuated by the rotary magnet, engage the rotary ratchet, thus rotating the shaft one step every time the rotary magnet operates. When the calling line is found, it is extended through the bank wipers and the associated circuit of the line finder to a first selector. At this point, the customer receives dial tone.

5.00 SELECTORS

5.01 *General (Figures 13, 14, and 15)*

Selectors are of two general types, local and toll. Local selectors are generally used in all stages of the connection preceding connectors for the completion of local calls dialed by customers. Toll selectors are provided for the completion of incoming toll calls and for the completion of assistance calls handled by combined toll and DSA switchboards. Because of transmission and supervisory features which were required at one time, older offices may have separate toll selectors which form a dedicated path to the toll connector. In newer offices, the toll selectors are combined with the local selector past the entry point into the dial office. Normally local selectors require 3-wire banks except for handling calls from 2-party message rate lines and, under certain conditions, for calls from "two class" line finder groups (i.e., a combined flat rate and message rate, etc.). Toll selectors require 4-wire banks, except for toll preceding selectors which require 3-wire banks.

In the beginning of this section the basic design of the step-by-step system was said to consist of three major elements, the line equipment, the switch train and the connectors. The second element of these three, the switch train, is composed of selectors. Step-by-step selectors respond directly to dial pulses and through their operation, the call is routed through the switch train. The mechanical portion of the selector is almost identical with that of the line finder switch described earlier. The selector differs from the line finder in that the vertical stepping of the switch is controlled by the dial at the calling station.

The rotary movement of the selector is entirely automatic. Through this automatic operation, the selector serves to pick an idle trunk on the level to which the wipers were stepped by the vertical movement of the shaft under the control of the customer's dial. The speed of a step-by-step dial should be approximately ten pulses per second for proper operation of the selector switch.

The selector consists of a framework on which is mounted a shaft, two sets of brushes or wipers carried on the shaft, magnets, relays and two multiple banks. These banks are known as the line bank and the sleeve (private) bank. The lower bank of the two is the line bank and is basically the same in character as line banks previously described. That is, it is a two-conductor terminal arrangement consisting of 100 pairs of tip and ring contacts which are used for the talking circuit.

Attached to the lower end of the shaft are two wipers so spaced that a connection will be made to a corresponding contact with both the line bank and the sleeve bank at the same time.

With the vertical motion (see Figure 16) of the shaft under control of the calling customer, the wipers will be stepped up as many levels as are represented by the number of pulses in the digit dialed and will be placed in front of the proper terminal level. If, for example, 8 is dialed, the vertical magnet will cause the selector to step up to the eighth level. Due to the spacing of the wipers, the brushes opposite the sleeve bank will also be stepped up to the eighth level.

On each level of each selector there are ten terminals to which may be connected ten trunks to the next piece of equipment. When the wipers have reached the proper level the shaft is rotated in a clockwise direction just far enough to bring each of the wipers into contact with the first set of idle terminals of that level. The rotary motion will stop and leave the wipers connected to that set of terminals and hence to the trunk connected to that terminal.

Should the first trunk be busy the condition of the sleeve terminal will be such as to cause the rotary movement to continue until an idle terminal is found, at which point the rotary motion will stop. If all of the trunks in the group are busy, the shaft will be rotated past the last or tenth terminal on the level and an overflow signal will be given back to the calling customer.

Selectors are mounted on selector frames. (See Figures 17 and 18.) Each frame has two bays, either in line or "back to back." The back-to-back type was used almost exclusively in the very early installations and has been replaced by the single-sided or in-line type of frame. The single-sided frame has a capacity of two bays, each mounting eight shelves with 20 selectors on each shelf. Between the two bays is the terminal assembly which is generally known as the Distributing Terminal Assembly (DTA) (see Figure 19). The double-sided or back-to-back type frames have less capacity. They consist of two bays arranged back to back with sufficient space between for maintenance activity. Each bay has six "20-switch" shelves providing a total frame capacity of 240 selectors. This double-sided system is closed at one end by the terminal assembly. Originally a "flat type" assembly (see Appendix IV) was employed. This has since been changed and replaced by the distributing type assembly.

As mentioned above, selectors are installed on a framework composed of two selector bays with a distributing terminal assembly located between the bays. Each bay will accommodate a total of 160 selectors. Every bay of local first selectors is designated by numbers in the 100 series. Bays of second selectors are designated in the 200 series, bays of third selectors in the 300 series, etc. Toll selectors are designated in the 600 series. The first bay of first selectors in an office is numbered 101; the second 102, etc.

Selector shelves are divided into half shelves. The half shelves in a bay are designated by letters. The shelves are divided so that the banks of ten selectors can be multipled or wired together at

the terminal assembly at the end of the bay. Greater flexibility in the various multipling of the levels of the banks can be obtained by dividing them into groups of ten than would be possible if they were allowed to remain in groups of 20.

Since the selector banks are grouped in multiples of ten, the same trunks that appear on each level of the banks of each half shelf are run to terminal blocks at the terminal assembly at the end of the bay. By wiring the terminal blocks together, any number of bank assemblies can be connected to ten outgoing trunks as required.

Assuming that the traffic over the eighth level of the first selectors is such that ten selectors would provide a load for ten trunks, then trunk No. 1 would appear on the first contact on the eighth level of the banks of all ten selectors. Trunk No. 2 would be connected to the second contact of the eighth level of the 10 selectors, trunk No. 3 to the third contact, trunk No. 4 to the fourth contact, and so on.

Should the traffic on the sixth level be less than the traffic on the eighth level, to the extent that it would take 100 first selectors to load ten trunks, then the terminal assemblies of the sixth level of 100 selectors, i.e., ten bank assemblies, would be strapped together making ten outgoing trunks from this level of 100 selectors. Thus the distributing terminal assembly permits multipling as many bank assemblies as desired on the same group of trunks.

Cables lead from the bank assemblies to the back side of the distributing terminal assembly. At the distributing terminal assembly, it is possible to arrange the trunks from the levels of the particular selector banks to the next switch in the train. The contacts on the distributing terminal assembly (DTA) on which the cables from the bank assembly are terminated actually appear on both sides of the frame. It is possible, therefore, by strapping terminals of the bank assemblies together on the front side of the DTA to give the number of bank assemblies access to the same group of trunks. (i.e., for ten or less trunks, by strapping terminals of the first bank assembly to corresponding terminals of the second bank assembly at the DTA both bank assemblies will have access to the same ten trunks.)

The outgoing trunks are connected to the DTA terminals of only one of the bank assemblies. It is possible, therefore, by tying all of the bank assemblies on a frame together at the DTA to give all bank assemblies on the frame access to the same group of trunks. Furthermore, it is possible to tie frames together, resulting in bank assemblies on more than one frame having access to this same group of trunks.

5.02 *Path of a Call – Routing Selections (Figure 20)*

Dialing by the customer opens and closes the circuit of the customer's line as the dial returns to normal. By dialing, the customer causes pulses to be sent through the switches in the central office where his line originates and through the switches in the central office where the called line terminates. When the customer removes his receiver from the switchhook, a line finder automatically starts hunting for the calling line.

It steps up vertically under the control of the vertical magnet and stops its vertical movement upon reaching a grounded commutator segment and begins to rotate its brushes or wipers over the terminals on that level until the calling line is located through its sleeve terminal which has battery on it.

When the line has been found, a circuit is completed to a first selector which returns dial tone to the calling customer to indicate that the equipment is ready for dialing. The first series of pulses steps up the first selector to the dialed level. The selector then hunts over the terminals of this level until it finds an idle trunk or, finding all trunks busy, returns an overflow signal.

If the selector is successful in locating an idle trunk, it extends the calling line through to a second selector, or perhaps to a trunk which routes the call to an operator or a desk, or some other type of equipment. If connected to a second selector, and a second series of pulses is dialed by the customer, these pulses cause the second selector to step up to the level desired and upon reaching this level, the selector will automatically hunt for an idle trunk to the next group of switches.

The selector in each case responds to one series of pulses and rotates automatically to find an idle trunk on the dialed level. (This description does not cover digit absorbing selectors. They will be discussed later.)

5.03 *Local Selectors (Figure 21)*

The local selector bank is a 200 point bank (see Figure 21). The lower half of the assembly provides the tip and ring terminals for 100 circuits. The upper portion of the bank contains the associated 100 sleeve terminals. The local selector must guard the trunk, i.e., prevent double connections, and prevent the trunk from releasing. It must lift the shaft vertically to the desired level in accordance with the digits dialed. In rotating the wipers over the terminals of a given level in order to select an idle trunk, the selector must:

(1) Rotate the shaft.

(2) Keep the tip and ring wipers electrically clear while passing over the trunks in order to avoid interference with working connections.

(3) Test each trunk for a busy or idle condition through the sleeve wipers.

(4) Halt the rotation on the first idle trunk.

(5) Extend the connection through to the next switch.

(6) Guard the trunk until the next switch responds.

The selector must also be prepared to release the connection when the customers have completed their call.

There are several designations for local selectors. They are commonly known as first selectors, second selectors, third selectors, fourth selectors, fifth selectors, auxiliary selectors, service code selectors, and auxiliary service code selectors. (Selectors are usually designated by the digit on which trunking occurs.) On the following pages each of these will be discussed in detail.

5.03.1 *First Selectors* — The first selector provides dial tone when it is connected through a line finder to a calling customer's line. In addition, the first selector provides the proper routing for the originating call. Following the receipt of the first digit dialed, it is used to extend the calling connection to the next switch in a train which may be another selector, a connector or a trunk. Normally, the levels on the first selector are arranged so that the zero level (tenth) is used for operator trunks. These trunks are connected to cord switchboards, TSP or TSPS positions. The first level is used to access Direct Distance Dialing equipment. In some installations, level one access service code selectors. These selectors are discussed in paragraph 5.03.7. The remaining levels of the first selectors normally provide trunk terminals to other offices, second selectors, operators, desks, or in a few cases to connectors.

In order to segregate the coin box telephones from other classes of service, coin box first selectors are segregated from other first selectors. This makes it possible to multiple these coin selectors to a special group of trunks if it is desired. In some cases, a special group of first selectors is provided for operators to be used for completing connections to customers' lines in the local area and for completing connections to certain miscellaneous desk positions. In addition, to facilitate operating methods, separate trunk groups from the zero level of the subscriber first selectors may be required for classes of service such as flat rate, individual message rate, etc.

5.03.2 *Second Selectors* — The second selector is the second step in the train of selection and normally responds to the second digit or letter dialed. In a 7-digit system, it normally would select a path to another office or to the next set of switches within the local office. Second selectors are normally divided into three categories — local second selectors and incoming second selectors from other local offices and toll second selectors from operators (toll switch) or from the toll dial offices. The first two categories of selectors may be mounted separately on the second selector frames or they may be mixed on the same frame. In areas having large P.B.X. development, if local and incoming traffic is mixed in such a way that each subgroup of the second selectors contains a proportionate amount of local and incoming traffic, a considerable saving in the number of succeeding selectors may be obtained through grouping when the local and incoming peak loads do not occur at the same time.

5.03.3 *Third Selectors* — The third selectors is required only in systems of five or more effective digits. It is the third step in the train of selection and responds to the third digit dialed. The third selectors may be separated into local, incoming and toll in a manner similar to that described for second selectors. In the case of third

selectors, a separation is normally made between toll and local incoming selectors. When a toll third selector is provided, it is usually an incoming transmission selector from the toll switchboard used for toll switching purposes. This type of selector will be discussed in detail later. Where toll calls are dialed directly into an office, this traffic is normally combined with the toll switch traffic on the third selector. Generally speaking, the third selector is identical to the second selector.

5.03.4 *Fourth Selectors* — The fourth selector is required only if the system contains six or more effective digits. It is the fourth step in the train of selection and responds to the fourth digit dialed. Separate groups of fourth selectors when provided to handle toll calls are known as toll fourth selectors. The local fourth selector is identical to the second and third selectors.

5.03.5 *Fifth Selectors* — The fifth selector is needed only in a system containing seven digits. It is the fifth step in the train of selection and generally responds to the fifth digit dialed. Fifth selectors are sometimes divided between toll and local in a manner similar to that explained above for third and fourth selectors. The fifth selector is similar to the selectors preceding it in the switch train.

5.03.6 *Path of a Call – Routing to Connectors (Figure 22)* — Before explaining other types of selectors, and in order to consolidate the subject of local selectors, the path of a call will be reviewed. The progressive buildup of a step-by-step dial connection in skeleton form for a 7-digit number begins when the customer takes his receiver off the hook. This causes the line finder to operate automatically to locate the calling line and extends it to a first selector.

When the first selector is connected to the line, the customer hears dial tone. This signal tells the customer that he may dial the number he desires. The customer dials the first number of the office code. The pulses sent out as a result of the customer's dialing causes the first selector shaft to rise to the desired level. The shaft then rotates automatically over the terminals on that level until it locates an idle trunk to a second selector. If no idle trunk is available, it will move to the eleventh rotary step and return overflow tone to the calling customer. If the customer does not receive overflow at this point he will continue to dial.

The dialing of the second number of the office code causes the second selector shaft to rise to the desired level. It then rotates automatically until it locates an idle trunk to a third selector. Dialing the number of the office code causes the third selector shaft to rise to the desired level. It then rotates automatically to find an idle trunk to a fourth selector. The dialing of the first numeral of the called number causes the fourth selector shaft to rise to the desired level where it automatically rotates horizontally until it locates an idle trunk to a fifth selector. The dialing of the second numeral of the called number causes the selector shaft to rise to the desired level where it rotates automatically in order to locate an idle trunk to a connector.

5.03.7 *Service Code Selectors* — In the past service code selectors have been used to provide access to Directory Assistance, CAMA, business office, repair service, local test desk, reverting call switches, local operators, etc.

With the conversion of the service codes to the X11 format, the necessity for service code selectors has decreased. There are some offices that still use this type of selector, and for this reason, a description of them and their use is included here.

All levels of the service code selectors are available to serve codes except the first level. These selectors are similar to any other local selector. In recent installations, service code selectors are provided with digit absorbing features. Levels 2-0 of the service code selector are arranged to refuse access if any one of them is the first digit dialed into the switch. In this case, the selector rises to the level dialed which is wired to give the calling customer a busy. As an exception in certain areas, only the second level through the ninth level are wired to give busy on the first pull of the dial and the zero level of the service code selector is multipled to the zero level of the first selector.

The first level of the service code selector in early installations connects calls to an auxiliary service code selector to nullify preliminary pulses on 3-digit service code calls. In later installations, when a one is received on the service code selector it is absorbed, that is, the selector rises to the first level and immediately returns to normal. This can be repeated any number of times and as a result offices so arranged do not require auxiliary service code selectors.

5.03.8 *Auxiliary Service Code Selectors* — In earlier installations, the auxiliary service code selectors were provided to nullify the effect of a preliminary pulse on 3-digit code calls in a manner similar to that of the auxiliary first selector on customer calls. In recent installations this type of selector is not installed.

5.04 *Other Types of Selectors*

5.04.1 *General* — In order to provide for growth and improved service in step-by-step areas and in order to make it possible for step-by-step equipment to fit economically into the numbering plan for the System, several special types of selectors have been developed. Some of these developments are covered below.

5.04.2 *Selector-Repeaters (Figure 23)* — When in a large multioffice area a small branch office is provided, which is, in effect, a part of one of the units of the main office, the selector-repeater may be used to introduce economies in the use of facilities. Without the use of selector-repeaters a local call originated in this small branch office would need to be trunked into the distant equipment of the main office and then routed back over another path to the small branch office, thus making it necessary to use two trunks for one call. To avoid this uneconomical use of facilities, the selector-repeater is used in the small branch office.

In the case of a call to the main office, this switch acts by repeating the pulses and building up the switch train in the usual manner. For a local call, to a station within the small branch office area, the outgoing trunk to the main office and its associated selector is by-passed in favor of a trunk to the local switch train thus making the outgoing trunk available to handle outgoing traffic. This switch also performs the regular functions of a selector or repeater, that is, it provides a ground for holding the line finder, supplies battery to the calling station on calls to the main office, reverses battery when a call to the main office is answered, selects idle trunks to both switch trains, etc.

A customer in the branch office upon lifting his receiver seizes a selector-repeater in much the same way as a first selector is seized by a customer under normal circumstances. The selector-repeater will find a trunk to the main office. When the equipment in the main office is seized, the customer will receive dial tone. When the customer hears dial tone, he begins dialing. At the end of the pulses of the first digit, the incoming first selector in the main office will cut in at a particular level determined by the digit dialed. If the main office is not a step-by-step office, but is of another type of equipment such as No. 5 crossbar, the main office equipment will function in its normal manner. All numbers which are local to the branch office will have a first digit arranged so that the equipment will cause the selector, when this digit is dialed, to cut in on a level which is arranged to cause the incoming selector and trunk to release, thereby, making them available for other calls, and the selector-repeater is now ready to choose an idle trunk to a local selector.

On a call to the main office, the incoming selector will automatically cut in on the level dialed and find an idle trunk to the next switch of the main office incoming train. The remaining digits of the desired number are then dialed and repeated through the selector-repeater. When the branch office customer's line becomes permanently grounded or short-circuited, a main office trunk is selected in the same manner as covered above for an originating call. This will bring in a permanent signal on the incoming first selector at the main office.

5.04.3 *Digit Absorbing Selectors* — Digit absorbing selectors are selectors arranged to absorb, cut through, or block digits dialed in accordance with a prearranged scheme. For example, if the called number desired were 332-7689 digit absorbing selectors could be arranged so that the numbers 33 would be absorbed by the first selector, then the numeral "2" would be used to operate the first selector. The "7" would operate a fourth selector, the "6" would operate a fifth selector and the numerals "8" and "9" would operate the connector. Thus, selectors in the train can be reduced and economies can be realized.

Digit absorbing selectors are so arranged that the shaft is moved by certain digits but not effectively, in that it returns to normal rather than hunting over the level dialed. The levels on which digits are to be absorbed are marked on the digit absorbing selector by bending cams associated with the normal post springs. In most cases digit absorbing selectors are placed at the beginning of the switch train.

As mentioned above, digit absorbing

selectors can be arranged to absorb, cut through, or block digits dialed. Outlined below are the various functions of digit absorbing selectors:

(1) Digit Absorption — Digit absorption may be used on selectors in various combinations; once-only, or repeated absorption, once-only and/or repeated absorption, and two digit absorption. The table below shows the various types available. It should be noted that in cases where it is necessary to absorb any first digit, all levels can be marked for once-only absorption.

Digit Absorption Features

Selector Designation	Once-Only or Repeated	Once-Only and/or Repeated	Two Digit Absorption	Blocking
Local	X	X	X	X
Toll Transmission	X			X
AB Toll Transmission	X			X
Toll Incoming (or Intermediate)	X	X		X
AB Toll Preceding		X		X

(a) Once-Only or Repeated Absorption — On a switch arranged for once-only or repeated absorption specific levels may be marked for either type of absorption, but the two types may not be mixed on the same switch. Levels not marked for absorption may be marked for blocking. These arrangements are available for local, toll transmission, toll incoming and AB toll transmission selectors.

The switch is often used for once-only absorption and blocking.

On a switch arranged for repeated absorption it continues to absorb digits until a level not marked for absorption or blocking is dialed. The once-only or repeated absorption switch is often used as a service code selector. In this case it is arranged to absorb repeatedly on the first level and to block all other levels, unless a digit (necessarily 1) has been absorbed. For example, if the code 112 were dialed, the first selector would trunk hunt on "1" and connect to the service code selector. The second digit, "1", would be absorbed by the service code selector. On the third digit, "2", the switch will trunk hunt. If the second digit dialed had been "2", the switch would have blocked and overflow would have been returned to the customer. However, if the code 1112 were dialed or outpulsed in error, the switch would absorb the third "1" and trunk hunt only when the "2" was dialed. It will be noted that in this instance the blocked levels are unlocked by the dialing of a digit corresponding to a repeatedly absorbed level.

(b) Once-Only and/or Repeated Absorption — A switch that provides once-only and/or repeated absorption may have any combination of the two types of absorption on any one switch. Levels may be marked for blocking, if desired. The switch will absorb repeatedly or block when those levels so indicated are dialed until a level marked for once-only absorption is dialed. Blocking may be used on any level not marked for absorption. Levels marked for blocking and repeated absorption will be unlocked when a level marked for once-only absorption has been dialed.

(c) Two Digit Absorbing Selector — The two digit, digit absorbing selector knows which digit it is working on and can take a different action accordingly. This is controlled by the markings on four sets of

normal post springs. On the first digit the switch will absorb, block, or trunk hunt, according to the marking on the level dialed. If the first digit has been absorbed, the switch will also absorb on the second digit or it may block or trunk hunt. However, the levels assigned for each operation are completely independent of each other. If the first and second digits have been absorbed, the switch will trunk hunt on all levels when the third digit is dialed. The switch will return no-such-number tone or overflow tone on levels marked for blocking. This circuit allows more freedom in the choice of office codes and permits more flexibility than would be possible without its use.

(2) Blocking — Blocking is used to prevent wrong numbers and to restrict service. When a level is marked for blocking, any call reaching that level will receive overflow or no-such-number tone, unless the previous level dialed was marked for "once-only absorption." For example, if the code is 868, but certain customers should not have access to it, it is necessary to block their access to that code in case they might attempt to dial it. If the level for the first digit, in this case "8", is marked for blocking, the customer will receive overflow tone when that numeral is dialed.

5.04.4 *Reverting Call Selectors* — Reverting call selectors are provided to enable one station on a party line to dial another station on the same line. These selectors may also be arranged to permit an employee in non-message rate offices to ring the bell of the particular station from which he is calling in order to make a ring test of that bell simply by dialing a ring back code. Two types of one-digit reverting call selectors are available for other than multi-party lines; one for use in offices having semi-selective 4-party service, and the other for use in offices having 4-party full selective ringing service. Each may be arranged to refuse calls from 2-party message rate lines. A 2-digit reverting call selector is available for use with 8-party semi-selective terminal per station equipment. These 2-digit selectors also may be used for other than multi-party lines. However, 2-digit selectors are not arranged to refuse calls from 2-party message rate lines. The use of the reverting call selectors in common by multi-party and 2- and 4-party lines where feasible will usually prove to be economical for new installations. However, in existing installations continuation of the use of 1-digit reverting call selectors will probably be advisable. Where two types of reverting call selectors are involved two separate selector levels will be required. In the case of 10-party terminal per station reverting call selectors are not required because 10-party connectors are specially designed to serve this purpose. All types of reverting call selectors are mounted on shelves having a capacity of ten selectors each. Common equipment occupies the space of one selector on the first shelf with 1-digit reverting call selectors. Ten selectors may be mounted on the second shelf. However, in the case of the 2-digit reverting call selectors the second shelf will accommodate only the same number of selectors as the first shelf.

5.05 *Toll Selectors (Figure 24)*

The following paragraphs discuss the various types of toll selectors used in step-by-step offices. Some or all of these kinds of selectors may still be in use around the System. For this reason each is described and its function stated. Most of the newer offices probably will have only one of these types of selectors.

5.05.1 *General* — As was explained earlier, there are two general designations for selectors, local and toll (including intertoll). Toll selectors are provided for the completion of incoming toll calls, delayed originating toll calls, and for the completion in some cases of assistance calls handled at combined toll and DSA switchboards. It was also pointed out that because of varying transmission and supervisory requirements toll and local selectors are mounted on separate frames and separate trunking paths are generally maintained for toll and local service. Toll selector frames mount shelves of ten selectors each except in some special cases. In these cases the number of shelves per frame will vary depending upon the type of toll selector to be used. The ten banks of each toll shelf can be multipled together in order to provide a proper load for the trunk groups to the next selectors. Distributing terminal assembly equipment is not normally provided with toll frames. The small amount of simple graded multiple required from these selectors may be provided at the trunk distributing frame.

Twenty capacity toll selector shelves with distributing terminal assembly are available for

mounting some intertoll and toll transmission selectors, but they are not designed to mount toll intermediate selectors. All toll selectors use four wire banks except toll preceding selectors which use three wire banks.

There are several types of toll selectors available, namely, toll transmission AB toll transmission, toll intermediate, toll preceding and "A" board completing.

5.05.2 *Toll Transmission Selector* — The toll transmission selector is used to terminate trunks from toll switchboards, trunks from toll preceding selectors, or trunks from step-by-step intertoll or No. 4 type toll systems. Toll transmission selectors must be located in the same building as the associated dial office equipment.

While there are many different operations performed by the toll transmission selector, the main functions of this switch are to extend the call to the next selector and repeat the dial pulses received from the dial operator or toll system. It provides the operator with a signal when a busy line is encountered and provides the operator with a signal when the called line is seized. In addition, it provides the following:

(1) Enables the toll operator to start machine ringing.

(2) Enables the toll operator to have supervision.

(3) May be arranged to enable the operator to apply uninterrupted ringing to the line of a P.B.X. for reringing.

(4) It supplies the called party with talking battery.

(5) Holds the connection under the joint control of the operator and the called party.

(6) Restores to normal when the trunk is abandoned by both the operator and the called party.

In some areas toll transmission selectors are equipped with an additional relay which allows coin collect and return current to be placed on the station line at the proper time. In other areas a separate coin control circuit is used.

5.05.3 *Toll Intermediate Selector* — The toll intermediate selector may be used in all stages of selections between toll transmission selectors and connectors. It may also be used in place of the toll transmission selectors to terminate 4-wire switching trunks from the toll switchboard or step-by-step intertoll systems located in the same building as the dial equipment. In this case, transmission features are incorporated in the trunk or selector circuit. The toll intermediate selectors are available in non-digit absorbing or digit absorbing selectors arranged to absorb specified digits once or repeatedly, but not both on the same switch. They may be arranged to block by returning an overflow signal unless a level is arranged to absorb a digit.

In general, the toll intermediate selector functions as follows. The dial pulses which are repeated by the transmission selector causes its shaft to be raised to the proper level where it automatically cuts in and selects an idle trunk to a connector. Its operation is almost identical with that of the regular local selectors except for the addition of a lead which provides the toll operator with control of the start of ringing. When an idle trunk is found by an intermediate selector, it is held through the ground on a sleeve lead. If all trunks on the level dialed are busy, the intermediate selector will rotate to the 11th rotary step and give the operator or customer a reorder signal.

5.05.4 *A-B Toll Transmission Selector* — A separate train of switches is sometimes provided for toll operators who complete A-B toll calls. It is used in place of a local train when it is necessary to provide the operator with distinct signals on line busy and paths busy conditions or when it is necessary to provide toll grade talking battery. This train is arranged for local or tandem operation. The switches in the A-B train are similar to those for the regular toll train. In some cases the A-B toll transmission selector is preceded by one or two tandem preceding selectors. In addition, the selector is used to terminate inward switching trunks from step-by-step intertoll or No. 4 type toll dialing systems. The corresponding levels of A-B toll transmission and toll transmission selectors can be multipled to a common group of toll intermediate selectors. A-B toll transmission selectors may be preceded by toll preceding

selectors. A-B transmission selectors do not provide for controlled ringing. The A-B toll transmission selector may be arranged to function in the following ways:

(1) Non-digit absorbing.

(2) Digit absorbing arranged to absorb any first digit received.

(3) Digit absorbing arranged to absorb specified digits once or repeatedly, but not both on the same switch. May be arranged to block on specified levels.

(4) Same as three, but in addition is arranged to cancel transmission features on any specified level for trunking to a distant office. Both the digit absorbing feature and the transmission cancellation feature may be applied to the same level.

To review, the A-B toll transmission selector functions in the A-B toll train which are similar in many respects to those performed by toll transmission selectors in the regular toll train but that differ mainly as follows. The A-B toll transmission selector provides immediate rather than delayed ringing. It provides local rather than toll supervision, that is, the operator receives no signal when the called line is seized. The connection is held under the control of the originating operator and restores when it is abandoned by her. The selector is not arranged for coin control since this train is not used for reaching calling customers in connection with delayed calls.

5.05.5 *Toll Preceding Selectors* — Toll preceding selectors are used in the train immediately preceding toll transmission or A-B toll transmission selectors in order to provide common trunking to all offices in the building. They are available in non-digit absorbing or digit absorbing arrangements.

5.05.6 *"A" Board Completing Selectors* — These selectors are similar to toll transmission selectors. They provide for the control of start of machine ringing in connection with the completion of toll calls by "A" operators with access to loop dialing types of toll trains only. These selectors are available only in offices located in the same building as the "A" switchboard.

5.05.7 *Intertoll Selectors — Regular and Auxiliary* — An intertoll first selector is required for each intertoll trunk used to handle traffic on a dialing basis. Levels 2-9 of these intertoll first selectors may have access to switching trunks to local offices in the area. Level "1" is used to gain access to auxiliary selectors which serve trunks to operators. The zero level is normally used at switching points to gain access to "through selectors" on which appear intertoll trunks to other toll centers for use in built-up connections to distant points.

Two types of intertoll first selectors are available; a combination first and transmission selector (for use in areas where the use of switching trunks in local offices in the toll building is or will be greater in the ultimate than the use of the intertoll first selectors) and an intertoll first selector without the transmission feature. (For use in areas where the number of switching trunks to local offices in the toll building is less than the number of intertoll first selectors.) In this case the trunks terminate on transmission selectors in the local offices.

5.05.8 *Intertoll Second Selectors* — Intertoll second selectors normally provide access to the switching trunks to the local offices. These selectors may have the transmission feature or not as required by the trunking plan. A specified second digit or any second digit may be absorbed by this selector which then becomes a third selector since it makes selection after the dialing of the third digit.

Intertoll second selectors are also provided to give access from the zero level of the intertoll first selectors to intertoll through selectors in those cases where the number of intertoll trunk groups to be reached on an intertoll dialing basis is greater than ten initially or will be greater soon thereafter.

5.05.9 *Selectors in Toll Train in Local Offices* — In general, it is economical to provide separate groups of trunks from the intertoll first or second selectors for the intertoll dialed traffic and for the traffic completed from the toll switchboard. However, an applique circuit may be provided on the toll switching trunks to the local offices to permit the appearances of these trunks to be multipled both on the banks of the intertoll first or second selectors as the case may be, and at the switchboard on jacks. This latter arrangement

may have a field of application on groups to outlying offices where the conductor saving with a joint group from the switches and switchboard is a factor. With this arrangement, the number of digits dialed over the intertoll trunk beyond the intertoll first or second selector step, as the case may be, must be the same as the number of digits dialed over these trunks from the switchboard.

Similarly, an existing A-B toll train may be used jointly for A-B toll and intertoll dialing.

If the transmission and ringing control feature is included in the intertoll first or second selector, or in the 4-wire trunk circuits between the intertoll first selector and the selector in the local office, a toll intermediate type of selector is used at the incoming end of the trunks provided from the intertoll selectors.

If the transmission and ringing control feature is provided in the local office, a toll transmission type of selector arranged for delayed start of machine ringing may be used, if existing selectors are available for this purpose. It is, however, necessary to provide an automatic start of ringing on this type of selector. Therefore, it is usually more economical to use the A-B type or the intertoll type of selector, which are arranged for immediate start of ringing, when it is necessary to add transmission selectors. The intertoll type which is more economical than the A-B type because it does not require an out trunk circuit, can however, be used only in local offices located in the toll building.

The banks of the intermediate or transmission types of selectors provided for the intertoll dialing traffic are multipled to the banks of the selectors of the corresponding selector stage in the switchboard toll switching train.

5.05.10 *Intertoll Auxiliary Selectors* — Intertoll auxiliary first selectors are reached from the first level of the intertoll first selectors and provide access to groups of trunks to operators. If the ten levels of the intertoll auxiliary first selectors are not sufficient to accommodate all of these groups of trunks to operators intertoll auxiliary second selectors are provided and reached from one or more levels of the intertoll auxiliary first selectors.

5.05.11 *Intertoll Through Selectors* — Intertoll through selector groups are provided to accommodate the intertoll trunk groups to be reached on a through dialing basis. One level of a through selector is required for each intertoll trunk group. The number of selectors in a group providing access to these trunks is based on the CCS load indicated by the point-to-point record for the circuit groups involved. The through selector groups, wherever possible are of the same size to facilitate load balance.

In general, all intertoll trunk circuits in a group of ten or less appear on the switches and on jacks in the switchboard. If the number of trunks in a group is more than ten, rotary switches may be associated with the levels used for groups in excess of approximately 12 to permit access to all of the trunks in a group, thus providing for more efficient use of the intertoll trunks from the switches. Groups of more than ten may also be graded if the cost of the rotary switches cannot be justified. Access is had to each group of intertoll through selectors from a level of the intertoll second selectors or, if there is only one group of through selectors, from the "0" level of the intertoll first selectors.

5.05.12 *Toll Tandem Selectors* — Toll tandem operation provides a means for the operator to obtain access to toll circuits which do not appear in the switchboard multiple. Trunks from the toll tandem multiple terminate on tandem first selectors. The intertoll trunks appear on the banks of the first selectors or on the banks of succeeding selectors. The toll tandem train may consist of several stages of selection depending upon the particular requirements of the situation.

(1) Regular intertoll selectors are employed, if stop dial and overflow features are not required.

(2) Intertoll through selectors are provided for the last selector stage in the train, if stop dial and overflow features are required. Regular intertoll selectors are used for the preceding stages.

5.05.13 *Path of a Call – Toll (Figure 24)* — In order to summarize the use of the various types of toll selectors, previously described, the progress of a call will be reviewed from a No. 1 toll board equipped with dials over a loop dialing toll

train to a called station, the number of which is 622-6471. In completing this call which has been given to her by a customer or another operator, the toll operator selects an idle outgoing trunk from the group of 622 trunks in the switchboard multiple.

Following this selection she operates the dial key and dials the called number. Pulsing from the dial is routed through to the toll transmission selector as the dial returns to normal. Since the first numeral of the called number is "6," 6 pulses are sent out from the dial circuit, through the cord circuit, over the outgoing trunk circuit, to the toll transmission selector circuit. As a result, the toll transmission selector shaft and wipers are stepped up to the sixth level and there select an idle trunk to an intermediate selector. The circuit is now complete from the switchboard to the intermediate selector via the toll transmission selector.

As the operator dials the next normal "4", four pulses are sent out over the cord circuit through the trunk circuit to the toll transmission selector circuit, where the toll transmission selector circuit repeats the pulses to the intermediate selector. The intermediate selector shaft and wiper are stepped to the fourth level and select an idle trunk to a connector.

The circuit is now complete from the switchboard to the toll transmission selector through to the intermediate selector and to a connector. In this operation as in the operation of all selectors, if an intermediate selector tested a busy trunk it, of course, would automatically pass on to the next trunk until it located an idle trunk.

If all of the trunks were found to be busy, the sleeve wiper or brush rotating beyond the tenth terminal of the intermediate selector would cause the toll transmission selector to reverse the direction of battery back over the pulse circuit to the dial, and interrupt it at the rate of 120 IPMs.

If a path is available, the toll operator dials the next numeral "7". This causes 7 pulses to be sent out from the dial circuit through the cord circuit over the outgoing trunk circuit to the toll transmission selector. The toll transmission selector repeats the pulses through an intermediate selector to the connector circuit. This causes the connector shaft to step up to the seventh level.

Following this operation, the toll operator dials the last numeral, "1", which causes a single pulse to be sent out from the dial circuit through the cord circuit through the outgoing trunk circuit to the toll transmission selector. The toll transmission selector repeats the pulse through the intermediate selector to the connector circuit, which has already been stepped up to the seventh level. This last numeral causes the connector brushes or wipers to be rotated to the first terminal on the seventh level.

If the line is found to be busy, interrupted battery will be sent back through the circuit to the toll transmission selector. The toll transmission selector reverses the direction of the battery back through the pulse circuit to the dial and interrupts it at the rate of 60 IPM's, and the operator hears busy tone.

If the called line is idle the toll transmission selector releases the dial circuit and connects the supervisory circuit so that the supervisory lamp burns steadily. This is a signal to the toll operator to operate the ringing key. This action starts the ringing circuit of the connector and the proper ringing is placed on the line to the called station.

The called customer will then answer by removing the receiver. This action trips the ringing current at the connector and extends the circuit from the called station through the connector and intermediate selector to the repeating coil of the transmission selector and in this way completes the talking circuit through this portion of the equipment. The toll transmission selector also causes the supervisory lamp to go out indicating to the operator that the talking path is completed. When the conversation is completed and the called customer hangs up his telephone, the toll transmission selector causes the supervisory lamp of the cord circuit to light as a disconnect signal.

If at this point, the toll operator finds it necessary she may recall the called customer by operating the ringing key. If the operator wishes to disconnect she removes her plug from the jack, the cord and trunk circuits are released, and the toll transmission selector is released which in turn releases the intermediate selector and the connector.

5.05.14 *Toll Switch Call (Figure 24A)* — In making a toll switch call, let us assume that the operator is attempting to reach 232-3260. The operator will select an idle trunk in the 232 trunk group which appears in the switchboard multiple. When the plug has been fully seated in the jack, the operator, following the designated practices, will begin dialing. She will dial the numeral 3, which is the first digit of the station number. At this point the toll incoming selector shaft moves up to the third level and selects an idle trunk to a toll intermediate selector. As the operator dials the next numeral in the station number, 2, the toll intermediate selector shaft moves upward to the second level and selects an idle trunk to the connector. As the operator dials the third numeral of the station number, 6, the connector moves up to the sixth level and as the operator dials the fourth numeral of the station number the shaft rotates, moving the wipers across to the tenth terminal. A busy test is made by the equipment when the tenth terminal is reached and if it is found to be idle, the operator will start ringing by operating the ringing key. As the ringing starts, the operator receives a supervisory light which goes out when the called station answers.

5.05.15 *Incoming Intertoll Dial Call* — A toll call originated at a distant point will follow the same path after reaching the called central office unit whether originated by an operator or a customer. At this point an idle incoming trunk would be utilized to reach a toll transmission selector. This may be accomplished either directly or via a toll preceding selector in the calling office. A trunk and a transmission selector in the toll train are selected if the office is a step-by-step office. The necessary digits are dialed by the distant operator or customer. The necessary intermediate toll selectors are utilized to connect the incoming call to the correct connector terminal through the toll transmission selector. The number of toll intermediate selectors utilized between the toll transmission selector and the connector depends upon the numbering plan.

6.00 CONNECTORS

6.01 *General (Figures 25, 26, and 27)*

The connectors are the third element of step-by-step equipment and as such they are the last switches of the series of switches in a step-by-step office. The connectors connect the switch train and its preceding elements to the called party's line. In addition, the connectors provide the proper ringing signal and return an audible ringing signal to the calling party. If the called station is busy, the connector will return the busy signal to the calling customer. Each connector has access to 100 connector terminals. Connector terminals arranged to connect to a line or to a station are known as terminal-per-line connectors or terminal-per-station connectors, respectively.

6.02 *Function*

In its function, the connector is similar to a selector. Its wipers are capable of choosing any set of terminals in its multiple banks by stepping vertically to the required level, and then rotating to the required terminal. The connector, as in the case of the selector, has the upper movement of its shaft controlled by the pulses coming from the dial at the calling station. However, the rotary movement of the shaft of a connector, instead of being controlled independently of the customer's dial, is governed directly by another series of pulses from the dial.

Since it is necessary for the connector to select a particular set of terminals in the chosen level to complete the connection to the called station, it is necessary that the customer's dial control the stepping over the terminals. For example, if the last two digits in the telephone number of the called customer were 36, the connector shaft and its associated wipers would be stepped up to the third level by the next to last or "tens-digit" series of pulses. Then, the wipers are stepped around to the sixth set of terminals on the third level by the "units-digit" pulses.

6.03 *Description (Figures 27, 28, 29, and 30)*

The connector switch in appearance is little different than other step-by-step switches. It is composed of a framework, a shaft and associated wipers, a multiple bank and associated relays. The connector has a large number of relays associated with it than does the ordinary selector because it has additional functions to perform. The connectors normally respond to the tens and units digits dialed by the calling party or operator. Of the 100 connector terminals provided in each regular connector group, 99 are available for connection to customers' lines or stations. Terminal 99 is used as a test terminal of the 100 connector terminals provided. Level hunting con-

nectors use one for test purposes and rotary hunting connectors use two terminals for test purposes.

In terminal-per-station offices all unassigned terminals are normally connected to intercept. In terminal-per-line offices intercept service is more of a problem and will be covered later.

Each level of the local selectors immediately preceding the connectors handles the local terminating traffic to one connector group, that is, 100 connector terminals. Corresponding levels of toll selectors which immediately precede the connectors handle the incoming toll traffic to the same 100 connector terminals. When combination local and toll connectors are used, separate cabling is provided from the local and toll selector banks to the connectors. However, sleeve contacts are common so that a local circuit and its corresponding toll circuit may be considered as one trunk incoming to that particular connector 100. Connector frames upon which the connector groups are mounted normally have a capacity of 7 shelves. (See Figure 26.) Each shelf has space for mounting 11 connectors. The first switch space on the left of the shelf is wired as a test connector. The remaining connectors on a shelf are used for completing calls from customers or operators. The connectors on a single shelf are multipled and serve a group of 100 terminals. A fully-equipped shelf would, therefore, provide sufficient paths for completing ten simultaneous calls to that particular group of 100 connector terminals. Of course, it is possible to provide fewer than ten connectors per hundred group and, on the other hand, it is also possible to provide more than ten connectors per hundred group. Under heavy traffic terminating traffic conditions, more connectors would be provided and, conversely, under light traffic conditions fewer connectors would be provided. When more than ten connectors are required per hundred group for customer traffic to that hundred group, two or more shelves may be multipled together in order to provide the additional connector capacity. Under these circumstances only one test connector is required for the group. The connector terminals are cabled to the horizontal side of the intermediate distributing frame in most offices. They are connected by jumpers from this point to their assigned line circuit.

There are several types of connectors in use. Broadly, they are known as non-hunting connectors, rotary hunting connectors, and level hunting connectors. The table below will illustrate in greater detail the several types of connectors and their normal use:

Connector Type	Use
Non-hunting	
1-Ring, local, toll or combination	Individual Flat Rate, message, coin, 2-party, and 1-ring 4-party
2-Ring, local, toll or combination	4-Party, 2-ring (also Ind., message, coin and 2-party)
10-Party, terminal per station, local, toll, or combination	10-Party (Rural Service)
10-Party terminal per line, local or toll	10-Party (Rural Service)
8-Party, terminal per station, local, toll or combination	8-Party
Rotary Hunting	
1-Ring, local, toll or combination	Smaller P.B.X. groups and consecutive groups of individual lines arranged for terminal hunting.
Level Hunting	
1-Ring, local and toll	Larger hunting groups.

(a) *General* — Main stations and hunting trunks are assigned to each connector hundred group in accordance with the type of connectors serving that group. For example, all classes requiring 1-ring non-hunting connectors, except coin, are intermixed in the same connector hundred. Coin stations are normally segregated in separate hundreds for operator identification purposes.

Various classes such as P.B.X., multiparty, and the like tend to have different traffic characteristics. Their peak loads are likely to occur at different times and may last for different intervals. In order, therefore, to reduce the effect of peak loads, a diversifica-

tion of traffic is desirable. The objective of this diversification is to spread these traffic peaks among several thousands. Multi-party and P.B.X. groups are normally spread among the various thousands in any particular office.

Connector arrangements, and traffic volume per connector group, determine the multipling arrangements for the selectors which immediately precede the connectors.

The preceding table indicates that there are several types of connectors. In addition to the classifications shown in the table, there are other significant limitations placed on connectors. They are described by the words local, toll, or combination. Local connectors are used on purely local connections. Toll connectors are used on toll connections and supply features suitable for long distance transmission. Local connectors are equipped for automatic ringing. Toll connectors are equipped for ringing which is controlled either by the operator, as in the connection of toll switch calls, or by the incoming selector and associated control relays, in the case of intertoll calls. In addition to local and toll connectors, there are also combination connectors which are equipped for use on both local and toll connections. Their use, in many cases, results in economies, by making it possible to efficiently group toll and local calls as contrasted to the inefficiencies which would result if local and toll calls had to be completed on separate trains.

With these broad categories in mind concerning the various types of connectors, it seems logical at this point to describe in some additional detail the characteristics which distinguish non-hunting connectors, rotary hunting connectors, and level hunting connectors, one from the other.

(b) *Non-hunting Connectors* — Non-hunting one-ring and two-ring connectors are used for the bulk of the connector requirements in step-by-step offices. They serve the usual 1, 2, and 4-party stations, either flat rate, message rate, or coin.

One-ring connectors are used for 1, 2, and 4-party full selective ringing. They are normally provided except for 4-party stations requiring semiselective (2-ring) signaling. When this requirement no longer exists, these 2-ring connectors can be modified for 1-ring operation if it is desired. There is very little difference between a 1-ring and 2-ring connector. The major difference being that the 2-ring connector has an additional relay which operates under the control of a ground so that ringing is placed on the line only at the beginning of the first of two rings, thus preventing a possible false ring. The ringing cycle for the 2-ring connector like the 1-ring connector is 6 seconds and is broken down as follows:

Tip Side	Ring Side
1" ring	1" ring
1" silence	1" silence
1" ring	1" ring
3" silence	3" silence

(c) *Rotary Hunting Connectors* — Rotary hunting connectors are employed when consecutive groups of numbers requiring terminal hunting are to be assigned which are not large enough to warrant level hunting equipment. Other classes of service may be assigned to rotary hunting groups as well as consecutive lines. The rotary hunting connector is capable of hunting over a maximum of ten customer lines or trunks. If P.B.X. systems of more than ten trunks are to be served, graded arrangements may be employed or level hunting connector groups provided. If graded arrangements are used, a minimum of one connector shelf for each group of ten P.B.X. or other consecutive trunks or fraction thereof is necessary. At least two connector shelves are normally provided to serve groups of 10-15 trunks, and three connector shelves are provided to serve groups of from 16-20. Also the equipment should be so assigned that the traffic per shelf, local and toll, will be approximately equal. As mentioned above, it is possible to serve P.B.X. groups of more than ten trunks with rotary hunting connectors. Often when this is done separate subgroups of local and toll connectors are provided. Combination rotary hunting connector groups may be used in smaller offices when the maximum number of connectors required in the ultimate period is not likely to exceed ten per group. It is not

customary to use combination connectors in excess of ten per group.

If less than ten trunks are required to a given P.B.X., several small groups of P.B.X. trunks may be placed on the same rotary hunting type connector level. The listed number will be dialed in each case and the connector will step to the first trunk of a group under the influence of the dial and hunt over only those trunks on that level associated with the particular listed number. If all trunks are busy, a circuit condition on the last terminal of the group causes the connector to send back the busy signal in the usual manner. The only restriction is that the trunks in a given group must have consecutive telephone numbers. The listed P.B.X. number cannot end in zero.

In the event that the number of trunks to a given P.B.X. exceeds ten, various methods have been devised to give equal access to all trunks from connector levels using rotary hunting type equipment.

Assuming for purposes of illustration that the P.B.X. group is located in the 4100 group. The customer's listed number is 4111. The connector hundred has three shelves of connectors and the customer desires a total of 30 trunks with ten consecutive trunks 4111 to 4110. The additional 20 trunks will be provided by cutting the strapping between terminals on shelves A, B, and C, thus providing the customer with ten individual appearances on each shelf. The "block method" of graded multiple assignment requires the assignment of a terminal in the same connector hundred to each terminal appearance of this customer's P.B.X. on the B and C shelves. Thus, 4111B could become 4121 and 4111C could become 4131 — or any other number available for assignment in the same P.B.X. hundred. A call terminating on the B shelf would still take one vertical step but would seize the 4121 terminal if the first trunk were idle. Under like circumstances, a call terminating on the C shelf would take one vertical step but would seize 4131. These terminals are made available for this purpose by cross connections on the terminal block at the right of the connector shelf.

Another method would be to subgroup the toll and local connectors (where combination connectors are not used), and divide a 20-line P.B.X. into two groups of ten — placing ten trunks on the local connectors and the other ten trunks on the toll connectors. Obviously this method tends to give the customer inefficient incoming service, and such an arrangement is not recommended.

(d) *Level Hunting Connectors* — Level hunting connectors are capable of hunting over a maximum of 99 P.B.X. trunks in groups of ten and are used to serve groups to large P.B.X.'s which cannot be accommodated on rotary hunting connectors.

The function of level hunting connectors is as follows: Assume a level hunting connector serves a large group of P.B.X. trunks. In this case, the trunks are connected to the various levels consecutively. This type of connector will hunt completely over a level, restore to normal if there is no idle trunk on that level, and then by means of a commutator and a recording ("minor") switch, which is mounted on the connector, it will step to a second level and hunt over it. This is continued over the various levels until an idle terminal is reached or until all trunks in the group have been tested.

The recording (minor) switch is operated by the tens digit of the number (units digit is ineffective). The hunting sequence of the connector is controlled by strapping on the banks of the recording switch. Each shelf (or each switch) of connectors may be arranged to hunt the levels assigned to the group in a definite order. These assignments should be made so that the traffic load on the P.B.X. trunk is equalized.

Separate subgroups of local and toll level hunting connectors are normally provided. When more than one graded subgroup of local connectors are required, the subgroups are arranged in approximately equal size avoiding, if possible, the use of subgroups of ten or less than ten connectors. On level hunting connector shelves, one level is required for each ten trunks or fraction thereof in the P.B.X. trunk group. Not more then one P.B.X. can be assigned to any one level. Those terminals

on a level to which working trunks are not assigned are multipled to working trunks of the P.B.X. assignment so that each terminal on a level is connected to a working trunk.

If the nature of the large P.B.X.'s is such that it is undesirable to assign several of these customers to the same connector group, the number of level hunting connector groups must be increased. When this is done the spare assignments should be filled with smaller P.B.X. groups. When both level and rotary hunting connectors are provided in an office, P.B.X. groups of 7-10 lines should be carefully analyzed for growth requirements and assigned in the level hunting connectors if it appears that they will have a requirement for more than ten lines in the near future.

The local level hunting connector is arranged to start hunting as soon as the "tens digit" is dialed. Where the entire connector group serves a single group of P.B.X. trunks, the local connectors may be arranged to start hunting immediately after a connector has been obtained. Where a level hunting connector group serves a P.B.X. of more than 99 trunks, a graded multiple arrangement of the P.B.X. trunks is generally used. Where such an arrangement is specified in the initial sales contract, or where a P.B.X. group is expected to equal or exceed 99 trunks, based on the administrator's judgment, an adequate portion of the hundred group of customers' numbers next higher than the one in which the listed number of the P.B.X. appears should be reserved. This arrangement provides that all the trunk assignments for this large P.B.X. may be consecutive.

6.04 *Miscellaneous Connectors*

In addition to the classifications of connectors described above, there are other types, such as test connectors, divided code ringing connectors, multi-party connectors, etc.

6.04.1 *Test Connectors* — Test connectors provide a means for routine testing of customers' lines. In addition they enable operators to verify busy reports. The test connector is so arranged that it will establish a connection to a set of terminals even though those terminals test busy.

6.04.2 *Multi-party Connectors* — Multi-party connectors are usually referred to as Code Ring connectors. They are used in serving rural lines on a full dial basis. To give this service, separate connector groups are provided. These are available for terminal-per-line or terminal-per-station operation in three general types: eight-party semiselective terminal per station; ten-party divided code terminal per station; ten-party divided code terminal per line.

The selection of the type of terminal per station equipment to be used is usually dependent upon local policy. Terminal-per-line equipment is generally considered unsatisfactory because only partial intercepting service can be economically provided.

(1) Eight-Party Semiselective Terminal-per-Station — With the use of eight-party terminal-per-station connectors, ringing similar to that provided on 4-party full selective ringing lines is used to provide semiselective ringing for the eight parties. Although special ringing facilities are required for this purpose in semiselective ringing offices, the connectors are designed so that any terminal may be assigned to any station since the ringing code is determined by suitable cross connections. Where desired, therefore, two-party and four-party stations may also be assigned in these groups. Intercepting service may be provided when these connectors are used. The eight-party terminal-per-station groups can be served by combination connectors. No selector circuit has, as yet, been designed for use with a repeated dialing toll train. In making reverting calls, a two-digit reverting call switch is required as was explained earlier in the description of reverting call selectors.

(2) Ten-Party Divided Code Terminal-per-Station — Ten-party terminal-per-station dial equipment provides a five code divided ringing system for use on multi-party lines. In general, this arrangement is more economical than the eight-party terminal-per-station equipment. The ringing arrangements of this type of equipment may be considered as less desirable than that provided for by eight-party terminal-per-station equipment. With this arrangement half of the stations on the line will be rung at one time. The customer desired should answer if his ringing code is

rung. The usual central office ringing supply can be used so that no special ringing facilities are required. This results in economies when compared to the eight-party terminal-per-station arrangement. Intercepting service can be provided with this equipment, and any station can be associated with any connector terminal in the multi-party group. With this type of equipment either combination connectors or separate local and toll connectors can be provided. The toll connectors are arranged to function with either loop or repeated dialing trains. To make a reverting call, the customer dials a listed number, receives busy tone and hangs up. The connector recognizes the fact that both calling and called stations are on the same line, releases the line finder and selectors involved in the connection; but remains operated itself and applies ringing current to the line until either the called or calling party lifts the receiver to trip the ringing. The answer of either station trips the ringing.

(3) Ten-Party Divided Code Terminal-per-Line — Ten-party terminal-per-line dial facilities provide a five code divided ringing system for use on multi-party lines. With this arrangement, as in the case of ten-party terminal-per-station equipment, half of the stations will be rung at the same time, and as a result, five ringing codes are required. An additional numerical digit is required with each customer's number to determine the ringing code to be applied. This arrangement utilizes a recording (minor) switch which is built into the connector switch circuit. This switch has its own rotary and release magnets and is equipped with a ten-point bank on which the ringing codes are terminated.

Intercepting facilities for intercepting a particular party on a line through the use of a detector circuit for selecting circuits are available. These circuits are quite expensive and as a result it is necessary to utilize them to the utmost.

Calls from coin and message rate lines to numbers in ten-party divided code terminal-per-line connector groups will have the coin collected or a charge made if the call is answered by any party on the line. Separate local and toll connectors are provided. Toll connectors are arranged to function with either the loop or the repeated dialing type of toll train. Reverting calls are made in the same manner as previously described for ten-party divided code terminal-per-station equipment.

(4) Ringing Code Leads — A sufficient number of ringing code leads must be provided in terminal-per-station offices to serve the type of development to be assigned in the multi-party groups. Some offices are arranged for 40 leads per code for each multi-party group. In some cases, this arrangement proves to be inadequate. A more recent design provides 600 code leads per code relay with a maximum of five relays per code or 3,000 code leads per ringing code. In new installations, 600 code leads per code will normally be provided. In cases where this arrangement does not provide sufficient code leads for a particular ringing code, or if more than 15 multi-party connector groups are provided, the number of code leads may be increased.

6.04.3 *Free Service Connectors* — Official lines to which free service is to be given from message rate and coin lines are assigned in separate connector groups. These groups are equipped with connectors arranged to provide free service over the entire group or over a number of levels of the group. Any connector group may be arranged to apply free service over all levels. Local or combination one-ring connectors and local or combination rotary hunting connectors may be arranged to provide free service on certain levels. These arrangements must be specified in the traffic order.

7.00 TRUNK CONCENTRATING EQUIPMENT

7.01 *General*

Trunk concentrating facilities provide a means for combining trunks or subgroups of trunks into one large group. Such a combination results in increased trunking efficiency and therefore results in savings in trunk and switching equipment and in outside plant. There are several types of trunk concentrating equipment, namely, plunger out-trunk switches (see Appendix III), rotary out-trunk switches, trunk finder intercepting concentrating equipment on rotary switches or trunk finders.

7.02 *Rotary Out-Trunk Switches (Figure 31)*

Rotary out-trunk switches are a type of

trunk concentrating facility which makes for more economical operation. The 22-point rotary switch is a development for concentration, sometimes referred to as a 200-type selector. These rotary out-trunk switches are arranged in units with a capacity for ten switches per unit. Two or three of these units are multipled together to provide capacity for a subgroup of less than 22 interoffice trunks. One of the 22 terminals on each switch is required for maintenance purposes, thus limiting the capacity of the trunk switch to 21. Normally, two or more trunk subgroups of 21 trunks or less are combined in accordance with a fixed pattern. This combination results in larger trunk groups.

The arrangement of trunks associated with rotary out-trunk switches is normally such that the first choice trunks of each selector multiple subgroup may be connected directly on outgoing repeaters (these are referred to as direct trunks) and multipled as well, on rotary switches. Thus, the banks of the rotary switches are usually connected to all outgoing trunks in the group including the direct trunks. As a result, most of the traffic is provided access to the trunk group over direct trunks. The remainder of the traffic is provided access via the rotary out-trunk switches which may select over the multipled direct trunks which are idle or "less preferred" trunks terminated only on the rotary switch banks. These trunks are often referred to as secondary access trunks.

7.03 *Trunk Finders*

For economical operation, 100-point or 200-point trunk finders are available for combining groups of trunks into one common group. Trunk finders operate in a manner which is similar to line finders. They are arranged in units of ten finders. One 11' 6" trunk finder frame will accommodate seven direct finder units. The 200-point trunk finders may be arranged in groups of from ten to 140 finders with a capacity of 200 incoming trunks. The 100-point finders may be arranged in groups of from ten to 40 finders with a capacity of 100 incoming trunks.

7.04 *Rotary (Extension) Switches (Toll Application)*

Rotary type switches, similar to those used as rotary out-trunk switches, are used in connection with toll trunking to gain access to large groups of toll circuits. These switches, with associated banks and relays, are provided in units of either five or ten banks as required to meet the traffic needs.

Where switch access is obtained on the banks of either the through selectors or the auxiliary selectors to groups of approximately 12 or more intertoll, tributary, or community dial office trunks, the provision of rotary switches makes it possible to secure access to all of the trunks in a large group on a step-by-step selector level of ten terminals. This rotary switch provides access to 22 trunks. This switch is of the (preselecting "stay-put") type, and, therefore, hunts over the terminals in order from low numbered to high numbered trunks, and then repeats.

7.05 *Intercept Concentrator Equipment*

For the purpose of concentrating intercepting traffic several types of equipment have been used. They include step-by-step selectors, rotary switches, plunger switches, and trunk finders. The basic function of these equipments when used for this purpose is unchanged.

Calls to vacant terminals, vacant toll selector levels, vacant local selector levels, calls to stations which have been disconnected or have been affected by number changes, and calls which are being intercepted for any other reasons must be routed to intercepting operators or, in the case of vacant or disconnected numbers, they may be routed to a recorded announcement. All vacant connector terminals are also wired to intercepting trunks. Upon receipt of a call resulting from any of the conditions described above the operator will inform the calling party that the number dialed has been changed, disconnected, etc. Individual intercept trunks may terminate directly on jacks in the switchboard or desk multiple or in the call distributing equipment connected with a desk or AIS. However, it is more economical to concentrate these trunks. Early installations utilized plunger type concentrators. Newer offices utilize rotary switches or line or trunk finder type concentrator facilities. Intercept trunk finder units using step-by-step switches have been provided in 50-, 100-, and 200-point units. A smaller unit using a rotary type switch has a capacity of 22 intercepting circuits.

Intercepting circuits for connector hundreds may be concentrated with trunk finders

in a manner similar to lines on line finders, the intercepting circuit being the line and the trunk finder being the line finder. The intercepting circuit is connected to a trunk in the same manner as that in which a line is connected to a first selector.

The trunk finders are equipped so that they cause a lamp to be lighted at the switchboard on trouble intercepting calls, and, thus, it is possible to differentiate trouble intercepting calls from regular intercepting calls. In order to accomplish this it is necessary to segregate trouble intercepting trunks by groups of 20 on corresponding levels of the upper and lower 100's of the trunk finders' banks for the 200-point switch and by groups of ten for the 100- or 50-point switch. Any terminal of the rotary type switch may be used for trouble intercepting. Connector terminals are associated with intercept trunks at the horizontal side of the intermediate distributing frame through the use of jumpers between vacant terminals or through the use of strap wires between connector bank terminations and corresponding terminations of the intercepting trunk.

Each intercept trunk concentration unit is usually furnished with a few "special" intercepting trunks. These trunks are assigned to a particular terminal to which it is expected that a great number of calls will be made. For example, if a P.B.X. group is disconnected or number changed each terminal of the group might be strapped to a "special" intercept trunk, thus making it possible to intercept more of the calls routed to these numbers.

Provision is made for vacant selector level intercepting by terminating two or more intercept trunks at the top of each selector bay terminal assembly. When it is necessary that a vacant level be intercepted the contacts of that level on each shelf involved are grouped together. When these contacts are grouped, jumpers are run from the terminal assembly on the rear of the uppermost shelf in the group to the intercepting trunks at the miscellaneous terminal strip. These trunks terminate at the intercepting concentrator equipment in the same manner as vacant connector terminals.

8.00 REPEATERS (Figure 32)

The principal functions of repeaters are to reduce a 3-wire connection between offices to a 2-wire connection, to repeat pulses, and improve long loop transmission.

For connections between lines working out of the same office, or out of two offices located in the same building, the switches composing the train are relatively close together; therefore, it is economical to provide the regular 3-wire trunks all the way from the line switch or line finder to the connector. But in case the two offices are in two separate buildings, possibly several miles apart, the length of such trunks may prevent the dial pulses from satisfactorily operating a selector or connector in the distant office if a long subscriber loop also is involved. Further, it is often impossible and very uneconomical to operate the holding circuit over the third wire (or "S" lead).

In such cases a "Repeater" is interposed at the originating office between the last selector and the outgoing end of each trunk to a distant office.

This repeater has relays which are operated by the dial pulses from the calling station and produce equivalent dial pulses on the trunk, which operate the associated selectors and connectors at the distant office.

Battery for dialing and for talking is furnished the calling station through the repeater.

Supplying talking battery from the repeater to the calling party insures more uniform transmission, which would not be obtained if the connector in the distant office was the source of supply.

Dialing battery in the trunk loop is furnished through each successive incoming selector and finally through the connector at the terminating office.

The called station's talking battery is furnished through the connector just the same as on calls not trunked through a repeater. Repeater switches consist of relays and condensers and repeat coils. They do not have the switching mechanism of selectors and connectors.

The outgoing repeater may not always retransmit the dial pulses with the same precision that a dial gives. Usually the switches in the distant office will operate satisfactorily on the repeated pulses. Where a trunk is very long, however, the distortion of the pulses may be increased to a point

where the distant switches will no longer function. In this case, a special repeater, called a "pulse correcting" repeater is added at the incoming end of the trunk. This repeater replaces the distorted incoming pulses by new pulses which will operate the switches satisfactorily.

9.00 TRUNKING

9.01 *General (Figure 33)*

The term trunking as it is used here refers not only to interoffice trunking, but more broadly to all types of trunking including interframe trunking.

In the step-by-step dial system, there are a number of distributing frames which differ more in name than in construction. The Main Distributing Frame is essentially a meeting point for outside lines and centtral office equipment, whereas the Intermediate Distributing Frame is the frame to which the office equipment is actually connected.

The Main Distributing Frame, Intermediate Distributing Frame, and the other distributing frames each have a vertical and horizontal side, which refers to the manner in which the terminal blocks are mounted.

Each frame name may be abbreviated. When the vertical or horizontal sides of a particular frame are referred to, the letter V or H is simply placed before the abbreviation, as H.I.D.F. for horizontal side of the intermediate distributing frame.

Every telephone line or "cable pair" is made up of two wires commonly referred to as tip and ring (T & R). They enter the building through the cable vault and are terminated on the vertical side of the main distributing frame (V.M.D.F.). At the V.M.D.F. a two-wire jumper (T & R) connects the incoming line to the horizontal side of the main distributing frame (H.M.D.F.). These two-wire jumpers on the M.D.F. provide the necessary flexibility to change the outside cable pairs when necessary due to faulty cable or to the customers having moved to other locations in the area served by the same building.

From the H.M.D.F. the customers' numbers or lines are permanently cabled to the horizontal side of the intermediate distributing frame (H.I.D.F.). At the H.I.D.F. are also the permanently cabled T, R, and S (tip, ring, and sleeve) leads to the terminals or lines, M (message register) leads to the message register rack. A jumper (three or four wires, depending on the class of service) joins the H.I.D.F. to the V.I.D.F. At the latter point, T, R, S, and M leads are permanently cabled to the line finder frames.

It is evident that changes in the traffic characteristics of the customers connected to any office and the number of calls originated by them will make it necessary to modify the assignment plan for the loading of lines to the various line finder groups.

In addition, but less frequently, the number and size of the groups of trunks from selectors will also be affected. It is, therefore, necessary to arrange and group the terminals of the lines and trunks in such a way that these changes can be made quickly and conveniently.

9.02 *Distributing Frames (Figure 33)*

There are several places where this grouping occurs, the most important, being at the Distributing Frames and the Terminal Assemblies.

In a step-by-step office, there are usually either two or three types of Distributing Frames used. There is the Main Distributing Frame, Intermediate Distributing Frame, and a Trunk Distributing Frame.

The principal use of each of these various type frames is as follows:

(a) Main Distributing Frame — This frame is used as a means for jumpering between connector terminals (or telephone numbers), or line finder terminals (line circuits), and outside cable pairs. Prior to about 1930, it had been the practice to terminate the telephone numbers on the horizontal side of the M.D.F. Since then, except for additions to existing installations, it has been the general practice to terminate the Tip (T) and Ring (R) of the line finder group terminals on the H.M.D.F., and to terminate numbers on the I.D.F.

Occasionally, miscellaneous circuits such as incoming selectors also are terminated on the horizontal side of the M.D.F. frame.

(b) Intermediate Distributing Frame — This frame is used for the termination of the connector terminals (telephone numbers) and the subscribers' line relay circuits. The former appear on the horizontal side whereas the latter appear on the vertical side. Connection between these is done by 3-wire jumpers in accordance with traffic assignments.

(c) Trunk Distributing Frame — This frame is used for jumpering between miscellaneous relay circuits and other associated equipments. Cross connections between line finder and first selector, level trunks to repeaters, concentrating switches or trunks to repeaters, etc., are usually arranged for on this frame.

9.03 *Line Finder Trunking (Figures 34 and 35)*

When line finder equipment is used, groups of 198 lines or less are connected to finder units which each have access to a certain number of selector trunks, depending on the number of line finders equipped. (Terminals 10 and 110 are used for test, and, therefore, are not provided with line equipment.) With line finder type trunking there is always a first selector for each line finder. In most cases the line finders are cabled to the horizontal side of the T.D.F. and cross connected there to the first selectors which are cabled to the vertical side of the T.D.F. The line finder assignment of any one line finder unit should be "scrambled"* over all selector shelves. That is, if any office were equipped with 20 first selectors shelves and the line finder units were equipped with 20 line finders, the 20 line finders of the unit would be assigned one each to the 20 selector shelves. This arrangement permits better distribution of originating traffic and guards against possible equipment trouble that might result in the failure of an entire selector shelf, such as a "blown" fuse.

There are three 200 line (198 equipped lines) standard line finder units which have a capacity of 16, 20, and 30 line finder switches. The size of the unit used depends upon the C.C.S. generated by its associated lines. For the purpose of the following description the 20 switch unit as provided for the No. 1 type offices will be used.

If necessary, the number of switches initially installed in any group may be only a part of the switch capacity, the remainder being added as occasion demands.

* *Covered on ED-31279*

All of the customers' lines of a group appear in the multiple banks of each line finder associated with that group, so that any finder can connect any line to a selector associated with that particular finder.

In order to shorten the time necessary for a customer to be connected to an idle selector and to minimize and equalize the wear on the mechanical parts and relay contacts on the switches by distributing the load, the multiple banks of the line finders are "slipped," and the wiring between a group of 200 lines and the associated finders is so arranged that ten subgroups (each consisting of 20 lines) each have a different first choice finder. The first two choice finders are usually referred to as the "home" finders. Figure 34 shows the "slip" arrangement in the banks. Thus, if a customer's line is assigned to any of the equipped line circuits 11-10 or 111-110, the first choice or "home" finders would be switches 1 or 11. If these finders are busy, the 3rd and 4th choices would be switches 10 and 20, respectively. The 5th and 6th choices being switches 9 and 19 and so on with finder No. 12 being the last or 20th choice. Customers assigned to the 61-60 or 161-160 series would have for their "home" finders, switches 6 and 16 and with 3rd and 4th choices being switches 5 and 15, respectively, and so on. It is because of this arrangement that assignments in a new line finder unit should be made proportionately in each of the ten subgroups as the unit is being loaded. A table showing the sequence of choice of line finders for calls from any line in the group is shown in Figure 35.

New line finder units are frequently installed with less than 20 line finders equipped. In these cases, the equipped positions are in accordance with a prescribed pattern, the order of installation being as follows:

1, 6, 4, 9, 2, 7, 3, 8, 5, 10, 11, 16, 14, 19, 12, 17, 13, 18, 15, and 20.

Conversely, it is occasionally found economical in the interests of good engineering, to remove the excess line finders from an installed unit. In these cases, the line finders should be removed in the opposite sequence to which they were installed. Thus, the order of removal would be:

20, 15, 18, 13, 17, 12, 19, 14, 16, 11-10, etc.

Calls from message rate and coin box customers are trunked through message register and coin box trunk equipment before reaching a selector; therefore, it is necessary to arrange customers' lines and the line finders in such manner that one group of finders will serve flat rate customers, a second group will take care of message rate service and still another group will be used for the prepay coin box service. Under certain conditions a group of message rate line finders may serve flat rate as well as message rate lines.

9.04 *Selector Trunking*

There are two types of selector frames: the "low" type (used in the older offices) consisting of 2 bays placed back to back, each having 6 shelves upon which are mounted 20 selectors and associated multiple banks. The two bays are joined together at one end by the terminal strip support on which the terminal strips from the selector banks are assembled.

The high type selector frame — which supersedes all previous kinds — also consists of two bays, but the bays are erected in line, with a distributing type terminal assembly between them. Each bay contains a maximum of 160 selectors (8 shelves, each having 20 switches) with the associated multiple banks and a small individual bay fuse panel. The selector shelves each have their own supervisory equipment. (Figure 18.)

9.05 *Distributing Terminal Assemblies*

There are two types of selector terminal assemblies, the older, known as the flat ("pinch") type, uses terminal strips similar to those used with line switches and the other is the distributing terminal assembly.

Selector banks are ordinarily wired in groups of ten, the 100 circuits of each bank being multipled straight (not slipped as are those of the line finders). Therefore, in a fully equipped "low" type selector frame it would be possible to have, if necessary, 24 different groups (ten per group) of selectors and in the "high" type, 32 groups. (Figure 18.)

The methods of terminating the multiple bank wiring, outgoing cables, tie cables to other bays and the grouping of shelves, etc., on the two types of terminal assemblies are different. It is necessary to have a clear understanding of both of these systems in order to obtain a thorough knowledge of selector trunking. However, since the flat type assembly is now absolete it will be discussed in Appendix IV. The distributing terminal assembly used currently is discussed here. (Figure 19.)

On a distributing type terminal assembly (D.T.A.), the 100 circuits from each multiple bank are terminated in one group. The bank terminal strips consist of small molded strips of insulating material, each containing ten terminal pins in a horizontal row. The rear projection of each pin has two notches; the inner is used for terminating a wire from the multiple bank and the outer for one wire of the jumper to an outgoing trunk or tie cable. The front end of the terminal pin is slotted to provide two soldering lugs, one directly above the other.

Three 10-point strips assembled one above the other provide the T, R, and S terminals for one selector level, and ten such groups arranged horizontally provide terminal facilities for the ten levels — or 100 circuits — of one half shelf of ten selectors. (Figure 18.)

In the case of toll terminal assemblies, the strips would be arranged four deep, that is, one terminal pin for each T, R, S, and C lead.

The ten groups are clamped between two angle irons and mounted on the framework of the terminal assembly.

Since the high type selector frames have a capacity of 32 ten switch half shelves it will require 32 terminal assemblies mounted one above the other for a fully equipped frame. The arrangement of the pins on the strips is such that when the strips are mounted in the terminal assembly the T, R, and S terminals of one shelf of selectors will be in line vertically with the corresponding terminals of other selector shelves. (Figures 19, 36, and 37.)

Each level may then be multipled by means of vertical strap wires, using the front projection of the terminal pins, through as many half shelves of selectors as may be required. When it is necessary to provide a reversal a small local form is used in place of the regular vertical strap wire.

Outgoing trunk cables, tie cables, miscellaneous circuits such as tone and intercepting

trunks, etc., are terminated on I.D.F. type terminal strips, which may be 3, 4, 6, or 8 row strips, as required.

These strips are mounted vertically on either side of the terminal assembly and then by the use of standard jumper wire the outgoing trunks are cross connected to any desired group of selectors.

One of the most important advantages of the "D.T.A." type assembly is the ease with which additions and rearrangements can be made.

The multiple slip arrangement commonly used with the flat type terminal assemblies is not used with the D.T.A. types. In place of the slip, a type of multipling called "graded multiple" is used, the D.T.A. assemblies being particularly adapted to the use of this system. Graded multiple is an arrangement for associating a subgroup of more than ten trunks with several shelves of selectors in such a way that some of the trunks are common to all of the shelves of selectors involved while the remaining trunks are individual to one or more shelves.

The last trunk in any group is multipled straight so as to be the last choice for all the selectors in order to obtain an accurate check when a last trunk busy record is required.

9.06 *Arrangement of First Selector Bank Levels*

The top or "0" level of the first selector banks serving line finders is assigned to trunks to the operator.

The bottom or first level is assigned to access Direct Distance Dialing equipment.

The remaining eight levels may be used as desired for trunks to regular selectors in the same or in another step-by-step office.

Levels that are not in use are connected either to the intercepting operator or to a "vacant" level tone or, a recorded announcement. It is more desirable to have these calls handled by an operator who may instruct the customer. Should a customer accidentally dial into an unequipped level, he will either be informed of this condition by the operator or will hear "tone." In both cases he must hang up and then dial the correct number.

9.07 *Special Service Trunks*

Classes of service are segregated at the line finders. The traffic from these classes and from the DSA Switchboard may be combined over a group or subgroup of trunks from the first selector levels, except on the trunks from the first and "0" levels.

Because of differences in operating methods, separate trunk groups to the Toll Operator, are required for certain classes of service, some of which are:

(a) Flat Rate

(b) Message Rate

(c) Coin Box (Prepay)

9.08 *Construction of a Switch Train*

The number of switches to set up a train and complete a call in a step-by-step office depends, of course, on the numbering plan utilized in the area served by the office. Regardless of the plan, a regular selector is required for each digit in the number except the final two digits which require a connector. (Terminal-per-line connectors require 3 digits.) Digit absorbing selectors, when used, reduce the number of selectors required corresponding to the number of digits absorbed.

For purposes of explanation, assume the use of a 7-digit system, as follows:

In 7-digit areas the selectors are ordinarily divided into two main classes, that is, local and incoming. The local selectors are associated with the trunks from the first selectors in the same office, and the incoming selectors are associated with the incoming trunks from distant offices.

The incoming trunks from other offices are cross connected at the main frame so that in some cases they may be distributed over the various shelves in such a way that, as far as possible, each subgroup of trunks to succeeding selectors will carry a proportionate part of the incoming traffic. The distribution, however, is limited by the number of incoming trunks and their associated peg count registers. A register is associated with all the trunks on a quarter, half or full shelf (a full shelf being 20 switches).

This means that trunks from only one office should be assigned to any one section of a shelf. Experience has indicated the desirability of "scrambling" local and incoming selectors as much as possible, in order to obtain a more even distribution of traffic.

The local first selector to second selector trunks, second to thirds, and thirds to connector switches are cabled direct from the terminal assemblies to the jacks of the succeeding switches except in the cases just mentioned in the preceding paragraph where the locals and incomings are scrambled on the selector bay. In these cases the trunks from local firsts are usually cabled to the T.D.F. for cross connection to the local seconds.

Trunks to other offices from the levels of the first selectors may either be trunked to repeaters or they may be trunked through Rotary Out Trunk Switches or through Plunger Out Trunk Switches.

The use of outgoing trunk concentrating switches generally depends upon the number and size of the outgoing trunk groups and the economies of each individual situation should be examined separately.

9.09 *Connector Trunking (Figure 38)*

There are several types of connectors, among which are non-hunting combination 1-ring and 2-ring (often referred to as "regular" when not designated for a particular class of service such as coin), local or toll rotary hunting, local or toll level hunting, and ten-party (rural) connectors. Local connectors are associated with trunks from the preceding local selector banks only and toll connectors with trunks from the preceding toll selector banks only.

One connector is provided for each working trunk from the preceding selectors. In the case of combination connectors, there will be separate cabling from the local and toll selector banks but both circuits will terminate at the same combination connector and are considered as one trunk. One test connector is provided for each group of 100 connector terminals.

All the connectors serving a given group of 100 terminals constitute a connector hundred (sometimes referred to as a connector board) and each hundred is assigned to a certain type of connector (regular, rotary, level, rural or coin box).

A given level of the preceding local selector multiple handles the local traffic incoming to a maximum of 100 connector terminals and the corresponding level of the preceding toll selector routes the incoming toll traffic to the same 100 terminals.

The number of trunks per level from each of these multiples is usually small and so each of the two groups is relatively inefficient. To reduce this inefficiency as much as possible it is usually found economical to combine the trunks from both levels and terminate the combined group of trunks on combination connectors. Combination connectors are available for Rural Connector frames (Terminal-per-Station Type).

9.10 *Toll Trunking (Figure 24)*

Thus far we have covered principally the trunking of local calls. Next, the loop train will be described.

Toll selector frames normally mount two shelves of ten selectors. Distributing terminal assembly equipment is not provided with ten size shelves since the small amount of graded multiple required can usually be arranged for at the T.D.F. However, twenty capacity shelves are sometimes provided for some types of intertoll and toll transmission selectors. These frames are equipped with D.T.A.'s.

Incoming trunks from toll switchboards and dial intertoll systems usually terminate on third or fourth selectors depending upon the area's trunking arrangements. Trunks from toll switchboards used for completing delayed outward calls which require control ringing must terminate on toll transmission selectors or toll preceding selectors. These in turn are trunked to transmission selectors. Trunks from inward toll switchboards and dial intertoll systems may terminate on this same type of equipment, but if they are, special equipment is required to start ringing. Normally, AB toll transmission selectors are used to terminate (either directly or via toll preceding selectors) toll switching trunks from intertoll dial systems. The banks of the two types of transmission selectors may be multipled to common groups of intertoll intermediate selectors. The trunks from the banks of the toll fifth selectors terminate on connectors.

9.11 *Testing and Verification*

A test connector is provided for each connector group terminals in the step-by-step office. Each test connector is cabled to the banks of the test distributors which have capacity of 100 circuits. Should the testman desire to make a test on station 622-3456, he would choose a trunk to the particular office test distributor, dial 34, which would connect him to the proper test connector, and then 56, which would connect him to terminal 56.

Verification test calls made from the switchboard utilize a switch train similar to that used by the testman. In this case, jacks in the multiple are associated with "operators" test distributors (2-digit), the banks of which are multipled with those of the test distributors used by the testman. The test connectors are, therefore, used jointly by the operators and the testmen.

9.12 *Multiple Arrangements (Figure 39)*

(a) General — Since grading is seldom arranged on selector bays equipped with flat type terminal assemblies the discussion on this subject will be restricted to installations with distributing type terminal assemblies.

In order that as many selectors as traffic conditions require will have access to a group of trunks on a particular level, the bank terminals are multipled for as many sets of terminals as necessary to provide a sufficient load for each particular subgroup of trunks.

Selectors have their banks multipled in groups of ten. The selectors given access to the same subgroup of trunks on a particular level comprise a ***subgroup of selectors.*** When ten or less selectors in a subgroup are to be given access to ten or less trunks on a particular level no multipling between selectors is required. Larger selector subgroups are built up by multipling together the required number so that the number of selectors per subgroup is usually some multiple of ten and the number of trunks in the subgroup is determined by the traffic to be carried. (Figure 19.)

Subgroups of ten or less trunks are known as ***straight multiple subgroups*** since each trunk is common. Subgroups of more than ten trunks are known as ***graded multiple subgroups*** since part of the trunks are common and the remainder are individual.

In order that all the selectors of a ***straight multiple subgroup*** having access to ten or less trunks will not rotary hunt over the trunks in the same order, all of the working trunks of each level are usually reversed approximately in the middle of the subgroup of selectors having access to them. The last trunk in most cases is not reversed in order that L.T.B. registrations may be obtained. The reversal distributes the traffic load over the trunks, distributes the wear on the switches, and reduces hunting time, thus, reducing the possibility of clipped digits. However, if there are four trunks or less equipped, no reversal is used and all trunks are multipled straight.

In order that all of the selectors of a graded multiple subgroup will not hunt over the common trunks in the same order, the common trunks (except the last as explained above) are usually reversed approximately in the middle of the subgroup of selectors having access to them. Where trunks are reversed, either in straight or graded multiples, the designations of these trunks are applied to the first bank terminals of the subgroup, the trunk numbers below the reversal being in the reverse order. These reversals are accomplished by the use of reversal forms (bugs) in place of straight vertical straps or by jumpers. If the traffic delivered by the two halves of a subgroup is substantially different, the reversal is usually located at some other point which more nearly splits the traffic on each side of the reversal.

In general, the number of trunks appearing before a subgroup of selectors will not be a multiple of ten. However, trunks from one or more subgroups are connected to the outgoing "cables" in such a manner as to equip them solidly so as to avoid, where possible, unequipped selector positions on the shelf of the succeeding switch in the train. By "cables" is meant ten consecutive cable circuits to ten consecutive selectors on a succeeding shelf or half-shelf. The lower choice trunks carry heavier traffic than the higher choice trunks. In order to distribute

the load evenly over succeeding shelves of switches, the trunks are cross connected to outgoing cables in such a way as to distribute trunks of different choices over the cables.

(b) Subgroups of Less Than Ten Trunks — Where a subgroup of selectors will furnish a load for less than ten trunks, the working terminals are multipled in the same manner as for a full subgroup of ten trunks, that is, the last working terminal is multipled straight to the bank terminals for all of the selectors in the subgroup and the remaining working terminals are multipled with a reversal in the middle of the subgroup, except that where there are four or less trunks total, no reversal is made. The trunks are assigned to the bank terminals from one up.

The remaining terminals are multipled straight through all of the selectors in the subgroup and the "T," "R," and "S" or the "T," "R," "S," and "C" punchings of the terminals are multipled on the rear of the frame with strap wire to the corresponding punchings of the highest numbered working terminal in the subgroup. This strap wire is run on the group of bank terminals from which the outgoing jumpers are taken as a safeguard against failure to remove straps as trunks are added. The same also applies in vacant levels to the terminals beyond the no-such-number tone or intercepting trunk circuits.

In this case the outgoing jumpers will occur only on two levels, so that the horizontal strapping on the other levels is placed where out jumpers are located. If in any of the cases more than two unequipped bank terminal strips are bridged by jumpers for the working terminals, they are not similarly bridged for the non-working terminals, but instead, the non-working terminals are connected by horizontal straps to the last working terminal both above and below the gap caused by the unequipped terminal strips.

(c) Trunks to Combination Connectors — Where a connector shelf is equipped only with combination connectors, each connector is wired to both local and toll selectors. The trunks from the local selectors are associated with the combination connectors in straight numerical sequence so that the connectors will be assigned from left to right, that is, from one up. However, since a reversal is provided in the middle of the local selector multiple, half of the local selectors hunt forward and the other half backward over all the connectors in the group except the last equipped connector whose associated trunk is carried through without reversal. The trunks from the toll selectors are also associated with the combination connectors in straight numerical sequence so that the connectors are selected from left to right. No reversal is provided in the multiple of toll selector subgroups immediately preceding connectors. (Exception — Trunks to Rotary and Level Hunting Connector Hundreds.)

Where both local and combination connectors are required to serve the same "hundreds" group, the combination connectors are made the last choice of the local selectors to avoid delaying toll calls. To accomplish this, the assignment of the combination connectors is limited to the common trunks of a graded multiple. The trunks from the local selectors are assigned in the same order as the growth of the two types of connectors on the shelf. That is, Trunk 1 is assigned to the local connector on the extreme right of the connector shelf, and subsequent trunks to connectors in right to left progression until all the local connectors are assigned. The remaining unassigned selector trunks are associated with combination connectors in straight numerical sequence. The highest numbered combination connector on the shelf thus becomes the last choice of the local selector subgroup.

The trunks from the toll selector to the combination connectors are also wired to these connectors in a straight numerical sequence so that as the combination connectors grow no changes in existing cable connections at the toll selector frame will be necessary. The fact that there is a reversal in the common trunks from the local selectors largely eliminates any advantage of connecting the trunks from the toll selectors in a reverse order to those from the local selectors.

(d) Trunks to Toll Rotary or Level Hunting Connectors — In order to reduce the hunting time of toll intermediate selectors to

the larger groups of toll connectors, where there are two or more shelves of toll intermediate selectors per thousand, a reversal may be made in the multiple between these shelves of the trunk groups to toll rotary or toll level hunting connectors. This reversal may include all terminals of trunks common to all of the selectors, including the last terminals, as a result of which the last trunk will not be multipled straight as in the usual case. To make this reversal most effective, the toll intermediate selectors are equipped on the shelves and the preceding toll transmission selectors are connected with the toll intermediate selectors in such a manner as to obtain a reasonable balance of traffic between the two sides of the reversal. For example, 15 toll intermediate selectors are divided 8 and 7 on two shelves; 23 selectors are divided 10, 10 and 3 with reversal between the first and second shelves, 37 selectors divided 10, 9, 9, 9, or 43 selectors 10, 10, 10, 10, 3 with the reversal between shelves 2 and 3 (one subgroup to connectors) or between shelves 1 and 2 and 3 and 4 (two subgroups to connectors). Instances of as many selectors as in the two latter examples will seldom be encountered.

(e) Vacant Levels — Vacant levels of local selector multiple are tied to a recorded announcement. For customer instruction purposes or because of number changes or possible directory error, a vacant level (or levels) may be tied to intercepting trunks for operator handling.

Vacant levels of toll selector multiple may be wired to a recorded announcement. These, too, may be tied to intercepting trunks for operator handling.

(f) Subgroups Split Between Two Frames — In cases with graded multiple arrangements and distributing type terminal assemblies, it is desirable to split a subgroup between two selector frames. The jumpers from the D.T.A. punchings to the tie cable terminal strips are taken from divisions lower in the multiple than those from which outgoing jumpers are taken. In the case of common trunks, jumpers are taken from below the reversal when the reversal appears on the lower numbered frame. Where the reversal appears on the higher numbered frame, jumpers to tie cables on that frame are taken from a division above the reversal.

Where the reversal is made between selectors on separate frames, this is done in the tie cable jumpers at the lower numbered frame.

Whenever there are only 20 selectors in a subgroup equally divided between the two frames, the reversal is made in the tie cable jumpers at the lower numbered frame. The outgoing trunk jumpers are run directly between the outgoing trunk terminals and the tie cable terminals in order to avoid double jumpers on the bank terminals.

(g) Trunks to Connectors — The cabling for trunks to connectors is run straight regardless of the order of assigning connectors, the irregularities in assigning being provided for by jumpers at the D.T.A.

(h) Mixing Local and Incoming Traffic — If local and incoming traffic is mixed in such a way that each subgroup of selectors contains a proportionate amount of local and incoming traffic, a considerable saving in the number of succeeding selectors and connectors may be realized. This is because the local and incoming peak loads frequently do not occur at the same time. Furthermore, abnormal traffic peaks in either the local or incoming groups do not have such a serious effect when this traffic is distributed.

9.13 *Trunking Efficiency*

(a) Selector Graded Multiple Arrangements — Graded multiple arrangements usually specify subgroups of 20, 40, 60, 80, 120, 160, 240, and 320 selectors on from 11 to as many as 45 trunks. These arrangements provide efficient trunk groups.

These arrangements are entirely flexible and are applied to any of the present standard frames equipped with or without D.T.A. For subgroups of any size or any number of selectors on ten to 15 trunks, inclusive, the multipling plan used is the same as that for 20 selectors on ten to 15 trunks, inclusive. For trunk arrangements greater than 15 trunks, see Figure 39.

(b) Equalization of Traffic — Since the various trunks in a subgroup carry differing amounts of traffic, it is necessary, when engineering a job, to cross-connect these trunks to succeeding switches in such a manner that the load delivered to each succeeding half-shelf is approximately equal. Where the selectors are cabled through an I.D.F. or T.D.F. to repeaters, either direct or through out-trunk switches, to outgoing trunks, to DSA or toll boards, to information or other desks, any necessary equalization of distribution of traffic is accomplished at the distributing frame. The assignment of trunks of the graded multiple subgroups to the outgoing cables at the D.T.A. are usually made in a left to right, top down order in each subgroup and to consecutive circuits of successive cables. Cross connection for trunks from selectors to rotary and plunger type out-trunk switches follow a prescribed pattern.

For selectors cabled directly to other selectors in the same building, the equalization of traffic to cables is accomplished at the D.T.A. through the use of standardized cross-connection plans for use with the new graded multiple arrangements. (Figure 39.) As indicated previously, the term "cable" as used in conjunction with these plans and in subsequent discussion in this connection means the ten consecutive circuits to ten consecutive selectors on a following shelf or half-shelf. Actually, several such groups of circuits may be grouped in one cable. These cabling plans are designed to reduce to a very great degree the number of cross connection changes necessary when regrading to subgroups of other sizes than installed initially.

This is accomplished by the use of uniform cross-connection patterns for most of the subgroups termed "fundamental" subgroups, and supplemented by a few "fill-in" subgroups. Occasionally trunks to succeeding selectors in the same office are cabled to the T.D.F. or I.D.F. for the purpose of mixing local and incoming traffic as discussed previously in this section. In such cases, where connections to succeeding local selectors can be made in groups of consecutive selectors on the same half-shelf, the standard cross-connecting plans at the D.T.A. are used, the cross connections at the T.D.F. or I.D.F. being run straight in groups of ten.

The cross-connection pattern for each fundamental subgroup or pair of fundamental subgroups of a given graded multiple arrangement is the same and repeats itself as often as necessary for the complete assignment of the outgoing trunks. When the fundamental subgroups have been assigned to cables, in all cases except those where the number of trunks in the subgroup is a multiple of five, certain circuits in some of the cables remain unused and the trunks assigned to these gaps comprise the "fill-in" subgroups. With this arrangement, it is possible to increase or decrease the size of any trunk subgroup by changing the cross-connections of the trunks in the "fill-in" subgroups and only an occasional trunk in the "fundamental" subgroup. In this manner, the number of jumper changes required on regrades is considerably less than that required for the previous graded multiple patterns.

10.00 COIN AND MESSAGE RATE SERVICE

10.01 *Coin Service*

Step-by-step dial coin service may be given on individual lines. All classes of calls which can be made from flat rate lines may be made from coin lines, except CAMA.

The present prepayment coin circuits used are, in most cases, arranged on a "coin first" basis, that is, dial tone will not be heard until a coin has been deposited by the customer. The older prepayment coin circuit was arranged so that dial tone was heard when the receiver was removed from the switchhook.

The method of operation for the "coin first" type of prepayment coin service is outlined briefly below.

The calling party will be instructed to remove the receiver from the switchhook, deposit a coin or coins, and when the dial tone is heard, dial the desired number. The equipment is so arranged, however, that the coin may be deposited either before or after the receiver is removed. If the calling party dials without depositing a coin, dialing will be ineffective and it will be necessary for the calling party to deposit a coin and then, when the dial tone is heard, redial the desired number or service code. If the dial tone is not

available the coin will remain suspended in the coin box.

On a local call, the coin will be automatically collected after the calling party hangs up, unless the call is to a line arranged for free incoming service in which case the coin will be automatically returned after the calling party hangs up. If the calling party hangs up before the called party answers or on receiving the busy signal, the coin will be automatically returned when the switchhook is depressed.

If a call results in connection being made to an intercepting position, the coin will be automatically returned after the calling party hangs up.

On a call to Information or Repair Service the coin will be automatically returned after the calling party hangs up.

On a call to Long Distance, the coin will be automatically returned when the Long Distance operator answers on the recording-completing trunk.

In any of the above cases, if the calling party hangs up before the desired operator answers, the coin will be automatically returned when the switchhook is depressed.

In case a wrong number, double connection, or cutoff is received on a local call dialed from a coin station, the coin deposited will be collected. In such a case, the customer may receive credit or refund if he notifies the operator.

The purpose of a Prepay Coin Box Trunk Circuit which is located between the line finder and first selector is to provide means by which calls can be made from prepayment pay stations in a step-by-step office area.

Its functions are as follows:

(a) To connect the pay station through line finder to a first selector, thus providing the customer with dial tone.

(b) To prevent the transmission of dial pulses until after the coin has been deposited.

(c) To automatically refund the coin on calls to free stations and on calls which are not completed.

When a call is made from a pay station, the removal of the receiver from the switchhook completes a path through the line finder to this trunk circuit.

When a call is made from a pay station the removal of the receiver from the switchhook completes a path through the line finder to this trunk circuit, if the equipment is arranged for loop start operation. If ground start operation is provided, the removal of the receiver is ineffective until a coin is deposited. If the receiver is left off the hook and no coin is deposited with ground start operation, the connector terminal is unguarded and on an incoming call the ringing will be tripped. A no ring answer condition will normally result under these circumstances.

10.02 *Message Rate Service*

(a) General — Message rate service may be given on a dial basis on individual or two-party lines, one or two message registers being associated with each line. In the case of two-party service, one register is assigned to each station on the line and the equipment is so arranged that the proper register is operated when a station on that line originates a call that is completed if it is one for which a charge should be made.

All types of calls which can be made from flat rate lines can be made from message rate lines, and, with the exceptions noted herein, the operating features will be the same. If a local call is dialed from a message rate station to another station, and the called party answers, a register associated with the calling station will be operated when the called party answers. A call will not be registered when the called station is busy, if the calling party disconnects before the called party answers, or if the call is routed to an intercepting position or to a line arranged for free incoming service.

The trunks to all central office desks and operators' positions, such as Special Service, Long Distance, Information, Repair, etc., will be arranged so that on calls completed to them registration will not take place. If a special service operator completes a call through her position for which a charge should be made, it will be cared for in

accordance with the methods outlined in the respective sections of the operating practice covering the operation of these positions.

When, on a local call dialed by the calling party, a wrong number, double connection or cutoff is received, a call may be registered in error. The customer can have the charge cancelled by dialing the special service operator and explaining the case to her. The special service operator will then arrange for the necessary credit in accordance with standard operating practices.

Where message rate service on individual lines is given, each message rate line is equipped with a message register wired to the sleeve of the connector terminal in parallel with the cutoff relay of the line circuit. A Message Register Trunk is wired between each line finder and its first selector serving message rate lines. Where two-party message rate service is given, the message register is wired to the "M" lead of the line circuit.

When the called party answers, a reversal of battery from the connector toward the calling station causes the message register to operate. It operates and then locks preventing any further registration on the call.

11.00 TRAFFIC REGISTERS

11.01 *General (Figure 40)*

Traffic registers provide a measurement of traffic in various forms for engineering and administrative use. The provision of these registers varies somewhat, depending on trunking arrangements and local considerations.

There are several classifications of registers commonly used in the step-by-step dial central offices. In most offices, the traffic registers are centrally located on Traffic Register Racks located either on the central office or in the switchroom or preferably in the dial administration quarters. The most recent arrangement for mounting registers consists of a cabinet 6' 6" high, 2' wide, and 7-3/4" deep which may be placed against a wall. The cabinet has a capacity of 300 registers. Patching pin jacks are provided for associating the registers with the register control circuits. (For detailed description of registers, see Appendix I.)

11.02 *Peg Count Registers*

Peg Count (P.C.) registers are provided to measure the calls handled by the various groups of switches to which they are assigned.

(a) Line Finders — This register scores each time a line finder is restored to normal. All machine attempts, false starts, dial tone, etc., are counted.

(b) Trunk Finders — One register for each trunk finder group. Operation same as for line finders.

(c) Selectors — One register per 30 selectors where the trunk group does not exceed 30. One register per 20 selectors, or fraction thereof, are provided for groups of over 30. Registers may be provided for the following selectors:

Incoming local and toll selectors.

Operator first selectors.

Service code selectors.

Reverting call selectors.

Toll selectors preceding connectors.

Register wiring is arranged by quarter shelves on high type frames and half shelves on low type frames. Two or more of these quarter or half shelves may be combined on one register as required. The arrangement should be such that the registrations from one group or class may be obtained separately either from the reading of one register or by adding together the readings of two or more registers.

Peg count registers for digit absorbing selectors differ from those used with regular selectors which operate each time a selector is restored to normal. Registers used with selectors which absorb digits operate only when the selector restores to normal after reaching a trunk position.

(d) Connectors — One register per combination or (local) group. Where a group is served by both local and toll connectors (such as trunk hunting groups), one register for each subgroup of local and toll connectors. These registers operate upon the release of a connector.

(e) Time Announcement and Weather Trunks — One register for each trunk. This register

scores each time a time announcement or weather trunk is used.

11.03 *Last Trunk Busy Registers (L.T.B.)*

Last trunk busy registers score each time the last choice trunk of a group or subgroup is seized. One last trunk busy register may be provided for each subgroup or group to the toll operator, special service operator, information operator, time or weather announcement trunks, or interoffice trunk groups not reached via Out-Trunk switches, and on trunks to connectors. Subgroups to Out-Trunk switches may be equipped with last trunk busy registers if desired to indicate balance between the selector subgroups feeding the Out-Trunk switches.

11.04 *All Trunks Busy Registers (A.T.B.)*

All trunks busy registers score each time all trunks of a group become busy simultaneously. One register may be provided for each line finder group, each trunk finder group and each subgroup of either rotary or plunger out trunk switches (and on certain operator trunk groups).

11.05 *Overflow Registers (OFL)*

When desired, overflow registers may be provided for the purpose of obtaining data on busy lines or P.B.X. trunk groups. Two types of registers are available, one for use with rotary hunting connector hundreds in obtaining data on individual lines or P.B.X. trunk groups of ten or less trunks, and the second for use with level hunting connector hundreds in obtaining data on P.B.X. trunk groups of any size. No satisfactory means is available for obtaining these busy line data on lines in regular connector hundreds. In a level hunting group, data may be obtained on only one P.B.X. group at a time. These registers, however, may be changed from one P.B.X. group to another, as desired. One or more registers may be provided for each level or rotary hunting connector hundred.

11.06 *Time Registers*

A register associated with an electric master clock may be specified to check the accuracy of the starting time of the various cycles of register readings.

11.07 *Line Message Registers*

The number of subscriber line message registers required is specified in the traffic orders. One register is provided for each working individual, P.B.X. and 2-party message rate terminal, plus about 2 to 5 percent spare registers. The registers score the number of completed calls originated by the measured station.

STEP-BY-STEP TRAFFIC REGISTERS

(See Figure 40)

Reg. No.	Type of Reg.	Name of Register	Equipment or Trunking Qualification	Register Provisions	Register Operates
1	Peg Count (P.C.)	Line finder P.C. (LF)		One per line finder group	Each time line finder returns to normal
		Primary master switch P.C. (PRI M SW)		One per primary master switch	Each time a line switch returns to normal
2		Auxiliary first selector P.C. (AUX 1ST SEL and service code selector)	Calls from flat rate and coin box lines are counted separately	One per 40 selectors in the group	Each time selector returns to normal. Counts calls to service codes and preliminary pulse calls
3		Operators' first selector P.C. (OPR 1ST SEL)		One per 20-30 selectors in the group	Each time selector returns to normal
4		Local second selector P.C. (LOC 2ND SEL)	Provided when connector peg count registers are not provided		Each time selector returns to normal
5		Local third selector P.C. (LOC 3RD SEL)	Provided only when second selectors are not used		Each time selector returns to normal
6		Local incoming selector P.C. (LOC INC SEL)	Calls from each office are obtained separately	One per 20-30 selectors in the group. Trunks from manual offices or outtrunk switches in step offices	Each time selector returns to normal
6		Local incoming selector P.C. (LOC INC SEL)	Calls from each office are obtained separately	One per 40 selectors in the group. Trunks direct from selector levels in step offices	Each time selector returns to normal
7		Toll incoming selector P.C. (T INC SEL)	Provided only if toll second selectors immediately precede toll connectors	One per 20-30 selectors in the group	Each time selector returns to normal
7		Toll second selector P.C. (T 2ND SEL)			Each time selector returns to normal
8		Toll third selector P.C. (T 3RD SEL)		One per 40 selectors in the group	Each time selector returns to normal

Reg. No.	Type of Reg.	Name of Register	Equipment Trucking Qualification	Register Provisions	Register Operates
9	Peg Count (Cont'd)	Connector P.C. (CONN)	Combination connector	One per connector group (100 terminals)	Each time connector returns to normal
10		Connector P.C. (CONN)	Local and toll rotary connectors	One per connector group (100 terminals)	Each time connector returns to normal. Counts both local and toll calls on one register if connections are on same shelf
11		Connector P. C. (CONN)	Local level hunting connector	One per 30 or 40 connectors. Separate registers may be provided for toll. More than one register may be provided per connector group	Each time connector returns to normal
12		Connector P.C. (CONN)	Toll level hunting connector	One per 30 or 40 connectors. Separate registers may be provided for local. More than one register may be provided per connector group	Each time connector returns to normal
13		Service code selector P.C. (SERV C SEL)		One per 40 selectors	Each time selector returns to normal after reaching a trunk position. Counts calls to service codes
14		Reverting call selector P.C. (REV C SEL)		One per group	Each time selector returns to normal
15		Intertoll second selector P.C. (IT 2ND SEL) Intermediate (INT)		One or more per subgroup. For example: One or more per 2 prefix group of trunks, one per 3 prefix group of trunks, etc.	Each time selector returns to normal. Counts intertoll calls into the office by prefix

Reg. No.	Type of Reg.	Name of Register	Equipment Trucking Qualification	Register Provisions	Register Operates
16	Peg Count (Cont'd)	Intertoll auxiliary first selector P.C. (IT AUX 1ST SEL)			Each time selector returns to normal. Counts calls to operate codes (11X, 121 etc). Community dial offices and ringdown tributaries
17		Intertoll auxiliary second selector P.C. (IT AUX 2ND SEL)			Each time selector returns to normal. Counts calls to ringdown tributaries and 11X codes
18		"Zero" level intertoll second selector P.C. (0 LEV IT 2ND SEL)			Each time selector returns to normal. Counts all intertoll through dialed calls
19		Intertoll through selector P.C. (IT THRU SEL)			Each time selector returns to normal. Counts intertoll through dialed calls by levels from the "0" level second selector
20		"A" position P.C. (A POS)		One per inward toll or "A" position	Each time operator depresses peg count button at position
21		"B" position P.C. (B POS)	Call distributing "B" position	One per position	Upon the depression of the first key on any call
22		Call indicator trunk group P.C. (C I TRK GRP)	Out-trunk switches not provided in dial office	One per 40 trunks in the group	Each time a trunk is seized
22		Call indicator trunk group P.C. (C I TRK GRP)	Out-trunk switches provided in dial office	One per 30-35 trunks in the group	Each time a trunk is seized
23		Call indicator position P.C. (C I POS)	Call indicator position	One per position	Each time operator depresses peg count key
24		Information position P.C. (INF POS)	Where call distributing equipment is used	One per position	Each time an incoming trunk is connected to the position, except that calls over an interposition trunk or trunk from an outlying office will not be counted
24		Information position P.C. (INF POS)	Where call distributing equipment is not used	One may be provided per position	Each time operator depresses peg count button
		Intercepting trunk finder P.C. (INCPT TRK FDR)		One per group of intercepting trunk finders	
25	All Trunks Busy (ATB)	Line finder ATB (L F)		One per line finder group	When all line finders in the group become busy

Reg. No.	Type of Reg.	Name of Register	Equipment Trucking Qualification	Register Provisions	Register Operates
26		Operators' first selector ATB (OPR 1ST SEL)		One per 20-30 selectors in the group	When all operators' first selectors become busy
27		Keypulsing senders ATB (K P SDR)		One per sender group of 20 senders or less	When all senders in the group become busy
28		Keypulsing senders ATB (K P LK)		One per link	When all links in the group become busy
29		Toll switching trunks ATB (T SW TRK)		One per group of toll switching trunks, example: one per 2 prefix group of trunks. One per 3 prefix group of trunks, etc.	When all toll switching trunks become busy
30		Out-trunk switch ATB (O.T.S.)	Plunger or rotary type. See LTB registers where interoffice trunks do not go through out-trunk switches	One per subgroup of trunks from out-trunk switches	When all of the outgoing trunks from a subgroup of ROTS become busy
		Intercepting trunk finder ATB (INCPT TRK FDR)		One per group of intercepting trunk finders	When all intercepting trunk finders become busy
31	Last Trunk Busy (LTB)	Toll recording (operator) LTB		One per subgroup of trunks	When last trunk in the subgroup becomes busy
32		Interoffice trunks LTB (I 0 TRK)	Provided on trunks which do not go through out-trunk switches. See ATB. Registers where trunks go through out-trunk switches	One per subgroup of trunks	When last trunk in the subgroup becomes busy
33	Last Trunk Busy (LTB) (Cont'd)	Special service operator trunks ("0") LTB (SPL SERV OPR TRK) (SSOT)	Provided where trunks have three or more appearances at the "A" board	One per subgroup of trunks	When last trunk in the subgroup becomes busy
34		Reverting call selector LTB (REV C SEL)		One per subgroup of reverting call trunks	When last trunk in the subgroup becomes busy

Reg. No.	Type of Reg.	Name of Register	Equipment Trucking Qualification	Register Provisions	Register Operates
35		Connector LTB (CONN)	Provided in recent installations. Peg count registers are then provided only for coin and hunting groups	One per group of connectors	When last trunk in the sub-group becomes busy
36		Intertoll first selector LTB (I T 1ST SEL)	Provided in four digit offices. When a trunk appears on switches and on jacks, this register will be provided for the jack appearance	One per group of intertoll switching trunks	When last trunk in the group becomes busy
37		Intertoll second selector LTB (I T 2ND SEL) Intermediate (INT)	Provided in five or more digit offices. When a trunk appears on switches and on jacks, this register will be provided for the jack appearance	One per group of intertoll switching trunks. Example: One per 2 prefix group of trunks, one per 3 prefix group of trunks, etc	When last trunk in the group becomes busy
38		Intertoll information (Code 131) trunk LTB (I T INF TRK)		One per group of intertoll information (Code 131) trunks	When last trunk becomes busy
39		Intertoll inward operator (Code 121) trunk LTB (I T IN OPR TRK)		One per group of intertoll inward operator (Code 121) trunks	When last trunk becomes busy
40	Overflow (OFL)	Primary master switch OFL (PRI M SW)		One per primary master switch	Each time a call encounters an all trunks busy condition
41		Subscribers' line (Rotary Hunting) OFL (SUB L)	Provided for rotary hunting groups. The registers may be changed from one P.B.X. group to another as required	One or more per hundred group of customers' lines, in groups of ten lines or less. Several registers are usually provided for each office	Each time a call to the customers' line group encounters an all lines busy condition

Reg. No.	Type of Reg.	Name of Register	Equipment Trucking Qualification	Register Provisions	Register Operates
42		Subscribers' line (Level Hunting) OFL (SUB L)	Provided for level hunting groups. Only one register may be connected to the same level hunting group at the same time. The registers may be changed from one P.B.X. group to another as required	One per group of subscribers' lines	Each time a call to the customers' line group encounters an all lines busy condition
43		"B" link OFL (B LK)	Call distributing "B" links	One per link group	Each time a call to the "B" link encounters an all links busy condition
44		"B" sender OFL (B SDR)	Call distributing "B" senders	One per sender group	Each time a call to the "B" sender encounters an all senders busy condition
45 46	Dial Tone Speed (D.T.S.)	Test (T) Delay (D)	Dial tone speed testing equipment is arranged to test up to 200 line groups. Testing equipment is under control of a "Start" key	A pair of T and D registers are provided with the dial tone speed testing equipment. Additional pairs of registers may be added as required. D (delays) divided by T (tests) equals percent dial tone over 3 seconds	Each time a test is made, the "T" register operates. Each time a delay of over 3 seconds is encountered, the "D" register operates. Under normal load conditions, 1100 to 1200 test calls are made per hour
47	Group Busy Timing (GRP BSY T)	Group Busy Timing (GRP BSY T)		One per toll line group. The register readings are in tenths of a minute	Every 6 seconds while toll line group is busy

Reg. No.	Type of Reg.	Name of Register	Equipment Trucking Qualification	Register Provisions	Register Operates
48	Answering Time Recorder (A.T. RCDR)	Total Calls (TC) Delayed Calls (DC)	Answering time recorders are arranged for automatically obtaining speed of answer data on calls at most switchboards, and auxiliary desks	A pair of registers TC and DA are associated with the recorder. Additional pairs of registers may be added as required. DA (delayed answers) divided by TC (total calls) equals percent delayed answer	Each time a call is received by the recorder the "TC" register operates. Each time the answering interval exceeds a predetermined number of seconds the "DA" register operates
49	Register Reading Time Meter (T.M.)	Register Reading Time Meter (TM)	For checking accuracy of starting time of the various cycles of register readings and the elapsed time between readings	One per register bay. Time meter is similar to any other traffic registers. The readings are in tenths of a minute	Every 6 seconds. Controlled by master clock
50	Line Message Register	Line Message Register (SUB MSG)	Reverting calls have to be handled by the special service operator	One per individual line. One per station on 2-party lines. For message rate service	On originating calls when the called party answers, register does not operate on calls to service codes or special service operator trunks ("0"), or free service trunks

LINE SWITCH EQUIPMENT

1. GENERAL (Figure 1)

Line switches are an arrangement of apparatus which permits any one of a number of lines to be connected automatically to one of a group of trunks smaller in number than the total number of lines. It is a switch, the operation of which does not depend upon a digit in the called number or any other movement of the dial. It automatically extends the customers' line to an idle trunk leading to the next switch in the train. A primary line switch is associated with each customer's line. With each of these switches is associated a set of bank contacts. Each set is made up of eight contacts. Three contacts of each set are connected to the tip, ring and sleeve of the line; the remainder, called trunk contacts, are connected to the next switch in the train and associated apparatus. There are ten sets of bank contacts. The bank contacts are normally multipled. Customers' lines are terminated in primary line switches which are arranged in vertical columns in a framework made up of two bays. Each bay of lineboards has a capacity of 100 line plunger switches. There are four divisions per bay of 25 switches each arranged so that one master switch may be provided for each division. It is possible for one master switch to serve two or three or even four divisions. The number of divisions served by the master switch is determined by the originating customers' traffic.

2. DESCRIPTION (Figure 2)

The primary line switch consists of two relays, the line relay and the combined pull-down magnet and battery cutoff relay; a plunger arm and plunger with bank contacts.

The line relay is associated with the line and performs as any line relay when the customer lifts his receiver. The cutoff relay can cut off the ground and line relay from the line circuit. The line relay is equipped with a copper collar to make it slow in falling back after the current through its winding has been cut off.

The magnet drives the plunger into the bank and thus connects the bank springs and contacts. At the time that the plunger operates, ground is placed on the sleeve of the associated connector terminal to prevent an incoming call from completing to the line while it is busy.

The line switch plunger shown in Figure 3 does not form any part of the electrical circuit. It is merely a mechanical device so arranged that, when plunged, the two hard rubber rollers near its tip, press against one of the ten sets of contacts and connect the tip, ring and sleeve contacts of the customers' line to the trunk contacts leading to the next switch.

The terminals are so arranged and the line switch plunger is so pivoted, that the plunger may thus engage with any set of these contacts. In other words the customers' line may use any one of ten trunks, each leading to the next switch; but, of course, these trunks are shared with the other lines associated with a particular master switch. Hence, some provision must be made to insure an idle trunk for any line at any time that an outgoing call is to be made.

The master switch is provided with a ten point bank. The existence of ground or the non-existence of battery potential on each contact of this bank indicates the condition of the trunk to which it belongs. If the trunk is idle, there is an absence of battery on its master switch bank contact. If the trunk is busy, the corresponding contact is grounded. By this means the master switch can discover as it tests over them which trunks are idle and which trunks are busy.

3. FUNCTION (Figures 4 and 5)

When a call is originated, the associated line switch is drawn away from the guide shaft and out of control of the master switch. Immediately after this "plunging" has occurred, the master switch moves remaining plungers so that they are now opposite the next idle trunk. If all trunks are busy the master switch will continue to oscillate until a trunk does become idle.

As the line switch releases, the plunger comes back into contact with the guide shaft, but will not engage with the ridge of the shaft until the shaft has moved through some part of its oscillation under control of the master switch circuit. (This is known as picking up idle plungers.) With this sort of an arrangement it is possible for a particular line making successive calls to continue to seize the

same trunk repeatedly without actuating the master switch circuit, except as covered under "Secondary Pickup."

The primary functions of the primary line switch are as follows:

(a) Operate a plunger and extend the T & R leads of the line to an idle secondary line switch.

(b) Disconnect line relay battery and ground from the line.

(c) Cause the master switch to advance other line switch plungers standing in front of this trunk just seized to the next idle secondary line switch trunk.

(d) Cause the line to test busy on incoming calls at connector banks.

(e) Operate traffic registers.

The functions of the master switch are as follows:

(a) Keep idle line switch plungers directed toward idle trunks to secondary switches.

(b) Move all idle line switch plungers to the next idle trunk when the previous one has become busy.

(c) Prevent a line switch from operating while the plungers are being moved from one trunk to the next.

(d) Cause alarm circuit to operate if trouble develops and a relay is held operated longer than a normal period or an idle trunk is not found.

(e) When all trunks are busy, to oscillate until a trunk becomes idle.

4. ALLOTTER EQUIPMENT

An allotter consists of a 4-arc 25-point rotary switch and associated relay equipment mounted in the upper portion of the line switch frame, each of the rotary switches being associated with one line switch section of 25 plunger switches. The allotter is so arranged that it controls the operation of the line switches and allots battery to but one line switch per master switch at a time, thus preventing any double connections on the switches with which it is associated. Separate allotter circuits were designed for primary and secondary line frames.

SECONDARY LINE SWITCHES AND MASTER SWITCHES

1. GENERAL (Figure 6)

In large central offices, it is necessary to handle large amounts of traffic with as small an amount of equipment as possible. Large numbers of telephones offer a steadier total calling rate than small numbers of telephones, so that greater economy is possible.

One way to do this is to mingle the traffic from a number of groups of customer lines, so that each customer has access to more than ten first selectors. This is done by interposing secondary line switches between the primary line switches and the first selectors.

In appearance, secondary line switches are similar to primary line switches and the functions of the two are similar. Trunks from the primary line switch groups terminate on secondary line switches. The trunk terminals of the secondary line switch banks are connected to first selectors. Since the normal efficiency of ten trunk subgroups from the primary line switches is relatively low, secondary line switches are used and trunks from the primary line switches are cross connected in such a way as to gain the advantage of larger trunk groups, permitting first selectors to be operated in groups of 100 instead of the ten. Normally, 20 to 25 secondary line switches are associated with each secondary master switch circuit for proper traffic loading and distribution.

The secondary master switch controls the plungers in each subgroup of secondary line switches and its functions and operation are similar to those of the primary master switch.

Secondary line switches are provided on the basis of maximum simultaneous call seconds, whereas the primary line switches are provided on the basis of the number of physical lines. They are arranged in subgroups, each subgroup providing the proper load for its subgroups of trunks leading to first selectors.

2. FUNCTION

(a) *Secondary Line Switch* — The functions of the secondary line switch are:

(1) Operate a plunger and extend the T & R leads to an idle first selector.

(2) Cause the secondary master switch to advance other secondary line switch plungers in front of the selector to the next idle trunk.

(3) Assist in holding the primary line switch.

(b) *Secondary Master Switch* — The functions of the secondary master switch are as follows:

(1) Keep idle secondary line switch plungers directed toward idle trunks to selectors.

(2) Move all idle secondary line switch plungers to the next idle trunk when the previous one has become busy.

(3) Prevent a secondary line switch from plunging while the plungers are being moved from one trunk to another.

(4) Cause an alarm to sound if trouble develops and a relay is held operated longer than normal.

(5) Operate a register whenever all the trunks from a secondary group are busy.

(6) Move the primary master switches, directing traffic into this secondary group, to other less busy groups if three or more consecutive busy trunks are passed before an idle trunk to a selector is found in this group.

(7) Cause all primary master switches, directing traffic into this secondary group, to make a "sweep" and pick up all idle primary line switch plungers if this secondary group becomes "all busy."

(8) Operate a peg count register when provided.

(9) When all trunks are busy, to remain stationary until a trunk becomes idle. (An A.T.B. register is usually provided, which scores each time that all trunks from that subgroup of first selectors are busy.)

Calls are not delayed by this latter condition because means are provided to prevent calls from coming to this group during such periods, as explained briefly under the subject, "Secondary Kickoff," which follows.

3. SECONDARY KICKOFF

As mentioned previously, the trunks from the primary line switches are run to secondary switches and from the secondary line switches to first selectors. This provides a uniform distribution of calls, under normal conditions, to all the secondary groups and consequently to the first selectors. In spite of this carefully planned arrangement it is possible that calls may originate in several primary subgroups in such a way that their distribution to the secondary subgroups would be less uniform than is desirable; hence another feature has been added to this trunking arrangement, known as the *Secondary Kickoff*, the function of which is to determine when calls are coming in to any secondary subgroup at such a rate as to approach the capacity of the trunks out of that subgroup and if necessary, slow up the rate at which the next few calls would come in.

Calls may be considered as coming in too fast if a secondary master switch, in hunting, finds three or more consecutive trunks of its ten busy; hence a slow release relay is used in the secondary master switch circuit to determine this period of time which, by its release, makes busy all the then idle trunks from all the primary subgroups which terminate on secondary line switch in this secondary subgroup.

As soon as the secondary master switch finds an idle trunk it stops there ready to take another call. For the short period of time between reaching its third consecutive busy trunk and until it finds an idle trunk, calls are prevented from coming into its subgroup, thus slowing down traffic to a point where it can be handled satisfactorily.

The slow release relay is used for this purpose. It may be adjusted to release a little quicker or a

little slower than indicated, but the "three trunk period" is the one ordinarily used. When it releases it takes battery off the open main lead and puts on a ground, thereby grounding each idle trunk from the primaries and moving of all primary line switch plungers then standing in front of these trunks to other idle trunks.

Calls will not be delayed, they will merely be diverted to other less busy secondary subgroups, except in the cases where all other trunks from any primary subgroup are busy. In each such case the primary master switch will start oscillating and will come back to this trunk and stop in front of it.

Thus, the Secondary Kickoff acts as a finely adjusted traffic equalizer which smooths out some of the inequalities not taken care of by the arrangement of the trunks previously mentioned.

It has no effect on plungers that are in the banks and those which have been released but are not engaged with the guide shaft. It has little effect therefore, in reducing double plunging at the secondaries.

4. SECONDARY PICKUP

One of the objectives of telephone service is to prevent any intrusion whatever on a busy line. Hence, in all manual systems, the inevitable busy test at every point where intrusion might occur.

In the step-by-step dial system, all practicable means are used to prevent every piece of mechanism from making connection to a talking path while it is being used for some other call.

The first essential in accomplishing this is to provide enough talking paths or trunks with their accompanying switches to handle the busy-hour traffic.

In the step-by-step dial system, the great number of movements necessary to complete a connection within the short period of time allowed require that they follow each other in a very precise sequence; hence every time interval, however short, must be fully guarded to insure no possible interference.

The complex trunking between primary and secondary subgroups and thence to the first selectors requires careful attention to the guarding of these time intervals with the result that some ingenious arrangements have been developed of which the "secondary pick-up" is one of the most interesting.

The particular time element to be guarded by the secondary pick-up occurs in the normal operation of the primary master switch. It does not immediately pick up a line switch plunger when the latter is released from a trunk to which it has been connected, but leaves it standing in front of that trunk until the master switch releases that trunk on its forward movement, hunting, or on its return from trunk 1 to trunk 10.

During that time, which might be quite long when traffic is light, or very short when traffic is heavy, should this line switch plunge, it would again go in on the trunk from which it had previously been released. Normally, that would be all right because the secondary line switch on which this trunk terminates would be standing in front of the trunk to a first selector from which it, too, had previously been released, and the previous connection would be re-established. If, however, all outgoing trunks from this secondary subgroup become busy, then the plunger of the primary line switch must be prevented from plunging in on a trunk, thus, getting into a secondary subgroup from which there is no outlet for calls. At the same time, an outlet must be provided for any call that this customer may want to make at this instant.

The secondary pick-up is designed to take care of this situation; which it accomplishes by doing three things almost simultaneously, the instant that the last idle trunk out of any secondary subgroup is seized, as follows:

(a) Battery is taken off the open main lead of every primary subgroup that has one or more trunks to this secondary group, thereby preventing any line switch in any of these primary groups from plunging.

(b) Each primary master switch in each of these primary subgroups is started on one complete sweep over all its trunks to pick up all idle line switch plungers not then in engagement with the guide shaft.

(c) A ground is placed on each idle trunk into this secondary subgroup to make it test busy to its primary master switch after the

latter has completed its pick-up sweep, thus preventing calls from being sent into this secondary subgroup during the time that all its outgoing trunks remain busy.

During the entire time that the all trunks busy condition lasts, the secondary master switch remains in front of the last trunk that was seized. There is no need for it to oscillate (as the primary master switch does) because the release of any trunk will start it hunting; but it will not permit calls to be sent in until after it has stopped in front of this idle trunk, or some other trunk which meanwhile may become idle.

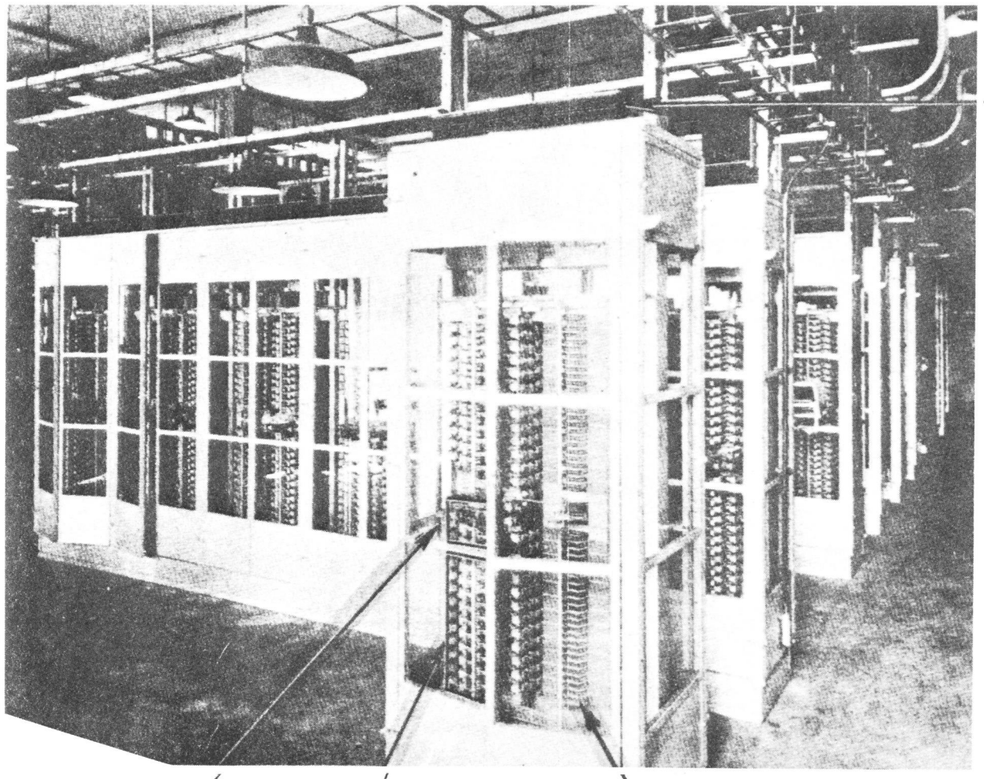
The various "pick-up" leads from all the primary master switches and from all the secondary master switches are usually bridged together at what is known as the *Secondary Pickup Test Panel*. The object of this is to provide a means for quick location of a ground which would totally block all originating calls as long as it remains on these bridged leads. Should such a ground remain on longer than a few seconds, the primary alarm circuit would sound.

5. MASTER SWITCH GOVERNOR

All master switches are provided with a governor which regulates the speed with which the solenoid is allowed to return the master switch shaft to a position in front of trunk ten on a return sweep. This speed is greater on secondary master switches than on primary master switches.

STEP – BY – STEP

PRIMARY LINE SWITCH FRAMES



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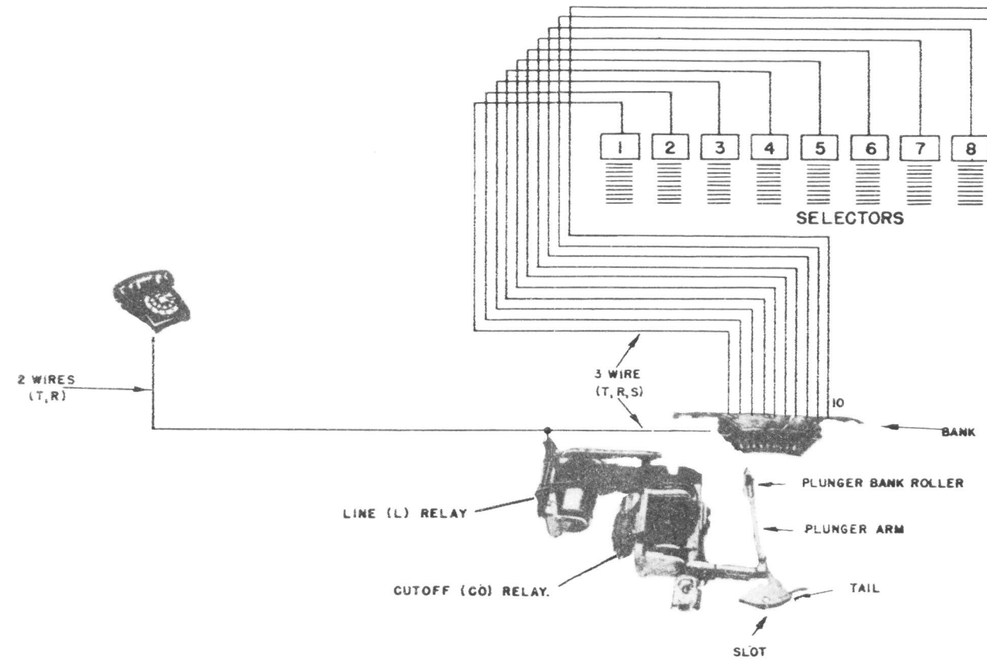
STEP-BY-STEP

METHOD OF CONNECTING CUSTOMER TO A
SELECTOR USING PLUNGER TYPE LINE SWITCH



WHEN THE CUSTOMER REMOVES THE HANDSET THE LINE (L) RELAY OPERATES AND (L) IN TURN OPERATES THE CUTOFF (CO) RELAY. RELAY (CO) PLUNGES THE PLUNGER ARM INTO ONE SET OF BANK CONTACTS CONNECTING THE CUSTOMER LINE (LINE IS MULTIPLIED TO ALL TEN SETS OF BANK TERMINALS) TO A SELECTOR.

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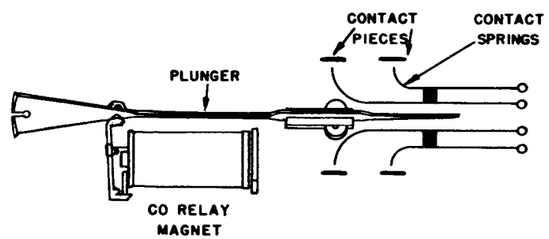
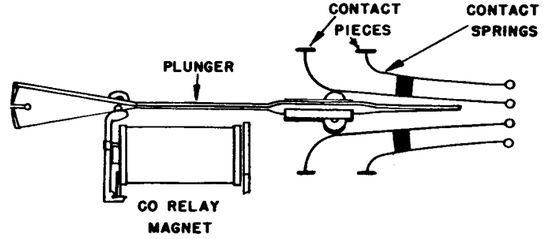
STEP-BY-STEP

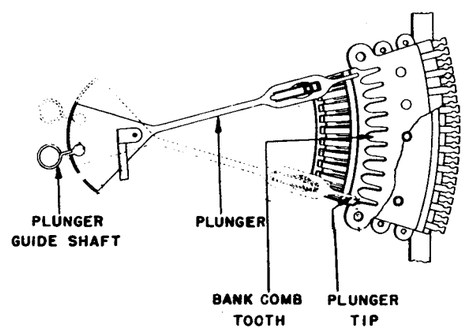
LINE SWITCH OPERATION



NON-OPERATED POSITION



OPERATED POSITION



MOVEMENT OF PLUNGER TIP IN BANK

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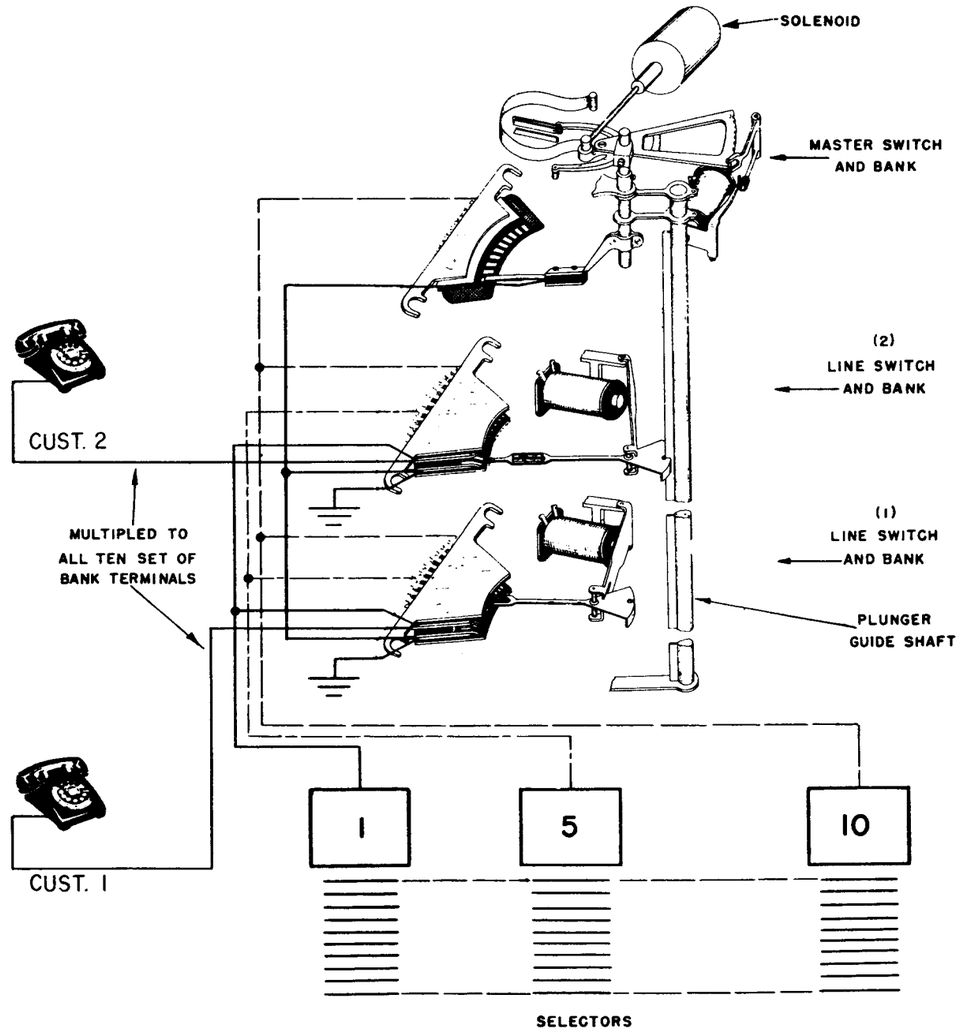
STEP – BY– STEP

RELATIONSHIP OF LINE SWITCHES TO MASTER SWITCH



CUSTOMER 1 HAS PLACED CALL USING LINE SWITCH 1 AND SELECTOR NO. 5 MASTER SWITCH HAS MOVED PLUNGER OF LINE SWITCH NO. 2 OPPOSITE NO.1 SET OF BANK TERMINALS WHEN CUSTOMER 2 REMOVES HANDSET LINE SWITCH NO. 2 PLUNGES INTO NO. 1 TERMINALS AND CALL IS EXTENDED TO SELECTOR NO. 1

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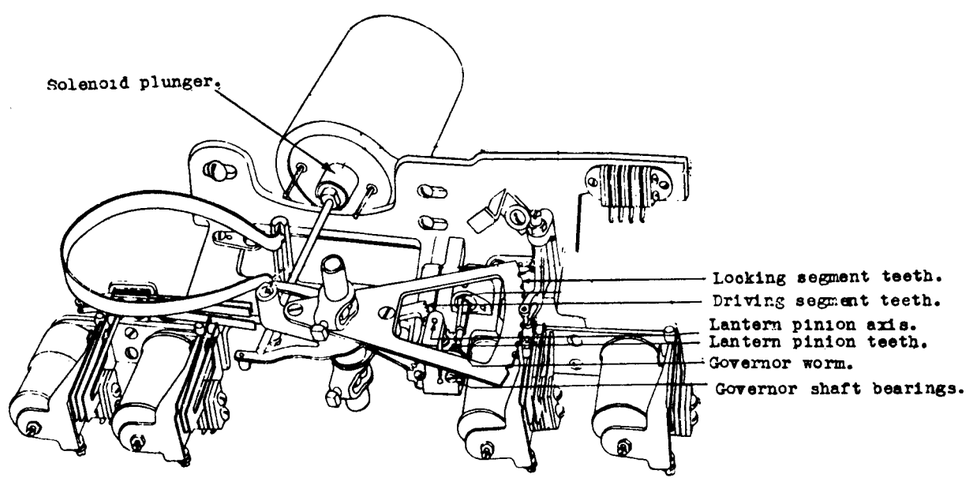
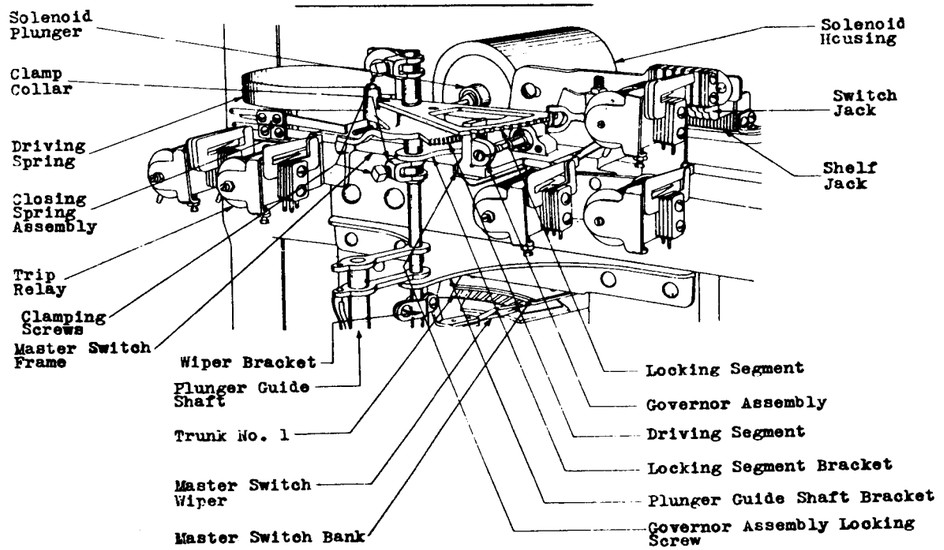
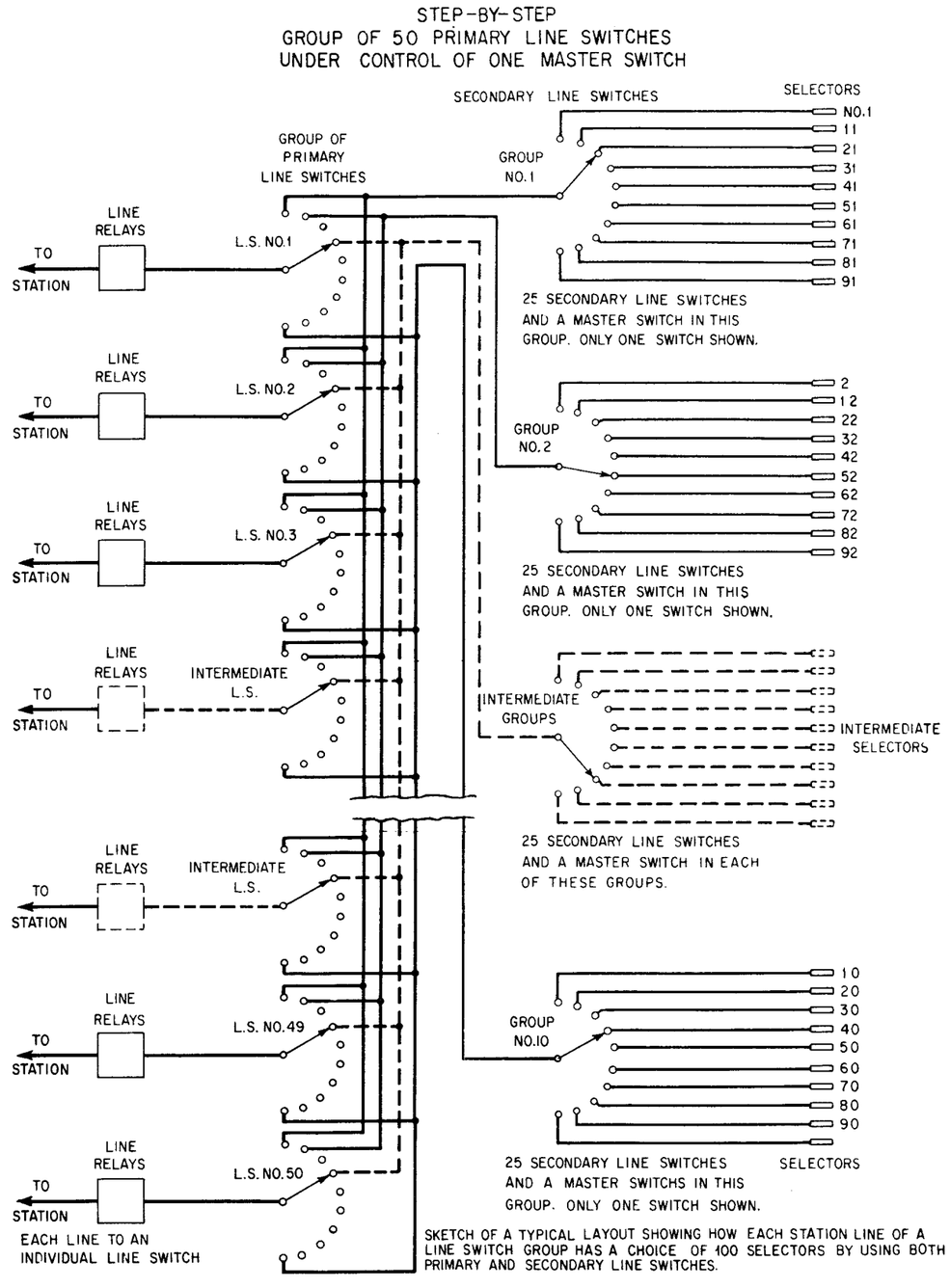
STEP – BY – STEP

MASTER SWITCH AND ASSOCIATED PARTS







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FLAT TYPE TERMINAL ASSEMBLIES

1. GENERAL (Figure 1)

This type of terminal assembly is composed of 36 supports upon which the selector bank cables terminate and connect to trunks leading to the next series of switches.

The selector banks are wired to terminal strips of 100 contacts and assembled in three separate groups on the terminal assembly. The groups are called: sleeves which appear in consecutive order on the top strip; the T (tip) and R (ring) of the "even" selector levels on the middle strip, and the "odd" levels on the bottom strip.

It should be noted that this arrangement is different than that of the primary line switches where the T & R of the entire 100 circuits are arranged in regular order.

The strip consisting of the 100 sleeve terminals is located on Support Number 1. The strip consisting of the T & R terminals, which are connected to the even levels of the bank, is located on Support Number 2. The strip containing the odd levels is located on Support Number 3.

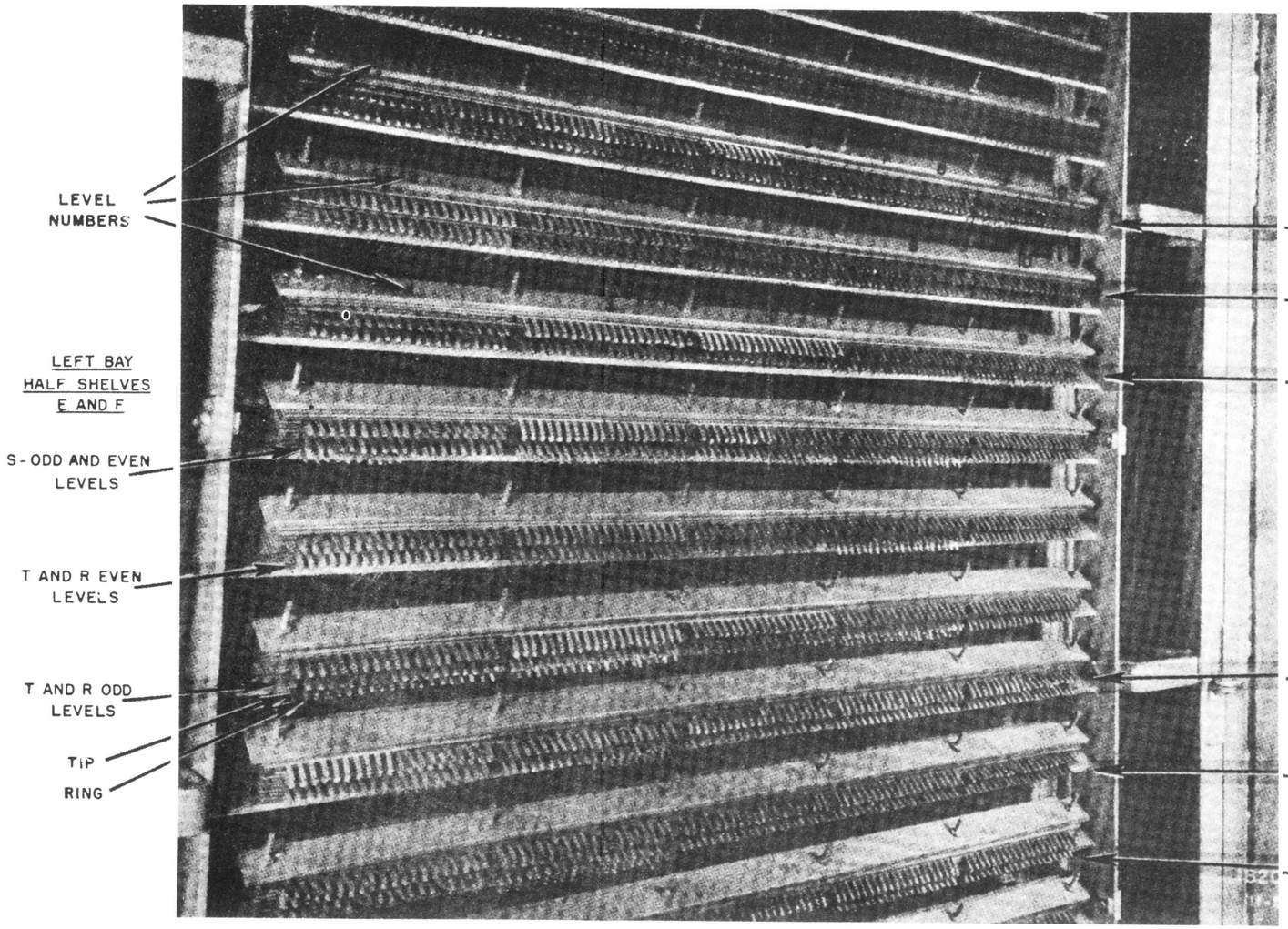
There are two terminal strips on each of the Supports 1, 2, and 3. The top strip is always connected to the left-hand shelf and the bottom strip to the right-hand shelf.

The above arrangement of terminal strips on supports makes it convenient to multiple the switches in one shelf with those in another shelf. To do this, the terminals of the two terminal strips on each support are bent together and soldered. (see Figure 2.)

These terminals are connected to outgoing trunks to other switches or trunks.

STEP-BY-STEP

FLAT TYPE TERMINAL ASSEMBLY SHOWING SUPPORTS
(REAR VIEW)



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PLUNGER OUT-TRUNK SWITCHES

Plunger out-trunk switches and their master switches are similar to secondary line switches and their master switches. The plunger out-trunk switches do not have as many relays and their operation is less complicated. The number of out-trunk switches provided varies in accordance with the amount of traffic offered to the group or groups.

The functions of the plunger out-trunk master switch are similar to those of the master switches associated with line switches. As a result only those variations which exist between the two types of equipment will be discussed.

The out-trunk master switch performs the function of holding the idle plungers of all of the out-trunk switches in this group in front of an idle trunk to the repeaters. In addition, the out-trunk master switch prevents calls from going into its group when all of its trunks to the repeaters are busy.

The plunger out-trunk master switch does not oscillate continuously when all of its trunks to the repeaters are busy because these trunks are each provided with a chain relay which operates when a trunk is seized. When all ten are operated they cause the operation of a relay which halts the master switch on the last trunk seized.

The plunger out-trunk master switch bank has ten trunks to repeaters. When one of these trunks is seized the master switch causes all other plungers then standing in front of that trunk to be moved away immediately to the next idle trunk, thus avoiding double connection. The master switch selects trunks in order from 10 to 1. When trunk 1 is seized the master switch will return all idle plungers to trunk No. 10 or to the next idle trunk below ten.

The importance of plunger out-trunk switches can best be illustrated by a brief description of the purpose they serve in the step-by-step system. Trunks from first selectors may go direct to second selectors or to connectors in the same office. On the other hand, trunks may go through repeaters and interoffice trunks to selectors in distant offices.

When these trunks are routed to distant offices and there are 20 or more in number, it is most economical to operate them as a single trunk group through the use of plunger out-trunk switches reached over trunks from preceding selectors.

It would be possible to have a group of 90 trunks divided into 9 small groups of ten trunks each from first selectors to repeaters and interoffice trunks in a distant office. Even though the busy-hour traffic through each of the 9 smaller groups might provide a full load, the combined busy-hour traffic through the 9 groups would normally provide considerably less than a full load for a single group of 90 trunks. Therefore, equipment and cable can be saved through the use of a single group.

This equipment was replaced about 1931 by the other types of concentrating equipment and is now considered obsolete.

INTERTOLL DIALING
(OPERATOR OR CUSTOMER)

1. GENERAL

Intertoll dialing is a system designed to enable calls to be completed through one or more toll points and the terminating local office directly to the called station or trunk. Intertoll dialing may be handled between two dial areas either over separate one-way groups or over a single two-way group. It may be applied between a dial area and a manual area, in which case the traffic into the dial area will be dialed whereas that into the manual area which is handled over the same group of intertoll trunks will be on an automatic manual basis. An intertoll dialing network may be built up of three or more toll points, of which those in dial areas are capable of acting as intermediate switching points between two other toll points. Intertoll dialing traffic will be originated by the outward toll operator, or, in the case of AB toll-type traffic, by the "A" operator at dial, common battery manual or magneto points, or with DDD by the customer.

The selection of the completing trunk is accomplished by a step-by-step selector similar to a toll intermediate selector called the intertoll selector. For through traffic, other slightly different selectors are employed; namely, the auxiliary intertoll selector for connecting to intertoll and operator office trunks and the through selector for intertoll trunks with overflow.

Some typical arrangements for handling different systems of traffic by operator intertoll dialing are described briefly in the following paragraphs.

2. TWO-WAY INTERTOLL TRUNK GROUPS – ONE-WAY DIALING – ONE-WAY AUTOMATIC

Between a toll office in a manual area and a distant dial area, the outward toll operator in the manual area selects the proper outgoing trunk and dials a code, the first digit or digits of which, step up the incoming intertoll selector or subsequent selectors at the distant office to the level on which the desired completing trunk is multipled. Subsequent digits when dialed by the outward toll operator direct the operation of the switch trains in the step-by-step office to effect the selection of a subscriber line or a service trunk. An incoming toll switchboard trunk also appears on the intertoll selector for reaching the inward toll operator for assistance in completing calls.

In the reverse direction the selection of the outgoing trunk by the outward operator lights the answering lamp in the incoming trunk circuit appearing before the distant inward operator who completes the call at the direction of the outward operator. In this case the incoming toll switchboard trunk circuit connects directly to the two-way trunk portion of the intertoll trunk.

Two-Way Dialing – No Through Switching – Terminal Trunk. If the toll offices at both ends of the dial intertoll trunk are located in dial areas, dialing may be performed in either direction over a two-way trunk group in the same manner as described for traffic between the manual area and the dial area. In this case both ends are arranged as for the dial area end.

3. ONE-WAY INTERTOLL TRUNK GROUPS – OUTGOING END – NO THROUGH SWITCHING

For the larger circuit groups it may be more economical to divide the group into two one-way groups. The outgoing end of each group is equipped with the operator's outgoing trunk, proper signaling and toll terminating equipment as required. This provides the outward operator with facilities for dialing to lines or trunks in the distant exchange area.

Incoming End. The incoming end of the one-way intertoll trunk is equipped with the usual toll terminating and signaling equipment and a one-way trunk which connects to the first intertoll selector. When the outward operator dials, the incoming selector or selectors are stepped up to connect to the desired completing trunk and thence to connect to the called line or trunk through the local office switch trains.

4. THROUGH-DIAL SWITCHING

(a) Dial Intertoll Trunk to Dial Intertoll Trunk. In offices where intertoll dial

through selectors are furnished, intertoll dial trunks may be picked up for switching the call through this intermediate point to a distant toll office. This is accomplished by equipping the two-way trunk for outward multiple at the selectors.

When the originating outward operator wishes to establish a connection to a customer or trunk in a distant exchange area through this intermediate toll point, she dials a code over the intertoll dial trunk to the intermediate toll point. The first digit or digits step up the selectors of the intertoll train at the intermediate toll point to connect to an intertoll dial trunk to the distant toll point. Subsequent digits dialed by the originating operator direct the selection of the completing trunk and the called line or trunk.

The auxiliary intertoll selector is used to establish through connections to tributary and short haul intertoll trunks and may be used on long haul circuits as well. However, a selector is available for use on long haul circuits, which provides overflow and reorder signals to the originating operator. This selector is called the ***through selector***, which operates as follows: If there is an idle trunk on the level to which a through selector is driven, it will operate in the same manner as an auxiliary intertoll selector. If there is no idle trunk on the desired level, the through selector will be prevented from rotary hunting and will return NC (30 IPM) flashing signal to inform the originating operator to release and try again.

(b) Dial Intertoll Trunk to Ringdown Intertoll Trunk. Where intertoll selectors are furnished, ringdown circuits may be picked up for switching the call through an intermediate point to an office connected by a ringdown circuit. The ringdown trunks are adapted to this purpose by applique circuits which are multipled on certain levels of the auxiliary or through intertoll selector. Preceding this selector is a trunk multipled to certain levels of the intertoll selector. This trunk is prepared to control the ringing signal over the ringdown circuit by means of a signal passed over a fifth lead from the auxiliary or through selector. This signal is obtained from the selector right normal post springs which are adjusted to operate at levels on which ringdown appliques are multipled.

The originating operator, in making an intertoll call through an intermediate toll point to a ringdown tributary, dials over an intertoll dial trunk to the intermediate point. The first digit or digits dialed direct the selector of the intertoll train to the level assigned to the trunk preceding the auxiliary or through intertoll selector, the next digit directs this selector to the level assigned to the ringdown circuits to the called office. When the final selector reaches an idle circuit, a signal is given to the preceding trunk to apply a two-second "spurt" of ring to bring in the called operator.

(c) Dial Intertoll Trunk to Community Dial Office Trunk. Where intertoll selectors are furnished, community dial office trunks from the toll switchboard may be arranged to be multipled on the banks of the auxiliary intertoll selector. In this case, the auxiliary selector is used because certain community dial offices (Link Type) are not arranged to immediately receive dial signals. If this is the case the left normal post springs of the auxiliary selector are adjusted to operate at these levels to send a "Stop Dialing" signal to the calling trunk.

The originating operator dials the code assigned for the selection of the proper community dial office trunk and then dials the customer's number. However, if a "Stop Dialing" signal is received upon dialing the office code, the originating operator waits for the "Start Dialing" signal before proceeding with dialing the remaining digits to obtain the desired customer or trunk.

(d) Intermediate Dialing. Intermediate dialing trunks may be provided at offices, which may serve as intermediate points in multi-switched connections, to enable the operator at this point to assist the calling operator and still provide supervision from the called customer to the calling operator. The trunks appear in two jacks in the switchboard, an answering jack and a calling or dialing jack. The operator at this point answers the trunk in response to a lighted answering lamp, receives the order orally, plugs into the calling jack with the other end of the cord, dials the digits necessary for completion of the call and takes down both cords. The connection is then held under the control of the calling operator alone; although the intermediate dialing operator can be

recalled by a rering from the calling operator if the call goes to a switching trunk or an operator office trunk and the called customer has his receiver off the hook. The recall of the intermediate dialing operator releases the succeeding selectors. If the call goes to an intertoll trunk, a rering by the calling operator is repeated through the train against either an on or off-hook condition. The intermediate dialing operator is not recalled and the selectors are not released.

The switchboard appearance of the intermediate dialing trunk is obtained by using the incoming toll switchboard trunk circuit in conjunction with the intermediate dialing trunk. The incoming selector, directly associated with the intermediate dialing trunk, can be either the auxiliary intertoll selector or the combined intertoll and transmission selector.

5. SELECTOR EQUIPMENT

(a) General — Four types of selectors are used in the intertoll dialing system, the intertoll selector, the auxiliary intertoll selector, the through selector and the combination intertoll and transmission selector.

(b) The intertoll selector is of the step-by-step type and is similar to the toll intermediate selector. It mounts on a single shelf which has capacity for ten switches which in turn are arranged for mounting on the toll selector frame which has a capacity for eight shelves. The intertoll selector employs four wires designated T (tip), R (ring), S (sleeve), and SP (supervisory). They are used in general as follows: tip and ring for talking, holding forward, pulsing and pad control; sleeve for busy test and holding; and supervisory for supervision backward from the called customer or trunk. The dial pulsing path through the selector is from ground through the pulsing contacts in the selecting trunk and then over the tip and ring directly through the switch and banks to battery on the winding of the pulsing relay in the selected trunk.

(c) The auxiliary intertoll selector is similar to the intertoll selector but has in addition two sets of normal post springs. One of these sets is used to furnish start dialing signals to the calling trunk when the selected trunk terminates in equipment not prepared to receive pulses immediately after seizure, such as certain link type community dial offices. The other is used to indicate to the preceding trunk that the selector is up on a ringdown connection and will require a two-second ring.

(d) The intertoll through selector mounts on a double shelf and performs the same functions as the auxiliary intertoll selector and, in addition, supplies overflow and reorder signals.

(e) The combined intertoll and transmission selector mounts on a double shelf and functions as either an intertoll selector or a transmission selector, receiving pulses over the tip and ring. The choice of functions for any specified level is under the control of normal post springs.

(f) The selector banks (tip and ring) used on the intertoll selectors have precious metal contacts.

(g) The switch trouble and fuse alarms are the same as for step-by-step office equipment except that a permanent signal is indicated by a green shelf lamp, a white aisle pilot and a single stroke bell.

If the selectors are located in the step-by-step office, the regular step-by-step alarm frame equipment is employed but if they are located in the toll office this equipment is furnished specially for intertoll dialing and mounted on the miscellaneous relay rack.

(h) A test frame trunk to intertoll selectors and trunk relay equipment is furnished from the test and control board or toll testboard to provide a talking circuit between these points.

6. TRUNK EQUIPMENT

(a) Relay rack unit equipment arrangements are provided for all trunk relay equipment except a few circuits for which the demand does not warrant the provision of such arrangements.

(b) The dial intertoll trunk consists of line equipment similar to that used by a straightforward intertoll trunk. Patching jacks are omitted unless the circuit may be used to make good a full period talking circuit. The drop equipment consists of the outgoing operator trunk and the two-way trunk for two-way circuit groups, or the one-way trunk for the incoming end and the outgoing operator's trunk and in some cases the two-way trunk for the outgoing end of one-way circuit groups.

(c) The completing trunks required for intertoll dialing are the outgoing trunk to loop dialing toll transmission selectors, the outgoing trunk to repeated dialing toll transmission selectors, the outgoing trunk to local offices arranged for reverse battery supervision and the four-wire toll switching trunk to toll intermediate selectors in the same building. The intertoll selector multiple may also be directly connected to toll transmission selectors arranged for intertoll dialing located in the same building. These may be new selectors or AB toll transmission selectors modified to receive dial pulses.

(d) The service trunks required with the intertoll dial system are trunks to the information desk, the auxiliary intercepting trunk and incoming trunks to the toll switchboard.

(e) A trunk preceding the auxiliary intertoll selector is required to control ringing when ringdown circuits are selected by the auxiliary intertoll selector.

(f) Intermediate dialing and keypulsing trunks are required for use at intermediate points on multi-switch connections to enable the operator at this point to assist the calling operator in dialing the digits to the points beyond.

7. SWITCHBOARD EQUIPMENT

(a) Dials are required at all switchboard positions arranged for step-by-step intertoll dialing and start dialing pilots must be equipped in each position.

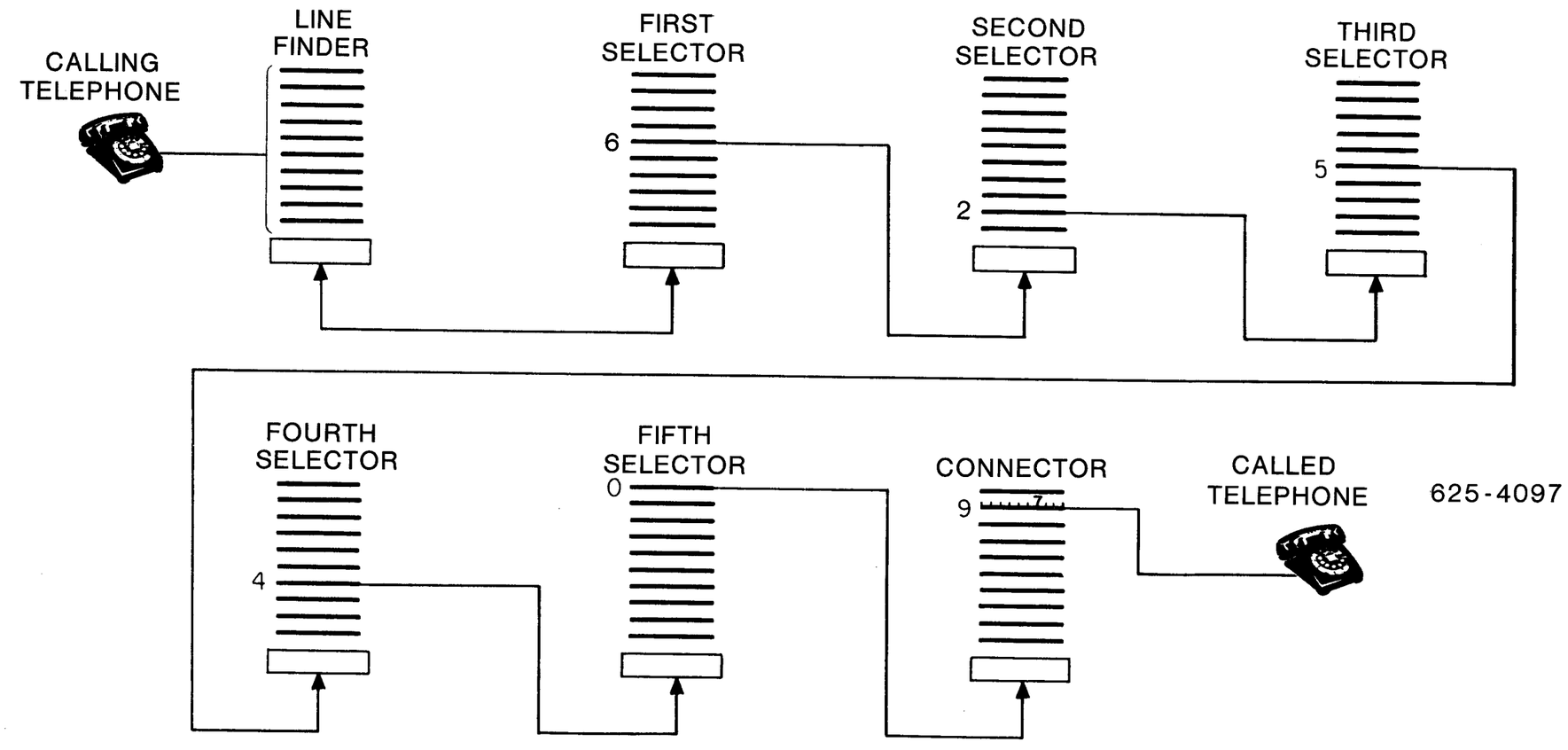
(b) No. 1 Toll Switchboards where step-by-step intertoll dialing is applied are modified for d-c supervision and dialing on front and back cords. However, at jobs where the application of intertoll dialing is so limited as to not warrant the expense of modifying the cords, arrangements are sometimes made for using the existing dialing facilities if less efficient operation can be tolerated. In this case, in boards not already arranged for dialing, a dial cord may be added.

8. LOCATION OF EQUIPMENT

The intertoll selectors and the equipment immediately associated with the intertoll trunks are usually located in the toll equipment room to obtain the shortest cabling lengths and thereby hold transmission losses to a minimum. There may be cases where it is desirable to locate the selector equipment in the local step-by-step equipment room in order that it can be maintained by personnel already familiar with selectors of this type. Where this is the case, the completing trunk equipment is located with the local equipment.

STEP-BY-STEP

PATH OF A CALL



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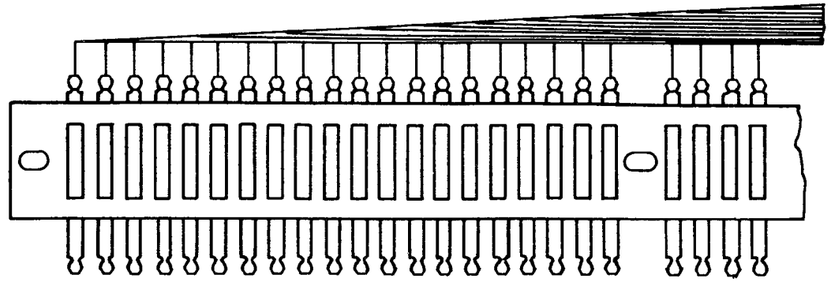
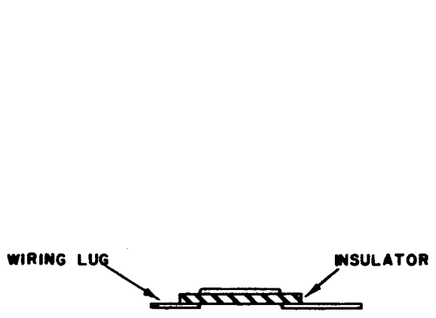
STEP – BY – STEP

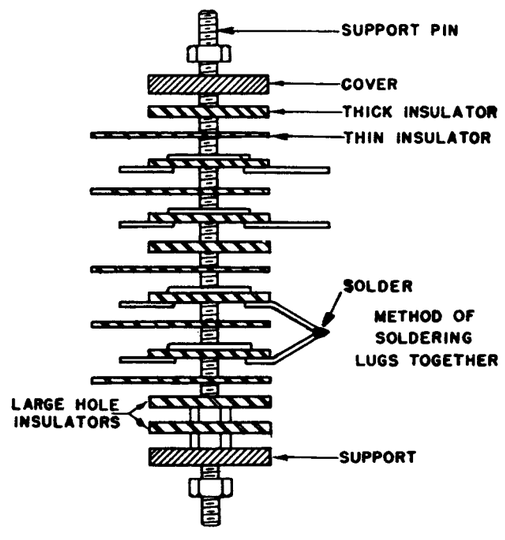
FLAT TYPE TERMINAL STRIP AND ASSEMBLY



END OF TERMINAL STRIP
TOP VIEW



CROSS SECTION
OF TERMINAL STRIP



CROSS SECTION OF
TERMINAL ASSEMBLY

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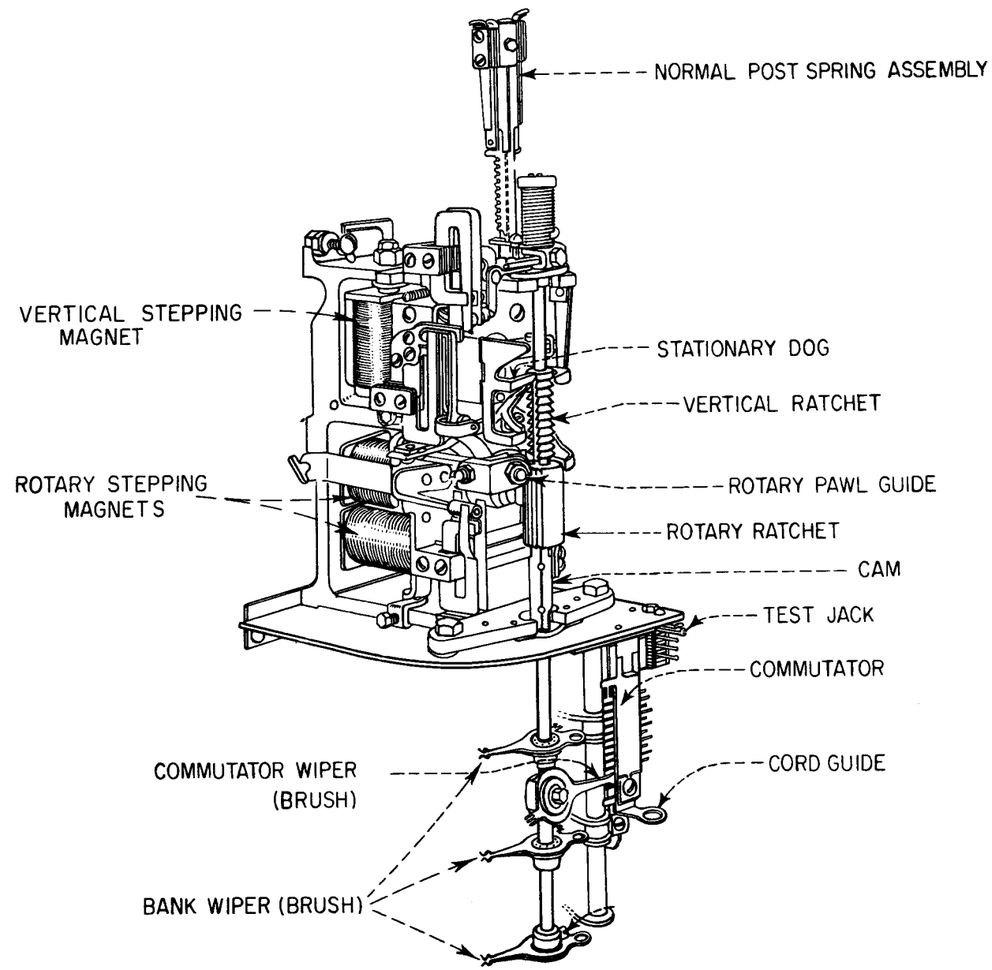
STEP-BY-STEP SWITCH
LEFT SIDE
RELAY ASSEMBLY & STEPPING MECHANISM



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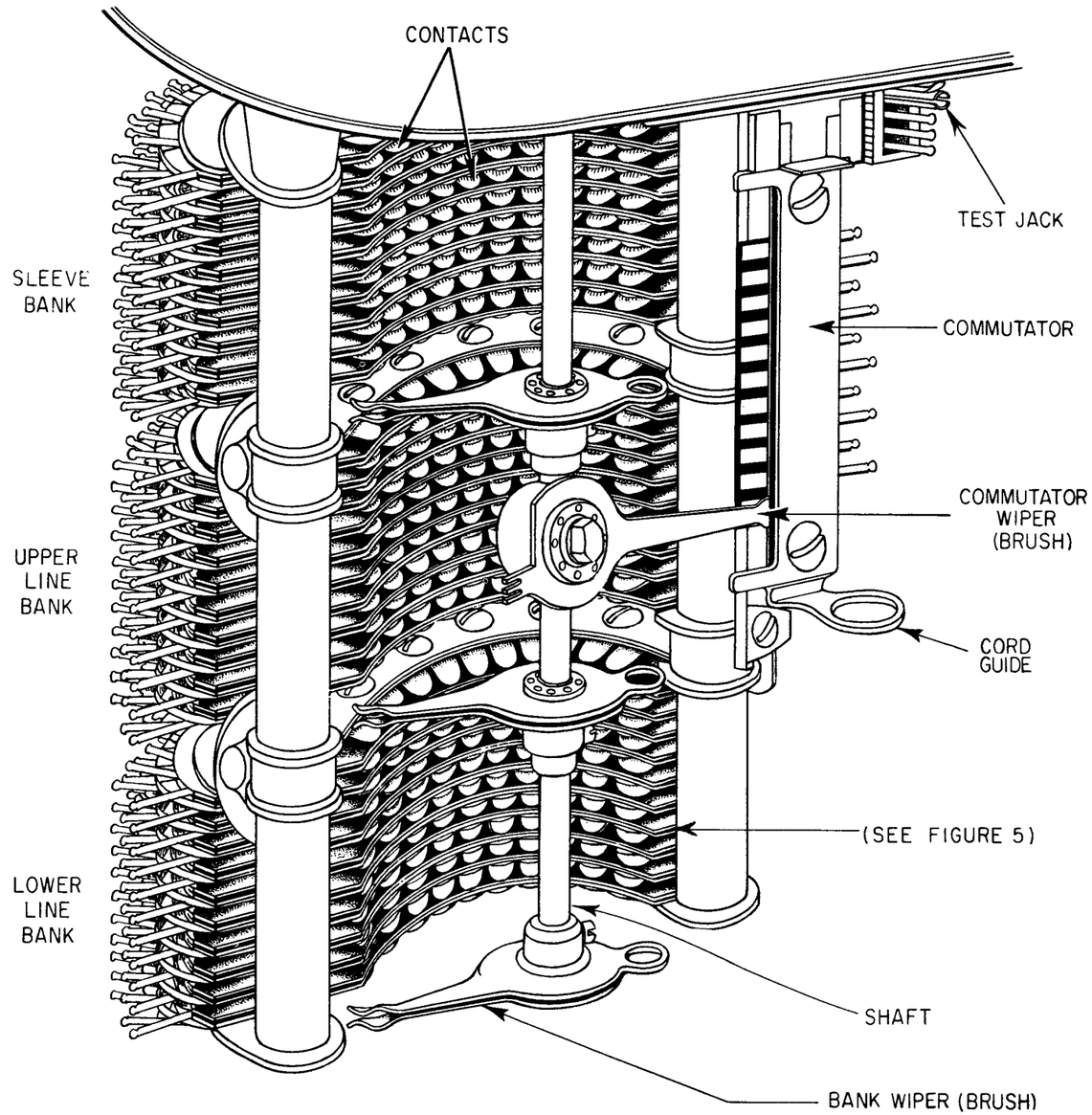
STEP-BY-STEP
MULTIPLE BANKS



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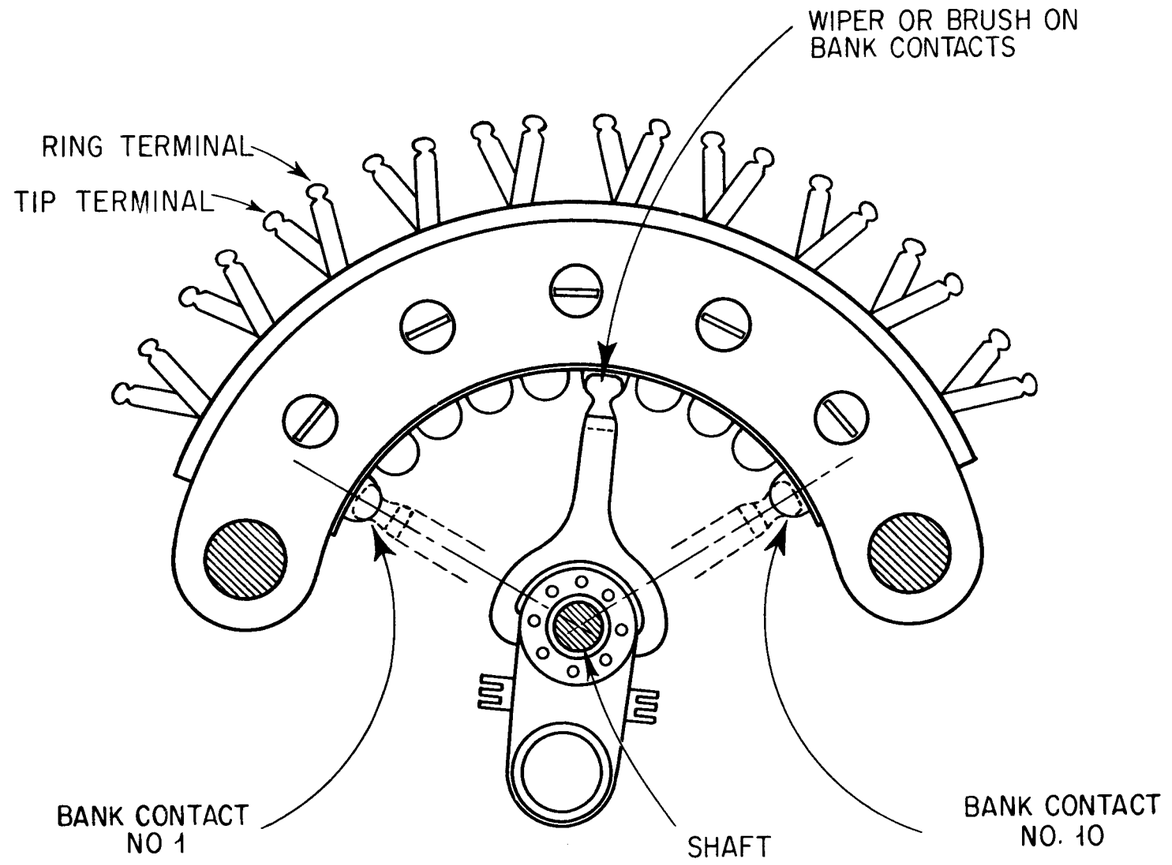
STEP-BY-STEP
BANK CONTACTS



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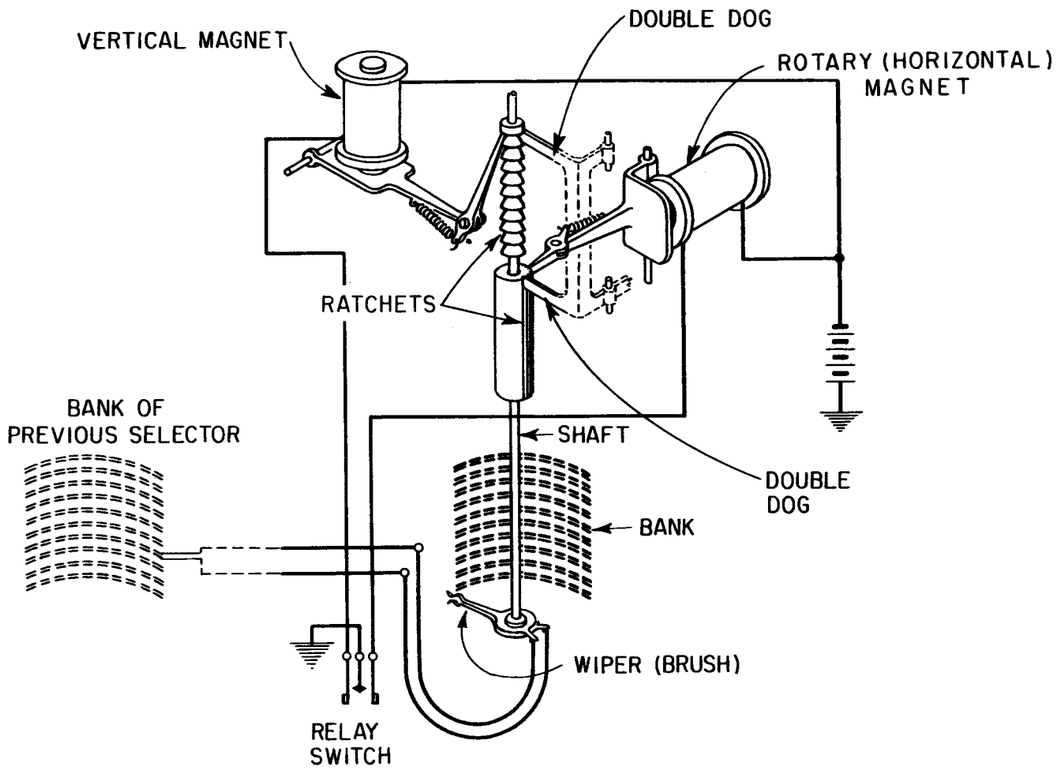
OPERATION OF STEP-BY-STEP SWITCH



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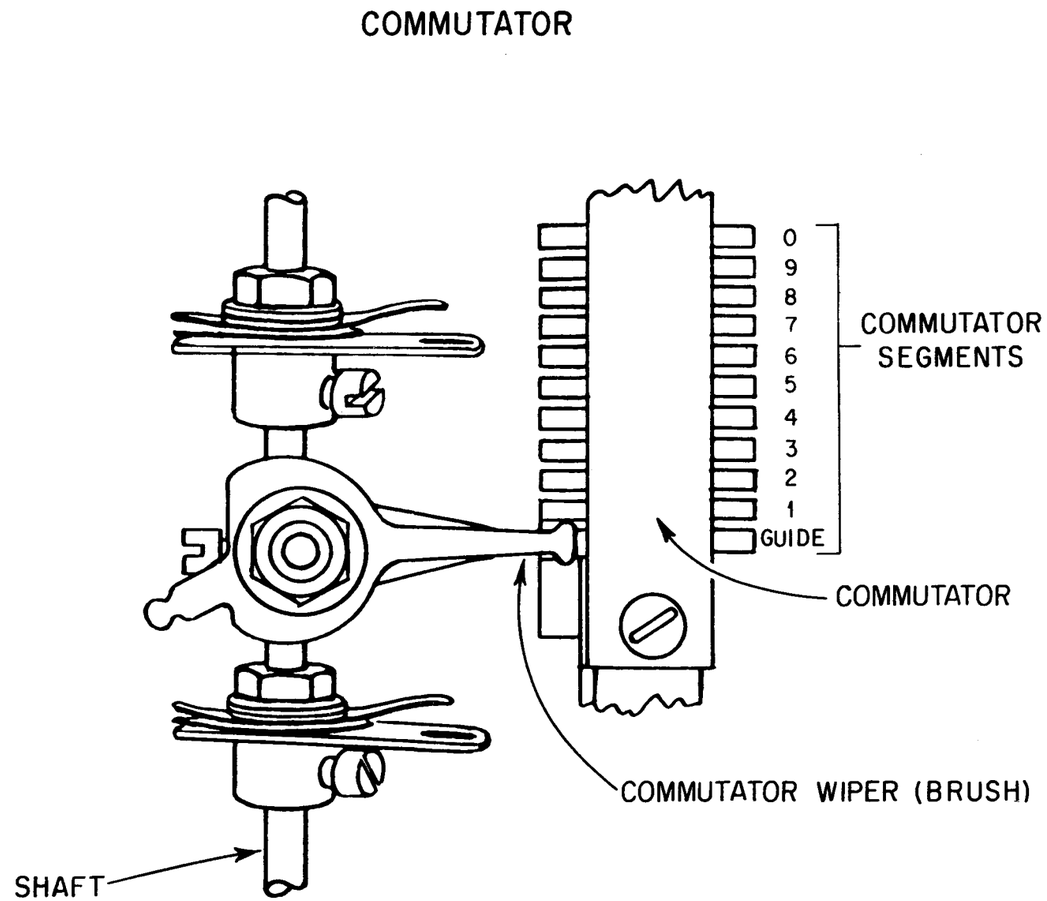

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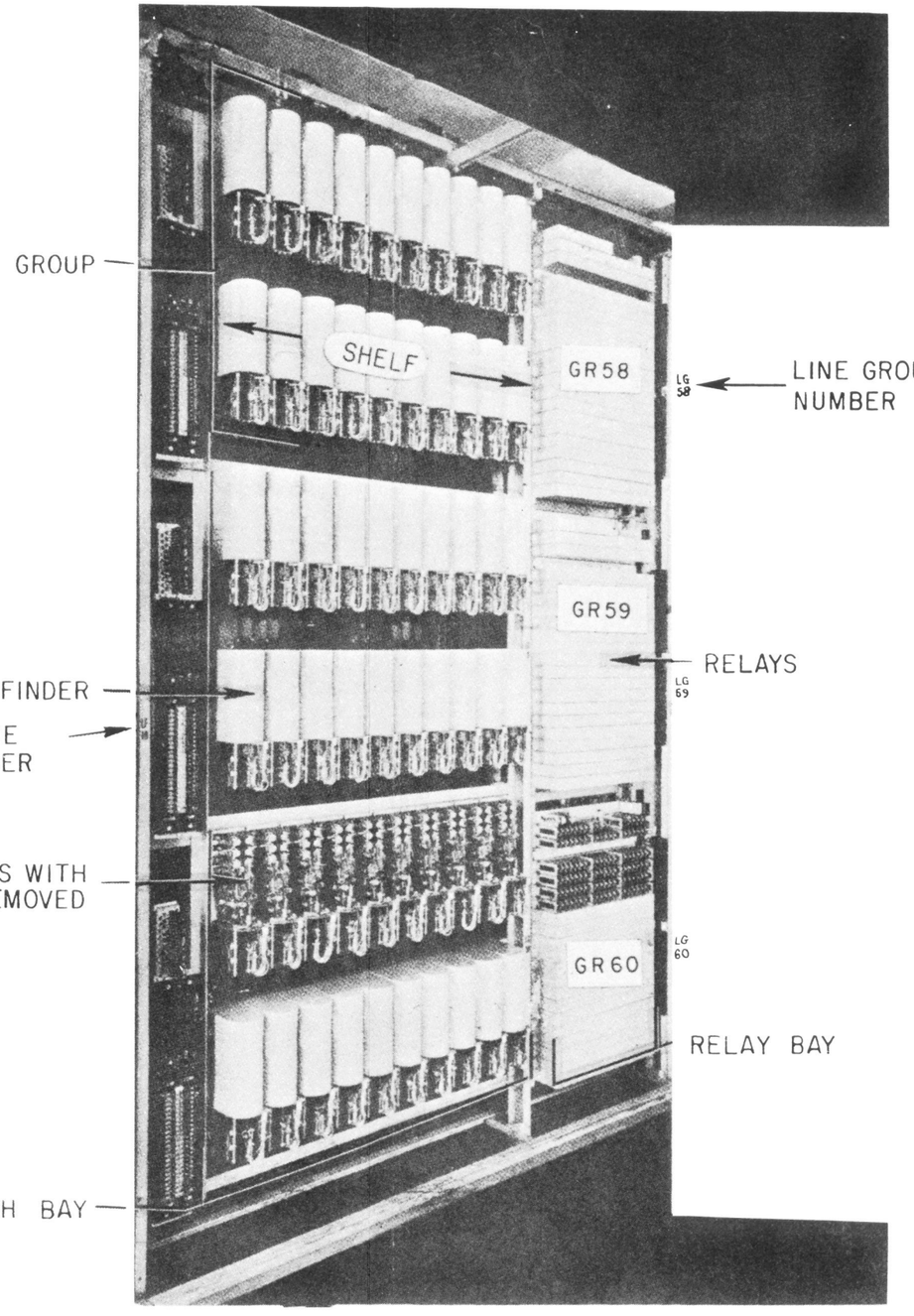
STEP-BY-STEP
LINE FINDER FRAME



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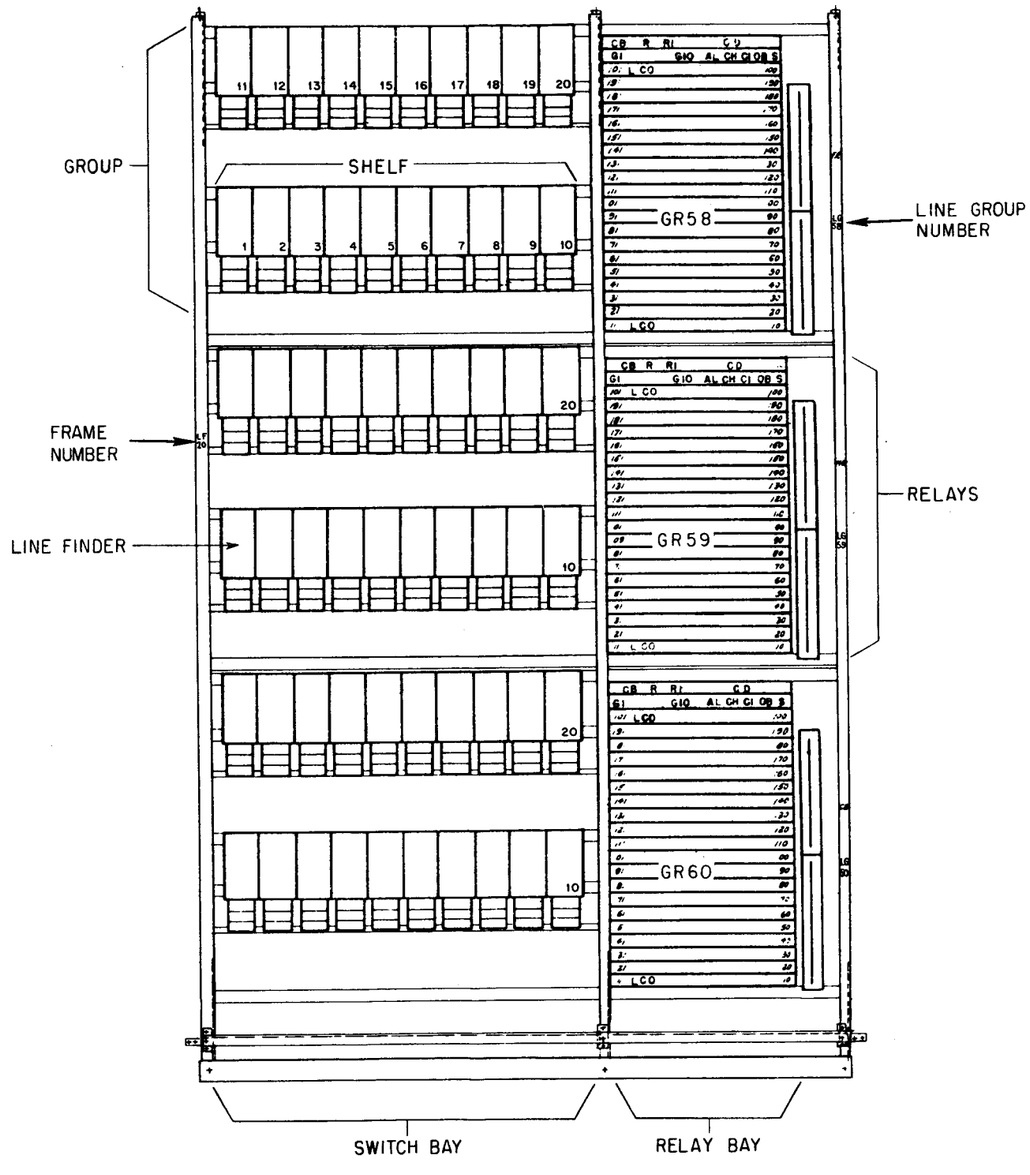
STEP-BY-STEP

LINE FINDER FRAME
(SCHEMATIC)



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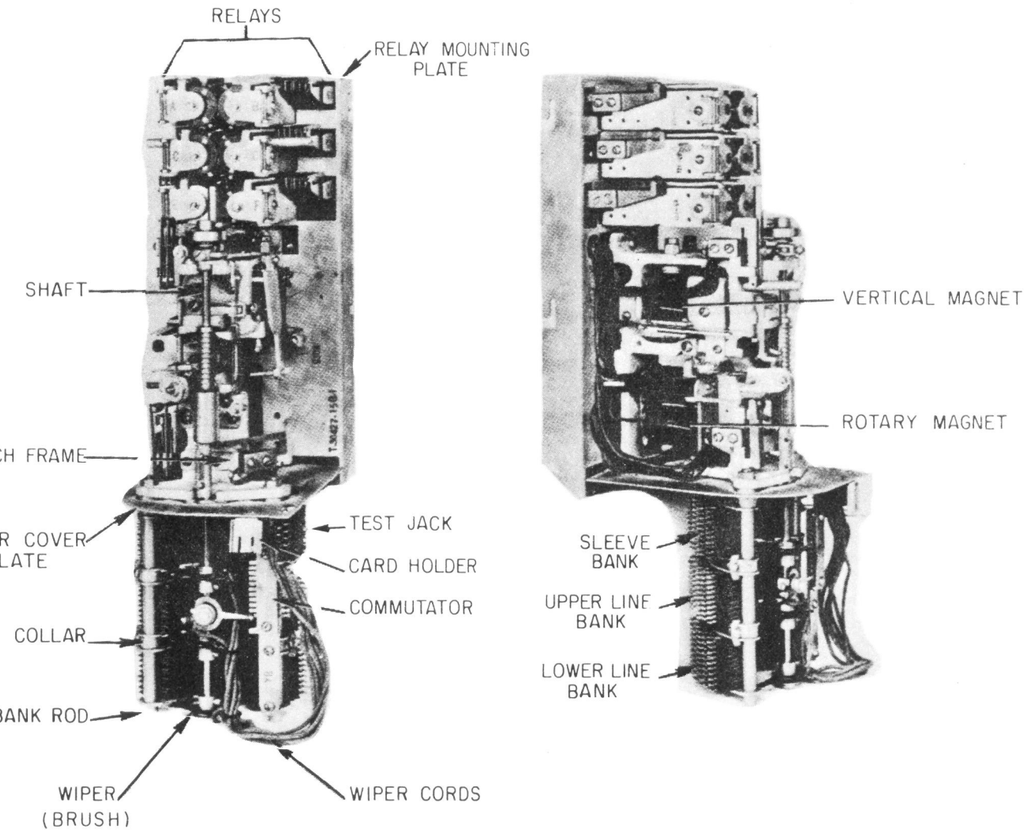
STEP–BY–STEP

LINE FINDER

200 POINT LINE FINDER SWITCH AND BANKS



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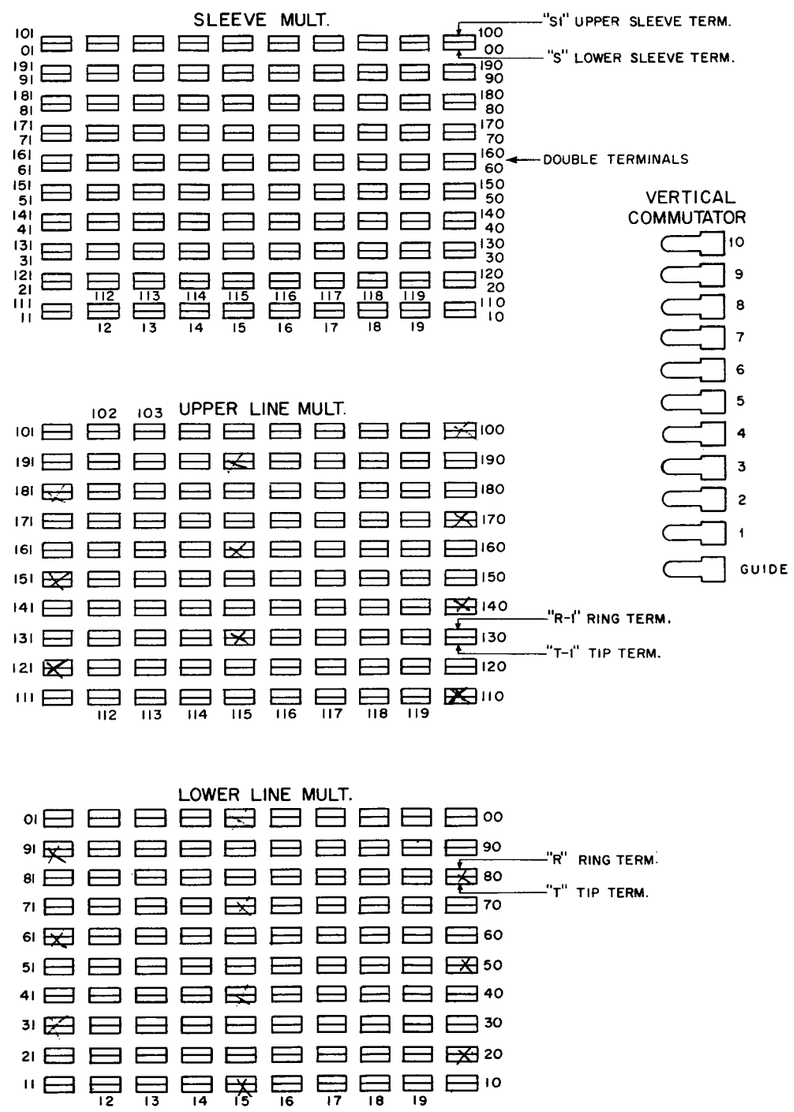
STEP-BY-STEP
LINE FINDER TERM BANKS



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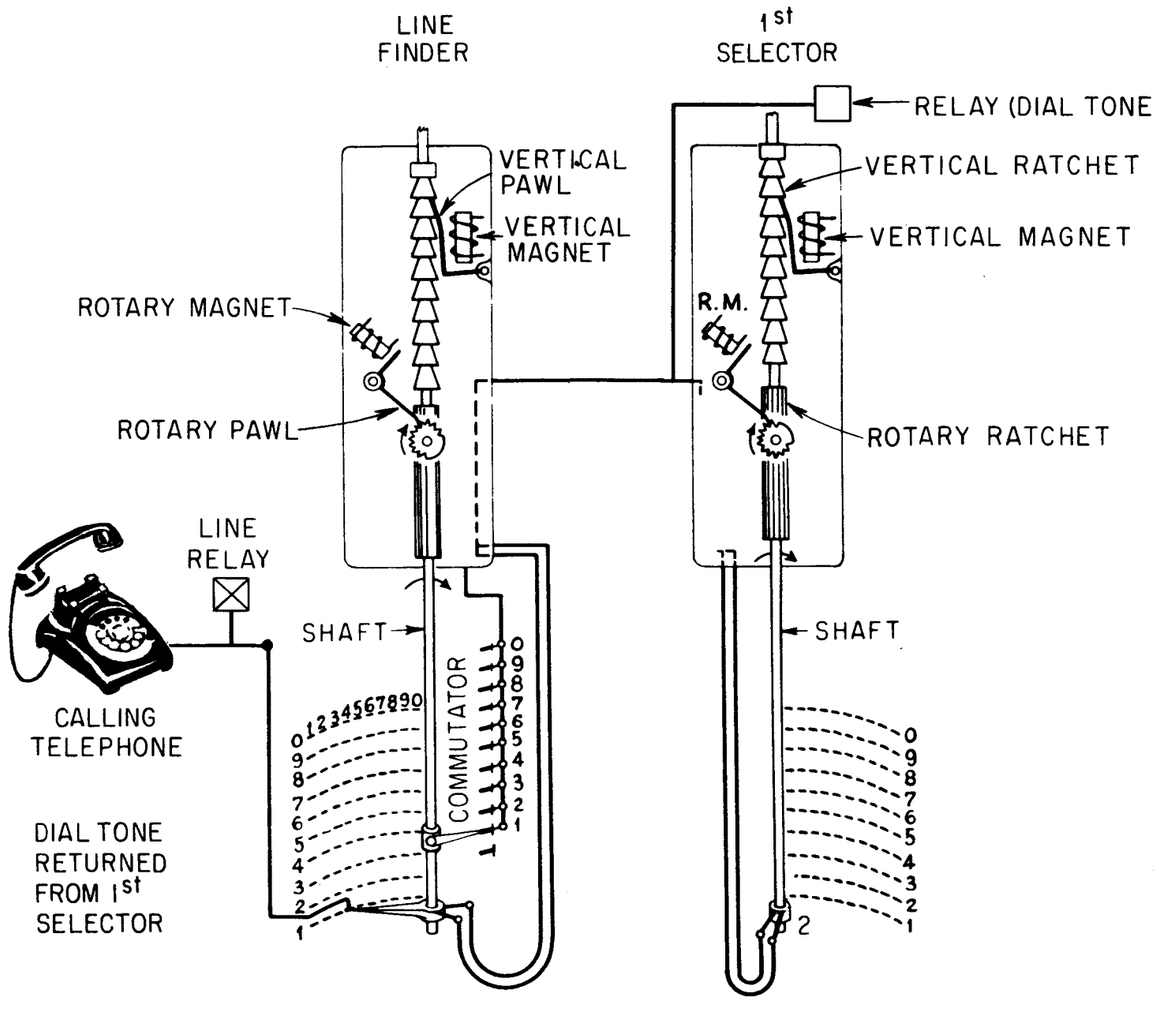
STEP-BY-STEP
PATH OF A CALL
DIAL TONE



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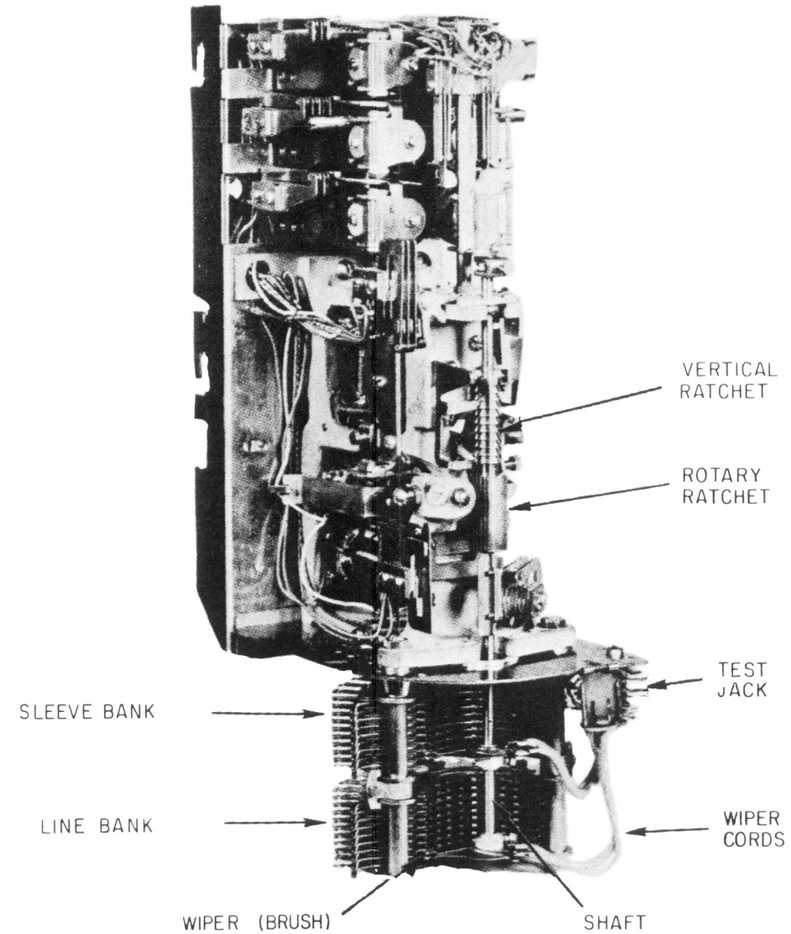
STEP – BY – STEP

SELECTOR SWITCH



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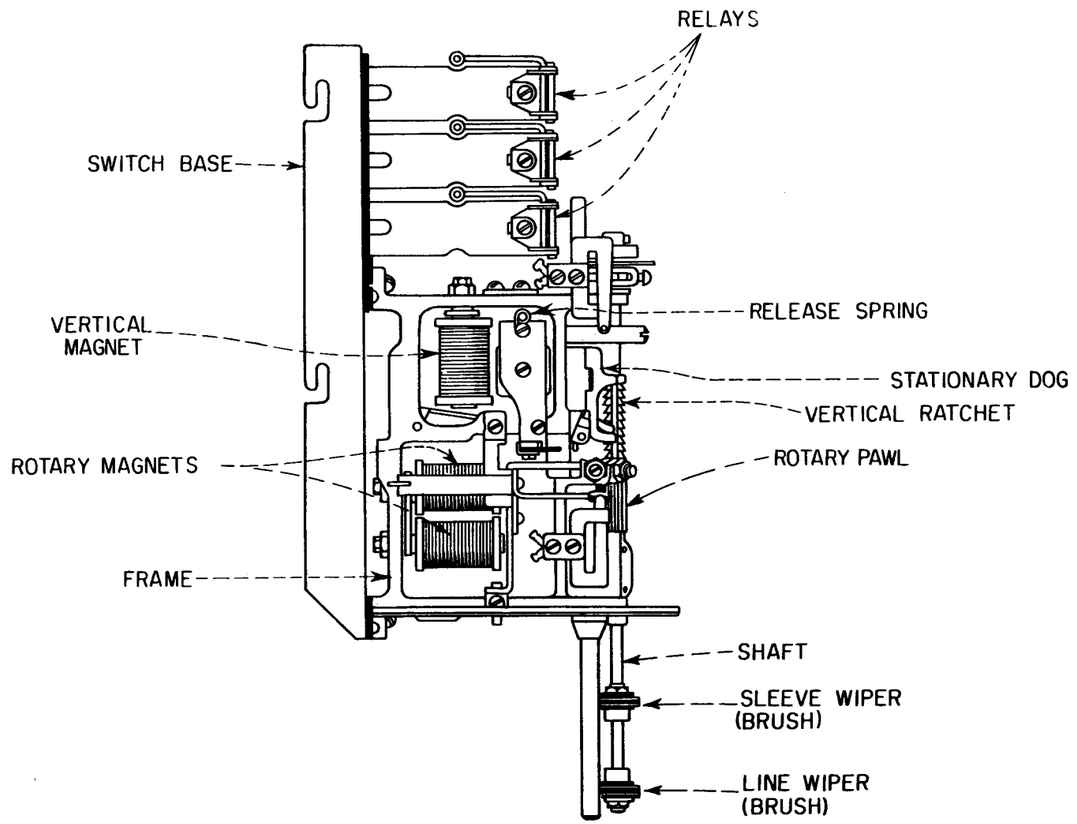
STEP – BY – STEP

SELECTOR SWITCH
LEFTVIEW



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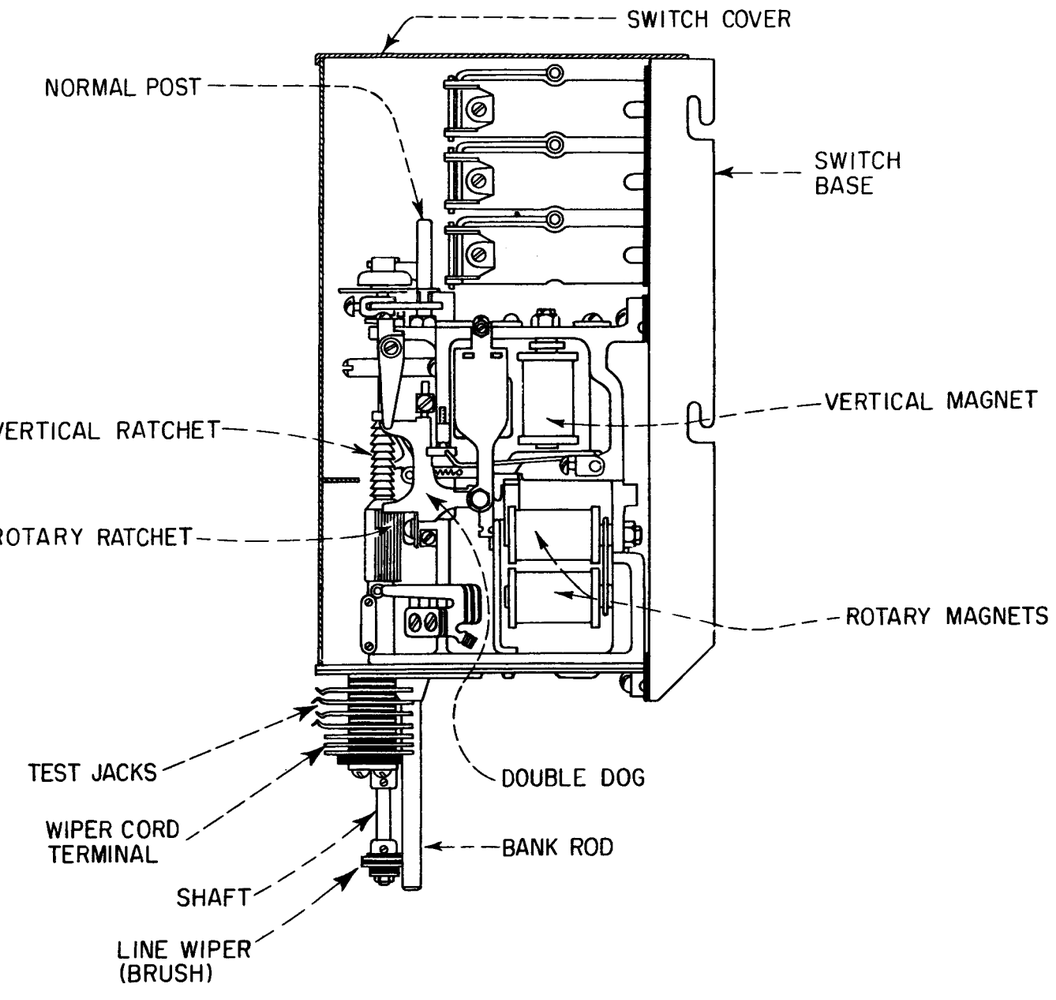
STEP - BY- STEP

SELECTOR SWITCH
RIGHT VIEW



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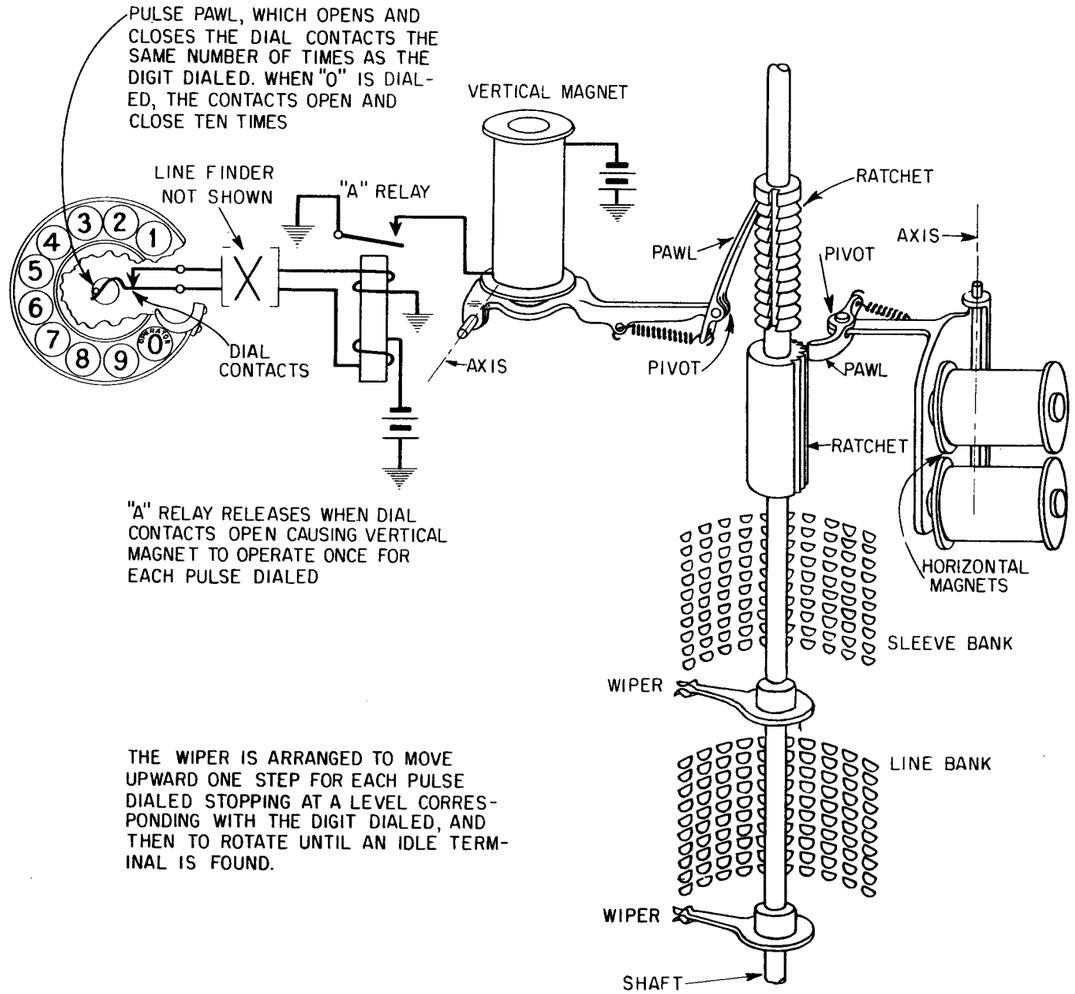
STEP - BY - STEP

STEP - BY - STEP SELECTOR
(OPERATION)



"A" RELAY RELEASES WHEN DIAL CONTACTS OPEN CAUSING VERTICAL MAGNET TO OPERATE ONCE FOR EACH PULSE DIALED

THE WIPER IS ARRANGED TO MOVE UPWARD ONE STEP FOR EACH PULSE DIALED STOPPING AT A LEVEL CORRESPONDING WITH THE DIGIT DIALED, AND THEN TO ROTATE UNTIL AN IDLE TERMINAL IS FOUND.

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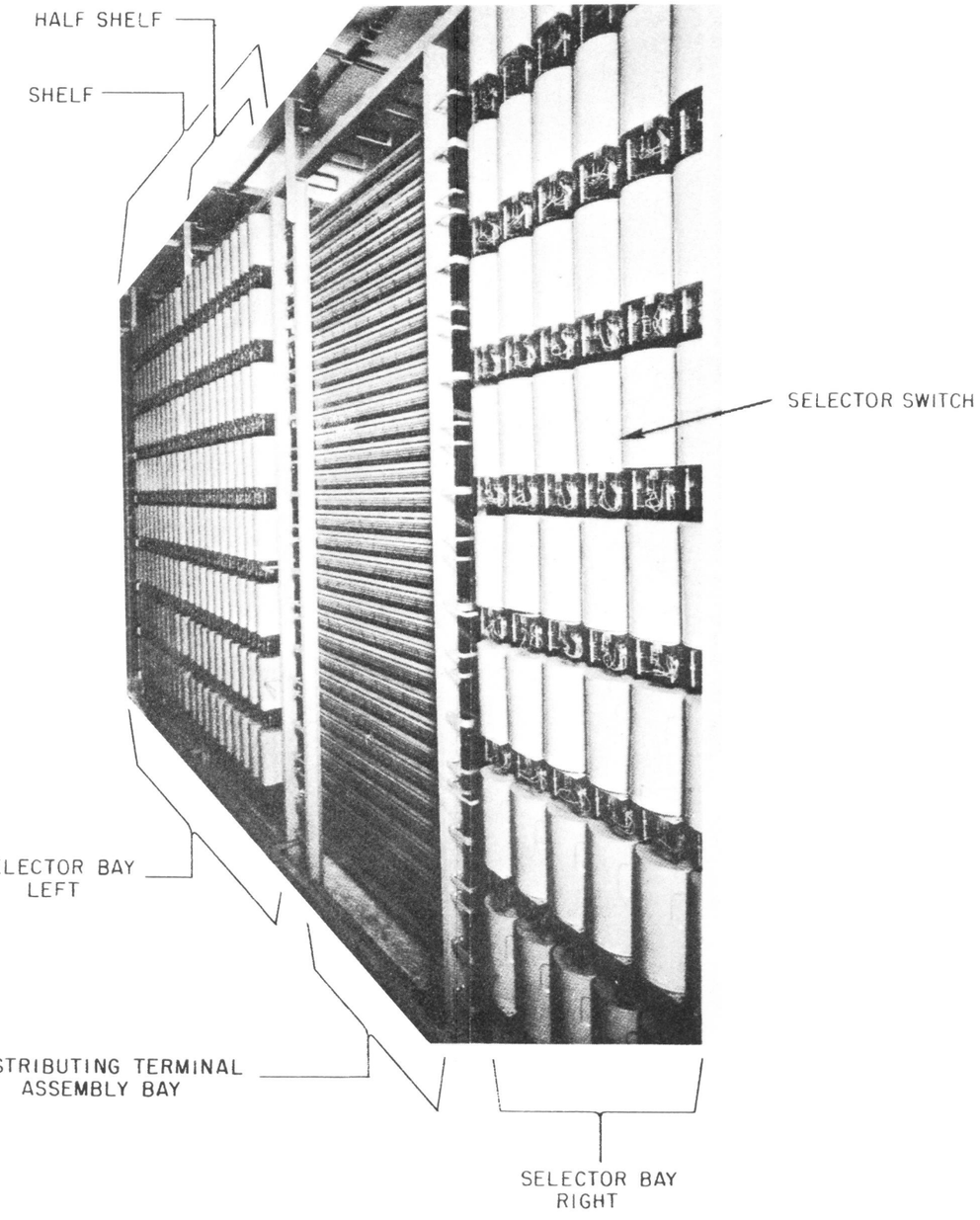
STEP-BY-STEP

SELECTOR FRAME



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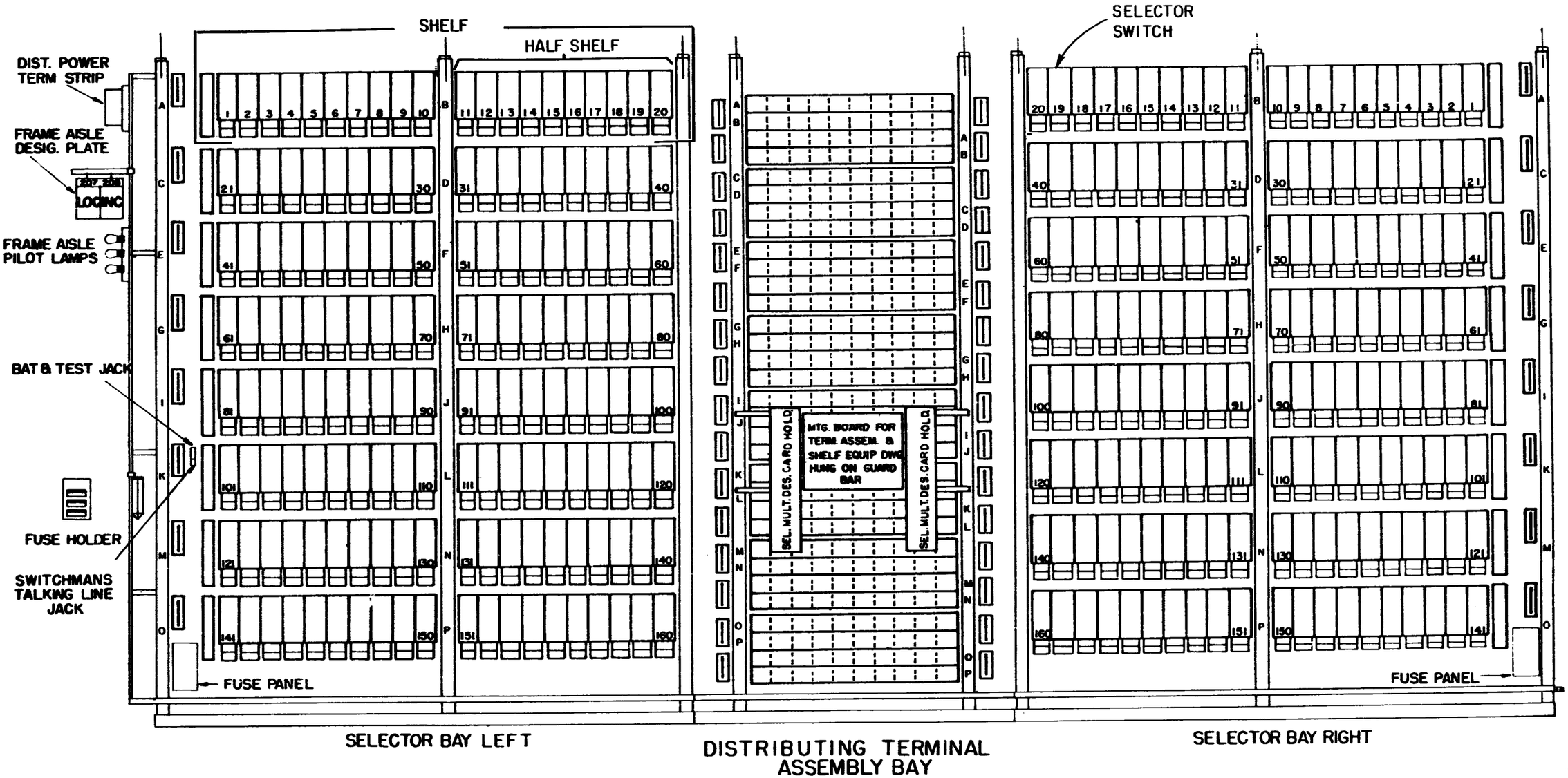
STEP – BY – STEP

SELECTOR FRAME
(SCHEMATIC)



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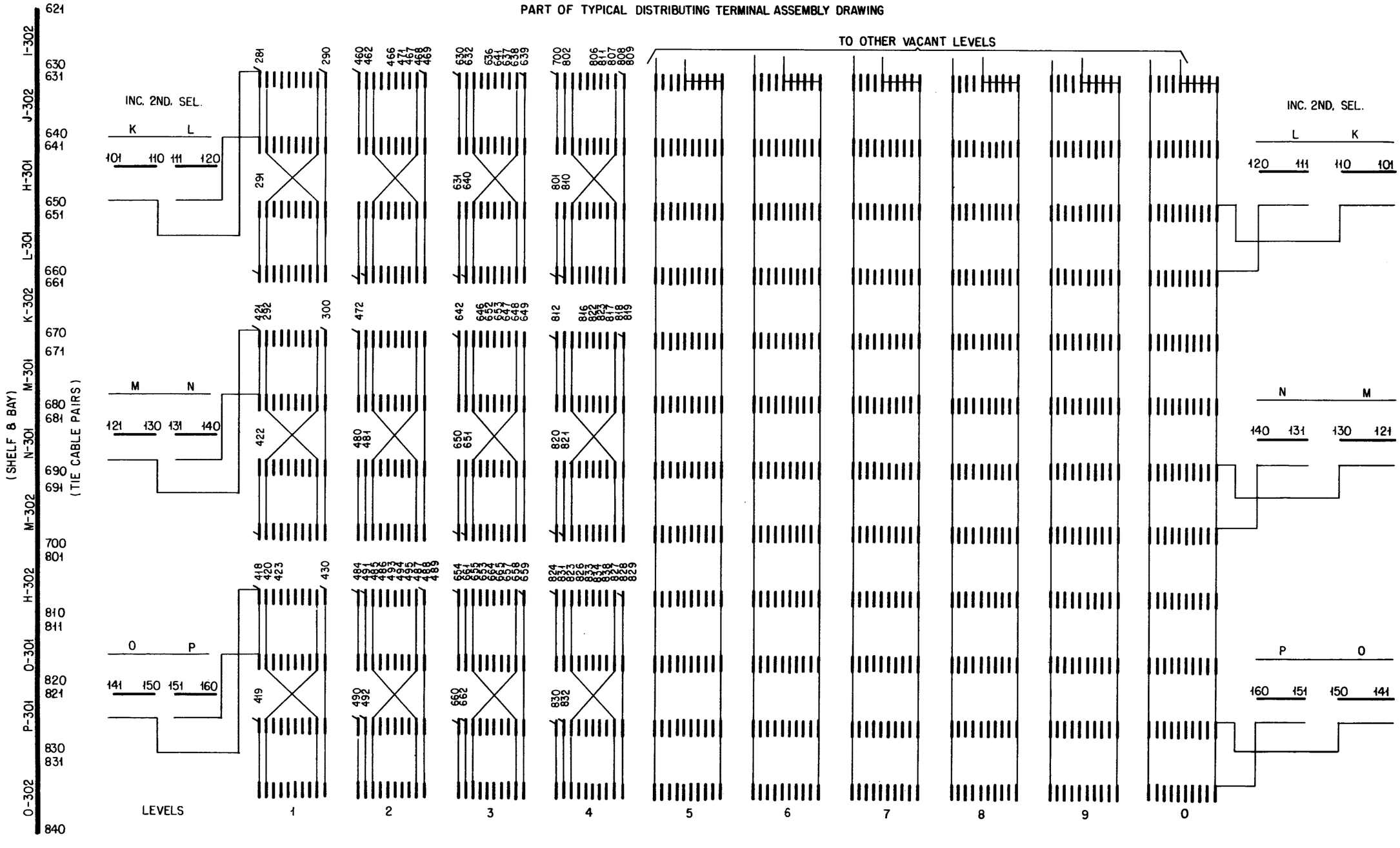
STEP-BY-STEP

PART OF TYPICAL DISTRIBUTING TERMINAL ASSEMBLY DRAWING



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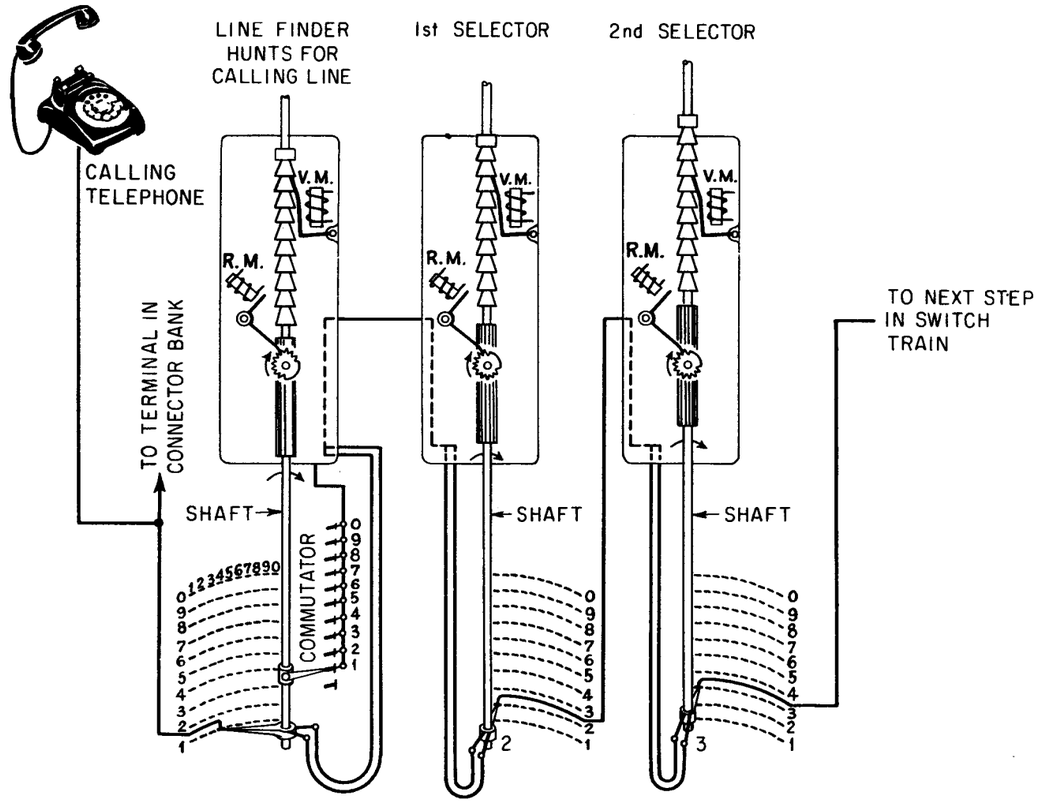
STEP-BY-STEP

PATH OF A CALL

ROUTING SELECTIONS



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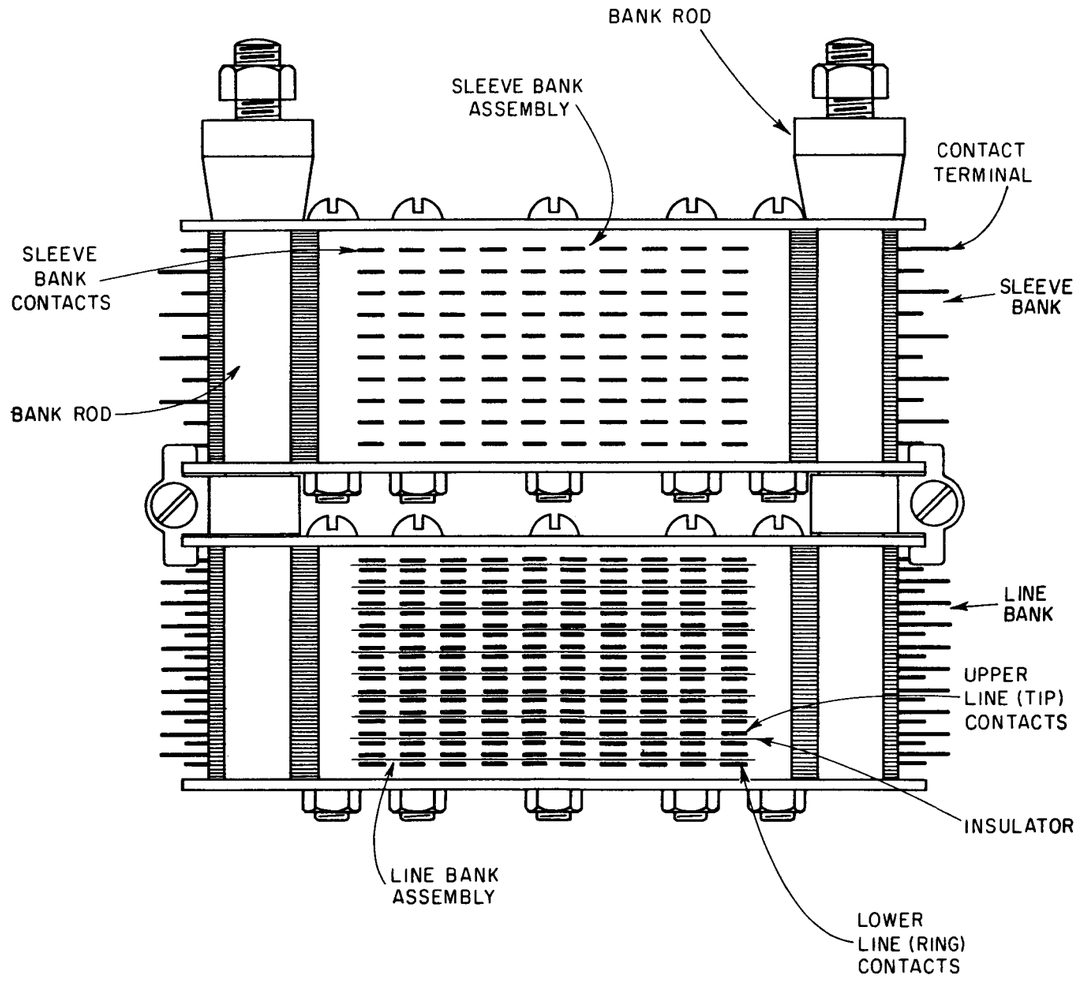
STEP-BY-STEP
SELECTOR BANK



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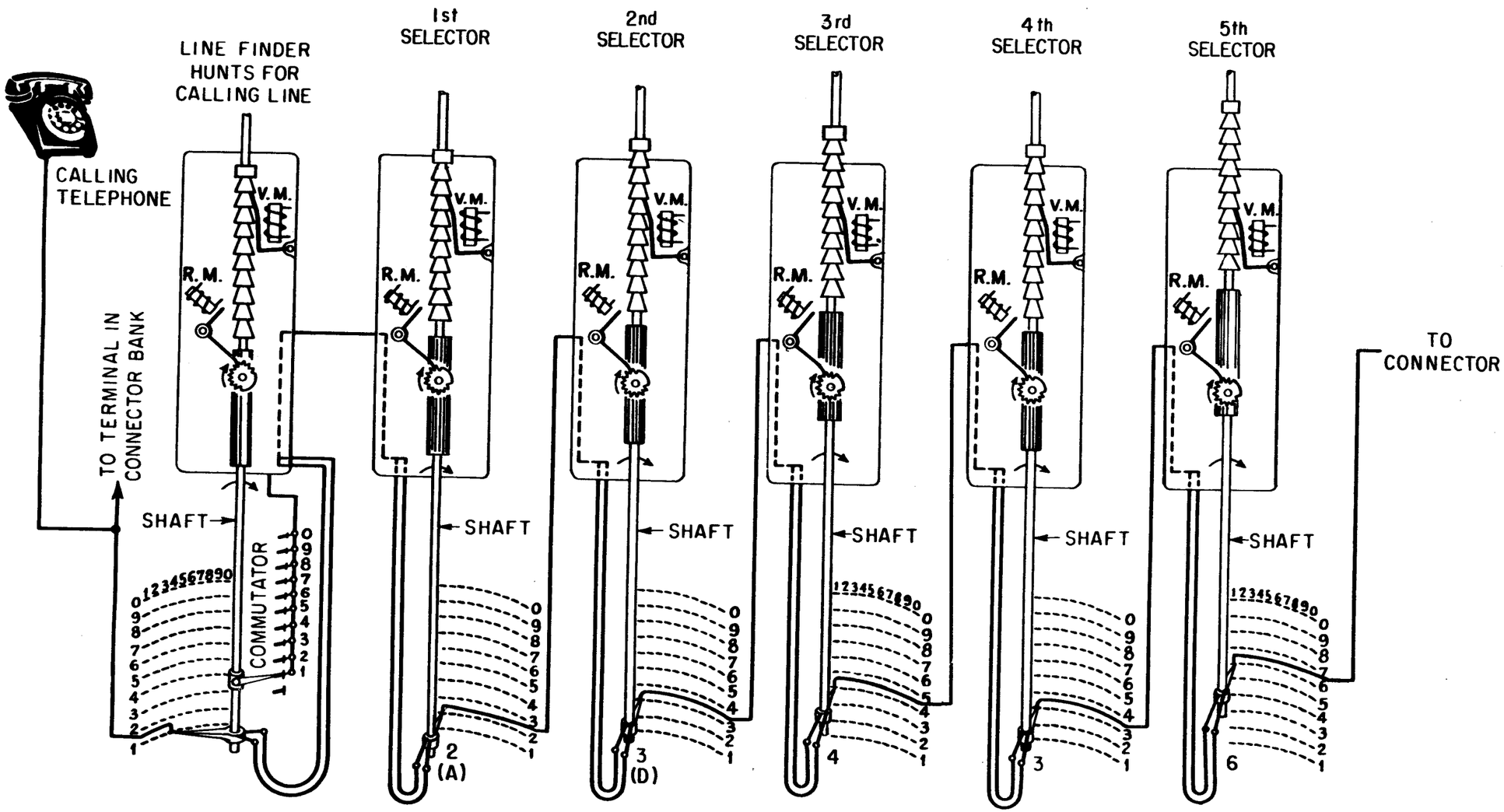
STEP – BY – STEP

PATH OF A CALL
SEVEN DIGIT SYSTEM

ROUTING TO CONNECTORS



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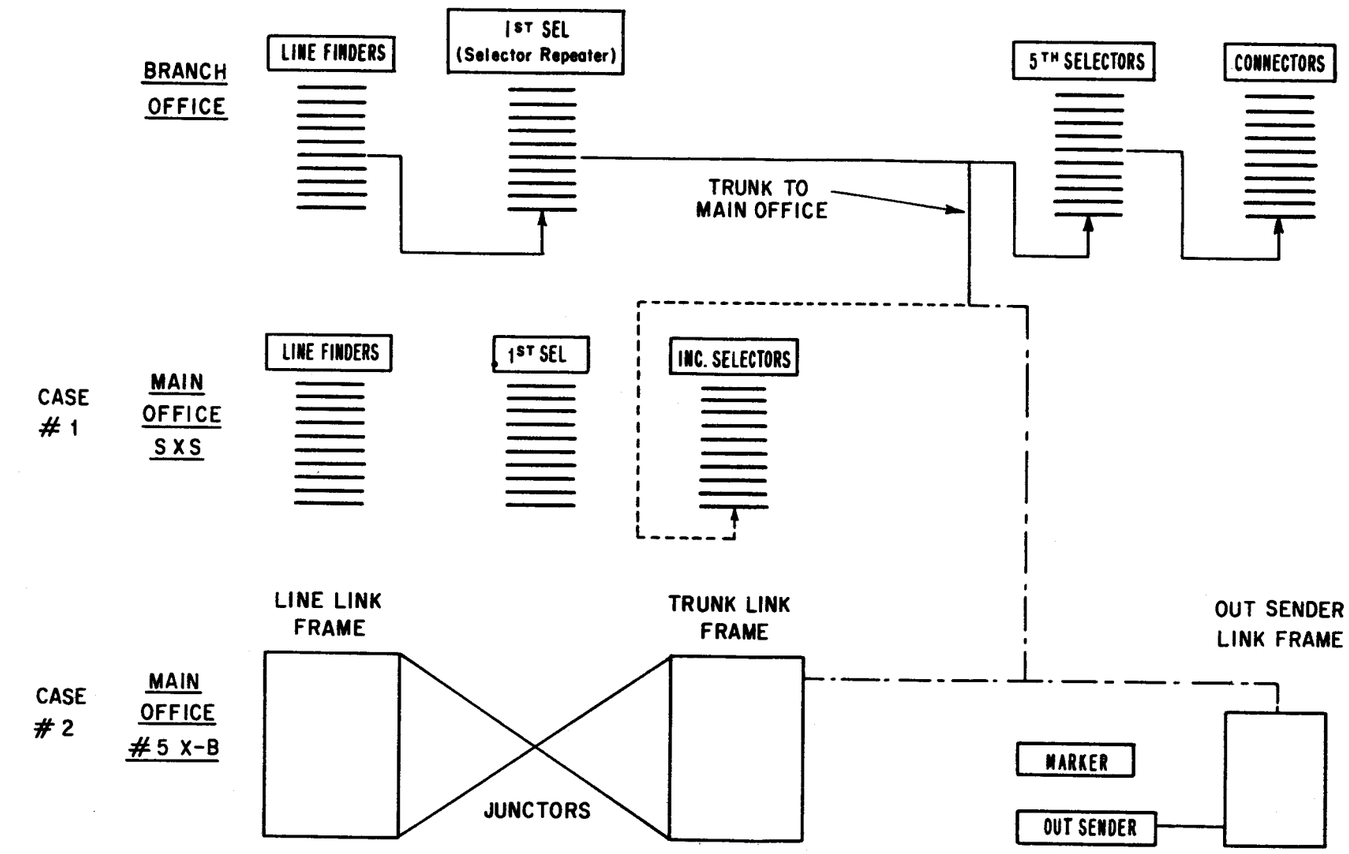
STEP-BY-STEP

SELECTOR REPEATER



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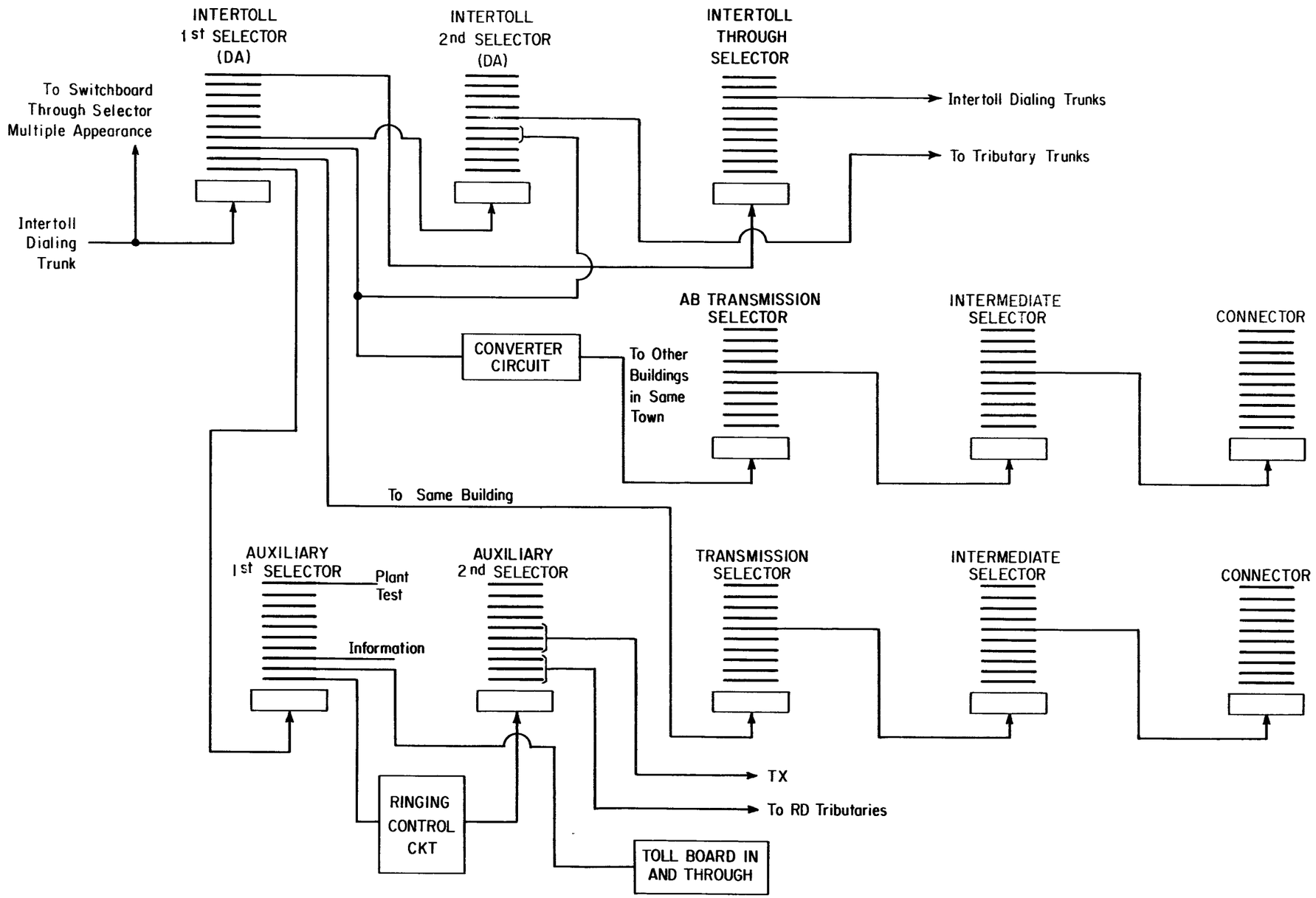
STEP – BY – STEP
TOLL AND INTERTOLL CALLS



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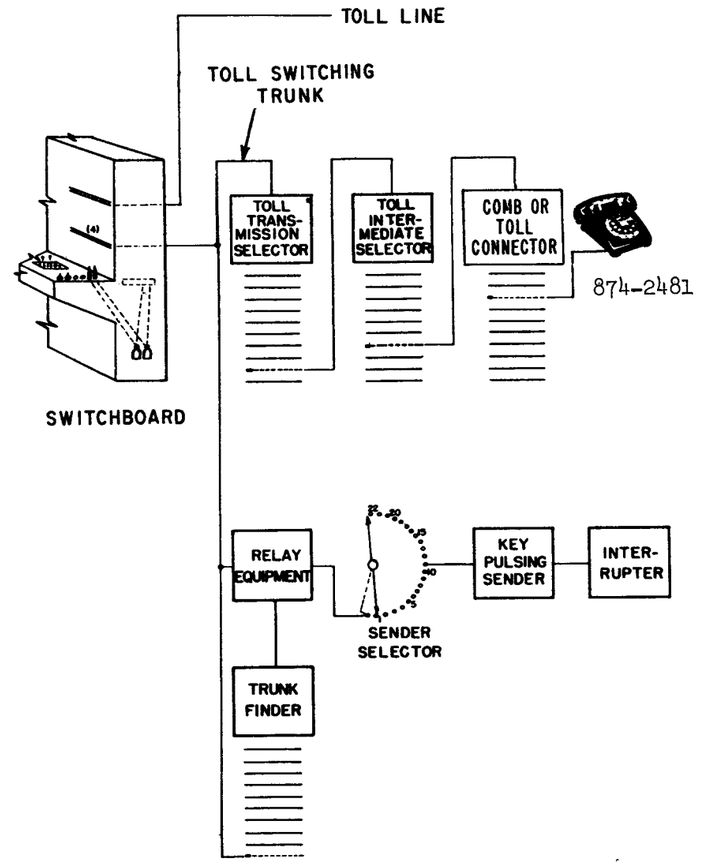
STEP-BY-STEP

TOLL SWITCH CALL



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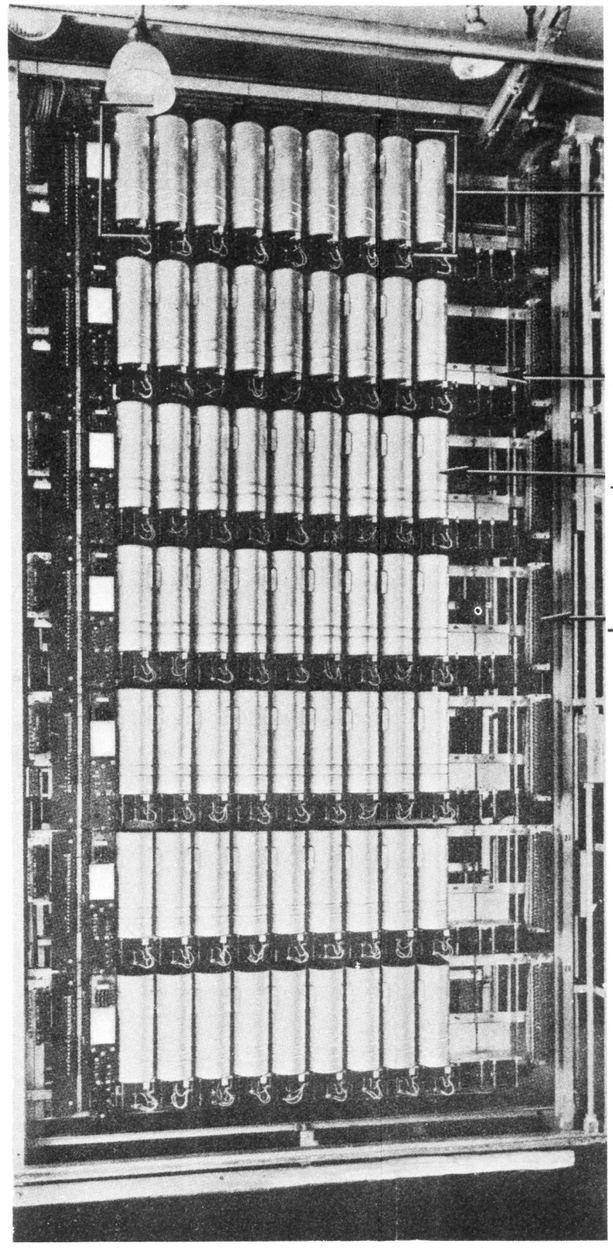
STEP-BY-STEP
CONNECTOR FRAME



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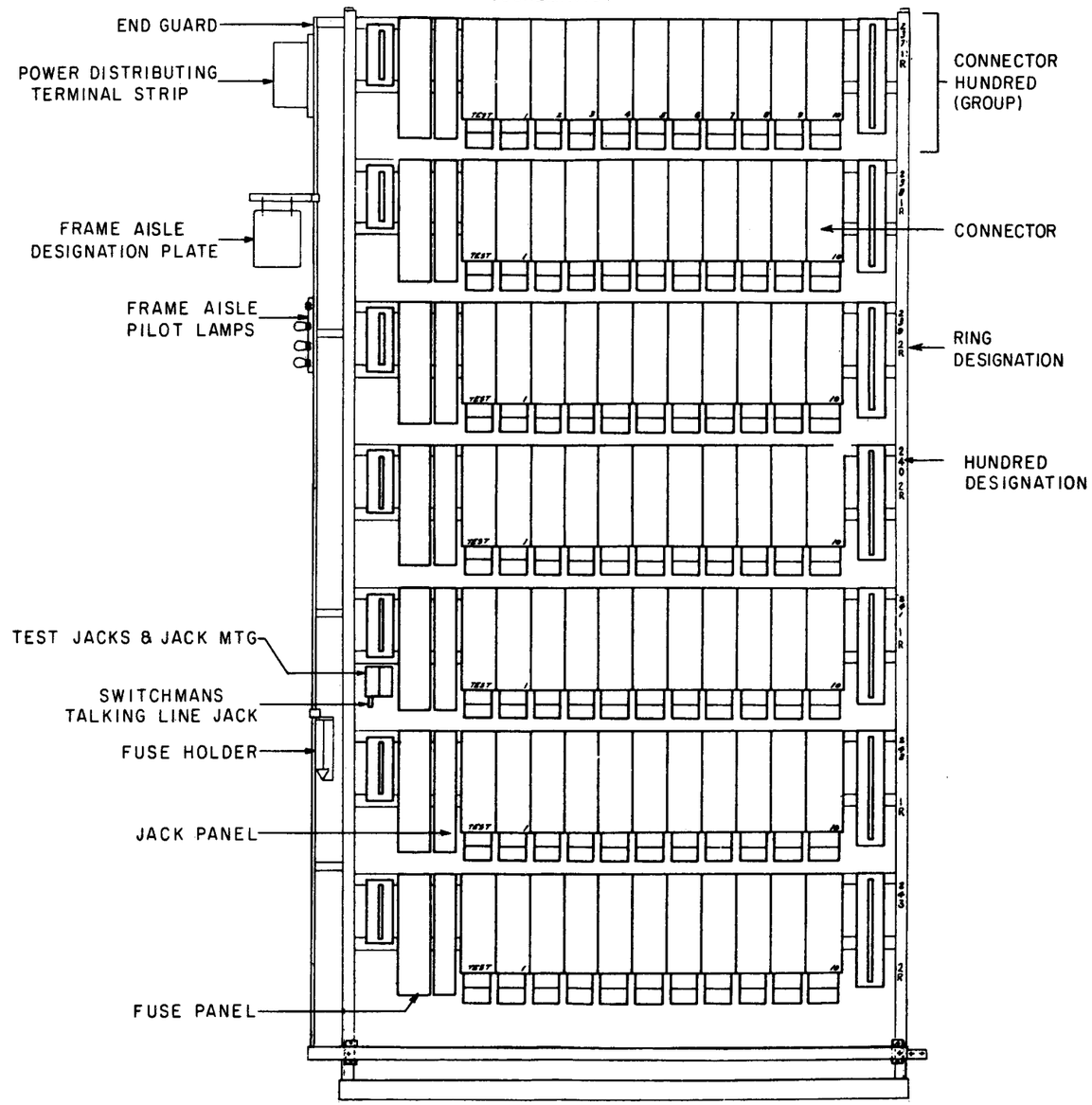
STEP – BY– STEP

CONNECTOR FRAME

(SCHEMATIC)



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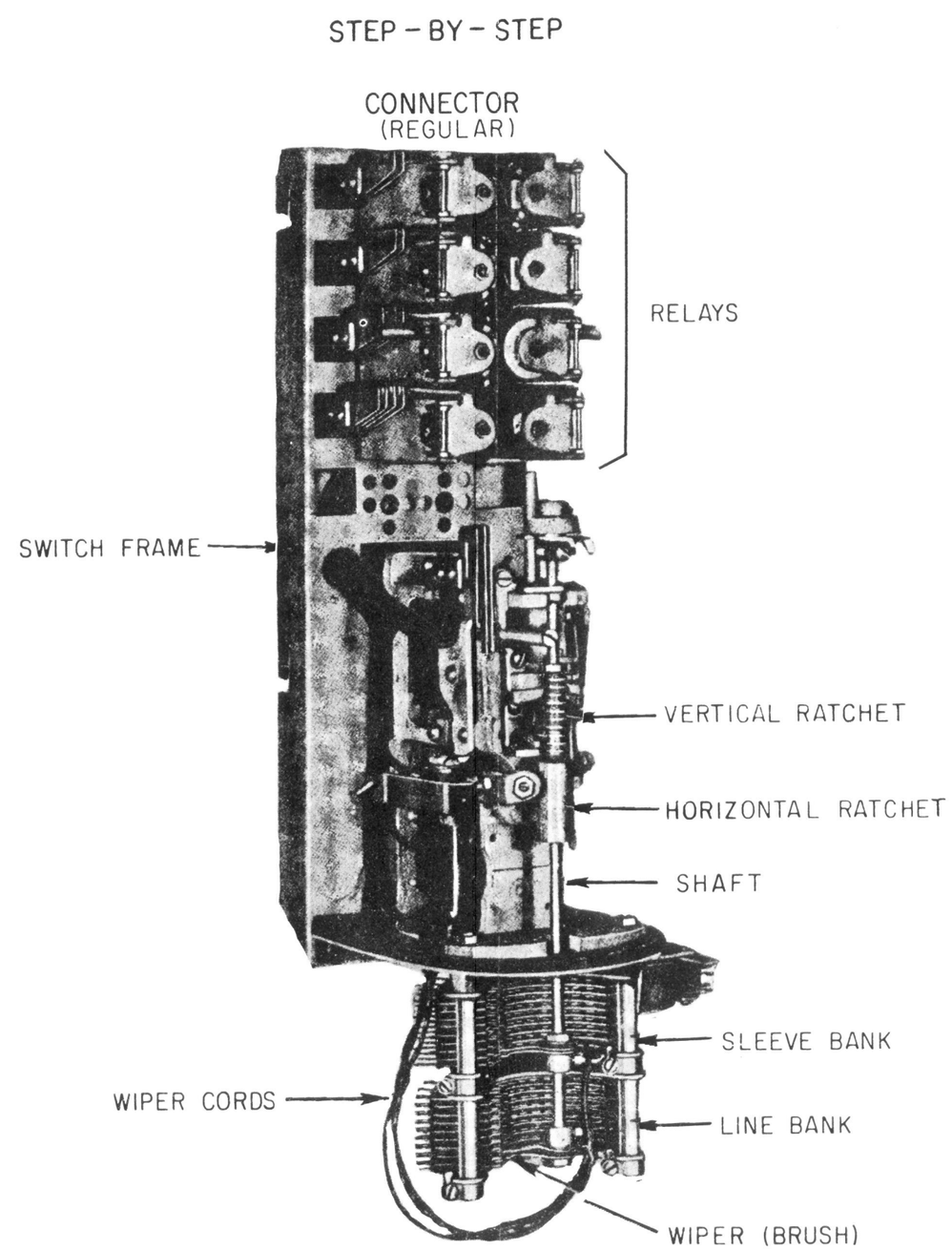

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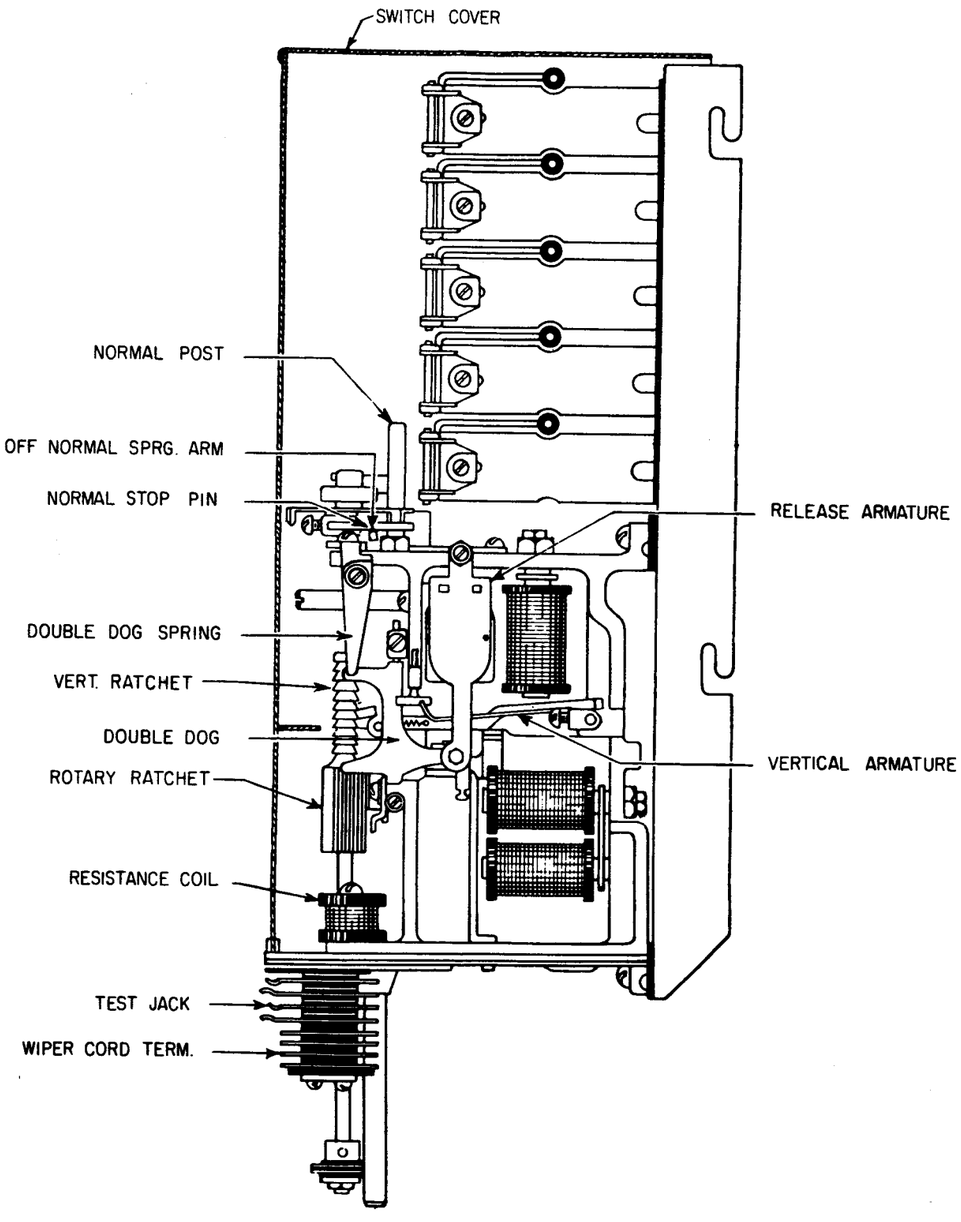
STEP-BY-STEP
CONNECTOR SWITCH, RIGHT VIEW



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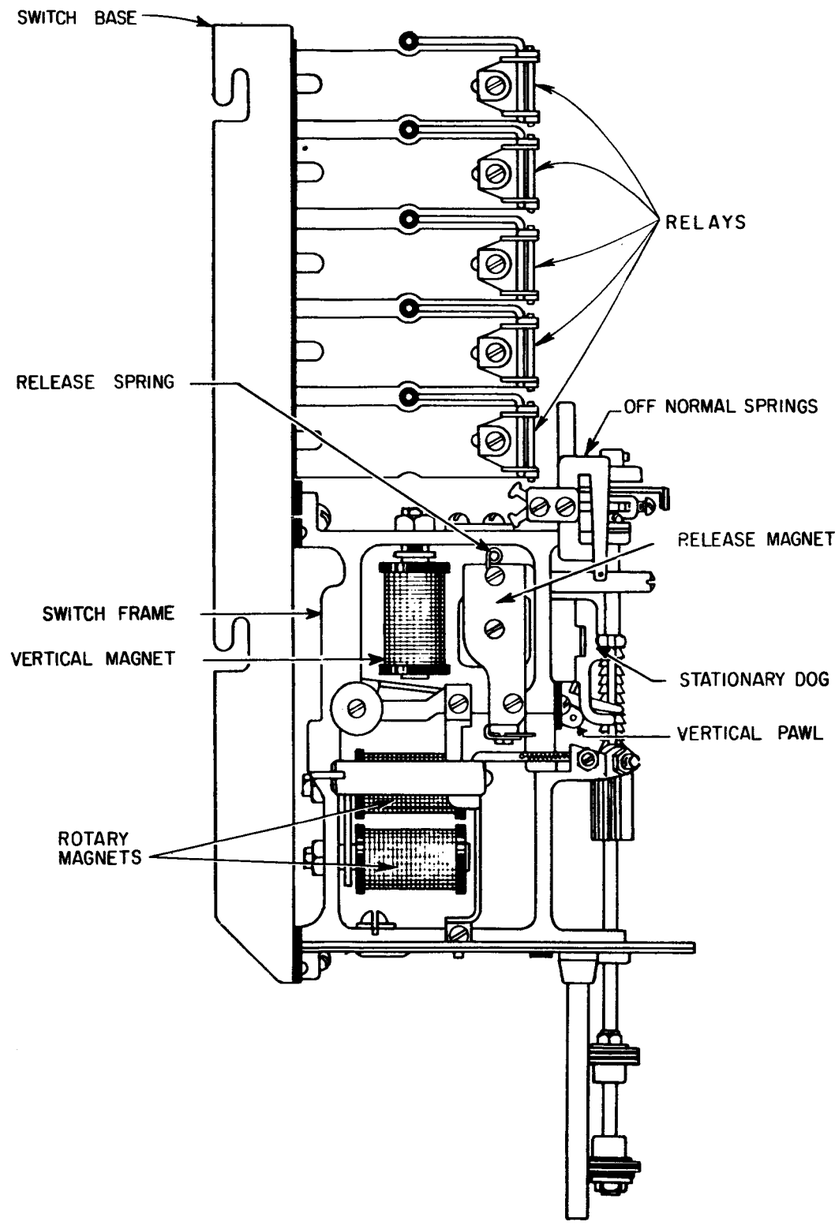
STEP-BY-STEP
CONNECTOR SWITCH, LEFT VIEW



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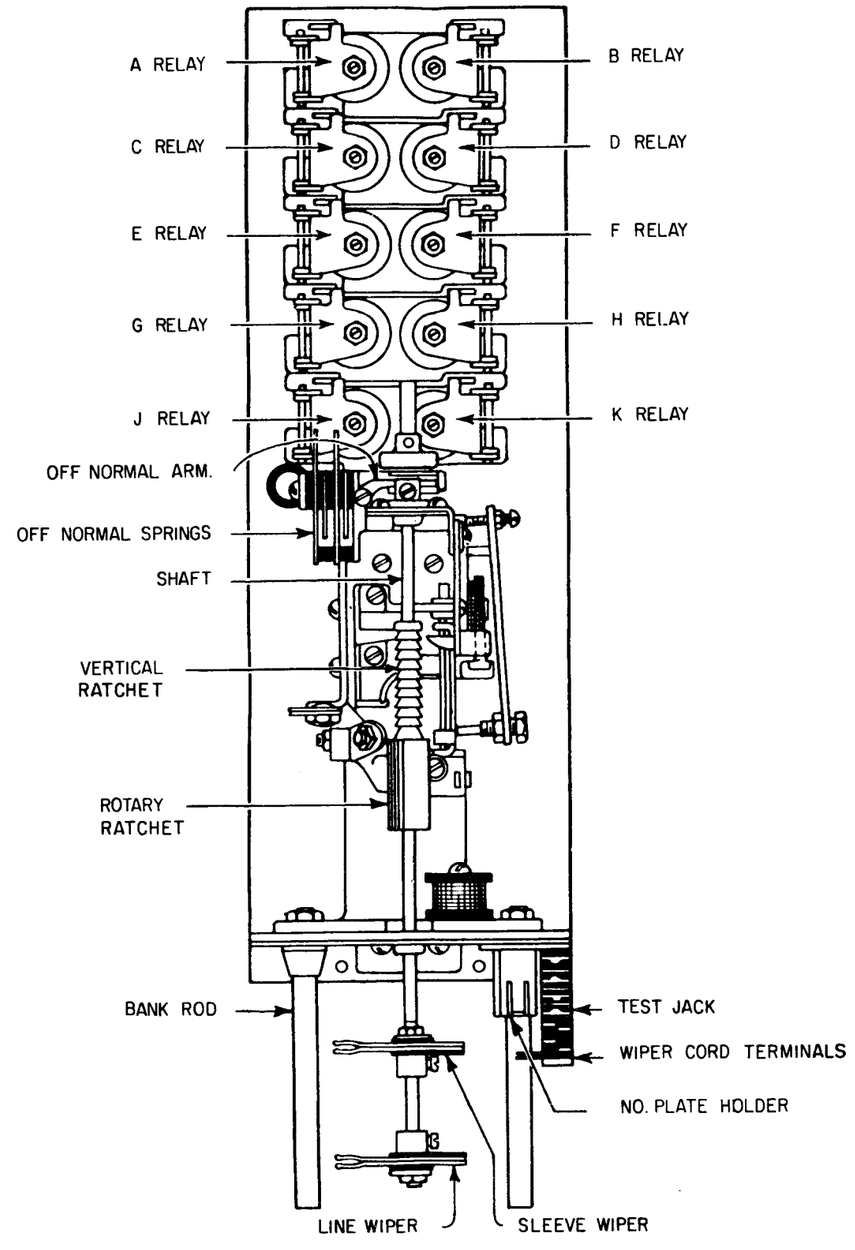
STEP-BY-STEP
CONNECTOR SWITCH, FRONT VIEW



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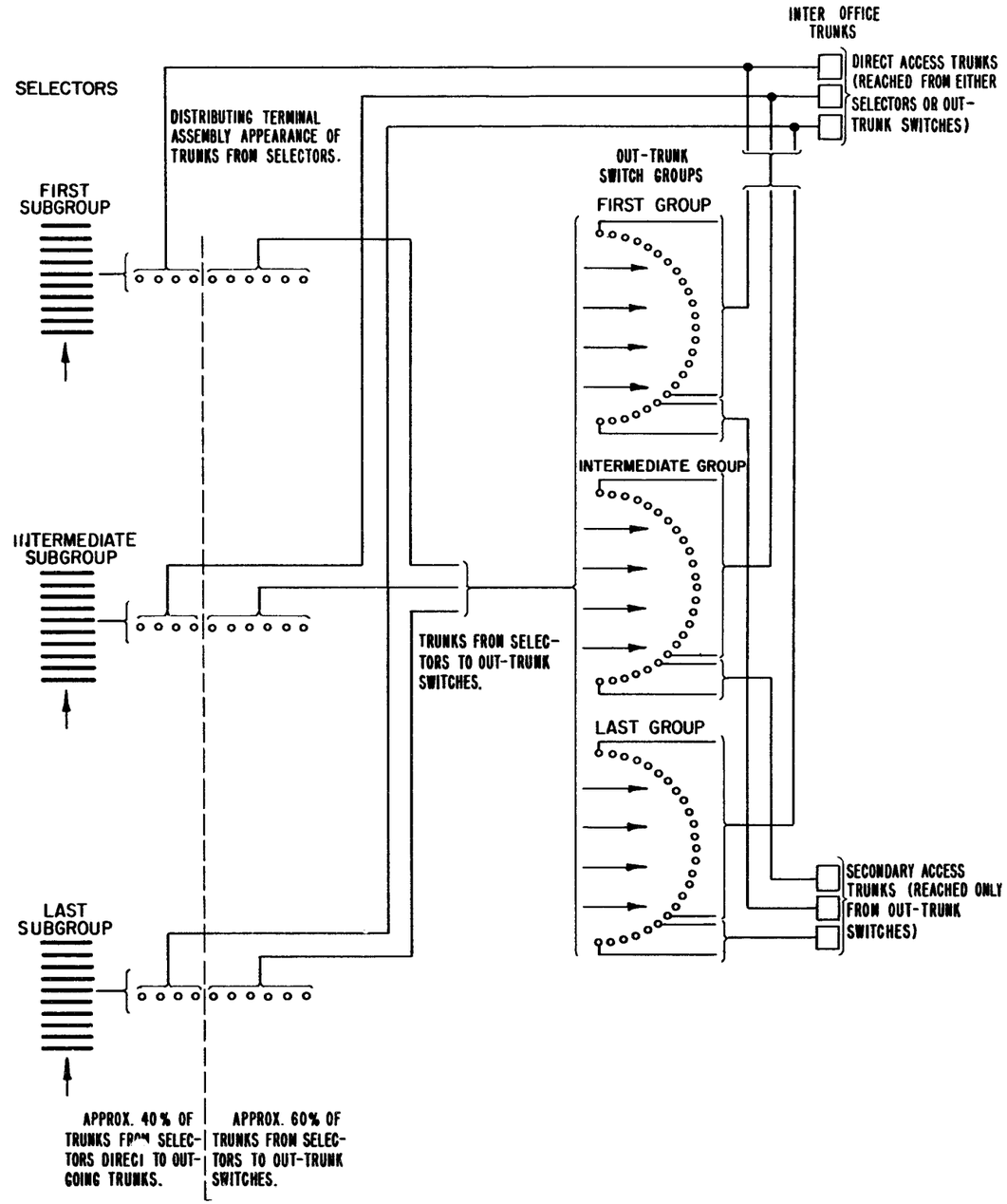
STEP-BY-STEP
ROTARY OUT-TRUNK SWITCH SCHEMATIC



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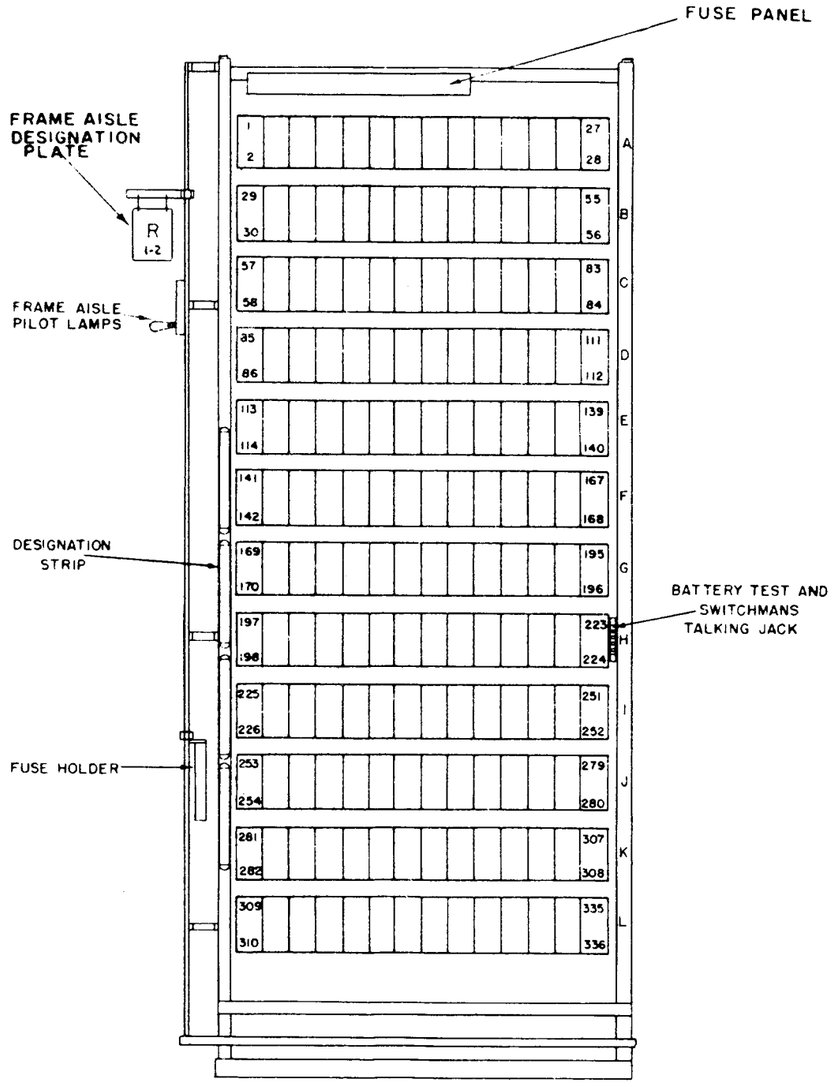
STEP-BY-STEP

REPEATER FRAME



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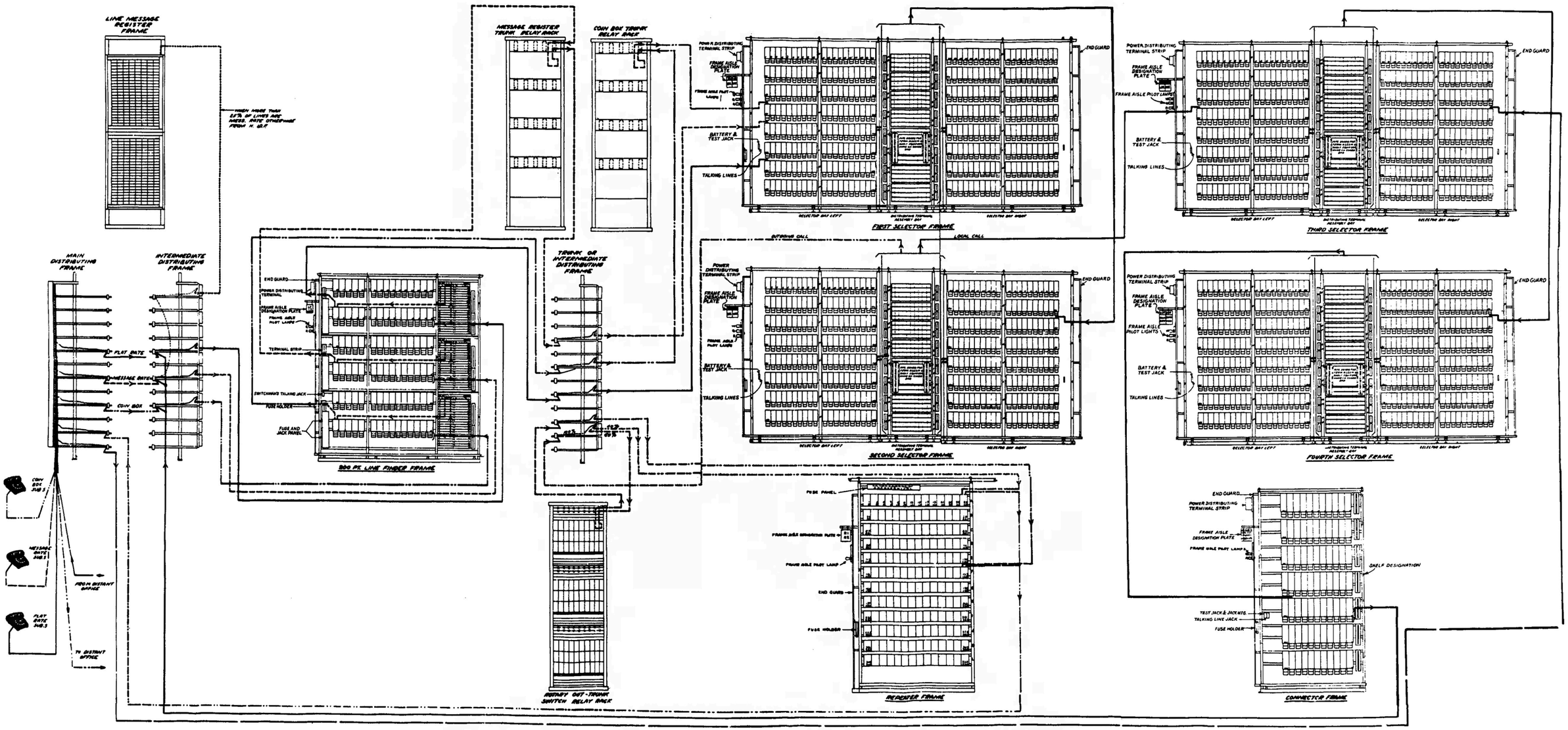
STEP-BY-STEP
TRUNKING
STEP-BY-STEP OFFICE



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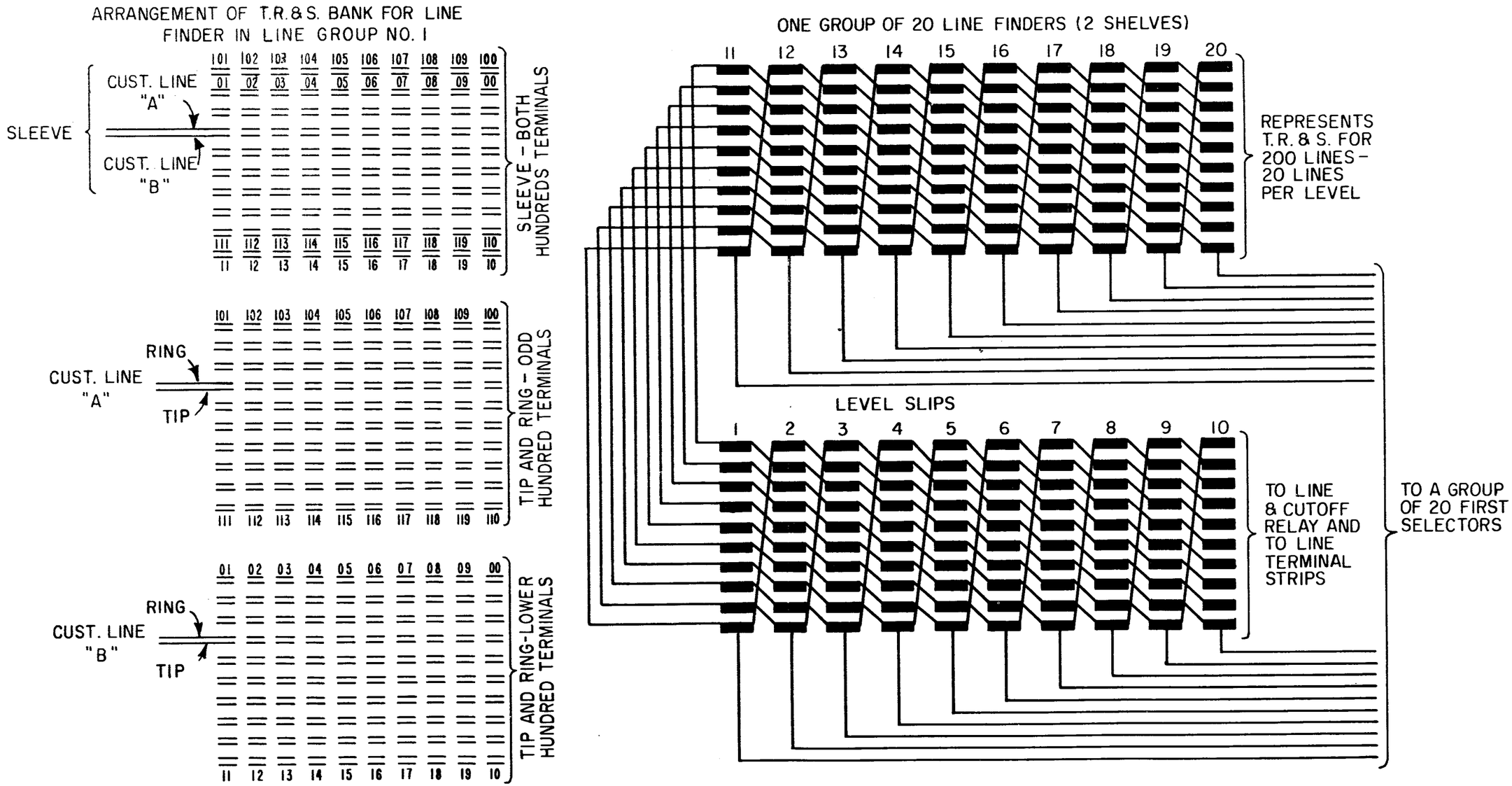
STEP – BY – STEP

LINE FINDER SLIPPING

200 POINT LINE FINDER

(TYPICAL GROUP OF 20 LINE FINDERS SHOWING MULTIPLE SLIP)



STEP – BY – STEP

LINE FINDER TRUNKING

SEQUENCE OF SELECTION FOR SUBGROUPS OF A TYPICAL 20 LINE FINDER SWITCH UNIT

Lines	Sub-Group	LEVELS									
		1	2	3	4	5	6	7	8	9	10
		Home Finders	Sequence of Selection - Other than Home Finders								
91-90 - 191-190	9	9,19	8,18	7,17	6,16	5,15	4,14	3,13	2,12	1,11	10,20
81-80 - 181-180	8	8,18	7,17	6,16	5,15	4,14	3,13	2,12	1,11	10,20	9,19
71-70 - 171-170	7	7,17	6,16	5,15	4,14	3,13	2,12	1,11	10,20	9,19	8,18
61-60 - 161-160	6	6,16	5,15	4,14	3,13	2,12	1,11	10,20	9,19	8,18	7,17
51-50 - 151-150	5	5,15	4,14	3,13	2,12	1,11	10,20	9,19	8,18	7,17	6,16
41-40 - 141-140	4	4,14	3,13	2,12	1,11	10,20	9,19	8,18	7,17	6,16	5,15
31-30 - 131-130	3	3,13	2,12	1,11	10,20	9,19	8,18	7,17	6,16	5,15	4,14
21-20 - 121-120	2	2,12	1,11	10,20	9,19	8,18	7,17	6,16	5,15	4,14	3,13
11-10 - 111-110	1	1,11	10,20	9,19	8,18	7,17	6,16	5,15	4,14	3,13	2,12
01-00 - 101-100	10	10,20	9,19	8,18	7,17	6,16	5,15	4,14	3,13	2,12	1,11

Line and cut-off relays associated with 200 lines are numbered 11-10 and 01-00 and from 111-110 to 101-100. Lines 11-10 to 01-00 appear on lower bank, and lines 111-110 to 101-100 appear in upper line bank.
Lines 11-10, 111-110 appear on first level of switches 1 and 11.

Sub-group relay 1 is associated with switches 1 and 11. Line finders 1 and 11 are the home finders of lines 11-10 and 111-110, which, with sub-group relay No. 1 and line finders 1 and 11, may be called collectively sub-group No. 1.

ILLUSTRATION OF LINE FINDER MULTIPLE SLIP

01-00	11-10	21-20	31-30	41-40	51-50	61-60	71-70	81-80	91-90
91-90	01-00	11-10	21-20	31-30	41-40	51-50	61-60	71-70	81-80
81-80	91-90	01-00	11-10	21-20	31-30	41-40	51-50	61-60	71-70
71-70	81-80	91-90	01-00	11-10	21-20	31-30	41-40	51-50	61-60
61-60	71-70	81-80	91-90	01-00	11-10	21-20	31-30	41-40	51-50
51-50	61-60	71-70	81-80	91-90	01-00	11-10	21-20	31-30	41-40
41-40	51-50	61-60	71-70	81-80	91-90	01-00	11-10	21-20	31-30
31-30	41-40	51-50	61-60	71-70	81-80	91-90	01-00	11-10	21-20
21-20	31-30	41-40	51-50	61-60	71-70	81-80	91-90	01-00	11-10
11-10	21-20	31-30	41-40	51-50	61-60	71-70	81-80	91-90	01-00
LF 1 & 11	2 & 12	3 & 13	4 & 14	5 & 15	6 & 16	7 & 17	8 & 18	9 & 19	10 & 20

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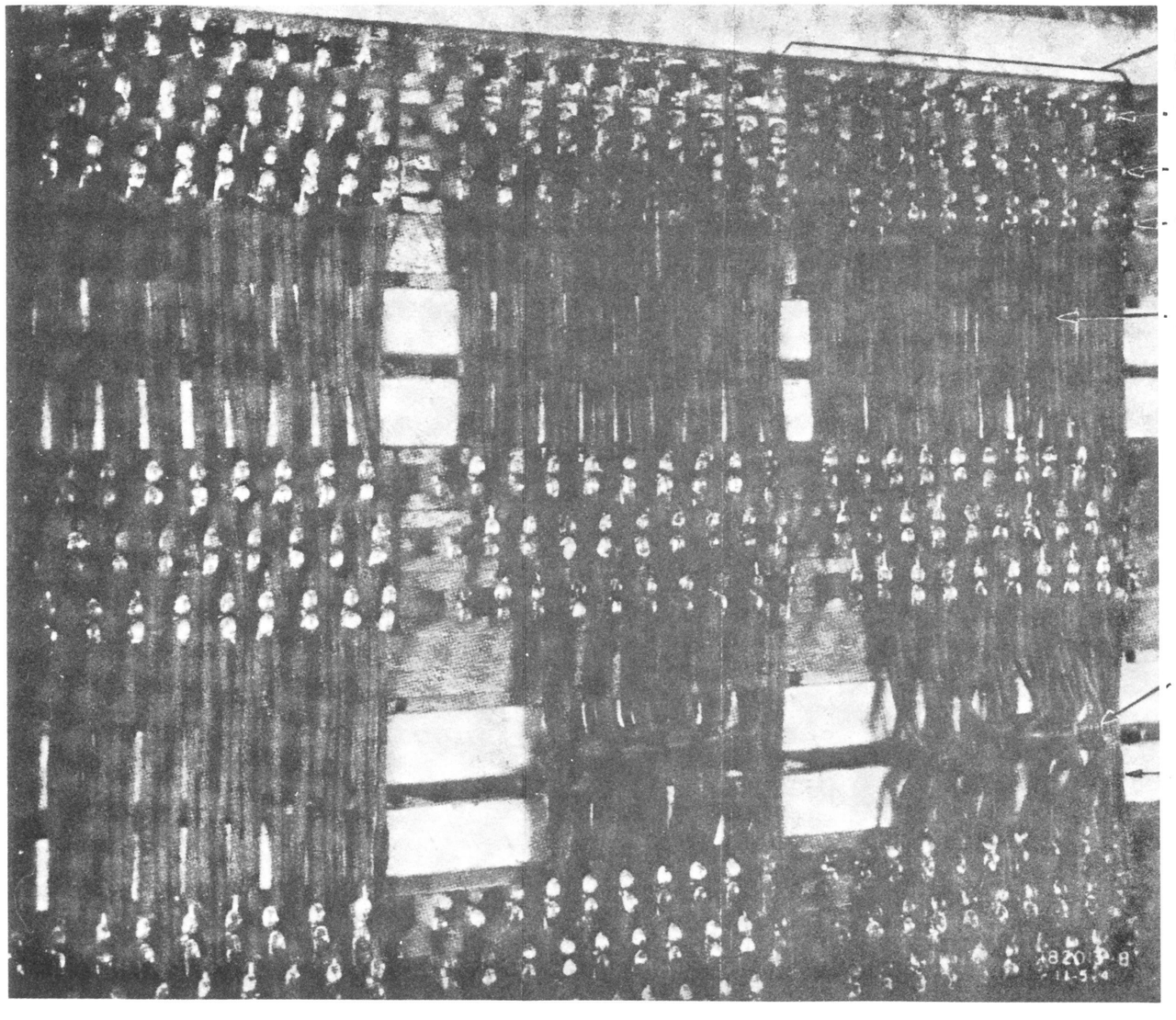
STEP – BY– STEP

DISTRIBUTING TERMINAL ASSEMBLY
(CLOSE–UP OF STRAPPING)



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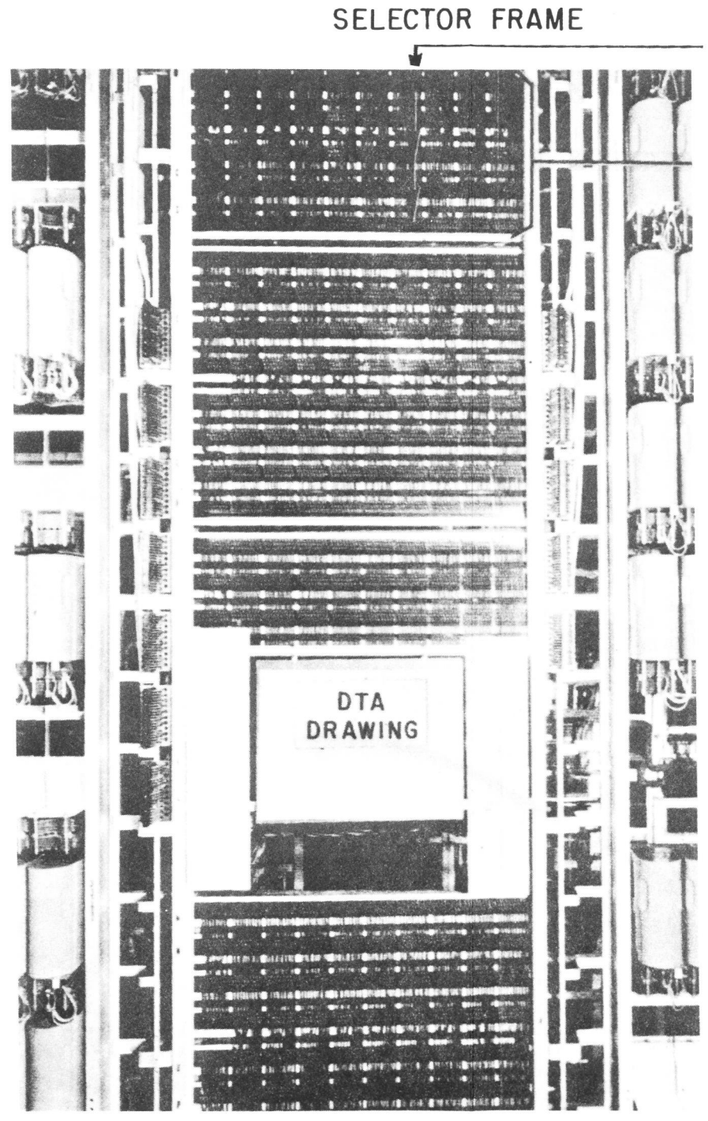
STEP – BY – STEP

DISTRIBUTING TERMINAL ASSEMBLY



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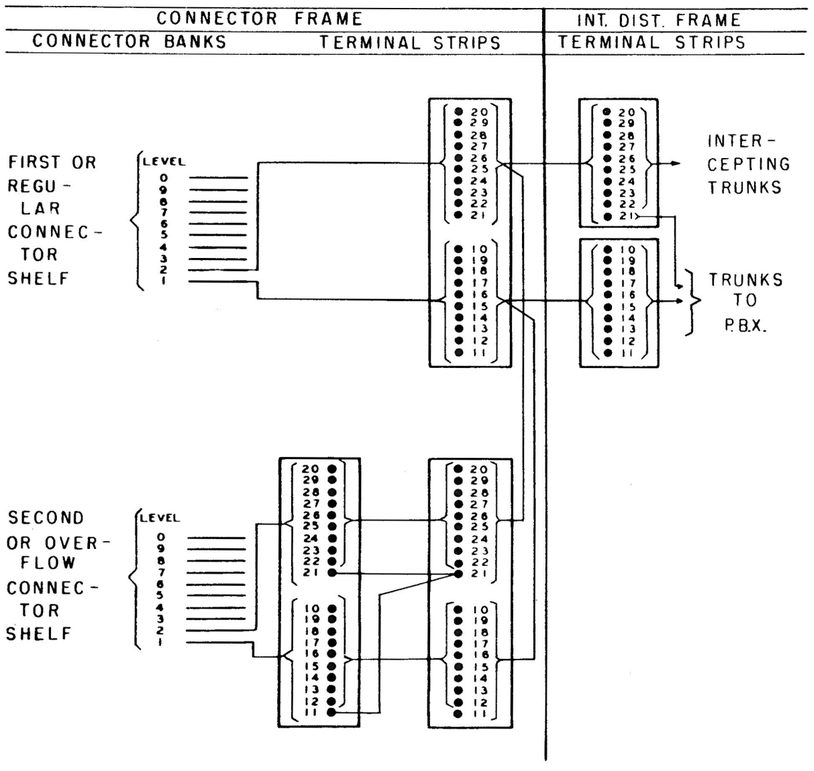
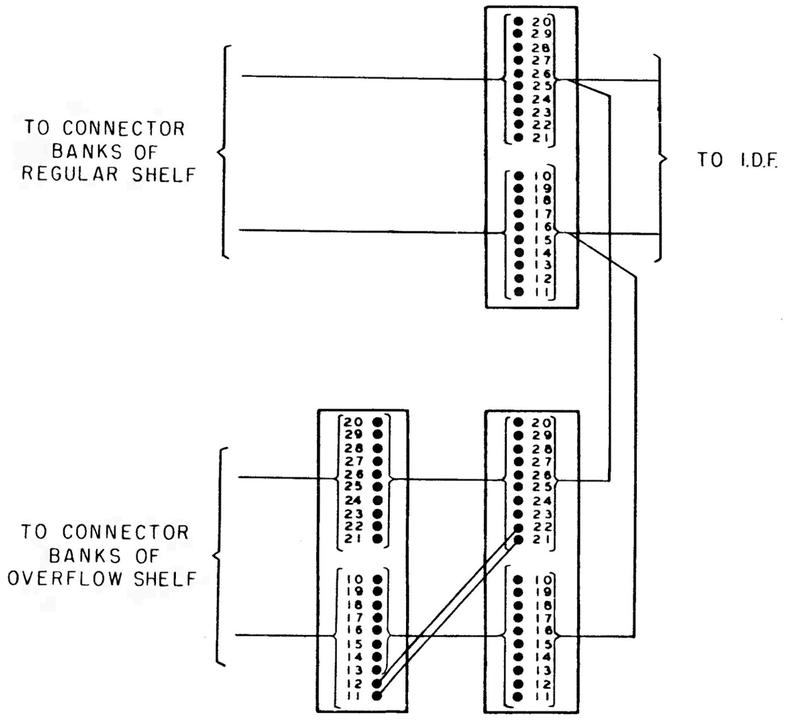
STEP – BY – STEP

CONNECTOR TRUNKING

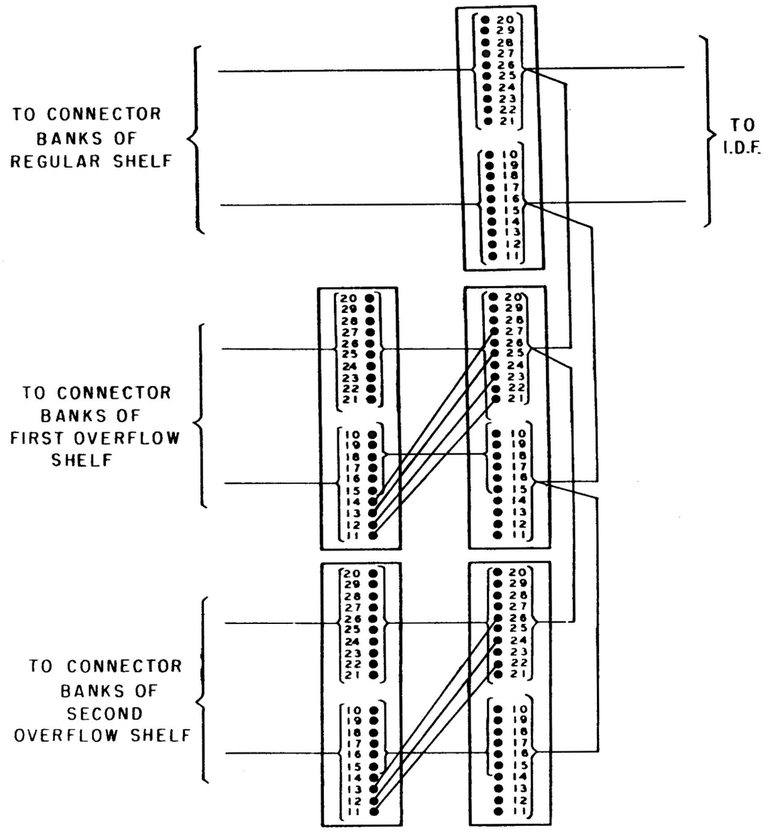
CABLING AND CROSS-CONNECTING ARRANGEMENT FOR GRADED MULTIPLE P.B.X. GROUP OF 11 TRUNKS WITH TWO CONNECTOR SHELVES



CROSS-CONNECTING ARRANGEMENT FOR GRADED MULTIPLE P.B.X. GROUP OF 12 TRUNKS WITH TWO CONNECTOR SHELVES



CROSS-CONNECTING ARRANGEMENT FOR GRADED MULTIPLE P.B.X. GROUP OF 17 TRUNKS WITH THREE CONNECTOR SHELVES



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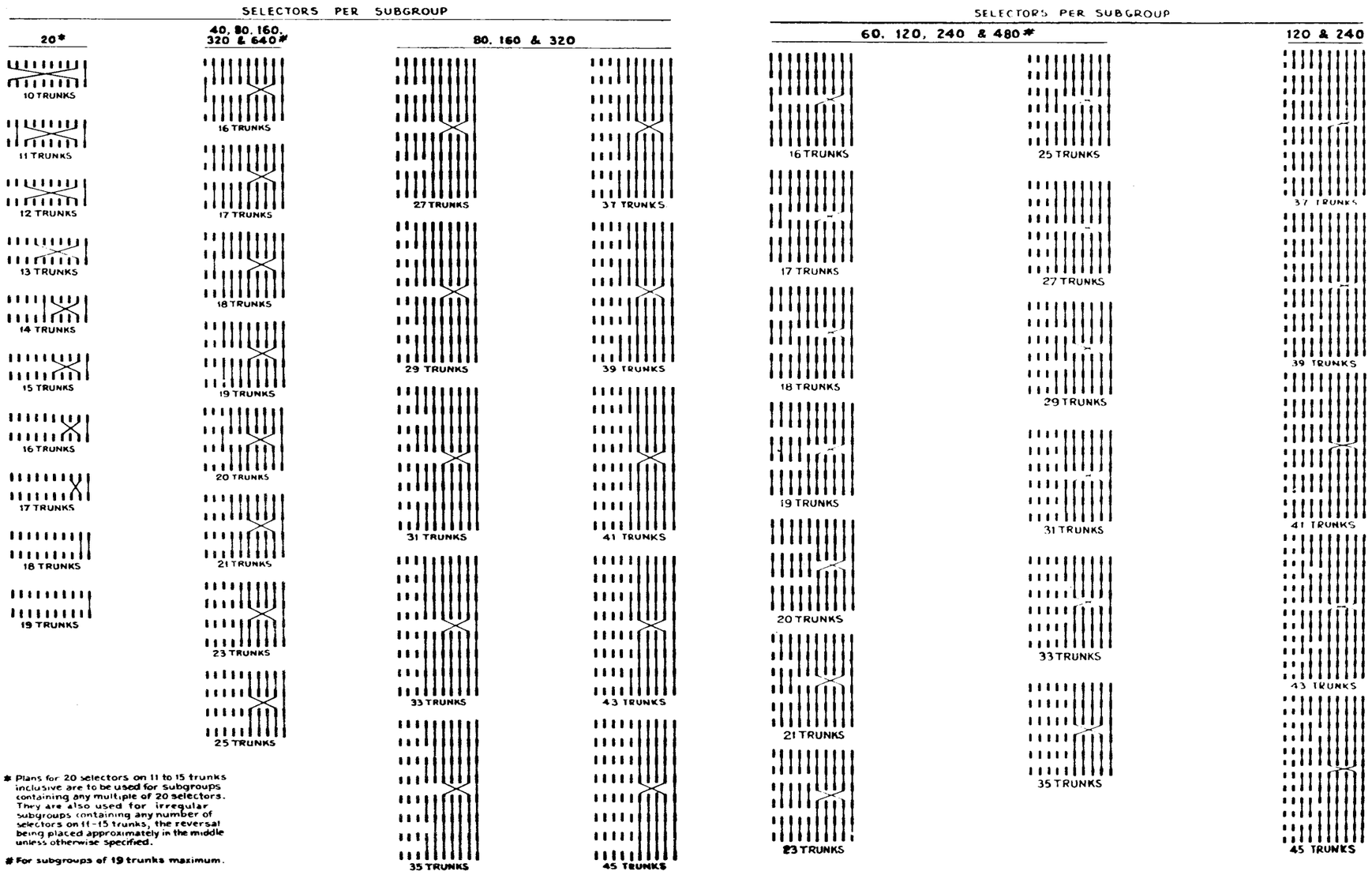
STEP–BY–STEP

GRADED MULTIPLE ARRANGEMENTS

(FOR TRUNKS FROM SELECTOR MULTIPLE TO OTHER SELECTORS, TRUNKS OR REPEATERS)



* Plans for 20 selectors on 11 to 15 trunks inclusive are to be used for subgroups containing any multiple of 20 selectors. They are also used for irregular subgroups containing any number of selectors on 11–15 trunks, the reversal being placed approximately in the middle unless otherwise specified.

For subgroups of 19 trunks maximum.

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STEP – BY– STEP

TRAFFIC REGISTERS

PATH OF A CALL
SELECTORS & CONNECTORS