

STEP BY STEP DIAL SYSTEM

TRAFFIC TRAINING COURSE AND REFERENCE MANUAL

**THE OHIO BELL TELEPHONE COMPANY
NORTHEASTERN AREA**

FOREWORD

The telephone company has for sale only one thing—service. Service to the average customer means only one thing—the privilege of talking to some other person at any place and any time that he wants to do so. In other words, telephone service is nothing more or less than providing interconnection. Interconnection may make use of the services of an operator or of an operator and a wide variety of mechanical devices or by mechanical switching devices in themselves.

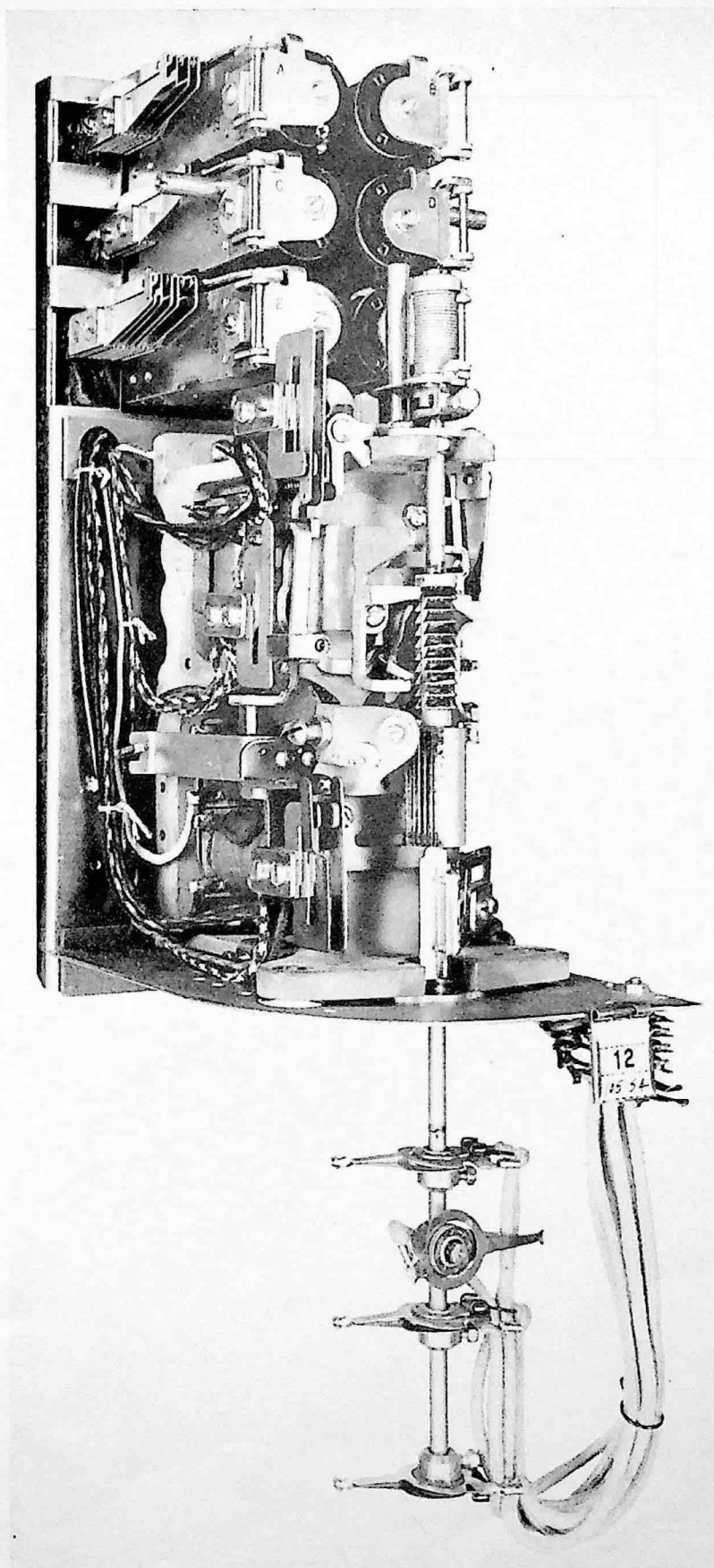
In the telephone company's functional organization, the Traffic Department has been assigned the responsibility of making interconnection "work" so that the customer will get the service that he wants and for which he pays. In order for the Traffic Department to fulfill its assigned responsibility, the people in it should be expert in understanding and solving interconnection problems.

The growth of mechanization through the extension of nationwide toll line dialing either by the operator or the customer is placing more and more emphasis on the use of mechanical switching devices.

This training course on the operation of step-by-step systems has been prepared to train the men and women in the Traffic Department in fulfilling their responsibility. This material will be used not only in training but in helping to solve particular step-by-step interconnection problems. Use it to help yourself become an interconnection expert.

A handwritten signature in black ink, appearing to read "G. H. Rouben". The signature is fluid and cursive, with a long, sweeping flourish extending from the end of the name.

General Traffic Manager



One of several Switches used in the
STEP-BY-STEP Dial System

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STEP-BY-STEP DIAL SYSTEM

1.0 GENERAL

This treatise of the Step-by-Step type Dial System is intended primarily to acquaint the new Traffic men with the fundamental principles of this type dial telephone equipment and its operation, thereby enhancing him with a knowledge of the words and terms peculiar to it, the part played by each individual equipment unit utilized in the completion of a dialed call, intra and inter-office trunking arrangements, and, above all, to instill in him sufficient knowledge of the dial equipment to enable him to perform a more complete and successful traffic job.

It is not the intent of this course to provide and teach a new employee the mass detailed information needed, say, to perform a maintenance job in the equipment, however, he should be able to talk the "Step-by-Step" language with any other person so versed in his own right, and, too, be able to recognize possible sources of equipment shortages, overloads, and failures as might be exemplified by the analysis of service results. In other words, it is the intent of this course to provide a means whereby employees, whose work does not require a technical knowledge of SXS equipment but whose ambition impels them to keep informed on all our company's activities, can get the information they desire on this subject with a moderate expenditure of time and effort.

Employees taking this course should have a knowledge of the basic laws governing the action of electricity, at least a knowledge of it equal to that which may be gained from Section 4 that follows.

To get down to the "fundamentals", suppose we take stock of what we have to work with in making telephone connections by machinery.

First, and most important, we have an intelligent human being at or near each of any two telephones to be connected; otherwise the connection fails in its purpose of establishing communication between those two people.

But the effort that may be required of them must be small enough to avoid imposing burdens that would tend to make the service unattractive.

Second, we have a pair of wires from each telephone to the central office.

Third, we have electromagnets in a sufficient variety of forms to make all the motions necessary for the connection of any one line to any other line in the same exchange or local service area. Already, the application of these "motions" has been extended to permit connection of the customers in a few locations to customers at some distant location on a toll basis.

At the telephone itself there is the familiar switch hook which provides a means for connecting and disconnecting the talking and listening apparatus; hence, the addition of a dial, which is merely a circuit interrupting device for controlling the electromagnets at the central office, completes the essentials of the step-by-step dial system.

Without going into the details of the development of this system, it is interesting to speculate on how an ingenious and resourceful person might separate this problem into its elements and gradually work out a solution for each such element.

Actually it has taken the intensive effort of a great many brilliant minds extending over a long period of time to reach the present stage of development; and some of the best improvements are of comparatively recent origin thus leading one to believe that further improvements will continue indefinitely, particularly with respect to intertoll dialing.

To a large extent the successful operation of a dial office depends upon three main factors:

- (1) Sufficient equipment properly maintained.
- (2) Subscribers properly instructed to dial accurately and willing to cooperate.
- (3) Enough Operators properly trained and placed.

While the fundamental data on which a dial office is engineered are accurate at the time it is engineered, it is essential that these data be continually reviewed after the office has been in operation to determine whether conditions have changed. The adequacy of the equipment can be checked from the readings of the registers provided for this purpose and the proper assignment of subscribers to this equipment from the assignment records. Obviously, it is just as important to eliminate excess trunks as it is to add trunks when needed. This should be borne in mind when register readings are being checked. Routines have been generally set up for eliminating any surplus trunks by making busy a number of trunks in each group and then reading the overflow or last trunk busy registers for the necessary adjustments.

The traffic man in charge of a dial office, or offices, should have a fairly good working knowledge of dial central office engineering, and of plant reactions, in order to be able to translate equipment trouble into causes and to determine what action should be taken.

He should, at all times, be familiar with the following items pertaining to the service:

- a. General quality of the service.
- b. Service given by special service, intercepting, repair clerk operators, etc.
- c. Nature and amount of equipment trouble.
- d. Whether trouble is being cleared promptly by the Plant Department.
- e. Percentage of subscriber's faulty usage and steps being taken to reduce it.
- f. Number and nature of verbal and written service criticisms.
- g. Assistance traffic—Type and quantity.
- h. Percent completed of total originating calls.
- i. Percent Equipment and Operating Irregularities, including percent paths and trunks busy and overflow register readings.

The closest cooperation within the organization as well as with the public is necessary, and the local department heads should make available to each other information obtained from all available sources as to how the equipment is operating and being operated by the public.

The Commercial Department obtains this information from reports made by their representatives in routine contacts with subscribers.

The Plant Department obtains this information from their routine tests and from records kept at the repair clerk positions, from Assistance tickets prepared by Assistance or Toll operators, various central office alarms, from routine contacts with the subscriber, etc.

The Traffic Department obtains this information from routine service observations, from verbal and written criticisms, customer surveys, from records kept by special service and intercepting operators, from peg count, last trunk busy, all trunks busy and overflow register readings, etc.

As the traffic man in charge of a dial office is able to obtain so much more information relative to the quality

of service than are the representatives of the other departments, it is necessary for him to bring to their attention, unsatisfactory conditions beyond his control and to develop with them a plan of action to remedy the trouble.

A traffic man may be considered as the "watch-dog" of good telephone service.

AUTOMATIC DIAL TELEPHONE EQUIPMENT

2.00 GENERAL

Since first introduced, various types of automatic dial telephone systems have been developed. Principally, these may be identified as Panel, Step-by-Step and Crossbar type systems, the latter being the most recent type introduced by the Bell System. All-relay type automatic systems are also available, such as those developed and distributed extensively to the smaller Independent Companies by the Kellogg, Stromberg-Carlson and other Corporations. A very popular system known as the "Auto-Manual" is available from the North Electric Company located at Galion, Ohio.

Panel and Crossbar systems were designed principally for use in the large city and metropolitan areas. Step-by-Step systems lend themselves to the small and medium size communities and towns. The All-Relay and the Auto-Manual systems are also of the small community or town variety.

The term "automatic" as applied to telephone systems, refers to those systems in which apparatus at the Central Office, under control of a dial operated by a subscriber, does the work that is done by operators in manual systems, except in the case of auto-manual systems.

The primary object of the automatic system is to eliminate the necessity of the central office operator. In order that each subscriber may control the formation of his own connections, there is added to his station equipment, a calling device or "dial", the manipulation of which establishes circuit conditions that cause the central office mechanism to establish the connections he desires.

In automatic telephone systems, the following connections are established and functions performed without the presence of any guiding intelligence of the central office:

1. Connect and disconnect lines.
2. Ring the called subscriber even though he must be selected from among those on a party line.
3. Not connect with a line that is already in use, and signal the calling subscriber that the line is busy.
4. Make connections to trunk lines and through them to lines in other offices, and then perform the operations described in items 1, 2, and 3.
5. Perform other operations necessary for telephone service.

Since it is obvious that the most practical approach in learning the principal functions of each of the various type of automatic dial telephone systems is to concentrate on one system at a time, this particular course will pertain almost wholly to the Step-by-Step type system. Manuals are already available for study concerning the Panel and Crossbar type systems.

2.01 STEP-BY-STEP SYSTEMS

The Step-by-Step equipment sometimes referred to as the Strowger Automatic System, was, as mentioned above, designed primarily for community or small town installations. The Strowger equipment consists principally of the following mechanical devices:

1. Telephone

2. Dial, or Calling Device
3. Lineswitch, Primary and Secondary.
 - (a) Plunger Type-associated with Master Switch.
 - (b) Rotary Type
4. Line Finder (replaces line switch)
5. Master Switch (associated with Line Switch)
6. Selector
7. Connector
8. Miscellaneous Equipment.

The Step-by-Step dial system may be considered to consist of three major parts; line equipment, switch train and connectors. Line equipment serves to connect a calling party to the switch train. The switch train, consisting basically of SXS selector switches, operates in a proper sequence to extend the calling party's connection to the connector group which serves the called party. Connectors complete the connection to the called party's line.

Step-by-Step selectors respond directly to dial pulses. As a consequence, the dial numbering plan and step-by-step trunking design are inseparable. Because of this correlation, a considerable simplification of design and a resultant saving in equipment often results from a careful selection of dial central office codes as well as the selection of the type of step-by-step equipment needed to fulfill the requirements of the proposed numbering plan. These factors are becoming increasingly important with the advent of universal numbering plans and the desirability of 2-5 numbering.

The Step-by-Step System is applicable to two, three, four, five and six and seven digit number plans. Six digit numbering plans, as a rule, consist of a two digit prefix (office name) followed by four numerical digits. The current trend in number plans is the two-five arrangement, i.e., a two digit prefix, an office numeral and these followed by four numerical digits. Existing plans which do not conform to the 2-5 arrangement will eventually be changed to the 2-5 plan in order to facilitate extension of as well as to further facilitate refinements in plans for nationwide intertoll dialing. A brief description of each of the mechanical devices used in the Step-by-Step System is furnished in Section 5.

Practically all Step-by-Step equipment is manufactured by either the Western Electric Company or the Automatic Electric Company. The latter deals primarily with the Independent Companies of this country as well as those Companies or Governments of foreign lands. The W.E. Co. is the major supplier for the Bell System.

Several types of Step-by-Step Systems are available. Each is coded for identification purposes and each is designed to care for the particular need of the community or town in which it is installed. The smaller the office the less are the needs for some of the refinements found in the larger offices, thus the type of trunking, the type of alarm circuits, cabling arrangements, etc. are readily indicated by the code assigned to a particular installation.

Step-by-Step is descriptive of the manner in which dialed calls progress, each digit dialed by the subscriber causing a separate mechanism to function to advance the call through various "steps" necessary for completion.

3.0 TYPES OF STEP-BY-STEP OFFICES

3.01 The various types of SXS offices employed by the Ohio Bell Telephone Company are as follows:

Code	Manufacturer	Approximate Capacity*
360-A	W.E. Co.	200-300 Lines (T/L)
375-A or B	A.E. Co.	200 Lines (T/L)
35-E-97	A.E. Co.	1000-3000 Main Stations (T/L and/or T/S)
355-A	W.E. Co.	1000-3000 Main Stations (T/L and/or T/S)
350-A	W.E. Co.	3000-5000 Main Stations (T/S)
No. 1	W.E. Co.	10000-50,000 Main Stations (T/S) **

* Each office or wire center.

**Terminal per line (T/L) equipment is available if desired.

Each of the above type employ the Strowger switch. The 375-A (or B) is known as a link (line finder and connector associated) type office and is thought of as the "jack per line" type equipment. Originally the 360-A was of the "jack per line" arrangement, however, recent developments have made these offices more flexible by the adoption of terminal-per-station (jack per station) refinements to the existing installations. A.E. Co.'s 35-E-97 type equipment was introduced in the early thirties. The 355-A equipment was released by the W.E. Co. in 1938. Further description of the 375-A and 360-A type offices can be found in T.C. 340.

The two principle types of step-by-step offices used are; the No. 1 and No. 350-A. The chief difference between these two is that the No. 350-A office is arranged for unattended operation. Operator calls accordingly may be handled by an operator in a distant office, known as the operator office, and trouble condition alarms are extended to the operator office when the office is unat-

tended. No. 1 operator calls may also be handled at a distant office but alarm leads may be extended only to a limited extent.

Also, since the 350-A was designed primarily for unattended operation in the smaller towns, equipment costs, and resultant installation costs, were minimized as compared to the No. 1 type. The 350-A power plant and the alarm systems were greatly simplified, as compared to the power and alarm systems of the No. 1 type office. Switch shelf and trunk equipment for the 350-A and the No. 1 types of offices are identical except that arrangements have been standardized for the 350-A office to permit the mounting of two or more varieties of switches on the same shelf.

The 360-A, 375-A or B, 35-E-97 and 355-A type offices are generally considered as community dial (unattended) type offices. Operator calls from these are, in most instances, handled by operators at a distant office, as are the trouble condition alarms.

SECTION 4

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4.0 FUNDAMENTALS

4.01 ELEMENTARY ELECTRICITY

The general term electricity is the name given to an invisible agent known only by its effects. The electrical effects with which we are most familiar are: light, heat, power, voice transmission, and many others which we use and depend upon each day. The exact nature of electricity is unknown, but is being studied by scientists to definitely determine what it is. However, it is unnecessary for one to know what electricity is in order to be able to utilize electrical phenomena to serve his ends.

It is obvious that it is unnecessary for one to know exactly what water is, when he uses the energy of falling water or water under pressure to develop power. It is, however, necessary to know how water acts and how it may be used in the development of power. Therefore, in the study of practical electricity, the question of what electricity is, need not be considered. But the description of how it acts and how it can be directed and controlled so as to do useful work is essential.

The laws which govern the flow of electricity in closed circuits are in general similar to those which determine the flow of water in a water circuit. Water flowing in a pipe may be a medium for transmitting energy in the same way that electricity flowing in a conductor is a means of transmitting energy.

Contrivances such as batteries and generators should be regarded as arrangements whereby electricity may be put into motion or forced to move. An electric generator may be thought of as a pump which forces electricity to flow within a circuit.

Electricity in motion is called an electric current. Therefore a current of electricity in a wire is electricity in motion in that wire. There can be no current flow without a complete circuit to and from the source. The electrical unit of current flow is the "ampere," generally designated by "I".

The force which causes electricity to move or to flow is known as electromotive force, (e. m. f.) pressure, potential difference, or voltage. The electrical unit of pressure is the "volt", generally designated by "E". If an e. m. f. is applied to a closed or complete conducting circuit it will force electricity to circulate or flow around in the metal or material of that circuit. The flow of water through a pipe is determined largely by the hydraulic pressure that is forcing the water through the pipe. A similar electric pressure or e.m.f. measured in volts, causes electricity to flow through conductors.

Electrical resistance is the opposition which is offered by an electrical conductor to the flow of current. It is obvious that the opposition offered by the friction of the flowing water against the insides of the pipes will tend to decrease the flow of water in a hydraulic circuit. In a similar manner the flow of the current in an electrical conductor will vary in accordance with the resistance offered to the flow. The electrical unit of resistance is the "ohm" generally designated by "R" in formula or "w" (Omega) as abbreviation. It is evident that the amount of electricity that will flow through a given circuit will be determined not only by the voltage forcing the current, but also by the resistance offered by the conductors. With a specified voltage, the greater the resistance the smaller the current and vice versa.

Electrical units and measurements are used to measure electricity in a manner similar to those used to measure pressures or quantities of other things. These units were determined by scientists and standards were adopted in order that the units would be the same in all parts of the world. Meters have been built so that when applied to an electrical circuit, they would indicate its relative value to that of the standard. Meters are depended upon for the measurements of all of our electrical units including amperes, volts, and ohms.

A simple but important relation exists between the e. m. f. (volts), the current (amperes) and the resistance (ohms). This relation which has been termed "Ohm's Law" may be expressed as follows: The result produced (current flow in amperes) is directly proportional to the effort (electromotive force in volts) and inversely proportional to the opposition (resistance). Formulas expressing the same relation are shown below.

$$(1) \quad I = \frac{E}{R}$$

$$\text{Current (I)} = \frac{\text{Electromotive Force (E)}}{\text{Resistance (R)}}$$

$$\text{or}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$(2) \quad R = \frac{E}{I}$$

$$\text{Resistance (R)} = \frac{\text{Electromotive Force (E)}}{\text{Current (I)}}$$

$$\text{or}$$

$$\text{Ohms} = \frac{\text{Volts}}{\text{Amperes}}$$

$$(3) \quad E = IR$$

$$\text{Electromotive Force (E)} = \text{Current I} \times \text{Resistance (R)}$$

$$\text{Volts} = \text{Amperes} \times \text{Ohms.}$$

Of the various forms of electric current the four most commonly considered in telephone work are: direct current, alternating current, pulsating current and unidulating current.

A **direct current** is one which always flows in one direction and when of constant strength is called a continuous current. The storage battery and the direct current generator are the most commonly known sources of direct current used in telephone practice, although the rectifier in various forms has gained widespread popularity.

An **alternating current** is one which is constantly reversing its direction. A cycle is one complete reversal of current flow, that is, a current rising to maximum value and returning to zero, first in one direction, and then rising to a maximum value and returning to zero in the opposite direction. The number of cycles per second is known as the **frequency**. Alternating current of frequencies from 16 to 66 cycles per second are used

for operating telephone sub-station ringers. These are known as ringing currents. Alternating currents of frequencies up to about 15,000 cycles are audible. Frequencies from 250 to 3,000 cycles play an important part in voice transmission.

Pulsating current is a continuous current, constant in direction, but periodically varying in value so as to flow with a series of pulsations, usually falling to zero periodically.

Undulating current flows always in one direction but changes in value. It may be caused by mixing A. C. and D. C.

In dealing with alternating current and pulsating current circuits, besides the resistance of the conductors there are two other factors that must be considered; viz., **inductance** and **capacitance**.

Electricity in motion always produces a magnetic field. This magnetic field is produced at right angles to the wire. When the current in an electric circuit varies, the number of lines of force will also vary, increasing when the current increases and decreasing when the current decreases, thereby inducing an e. m. f. in any conductor within their range of action. When current is changing, increasing or decreasing, it will induce a proportional current in a wire or coil parallel with it. This effect is termed **inductance**, therefore, it is the name or term which signifies the result of arranging an electric conductor and a magnetic circuit as described above. The unit of inductance is the "henry." Coils are often measured in "milli-henrys" (one thousandth).

When two plates of conductive material are parallel, close to each other and separated by a dielectric, they are said to possess **electrostatic capacitance**. If an e. m. f. is applied to the plates, they will receive an electric charge and a very small quantity of electricity will be stored in the combination. When constructed specially for this purpose they are called condensers, and the quantity of charge they will hold is a measure of their capacitance. The unit of capacitance is the "farad."

Since the "farad" is too large for a commercial unit, a fractional part of it is used in measuring commercial apparatus. Condensers are measured in "micro-farads" (one millionth).

In calculating current flow in alternating current circuits, inductance and capacitance of the circuit must be properly combined with the resistance of the conductor in order to get the total retardation or resistance (**Impedance**) offered to the flow of electricity, however, it is beyond the scope of these notes to go into details on this subject. $I = E/XZ$ (I = Current: E = Voltage and Z = Impedance).

A substance which offers little resistance to the flow of electricity, is a good **electrical conductor**.

Most metals are good conductors, copper being one of the best. For this reason copper wire is used on relays and magnet windings for telephone equipment. German silver wire is a fair conductor, but offers a much greater resistance than copper. It is used in the windings of resistance coils.

A substance which offers a very high resistance to the flow of electricity is a poor conductor. Extremely poor conductors, such as rubber, cotton, silk, mica, enamel,

and many others, are known as **insulators**, and are used to safeguard a body against the flow of electricity to or from that body.

Most metals increase in resistance as they become heated. Non-metals, such as carbon and glass, decrease in resistance as they become heated.

4.02 ELEMENTS OF MAGNETISM

Magnetism is that property which can be induced in certain substances called magnetic substances by virtue of which they are enabled to attract other similar substances and to point geographically north when freely suspended in a horizontal position.

Magnetism is a peculiar property of iron, nickel and cobalt and is most pronounced in iron and certain of its alloys, particularly steel.

There are two types of magnets:

1. Natural
2. Artificial

A "natural" magnet is one which has been made by nature alone. An "artificial" magnet is one which has been made by man.

The poles of a magnet are the places on a magnet where the attracting power is the greatest. Every magnet has two poles at least. If the magnet has more than two poles, the poles in excess of two are called "consequent" poles and these tend to weaken a magnet. The two main poles are called "salient" poles.

A type of magnet having no poles is a "closed" magnet. Example: the triangle and thin ring. When these are broken we find at least two poles. A closed magnet has no magnetic field.

There are two (2) laws of magnetic poles. (1) Unlike poles attract, and (2) like poles repel. Magnetic lines of force are the cause of magnetic attraction. A "magnetic line" is an invisible line of force which exists about a magnet and which is said to be responsible for all magnetic action. (Magnetic lines of force flow from the north pole to the south pole on the outside of the magnet and from the south pole to the north pole on the inside of the magnet). The inside lines of force are known as "flux".

Every magnetic line of force has four (4) characteristics:

- a. The line of force tends to contract lengthwise, it has no shortening power.
- b. The lines of force tend to repel each other.
- c. Have the same strength throughout their length.
- d. They are without ends, they never cross and they always form closed loops.

The strength of a magnet depends upon the number of lines of force.

Magnetic lines are derived matter and since matter is made up of molecules it remains that every molecule is a magnet in itself having a north and a south pole. (A north pole is generally designated as positive (+) and the south pole as negative (—). In a substance,

which is not magnetized, these molecules arrange themselves in closed formations (ring formation) with their unlike poles together. The formations have no poles although the molecules comprising them do have poles.

In a magnetic substance which is not magnetized, these molecules have been broken up and the molecules have been arranged in parallel lines with their unlike poles together.

"Permeability" is the relative ease with which a substance permits the passage of lines of force. Iron has high permeability, whereas steel is not so much.

"Retentivity" is the ability of a magnetized substance to retain its magnetism after the magnetizing agent has been removed.

"Residual Magnetism" is the magnetism which remains in a magnetized substance after the removal of the magnetizing agent.

Magnets as we know them may be classed as "permanent magnets" and "electro-magnets". A hard steel bar when magnetized becomes a permanent magnet because of its high retentivity under normal conditions unless subjected to heat or jarring. Soft iron tends to become easily magnetized when subjected to a magnetizing influence, but does not retain an appreciable part of the magnetism thus imparted to it. Consequently, permanent magnets are of steel and cores for electromagnets are ordinarily made of soft iron.

PERMANENT MAGNETS—A permanent magnet attracts iron and steel and gives magnetic qualities to iron or steel brought close to or in contact with it, just as a natural magnet does. Magnetite (Magnetic iron ore) is the most common name given to the latter.

Mention was made above to "Magnetic Lines of Force". These are the invisible lines along which the force of the magnet is exerted, and the space through which they extend is called the magnetic field. If iron filings are sprinkled on a piece of paper laid over a bar magnet and the paper gently tapped they will arrange themselves in curves as shown in Figure 1. The iron filings will collect in greater amount at the two ends of the magnet where the force is strongest and will gradually be brought close to the magnet, if tapping the paper is continued, just as if the curves along which they lay were composed of invisible rubber bands gradually getting shorter.

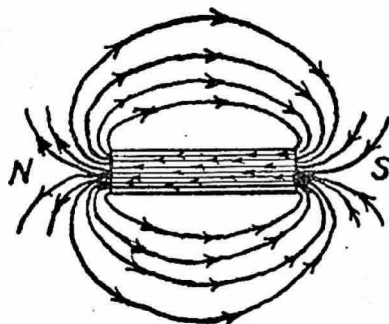


Figure 1
MAGNETIC FIELD OF BAR MAGNET
Showing Lines of Force

Magnetic lines of force pass through every known substance, there is no known magnetic insulator. This may be shown by putting a thin piece of wood, glass, tin, zinc, aluminum or any other substance on a pole of the magnet and noting that iron filings or other pieces of iron or steel are attracted almost as strongly as if the separator were not there. The only difference, if any is noticed, would be due to the thickness of the separator and not to the kind of material used.

THE HORSESHOE MAGNET—Magnetic lines of force pass more easily through iron or steel than through any other substance; therefore, if instead of a bar magnet we take a magnet shaped something like a horseshoe with the two poles close together and join the two poles by a piece of soft iron, substantially all the lines of force will pass through the magnet and the piece of soft iron and the latter will be strongly attracted to the magnet. See Figure 2. This form of magnet is called a horseshoe magnet, and the piece of soft iron the "armature".

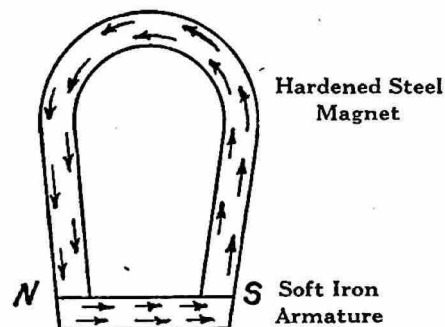


Figure 2
HORSE-SHOE MAGNET
with Armature

ELECTRICITY CAUSES MAGNETISM—In the foregoing, no mention is made of the cause of magnetism. It will now be shown that magnetism is produced by an electric current, and that it is upon this linkage of magnetism and electricity that the greater part of the practical use of electricity depends. Generators, motors, transformers, telephones and nearly all their associated apparatus depend upon magnetism for their action and almost invariably upon magnetism produced by an electric current.

A conductor carrying an electric current has a magnetic field around its entire length. If the conductor is a thin wire the lines of force are circles of all sizes from very small to very large and whose common center is the wire. At every point on the wire the planes of these circles are at right angles to the direction of the wire.

This may be shown by passing a wire through a piece of cardboard, sending a current through the wire and sifting iron filings on the cardboard. They will arrange themselves in circles, as above described and as shown in Fig. 3. Each bit of iron becomes a magnet and they arrange themselves so that unlike poles are nearest each other. If the current is continuous and flows upward, as shown, these little magnets will all point in the direction shown by the arrow heads, e.i., counter clockwise.

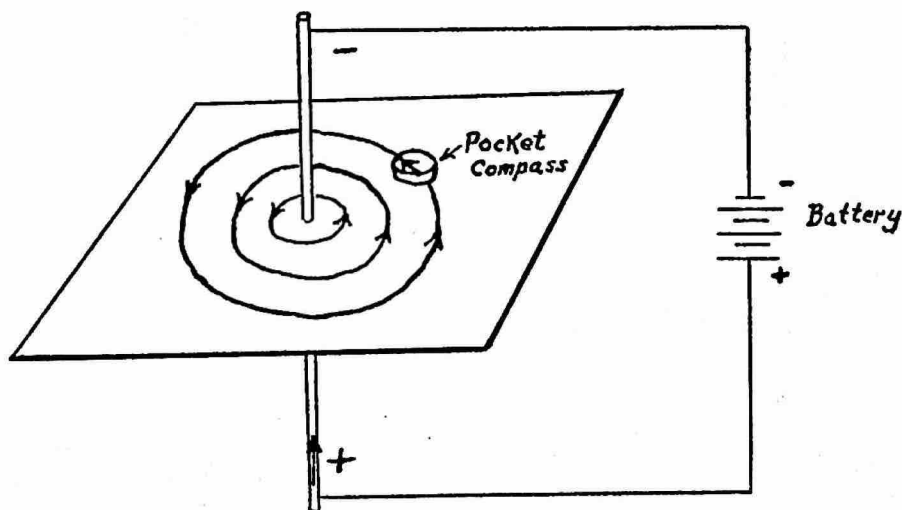


Figure 3

MAGNETIC FIELD AROUND CURRENT-CARRYING STRAIGHT CONDUCTOR

A good way to remember the relation between the current flow and the direction of lines of force caused by it is to think of current flowing from the head to the tip of a right hand screw and then think of the lines of force as circles around the screw in the direction in which the screw must be turned to be driven in. Or, by using the conventional "right hand rule". In the latter case, grip the wire with your right hand with thumb extended in the direction of current flow. Your fingers will point in the direction of the lines of force.

THE SOLENOID—A given current through a wire will produce a certain definite number of lines of force for each unit length of the wire. In a straight wire these lines of force are spread through a large space but may be brought into a small space by bending the wire into a circle; the space inside the circle now carries all the lines of force that were on one side of the wire when it was straight. The number of lines is not increased by bending the wire—they are only concentrated into a smaller space. The concentration of these lines enables us to make better and more efficient use of them, than if they covered a larger area.

If two equal circles of wire each carrying current in the same direction are brought parallel to, and close to each other, their lines of force are added and merged further strengthening the field; with each further added circle there is a corresponding increase in the strength of the field. See Figure 4.

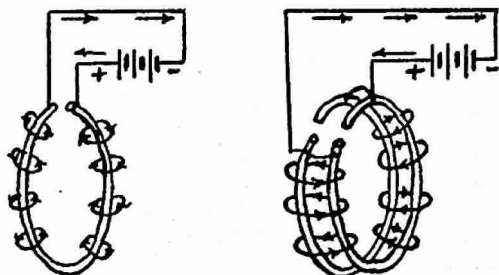


Figure 4

Showing Magnetic Lines of Force around a wire bent into a ring and around two such rings.

A single wire may be formed into a coil or helix and for each complete turn the effect will be, when current is sent through it, the same as for each circle above described. Such a coil is known as a solenoid. A diagram of its magnetic field is shown in Fig. 5. Note the similarity of this field to that of a bar magnet and further note that if the direction of current be reversed the positions of the north and south poles will also be reversed.

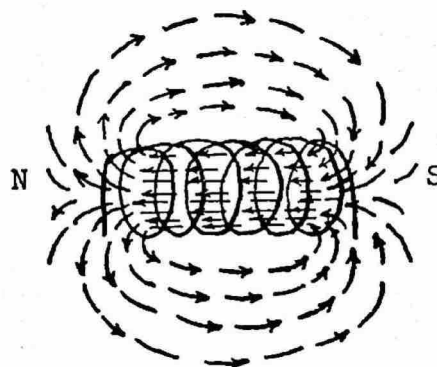


Figure 5

SOLENOID

ELECTROMAGNETS—A bar of iron placed within a solenoid is magnetized by current flowing in the solenoid, and the magnet thus produced is an electromagnet.

The electromagnet has a definite polarity which may be easily determined as follows: Grasp the solenoid in the right hand in such a manner that the fingers point in the direction in which the current flows. The thumb extending at right angles to the fingers will point in the direction of the north pole of the magnet which, it will be noted, is in accordance with the right-hand screw rule mentioned above for indicating the relation of the direction of lines of force to the current flow.

The magnetic field of an electromagnet will be the same as previously described for a bar magnet except that the electromagnet may be made more powerful than a magnet produced by any other means.

If the bar be bent in the form of a U and one leg inserted in the solenoid, an electromagnet will be formed whose field will be the same as the horseshoe magnet shown in Fig. 2.

Common examples of electromagnets are:

Lifting magnets, used to handle iron bolts, rivets, plates, scrap iron, etc., remote control switches, circuit breakers, door bells, door openers, buzzers, telegraph relays and sounders, telephone bells and telephone relays.

In all of these and in many other similar devices, successful operation depends upon the creation of an intense magnetic field at a particular place in the mechanism, which field will cause a movement of some part of the mechanism. The moving part must return to its former position as soon as possible after the current is cut off, therefore, the magnetic field must disappear very quickly and very completely after the current stops flowing in order that the moving part may be returned to normal either by its own weight or by the aid of a spring.

To accomplish both of these purposes very soft iron is used to carry the magnetic lines of force in the above mentioned types of electromagnets; first, because a piece of iron will carry about 2500 times as many lines of force as would a volume of air of the same dimensions, and second, because very soft iron will lose practically all its magnetism almost immediately upon the removal of the magnetizing force.

In the following paragraph on "The Relay" is shown how these principles are applied.

RELAYS—A relay is fundamentally an electrically operated switch. It consists of an electromagnet (core and winding), an armature and spring assembly. These parts are arranged in such a way that when the core becomes magnetized by an electric current through the winding, the armature is attracted by the core and moves sufficiently to open or close the contacts of the spring assembly.

When the circuit through the relay winding is closed, the core becomes magnetized and sets up magnetic flux in the magnetic circuit. Sufficient magnetism must be created in the space between the armature and the poles to cause the armature to move forward. The current flowing around the core of the magnet creates a magnetomotive force which drives magnetism through the magnetic circuit, all of which is made of soft iron or air.

Unfortunately, not all of the magnetism created by the current passes through the air gaps into the armature; a large part of it is lost by its direct passage from one end of the core to the other end through the air. This is called "Leakage Flux". That magnetism which passes through the air gap into the armature is the only magnetism which results in a pull on the armature, and it is, therefore, called "Effective Flux".

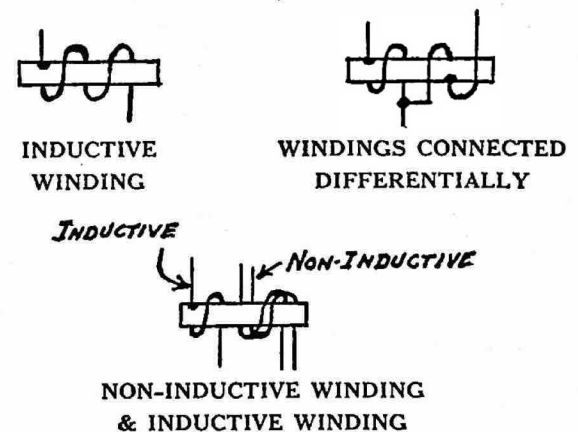
The reason for the movement of the armature may be explained somewhat as follows. When the electromagnet is excited, one end of the core becomes a north pole and the other end a south pole; and if the direction of current is reversed the poles are reversed. When the direction of current flow is such as to make the end of the core nearest the air gap a north pole, the lines of

force, or flux, go out of the core, across the air gap and into the armature, thence through the return pole piece to the other end of the core, thus completing the magnetic circuit. With the end of the core nearest the air gap a north pole, the end of the armature facing it becomes a south pole, because it is the other end of a magnet. Since unlike poles attract each other, the armature will be drawn toward the core if the flux produced by the current through the winding is great enough.

The design of the magnetic structure of a relay—that is, the core and the armature is based mainly upon the requirements of the relay, but, relays are chosen also with respect to first cost and efficiency of operation.

Relay Windings—There may be from one to four windings on a relay. For purposes of differentiation, windings are classified as primary, secondary, tertiary, and quarternary. At least one winding on every relay must be an inductive winding. An **inductive winding** must be wound in such a manner that the current will always flow around the core in the same direction and thus cause the core to become magnetized.

A **non-inductive winding** is wound so that the current will flow around the core in one direction through half of the winding and in the opposite direction through the other half of the winding, thus neutralizing the inductive effect. The term "differential relay" is sometimes used and refers to a relay having two inductive windings of the same number of turns and resistance, connected so that the inductive effect of one winding neutralizes that of the other. Thus, relays equipped with differential windings may be operated by energizing one winding and then released by energizing the other winding. The following figure shows the most common symbols used on a circuit drawing for relay windings.



The maximum number of ampere turns that can be safely applied to a relay winding is determined by the maximum permissible temperature rise in the winding. This rise in temperature is dependent upon the circuit conditions and upon the heat dissipating capabilities of the winding and relay structure.

Contacts—The selection of the proper contact material is important, as in most cases the useful life of a relay is determined by the life of the contacts. The contact material must be practically free from corrosion as corrosion acts like a high resistance film on the contact

surface. Contacts must also be able to withstand the electrical wear caused by arcing, and must be sufficiently hard to limit the wearing away to a minimum.

Relay contacts are made from No. 1 contact metal (an alloy of platinum, gold and silver), No. 2 contact metal (palladium), platinum, tungsten, etc. Contacts are usually attached by spot welding to the contact members, except in the case of contact screws where they are tightly fitted.

In order to prolong the life of contacts, contact protection circuits are used in a number of instances. They are for the purpose of limiting the arcing of the contacts and consist in most cases of either a non-inductive shunt across the winding, or a non inductive resistance in series with capacity across the winding or contacts.

Relay Requirements—Relays are adjusted to certain mechanical and electrical requirements to insure their operation in the circuit for a reasonable length of time. Although a relay may apparently function satisfactorily in a circuit when it meets its electrical requirements, there is no assurance that its adjustment is permanent unless certain mechanical conditions are met. The electrical requirements for the relays in a particular circuit are usually shown in a chart on the schematic circuit drawing prints (S D Sheets), whereas the mechanical requirements for each type of relay are shown in the Bell System Maintenance Practices.

Slow Acting Relays—Slow acting relays play an important part in the circuit design of dial switches. They are used to delay momentarily the operation of the relay armature.

Slow acting relays are of two classes; i.e., the slow operating relay and the slow releasing relay. This slow acting feature is accomplished by the use of a copper collar mounted on the relay. In the former, this collar is mounted at the armature end of the relay, whereas it is mounted on the heel of the slow releasing relay.

4.03 CIRCUITS

In order for electric current to flow there must be a complete path, that is, a closed circuit; and this closed circuit must include the battery or whatever source of current is used. A break in a wire, or other conductor, creates infinite resistance thus preventing the flow of electricity past that part of the circuit in which the break occurs. When tracing a circuit, it is best to start at one terminal of the battery and follow the circuit through wires, connections, and apparatus until you reach the opposite terminal of the same battery.

Electrical circuits are shown in two general classes, wiring diagrams (T & ED Drawings) and schematic diagrams (S D Drawings). A wiring diagram shows the apparatus approximately in its relative position. It is used mostly for reference when wiring the apparatus in the shop or during installation and when tracing connections. A schematic diagram is electrically the same as the wiring diagram but the parts are rearranged in such a way as to show more clearly the paths of current flow, the relation of the apparatus, and the principals underlying the design of the circuit. A schematic diagram may contain all the circuits or it may contain only

one circuit path re-arranged to show itself more clearly. Available with each schematic drawings are "circuit explanation" sheets (C D Sheets).

4.04 TELEPHONE PARTS

TRANSMITTER—A telephone transmitter is that portion of a telephone by means of which sound waves from the voice or other mediums, are converted into electrical energy that can be transmitted to another point on the line for reception by means of a receiver.

The transmitter is made up of a diaphragm so mounted that its vibratory motion, caused by sound waves directed toward it, will be transmitted to a mass of carbon granules in a cup, the granules being arranged in series with the transmitter circuit. This is known as the variable resistance method of producing current waves.

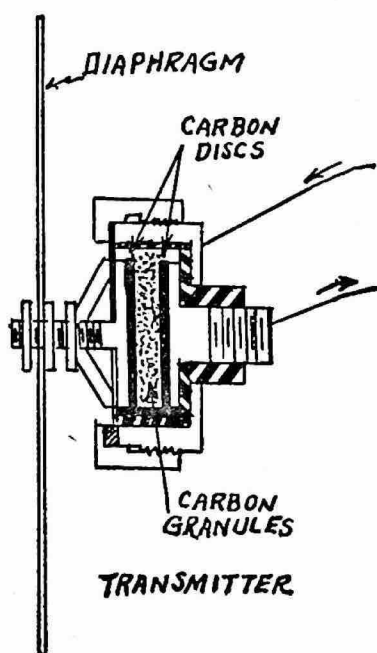
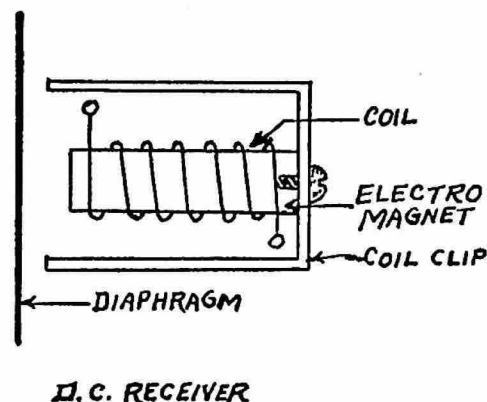
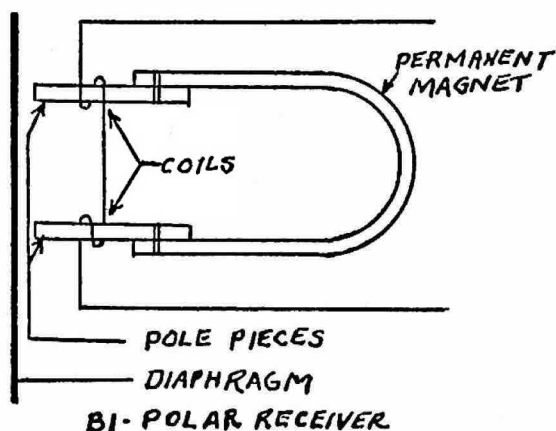
The carbon granules are contained in an insulated metal cup known as the electrode chamber in which are two carbon discs. These carbon discs, namely the front and rear electrodes, support the carbon granules. The movement of the diaphragm, which is rigidly secured to the electrode chamber, compresses and decompresses the mass of granular carbon between the two electrodes. In this way the resistance of the path from one electrode to the other through the carbon granules, is varied. The current is thereby varied in strength as the air pressure varies on the diaphragm. This varying current is sent out over the line to the connected receiver.

RECEIVER—Two general types Bi-Polar and D. C. The former type of receiver includes a permanent magnet, magnet coils and a diaphragm. The permanent magnet attracts the diaphragm placing a certain tension upon it. One-half cycle of alternating current flowing through the magnet coils adds to the pull on the diaphragm that is exerted by the permanent magnets, and the other half cycle subtracts from their pull; therefore, the diaphragm makes one complete cycle or vibration during the period that one complete cycle of alternating current flows through the magnet coils.

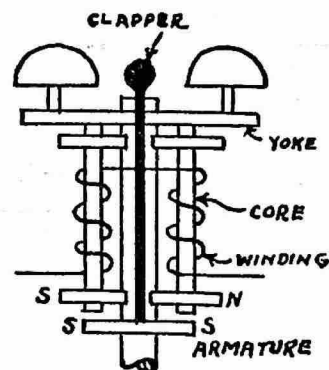
D. C. RECEIVER—Until about 1909 it was the universal practice to use permanent magnets for giving the initial polarization to the magnet cores of telephone receivers. This is still done and necessarily so on receivers used on magneto telephones where no current is supplied from a central office. In common battery systems, such as we use for dial service and where the direct current is supplied from the central office to the local stations, it has been found that the current which must flow through the line to furnish talking battery may be used for the additional purpose of energizing the receiver magnets so as to give them the initial polarity.

When the strength of the current flowing through the receiver magnet coils is varied, the tension on the diaphragm varies directly with the current and results in a vibration of the receiver diaphragm. When a voice through a telephone transmitter causes the variation of current, the receiver diaphragm responds and reproduces the sound of the voice.

Diagrams of a typical transmitter and receiver follow:



RINGER—The essential parts of a “ringer” of the more common construction is shown below:



POLARIZED RELAY RINGER

It has two electromagnets called ringer coils, the cores of which are joined by a yoke which also serves as a support for the bell gongs. To the yoke is attached a U-shaped permanent magnet as shown so that one end of the magnet is above and halfway between the upper ends of the cores. Its lower end hangs just below the

center of the armature. The armature, to which is fixed the bell clapper, is pivoted at its center point (support not shown) in such a manner that when either end is attracted toward its pole piece, the clapper will strike one of the gongs.

The windings of the two coils are connected in series so that the magnetic field produced by current in one winding will add to the field produced by current in the other winding.

The winding consists of many turns of very fine wire hence the high frequency voice currents on a telephone line will not pass through them, but enough low frequency alternating current from the ringing generator will pass to operate the ringer. Thus the ringer may be bridged across the telephone line.

The action of the ringer when low frequency A. C. is flowing through the coils is as follows:

Assume that the permanent magnet has its south pole at the armature end as shown. It will act upon the soft iron armature and induce a north pole at the center of the armature and a south pole at each end of the armature.

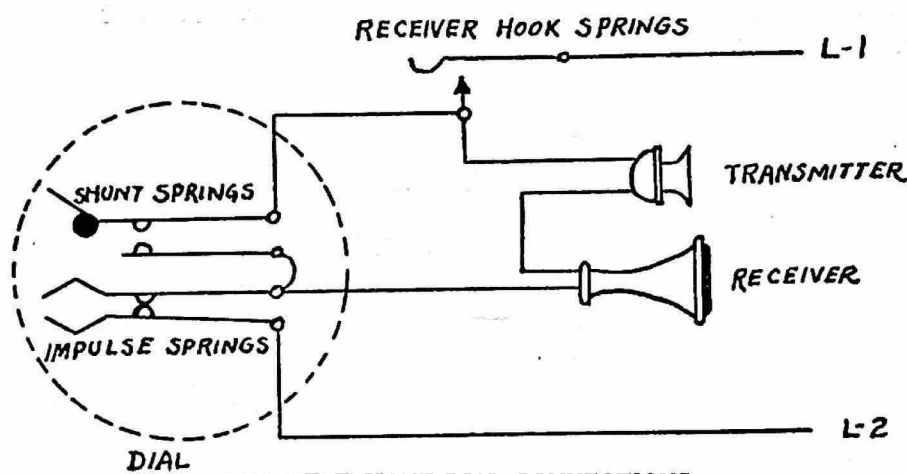
Assume that the current for the first half cycle is such as to produce a north pole at the right hand pole piece and a south pole at the left hand pole piece. These poles are indicated by the letters N and S in the sketch; the right hand end of the armature (south pole) will be attracted toward its pole piece (north pole) while the left hand end of the armature (south pole) will be repelled by its pole piece (south pole) and the clapper will be thrown against the right hand gong.

During the second half of the cycle the current will be reversed and this will reverse the polarity of the pole pieces. We will now have a south pole at the right hand pole piece which will repel the right hand end of the

armature and a north pole at the left hand pole piece which will attract the left hand end of the armature hence the clapper will be thrown against the right hand gong.

With each succeeding cycle of A. C. (ringing) current the above action will be repeated and the gongs will continue to be struck repeatedly as long as current is applied.

THE DIAL—For the purpose of automatic operation each telephone is equipped with a calling devise, known as the dial and as shown in the following sketch:



The dial is essentially a circuit interrupter. When the finger plate of a dial is released after being turned from its normal position, it interrupts the line circuit in quick succession (10-12 interruptions per second) a number of times corresponding to the digit dialed. Each time the line is interrupted, what is known as an impulse is transmitted to the dial central office equipment. It is the impulses that are sent over the line at the will of the customer, which start the dial switches in motion and cause them to establish connections between customers.

INDUCTION COIL—An induction coil is merely a transformer which consists of two insulated wires wound around an iron core. One of the windings called the primary (P) winding, in series with a transmitter and battery, forms a closed local circuit, while the other winding called the secondary (S) winding, in series with the receiver and the line, forms a separate circuit.

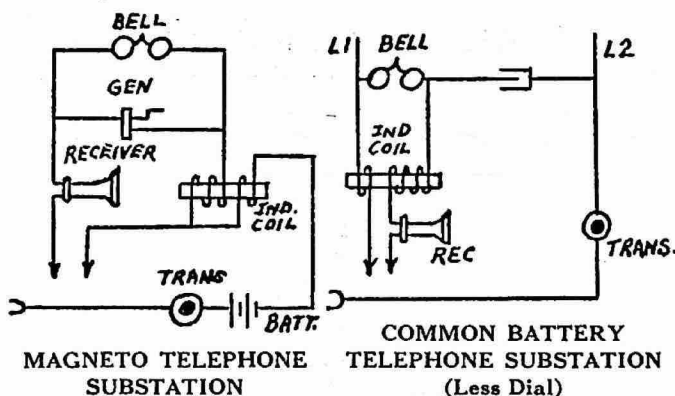
If a direct current is flowing in one of the windings and remains constant, no current whatever is produced in the other. However, if there is a change in the current in one of the windings, there will be produced a current in the other. A continued variation of the current flow in one winding will result in the flow of an alternating current in the other winding.

The separation of the transmitter circuit from the line gives a vastly wider range in talking currents.

The secondary winding has more turns than the primary winding, and the voltage in the secondary is correspondingly higher than in the primary. High voltages in the secondary winding are admirably adapted to transmit current in a high resistance line, for exactly the

same reason that long distance power transmission meets with but a fraction of the (I^2R) losses when the sending voltage is doubled. Thus the induction coil serves two purposes, increasing the range of change in the transmitter circuit and lessening the loss in the line circuit.

The induction coil used with a common battery telephone is somewhat different in design than that used at a magneto telephone substation, and it is connected differently. This is shown in the following two sketches:

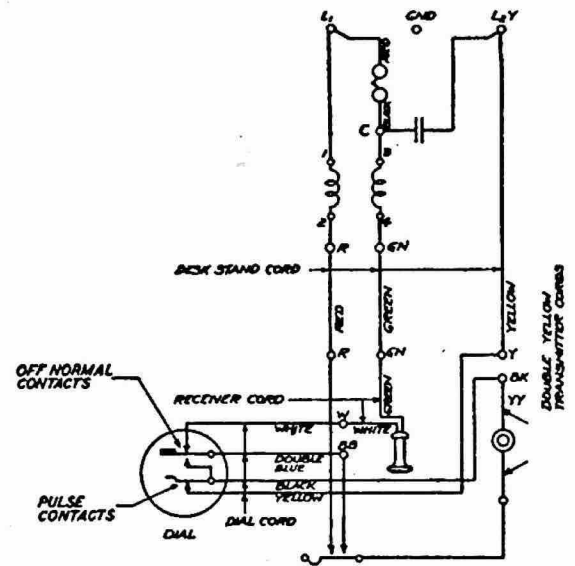


In the common battery substation the talking current is taken from the central office battery, flows over the line and through the transmitter and the primary winding of the induction coil at the substation. This is direct current upon which is super-imposed alternating voice currents—when the distant subscriber is talking—and these voice currents cause changes in the magnetic lines of force in the induction coil which induce similar voice currents in its secondary whence they are passed through the receiver.

The latter is a local circuit consisting of the secondary winding of the induction coil, the receiver, switch hook contact, transmitter and condenser. Voice currents pass easily through this condenser as do also the low frequency A. C. required to ring the bell.

THE REPEATING COIL—The fundamental principle of the repeating coil is the same as that of the induction coil. It is used when it is necessary to have the inductive association of two circuits that are conductively or physically separated.

THE RETARDATION COIL—An "Induction" coil wound on a core and in such a manner as to oppose the flow of alternating current, is known as a Retardation Coil. In general, it may be said that a retardation coil is used whenever it is desired to add inductance to a circuit. Coils of this type are used in operators' telephone sets, incoming selector circuits, dial trunk circuits, etc.



DIAL SUBSCRIBER STATION CIRCUIT

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5.0 DEFINITION OF TERMS AND EXPLANATION OF EQUIPMENT—SXS DIAL SYSTEMS

- 5.01 **TELEPHONE:** The telephone is a compact unit made up of parts necessary for the reception and the transmission of speech and for ringing, or signalling the party called. The original telephones were of the magneto or local-battery type, whereas the present day instruments are known as the common battery type.
- 5.02 **DIAL:** The dial, a circuit interrupter, or impulse sending device operated by hand and used in conjunction with the telephone to establish the circuit connections that operate the switches (Selectors and Connectors) at the dial central office. Its function is that of rapidly opening and closing the line circuit, the number of times, corresponding to the figure dialed. Dials are adjusted to operate at a speed of about 10 impulses per second. Dials will operate switches satisfactorily if running as slow as 8 impulses per second or as fast as 12.
- 5.03 **DISTRIBUTING FRAMES:** Distributing Frames are provided in our telephone central offices to provide a flexible arrangement for connecting subscribers' lines to the equipment, and, too, for inter-connecting various types of equipment within the office. These connections are made with cross-connecting wire (jumpers). These "jumpers" may be of either single, double, triple or quadruple wires depending on their particular application. Single wire jumpers are usually brown, the double wire jumpers being black and white, the triple red, white and black and the quadruple red, white, black and green.

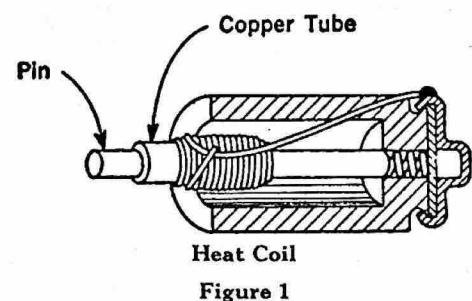
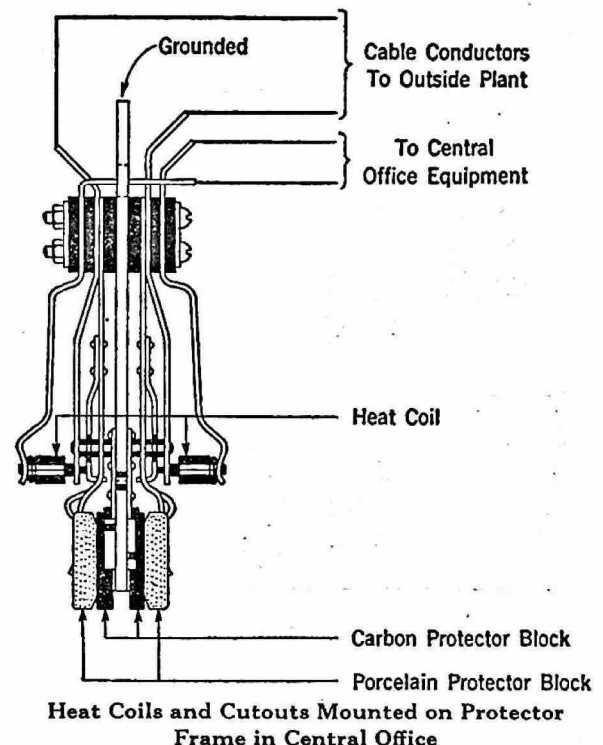
Most all distributing frames are of the double sided variety—vertical side and horizontal side. Occasionally, single sided distributing frames are provided where there are floor space limitations.

They are used frequently in the newer offices as trunk distributing frames for cross-connecting line finders to first selectors. The "jumpers" are run between terminal strips (blocks) to which permanent cabling from the equipment has been terminated.

- 5.031 **PROTECTOR FRAME:** In order to protect the dial equipment from high voltages and abnormally high currents, which may be due to lightening or a power line coming into contact with a telephone line, a Protector is provided for each line. The Protector (See Fig. 1) is made up of two distinct parts: carbon blocks and heat coils. The carbon blocks, one of which is grounded, are separated by an air-gap the thickness of a sheet of paper. The other block makes contact with the line and when a high voltage is impressed on the line a spark will jump across the air-gap to the grounded block, thus protecting the equip-

ment. The heat coil has a winding wound around a copper sleeve, which is soldered to a small brass bar. The heat coil winding is connected in series with the telephone line so that a high voltage on the line will cause the heat coil to heat up, due to the high current resulting from the high voltage. When this occurs it melts the solder and permits the copper sleeve to be pushed back. The brass bar then makes contact with a strip of metal which is grounded and therefore the current flows to ground instead of through the dial equipment.

The customers' lines from outside are brought into a **cable vault** in large lead-covered cables. Each cable contains from 100 to 1200 (or more) pairs of wires. These lead covered cables are then "fanned-out" to the Protector Frame and connected to a protector. Every cable pair terminating on the frame therefore has its own protector. After passing through the protector the cable pairs are permanently cabled from the Protector Frame to the vertical side of the Main Distributing Frame (see Fig. 2) and terminated on terminal blocks on which are stenciled the Cable Number and Pair number.



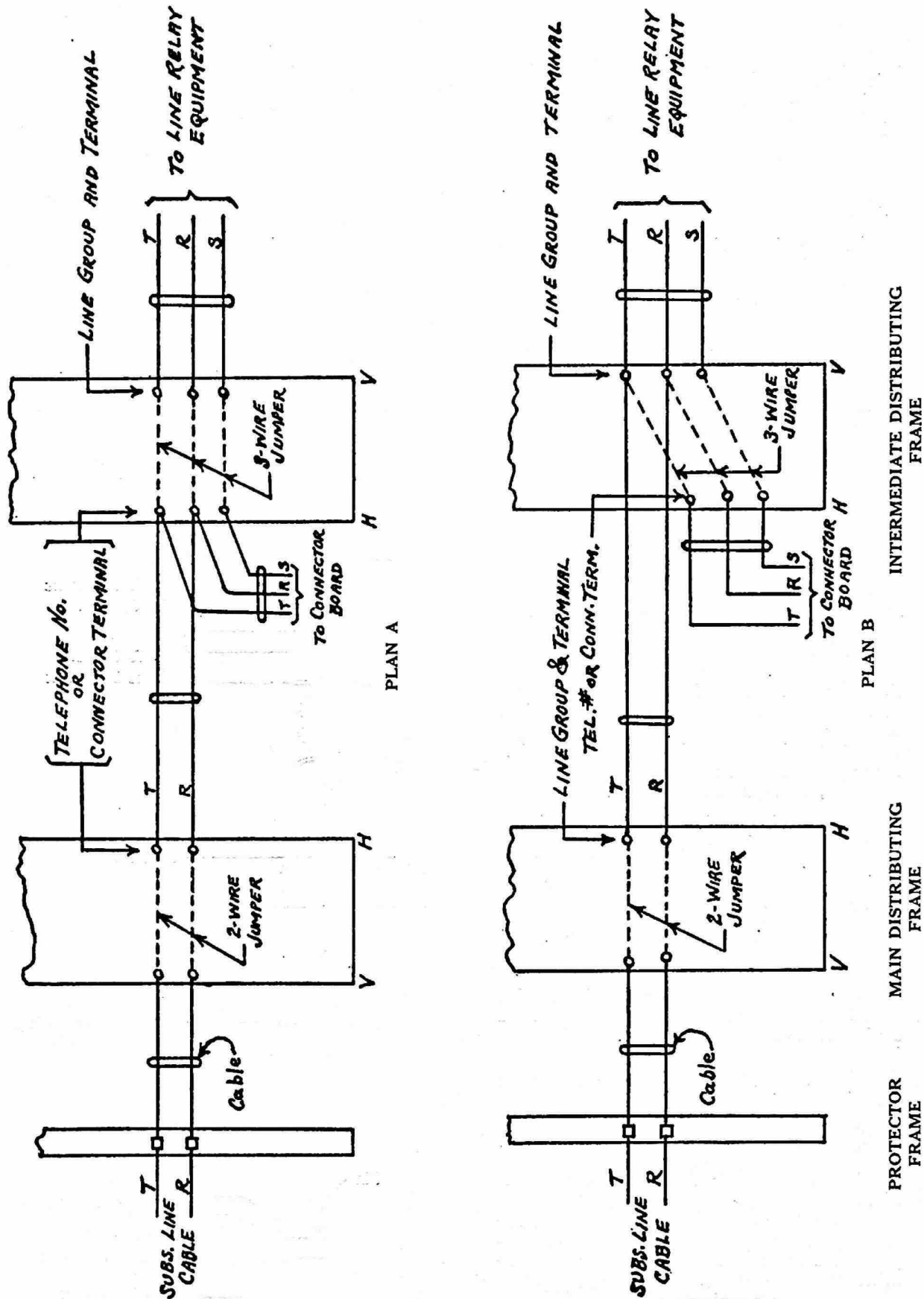


Figure 2

There is no cross-connecting work necessary on the Protector Frame and as such it is not in the true sense of the word a "distributing" frame.

In a great many cases (Small No. 1, 350-A and community dial type offices) the protectors are mounted on the vertical side of the Main Distributing Frame and the Protector Frame is not provided.

Trunk cables are terminated at Protectors the same as subscribers' lines, however, in the majority of cases "dummy" heat coils are used since these cables are usually all underground.

- 5.032 **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. (See Fig. 2, Plan A). 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. (See Fig. 2, Plan B).

Occasionally, miscellaneous circuits such as incoming selectors are terminated on the horizontal side of this frame.

- 5.033 **LINE INTERMEDIATE DISTRIBUTING FRAME:** This frame is used for the termination of the connector board terminals (Telephone Numbers) and the Subscribers' line relay circuits. (See Fig. 2). 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.

Four-party and ten-party bunching blocks are also installed on the vertical side of this frame.

- 5.034 **TRUNK DISTRIBUTING FRAME:** This frame is used for jumpering between miscellaneous relay circuits and other associated equipments. Cross-connections between Line Finders or Master-Switch trunks and First Selectors, Selector level trunks to Repeaters, concentrating switches or trunks to Repeaters, etc. are usually arranged for on these type frames.

- 5.035 **COMBINATION DISTRIBUTING FRAMES (C.D.F.):** These type frames serve the same purposes as do the M.D.F., I.D.F. and T.D.F. They are usually installed in the smaller offices (350-A, 360-A, 355-A, 35-E-97) and all cross-connection work is done on this one frame in the office.

- 5.04 **PRIMARY LINE SWITCHES AND MASTER SWITCHES:** In general, we may de-

fine a line switch as an arrangement of apparatus which permits any one of a number of lines to be connected automatically to an idle one of a number of trunk lines, smaller in number than the number of lines. It is a "non-numerical" switch because its operation requires no figure in the called number and no movement of the dial. In other words, it automatically extends the subscribers line to an idle trunk leading to the next switch in the train.

Subscribers' lines terminate in primary line switches which are arranged in vertical columns in a framework known as a line (switch) board and made up in two bays.

Each bay has a capacity for 100 line (plunger) switches each. There are four divisions per bay—A, B, C and D—of 25 switches each, arranged so that one master switch may be provided for each division; or one master switch could serve two or three divisions, or, (in extreme cases) all four divisions. The number of divisions which a master switch might serve is determined by the traffic engineer and is based on the originating call seconds offered by the associated subscribers' lines in the board. Figure 3 shows the arrangement of the switches and the divisions in a line board.

Take the case of one master switch for Division A and B, for example, the 25 banks of each division are mounted in a vertical pile with 13 line switches on the right and 12 on the left so that the plungers are in vertical alignment. Division B is directly below Division A and is arranged the same as Division A except that here 12 switches are on the right and 13 on the left. The master switch in this example would be located in the "B" position.

As mentioned previously there is a Primary Line switch associated with each subscribers' line. Associated with each of these switches is a set of bank contacts which consists of 10 sets of contacts. Each set is made up of 8 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.

The bank contacts are multiplied in each division.

The Primary Line Switch consists of two relays, the line relay and the combined P.D.M. and B.C.O. relay (P.D.M. = Pull Down Magnet; B.C.O. = Battery Cut-Off); a plunger arm (P.A.); 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 cut-off 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.

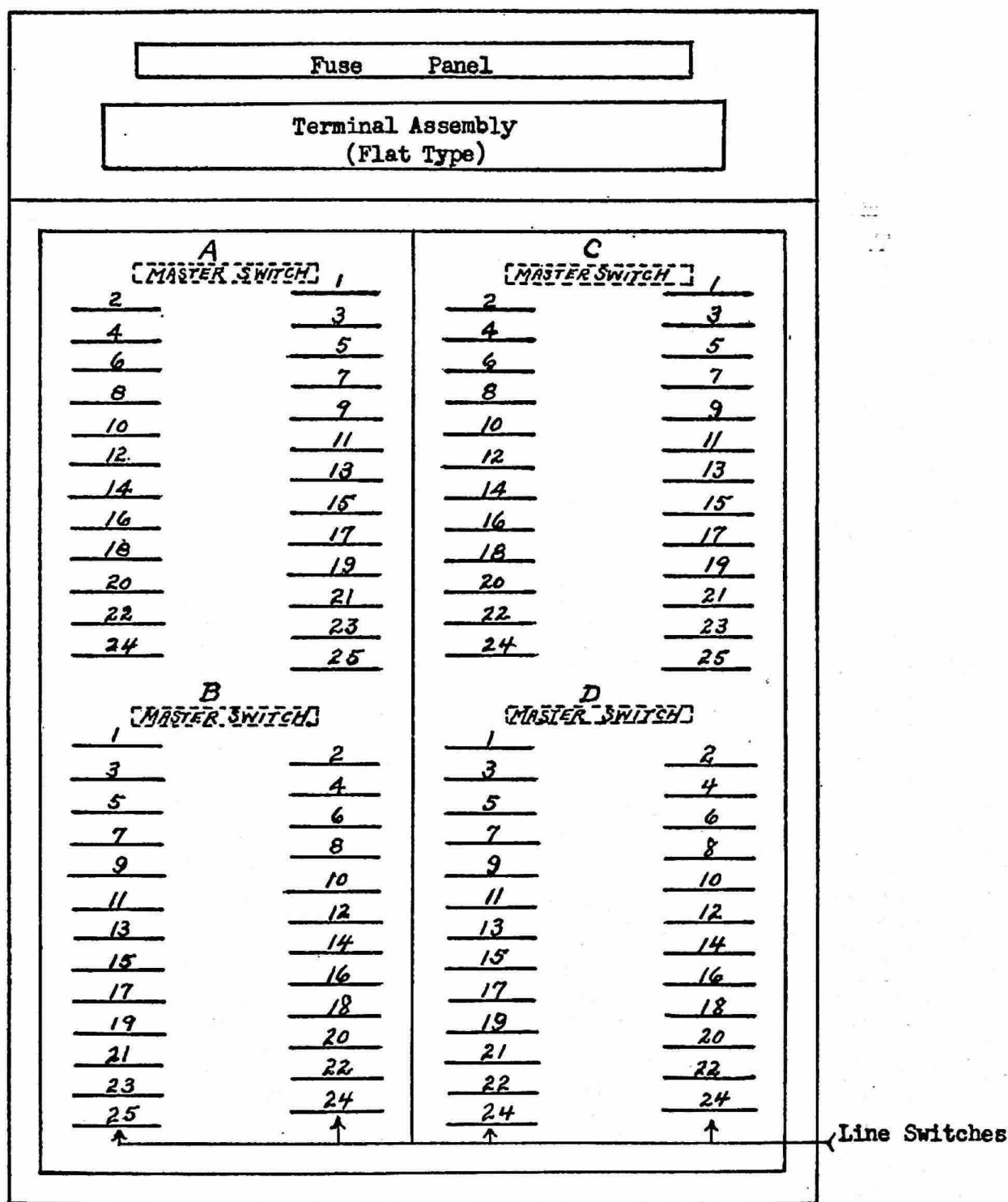


Figure 3
Line Switch Board Layout

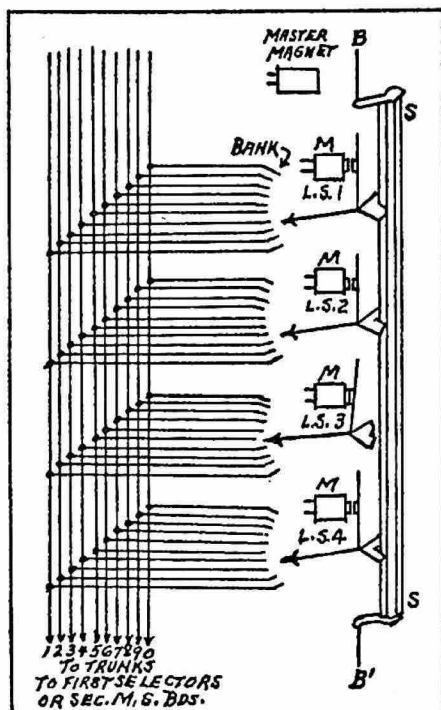
The magnet which drives the plunger into the bank and thus connects the bank springs and contacts, is operated by a very simple circuit. It is a low resistance coil and possesses great power. The B.C.O. portion of the second relay opens up the operating path of the line relay on incoming calls to the line, thus preventing the L.R. from operating when the customer answers an incoming call. On an originating call, the B.C.O. also locks to ground on the sleeve (RLSE. TRK.) to the succeeding switch, thus keeping the operating path of

the L.R. open for the duration of the call. At the time that the plunger operates, ground is placed on the sleeve toward the associated connector terminal to prevent an incoming call to complete to the line while the latter is busy.

The line switch plunger shown in Fig. 4 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 or 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 point is grounded. By this means the master switch can discover which trunks are idle and which trunks are busy.

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 the 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

The master switch, Fig. 4, indicated by the master magnet, takes care of this. It controls the plungers by means of a guide shaft S-S. In the fan shaped tail of each plunger, Fig. 4, is a notch which fits over the inner edge of the guide shaft. The latter is carried on bearings at the points B and B'. This brings the axis of the guide shaft in line with the pivot points of the plungers.

These pivot points are on the ends of the plunger arms which are provided with springs to keep the plungers forced against the guide shaft, S. S. It will thus be seen that all of the idle plungers will be properly aligned and will be moved in unison whenever the master magnet or switch rotates the shaft S-S.

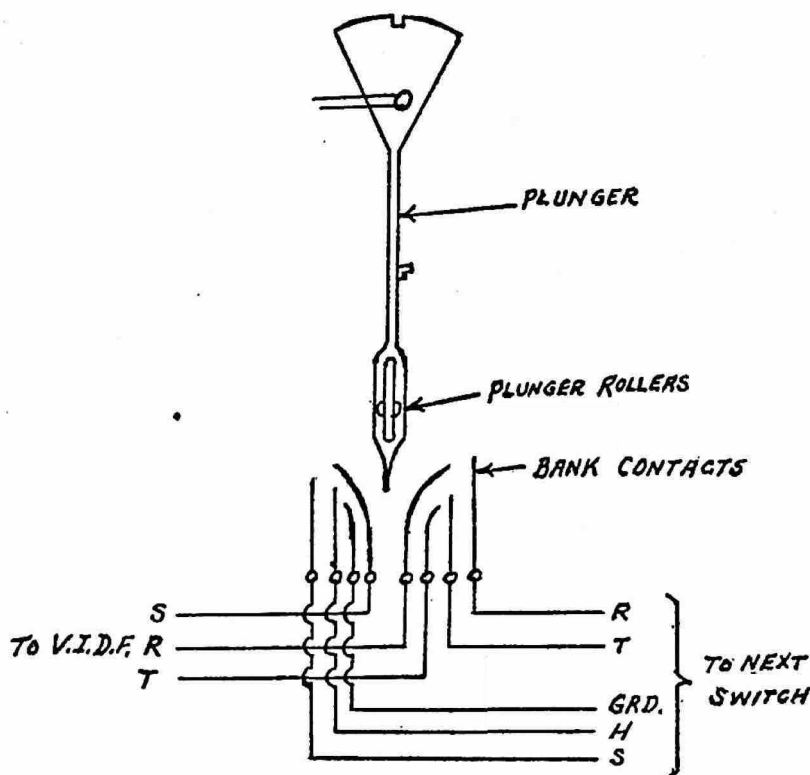


Figure 4

to seize the same trunk repeatedly without actuating the master switch circuit, except as covered under "Secondary Pick-Up" which will be covered later in this section.

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 board, 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 boards.

A Wheatstone Bridge arrangement for minimizing double seizures in primary boards has been designed. This circuit is such that it will control the open main battery voltage to the Pull-down magnets of the primary line switches to prevent not more than one magnet to operate at a time in a master switch section. Should two lines be seized simultaneously in the same M.S.

section, neither line switch will "plunge" until one subscriber, or the other, hangs up. The remaining switch will then operate.

Traffic Registers: Each subgroup of subscribers' lines (M.S. section) is provided with a **peg count** register to record the number of calls made from that section and an **overflow** register to record the number of times any call is delayed on account of all trunks being busy or for any other cause.

These records are necessary for supervision of the traffic and for engineering purposes.

The **peg count** equipment consists of relay F, (See Figure 6) cut in series with the Open Main lead, and a register, practically the same as a message register, which is operated through contacts on relay F.

Relay F operates once for each outgoing call, in turn operating the Peg Count Register once for each such case.

Relay F is slow release to ensure one full operation of the P.C. register for each operation of relay F and prevents false registration of calls on a fluttering of the Line Switch, due to trouble.

The **Overflow equipment** consists of relay G, cut in parallel with the contacts on relay D, and a register, practically the same as a message register, which is operated through contacts on relay G.

When all trunks are busy the Primary Master Switch is oscillating back and forth in order that it may take up a trunk as soon as one becomes idle. During this time relay D remains operated, keeping direct battery off the Open Main lead. Direct battery is also kept off the Open Main lead while the Primary Master Switch is hunting and while it is returning from trunk 1 to trunk 10 irrespective of whether all trunks are or are not busy.

During such times should a call originate, relay A of the calling party's line switch would operate, causing current to flow through high resistance relay G and relay F of the traffic registers and relay B of the line switch operating relay G but not relays F and B.

The operation of relay G should not, however, immediately operate the overflow register because an idle trunk may be found soon enough to constitute no actual delay of this call; therefore relay G is provided with a pendulum type contact spring which prevents the operation of the overflow register until relay G has remained operated long enough to constitute an actual delay of this call.

The usual adjustment of relay G is such as to make this no delay period about equal to the average time from taking receiver off the hook to the sending of the first pulse.

When an idle trunk is found, relay D releases, which releases relay G (by short circuiting) and operates relays F and B.

Summarizing, we can say that the primary functions of the Primary Line Switch are as follows:

1. Operate a plunger and extend the T & R leads of the line to an idle Secondary Line Switch.

2. Disconnect line relay battery and ground from the line.
3. 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.
4. Cause the line to test busy on incoming calls at connector banks.
5. Operate traffic registers.

Summary—Functions of Master Switch:

1. Keep idle line switch plungers directed toward idle trunks to Secondary.
2. Move all idle line switch plungers to the next idle trunk when the previous one has become busy.
3. Prevent a line switch from operating while the plungers are being moved from one trunk to the next.
4. 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.
(Note—Since alarms are considered more of a Plant function, rather than Traffic, information on these was omitted in the notes).
5. When all trunks are busy, to oscillate until a trunk becomes idle.

5.05 SECONDARY LINE SWITCHES AND MASTER SWITCHES:

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 more steady total calling rate than small numbers, so that greater economy is possible.

One way to do this is to mingle the traffic from a number of groups of subscriber lines, so that each subscriber 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 (boards) are similar to primary line switches (boards) 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 diagram illustrates a typical layout for a line switch group, showing how each station line of a line switch group has a choice of 100 selectors by using both primary and secondary line switches.

GROUP OF PRIMARY LINE SWITCHES

Each line to an individual line switch is controlled by a master switch. The primary line switches are labeled L.S. NO. 1, L.S. NO. 2, L.S. NO. 3, INTERMEDIATE L.S., INTERMEDIATE L.S., L.S. NO. 49, and L.S. NO. 50. Each primary line switch is connected to a line relay, which is then connected to the station (TO STATION).

SECONDARY LINE SWITCHES

The secondary line switches are organized into groups. Group No. 1, Group No. 2, and Group No. 10 are shown. Each group contains 25 secondary line switches and a master switch. The selectors for these groups are numbered 1 through 91, 2 through 92, and 10 through 100, respectively.

SELECTORS

The selectors are organized into groups. Group No. 1, Group No. 2, and Group No. 10 are shown. Each group contains 25 secondary line switches and a master switch. The selectors for these groups are numbered 1 through 91, 2 through 92, and 10 through 100, respectively.

INTERMEDIATE GROUPS

The intermediate groups are shown between the primary and secondary line switches. They contain 25 secondary line switches and a master switch in each of these groups.

Sketch of a Typical Layout

Showing How Each Station Line of a Line Switch Group has a Choice of 100 Selectors by Using Both Primary and Secondary Line Switches

Figure 5

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 the 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.

Summarizing—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 this selector trunk to the next idle trunk.
3. Assist in holding the primary line switch until the holding ground has been extended through from the selector.

Although we have not gone into a detail explanation of its circuit operation it will suffice to merely list the various **functions of the Secondary Master Switch**, these being:

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. This register records the number of calls made from that subgroup. These registers are not always provided with the secondary boards, however.
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 Kick-Off" that follows.

5.051 SECONDARY KICK-OFF: As mentioned previously, and as will be covered somewhat in Section 8 under subject "Trunking", we cover-

ed, in a brief sort of way, how the trunks from the primary line boards are run to secondary switches and how the trunks from the Secondary Line boards to the first selectors are run in order to provide a uniform distribution of calls, under usual conditions, to all the secondary groups and consequently to the first selectors.

But 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 Kick-off**, 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 to handle 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, (in effect) 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; but, for the very small period of time that it reached its third consecutive busy trunk until it found an idle trunk, calls were prevented from coming to its subgroup, thus slowing down traffic to a point where it could be handled satisfactory.

Relay D (Secondary Relay) shown in Figure 6 is the slow release relay 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 lead H on each idle trunk from the primaries, which operates relay C of each primary master switch having wipers resting on idle trunks to this secondary subgroup, resulting in the 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 (or trunks) and stop in front of it as soon as or shortly after relay D is again operated.

Thus the Secondary Kick-Off 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, therefore, it has little effect in reducing double plunging at the secondaries. (The allotter circuit was designed to minimize double plunging).

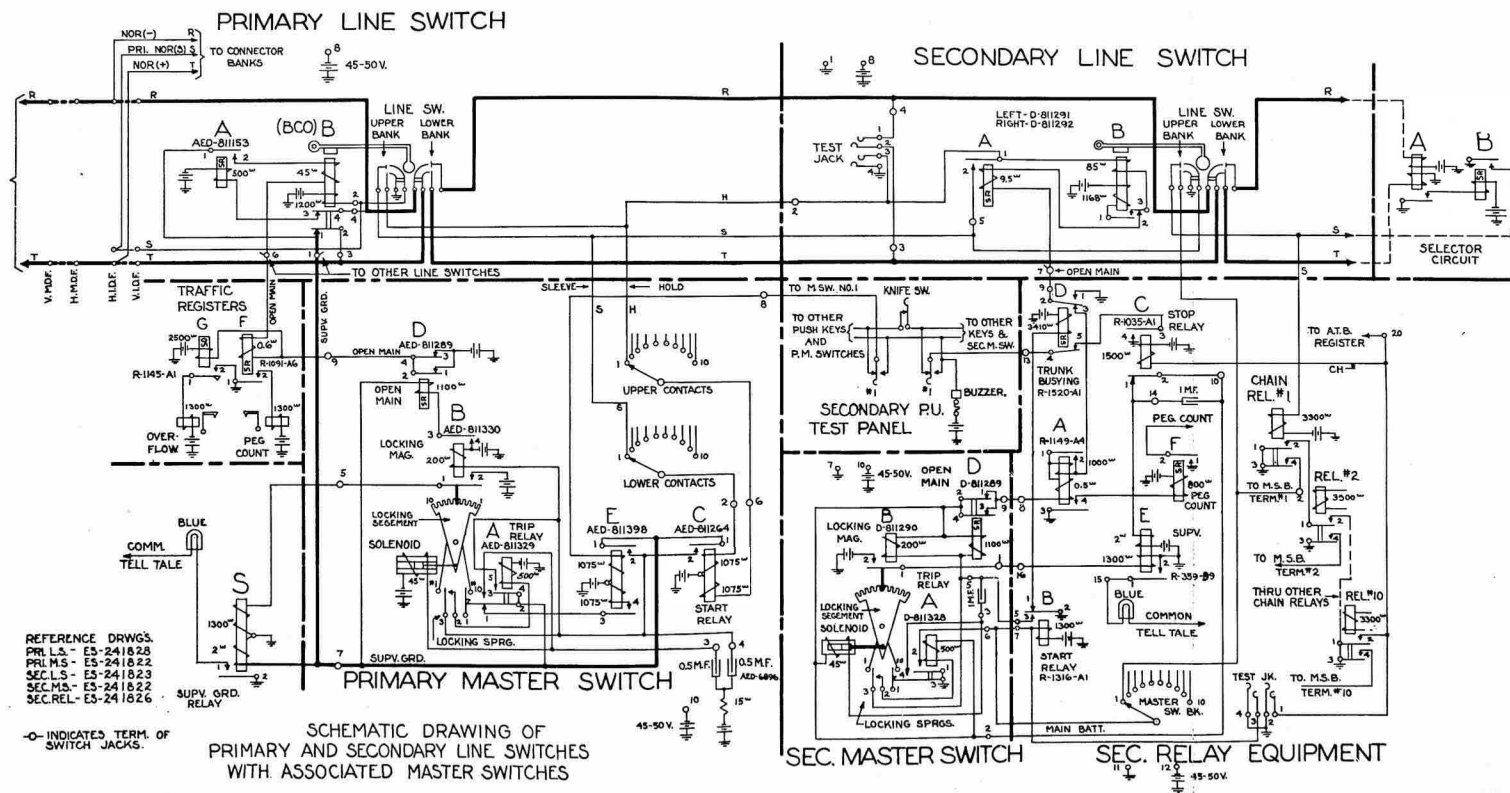


Figure 6

5.052 SECONDARY PICK-UP: One of the ideals 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; and the ceaseless effort on the part of all operating employees to hold inviolate the warning that the busy test gives.

In all dial systems, 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 is to provide enough talking paths or trunks with their accompanying switches to handle, with the least practicable delay, the busy hour traffic; and this of course, is done; but more than this is necessary.

In dial systems 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 ensure no possible interference.

In the SXS dial system, 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; because, the reader will recall, 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 reaches 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 reestablished.

If, however, (as happens frequently during periods of heavy traffic) all outgoing trunks from this secondary subgroup become busy, then the plunger of the primary line switch that we are considering being poised in front of a trunk terminating in a secondary line switch in a subgroup having no idle trunks, quick action must be taken to prevent the primary line switch from plunging in on this trunk and thereby getting into a secondary subgroup out of which at this time 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 does by doing three (3) things at practically the same time as follows:

The instant that the last idle trunk out of any secondary subgroup is seized:

1. 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.
2. 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.
3. A ground is placed on the H lead of 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 its last idle 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 one 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 Pick-Up 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, and the switchman could, by opening a knife switch determine (by the stopping or non-stopping of the alarms) if the ground is on the primary leads or on the secondary leads. Then by operating an associated push type key on each lead in succession, he could determine the particular lead in trouble because the buzzer would sound when the push key of the grounded lead is grounded. (See Fig. 6).

5.053 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 10 on a return sweep. This speed is greater on Secondary Master Switches than on Primary Master Switches.

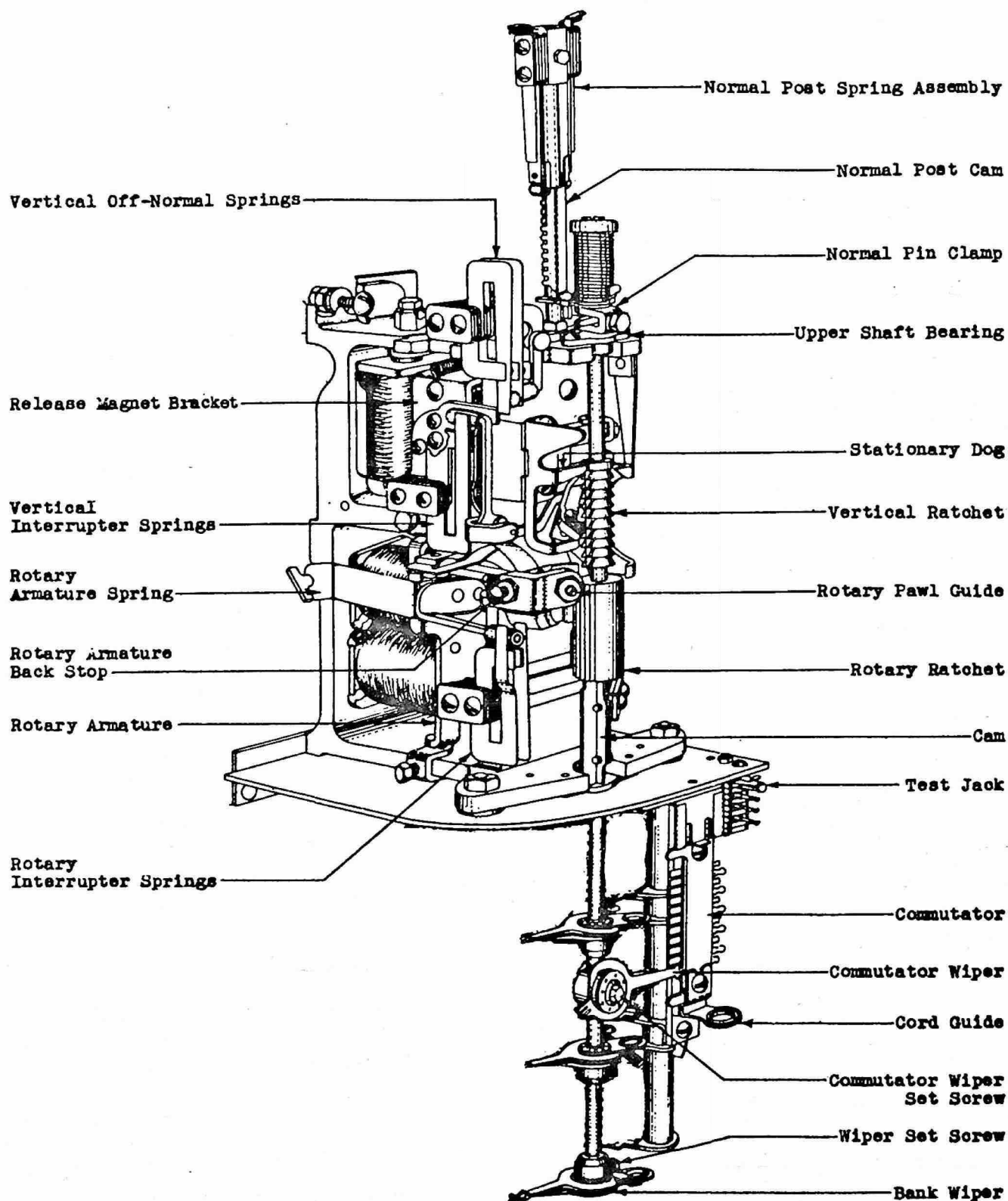
Note:

Figure 6 is a Schematic circuit of Primary and Secondary Line Switches with associated Master Switches. It is included in these notes as reference only as the detailed study of circuit operation is not intended in the course.

5.06 STEP-BY-STEP SWITCH:

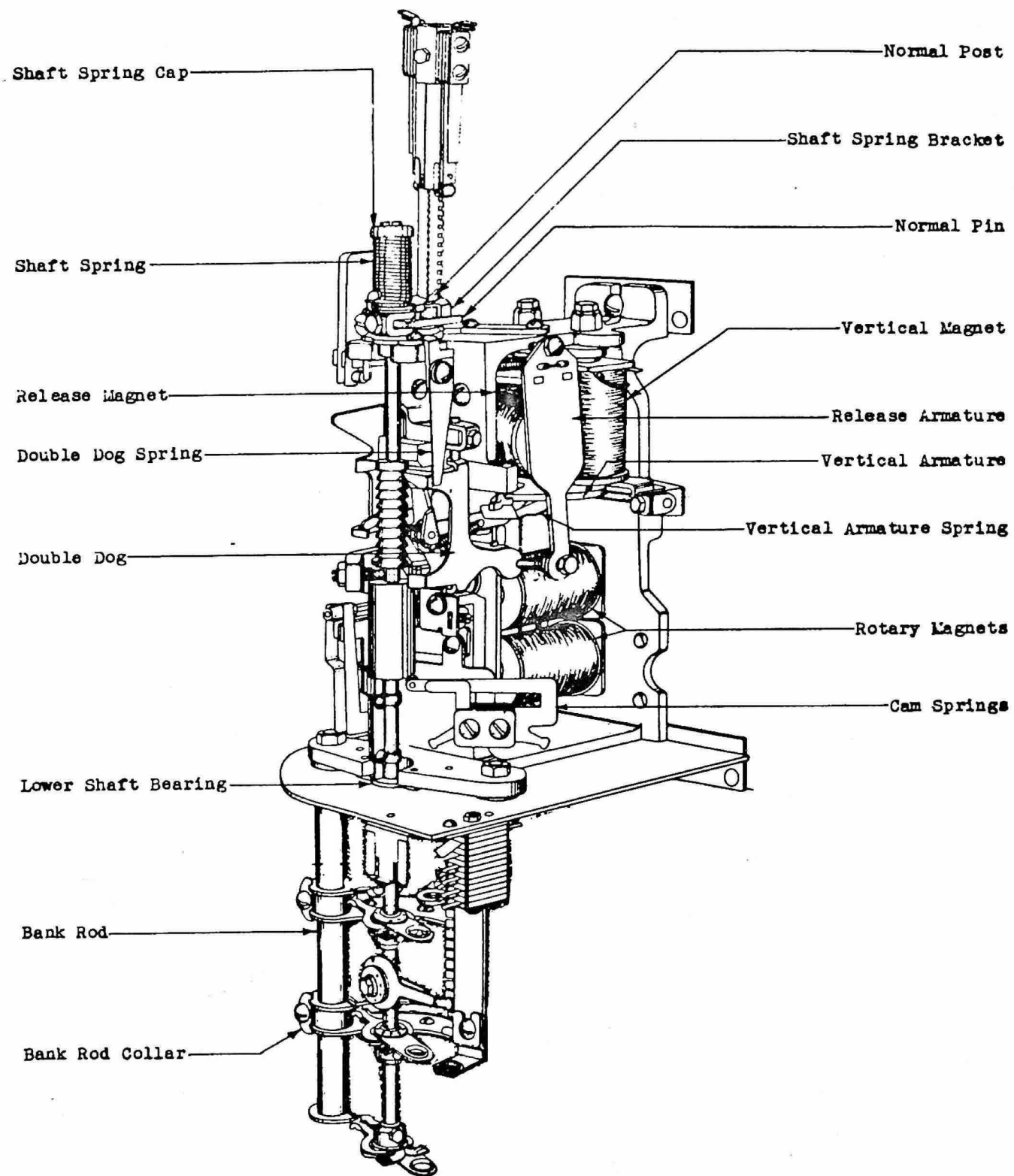
Arrangement of Step-by-Step Switch—For the purpose of explanation, the step-by-step switch has been divided into three parts:

- a. The Upper Section—relay assembly



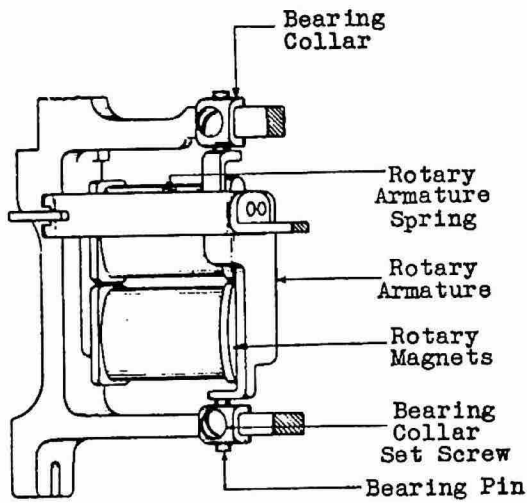
Illustrating Parts of 197 Type Switch
as Viewed from the Left Side

Figure 7

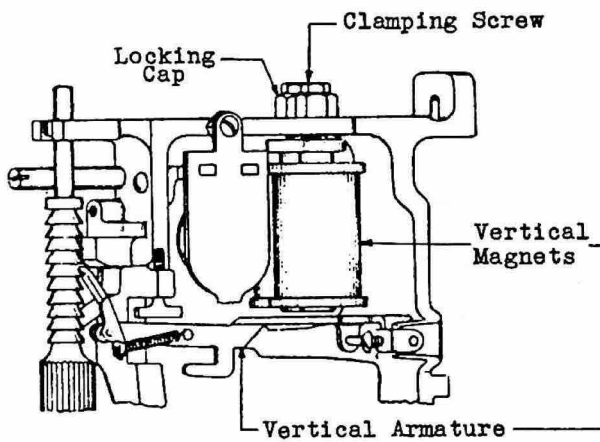
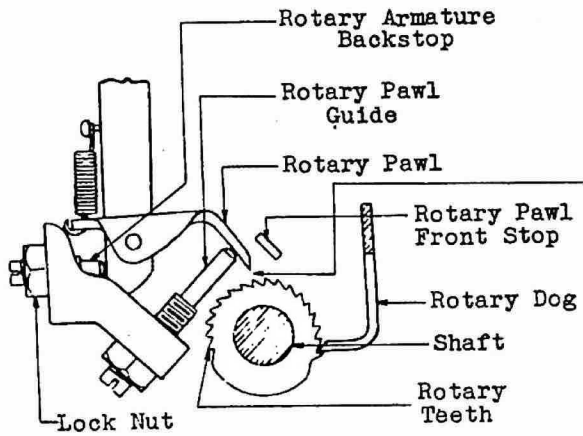


Illustrating Parts of 197 Type Switch
as Viewed from the Right Side

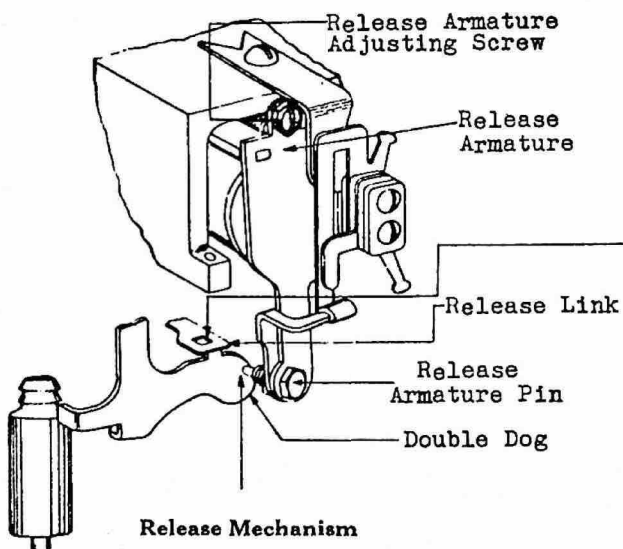
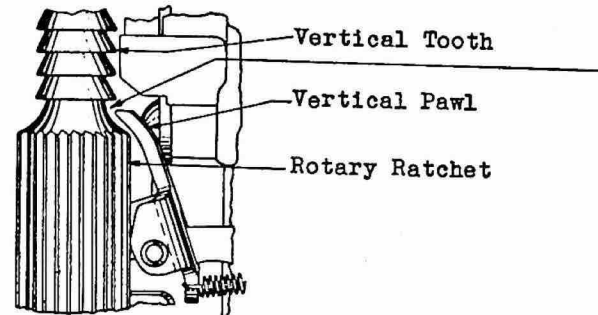
Figure 8



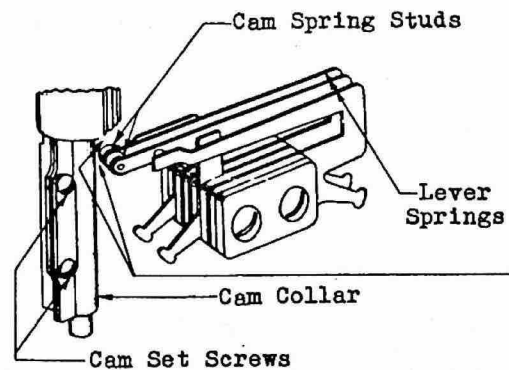
Rotary Stepping Mechanism



Vertical Stepping Mechanism

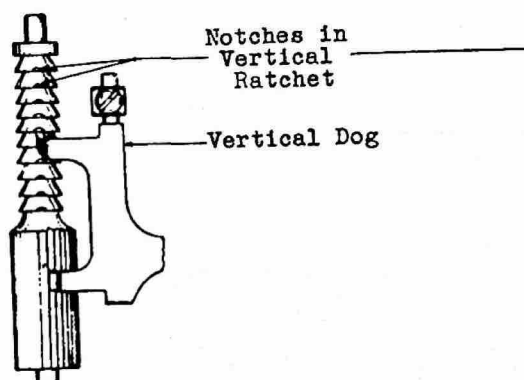
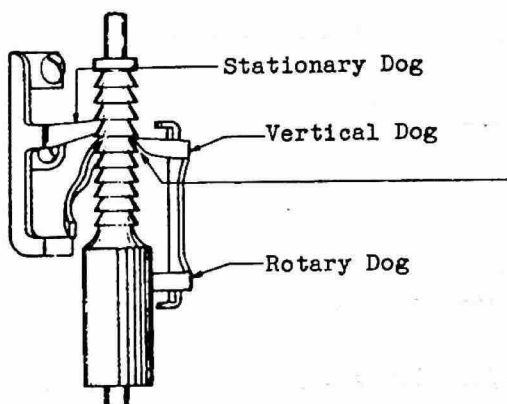
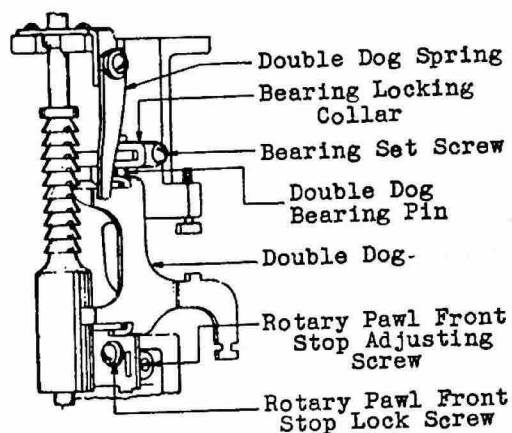


Release Mechanism

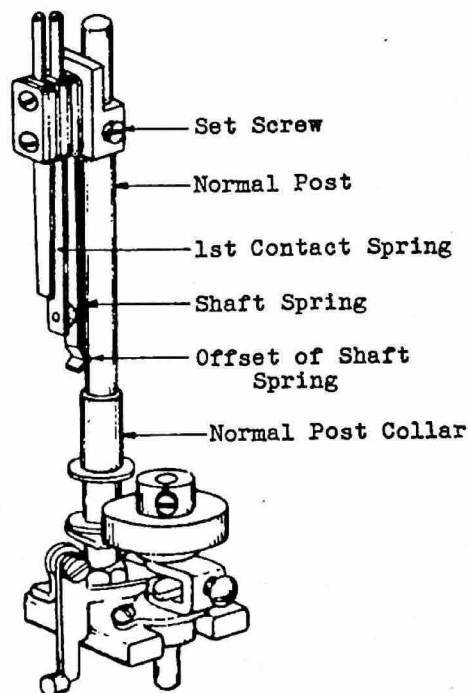
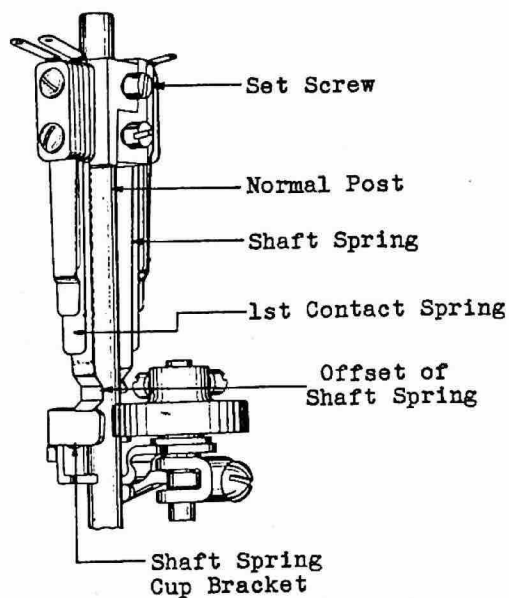


11th Position Rotary Cam Spring Assembly

Figure 9-A



Double Dog Mechanism



Normal Post Spring Mechanism

Figure 9-B

- b. The Middle Section—Stepping Mechanism Assembly
- c. The Lower Section—Multiple Bank Assembly.

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

The Middle Section—stepping mechanism assembly, contains springs, ratches, pawls, magnets, etc. which are associated with the vertical and rotary stepping mechanism to operate and release the shaft and its wipers. Either an intra-office trunk (path) or interoffice trunk is connected to the shaft wipers.

Figure 9-A illustrates the Stepping Mechanism.

The Lower Section—multiple bank assembly.

Note: All terminal appearances in the multiple bank are made up of two lugs.

There are 10 terminals per level which are arranged in a semi-circle and in layers of 10 levels. This is the lower bank assembly for 100 tip and ring connections. Since more than two wires are used on a call, a duplicate upper bank assembly is installed for connecting a third

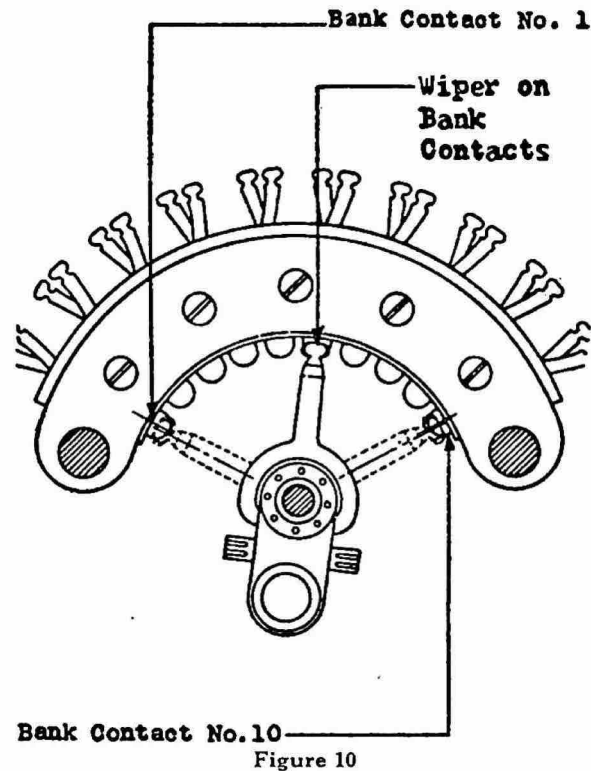


Figure 10

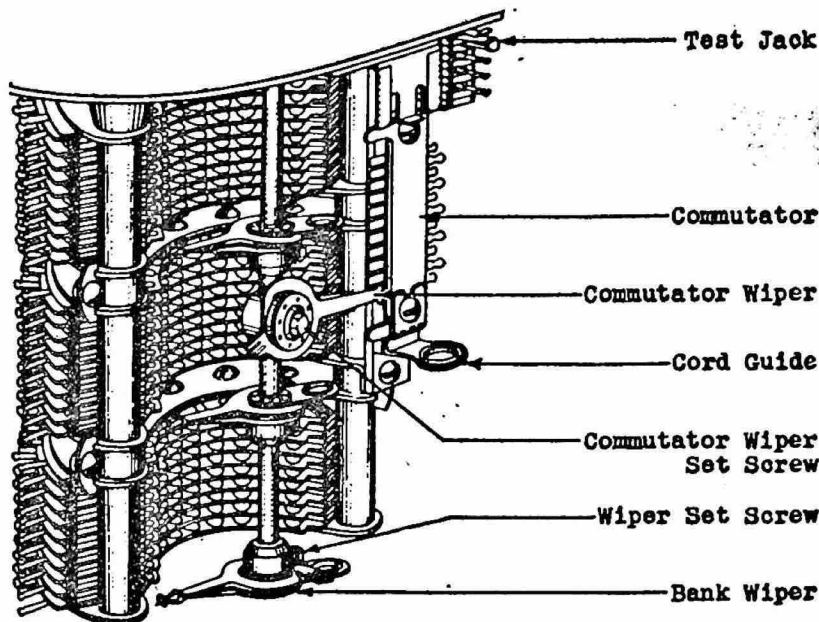


Figure 11

Multiple Bank

wire (sleeve) and sometimes a fourth wire (control—for toll circuit start of ringing). As a result, a 100-point switch has two banks of 100 terminals. However, it accommodates only 100 circuits. (Tip and ring on the lower bank and sleeve on the upper bank).

As an exception to the above, certain (not all) line finder switches have three groups of 100 terminals and are equipped to serve 200 subscribers. The multiple bank, which is shown in Figure 11, has 100 tip and ring terminals in the lower bank, 100 tip and ring terminals in the middle bank and 200 sleeve lugs in the upper bank. The 100 subscribers in the lower

bank secure sleeve from the 100 bottom lugs of the sleeve terminals in the upper bank and the 100 subscribers in the middle bank secure sleeve from the 100 top lugs of the sleeve terminals in the upper bank.

The 100 terminals of all multiple banks, on all switches, have a standard numbering arrangement.

The levels from bottom to top are numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

The terminals from left to right are numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

Any "zero" digit represents a "10," or a multiple of 10, i.e.,

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

Connections to the multiple bank terminals may be either subscriber's lines, intraoffice trunks (paths), interoffice trunks, operator trunks, or test lines.

Operation of Step by Step Switch

The multiple bank shown in Figure 12 has 10 levels of 10 terminals each. Mounted vertically before it is the selector or shaft. Mounted on the selector is a brush or wiper. The vertical and horizontal (or rotary) magnets are also shown.

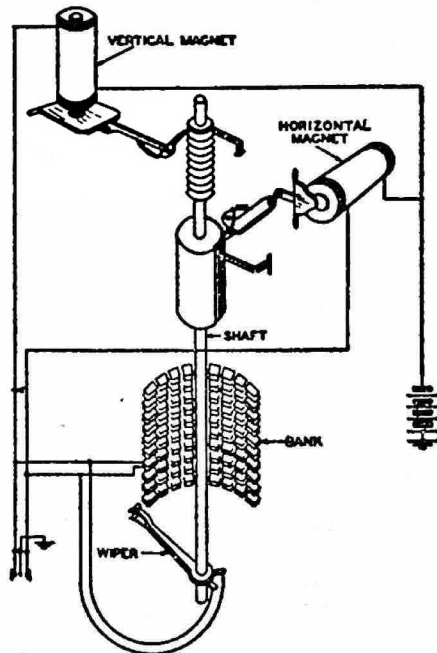


Figure 12

The vertical magnet controls the vertical movement of the selector.

The horizontal (or rotary) magnet controls the rotary movement of the brush.

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

- By pulses. The first series of pulses step up the selector to the dialed level. The second series of pulses rotate the brush to the desired terminal. (This is on the "Connector" described later.)
- By P.B.X. hunting. Same as described in "A" above, plus automatic testing beyond the listed line for a P.B.X. group of incoming service trunks. (Also on the connector)

- By trunk testing. The first series of pulses step up the selector to the dialed level and then the brush rotates and tests automatically to select an idle trunk. (This is on the "Local Selector" described later.)
- By line finder hunting. Each line finder switch has an associated commutator to the right of the multiple bank, and the selector has an extra wiper connected to it, called the commutator brush. These are shown in Figure 13.

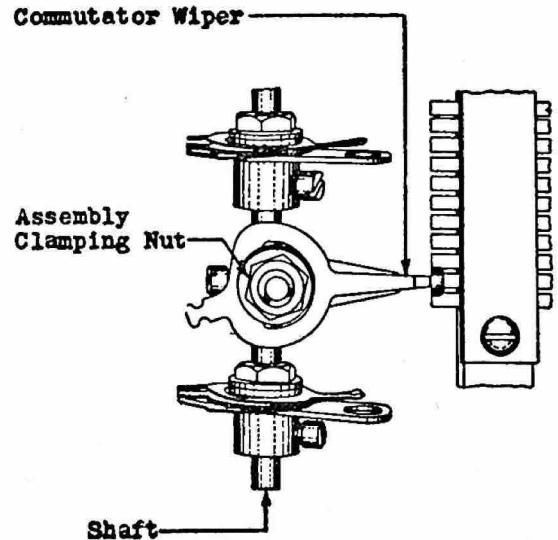


Figure 13

A calling subscriber energizes his terminals, in the line finder group, which in turn places a condition on the associated commutator level segments—but is used, in this case, only on the subscriber's first choice switch. At the same time, an associated start circuit operates to start the selector hunting for the desired level. The conditioned commutator segment stops the selector's upward movement. Then, the multiple bank brush is rotated to the energized terminal.

Note: If any first choice switch is busy, the operation described above takes place on the second choice switch, etc.

When there are three banks and 200 subscribers on a line finder switch and terminal 33 is energized, the selector brush will connect with both 33 and 133 terminals, but only one circuit will be established. The lower sleeve lug would establish a circuit to number 33 terminal and the upper sleeve lug would control connection to the number 133 terminal. In this case, if terminal 33 was in use and the subscriber served from terminal number 133 wanted to make a call, the connection for terminal 133 would have to be made on another switch.

5.07 LINE FINDER FRAMES AND LINE FINDERS:

LINE FINDER FRAME: The standard 11'-6" line finder frame has a capacity for three units of either 16, 20, or 30 line finder capacity line groups, thus a capacity of about 600 subscriber lines.

Standard units of 16, 20 and 30 finders with a group of 200 line and cut-off relays associated with each unit are generally provided for the No. 1

and 350-A type offices. Actually, however, the capacity of any one unit is governed by the calling rate of its associated lines. On an initial installation the maximum capacity of switches or lines, or both, may not be provided but they can be added afterwards as traffic conditions warrant. Further details in this connection will be covered in Section 8 under subject "Trunking".

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

Each group of line finders and associated line relays is divided into ten subgroups. In a twenty switch unit (which will be used for the purpose of this description) there would therefore, be ten subgroups of two line finders and twenty line circuits each.

Three multiple banks with 100 sets of double terminals each and a set of vertical terminals or commutator segments are provided for each finder. The T & R of the first 100 line circuits (00-99) appear in the lower bank, the second hundred line circuits (100-199) in the center bank and the sleeve leads for both hundreds in the upper bank. The commutator segments are placed at the right side of the switch between the middle and upper banks. See Figures 11 and 13 in Paragraph 5.06. Figure 14 shows how these terminals are arranged and how the 200 line relay circuits are connected to the banks of switch 10. The arrangement of the line finders in the other subgroups is different, as will be shown later.

The bank wiring of the two finders in any subgroup is identical, but the first, or lower, finder (if idle) will always operate first.

The line finder shaft is equipped with three sets of horizontal wipers (one for each bank); and one vertical wiper wired to one of the relays in the finder. As the shaft moves upward the vertical wiper passes over the vertical commutator terminals. The vertical commutator regulates the vertical motion of the shaft or determines at which level the horizontal wipers will cut in.

The tenth vertical commutator terminal is permanently grounded so that, should a line finder in hunting, not find a ground on any lower numbered terminal it would be stopped at the tenth level and cut in there even though the call which started it had been abandoned.

There is also a contact which closes when the horizontal wipers pass beyond the 10th terminals on the 10th level so that on an abandoned call or on an accidental ground that may start a finder hunting, a line finder will go to an imaginary 11th terminal on the 10th level and will then return to its vertical normal or idle position.

Just as important in a manual system that the speed of answer be rapid, so in this system a line finder and its associated first selector should be connected to the calling line, ready for the customer to start dialing as soon as possible after he takes the receiver off hook. (The objective is dial tone within 3 seconds).

For this reason, in the typical arrangement that we are considering with 20 line finders for every 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, "3rd and 4th choice" for another subgroup, "5th and 6th choice" for a still different subgroup and so on until they become "19th and 20th choice" for the remaining subgroup. Figure 15 shows how the banks are wired to take care of this condition, the commutator multiple arrangement also being wired accordingly.

Thus in any subgroup, two calls can be handled at the same time by its "home finders" going only to the first level; and, since this is nearly a normal calling rate, most of the traffic would be so handled, resulting in a "high speed of answer" and the minimum wear on the line finder switches.

Traffic in excess of this, in any subgroup, would be handled by a "home finder" (or finders) temporarily borrowed from the next subgroup; in which case the latter would have to go to the second or other higher level, but, with the lines grouped with due regard to their calling rates, only a small percentage of the calls would have to be handled by "borrowed" finders.

Figure 14 pictures the arrangement of line circuits on the banks for the "home finders" for subgroup 10; while the table (Figure 16) indicates the arrangement of the line circuits on all the finders for the entire group.

Referring to Figure 14, the bank terminals are shown viewed from the wiper or front side of the banks and the line circuits on the first level counting from left to right are 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0, this level being the 1st appearance of these circuits in subgroup 10.

This may appear odd to persons accustomed to the numbering of the subscribers multiple in manual switchboards in which the first ten lines are indicated by writing 0 to 9, whereas in dial practice they are designated 1 to 0.

The standard wiring of the banks used in step-by-step system is such that circuit 1 is really 01, that is, up ten and in 1; circuit 02, up ten, in 2; circuit 55, up 5 in 5; circuit 11, up 1, in 1, etc.

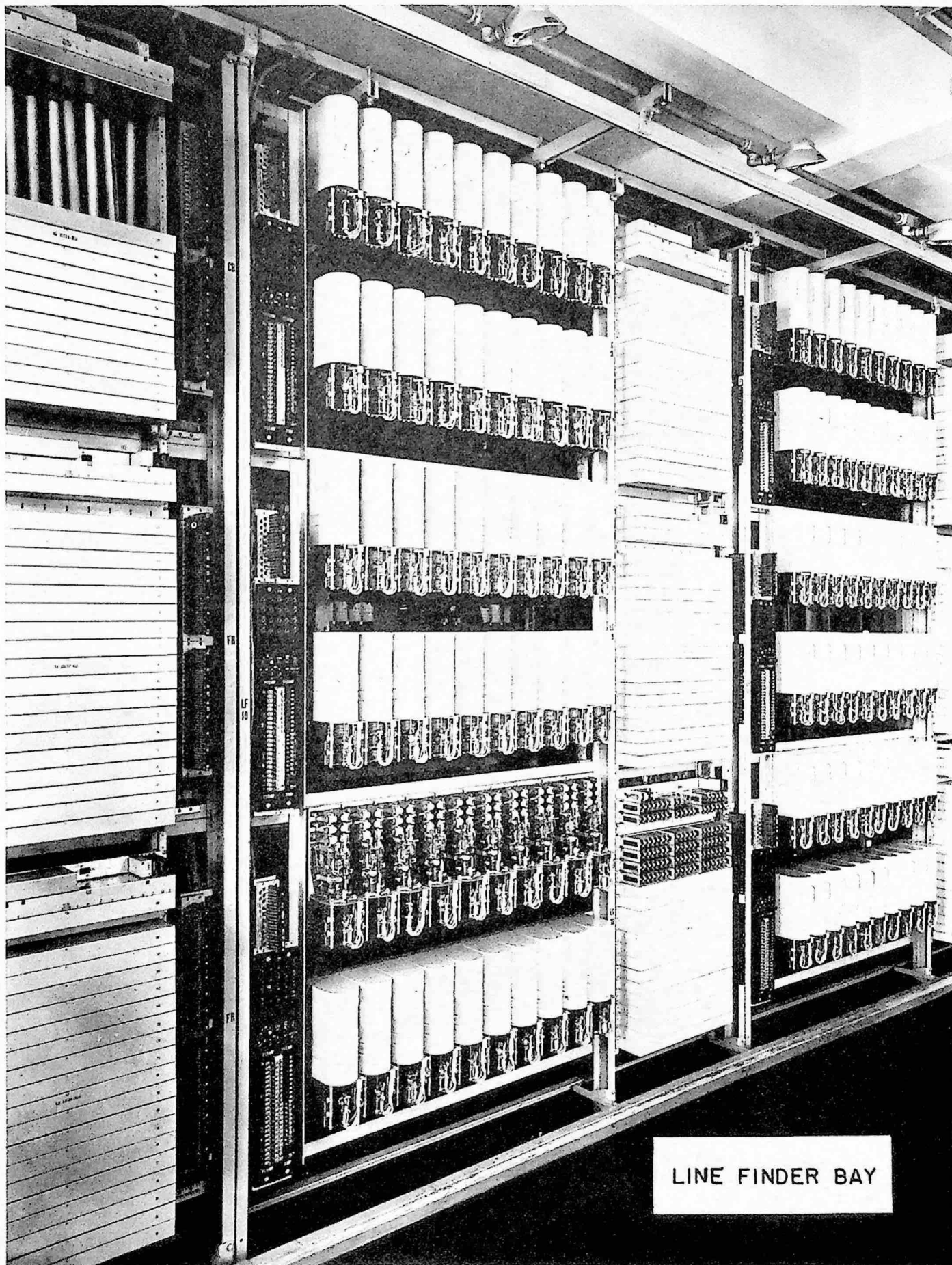
Line Finder banks are wired somewhat differently, as has been explained in the foregoing paragraphs, and the only place in which the terminals of a line finder bank appear in the usual normal position is in group 1 on switches 1 and 11 (See Figure 16) but always the line relay circuit whose last digit is "1" goes on the first terminal to the left and the one whose last digit is "0" goes on the extreme right of any level of the bank.

In all Step-by-Step bank numbering and dialing "0" does not mean Zero. It means Ten.

Referring to the table (Figure 16) the first and second columns indicate the make-up of the ten subgroups into which these 200 line relay circuits are divided; while the third column gives the "home finders" for each subgroup.

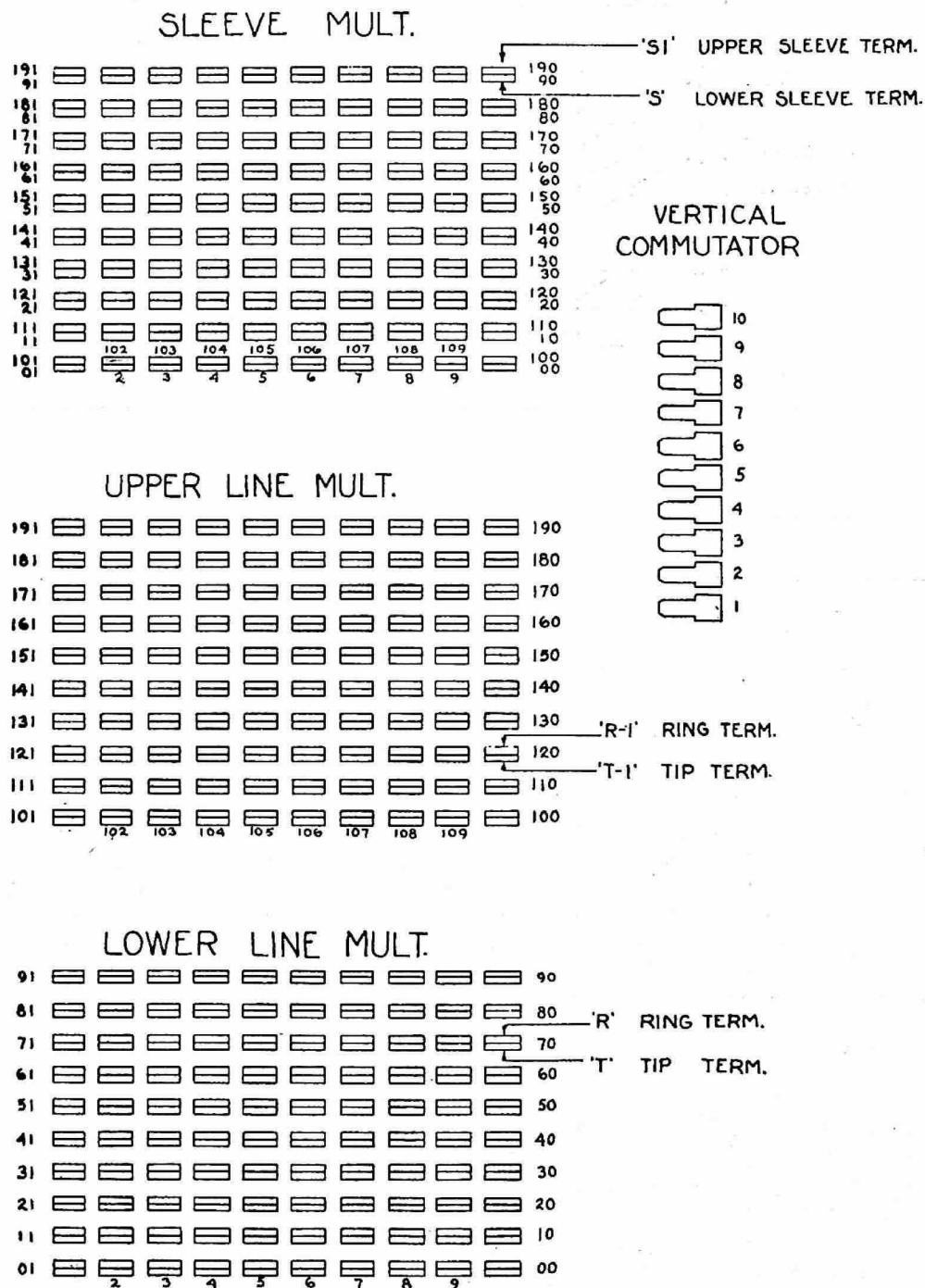
Figures 1, 2, 3, etc. along the top indicate the levels to which the line circuits in the several subgroups are connected on the finders whose numbers are shown in these columns.

For example, the 10 line relay circuits 11 to 10 in the lower hundred and the 10 circuits 111 to 110 in the upper hundred comprise line subgroup 1 and are connected to the first level of home finders 1 and 11 (line



LINE FINDER BAY

LINE FINDER TERM BANKS



SKETCH SHOWING ARRANGEMENT OF THE TERMINALS
OF A HOME LINE FINDER IN SUB-GR. NO. 10

Figure 14

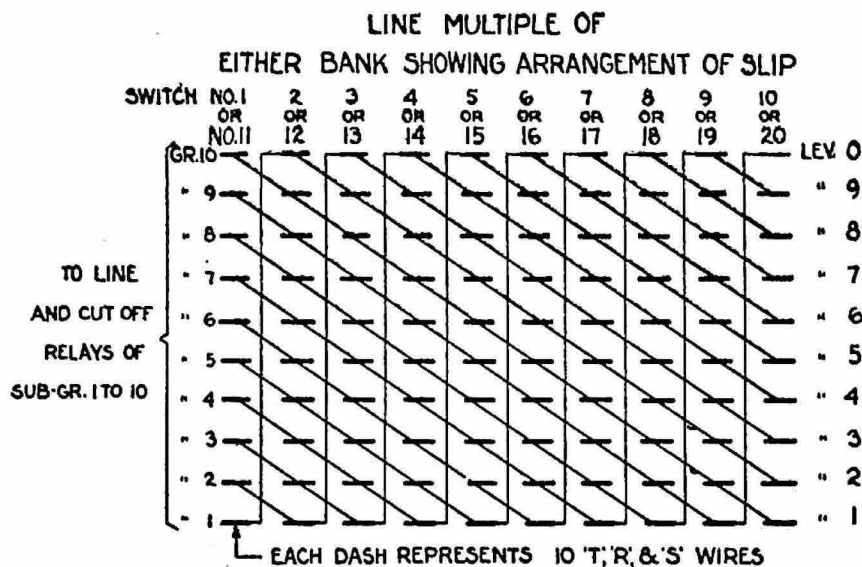


Figure 15

CHOICES		1st 2nd	3rd 4th	5th 6th	7th 8th	9th 10th	11th 12th	13th 14th	15th 16th	17th 18th	19th 20th
LEVELS		1	2	3	4	5	6	7	8	9	10
Line Relay Circuits	Sub-group	Home Finders	Sequence of Selections other than Home Finders								
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
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

Figure 16

TABLE, SHOWING SEQUENCE OF CHOICE OF LINE FINDERS FOR CALLS
FROM ANY LINE IN THE GROUP

finder subgroup 1), to the second level on finders 10 and 20 which are the 3rd and 4th choices respectively for this subgroup, and so on to the 10th level of finders 2 and 12 which would be last choice.

Line Finder equipment in the community dial offices, although it performs the same general functions as the No. 1 office finder, is arranged somewhat different. The community dial type line finder unit, instead of employing the "home finder" arrangement, has an associated distributor or allotter. This allots to one finder at a time the work of serving the calling customer and in a prescribed sequence. The distributor is a rotary line switch (200-type selector) which remains on an idle contact. Calls are allotted to finders 1, 2, 3, 4—etc., in that sequence. After the last finder (No.'s 10 or 20) has taken a call, the cycle will repeat.

The line finder banks of the community dial type units are also wired (multiplied) different than in the No. 1 office type of equipment. Further details concerning this type banks will be covered later in this section.

Getting back to the No. 1 type line finder unit, Figure 17 pictures the arrangement of the line circuits of subgroups 1, 9 and 10 on their "home finder" banks, and also indicates the relays which determine the order in which the line finders respond to incoming calls.

Without getting into the complete detail operation of the line finder circuit, following is an outline of the progress of a call:

Assume that a call originates at MAin 2953 and that this number has been assigned to line relay circuit 08

which is in subgroup 10 and that no other call in this subgroup is in progress.

The operation of line relay 08 operates relay G of subgroup 10 which in turn operates start relay A of line finder 10 (first "home finder") and this finder immediately connects with circuit 08. As it does so, its relay D operates and locks, switching the start lead from subgroup 10 to the ST relay of the second "home finder" for this subgroup, and releases relay G.

If now a second call should come in from any other station in subgroup 10, it would operate this same G relay and start relay A of the second "home finder". The latter would connect with the calling station and operate the lock relay D of the second "home finder".

Assume now that a third call comes in from still another station in the same subgroup. Then the same group relay would again operate; but (since the "D" relays of both "home finders" of this group are operated) the start lead from relay G is disconnected from both ST relays of the "home finders" and is connected to the ST relay of the "home finder" of subgroup 9 (if the latter is idle); hence, this third call will be taken up by this finder as it is the third choice for subgroup 10.

If both the "home finders" for group 9 are busy, their D relays will be operated and the call will be directed through them to the next group (8) and so on to switches 1 or 11 which would be the last two choices for subgroup 10.

In like manner one may determine from Figures 15 and 16, just which finder would take any call from any subgroup, taking into account which finders are busy and which are idle at that instant.

Figure 18 is a schematic drawing of line finder, Common, Group and Switch Trouble Alarms for reference purposes.

COMMUNITY DIAL OFFICE—LINE FINDER GROUPS:

As mentioned earlier in this section, the community dial line finder equipment performs the same general purpose as that in the No. 1 type office. Each line group consists of either 10, 16 or 20 line finders. A 6 finder group is available for 355-A Installations. The 6 and 10 groups have a line capacity of 100, whereas the 16 and 20 size groups have a capacity for 200 subscriber lines. These groups may be provided initially either fully equipped or partially equipped. In the latter case, increments of equipment (line relays and line finders) may be added to the groups from time to time until the ultimate capacity of each is finally reached.

The 16 and 20 finder groups are arranged in two shelves—the lower shelf (L.F. 1-8 or 1-10) is referred to as the "A" shelf and the upper shelf (L.F. 9-16 or 11-20) as the "B" shelf. Each are equipped with "600 point" banks (upper, middle and lower—each with 200 points or contacts)

We will not go into any further detail concerning this C.D.O. equipment, except that it may be of interest to

the traffic man to be familiar with the line circuit terminations on the banks of a few of the more common type community dial installations.

Bank Multiple—35-E-97 Type Office

UPPER BANK

200 Sleeves Terminate in this bank:

MIDDLE BANK (T & R)

Level	"A" Shelf	"B" Shelf
	L.F. 1-10	L.F. 11-20
0	01-00	11-10
9	91-90	21-20
8	81-80	31-30
7	71-70	41-40
6	61-60	51-50
5	51-50	61-60
4	41-40	71-70
3	31-30	81-80
2	21-20	91-90
1	11-10	01-00

LOWER BANK (T & R)

Level	"A" Shelf	"B" Shelf
	L.F. 1-10	L.F. 11-20
0	101-100	111-110
9	191-190	121-120
8	181-180	131-130
7	171-170	141-140
6	161-160	151-150
5	151-150	161-160
4	141-140	171-170
3	131-130	181-180
2	121-120	191-190
1	111-110	101-100

Bank Multiple—355-A Type Offices

Note: (Two arrangements have been provided for the 355-A type offices. The first installations were in accordance with J-Specifications J-32006 A1, A2—etc. Later installations were in accordance with J-Specifications J-32006 F1, F2—etc. The bank multiple of each is shown).

UPPER BANK

200 Sleeves terminate in this bank:

LOWER BANK (T & R)

MIDDLE BANK (T & R)					Level				"A" Shelf	"B" Shelf	"A" Shelf	"B" Shelf
Early Installations		Later Installations				L.F. 1-10	L.F. 11-20		L.F. 1-10	L.F. 11-20	L.F. 1-10	L.F. 11-20
Level	"A" Shelf L.F. 1-10	"B" Shelf L.F. 11-20	"A" Shelf L.F. 1-10	"B" Shelf L.F. 11-20								
0	161-160	61-60	101-100	110-111	0	111-100	11-10		01-00	10-11		
9	171-170	71-70	191-190	120-121	9	121-120	21-20		91-90	20-21		
8	181-180	81-80	181-180	130-131	8	131-130	31-30		81-80	30-31		
7	191-190	91-90	171-170	140-141	7	141-140	41-40		71-70	40-41		
6	101-100	01-00	161-160	150-151	6	151-150	51-50		61-60	50-51		
5	01-00	101-100	151-150	160-161	5	51-50	151-150		51-50	60-61		
4	91-90	191-190	141-140	170-171	4	41-40	141-140		41-40	70-71		
3	81-80	181-180	131-130	180-181	3	31-30	131-130		31-30	80-81		
2	71-70	171-170	121-120	190-191	2	21-20	121-120		21-20	90-91		
1	61-60	161-160	111-110	100-101	1	11-10	111-110		11-10	00-01		

As a matter of further interest, the following charts show the arrangement of lines on the various type units (when facing the unit from front).

35-E-97 Type Offices

111	116-121	131	136	156	161	181	186	106	"B"
L & L O		L		L		L		L	
115	110-125	135	130	150	165	185	180	100	

11	16	21	31	36	56	61	81	86	06	"A"
L & L O		L		L		L		L		
15	10	25	35	30	50	65	85	80	00	

Lines equipped in following order:

- 11-35
- 111-135
- 86-00
- 186-100
- 36-50
- 136-150
- 61-85
- 161-185

355-A Type Offices

6 or 10 Line Finder Capacity Units:

(J 32003 Y—List 2 6 L. F. Banks)

(J 32003 Y—List 6 10 L. F. Banks)

Alarm & Control Relays			
28	L	20	Grp. Rlys
19	21	L	27
11	L		18

3

2

1

61	L	60
51	L	50
41	L	40
31	L	30

7

6

5

4

01	L	00	11
91	L	90	10
81	L	80	9
71	L	70	8

Test Line 10

Note: Figures at right of each group indicate the order of installation of lines, should the unit be only partially equipped initially.

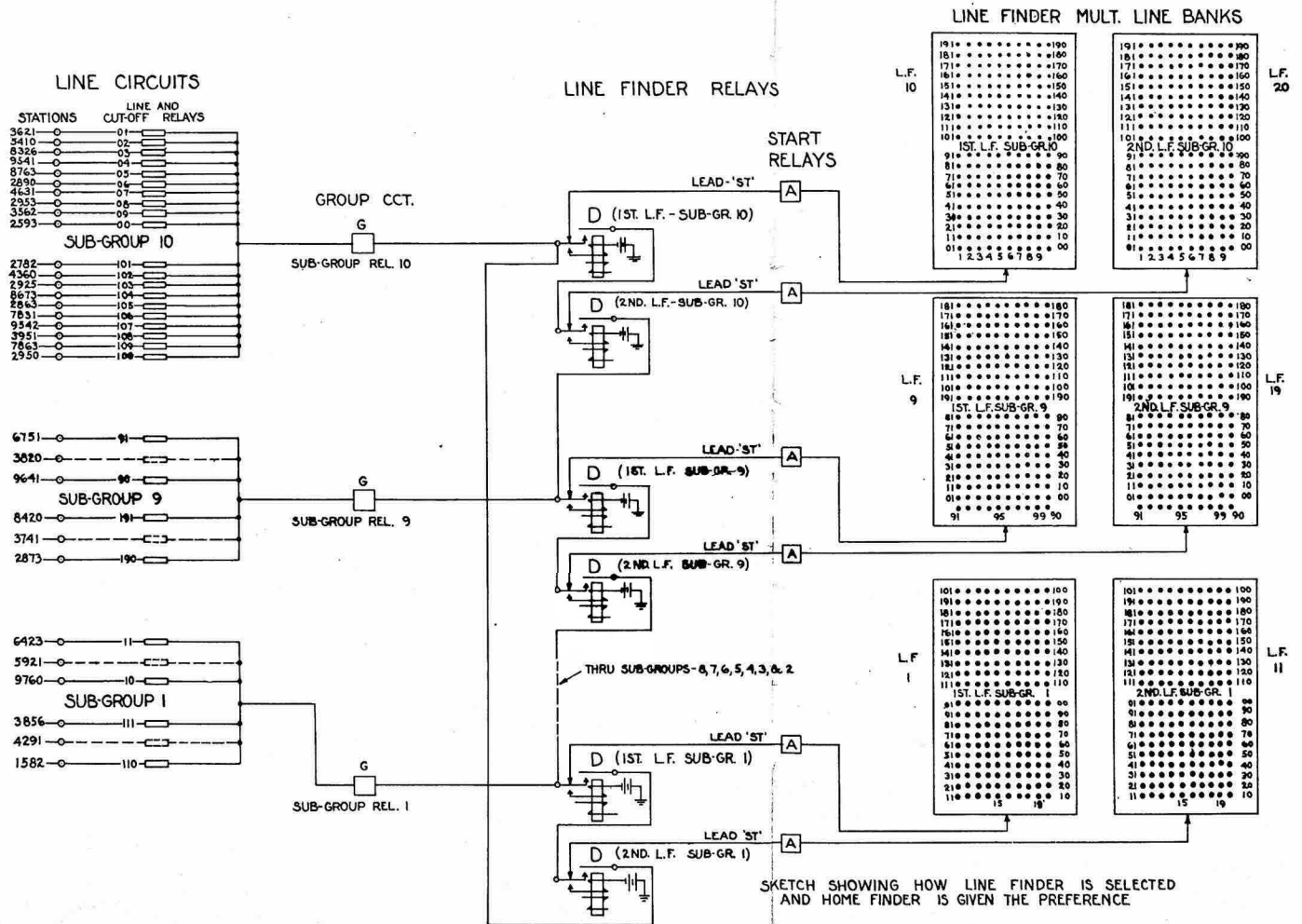


Figure 17



355-A Type Offices (Cont'd)
10 L.F. Capacity Units per J-32006-B

36	L	40	5	96	L	00	8
21	L	35	4	81	L	95	7
14	L & L O	10	3	66	L	70	6
L		Control		51	L	65	2
11 L & O	13	Relays	1				

(a) Test Line—50
(b) Order of installation of lines indicated at right.

Line Terminations on T & R Bank:

Level	Line Circuit Nos.
0	01-00
9	91-90
8	81-80
7	71-70

6	61-60
5	51-50
4	41-40
3	31-30
2	21-20
1	11-10

355-A Type Offices (Cont'd)

200 Pt. Early Installations per J-32006-A 1, A-2, etc.

96	L	00	13	196	L	100	3
81	L	95	11	181	L	195	12
66	L	70	7	166	L	170	8
51	L	65	1	151	L	165	14
36	L	40	9	136	L	140	10
21	L	35	5	121	L	135	6
14	L & LO	10		114	L & LO	110	
11 L & LO	13	Control Relays	2	111 L&LO	113	Control Relays	4

200 Pt. Later Installations per J-32006 F1, F-2, etc.

51	L	50	1	01	L	00	4	151	L	150	20	101	L	100	13
41	L	40	9	91	L	90	6	141	L	140	18	191	L	190	15
31	L	30	7	81	L	80	8	131	L	130	16	181	L	180	17
21	L	20	5	71	L	70	10	121	L	120	14	171	L	170	19
16	L&LO	10	3	66	L&LO	60	11	116	L&LO	110	12	166	L&LO	160	2
11	L&LO	15		61	L&LO	65		111	L&LO	112		161	L&LO	165	

Test Lines 50 and 161

Note: Figures at right of each group indicate the order of installation of the groups if a complete unit is not provided initially.

Early Installations: Line Finders 1-10 are 1st choice for lines in 1st 100. Line Finders 11-20 are 1st choice for lines in 2nd 100.

Later Installations: Line Finder 1-10 are 1st choice for lines 11-50 and 111-150. Line Finders 11-20 are 1st choice for lines 61-100 and 161-100.

Similar information for the No. 1 and 350-A type offices is covered in Section 8 under subject "Line Finder Trunking".

SUMMARY

Purpose of Line Finder: To establish a connection from a calling subscribers' line, or a trunk, to a first selector.

Functions of Line Finder: The principal functions of the line finder are:

1. To find a subscribers' line in a group of usually 200 lines appearing on the line finder bank and to extend the tip, ring and sleeve leads of the line to a first selector directly or through a trunk relay circuit.
2. To extend ground to the sleeve of the associated line when the line is found, for busy potential.
3. To cut off the line relay when the line is found by the finder or seized by a connector.
4. To hold line finder operated under control of the succeeding switch.
5. To advance the start lead to the next choice finder and to open the multiple chain circuit when:
 - a. Finder is removed from the shelf.
 - b. Finder goes to 11th rotary step.
 - c. Finder has seized a line.
 - d. Made busy at test jack.
 - e. Succeeding selector is made busy.
6. To provide an alarm on certain troubles, such as:
 - a. If the multiple chain circuit becomes crossed with battery or ground.
 - b. If the start lead becomes grounded and a continuous hunting of line finders takes place.
 - c. If any "G" relay remains operated for more than a predetermined length of time.
 - d. If the line finder fails to release.
7. To return to normal when call is abandoned, except when a call is held to an operators' trunk circuit.
8. To return to normal when the finder fails to find the line.
9. To provide a means for making routine tests.
10. To operate an All Finders Busy (A. T. B.) register if all the line finders in the group are busy.
11. To operate a peg count register when line finder restores to normal.

The finder principle consists in tying "tail-to-tail" a first selector and a finder switch. These two form a

permanent link. The finder picks up the calling subscriber much as does a manual operator. The first selector extends the call like a manual operator plugging into a trunk jack.

On a line finder the vertical and the rotary action is automatic.

Upon initiation of a call the subscriber's line relay is operated and an idle line finder starts hunting for this line, first in a vertical direction under the control of the vertical magnet, to find the level in which the terminal of the line appears, and, then in a rotary direction under the control of the rotary magnet to find the calling terminal. The vertical stepping is effected by a pawl actuated by the vertical magnet. This pawl engages the teeth of the vertical ratchet (see Figure 9-A) raising the shaft one step at a time. The rotary stepping is effected in a similar manner by having a pawl actuated by the rotary magnet engage the rotary ratchet (See Figure 9-A), rotating the shaft one step every time the rotary magnet operates.

When the calling line is found, the subscriber's loop is extended through the bank wipers and the associated circuit of the line finder to a first selector. The trunks between line finders and first selectors are wired from the line finder wipers through the selector circuit to the selector wipers.

Ordinarily, line finders are segregated into the following classifications:

Flat Rate Lines
Message Rate Lines
Pre-pay Coin Box Lines

Line finders are cross-connected to first selectors in accordance with a standard prescribed arrangement as covered on Drawing ED-30025-01. Basically, the idea is to "scramble" the finders of a particular line group over as many first selector shelves as possible. This makes for better traffic distribution, and, too, it would result in minimum interference to customers should a selector shelf (or bay) fuse operate.

5.08 SELECTORS—LOCAL

Purpose: The selector in the step-by-step office is used for establishing connections between subscribers and subscribers, subscribers and operators, or operators and operators.

* * * * *

The mechanical portion of the selector switch is practically identical to that of the line finder switch and, too, the connector switch which will be covered later. It employs the same type shaft, wipers, release mechanism, etc.

The Selector differs from the line finder, in that the vertical stepping of the switch is controlled by the dial of the calling station, which means that only one digit is required to operate it. The rotary movement is entirely automatic and serves to select an idle trunk from the level to which the wipers were stepped by the vertical movement of the shaft.

Selectors are mounted on Selector Frames. Each frame has two bays, either in line or setting "back-to-back", the latter being the type used in the early installations. The single sided ("in line" type) bay has a capacity of 320 selectors (two bays, each with eight shelves and 20 selectors per shelf). Between the two bays is the terminal assembly which is generally known as the Distributing Type Terminal Assembly. The Double-Sided ("back-to-back" type) frames have less capacity. They consist of two bays which set back to back to each other and with sufficient space between to permit maintenance activity. Each bay has six (6) "twenty switch" shelves, thus a total frame capacity of 240 selectors.

The double sided frame is closed at one end by the terminal assembly. Originally, a "flat-type" assembly was employed, but this was later changed to the "distributing type" assembly. Further details concerning this part of the selector frame is covered in Section 8, under "Trunking".

When a subscriber dials, the first series of pulses will control the operation of the first selector switch. However, before explaining this operation, maybe a brief statement regarding dial pulsing would be helpful.

Dialing opens and closes the circuit of the subscriber's line a certain number of times. By performing this operation the proper number of times, the subscriber tells the switches the central office in which the desired line is located and the number of that line. It should be noted that dialing "zero" opens and closes the circuit ten times and in step-by-step would cause the selector to rise 10 levels. The switch will then rotate to the first idle terminal. There is an eleventh rotary step on the selector beyond the tenth terminal, which operates an overflow relay to send out an overflow (busy) signal. There is no eleventh terminal on the bank, however. This then, is the way in which the subscriber tells the switches what number he wants. It is called "direct control" and "decoding" is not required as in other dial systems (Sender Types).

The selector (local) bank is a 300-point bank. The lower half of the bank assembly provides the out trunk tip and ring terminals for 100 circuits, whereas the upper portion of the bank has the associated 100 sleeve terminals. See Fig. 20.

Summarizing: The specific duties of the selector switch, in accordance with which the circuit is designed, are:

1. Guard and prevent the trunk and line switch (or line finder) from releasing.
2. Lift the shaft and wipers (vertical movement) to the desired level.
3. Prepare the release circuit.
4. Rotate wipers automatically to select an idle trunk.
 - a. Keep the wipers clear while passing over trunks.
 - b. Rotate shaft automatically.
 - c. Test each trunk for busy or idle condition.
 - d. Stop rotation at first idle trunk.
 - e. Extend line through to the next switch.

f. Guard trunk until next switch responds.

5. Release at any desired time.

In step by step the called for number is reached on a "connector" switch (explained later). The intermediate switches between the line finder switch and the connector switch are called selector switches. There are several different type selector switches (explained later) and there may be more than one selector switch used on one call.

In a four digit system, the principal switches involved in completing a local call are the line finder, first selector, second selector and connector. The relation of these switches when used to complete a local call is shown schematically below.

It will be noted the fundamental step-by-step switch is applied in several locations in a step by step "train," or sequence of step by step switches. The number of switches in a train is determined by the number of digits dialed, as will be described later. Briefly, to establish the train shown in Figure 24 would be as follows:

When a receiver is removed from the switch hook, a line finder starts hunting for the calling line. When the line has been found, a circuit is completed to a first selector which sends dial tone to the calling party to indicate that the circuit is ready for dialing. The first series of pulses step up the first selector to the dialed level. The selector then automatically selects an idle trunk which extends the calling line to a second selector. The second series of pulses step up the second selector which selects an idle trunk in the dialed level extending the calling line to a connector. The third series of pulses cause the connector to step up to the level dialed and the fourth series of pulses rotate the wipers of the connector to the terminals of the called line. If the line is busy the connector returns a busy tone to the calling subscriber. If the line is idle the connector rings the bell of the called party and returns an audible ringing tone to the calling subscriber.

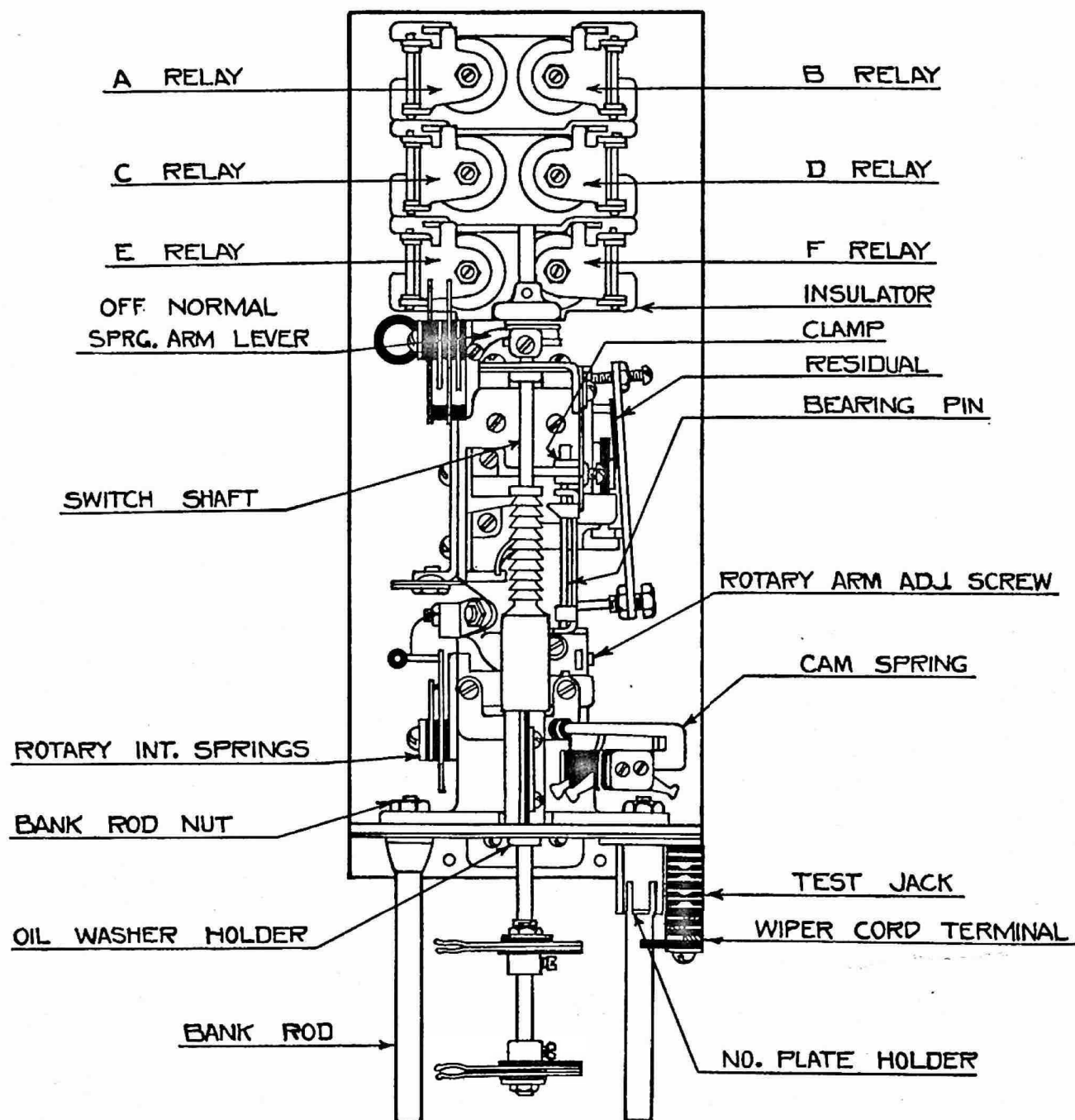
The selector in each case responds to one series of pulses and rotates automatically to an idle trunk on the dialed level. The connector responds to the last two series of pulses corresponding to the tens and units digits of the number dialed. From this it is obvious that a three digit system requires one selector and one connector, a four digit system requires two selectors and one connector. In other cases, described later, it is necessary to use a number of selectors.

5.0801 FIRST SELECTORS

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 connection to the next switch in a train which may be another selector or a connector, or to a trunk. The following information will help to visualize the levels on this switch.

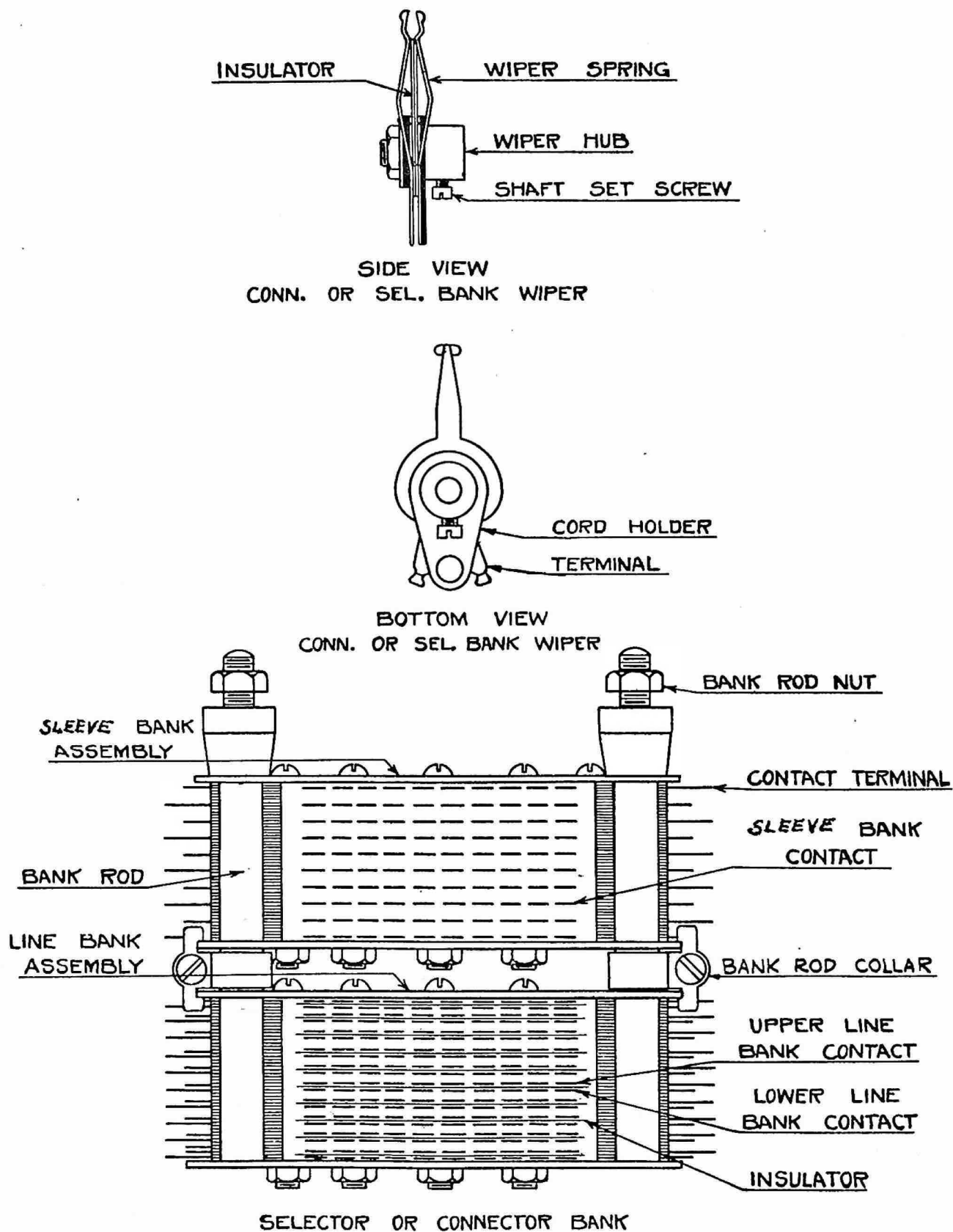
"0" level (tenth) is usually used for "zero operator" trunks.

"1" level (first), in earlier installations, is assigned to nullify the effect of preliminary pulses by giving access to a group of auxiliary first selectors which subsequently route the call in



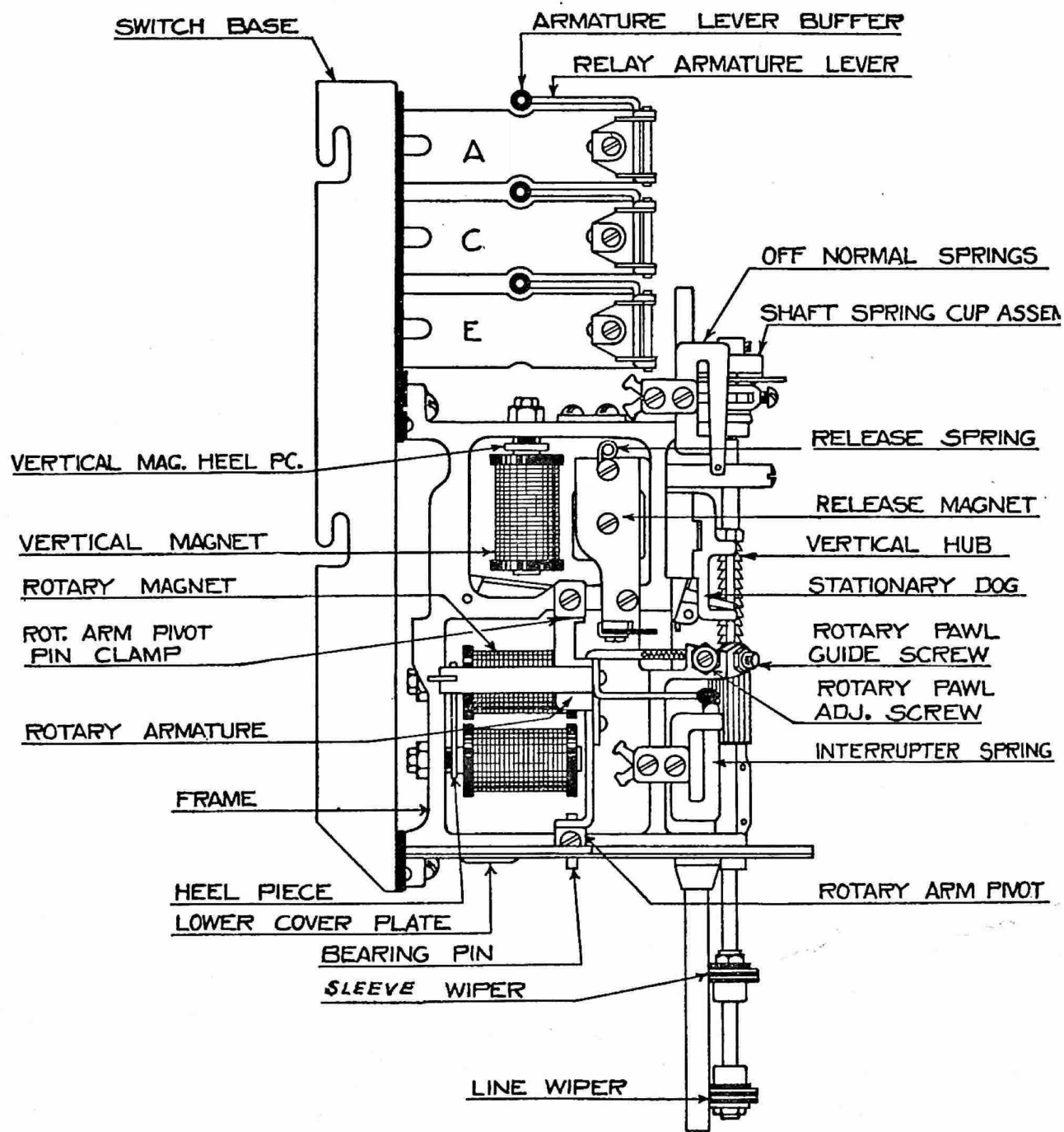
Selector Switch Front View

Figure 19



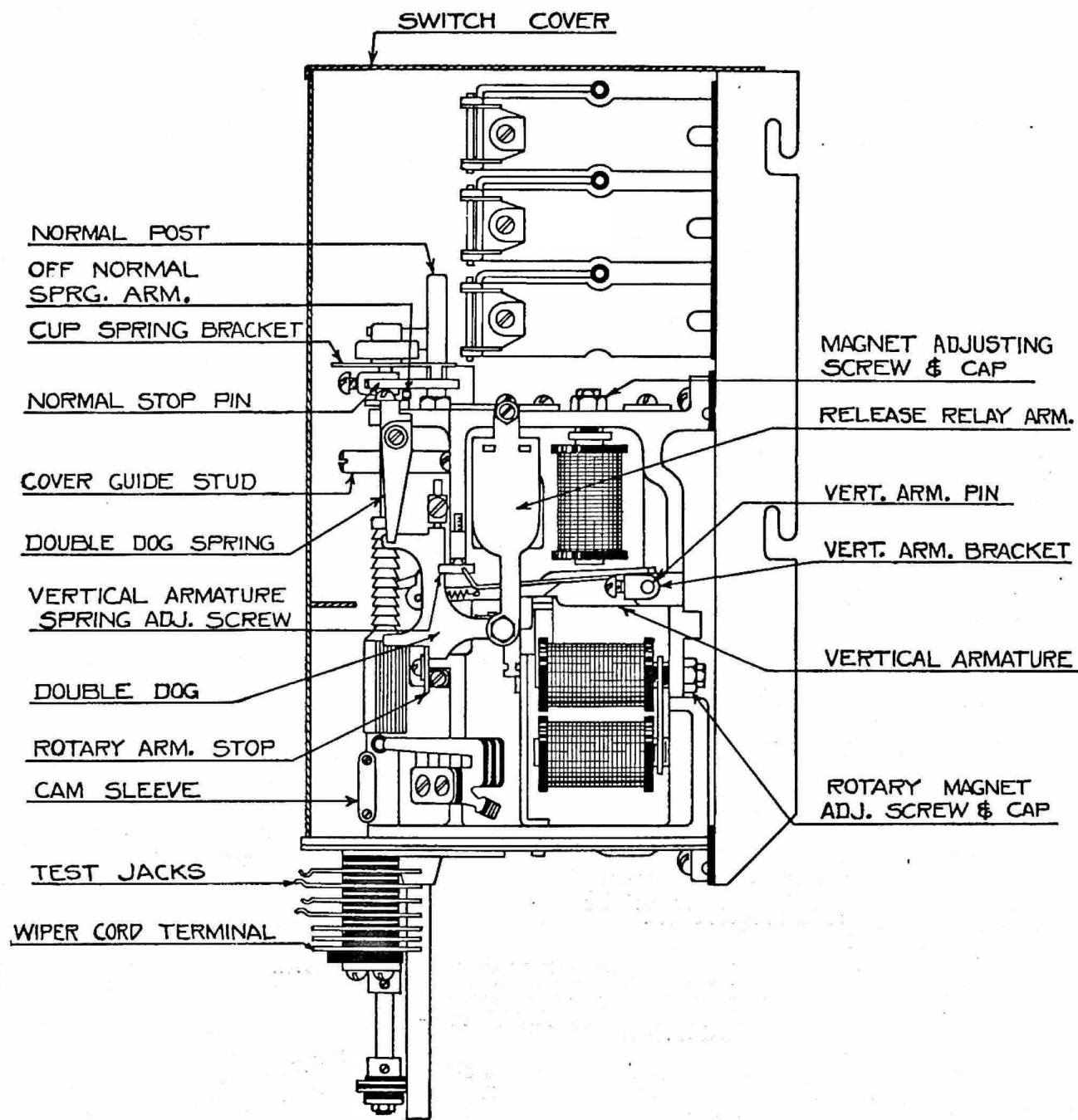
Wipers and Banks

Figure 20



Selector Switch Left View

Figure 21



Selector Switch Right View

Figure 22

the same manner as it would be routed if no preliminary pulse occurred. These auxiliary first selectors also provide means of reaching selectors which give access to trunks to specialized services such as Toll, Information and Repair Service.

The eight remaining levels of the first selector provide trunk terminals to other offices, to second selectors or to connectors.

Three digit dialing, with no outgoing trunk group could serve 800 subscribers and would not require second selectors.

If there were no second selectors, each outgoing trunk group would reduce the number of subscribers by 100.

If second selectors were available, then it could be arranged to serve 700 subscribers and use one level for routing to a second selector containing 10 trunk groups—one per level, but in this case it would require dialing an extra digit.

Four digit dialing, same as three digit dialing excepting that each level means selecting a path leading to a group of one thousand numbers instead of 100 numbers.

Five digit dialing in a multi-office area means selecting a trunk to another office or unit, or a path to a switch in the local office, which has access to a group of ten thousand numbers.

Six digit dialing in a multi-office area means setting up a connection to one of a group of second selectors from which trunks are selected to other units or offices in the same manner as from first selectors in five digit areas.

If no idle path or trunk is available, this selector sends back an overflow signal to the calling party.

If the number of calls to be handled by any group of equipment exceeds the capacity of ten trunks, a trunking scheme known as subgrouping may be employed. All the selectors in a group can be served by the same group of ten trunks by multiplying their banks together. If this multiple is split, it is possible to establish several subgroups of selectors and give each subgroup access to a different group of ten trunks. A subgroup is built up to its required size by multiplying together selector divisions, each of which ordinarily contains ten selectors. The number of subgroups established depends upon the number of trunks required to handle the traffic of the entire group.

The "graded multiple" arrangement can also be used whereby a few common trunks appear before all selectors in these divisions, while the remaining (individual) trunks are subgrouped to appear before the selectors of certain divisions only. Further detail on this will be covered in Section 8, under subject "Trunking".

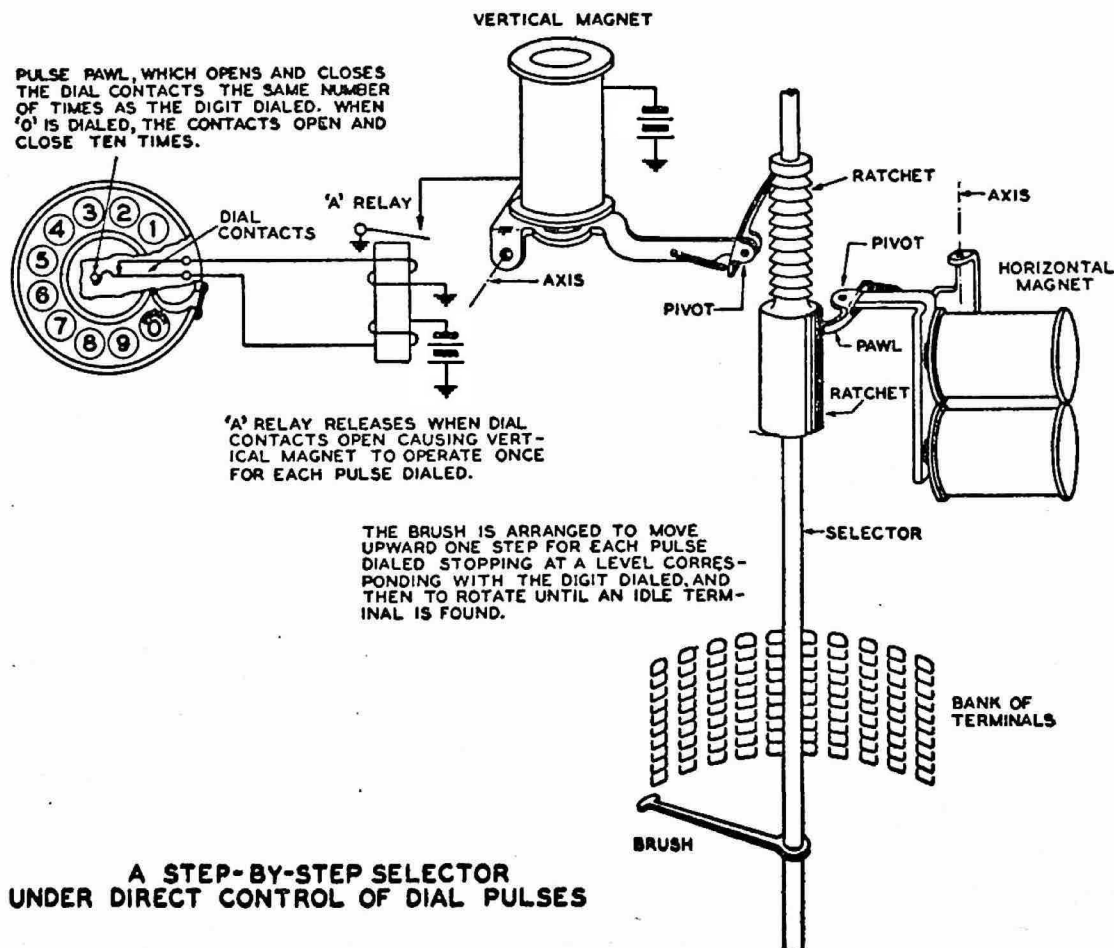


Figure 23

PROGRESS OF CALL
FROM ONE DIAL SUBSCRIBER TO ANOTHER
DIAL SUBSCRIBER
FOUR-DIGIT SYSTEM

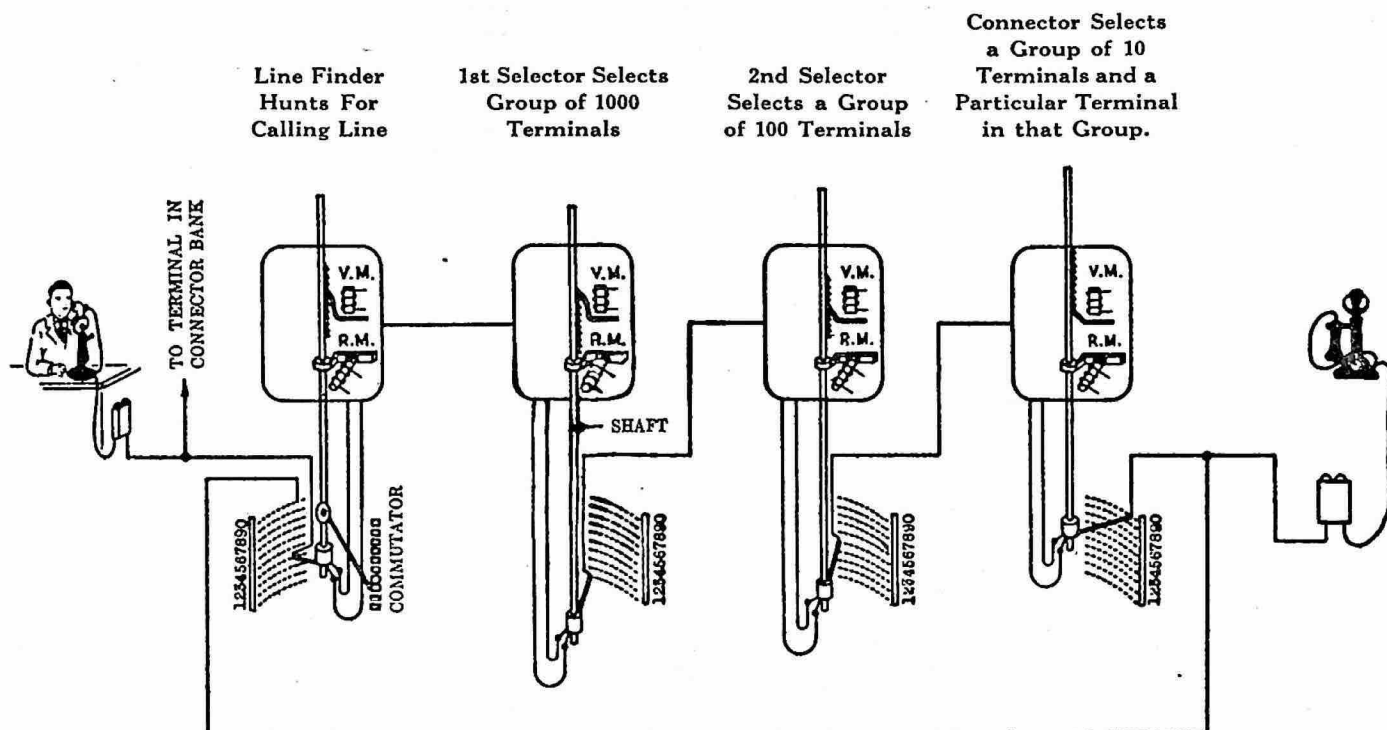


Figure 24

Coin box subscribers' first selectors are segregated from the other classes in order that these selectors may be multiplexed to a special group of trunks to the toll boards. (Single channel operation.)

A special group of first selectors is provided for "DSA" operators to be used for completing connections to subscribers' lines in the local area and certain miscellaneous desk positions.

5.0802 SECOND SELECTORS

The second selector is the second step in the train of selection and responds to the second digit or letter dialed.

The addition of a second selector in the train of switches permits the size of the office to grow beyond 800 lines.

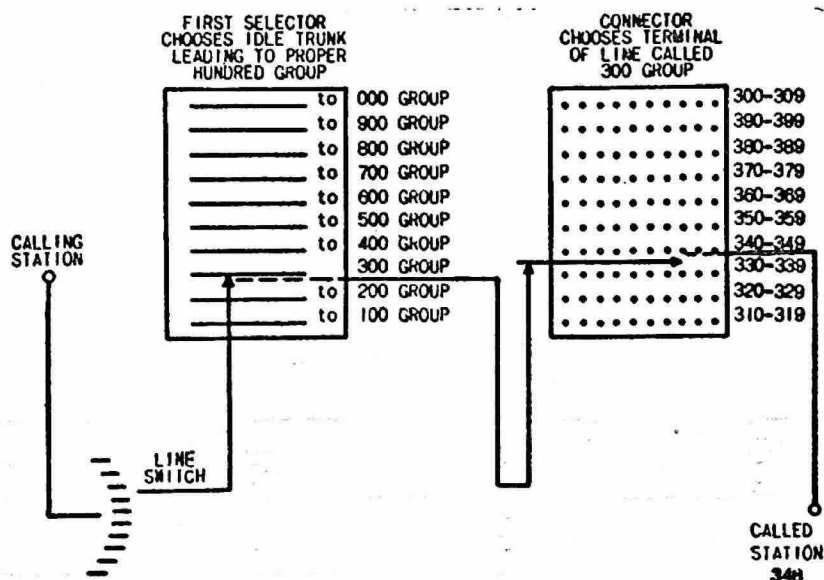
In a four-digit system it is the "hundreds" selector. In a five-digit multi-office area it is the "thousands" selector, similarly as the first selector is "thousands" selector in a four-digit system. It may be located in the office in which the call originates or in a terminating office. In the latter case it is called an "incoming" second selector. In a six-digit multi-office area where a combination of two digits is required to select a trunk to another office it is an "out trunk" selector.

The second selectors for a multi-office five digit system are ordinarily divided into two main classes:

- (1) Local second selectors.
- (2) Incoming second selectors.

These two classes of selectors may either be mounted separately on the second selector frames or they may be mixed on the same frames. In areas having a 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. 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. When mixed, for peg count reasons you will usually find that the mixing is done on a shelf (10 banks) basis.

For transmission and other reasons (explained later), incoming trunks are further subdivided to differentiate between those incoming from the toll board and intertoll and those incoming from local offices, and separate groups of second selectors are provided for each class.



Schematic Showing the Routing of a Three-Digit Call
in Step-by-Step Operation.

This schematic illustrates the routing of a call to 348 and shows that the first selector chooses an idle trunk leading to the 300 group and also the location of 48 on the connector bank.

Figure 25

5.0803 THIRD SELECTORS

The third selector is required only in systems of five or more digits. It is the third step in the train of selection and responds to the third digit dialed. In a five-digit system it is the "hundreds" selector. Each level of its multiple banks provides trunking to a group of 100 telephone numbers appearing in the terminal banks of connectors. In a six digit system it is the "thousands" selector.

In six digit systems also, the third selector may be separated into local and incoming in a manner similar to that explained for second selectors in the five-digit systems. Toll and Intertoll third selectors are also provided. The toll third selector is usually an incoming transmission selector from the toll switchboard (Toll Switch). These will be explained later. With respect to Inter toll, the intertoll third selector is the third selector in the intertoll train as is the local third selector in the local train.

Generally speaking, the third selector is identical both electrically and mechanically to the first and second selector. (Local and Intertoll)

5.0804 FOURTH SELECTORS

The fourth selector is required only in six (or more) digit systems. It is the fourth step in the train of selection and responds to the fourth digit dialed. It corresponds to the "hundreds" selector similarly as the second selector is the "hundreds" selector in a four-digit system.

Separate groups of fourth selectors, known as toll fourth selectors, are provided to handle incoming toll calls.

For the purposes of this course, the local fourth selector may be considered identical both electrically and mechanically to the preceding selectors in the train.

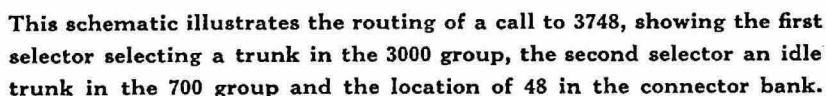
The mechanicals of the toll fourth selector is identical to the preceding toll selector, however, it is not identical circuitwise. The toll fourth selector is what is known as the "intermediate type" selector. (Note: In some of the older SXS offices the incoming toll selector is the "intermediate" type and the transmission features are incorporated within or associated with the second switch in the train).

a. Progressive Build-Up of a Dial Call

With the above in mind and before going into explanation of other type switches, etc. let us review briefly the subject "Local Selectors" and visualize the progressive building up of a dial connection as given in skeleton form in the following table for a six-digit number; followed by a simple explanation of the selector circuit operation:

1. Customer takes receiver off hook.
Primary Line Switch and Master Switch and Secondary Line Switch and Master Switch or Line Finder

Operate automatically, connecting calling line to a 1st Selector.



2. Customer hears Dial Tone.
3. Customer Dials.
 - (a) First digit.

Raises 1st Selector shaft, which rotates automatically to an idle trunk to a 2nd selector.
 - (b) Second digit.

Raises 2nd Selector shaft, which rotates automatically to an idle trunk to a 3rd selector.
 - (c) Third digit.

Raises 3rd Selector shaft, which rotates automatically to an idle trunk to a 4th selector.
 - (d) Fourth digit.

Raises 4th Selector shaft, which rotates automatically to an idle trunk to a connector.
 - (e) Fifth digit.

Raises Connector shaft to a certain level.
 - (f) Sixth digit.

Rotates Connector shaft to the called station's terminal.
4. Customer hears generator and waits for called party to answer or Customer hears busy tone and hangs up.

Figure 27 indicates the circuit completed between the calling station and the first selector at the moment that dial tone is sent out (notifying the calling party that the equipment is ready to receive the dial pulses).

The sleeve connections are omitted to simplify the diagram, it being assumed that the student will understand that the calling line is made busy and the line switches and 1st selector are held in the condition indicated by a ground on the sleeve lead at contacts 4-5 of relay B (Figure 28) which now takes the place of other grounds that were put on temporarily as the connection was built up.

As shown in Figure 28, battery is now sent out on the ring of the calling line through the P winding of relay A, subset, tip of line, S winding of relay A, "Overflow" (OF) contacts of the first selector, and the low resistance winding of the dial tone induction coil (not shown) to ground.

The dial tone remains on during the dialing of the first digit or until relay D operates and extends the connection to the second selector, at which time the tone is removed from the circuit as it is not required on any other than 1st selectors.

Figure 28 indicates the relays and magnets on a selector switch, with some of their wiring, which enable the dial pulses to control this switch.

We have marked this "Impulse Circuit" to make a (possibly too fine) distinction between the circuit in which the dial is directly included (usually referred to as the "Pulse Circuit") and the circuit in which are included the relays, etc., controlled more or less directly by relay A in the Pulse Circuit.

The principle of this circuit is the use of a quick acting and quick releasing relay (A) (which releases every time that the dial **Opens** the circuit and **operates** every time that the dial **closes** the circuit) to control other slow release relays (B) and (C) that **do not release** during these short time intervals.

This provides for a certain sequence of actions while the dial pulses for any one digit are being sent, and different actions during the time that the dial is being wound up for the next digit.

The principle of this circuit is of very general application throughout the step-by-step system, hence the student should thoroughly understand it.

At the same time that the student is studying the **Pulse Circuit** he should remember (as much as possible) the operation of the **First Selector**; because, all the selector switches in this system operate almost exactly the same. The connector also operates similarly, therefore when one knows the selector it is relatively easy to follow the complete operation through any train for any telephone number used.

The following narrative of the operation of the **First Selector** with emphasis on the **Pulse Circuit** is offered for such use as it may be to those interested in these circuits.

Referring to Figure 28, each selector has five relays designated A, B, C, D and E.

A, naturally suggest "first" and B, "second" and that is the order in which these relays—the vital part of the **Pulse Circuit**—operate.

As the customer gets ready to dial, his receiver is off the hook and relay A is held operated; which, in turn, holds relay B operated.

The latter puts a ground on the S lead from the secondary line switch to hold the primary and secondary line switches operated and to prevent any other secondary line switch from taking up the trunk to this selector.

Relay B also closes one opening in the circuit of the Vertical Magnet, but this circuit is now open at the back contact of relay A.

As the dial runs back on the first digit dialed the line circuit is **opened** and closed a number of times rapidly and it is at each **opening** of the circuit that relay A falls back, completing the Vertical Magnet circuit (in series with relay C) thereby stepping up the selector shaft to the level corresponding to the numerical value of the digit dialed.

The dial pulses are too rapid—from 8 to 11 per second—to let the slow release relays B and C fall back, but the quick acting relay A keeps step with them.

Get this firmly in mind:

Just before dialing begins, relays A and B are operated.

The dial pulses release and re-operate relay A rapidly, and for each time that relay A releases, the shaft moves up one step.

When the last dial pulse for the first digit has been received it is necessary to stop the vertical motion of the shaft and rotate it to an idle trunk to a second selector. This must be done quickly within the time taken by the customer to wind up the dial for the second digit—otherwise connection would not be made to the second selector in time for it to receive the dial pulses for the second digit. Refer to Figure 29.

Relay C operates in series with the Vertical Magnet, and, being slow release, remains operated while the dial pulses are being received. The "Off Normal" (ON) contacts close as soon as the shaft starts upward, closing a circuit for the operation of relay E by way of the ON contacts and contacts on operated relays B and C.

When the last dial pulse has been received, relay C releases, closing a circuit through the Rotary Magnet which automatically rotates the shaft until the wipers reach the terminals of an idle trunk to a second selector.

Refer to Figure 30.

A busy trunk to a second selector has ground on the S lead, while an idle trunk has neither ground nor battery on this lead.

As the Rotary Cut In Circuit operates the shaft to the first set of terminals on this level, relay E releases (because its circuit is opened at the 1-2 contacts of the rotary magnet) thereby releasing the rotary magnet.

This in turn again closes the circuit through relay E to the S lead on this trunk which, if busy, is grounded and relay E would again operate and energize the rotary magnet moving the wipers to the next set of terminals.

If the second trunk were busy, the above action would be repeated until an idle trunk is reached when current through relay E would not find a ground on the S lead but would find a path through the winding of relay D, the overflow springs (OF) and the 4-5 contacts on relay B to ground.

Refer to Figure 31.

This would operate relay D but not relay E; hence the wipers would remain on this trunk and the T and R leads would be disconnected from relay A and connected through to a second selector, thus preparing for the receipt of the dial pulses for the second digit.

Until relay D operated, the T and R wipers were "dead"; therefore, as they moved across busy trunks, they caused no interference with conversations going on over these trunks.

Had all trunks on this level been busy, the shaft would have continued to rotate one step beyond the 10th set of terminals (to the 11th rotary step) thereby operating the OF springs which send the customer a busy tone.

At present, in our territory, a busy trunk and a busy subscriber's line are indicated by the same tone.

The calling party should understand that the busy tone coming on before he has completed dialing means "paths busy" instead of "called line busy" and that he should hang up at once, as further dialing will be useless.

As he hangs up, relays A and B release, thereby completing the circuit through the release magnet which operates and restores the selector to normal.

The T and R wipers are "dead" (because relay D is not operated) hence there is no interference with busy trunks during this backward rotation, but the circuit from the winding of relay E to the S wiper is closed, hence relay E may operate as it passes across grounded S terminals; but that does no harm, because at this time relay B has been released, taking the ground off the the operating path of the rotary magnet and the S lead from the line switches.

Therefore the rotary magnet cannot now operate even though relay E should operate.

Taking the ground off the S lead from the line switches also releases them.

If the paths are not all busy and the customer continues dialing, the second selector, and such other selectors as may be in this train, will operate substantially the same as described for the first selector.

Figure 32 is the schematic circuit of a regular selector which is included for reference purpose.

5.0805 BY-PASS SELECTOR

In large multi-office areas, a small branch office is sometimes provided which is in effect a part of one of the units of the main exchange.

Ordinarily a local call originated in this small office would need to be trunked into the distant equipment and then routed back over another path, thus making two trunks busy for only one call.

To avoid this uneconomical use of apparatus the BY-Pass REPEATER (Selector) is used in the Sub-Office which eliminates the need for an incoming trunk from the distant office. In the case of a main office call this switch acts similarly to the regular 2-Wire repeater (to be covered in paragraph 5.19) by repeating the impulses and building up the switch train in the usual manner.

For a local call the outgoing trunk and its associated selector is "by-passed" in favor of a trunk to the local switch train, thus making the former available for the next outgoing call.

This switch also performs the regular functions of a selector or repeater, that is, it provides a ground for holding the line switch or line finder, supplies battery to the calling station on main office calls, reverses battery when a main office call is answered, selects idle trunks to both switch trains, etc.

A customer in the sub-office upon lifting his receiver seizes a by-pass selector (repeater) in much the same way as a customer in the Main offices seizes a first selector. The by-pass switch

will find a trunk to the main office and immediately seize the incoming selector in that office, thereby giving dial tone to the calling customer in the by-pass office. When this tone is heard, the customer may start dialing. At the end of the pulses the first selector (main office) will cut in at a certain level determined by the digit dialed. All local numbers will have a first digit which when dialed will cause the selector to cut in on a level which has **ground** on all its **ring** terminals and **battery** on its **tip** terminals. This condition causes the incoming selector and trunk to release thereby making them available for other calls and the by-pass repeater (selector) is now ready to choose an idle trunk to a local selector.

On a call to a Main office number, the incoming selector will automatically cut-in on the level dialed and find an idle trunk to the next switch of this train. The remaining digits of the desired number are then dialed and repeated through the by-pass selector-repeater.

If a subscriber 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. The attendant there can release the trunk by short circuiting the T and R of the trunk at the Test Jack of this selector.

Figure 33 shows the schematic circuit of a "Repeater with By-Pass Selector".

5.0807 DIGIT ABSORBING SELECTORS

In any exchange area the number of stations expected at the end of the ultimate period is apt to be considerably greater than at the beginning of that period; therefore, when making plans for step-by-step systems in such areas, it is essential to choose a numbering system for the initial installation with due consideration to the ultimate requirements.

In any such case it may be found that a 5-digit system would be adequate for several years but thereafter a 6-digit system would be necessary.

It would not be desirable to start out with the 5-digit system and change later to the 6-digit system as that might involve a wholesale change in telephone numbers which would be objectionable to our customers; and should the 6-digit system be adopted initially there is some disadvantage in having to dial the (present) superfluous digit but a more serious objection is a superfluous selector in the switch train.

If the conditions are such as to make it advisable to adopt the 6-digit system initially the latter objection may be overcome by using Digit Absorbing Selectors which are so arranged that the shaft is not effectively moved by the first digit dialed into it but is moved by the second digit in the regular manner.

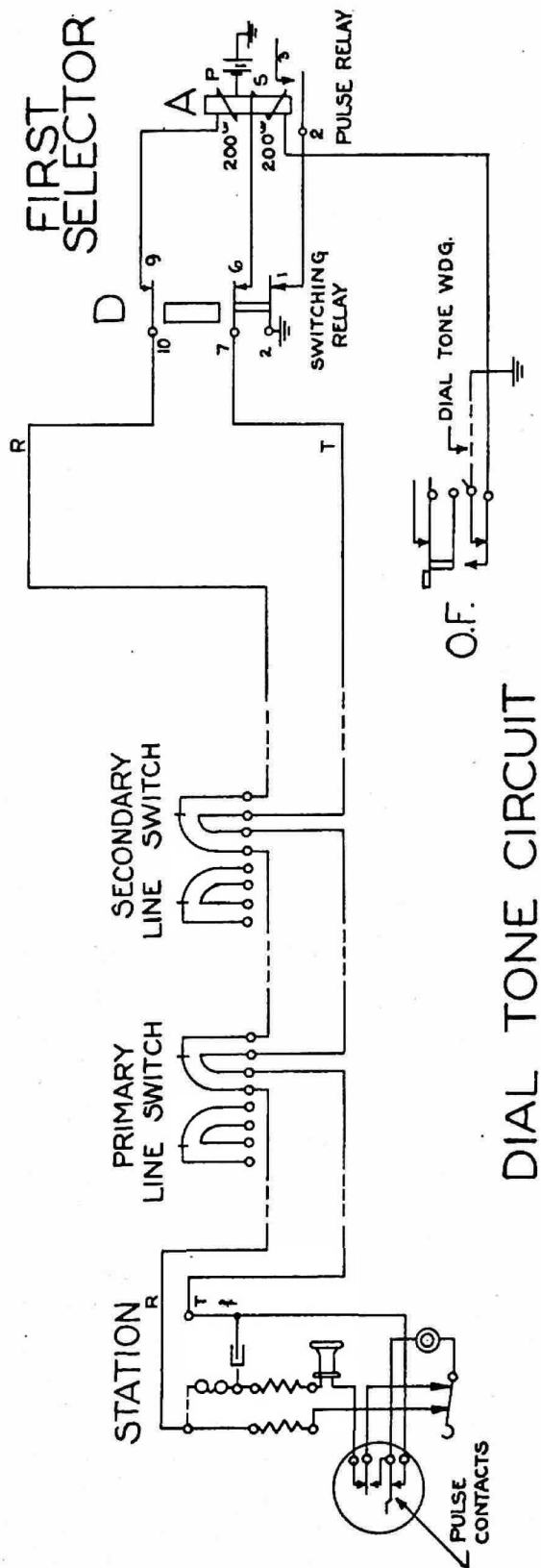


Figure 27

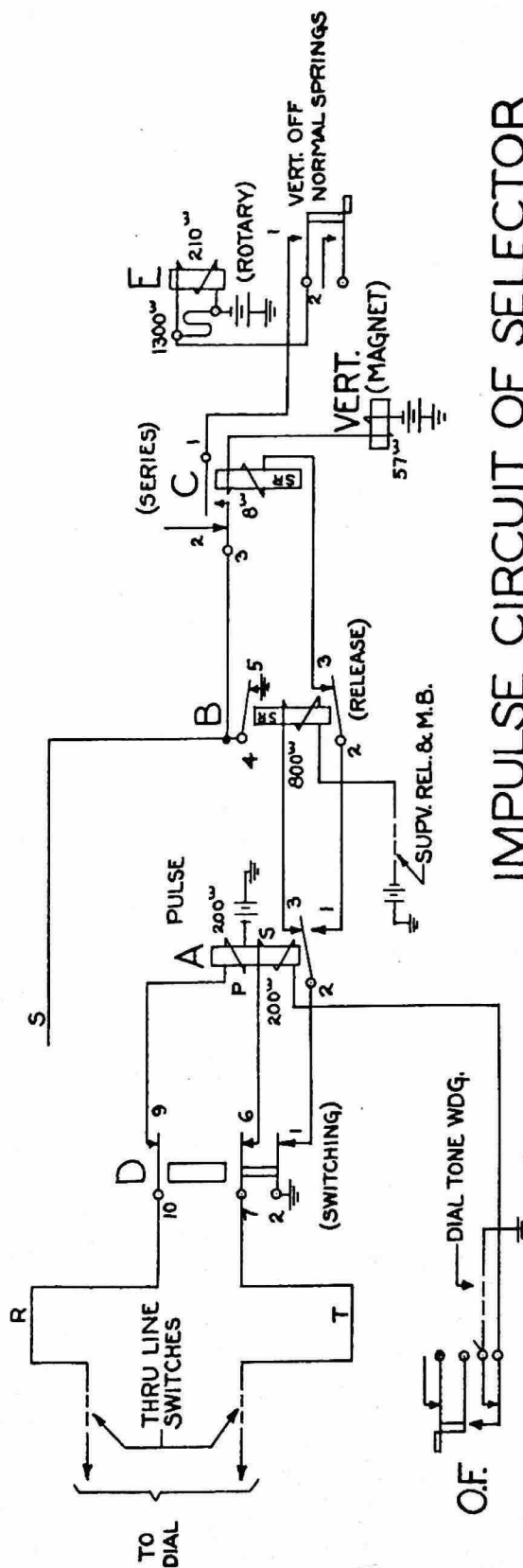


Figure 28

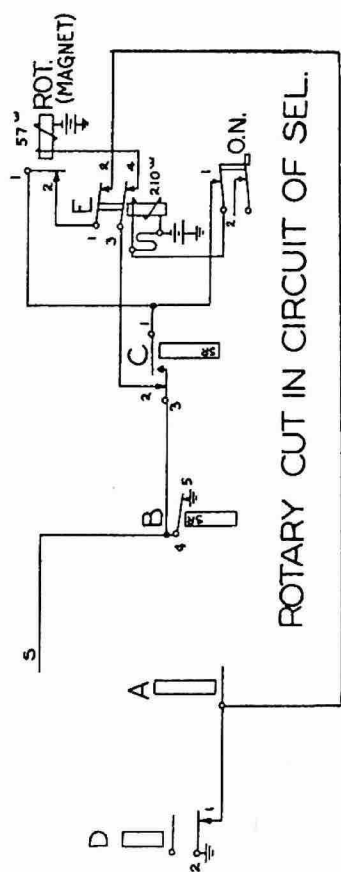


Figure 29

Figure 29

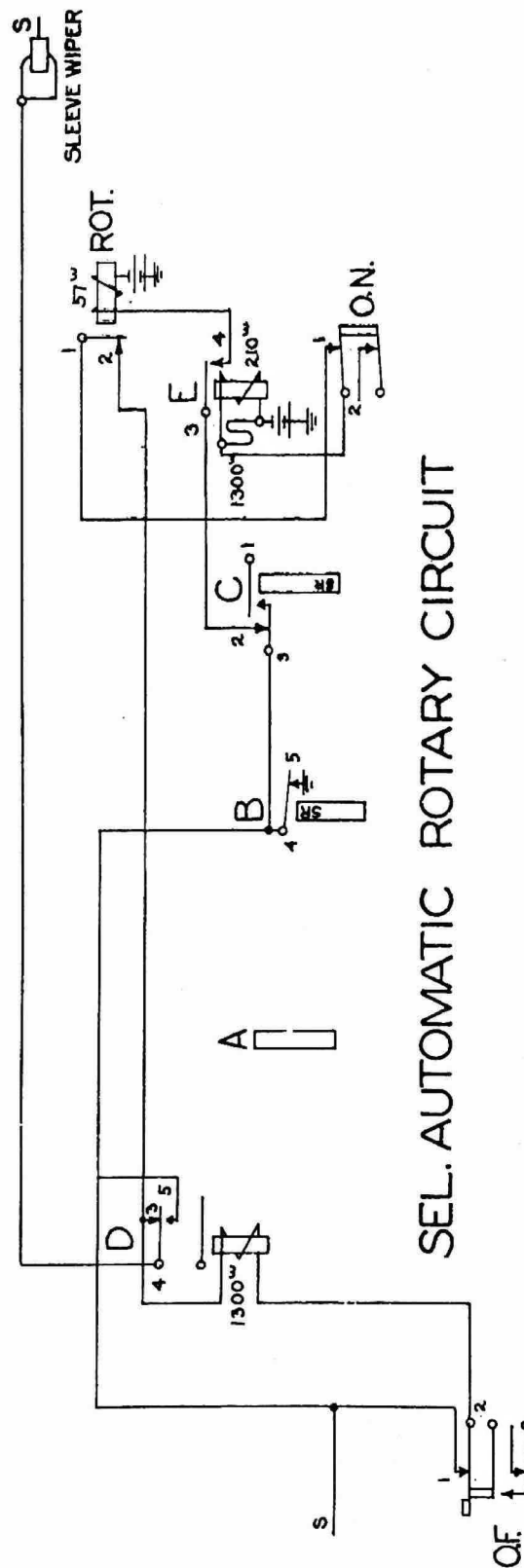


Figure 30

Figure 30

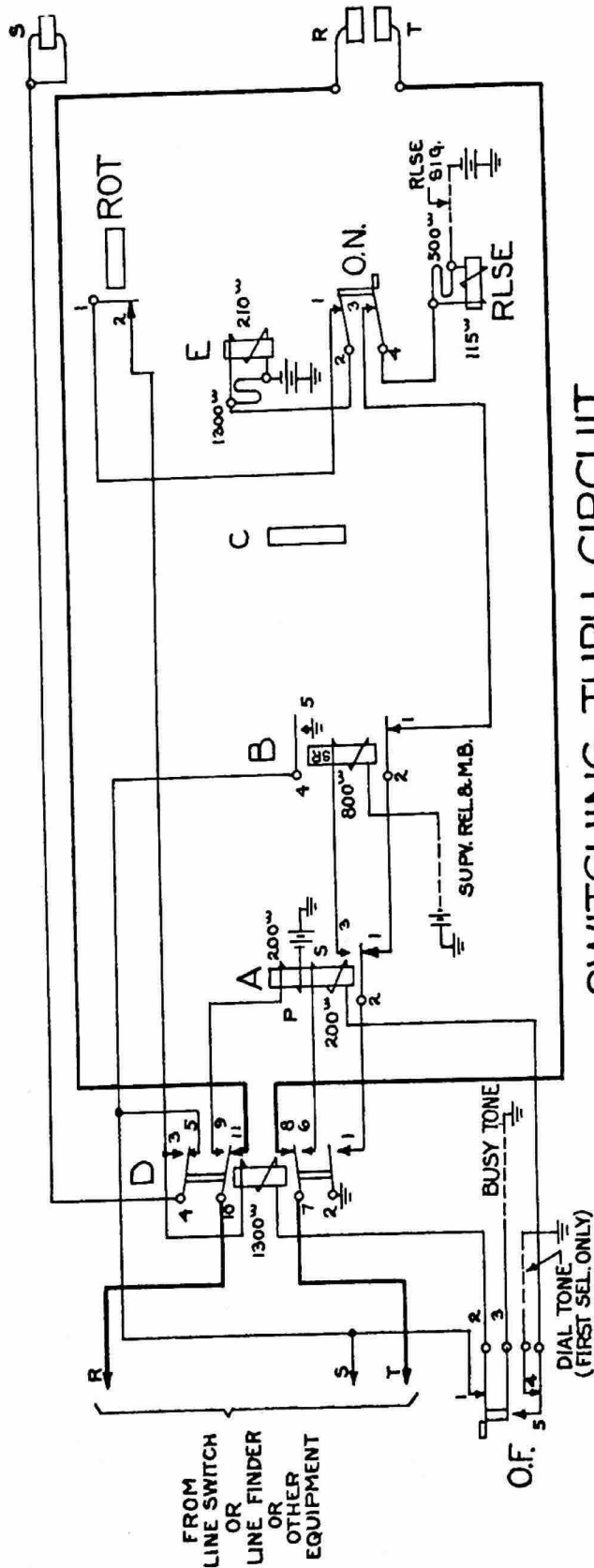


Figure 31

SWITCHING THRU CIRCUIT OF SELECTOR

REGULAR SELECTOR

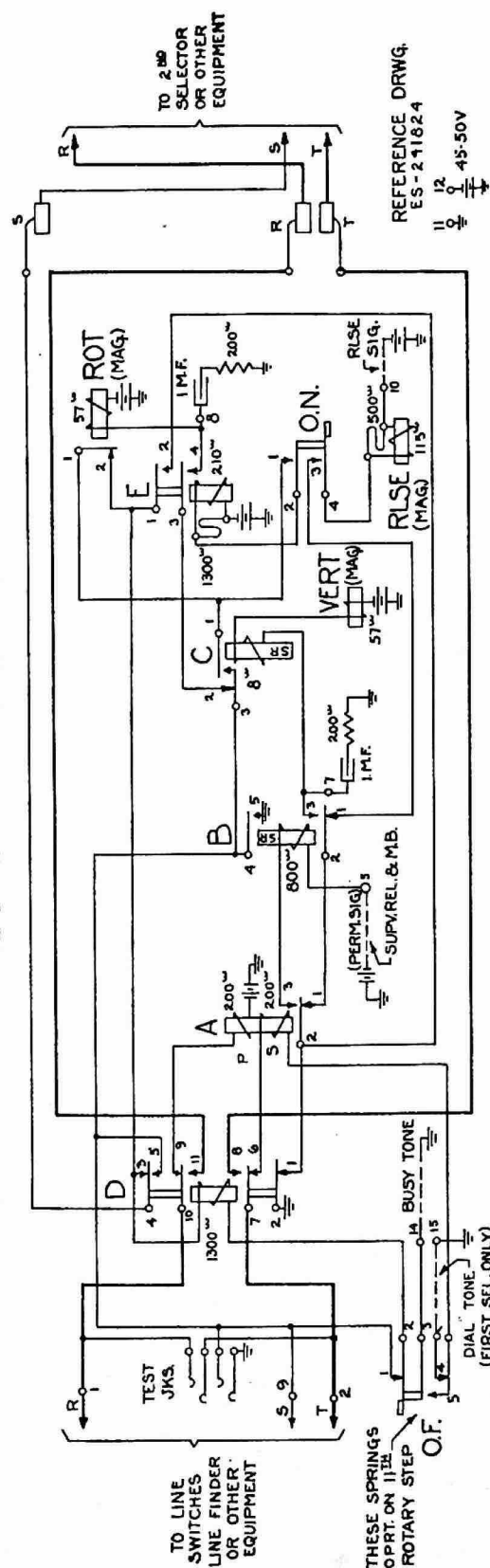


Figure 32

THE OHIO BELL TELEPHONE COMPANY READING COURSE
ON STEP-BY-STEP DIAL SYSTEM CENTRAL OFFICE EQUIPMENT

ISSUE No. 1
DATE - 5-16-29

Figure 32

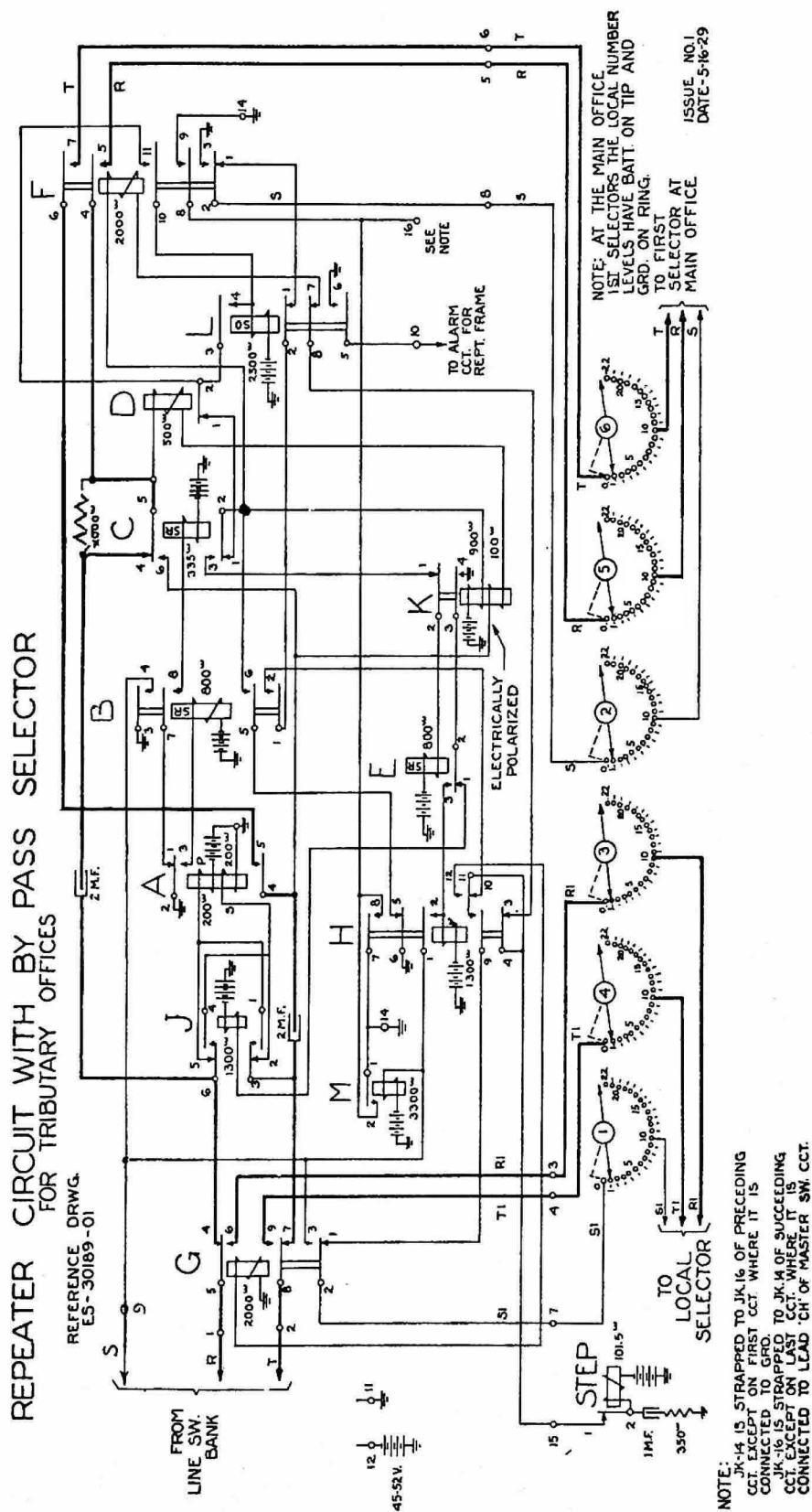


Figure 33

Figure 33



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They are generally put in the place of the regular 3rd selectors. The location for the regular 2nd selectors is left vacant until some future time when these will be required; then dialing the 1st digit operates the 1st selector in the usual way; the 2nd digit is absorbed by this digit absorbing selector which is located on the 3rd selector shelves and which will some time be used as regular 3rd selectors; the 3rd digit operates it and causes it to select a trunk to a 4th selector after which the rest of the operations are regular.

For example if MAin 7689 were dialed, M would operate the 1st selector; A would be absorbed; 7 would operate the Digit Absorbing 3rd Selector; 6 would operate the 4th selector and 8 and 9 would operate the connector.

See Figure 34 for circuit schematic of this type selector.

Later on, the Digit Absorbing Selector may be converted into a regular 3rd selector by minor changes, and another selector added to the switch train, thereby meeting the larger requirements without change of telephone numbers.

A more recent development is the Double Digit Absorbing (DDA) Selector. This switch will be used extensively in connection with the establishment of 2-5 numbering plans. The features of the DDA Switch are controlled by the setting of the normal post spring and cam assemblies for particular levels. Any level can be arranged to respond to a digit as follows.

1. Absorb a digit repeatedly. (A R Levels)
2. Absorb a digit once. (A Levels)
3. Return a paths busy signal if the level dialed has not been preceded by the dialing of a level arranged to be absorbed once.(B)
4. Any level not specified AR, A, or B will be selected when dialed and selector will hunt for an idle trunk in the usual manner.

These features of the DDA switch enable the Engineering Group to lay-out a 2-5 plan with the minimum number of selector trains and with considerable protection against customer mis-dialing. We will cover more concerning this DDA Switch in Section 6.

5.0808 AUXILIARY SELECTORS

Auxiliary selectors might best be called "Special Selectors", since the term is used to denote a special use of selectors rather than selectors of special design. One of the uses of auxiliary selectors is to care for calls affected by preliminary pulses, while other uses are for routing traffic to auxiliary operators and for reverting calls. These "special" selectors are seldom, if ever, provided in any except No. 1 and 350-A Type offices, and, occasionally in the larger 355A Type offices.

A special arrangement of selectors is used to guard against establishing wrong connections in those cases where an unintentional movement of the switch hook, when removing the receiver,

causes a "preliminary pulse". A preliminary pulse (p.p.) in its effect upon the first selector is equivalent to dialing the digit "1", consequently, coming as it does ahead of the regularly dialed digit, it has the effect of prefixing "1" to the number dialed.

In order to nullify the effect of the preliminary pulse, trunks are extended from the first level of the first selectors to the "special" second selectors, more commonly known as the "Auxiliary First Selectors".

All levels of the auxiliary first selectors are multiplied to the banks of the first selectors, except the first level. Therefore, if the customer proceeds to dial the called number, after first creating a preliminary pulse, the auxiliary first selector will step to the designated level and an idle trunk will be selected on that level just as though the digit had been dialed into the first selector in the proper manner.

The first level of the auxiliary first selector is trunked to Service Code Selectors.

In May, 1949, P. E. L. 4525, issued by the A.T. & T. Co., stated that auxiliary first selectors (in local trains) and auxiliary service code selectors (covered later) need not be installed in new offices and that they could be eliminated with any major equipment changes in existing offices.

The latest procedure routes a p.p. call direct from level one of the first selector to a digit absorbing type service code selector, which absorbs the digit "1" repeatedly. This switch will return a "busy" should any digit other than "1" be dialed into it without first having received a digit "1".

See Figure 35 for the Auxiliary Train Traffic Schematic.

5.0809 SERVICE CODE SELECTOR

Service code selectors provide access to Information, Repair Service, Local Test Desk, Reverting Call Switches, Toll Operator (two channel offices), etc. See Figure 35.

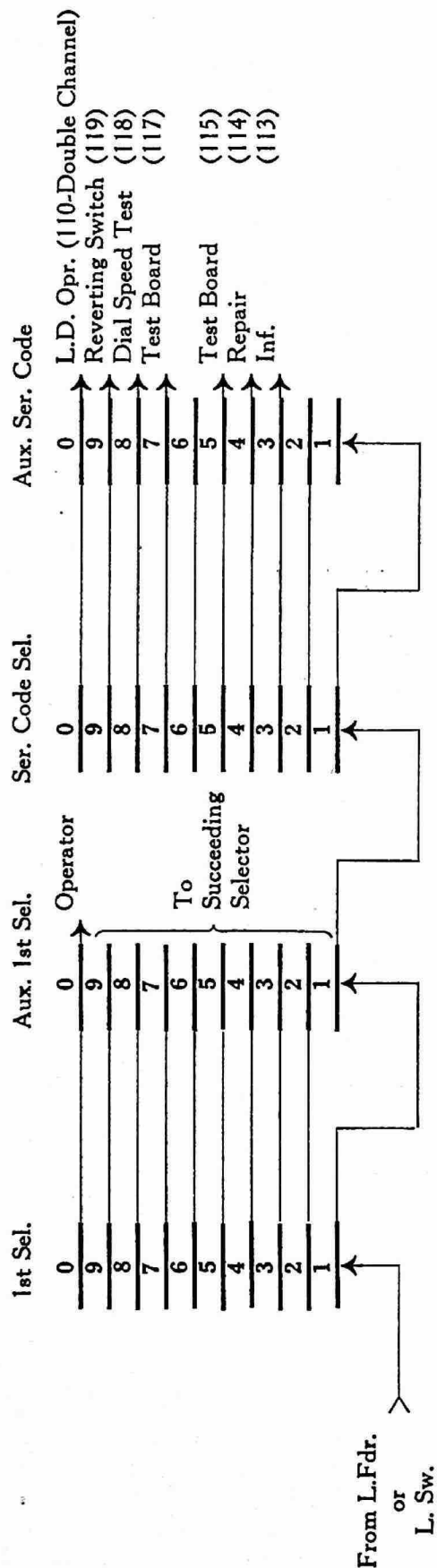
All levels of the Service Code Selectors are available to serve service codes, except the first level.

Mechanically and electrically these selectors are practically identical to any other local selector.

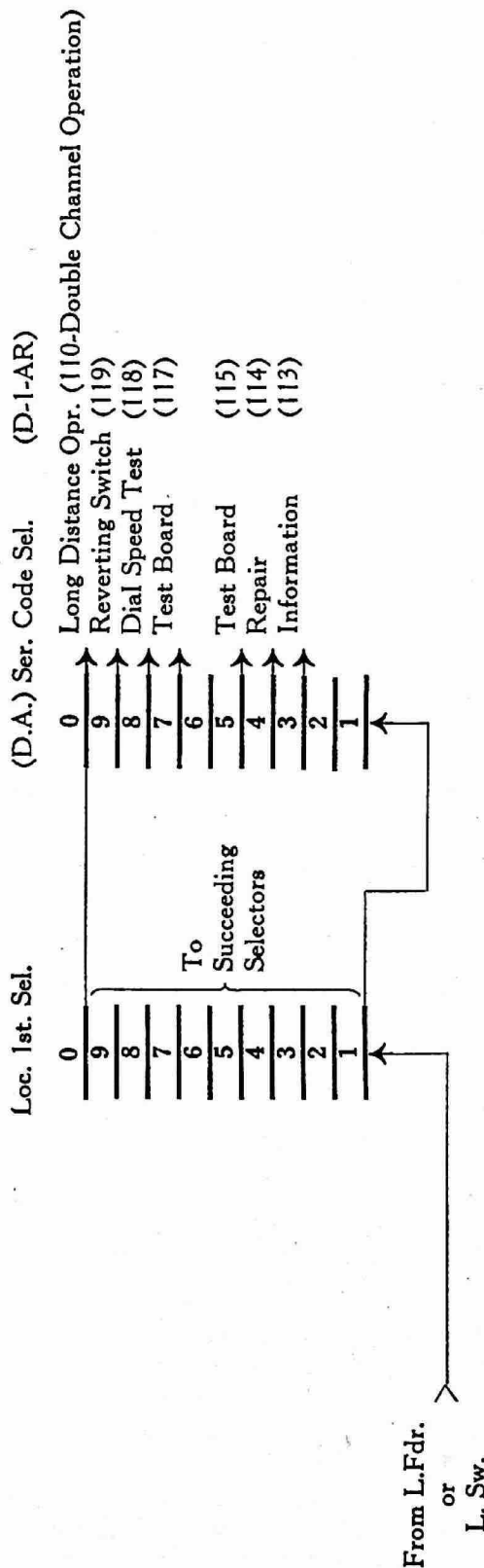
In later installations, service code selectors that have been provided in accordance with the provisions of P. E. L. 4525, the auxiliary (preceding) first selector has been eliminated. Levels 2-0 of the Service Code Selector are arranged to refuse access if anyone of them is the first digit dialed into the switch. In this case, the selector rises to the pulsed level which is wired to give the calling subscriber a "busy". As an exception, in certain areas, only the "2" to "9" levels are wired to give busy on the first pull of the dial and when this is done the "0" level is multiplied to "0" level on the first selectors.

SCHEMATIC SHOWING AUXILIARY TRAIN

IN STEP-BY-STEP OFFICE



Earlier Installations



Later Installations

Figure 35

The number "1" level, of the service code selector, in earlier installations routes calls to an auxiliary service code selector to nullify a preliminary pulse on three digit service code calls.

In later installations, every time a "1" is received on the service code selector it is absorbed, i.e., the selector rises to "1" level and immediately falls to normal. This can be repeated any number of times. Offices so arranged do not, therefore, require auxiliary Service Code Selectors.

When dialing the Information Service Code 113 in later installations, the first digit "1" is recorded on the first selector the second digit "1" is absorbed on the Service Code Selector, returning it to normal, and at the same time, the selector is unlocked for all levels "2" to "9" or "2" to "0" and the selector will now make selection on the third digit "3", when it is dialed, go to the 3rd level, and connect to the required service code trunk. Obviously, if a subscriber caused two preliminary pulses and dialed, he would be connected to the service code trunk desired regardless.

5.0810 AUXILIARY SERVICE CODE SELECTOR

In the earlier installations, the auxiliary Service Code Selectors were provided to nullify the effect of a preliminary pulse on three-digit code calls in a manner similar to that of auxiliary first selectors on subscriber calls.

Where this type of selector is not installed, as in later installations, the nullification takes place on the service code selector as previously described.

5.09 SELECTORS—TOLL

This paragraph describes the general purpose of the principal circuits used in Step-by-Step offices for completing calls from the Toll Switchboard to stations in the dial system office.

A description of the operation of some of the miscellaneous switches is also included.

The above circuits include:

1. Toll Transmission Selector (non-coin Loop Dialing*)
2. Toll Transmission Selector (coin, Loop Dialing)
3. Coin Control Selector
4. Toll Intermediate Selector
5. Combination Toll and Local Connector (to be covered in paragraph 5.10)

*By "Loop Dialing" is meant where the dialing circuit at the toll office forms a continuous metallic circuit with the trunk and toll transmission selector at the dial office.

An important element in the completion of toll calls to dial stations is to provide equipment enabling the toll operator to dial the customer in

advance of the actual completion but defer ringing until the other party is on the line.

Furthermore, to economize on circuit time, it is essential to provide every convenience for the toll operators to spread their time effectively over several uncompleted calls (over-lap) that each may have on hand at the same time.

In addition, to ensure satisfaction to our customers for this service to which, in general, more importance per call is attached (broadly spoken) than to local calls, every practical safeguard is provided to prevent interruption from any cause due to the rapid use of this equipment.

To meet these severe requirements this system, which is of considerable complexity, has been built up.

TOLL TRAIN—A separate toll train of switches is required to enable the toll operator to complete calls to the local subscribers. It is a four wire system, the fourth wire (c lead) joins the local equipment at the subscribers' bank terminal (Connector Board) by means of a toll or combination toll and local connector.

The regular toll train is available to Inward operators for completing toll calls to a step-by-step subscriber. This train is also available to the outward toll operator for completing calls on which the calling customer had been dismissed to be recalled (delayed call).

Before getting into the detailed description of the purpose and functions of each of the various type selectors utilized in the toll train, it might be of interest to briefly review the general outline of the progress of a call from say a No. 1 Toll Board over a loop dialing toll train:

(Called Number UN 4-7582)

1. TOLL OPERATOR SELECTS AN O.G. TRUNK OF GROUP UN-4 WHICH TESTS IDLE.
2. TOLL OPERATOR OPERATES KEY "MONITOR AND DIAL" FOR A MOMENT.
 - 2.1 Completes Dialing Circuit from pulse contacts of dial through T and R leads of O. G. Trunk, T and R leads to Transmission Selector and battery and ground.
3. TOLL OPERATOR DIALS SECOND DIGIT OF NUMBER -7.
 - 3.1 Sends 7 pulses from dial circuit through cord circuit over T and R leads through O.G. Trunk Circuit to Transmission Selector Circuit.
 - 3.2 Transmission Selector Shaft and wipers are stepped up to the 7th level and there select an idle trunk to an Intermediate Selector. (No ground on lead S of Intermediate Selector and lead C looped through to lead S.)
 - 3.3 A pulse circuit is now complete from the Transmission Selector over T and R leads to Intermediate Selector Circuit (Battery and ground in Intermediate Selector Circuit).
 - 3.4 The same pulse circuit is still complete from the dial through to the Transmission Selector,

but any pulses which are now sent will have no effect on the stepping circuit of the Transmission Selector.

- 3.5 If all trunks are busy the S wiper of Transmission Selector will be open for a moment but there will be no loop from the C wiper to the S wiper of Transmission Selector.
- 3.6 This will cause Transmission Selector to reverse the direction of battery back over the pulse circuit to the dial and also interrupt it at the rate of 120 I.P.M.
- 3.7 Operates Polarized relay in dial circuit which releases this circuit and connects Supervisory lamp circuit of cord instead.
- 3.8 Supervisory lamp flashes (120 I.P.M.)
- 3.9 If a trunk is busy, there is a ground on S terminal and the Transmission Selector will pass by it to the next.

4. TOLL OPERATOR DIALS THIRD DIGIT—5.

- 4.1 Sends 5 pulses from dial circuit through cord circuit over T and R leads, through O.G. Trunk Circuit, to Transmission Selector Circuit.
- 4.2 Transmission Selector repeats the pulses to the Intermediate Selector.
- 4.3 The Intermediate Selector Shaft and wiper are stepped to the 5th level and select an idle trunk to a Connector. (No ground on S terminal and terminal C looped through Connector to terminal S.)
- 4.4 The Intermediate Selector locks operated on ground over S lead at Transmission Selector and connects C, S, T and R leads from Transmission Selector directly to Connector.
- 4.5 A pulse circuit is now complete from Transmission Selector through Intermediate Selector to Connector (Battery and ground in Connector Circuit) over T and R leads.
- 4.6 If the Intermediate Selector wipers step on a busy trunk, the ground on S terminal causes it to pass by this trunk to the next.
- 4.7 If all trunks are busy the S wiper of Intermediate Selector will be open for a moment but there will be no loop from C wiper to the S wiper of Intermediate Selector.
- 4.8 This will cause Transmission Selector to reverse the direction of battery back over the pulse circuit to the dial and also interrupt it at the rate of 120 I.P.M. due to interrupted battery on R lead from Intermediate Selector.
- 4.9 Operates polarized relay in dial circuit which releases this circuit and connects supervisory lamp circuit of cord instead.
- 4.10 Supervisory lamp flashes (120 I.P.M.)

5. TOLL OPERATOR DIALS FOURTH DIGIT -8.

- 5.1 Sends 8 pulses from dial circuit through cord circuit over T and R leads, through O. G. Trunk Circuit to Transmission Selector Circuit.

- 5.2 Transmission Selector repeats the pulses over T and R leads through Intermediate Selector, to Connector Circuit.

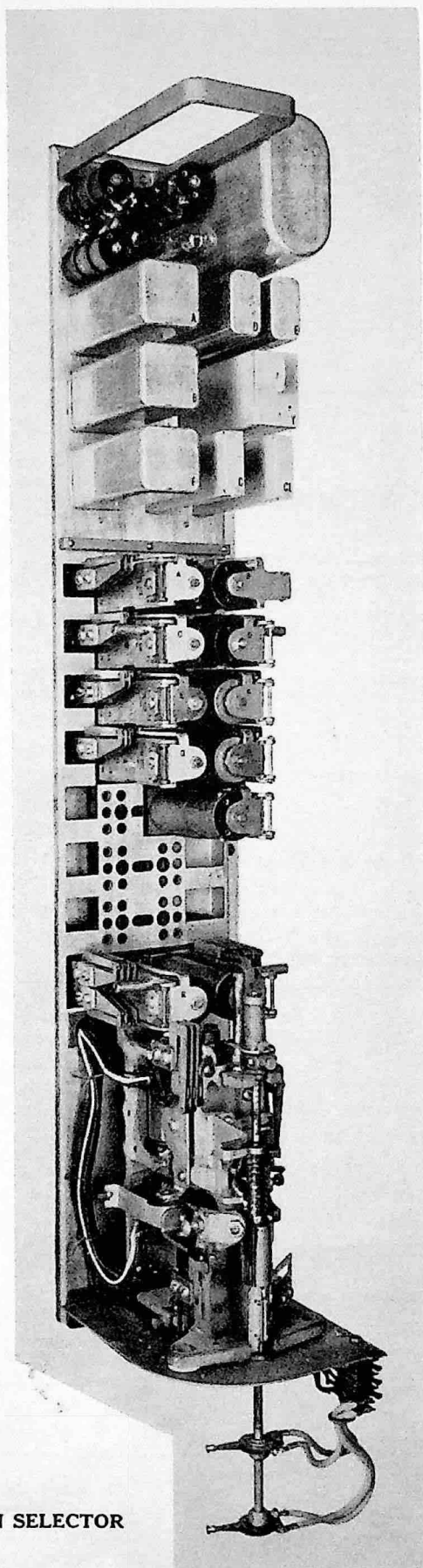
- 5.3 The Connector Shaft is stepped to the 8th level and the rotary circuit is prepared.

6. TOLL OPERATOR DIALS FIFTH DIGIT -2.

- 6.1 Sends 2 pulses from dial circuit through cord circuit over T and R leads, through O. G. Trunk Circuit, to Transmission Selector Circuit.
- 6.2 Transmission Selector repeats the pulses over T and R leads through Intermediate Selector to Connector Circuit.
- 6.3 The Connector wipers are rotated to the second terminal at this level (terminals of the desired line).
- 6.4 If the line is busy, ground on the S terminal causes ground to be removed from lead C back through Intermediate Selector to Transmission Selector and places interrupted battery on lead R to Transmission Selector.
- 6.5 This causes Transmission Selector to reverse the direction of battery back over pulse circuit to the dial and also interrupts it at the rate of 60 I.P.M., due to the interrupted battery on R lead (60 I.P.M.) from Connector and through Intermediate Selector to Transmission Selector.
- 6.6 Operates Polarized relay in dial circuit which releases this circuit and connects supervisory lamp circuit of cord instead.
- 6.7 Supervisory lamp flashes (60 I.P.M.) and operator hears busy tone.
- 6.8 If the line is idle, battery on S terminal causes ground to be removed from lead C back to Transmission Selector for a moment only when the loop between C and S leads is opened.
- 6.9 This causes the transmission Selector to reverse the direction of battery back to dial circuit but it is not interrupted. The Transmission Selector restores ground on lead C before ringing has time to be started in the connector circuit.
- 6.10 Releases Dial Circuit and connects supervisory lamp circuit and supervisory lamp burns steadily.

7. TOLL OPERATOR OPERATES RINGING KEY.

- 7.1 Ringing current sent out over T and R of plug from cord circuit, through O. G. Trunk, to Transmission Selector.
- 7.2 Transmission Selector removes ground from lead C to connector until a slow acting relay releases when it is replaced.
- 7.3 Starts ringing circuit of connector and the proper ringing is impressed on the line to the called station.



TOLL TRANSMISSION SELECTOR

Figure 36

8. CALLED STATION ANSWERS BY REMOVING RECEIVER.

- 8.1 The ringing current is tripped at the connector and T and R leads from the called station are extended through the Connector, Intermediate Selector, to the repeating coil of the Transmission Selector to battery and ground, completing this portion of the talking circuit.
- 8.2 Transmission Selector operates and removes battery and ground from T and R leads back through O. G. Trunk Circuit, to Cord Circuit.
- 8.3 Supervisory lamp goes out.
- 8.4 The talking path is now also complete from Cord Circuit over T and R leads through O. G. Trunk, to repeating coil of Transmission Selector Circuit.

9. TOLL OPERATOR REMOVES PLUG TEMPORARILY.

- 9.1 This trunk will test busy but will not be released until the called station hangs up.

10. TOLL OPERATOR REINSERTS PLUG BEFORE CALLED STATION HANG UP.

- 10.1 The circuits return to the same condition as before the plug was removed.

11. CALLED STATION HANGS UP.

- 11.1 Transmission Selector replaces battery and ground on T and R leads back through Trunk Circuit to Cord Circuit.
- 11.2 Lights supervisory lamp of cord as a disconnect signal.
- 11.3 The circuits are now in the same condition as before ringing was started and if the toll operator finds it necessary, she may again operate the ringing key and recall the station to the line.

12. TOLL OPERATOR REMOVES PLUG.

- 12.1 Cord and Trunk circuits release and open loop across T and R leads to Transmission Selector.
- 12.2 Transmission Selector releases and removes ground from C and S leads to Intermediate Selector and Connector.
- 12.3 Ground being removed from lead S, the Intermediate Selector releases and returns to normal.
- 12.4 T and R leads to connector are now open and it releases, returning to normal.

13. ALL CIRCUITS ARE NOW BACK TO NORMAL AGAIN.

5.091 TOLL TRANSMISSION SELECTOR—NON-COIN (See Fig. 36)

Purpose—This circuit is used for extending calls from the toll board to a toll selector or connector.

Functions—While there are many more different circuit operations performed by the

toll (Incoming) Transmission Selector than are performed by local selectors, the main functions of this switch are:

1. Selects a group of trunks.
2. Selects an idle trunk in the group.
3. Closes a circuit for operating the permanent signal until a trunk has been selected.
4. Extends the trunk to the trunk selected when an idle one is found.
5. Provides a pulsing loop for the trunk selected.
6. Repeat dial pulses from the toll operator to the trunk selected.
7. Causes the operator to receive line flashes when a busy line is selected or dialed.
8. Causes the toll operator to be signaled when the called line is seized.
9. Enables the toll operator to start machine ringing.
10. Enables the toll operator to have switch-hook supervision.
11. Arranged to enable the operator to apply uninterrupted generator to the line on P.B.X. re-ring.
12. Supplies the called party with transmitter battery.
13. Hold the connection under joint control of the operator and the called party.
14. Restores to normal when the trunk is abandoned by both the operator and the called party.

For circuit schematic of the non-coin type Toll Transmission Selector see Figure 37.

5.092 TOLL TRANSMISSION SELECTOR—COIN

In areas where coin service is provided, certain Transmission Selectors are equipped with an extra relay (relay L) which allows coin collect and coin return current to be placed on the station line at the proper time.

If the Dial Office is adjacent to or in the same building as the Toll Office it is customary to install at the Toll board an additional jack with two conductors for each outgoing trunk jack. This extends the CC and CO leads from the Transmission Selector associated with each O.G. trunk to the toll operator's position. Then by means of a coin cord and its associated keys, she may place either coin collect or coin refund current on lead CC and ground on lead CO through the Transmission Switch to the pay station. This is the only additional function available to the operator other than those covered previously for the non-coin switch.

In multi-office areas having a centralized toll office another arrangement for collecting or returning coins is by the use of what is known as the coin control selector. See 5.094.

Figure 38 is a schematic drawing of a typical coin-type Toll Transmission Switch.

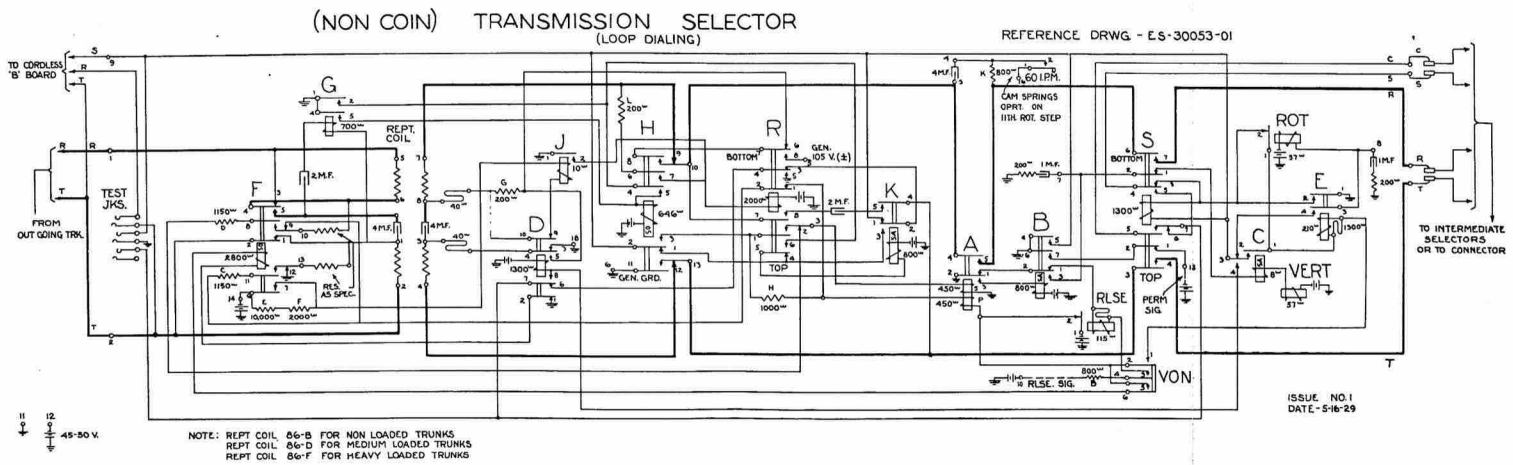


Figure 37

5.093 A-B TOLL TRANSMISSION SELECTOR

A separate train of switches is available to the "B" or toll operators who complete A-B toll calls and is used instead of a local train since it provides distinctive flashing signals to the operator on line busy and paths busy conditions and provides toll grade transmitter battery. The train is arranged for local or tandem operation. The switches in the A-B train are similar to those in the regular toll train. However, in some cases the A-B toll transmission selector is preceded by one or two tandem preceding selectors.

The A-B toll transmission selector performs functions in the A-B toll train which correspond in some respects to the toll transmission selectors in the regular toll train, and differ in other respects.

The main points of difference are as follows:

- It provides immediate rather than delayed ringing. Operator has no control over ringing; it is applied automatically by the connector.

- It provides local rather than toll supervision. Operator receives no signal when the called line is seized.

- Connection is held under control of originating operator and restores when abandoned by her.

- It is not arranged for coin control since this train is not used for reaching calling subscribers in connection with delayed calls.

- It is arranged to absorb digits. With one arrangement any first digit may be absorbed; with another arrangement any specified digit may be absorbed once or repeatedly.

- It provides reverse battery local or tandem type supervision rather than wet-dry toll switching type supervision.

5.094 TOLL-COIN CONTROL SELECTOR

If there is some distance between the Toll Board and the Dial office it is necessary economically to use special trunks over which the coin is collected or returned.

Therefore, instead of providing an individual coin trunk circuit for each O.G.T. circuit, a certain number of these trunks are terminated at what is known as Coin Control Switches in the Step-by-Step office which have access to 100 Toll Transmission Selectors, any one of which can be reached by dialing two digits, the coin control switch being a "two-digit" switch.

When the time arrives for a coin to be collected or returned on a certain circuit, the toll operator by means of a coin control cord and associated keys, and her position dial, dials the desired trunk number over a coin trunk circuit to the distant office causing the coin control switch in that office to select the proper transmission

selector (i.e., trunk 55 is the 5th terminal in on the 5th level of the C.C. Switch). This connects the proper CC, CO and CT leads from the transmission selector to the operator.

At the proper time the Operator can then operate either the Coin Collect (CC) or the Coin Return (CR) key at her position. She will receive a distinguishing tone over the CT lead from the O.G. trunk circuit to indicate that she has selected the proper trunk.

After the coin has been disposed of, the operator may disconnect the coin control trunk and use it for establishing a connection to some other coin box customer who may be waiting for his coins to be disposed of.

(The Coin Control Selector may be used similarly in connection with coin CLR trunks, also.)

Figure 39 is a schematic circuit drawing of a coin control selector.

Figure 40 shows the coin control cord and the coin trunk circuits.

5.095 TOLL INTERMEDIATE SELECTOR (Loop Dialing)

The toll intermediate selector is used between the Transmission Selector and the Connector. The dial pulses—which are repeated by the transmission selector—cause 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 lead C which is necessary in order that the toll operator may control the start of ringing.

When an idle trunk is found by the intermediate selector it is held by a ground on lead S and the leads T, R, S and C are connected directly through to a connector.

If all trunks on the level dialed are busy, the intermediate selector will rotate to the 11th rotary position and give the operator Re-Order (120 I. P. M. Flash) signal on supervisory lamp.

The circuit schematic for a typical toll intermediate selector is shown in Figure 41.

5.096 INTERTOLL SELECTORS—REGULAR AND AUXILIARY

An intertoll first selector is required for each intertoll trunk used to handle traffic on a dialing basis with a SXS office. On Levels 2 to 9 of these I.T. First selectors, access is had to switching trunks to local offices in the area. Level 1 is used to get access to auxiliary selectors on the banks of which appear trunks to operators and tributary offices and level "0" is used to get access to through selectors on which appear intertoll trunks to other toll centers used for built-up circuit traffic. See Paragraph 9.05 for further details concerning the Intertoll Selector.

Two types of intertoll first selectors are available. A combination first and transmission selector for use in areas where the number of switching trunks to local offices in the toll building is or will be greater in the ultimate than the number of intertoll first selectors. Since the transmission feature which provides the talking battery and the ringing control feature are incorporated in this selector, the trunks leading to the local offices in the toll building may be terminated on selectors of the toll intermediate type. This type of intertoll selector is also arranged to provide access to 2-wire trunks with relay circuits to local offices outside of the toll building. However, the transmission feature is canceled on calls to those offices and, therefore, transmission selectors must be provided at the incoming end of the trunks in the local offices. Similarly an optional feature permits canceling this transmission feature on calls to levels 1 and 0. Although this selector may be used to absorb any first digit, absorbing should not be required on digits 1 and 0. This selector does not permit cancellation of the transmission feature and digit absorbing on the same level; however, one level may have one feature and another level, the other feature.

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. In addition, this type of selector is used for offices which have 4-wire toll switching trunks from the switchboard in the same office. In this case the transmission feature is built into the trunk between the intertoll first selector and the intermediate type of selector in the toll train in the local office. Two types of these selectors are available, the regular and the auxiliary. The regular selector should be used where digit absorbing is not required. Only the auxiliary type is arranged for digit absorbing as covered above for the combination first and transmission selector. The type of selector to be used should be determined in conjunction with the Equipment Engineer.

In the case of 4-digit offices the location of the transmission feature in the intertoll selector train may be controlled by the location of this feature in the toll switching trunks. If the transmission feature is in the toll switching trunk or in the first toll switching trunk selector step in the local office it is necessary to have this feature in the intertoll first selector in order to permit common multiple from the intertoll first and the transmission selectors to the intermediate selector preceding the connector.

Intertoll Second Selectors

Intertoll second selectors are provided in 6-digit areas or for the 6-digit offices in combination 5- and 6-digit areas to 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. Their number should be based on the estimated total switch-

ing trunk ccs load and the desired Trunk Capacity Table, or Selector Capacity Table for graded groups. If only 5 digits are effective in a 6-digit office 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.

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 both on the banks of the intertoll first or second selectors, as the case may be, and at the switchboard in 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.

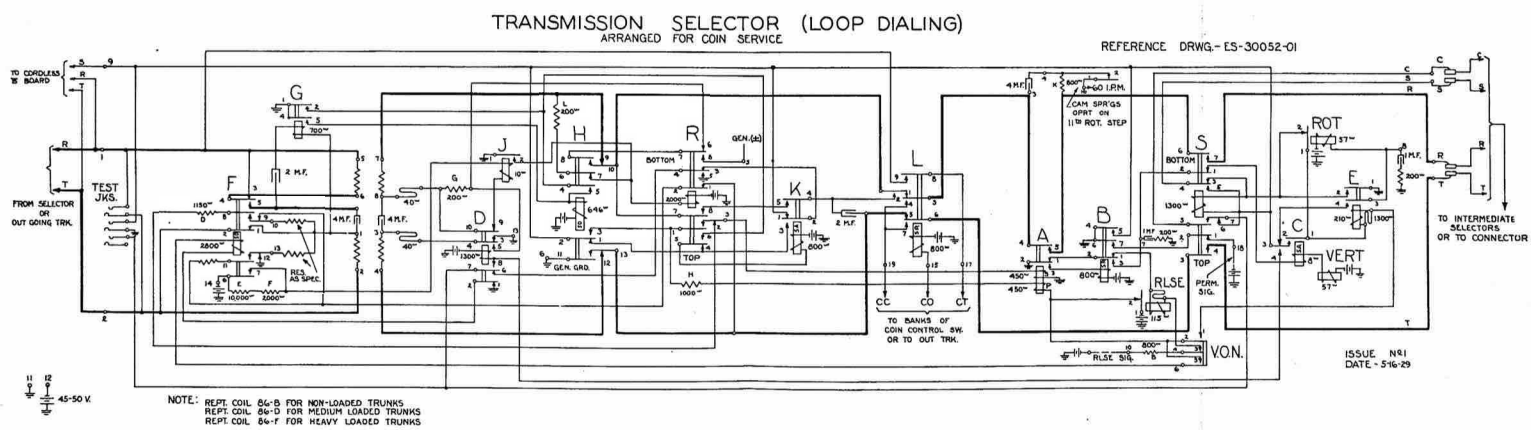
Similarly an existing A-B toll train may be used jointly for A-B toll and intertoll dialing.

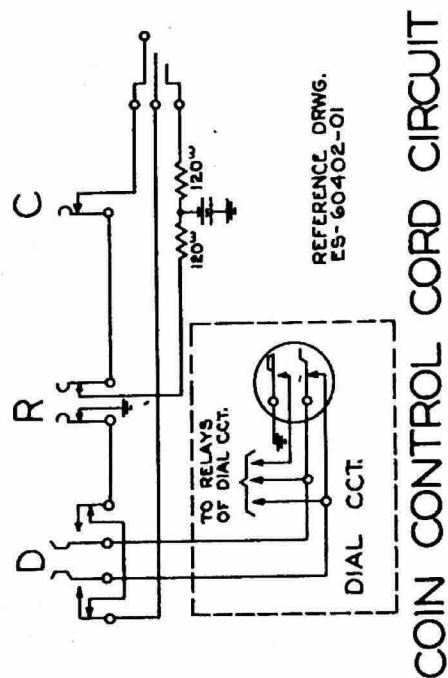
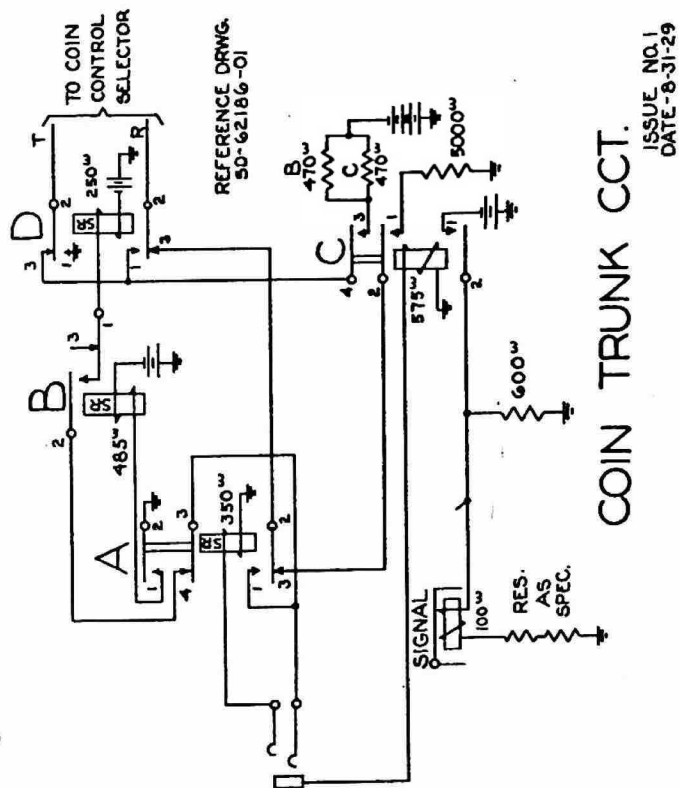
If the transmission and ringing control feature is included in the intertoll first or second selector, or in the 4-wire trunk circuits between the intertoll first selector and the selector in the local office, a toll intermediate type of selector is used at the incoming end of the trunks provided from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

In the case of 6-digit offices with 5 effective digits or 5-digit offices with 4 effective digits, an immediate ringing intertoll type or the A-B type of transmission selector may be used to absorb digits. The immediate ringing intertoll type is especially adapted for use in local offices in the same building with the intertoll first selectors.

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





REF. DRWG. ES-241769

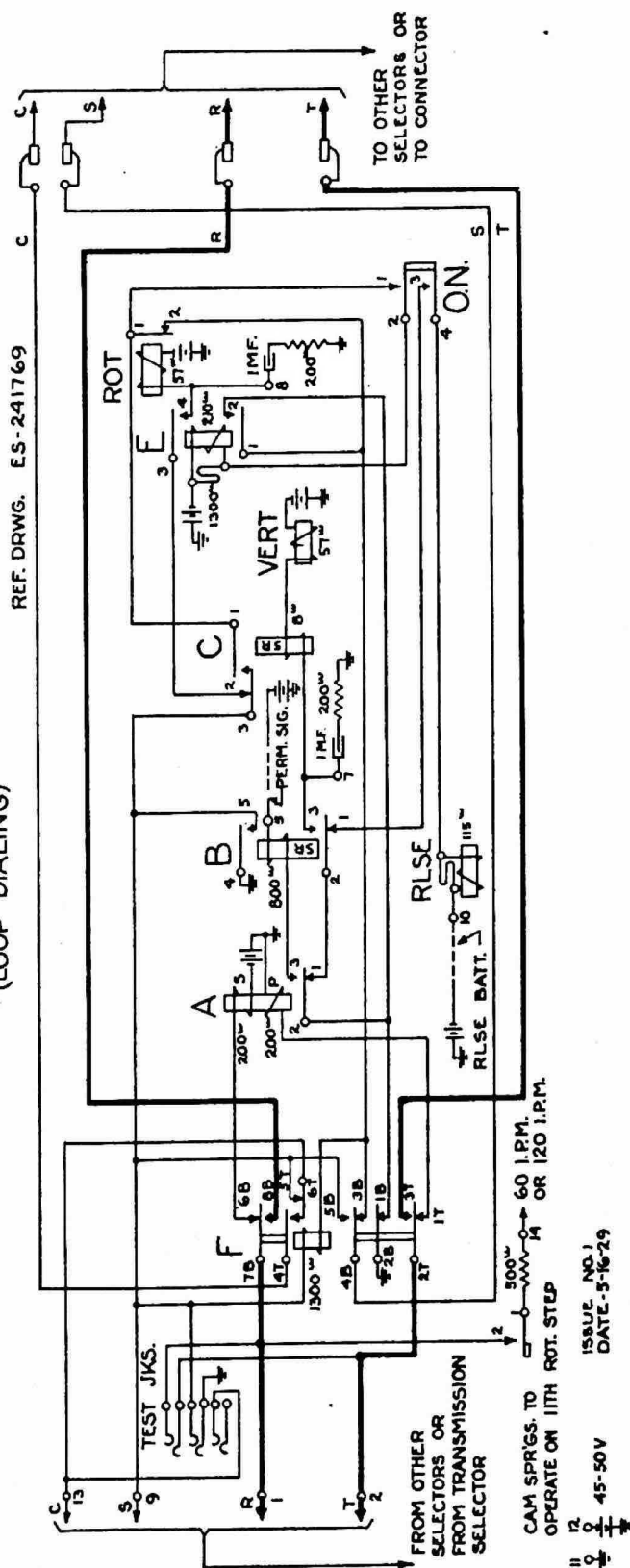


Figure 41

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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 and to manual and dial tributary offices. If the 10 levels of the levels of the intertoll auxiliary first selectors are not sufficient to accommodate all of these groups of trunks to operators and tributary offices, intertoll auxiliary second selectors are provided and reached from one or more levels of the intertoll auxiliary first selectors.

The number of these auxiliary first and auxiliary second selectors should be based on the sum of the estimated operator trunk and tributary trunk ccs load involved in each case and the desired Trunk Capacity Table (Usually 10) for ungraded groups or the step-by-step Connector Table. Any subdivision of the total traffic volume between groups of auxiliary second selectors is generally, in proportion to the number of each type of trunk appearing on each subdivision of selectors.

TRUNKS TO OPERATORS AND TRIBUTARIES

The number of trunks to operators which appear on the banks of the intertoll auxiliary first selectors is based on the estimated ccs load. These trunks including test trunks are as follows:

Code	Auxiliary First Selector Level Number	Destination of Trunk
11x	1	TX
121	2	Inward Operator
131	3	Information Operator
141	4	Route Operator
151	5	Call Order Operator
181	8	Toll Station Operator
191	9	CLR Operator
101	0	Test
102	0	Milliwatt Supply

Five Digit Codes:

11501	Universal TX Operator
11541	Toll Terminal Operator
11531	Charge Operator
11521	Mobile Operator
11511	Conference Operator

The third digit, namely "1" is ineffective when an intertoll auxiliary second selector is not used for reaching operator trunk, unless local trunking arrangement provides otherwise.

The trunks to TX operators which have the code 11 plus the TX operator number, such as 114 or 115, appear on the levels of the auxiliary second selectors corresponding to the last digit of these codes. If only one TX number is involved in a particular case where auxiliary second selectors are not provided, the trunk group may appear on the first level of the auxiliary first selectors. If this trunk group is to be arranged for transfer to an Inward position at night, this would be specified in the Traffic Order. When a team of TX operators is reached from the Inward Board in connection

with traffic completed over ringdown intertoll trunks, and is also reached over dial intertoll trunks, the total ccs load is prorated between these two sources and only a sufficient number of trunks provided in each group to care for this ccs load. One group of trunks, code 11501, known as universal TX, may be used for passing WH without TX number and other miscellaneous TX calls. By assigning 2-digit TX numbers with a common first digit, in offices otherwise requiring only one, alternate route traffic over ringdown intertoll trunks may be routed from the inward board to the same TX position as first route traffic from dial intertoll trunks.

The code "121" trunks may be arranged for pad control on through calls involving connection to ringdown and dial intertoll trunks. If this feature is desired it would be specified in the Traffic Order.

In small offices, if code "181" trunks are required for toll station traffic handling they may be strapped to the 121 code trunks and the traffic combined on these operator trunks. In the larger offices, segregation of the toll station traffic on a limited number of positions may be justified and, in this case, separate trunks should, of course, be provided for toll station traffic.

Other levels of the auxiliary first and second selectors may be used for trunks to manual tributary offices and to community dial offices. The trunks to manual tributary offices generally appear on jacks in the switchboard as well as on the banks of the intertoll auxiliary selectors. If the number of trunks in a group is ten or less, all of the trunks probably appear in both places. If the number of trunks in a group is more than ten, rotary switches as described in Paragraph 5.20 may be associated with the levels used for groups in excess of 12 or 13 to permit access to all the trunks in a group, thus providing for more efficient use of the tributary trunks from the switches. Access to the entire group with the use of rotary switches is especially advantageous in those cases where the number of auxiliary second selectors in a group is small. A graded arrangement of selectors would require a considerable increase in the number of selector banks and would be difficult to administer.

All community dial office trunk groups are placed on the auxiliary selector banks. Community dial offices reached generally on an intertoll dialing basis are provided with a flashing busy signal with the audible busy signal. In a community dial office provided with a toll train, the flashing busy signal with tone is, of course, provided. (All offices are not, however, arranged to provide both flash and tone to the O.T.C.)

All of the trunks in community dial office trunk groups of ten or less appear on the switches and on the switchboard. Groups of more than ten are treated as covered above for trunks to manual tributary offices.

When one-way trunks appear both on the banks of switches and on jacks in the switchboard the order of test should be in one direction on the

switches and in the other direction on the switchboard. In the case of two-way ungraded trunks which carry a considerable volume of traffic originating at the switchboard appearance of the trunks, it seems desirable to have the trunks appear in one order on the jacks at the switchboard and in the opposite order on the auxiliary selectors at the toll center and on the selectors at the community dial office. If, however, the volume of traffic originating on the switchboard is small or will decrease to a small volume in the near future, it appears desirable to have the trunks appear in the same order at both the switchboard and the switches at the toll center end, and in the other order at the community dial office.

For two-way groups appearing in a graded arrangement on the selector levels in the community dial office, the order of test at the two ends of the group should be in opposite directions. With the standard central office type of grading, the order of assignment at the toll center end to secure this test in the opposite direction should start with the trunks assigned to the terminals immediately ahead of the terminals used for the first common trunk in the community dial office and continue to the trunks on the No. 1 terminals. These should be followed by the common trunks, beginning with those in the middle of the reversal, and proceeding alternately to the left and to the right until all of the commons in the reversal have been assigned and finally by the last common trunk which is outside of the reversal. (See Fig. 88-A)

If the two-way trunk group appearing in a graded arrangement at the community dial office is also graded at the toll office end, the trunks which are individual at the community dial office should also be individual at the toll office but their selection on both intertoll switches and switchboard should be in the reverse order as compared with the community dial office. Similarly the same trunks should be common trunks at the two ends. However, their appearance at the switchboard should be in the reverse order as compared with the switches at the toll office end. (See Fig. 88-B, p. 135)

ZERO LEVEL INTERTOLL SECOND SELECTORS

Intertoll second selectors are 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 10 initially or will be greater soon thereafter.

5.097 INTERTOLL THROUGH SELECTORS

As many intertoll through selector groups are provided as are necessary to provide enough levels 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 group-to-group record for

the circuit groups involved and the Trunk Table. The through selector groups, wherever possible are of the same size to facilitate load balance.

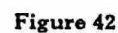
In general, all intertoll trunk circuits in a group of 10 or less appear on the switches and on jacks in the switchboard. If the number of trunks in a group is more than 10, rotary extension switches may be associated with the levels used for groups in excess of approximately 12 to permit access to all of the trunks in a group, thus providing for more efficient use of the intertoll trunks from the switches. Groups of more than 10 may also be graded as covered for ring-down trunks to manual tributary offices 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.

Intertoll through selectors are normally arranged to provide over-flow signals to the calling operator. If these signals are not considered necessary, the intertoll through selectors may be of the intertoll auxiliary selector type which is not arranged to provide these signals. The intertoll through selectors may be arranged to permit from one to a maximum of four operators to wait simultaneously for a circuit in a group. Where toll circuits appear in the switchboard multiple as well as on the banks of selectors, the number of connections that may be held on overflow should be limited to one for each 10 trunks in the group with a maximum of 2.

The number of trunks in each group or in subdivisions of each group in the case where both common and via circuits appear in the group, should be specified in the Traffic Order. If there are two types of trunks in a group, the via circuits should be made first choice. Terminal circuits are not ordinarily provided on the banks of the intertoll through selectors unless they are to be used in giving tributary operators access to direct circuits from the toll center over dialing trunks with a satisfactory grade of transmission to permit connections to terminal circuits. In this case it is necessary to assign one selector level and code for the terminal circuits and another for the via circuits to the called point. If there are also common circuits in the group they appear as last choice in each of the two (levels) locations on the through selectors.

A lamp arrangement to aid in the determination of the time when a delay should be posted on an intertoll trunk group is provided for offices handling switched traffic. This equipment which is located in the operating room, consists of a white lamp which lights when one or more but not all of the overflow circuits are busy, a red lamp which lights when all are busy and includes a key which when operated transfers to master busy all switches waiting for an idle circuit and also all new attempts. (System std. for Ohio CER-517) Recent development, however, permits a switched I.T. Call to seize a vacant circuit in the group even though this key might be operated.

Step-by-Step Dial System Traffic Training Course and Reference Manual



CONTROL CIRCUITS

Trunks appearing on the banks of the intertoll selectors and in jacks on the switchboard require a supervisory control circuit which is an applique circuit to interchange busy conditions between the switchboard appearance of this trunk and the switch appearance of the trunk. This equipment is specified by the Equipment Engineer and is not covered by the traffic order.

The Traffic Engineer must however, specify inter switch ringing control circuits if access is had to ringdown trunks on the banks of the auxiliary first or second selectors. This control feature provides ringing on the ringdown trunks. One control circuit is required for each trunk leading to either auxiliary first or second selectors which provide access to ringdown trunks. If both first and second selectors are used, it is generally more economical to provide access to all the ringdown circuits on the banks of the second selectors and to provide this interswitch control circuit in the trunks leading to these selectors only.

Similar interswitch ringing controls are required for ringdown trunks on the banks of the zero level second or through selectors and the manner of associating them with the selector groups should be the same as covered above for auxiliary selectors.

Figure 42, which follows, shows the equipment arrangement in a typical intertoll dialing installation.

5.098 TOLL TANDEM SELECTORS—REGULAR AND THROUGH

The Tandem first selector is used to extend a call from a toll trunk to another toll trunk. Each switch requires a jack in the Toll Tandem Multiple.

The Tandem Through Selector is identical to the regular I. T. Through Selector covered previously. The purpose of this switch is the same as the I. T. Switch except that only local toll operators have access to it. It is used to extend a call on a thru dialing basis from a tandem dialing trunk to an intertoll dialing trunk or to a ringdown intertoll trunk.

The tandem through selector provides the standard overflow (30 I.P.M.), circuit available (120 I.P.M.) and Master Busy (Irregular 60 I.P.M.) flashes to the toll operator, same as I.T. Through Selector (When Group Busy and Overflow circuits are provided).

The Toll Tandem train is usually provided in those cases where there is a shortage of toll line multiple space in the toll switchboard and/or if by the addition of toll line multiple the resultant "reach" to the miscellaneous multiple becomes prohibitive. The jacks of the Toll Tandem multiple terminate at toll tandem first selectors. Intertoll circuit groups are then terminated on the various levels of this switch and subsequently removed from the Toll Line Multiple. The toll operator must, therefore, dial a single digit tandem code over a tandem trunk to reach a particular I.T. group, as she is no longer able to "pick-up" the desired circuit in the multiple.

Where the standard intertoll busy and flash signals, etc. are desired, a Tandem Second Selector (Through Type) may be associated with one (more if necessary) level of the tandem first. Intertoll circuit groups are then assigned to levels of the Tandem Through Second Selectors. In these cases, the operator must dial a two-digit tandem code in order to reach any one of the various circuit groups so terminated on levels of the Through second.

The toll tandem multiple is arranged for Idle Trunk Indication in trunk groups of five. In other words, in any group of five consecutive tandem trunks (Jacks 0-4, 5-9, etc.) in the tandem multiple, the lowest numbered trunk (numbered upward from left to right) in the group, if idle, will be so indicated to the operator by a lighted trunk lamp. When all five trunks in the group are busy, there will be no associated trunk lamps lighted in the group.

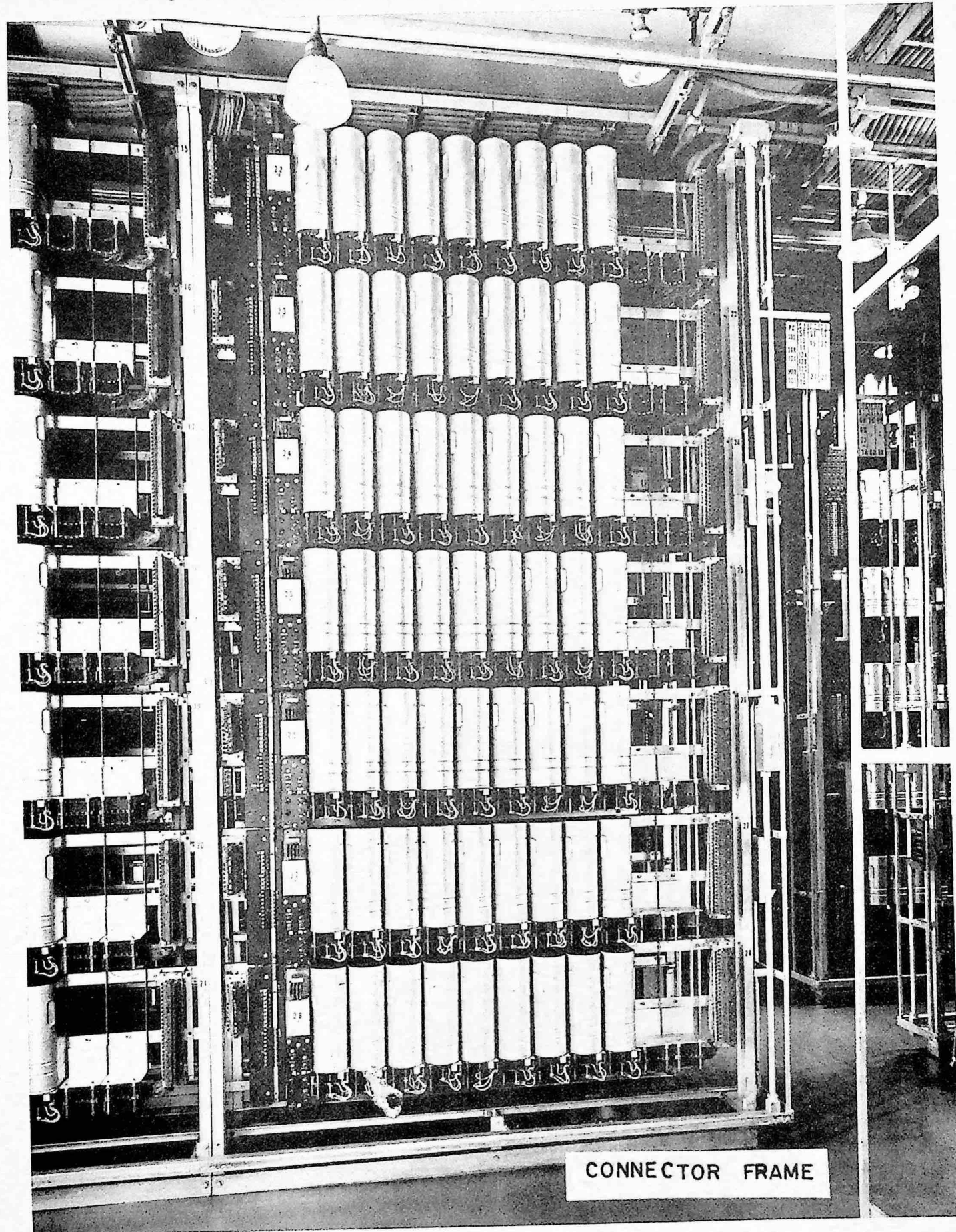
5.10 CONNECTORS

General—The connector switch has little to distinguish it in appearance from other step-by-step switches. It has a larger number of relays associated with it than does the ordinary selector because it has more duties to perform. Connectors are the last in a series of switches in a SXS Office and respond to the "tens" and "units" digit dialed by the calling party. It is essentially a two-digit line hunting switch as differentiated from a selector which is a one-digit trunk hunting switch.

A connector serves to select and connect to the called party's line, provide the proper ringing signal, return an audible ringing signal to the calling party and return the line busy signal if a busy line is encountered. In addition, it maintains supervision over the call in order to signal the other switches in the train when the calling subscriber hangs up and, on a local call, supplies talking battery to both subscribers.

Each connector group has access to 100 connector terminals. Each terminal is connected to a subscriber's line (except test terminal 99) when working. Unassigned terminals are connected to intercepting. Under terminal-per-line (TPL) operation, only one terminal is connected to a line, whereas under terminal-per-station (TPS) operation a terminal is required for each main station and P. B. X. Trunk.

Each level of the local selectors immediately preceding the connectors handles the local terminating traffic to one connector board (100 connector terminals). Corresponding levels of toll selectors which immediately precede the connectors handle the incoming toll traffic to the same 100 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 busy conditions are interchanged so that a local and its corresponding toll circuit may be considered as one trunk for traffic engineering purposes.



Connector frames (bays), upon which the connector boards (groups) are mounted, usually have a capacity of seven shelves and each shelf has space for mounting eleven connectors. The first switch space (to the left) on the shelf is wired as a test connector. The remaining connectors on the shelf are used for completing calls by subscribers or operators. The connectors on one shelf are multiplied and serve a group of 100 terminals. A fully equipped shelf would, therefore, permit completing ten simultaneous calls to that group of 100 terminals. There may be less than 10 connectors provided per group or there may be more. Under heavy terminating traffic conditions more connectors would be provided, under light traffic conditions fewer connectors. Where more than ten are required for subscriber traffic to the group, two or more shelves may be multiplied together, thus providing additional connector capacity. The connector terminals are cabled to and terminated on the horizontal side of the line intermediate distributing frame. From here they are jumpered to their assigned line circuit, as explained in Paragraph 5.033.

In early installations, connectors were mounted on the 9'-0" double sided frames, five shelves per bay. The present frames are usually 11'-6" high, single sided and, as mentioned above, have a capacity of seven shelves per bay. Further, it was not always the custom to cable out the connector terminals in the earlier dial installations. These were TPL type installations with the terminals permanently wired to line circuits with only the Tip and Ring leads cabled to the distributing (Main) frame. These offices did not always have a L. I. D. F.

In some offices, the official lines, to which free service from message rate or coin box lines is to be given, are placed in a separate group of connectors in order to prevent charging the calling party for the call. In offices requiring only a few official terminals, connectors (Rotary hunting type) of a specific board are arranged to give this "free service on specified levels".

There are three general categories of connectors; non-hunting, rotary hunting and level hunting. The various types within these categories and their normal use are shown below.

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, T/S, Local, toll or Combination.	10-Party (Rural Service)
10-Party, T/L, Local or Toll	10-Party (Rural Service)
Rotary Hunting	
1-Ring, local, toll or combination	Smaller PBX groups and consecutive groups of individual lines arranged for terminal hunting.
Level Hunting	
1-Ring, local and toll	Larger P.B.X. Groups

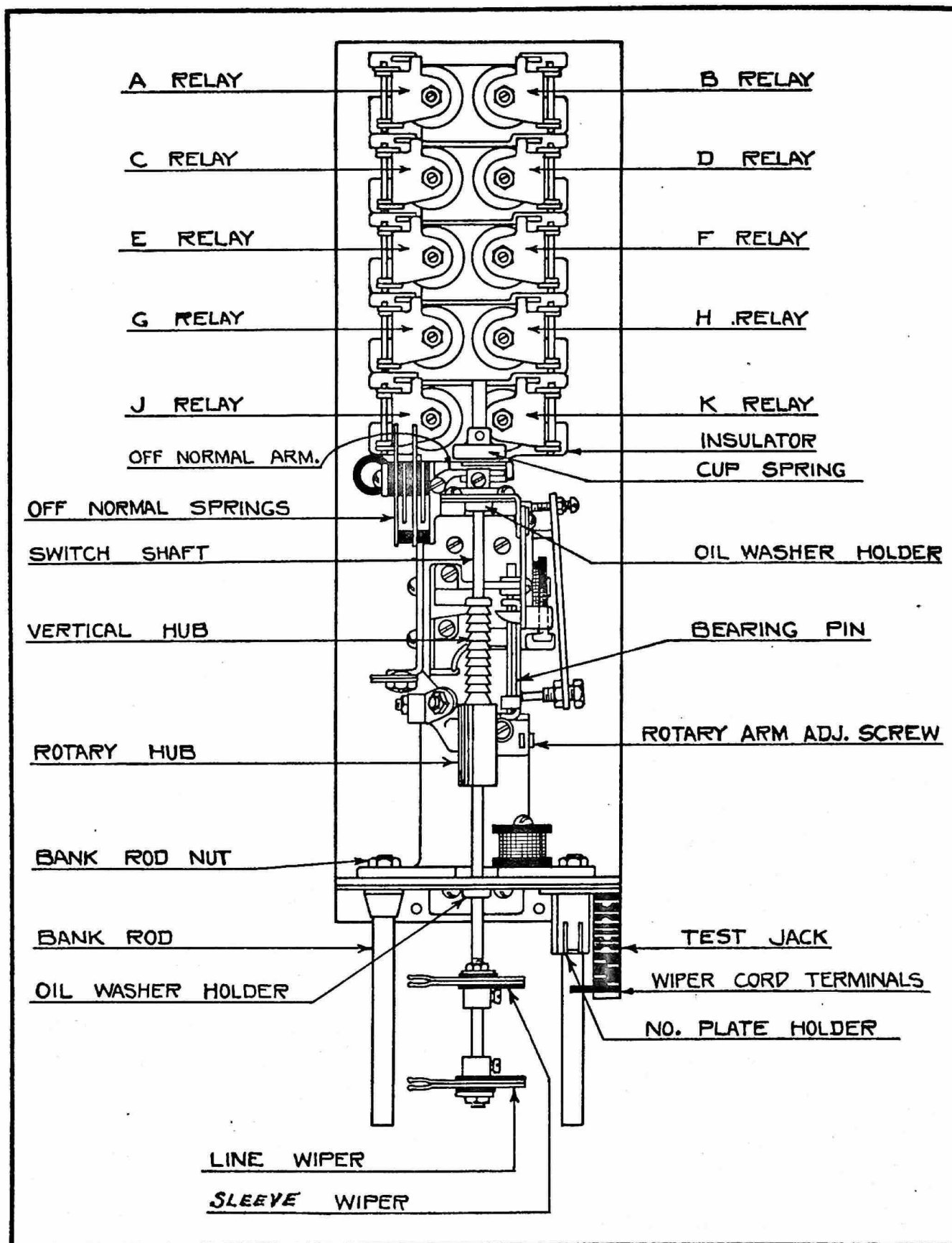
5.1001 LOCAL CONNECTORS—1-Ring and 2-Ring

Local connectors are used on purely local connections and are not used on toll connections. The 1-Ring connector is so designated because it "puts out" only 1 ring (1 long) on the called line during each ringing cycle. A ringing cycle is usually a period lasting 6 seconds, the ring lasting for only 2 seconds. In other words there is a 2 second ring and a 4 second silent interval during each ringing cycle.

There is practically no difference between a 1-Ring and a 2-Ring connector. The major difference is that the two-ring connector has an

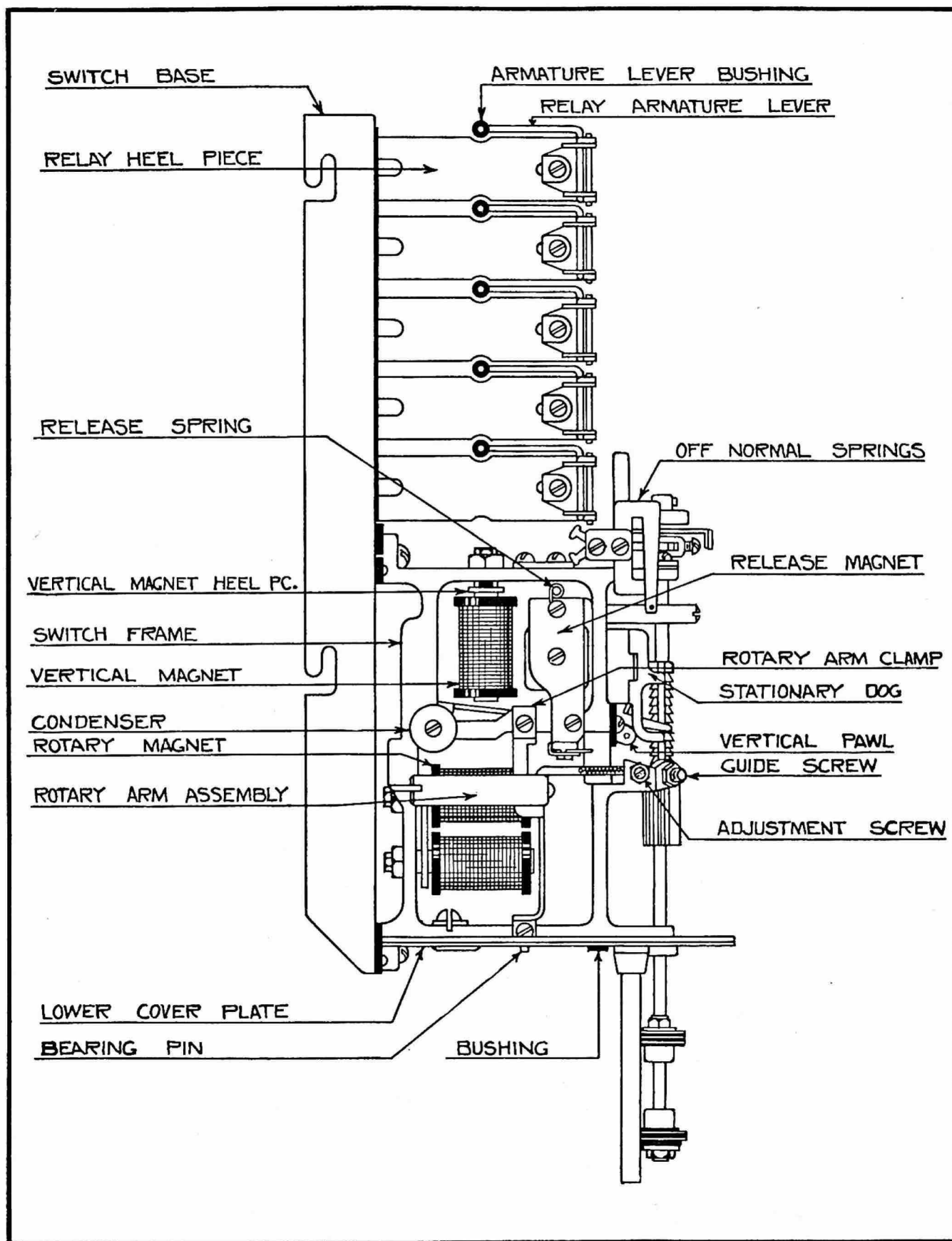
added (J) relay which is operated under control of a "pick-up" (PU) ground. The PU grd. is so arranged that it will operate the "J" relay and place ringing, (2 short rings) on the line only at the beginning of the first of the two rings and thus prevent a possible false ring. Like the 1-Ring switch, the ringing cycle is 6 seconds, with a breakdown as follows:

1" Ring, 1" Silent, 1" Ring and 3" Silent. This is shown graphically in Figure 46. Also shown in Figure 46 are the various ringing intervals most commonly used in SXS terminal-perstation code Ring (Rural) connector boards which will be covered later.



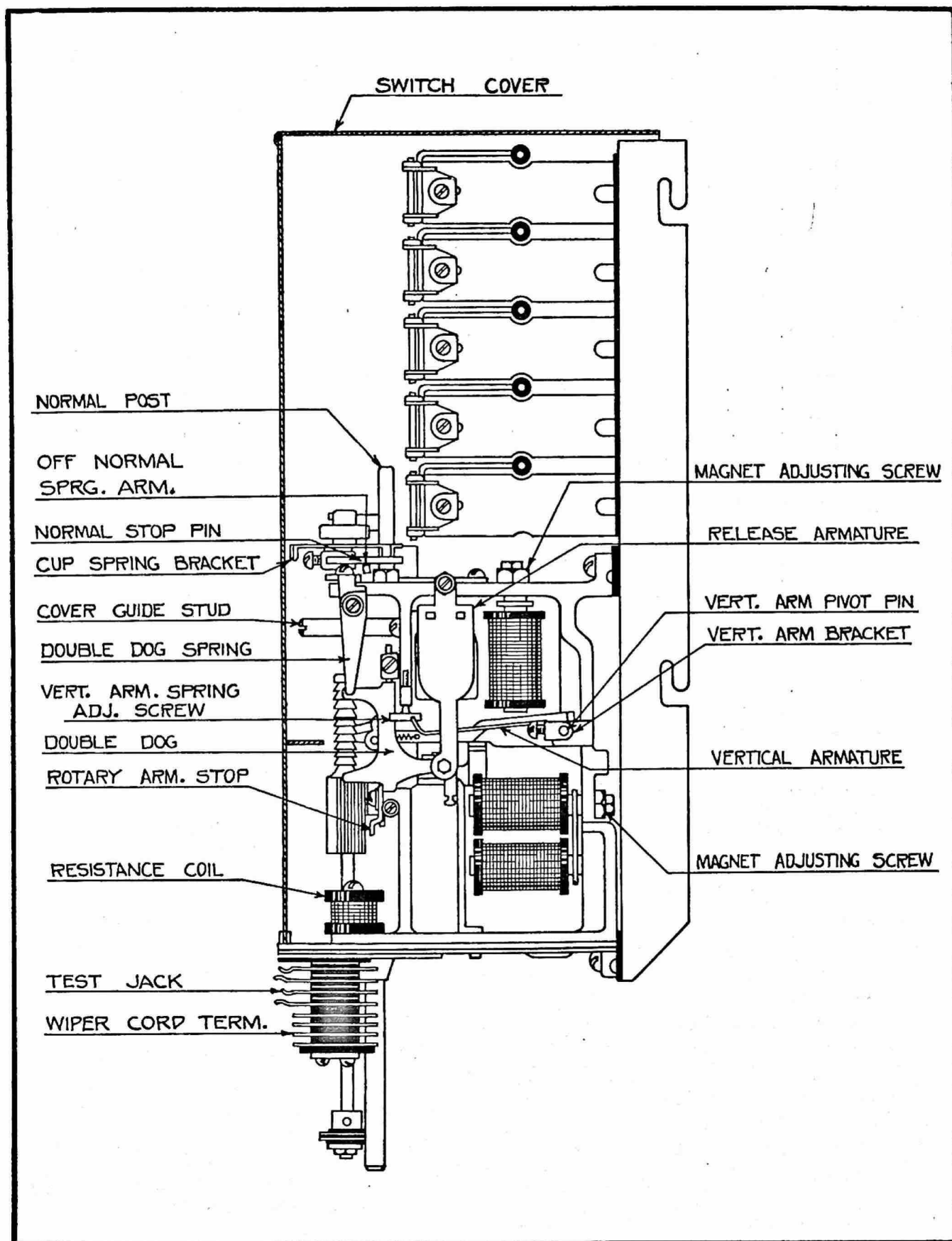
Connector Switch, Front View

Figure 43



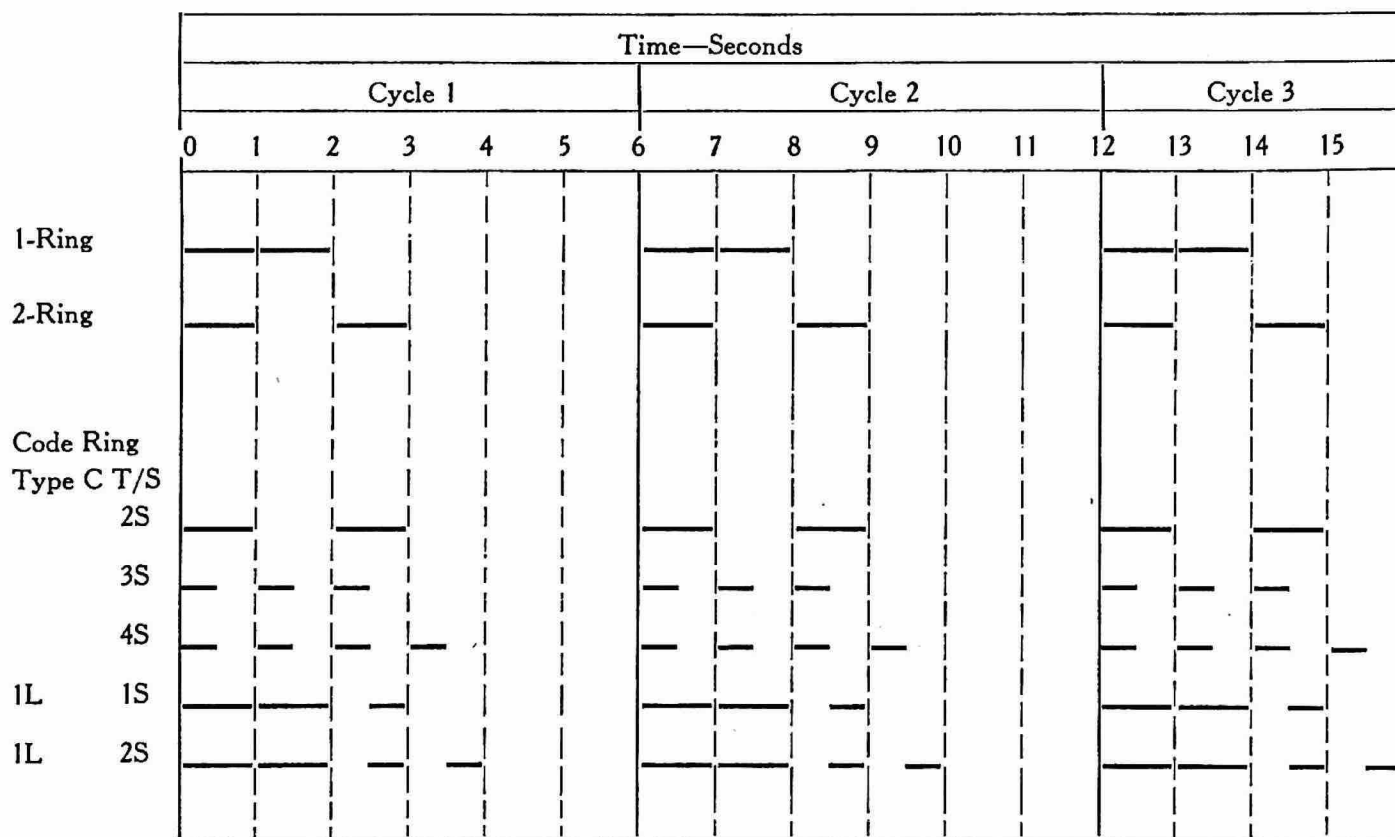
Connector Switch, Left View

Figure 44



Connector Switch, Right View

Figure 45



Ringing intervals most commonly used
in No. 1 SXS Offices

Figure 46

It is not the intent of this course to go into the detail circuit operation of the various types of equipment, however, it is felt that a general description of the operation of the local one-ring connector, at this time, will be helpful in that it will provide a more comprehensive background of the principal functions of a connector switch, keeping in mind that the principal functions of this switch prevail in all other types of connectors.

Since the connector is so similar to the selector, no general description of its mechanical operation is necessary. In the connector we have the familiar A, B and C relays (See Figure 47) and the vertical magnet, which, controlled by the dial pulses, elevate the shaft to the level determined by the numerical value of this digit.

The "vertical off normal" springs on the connector are wired slightly different from the VON Springs on the selectors but act substantially in the same way. The ROTARY magnet circuit is switched into play during the pause while the customer winds up the dial for the last digit.

As the dial pulses for the last digit are received, the ROTARY magnet is operated once for each momentary opening of the pulse circuit stepping the wipers around to the set of terminals on this level determined by the numerical value of the last digit in almost the same way that the shaft was elevated.

The current paths are easily followed on Figure 47, remembering that when the shaft is normal and the first

pulse of the next to the last digit is received, current flows through the VERTICAL magnet and winding of relay C in series, and then through VON contacts 3-5, contacts 2-3 relay B, and contacts 1-2 relay A to ground.

For each succeeding vertical step current flows through the VERTICAL magnet and winding relay C, contacts 3-2 relay C, VON contacts 4-5, contacts 3-2 relay B, and contacts 1-2 relay A to ground.

After relay C releases (just before the last digit is dialed) current then flows through ROTARY magnet and winding of relay E in parallel, contacts on non-operated relays K, G, and C, thence same as before; the result being that the wipers stop on the terminals of the called line if it is idle.

If the called line is busy, its S terminal is grounded.

The T & R wipers are dead (because relay D is not operated) but the S wiper is connected through contacts of relays E and K to the winding of relay G, therefore relay G operates; and, when slow release relay E falls back, relay G locks operated on a path through the contacts of non-operated relay K and the contacts of operated relays E, G and B.

Wiper S may have touched other grounded sleeve terminals as it swept across this level and relay G may have operated momentarily, but it would not lock operated until relay E releases.

This is another good example of using the very small time element in a "slow release" relay to accomplish a desired result.

The operation of relay G connects busy tone through a condenser to the tip of the calling line. The release of relay E also disconnects the winding of relay G from the S lead, leaving relay G held operated by a ground at contacts of relay B; therefore when the calling party hangs up, releasing relays A and B, all the switches in this train are restored to normal.

If the called line is idle, its sleeve will be connected to battery through the 1200-ohm winding of its cut-off relay, therefore relay G will not be operated; and, when relay E releases, connection will be made from the sleeve of the called line, through contacts 2-1 relay E, 125-ohm winding relay K, and contacts on relays G and B to ground, thereby operating the cut-off relay on the called line and relay K in the connector.

Relay K locks operated through its 1300-ohm winding to ground on relay B and puts a ground on the S lead which makes the called line busy to all other connectors while this connection is up.

Machine ringing is supplied through the ringing relay F so that as relay K operates, ringing current is sent out on the ring of the called line and generator ground is connected to the tip.

Relay K also closes "the audible ringing" connection through a 0.04 m.f. condenser to the calling party in the usual way.

Relay F is adjusted so that it will not operate on the ringing current required to ring the maximum number of bells permitted on the shortest line in this office, but will operate either on ringing current or on the "silent interval" direct current when the receiver is taken off the hook at called station.

The ringing current usually used is 20-cycle a.c. superimposed on approximately 16-19 volts direct current and the "silent interval" current is normally 48-volt d.c.

The shunt of 100-ohm non-inductive resistance in series with a 0.1 m.f. condenser placed around the 200-ohm winding of relay F is for the purpose of smoothing the flow of ringing current through this winding and thus preventing the relay from chattering.

Taking the receiver off the hook operates relay F which locks operated on current through its 1300-ohm winding and ground at relay B.

The operation of relay F cuts off the ringing current and closes the talking circuit to the called station; talking battery for the latter being furnished through the two 200-ohm windings of relay D.

The operation of relay D reverses the talking battery furnished to the calling station through the two 200-ohm windings of relay A, the latter remaining operated to keep relay B operated which in turn keeps relays K and F operated.

The reversal of the talking battery to the calling station operates a relay in the primary line switch or line finder circuit which operates the message register once only for this call. This relay locks operated so that while a brief open in the called station's circuit might

let relay D release momentarily and again reverse the current toward the calling station, it would not cause a second operation of the message register.

The talking circuit is now established all the way from the calling station to the called station.

The calling party controls the entire train including the connector as long as he keeps his receiver off the hook, even though the called party hangs up. This provides for the possibility of a brief open circuit condition at the called station due to transferring the incoming call to another station on a P.B.X., plan wiring, etc., without losing the calling party.

When the calling party hangs up first, at the end of the conversation, the entire train is released.

5.1002 TOLL CONNECTORS

Toll connectors are used on toll connections with current supply features suitable for long distance transmission. Toll connectors do not have an automatic ringing circuit, the ringing is controlled by the operator in the case of Toll Switch calls and by the incoming selector and associated control relays in the case of intertoll. This was discussed previously.

5.1003 COMBINATION TOLL AND LOCAL CONNECTORS

Combination connectors are used on both local and toll connections and their use results in economies by permitting, in many cases, an efficient group of connectors for both types of calls instead of inefficient groups, one local and one toll.

Their operation as local connectors was covered in Paragraph 5.1001. The following notes will, therefore, pertain to only the toll portion.

The next to the last set of dial pulses sent by the toll operator directs the connector shaft and wipers to the desired level and the last set of pulses rotates them to the terminal of the desired line.

If the line is busy, the connector will place a 60 I.P.M. ground on lead R back to transmission selector which, as has been explained before, causes the supervisory lamp at the toll position to flash at a corresponding rate, and the Toll Operator will hear the busy tone.

If the line is idle the supervisory lamp will light steadily.

Ringing will not start until the toll operator throws her ringing key which causes the release of a slow operating relay in the connector and starts the ringing of the called station, except on intertoll calls the ring starts automatically.

When the called station answers the ringing is tripped and the T and R leads are connected directly through from the line to the repeating coil of the Transmission Selector and to battery and ground. (Toll Switch Call)



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If the called station hangs up there will be no change in the connector circuit but relays in the Transmission circuit will be operated, as explained before, and cause the supervisory lamp at the toll position to light.

The toll operator may now ring the line again or remove the plug, in the latter case the Transmission Selector will remove ground from lead C and S and the equipment will be released.

The toll operator may also re-ring on a line having its receiver off the hook or on a P. B. X. line having a holding bridge across the line for recalling purposes.

Both 1-Ring and 2-Ring Combination Toll and Local connectors are used. (See 5.10)

5.1004 CODE RING (RURAL) CONNECTORS

Multi-party connectors are usually referred to as Code Ring Connectors and are for use in serving rural lines on a full dial basis. To give this service we must have separate connector groups (boards). As outlined in Paragraph 5.10 these are available for Terminal-per-Line operation or Terminal-per-Station operation. The latter is the most common type used in our No. 1 type SXS Offices. Some T/S rural boards are equipped with a combination of both local code ring and toll code ring connectors. Recently a combination toll and local T/S code ring connector was developed which has the same advantages as the combination one and two-ring switches mentioned previously.

Terminal-per-line equipment is considered as generally unsatisfactory since only partial intercepting service can be provided.

Ten-Party, Divided Code, Terminal-per-Station dial facilities provide a 5-code divided ringing system for use on multi-party lines. With this arrangement, half the stations will be rung at one time. Any station can be associated with any connector terminal (rural board) in the multi-party line group. Intercepting service can be given, also.

Reverting call switches are not required with this type of rural equipment. To make a reverting call, the subscriber dials the listed number, receives the busy signal and hangs up. The T/S connector recognizes the fact that both calling and called stations are on the same line, releases the line finder (or line switch) and selectors involved in the connection, but remains up 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 the first station trips the ringing.

Ten-Party; Divided Code, Terminal-per-Line facilities provide a 5-code divided ringing system for use on multi-party lines. With this arrangement, as in the case of the 10-party T/S equipment, half of the stations will be rung at the same time and, therefore five ringing codes are

required. An additional numerical digit is required for each subscribers' line number to determine the ringing code to be applied. This latter arrangement utilizes what is known as a "Minor switch" which is built into the connector switch circuit. It has its own rotary and release magnets and is equipped with a 10-point bank, to which are terminated the ringing codes.

Intercepting facilities for intercepting particular party on a line (Selecting Circuits) are available. These circuits are quite expensive and as a result they are usually provided only in limited quantities. Number changes and disconnects are, therefore, only associated with this equipment for a short time.

Ringing Code "A" Leads—Sufficient ringing code "A" leads are provided in T/S offices to serve the type of development to be assigned in the multi-party groups. These leads are usually terminated on the L.I.D.F. from which the assigned code is jumpered to the "A" terminal of the telephone number, the "A" terminal being the fourth wire off the T/S Rural connector board bank. (400 point). The code ringing supply enters the connector switch via this "A" lead and thence, back on the ring wiper to the called line. Later installations place interrupted ground on "A" leads for desired code ring.

Ringing code "A" leads are not required with T/L code ring connector boards.

The ringing codes generally provided in our No. 1 and No. 355-A type offices are:

Party on Line	T/S S X S No. 1	T/L S X S No. 1	T/L or T/S S X S 355-A
1	2-S (R)	1-L (R)	1-L (R)
2	2-S (T)	2-S (R)	1-L (T)
3	3-S (R)	3-S (R)	2-S (R)
4	3-S (T)	4-S (R)	2-S (T)
5	4-S (R)	1L, 1-S (R)	3-S (R)
6	4-S (T)	1-L (T)	3-S (T)
7	1L, 1-S (R)	2-S (T)	1L, 1-S (R)
8	1L, 1-S (T)	3-S (T)	1L, 1-S (T)
9	1L, 2-S (R)	4-S (T)	4-S (R)
10	1L, 2-S (T)	1L, 1-S (T)	4-S (T)

L = Long Ring; S = Short Ring;

R = Ring Side of Line; T = Tip Side of Line

The ringing cycle intervals for the No. 1 SXS T/S ringing codes is shown in Figure 46.

5.1005 HUNTING CONNECTORS—ROTARY AND LEVEL HUNTING

Hunting Connectors — Rotary Hunting Connectors are employed to serve consecutive groups requiring terminal hunting and P.B.X. groups which are not large enough to warrant level hunting equipment. Other classes of lines may be assigned in rotary hunting groups as covered in 5.10 under "Types of Connectors and Connector classes".

The rotary connector is capable of hunting over a maximum of 10 subscriber lines or trunks. If P.B.X. systems of more than 10 trunks are to be served, graded arrangements as covered in T. C. 279, may be employed or level hunting connector groups provided. If graded arrangements are used a minimum of one connector shelf per 10 P. B. X. trunks or fraction thereof (in the largest group) is necessary. At least two connector shelves are generally provided to serve groups of 11 to 15 trunks and three shelves to serve groups of 16 to 20 and, too, an arrangement so that the traffic per shelf, local and toll will be approximately equal.

Level Hunting connectors are capable of hunting over a maximum of 99 (100 less one test terminal) P.B.X. trunks in complements of 10 and are used to serve groups too large for rotary hunting groups. Separate subgroups of local and toll level hunting connectors are provided.

The equipment method of arranging level hunting connector shelves and levels is outlined in P.E.C. 320. (This, however, is more of an Engineering responsibility). One level is required for each 10 trunks or fraction thereof in the P.B.X. trunk group. Not more than one P.B.X. group may be assigned to any one level. Terminals in excess of the working terminals (trunks) in the levels assigned are usually tied back to working trunks of the P.B.X. assignments, so that each terminal on the level assigned is connected to a working trunk.

The local level hunting connector is arranged to start hunting as soon as the dialing of the "tens" digit has been completed.

Plans are available whereby P.B.X. Groups of over 99 trunks may be served on level hunting connector boards, however, since we seldom encounter groups of this size, the details will be omitted.

Small P.B.X. Trunk Groups

If less than 10 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 and no listed number can 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. "100" group is the forty-first hundred, the bottom row of terminals on the connector

bank would normally be lines 4111 to 4110, the lines on the second level 4121 to 4120 and on the third level 4131 to 4130. Assume, also, that all 30 of these connector terminals are required to serve a group of trunks to a P.B.X. The first group of connectors will have the first three levels arranged as has just been stated. The second group of connectors will have lines 4121 to 4120 on both the first and the second levels with lines 4131 and 4130 on the third level. The third group of connectors will have lines 4131 to 4130 on the first and third levels with lines 4121 to 4120 on the second level.

The number that will be dialed to obtain any one of these trunks will be 4111. If this call is to be completed through the first group of connectors, that particular connector will step up to the first level and will thereupon hunt over lines 4111 to 4110 for an idle trunk to the P.B.X. If a connector in the second group is used for the call, it will step up to the first level and hunt over lines 4121 to 4120 and if a connector in the third group is used, it will hunt over the lines 4131 to 4130. In this manner access is provided to each of the trunks in the P.B.X. group.

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 10—placing 10 trunks on the local connectors and the other 10 trunks on the toll connectors. Obviously, this method tends to give the subscriber inefficient incoming service and such an arrangement is not recommended.

A connector equipped to serve a larger group of P.B.X. trunks is known as a level hunting connector, as previously mentioned. In this case, the trunks are connected to the various levels consecutively. The listed number is the first terminal on the first level. This type of connector will hunt completely over the first level, restore to normal if there is no idle trunk on that level and then by means of a commutator and a "recording switch", which is mounted on the connector, will step to the second level and hunt over that. This is continued over the various levels until an idle terminal is reached or until all trunks in the group have been tested.

5.1006 TEST CONNECTOR

Test connectors provide a means for routine testing of subscriber's lines by the Plant Maintenance forces and, too, they enable operators to verify busy reports. The test connector is so arranged that it will establish a connection to a set of terminals, on the test connector bank, even though they test busy. The test connectors are reached from the Wire Chief's Desk (or Local Test Desk) through a "Plant" Test Distributor (See Paragraph 5.17), or from the operator's switchboard position through a Verification test (No Test) trunk to a "Traffic" Test Distributor.

The Test Connector circuit is quite simple compared to other connector circuits as you can see from Figure 50.

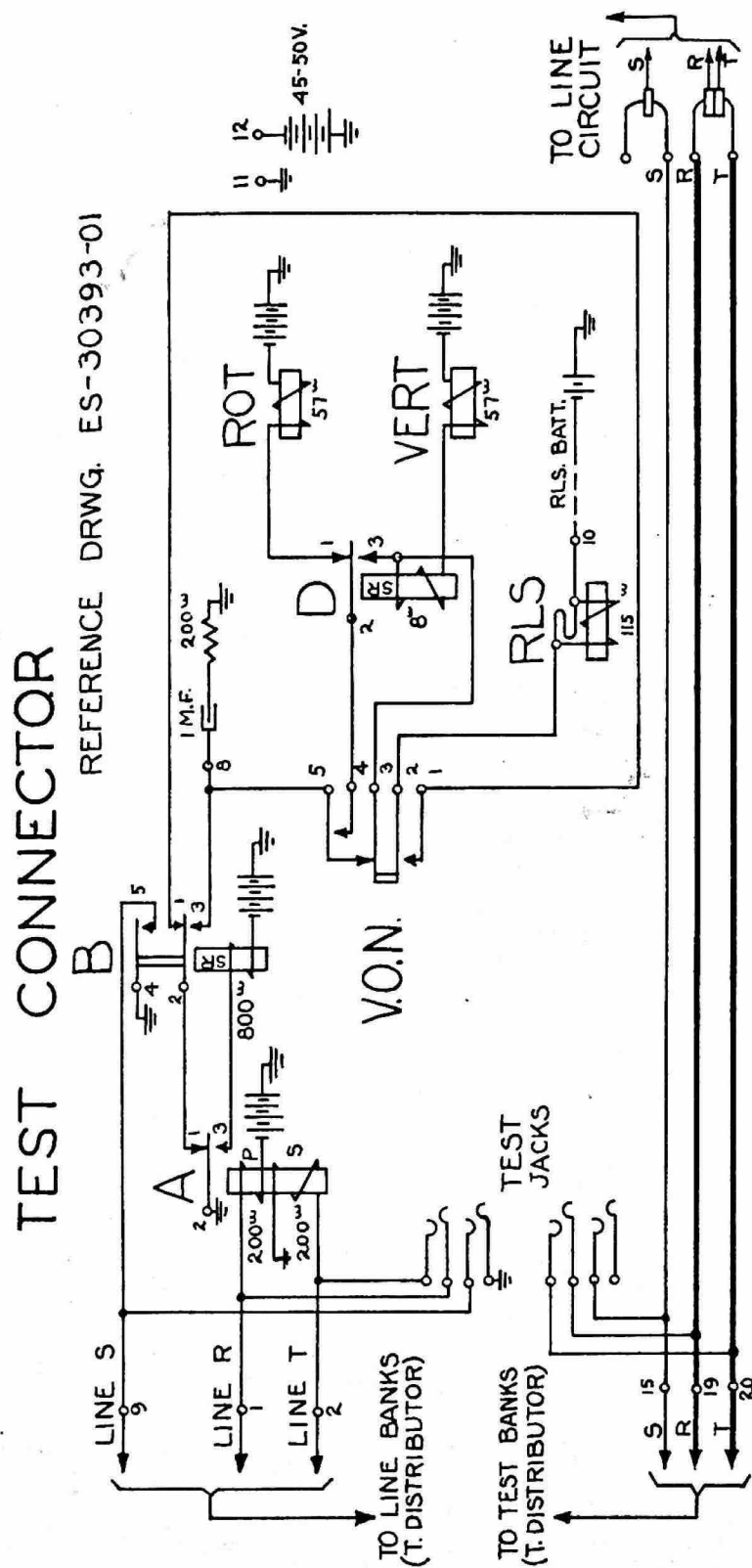


Figure 50

5.11 TRUNKS PRECEDING FIRST SELECTORS

General

Dial coin service may be given on individual lines with either single-slot or multi-slot coin boxes on a prepayment basis. Where conditions require, it is also possible to give single-slot prepayment coin service on two or four-party lines. All classes of calls which can be made from flat rate lines may be made from coin lines.

Coin Lines Handled on a Dial Basis

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 the dial tone was heard when the receiver was removed from the switchhook.

The methods of operation for the "coin first" type of prepayment coin service is outlined briefly, as follows.

The calling party will be instructed to deposit a coin, remove the receiver from the switchhook 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, re-dial the desired number or service code.

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. As an exception, if an intercepted call is completed through the intercepting position, the coin will be automatically collected after the calling party hangs up, as on any other completed call.

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 subscriber 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 may be collected.

5.1101 COIN BOX TRUNK CIRCUIT—PRE-PAY

The purpose of this circuit is to provide means by which calls can be made from pre-payment pay stations in a Step-by-Step office area.

Its principal functions are:

1. To connect the pay station—through its line switch (or line finder)—to a first selector, thus providing the customer with dial tone.
2. To prevent the transmission of dial pulses until after the coin has been deposited.
3. To automatically collect the coin on completed calls to stations on which a charge is to be made.
4. 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 switch, or line finder, to this trunk circuit.

5.1102 MESSAGE RATE SERVICE

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 and 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 dial 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. As an exception, if an intercepted call is completed through the intercepting position, registration will be effected as on any other completed call.

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 T. O. P. covering the operation of these positions.

register wired to the sleeve of the connector terminal (See Figure 18) in parallel with the cut-off relay of the line circuit, and a Message Register Trunk per Figure 51 is wired between each line finder and its first selector serving message rate lines.

When the called party answers, a reversal of battery from the connector toward the calling station operates the polarized relay S impressing, momentarily, the higher voltages on the message register. It operates and then locks on 48 volts, preventing any further registration on the call.

Where message rate service on direct lines is given, each message rate line is equipped with a message



Post-pay type coin lines are usually provided for the smaller community dial areas, since the cost of pre-pay coin facilities, and associated central office equipment, is prohibitive for only a few coin stations.

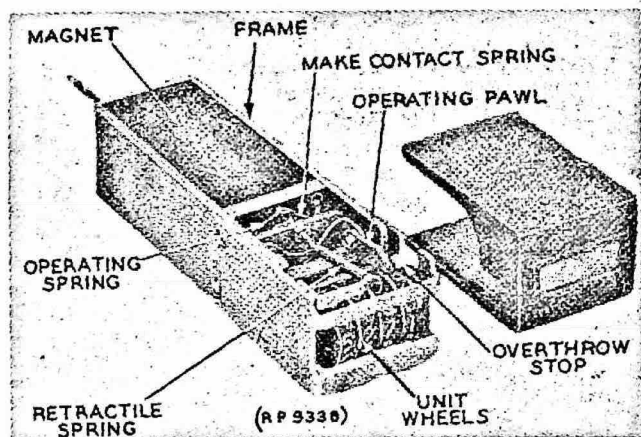
On assistance calls, calls for information, Repair Service, or the Business Office, and on long distance calls, coin customers will proceed the same as flat rate subscribers.

In the 360-A type community dial offices, a special arrangement known as the "Manual Post-pay" is utilized. In this case the subscriber will remove the receiver from the hook as on a call from a manual station. A rotary type selector, associated with each such line, automatically routes the call over the operator office ("0" Code) trunks to an operator at the Operator Office. This operator, after taking the calling party's order, will attempt to establish the connection. On completed calls, she will request deposit of coin and subsequently collect in accordance with the standard operating practice for the office.

If all operator trunks are busy at the time the calling party originates a call, the line busy signal will be heard.

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

There are three types of registers most commonly used in the dial central office, the 5, 12 and 14 types, which are electrically operated and used for both line (message) and traffic purposes. (The No. 10 type which is a manually operated register, is used extensively in the toll central offices). A No. 5 type register is shown in Figure 52. This register consists in its essential form of a geared counting mechanism, operated by an electromagnet. Each of the four number wheels of the counting mechanism is figured 0 to 9, thus permitting a total count of 9999. When the armature is operated, the operating pawl attached to it engages the ratchet wheel of the "units" wheel, and moves it clockwise 1/10 of a turn. A stop pawl and an overthrow stop prevent excessive backward and forward movement of the units wheel. As a protection against dust, the meter end of the register is enclosed in a removable black finished cover which is provided with a window.



No. 5 Type Register

Figure 52

The 12 and 14 type registers are practically of the same construction as the No. 5 type. From an external appearance stand point the three registers are identical. The figures on the number wheels of the 14 type have a pronounced difference, however. The 12 and 14 types were designed for high duty service, such as peg count and counting registers, where the very large number of operations make it desirable to employ a register having an increased life.

In most offices, the traffic registers are centrally located on a Traffic Register Rack located either in the central office or in the switchroom. The most recent arrangement for mounting registers, as covered in P.E.L. 4810, consists of a floor supported cabinet 6'6" high, 2' wide and 7 $\frac{3}{4}$ " deep which may be placed against a wall. The cabinet has a capacity of 300 registers. Patching jacks are provided for associating the registers with the register control circuits.

5.131 PEG COUNT REGISTERS

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

They are specified, as follows:

Line Finders. One register for each line finder group. This register scores each time a line finder is released. Machine attempts are, therefore, counted.

Trunk Finders. One register for each trunk finder group. Operation same as for line finders.

Selectors. One register per 30 selectors where the group does not exceed 30. One register per 20 selectors or fraction thereof for groups of over 30. Registers are 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 register circuits for digit absorbing selectors differ from those used with regular selectors which operate each time a selector is released. Circuits used with selectors which absorb any first digit received cause the register to operate each second time the selector is released. For other types of digit absorbing selectors, the register scores each time the selector connects to an idle trunk; i.e., registers on "cut-through."

Registers to be associated with digit absorbing selectors are, therefore, specified separately by type.

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.

Time Announcement Trunks. One register for each trunk. Scores each time a time announcement trunk is used.

5.132 LAST TRUNK BUSY REGISTERS (L.T.B.)

Last trunk busy registers score each time the last choice trunk of a group or sub-group is seized. One last trunk busy register is provided for each subgroup or group to the toll operator, special service operator, information operator, time or weather announcement trunks; and on interoffice trunk groups not through Out-Trunk switches. 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.

5.133 ALL TRUNKS BUSY REGISTERS (A.T.B.)

All trunks busy registers score each time all trunks of a group become busy simultaneously. One register is provided for each line finder group, each trunk finder group and each subgroup of either rotary or plunger out trunk switches.

5.134 OVERFLOW REGISTERS (OFL)

When desired, overflow registers may be provided for the purpose of obtaining data on busy subscriber lines or P. B. X. trunk groups. Two types of registers are available, one for use with rotary hunting connector groups in obtaining data on individual lines or P.B.X. trunk groups of 10 or less trunks, and the second for use with level hunting connector groups in obtaining data on P.B.X. trunk groups of any size. No satisfactory means is available for obtaining these busy line or group data on P.B.X. trunk groups of more than 10 trunks in rotary hunting hundreds or on lines in regular connector hundreds. 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 register is usually provided for each trunk hunting group.

5.135 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.

5.136 (SUBSCRIBER) LINE MESSAGE REGISTER

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 per cent spare registers. The registers score the number of calls originated by and completed by the measured station. For further detail concerning measured rate service and equipment, see Section 5.1102.

5.14 PLUNGER OUT TRUNK SWITCHES

Trunks from first selectors may go direct to second selectors or to connectors in the same office, or through repeaters and interoffice trunks to selectors or connectors in distant offices.

In the latter case, should the number of trunks to any one office be ten or less, this arrangement would be alright; but, in case of twenty or more trunks to any distant office, their operation in small groups of ten each would not be as efficient as it would be to combine all the trunks to the distant office into one group.

Figure 53 illustrates an arrangement that is possible, but very uneconomical, whereby the 80 trunks from 8 groups of first selectors are taken direct to repeaters and interoffice trunks to one distant office.

Here, even though the busy hour traffic through each group of first selectors might be enough to give a full

load to its ten trunks, the combined busy hour traffic through the 8 groups would not be apt to give a full load to the 80 inter-office trunks if worked as a single group, for the same reasons given in the discussion of primary and secondary line switches earlier in Section 5.

Figure 54 illustrates how the trunks from these 8 groups of first selectors might be taken to Out Trunk Switches and the trunks from the latter to the repeaters, thereby permitting the operation of all the trunks to the distant office in a single group. The resultant gain in efficiency would permit the satisfactory handling of this same traffic on fewer trunks—possibly half as many as would have been required without the Out Trunk Switches.

In this arrangement the cross connection of the trunks from the first selectors to the Out Trunk Switches would follow the same plan as the cross connection of trunks from primary line switch groups to secondary switches in order that the traffic might be distributed as uniformly as practicable over all these interoffice trunks.

The Out Trunk Switches and their master switches are similar to the secondary line switches and their master switches, but do not have as many relays and their operation is simpler.

The number of Out Trunk Switches in any one group may be varied (within certain limits) to provide the correct amount of traffic for its trunks.

Figure 55 is a schematic drawing of the circuit of one Out Trunk Switch of a group with the master switch and the relay equipment for that group.

The functions of the Out Trunk Master Switch and its operation are similar to those of the Master Switch associated with Secondary Line Switches; but sufficiently different to justify the following description.

One function of the Out Trunk Master Switch is to hold the idle plungers of all the Out Trunk Switches in its group in front of an idle trunk to the repeaters.

Another function of the Out Trunk Master Switch is to prevent calls from coming to its group when all its trunks to the repeaters are busy. This latter function is performed very simply by substituting ground for battery on the Open Main lead thereby "making busy" all idle trunks from the several selectors into this group.

There is no need for the Kick Off and Pick Up circuits provided on the Secondary Master Switches.

The Out Trunk Master Switch does not oscillate continuously when all its trunks to the repeaters are busy; because these trunks are each provided with a chain relay which operates when its trunk is seized and when all ten are operated they cause the operation of a relay that stops the master switch on the last trunk seized and the ground on the S lead of this trunk operates the relay which substitutes ground for battery on the Open Main.

As in the case of the Primary and Secondary Master Switches, the Out Trunk Master Switch bank has 10 contacts (trunks to repeaters). When one of these trunks is seized, the M.S. causes all other plungers then standing in front of that trunk to be moved away immediately to trunk 8, or to the next idle trunk, to avoid double connections.

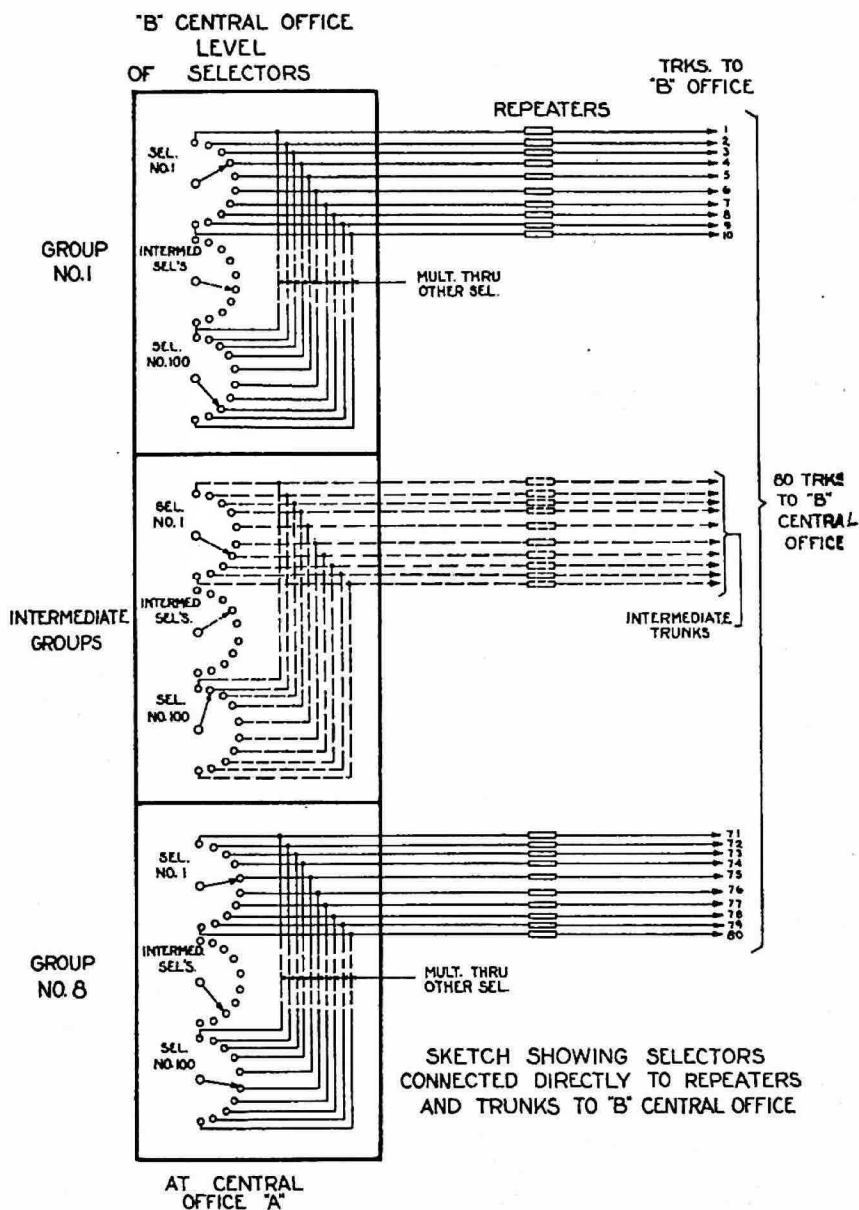


Figure 53

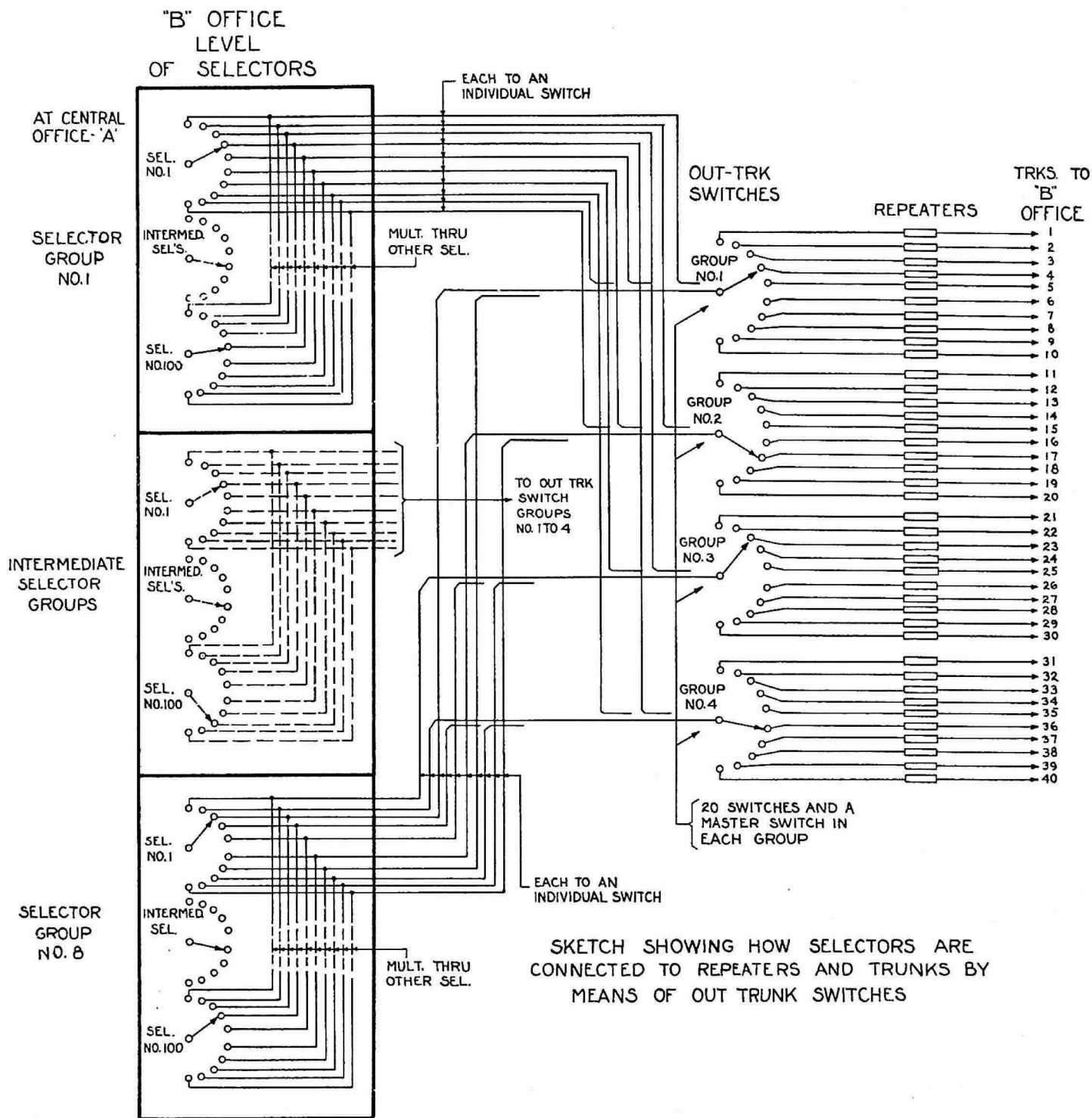


Figure 54

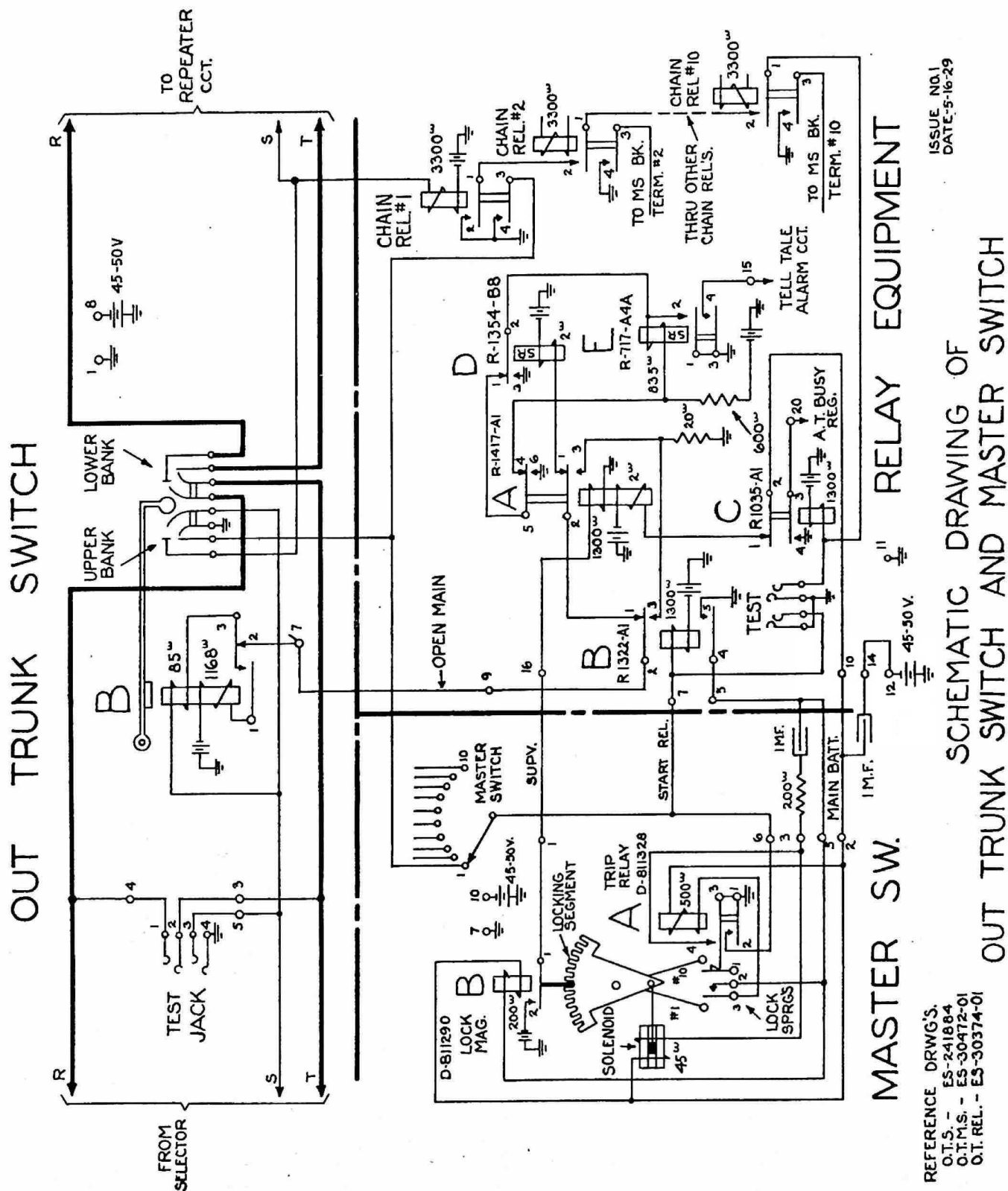


Figure 55

While not affecting the operation of the Out Trunk Master Switch which is now being described, it should be mentioned at this time that as soon as connection is made to a trunk repeater, the latter's A and B relays operate, putting a ground on lead S. This in turn operates a chain relay associated with this trunk and puts an auxiliary ground on the Out Trunk Master Switch bank terminal. This provides a convenient means for making this trunk and its repeater busy by grounding the S lead at the repeater.

The master switch selects trunks in the order from 10 to 1. When trunk 1 is seized, the M. S. will return all plungers (idle) to trunk 10, or to the next idle trunk below 10.

Should all trunks be busy, all chain relays would be operated, thereby operating Stop Relay C. This takes battery off the Out Trunk Master Switch, holding it on the last trunk to become busy (whatever its number) until a trunk becomes idle, at which time relay C would release and the Out Trunk Master Switch would move to the idle trunk.

Alarm circuits in the Out Trunk equipment advise the Plant Maintenance people of any circuit or equipment failures soon after they occur.

5.15 ROTARY OUT TRUNK SWITCHES:

As mentioned in Paragraph 5.14 under subject "Plunger Out Trunk Switches", trunk concentrating facilities provide a means for combining a

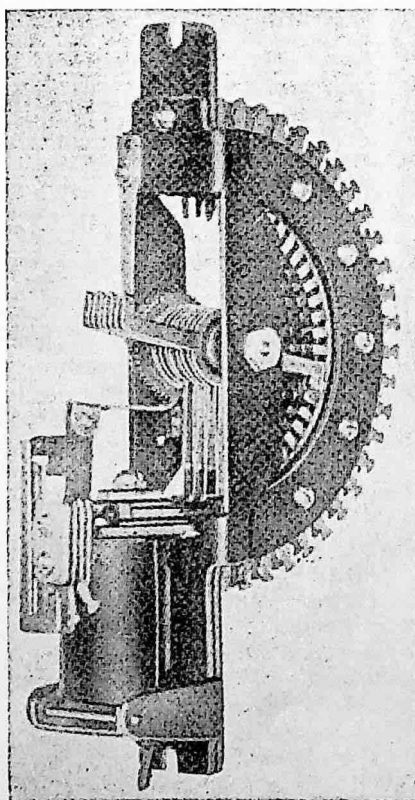


Figure 56

multiplicity of trunks or trunk subgroups into one large group. Such a combination results in increased trunking efficiency and, therefore, provides for equipment and outside plant savings. These savings, in terms of annual charges, will need to equal or exceed the cost of the concentrating equipment before its use becomes economical. The 22-point rotary switch is a more recent development for this trunk concentration arrangement. It is sometimes referred to as "a 200-type selector."

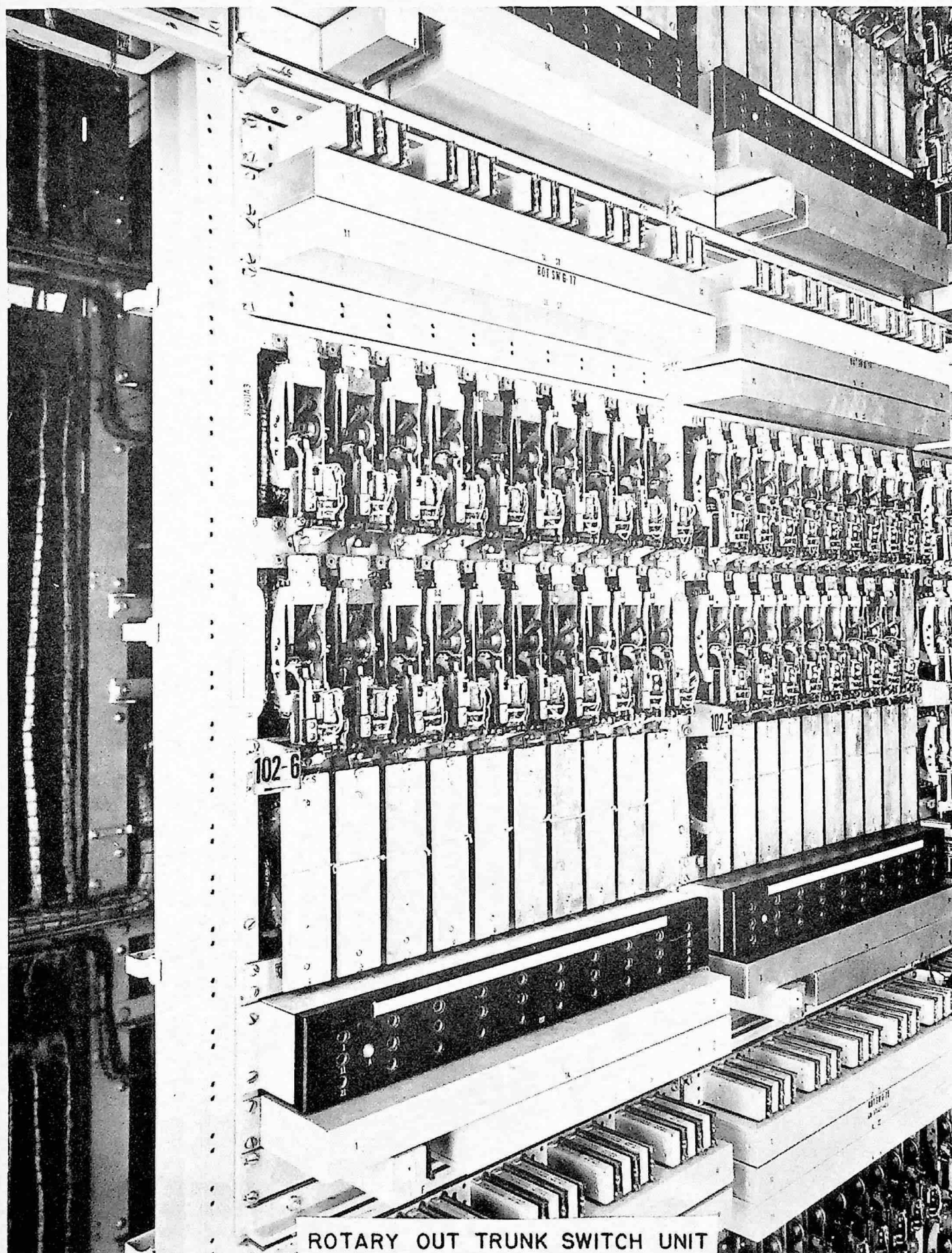
In the case of either the rotary or the plunger out trunk switches serving interoffice groups, the cost studies made by the Equipment and Traffic Engineers would normally compare the annual charges of the cable pairs and terminating selectors saved. The charges on cable are a function of mileage, type of conductors and loading; and it is, therefore, the usual procedure of our Traffic Engineers to consult with the Equipment Engineer when preparing these studies.

Figure 56, shows a picture of a Rotary Switch.

Rotary out trunk switches are 22-point selectors arranged in units with a capacity for 10 switches per unit. See Figure 57. Two or three of these units are multiplied together to provide switch capacity for a subgroup of 21 or less interoffice trunks. One of the 22 terminals on each switch is required for maintenance purposes, thereby limiting the capacity per out trunk switch unit to 21. Two or more 21 (or less) trunk subgroups are combined in a definite fixed pattern to result in larger trunk groups.

(See Paragraph 5.25 for a more detailed description of the Rotary Out Trunk Switch (206 and 209 types)).

The arrangement for rotary out trunk switches is such that some of the early choice selector multiple trunks of each selector subgroup are terminated directly on outgoing repeaters. These are referred to as "direct trunks". The remaining selector multiple trunks are each connected to a rotary switch. The banks of the rotary switches are connected to all out-going trunks in the group including the direct trunks. Hence, a considerable portion of the traffic is provided access to the trunk group over direct trunks, by passing the rotary switches. The remainder of the traffic is provided access via the rotary switches which may select other "direct trunks" which are idle or trunks terminated on the rotary switch banks. These latter are sometimes referred to as "secondary access trunks. See Figure 58.



ROTARY OUT TRUNK SWITCH UNIT

Figure 57

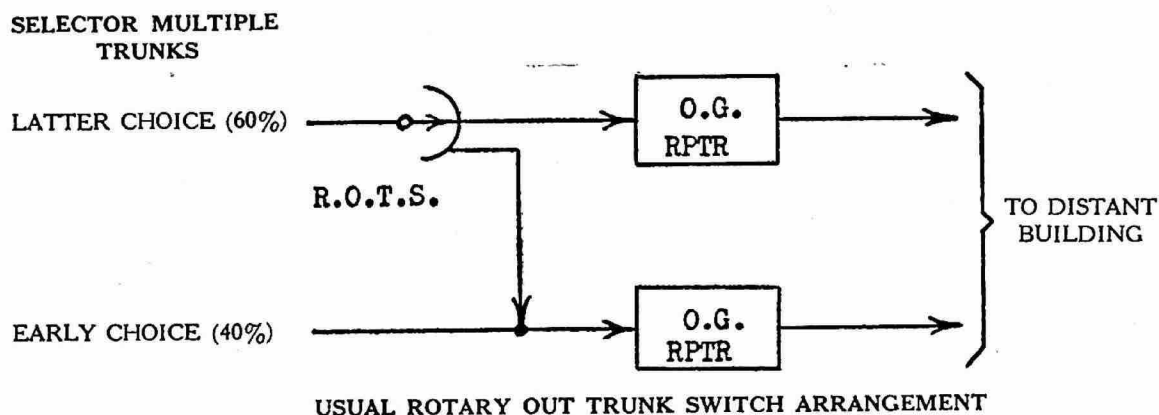


Figure 58

Rotary type switches have many uses throughout telephone plants. They are used in conjunction with Slow Answer Recorders, Automatic Usage equipment, in timing circuits of various kinds, sometimes as line switches (such as the manual coin box lines mentioned previously), in test sets, as allotters when associated with line finder groups in the Community Dial Offices, etc.

5.16 REVERTING CALL SWITCHES

Figure 59 shows a picture of a Reverting Call Switch. These switches (sometimes called selectors) are provided to enable one station on a party line to dial another station on the same line, except in the case of Terminal-per-Station Rural which has been covered in Paragraph 5.1004, in response to a dialed code.

These switches are also arranged, usually, to permit an employee, by dialing the correct ring-back code, to ring the bell of the particular station from which he is calling and thus make a ring test of that bell.

To reach a particular party on his line he dials a special number 119 plus either a single digit or a two-digit number instead of the number listed in the directory. After the number has been dialed the calling party hangs up which causes both his and the called party's bells to ring alternately. When the call is answered the ringing ceases, this indicates to the calling party that the called party is on the line; he then once more removes his receiver and begins the conversation.

The reverting call switch does not release on the first restoration of the receiver—that is, previous to the ringing period—and will not release until the parties have finished talking and both have hung up.

All types of reverting call switches are mounted on shelves having a capacity of ten switches each. Common equipment occupies the space of one switch on the first shelf.

In offices where Service Code Selectors are not provided, the reverting call switches are reached by dialing a first selector level.

The following tables indicate the codes to be dialed, following Code "119". Tables I and II apply to No. 1 and 350-A T/S type equipment. Table III will be used in most community dial offices for T/L Rural, and Table IV in offices employing harmonic type ringers:

TABLE I

		CALLED PARTY			
Calling Party	Party Desig.	1	2	3	4
	(1)	-7	-1	-9	-4
	(2)	-1	-8	-3	-0
	(3)	-7	-3	-9	-6
	(4)	-4	-8	-6	-0

TABLE II

		CALLED PARTY			
Calling Party	Party Desig.	1	2	3	4
	(1)	-11	-16	-12	-17
	(2)	-61	-66	-62	-67
	(3)	-21	-26	-22	-27
	(4)	-71	-76	-72	-77

TABLE III

Party Desig.	CALLED PARTY									
	1	2	3	4	5	6	7	8	9	10
(1)	-11	-12	-13	-14	-15	-16	-17	-18	-19	-10
(2)	-21	-22	-23	-24	-25	-26	-27	-28	-29	-20
(3)	-31	-32	-33	-34	-35	-36	-37	-38	-39	-30
(4)	-41	-42	-43	-44	-45	-46	-47	-48	-49	-40
(5)	-51	-52	-53	-54	-55	-56	-57	-58	-59	-50
(6)	-61	-62	-63	-64	-65	-66	-67	-68	-69	-60
(7)	-71	-72	-73	-74	-75	-76	-77	-78	-79	-70
(8)	-81	-82	-83	-84	-85	-86	-87	-88	-89	-80
(9)	-91	-92	-93	-94	-95	-96	-97	-98	-99	-90
(10)	-01	-02	-03	-04	-05	-06	-07	-08	-09	-00

TABLE IV

		CALLED PARTY			
Calling Party	Party Desig. and Ringing Frequency	1	2	3	4
		(33 $\frac{1}{3}$)	(50)	(66 $\frac{2}{3}$)	(16 $\frac{2}{3}$)
	(1 (33 $\frac{1}{3}$))	-7	-1	-2	-3
	(2 (50))	-1	-8	-4	-5
	(3 (66 $\frac{2}{3}$))	-2	-4	-9	-6
	(4 (16 $\frac{2}{3}$))	-3	-5	-6	-0

Where a customer does not know the correct code to dial in order to reach a particular party on his line, he can reach this party by dialing code "0" and telling the operator the number of the party desired and that this party is on his line. The operator will ask the calling customer to hang up and will then dial up the number over her Toll Switch Multiple. The calling customer is further instructed to come back on the line after a minute or so.

Figure 60 is a schematic drawing of the Reverting Call Switch with interrupter circuit.

5.17 VERIFICATION TEST DISTRIBUTORS

The verification test distributor is a selector switch used for verifying busies. The toll operator can go in on any idle "No Test" trunk assigned to a particular office, or Unit, and dial the desired number (4 numerical digits of the number). The first digit dialed propels the test distributor to the level corresponding to the digit dialed. The second digit will cause the switch to rotate horizontally to the bank contact of that level which agrees in number to the second digit. If this contact is busy there will be a ground on the S contact of the bank and the Operator will hear busy tone when she restores her dialing key. If the trunk is not busy, the test connector in the particular connector board will be seized. The final two digits will be disposed of in the test connector, as covered in Paragraph 5.1006. If the line dialed is busy, the cord supervisory lamp will retire on seizure of the "final terminal" and the Operator will hear conversation.

The above type distributor, since it utilizes a 100-point bank can, therefore, accommodate 100 different connector boards, or groups. Occasionally, where an office is small, it is possible to use a

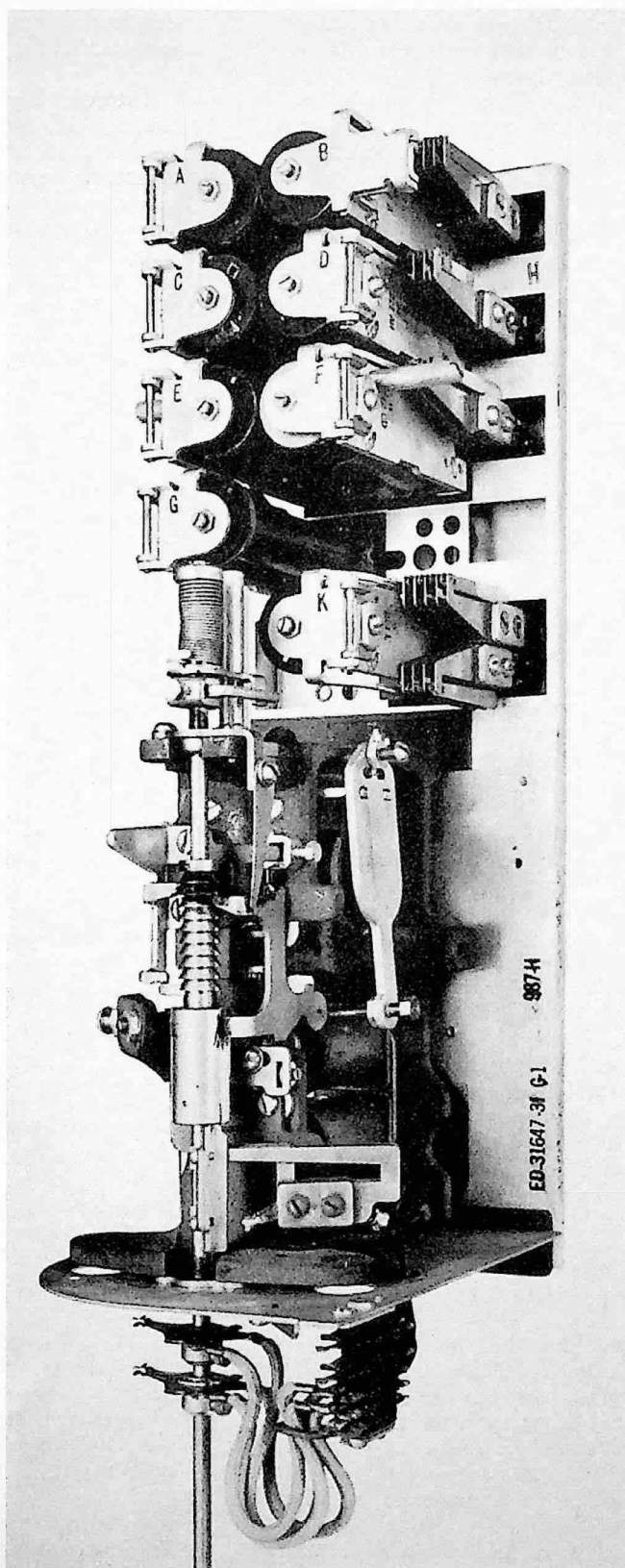
distributor arranged for selector operation. In other words, the switch will automatically cut-in (on rotary) after dialing the first digit into it.

Test Distributors are provided in several community dial offices, also. Access to these is usually accomplished by dialing "0" on the incoming Operator Office Selector, level "0" of these selectors being trunked to the test distributor, or distributors. (The Operator must, of course dial the desired number after having first dialed the digit "0".)

Plant Test Distributors function in a manner similar to the verification test distributor and the multiple banks on both distributors are wired in parallel. The Testman plugs in on a trunk to reach the distributor and, after dialing the 4 digits of the number, proceeds to make plant tests, including "Wheatstone" bridge tests if he so desires. The plant test distributor utilizes a different wiring option than that used for verification testing, however.

5.18 INTERCEPTING EQUIPMENT

General: Calls to vacant terminals, vacant toll selector levels and vacant local selector levels affected by directory errors, calls to stations which have been disconnected or have had the numbers changed, and other calls which are being intercepted for any reason, will be routed to intercepting operators. All unused connector terminals are also wired to intercepting trunks. Upon receipt of a call resulting from any of the above conditions, the operator will inform the calling party that the number dialed has been changed, disconnected, no such number, etc. In case of a changed number, the operator will give the new number to the calling party before disconnecting.



REVERTING CALL SWITCH

Figure 59

Intercept trunks may terminate direct on jacks in the multiple, however, they are usually routed via concentration equipment, thence to the Intercept positions for trunking economy. The early installations of No 1 SXS utilized Plunger type concentrators, whereas the more recent offices are equipped with line (trunk) finder type concentrator facilities.

Connector terminals are associated with intercept trunks at the H.I.D.F. by two methods.

1. "Hair-pin" jumpers between vacant terminals.
2. Strap wires between connector bank T, R and S terminations and the T, R and S terminations, respectively, of the intercepting trunk.

Figure 61 represents Method 1 and Figure 62, Method 2. The intercept trunks are usually assigned one trunk per connector board. In other words, all vacant terminals in a group will be bridged together under either Method 1 or Method 2. The trunk is then terminated either on a line plunger or a line circuit in the concentrator.

The trunks terminate on what would be equivalent to the line circuits in a subscriber's line finder unit. The trunk finder is associated with a trunk to the Intercepting operator. In the case of Plunger equipment, the Master Switch bank contacts (trunks) terminate at the Intercept positions.

Provision is made in each No. 1 SXS office for vacant selector level intercepting, by terminating two or more intercept trunks on a miscellaneous terminal strip located at the top of each selector bay terminal assembly. When it is necessary that a vacant level be intercepted, the first two (or more) contacts of that level on each shelf involved are grouped together. Then with these two (or more) contacts grouped, 3-wire jumpers are run from the terminal assembly punchings (rear side) of the upper-most shelf in the group to the two, or more, intercepting trunks which had been pre-terminated at the Miscellaneous terminal strip mentioned above. These trunks terminate at the intercepting concentrator equipment in the same manner used for vacant connector terminals. Separate type trunks are required for local vacant selector levels and for toll vacant selector levels.

After it has been decided that it is no longer necessary to intercept calls on the vacant local selector levels, the 3-wire jumpers are moved at the miscellaneous terminal strip from the intercept trunk punchings to other punching on the same strip, designated "No Such Number Tone" or "Vacant Level Tone". In the case of vacant toll selector levels, the S (sleeve) terminal of all contacts on the level will be grounded, this causing a switch that has been stepped to the vacant level to rotate to the 11th rotary position (overflow position) thereby causing the toll operator's cord supervisory lamp to flash at the rate of 120 I.P.M. In community dial offices not provided with a "toll train" the operator, under such a condition, will hear regular "busy tone".

Figure 63 is a general schematic of the intercepting arrangement normally provided in our larger SXS offices.

Intercepting facilities are also provided in Community Dial Offices. Trunk concentration in these cases is done by means of a 200-type (rotary) selector. Separate trunks to the operator may be used, or, if this is not feasible from a cost point of view, the intercepted calls are routed to the operator via the operator office trunks. A particular party on a T/L multi-party line may be intercepted by the utilization of a circuit known as the "Selecting Circuit". Only a few of these "selecting circuits" are provided in an office. Thus, when used, these are connected to a line for only a short period of time (two to four weeks) after which they are moved to another number which has just been disconnected. They may be "set" to intercept any one of the ringing codes by means of strap wire arrangements on a small terminal strip located on the relay rack unit.

Each Intercept Trunk concentration unit is usually furnished with a few "individual" intercepting trunks. These trunks are associated with a particular connector terminal to which a great number of calls are made. For example—suppose a 3-line rotary P.B.X. group is discontinued or that the customer's number is changed. Rather than strap all three of these terminals to the common trunk for that particular connector board, each terminal of the 3-line group is assigned to an "individual" intercept trunk and with the "rotary straps" left in place. With this arrangement, as many as three simultaneous calls may be intercepted, whereas, had the common trunk been used, the 2nd and 3rd call would have received the "busy" tone. (See Fig. 63)

5.19 REPEATERS:

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 three-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 over such a trunk in series with a long subscriber loop. Also 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 out-going 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.

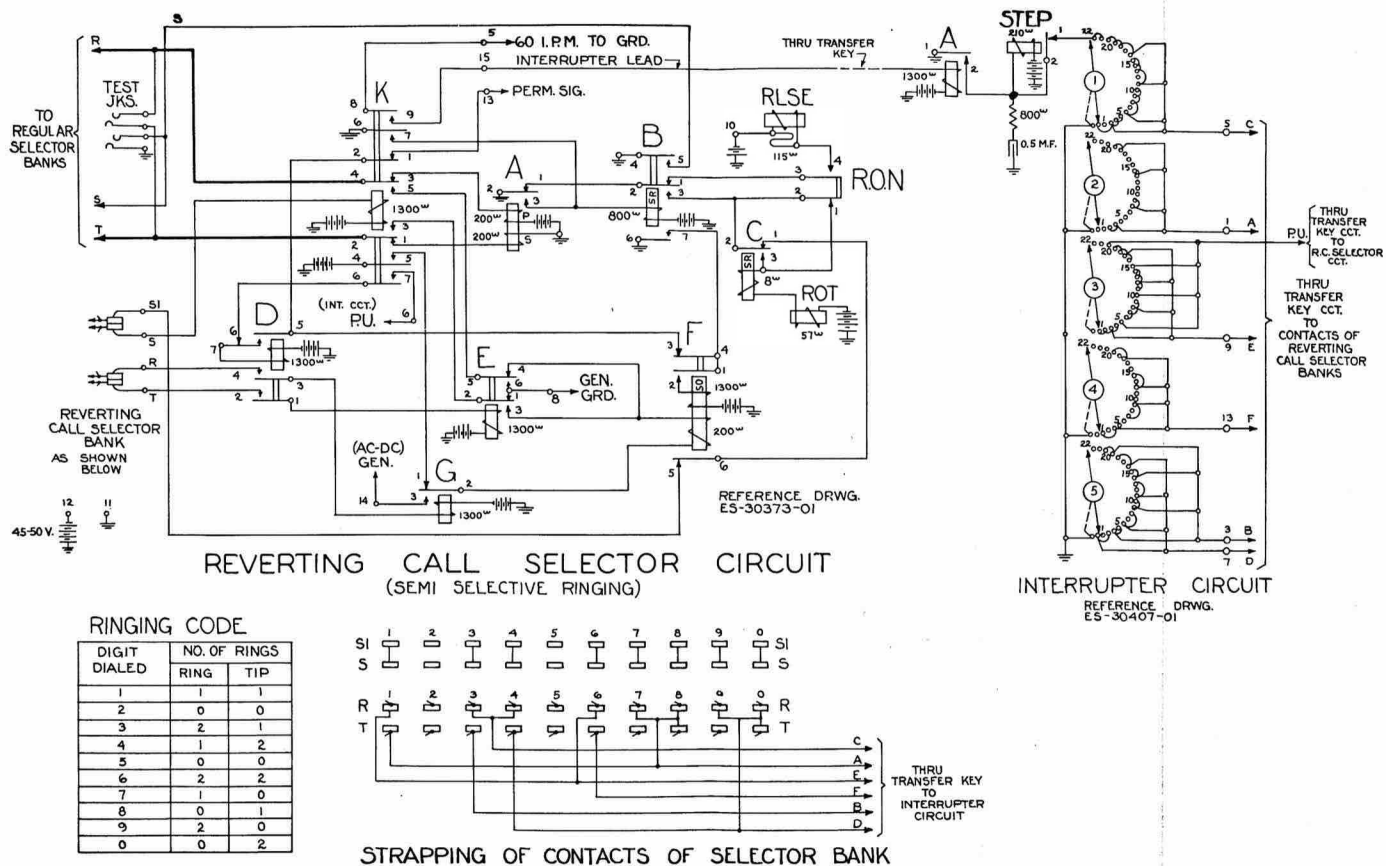
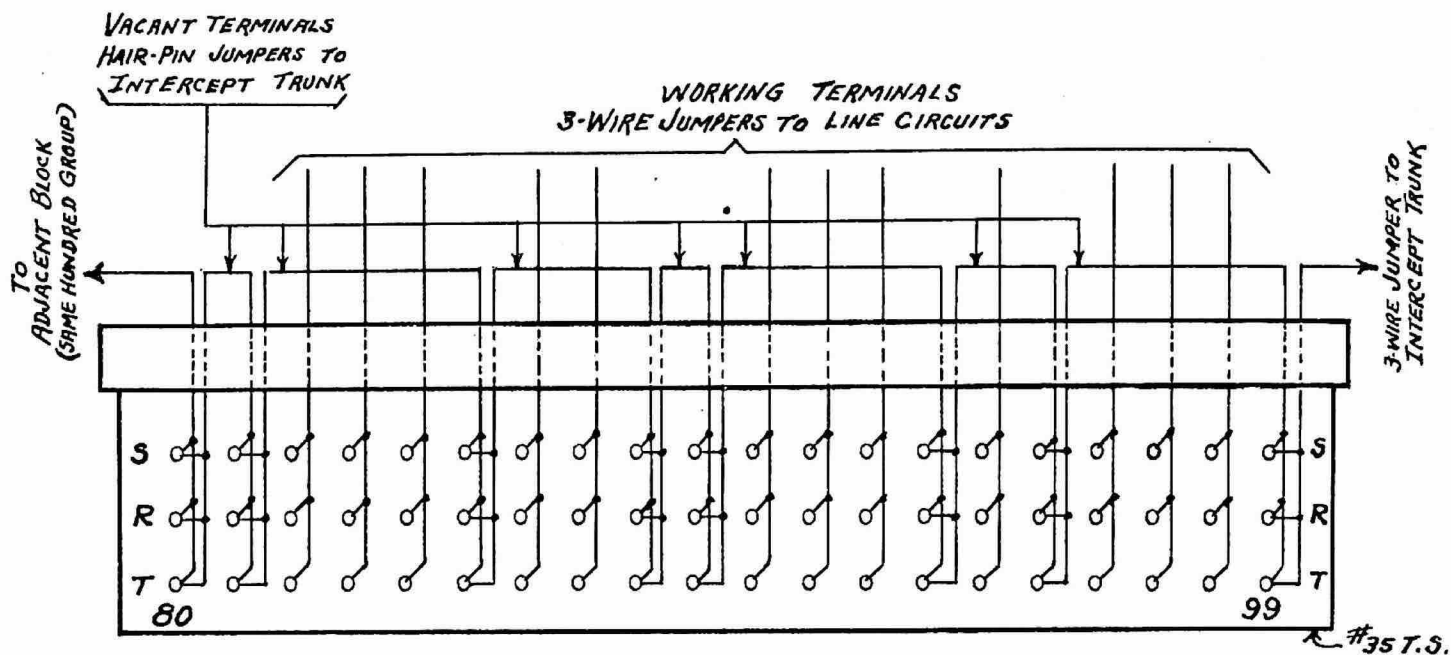
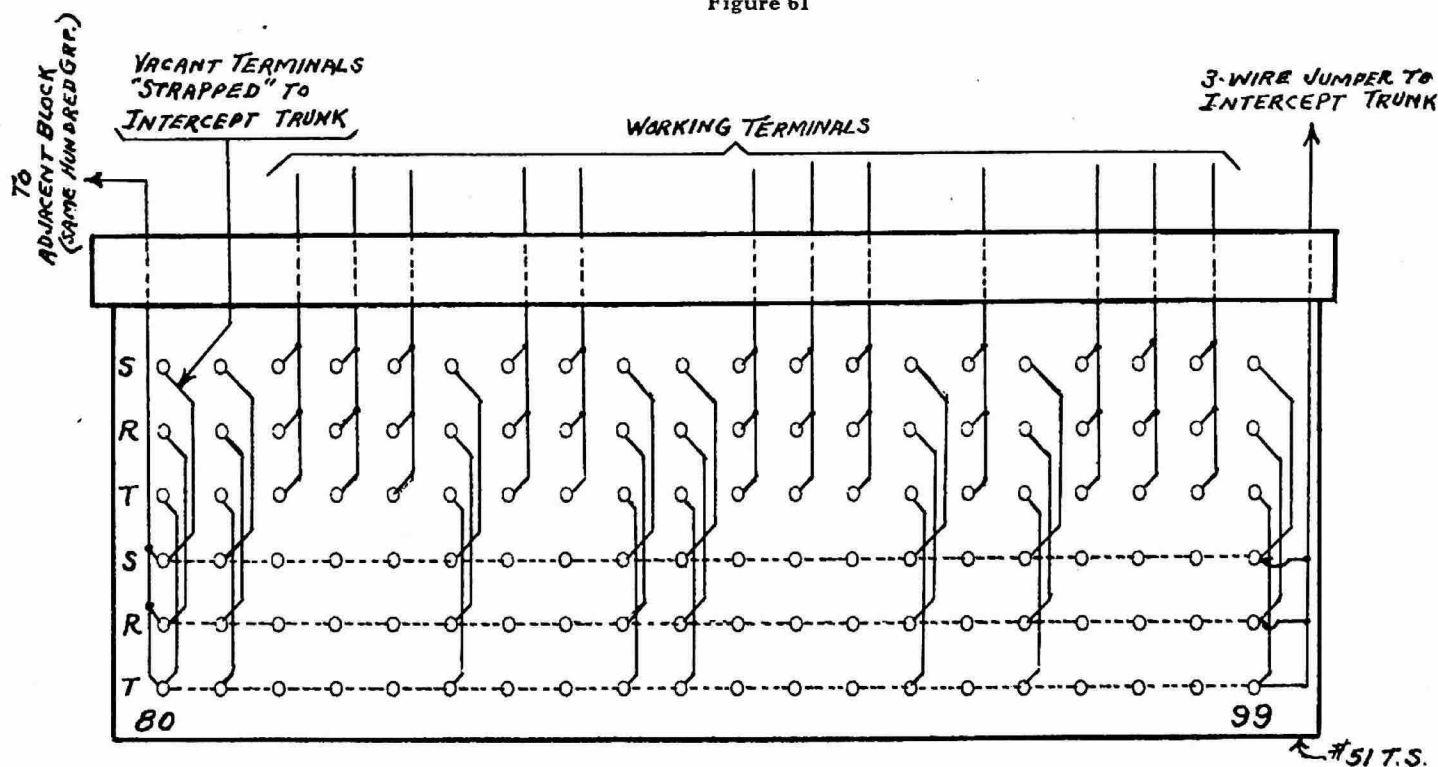


Figure 60



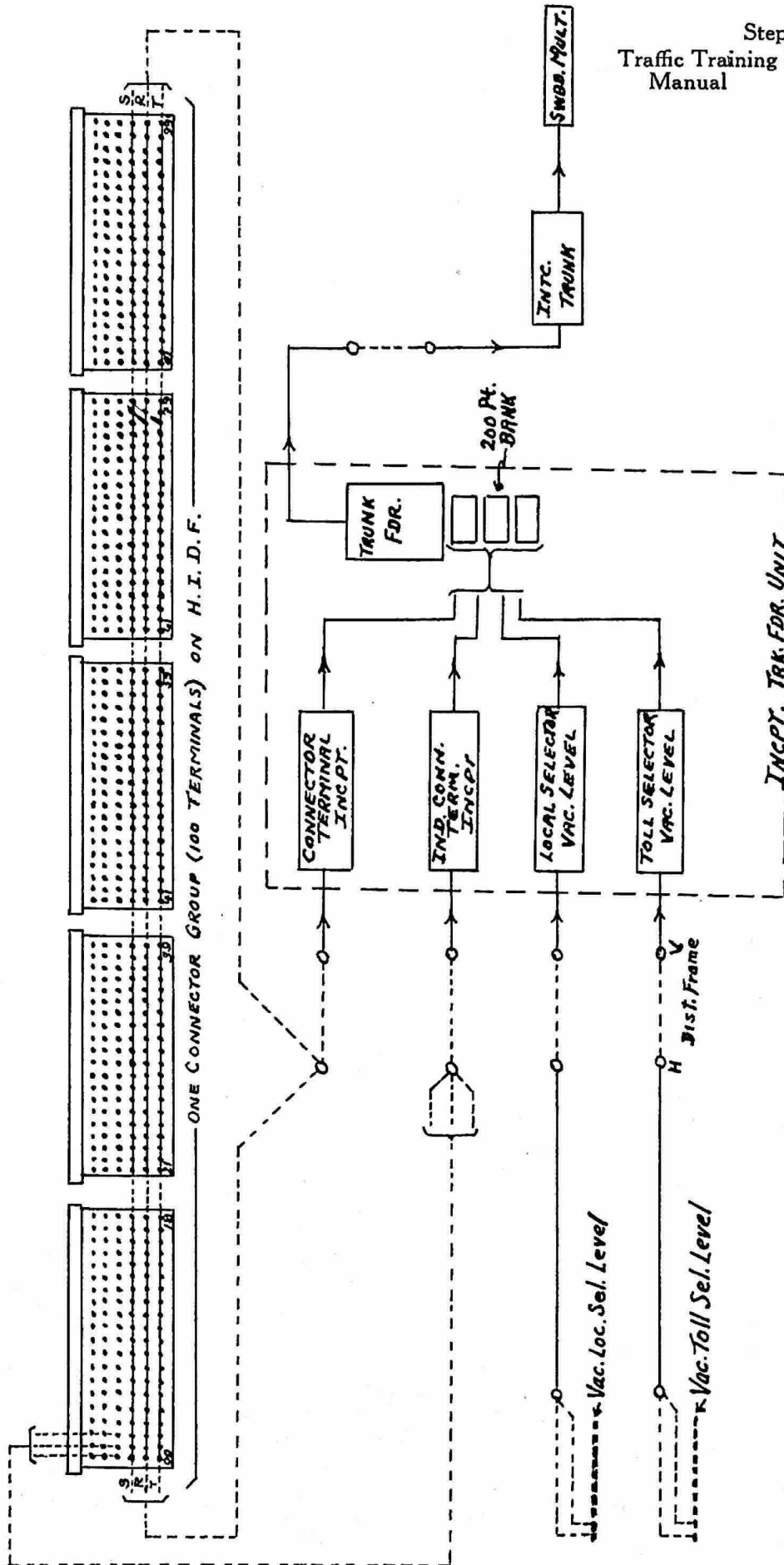
Sketch showing how vacant terminals are connected to intercepting trunks at terminal block on H.I.D.F.

Figure 61



Sketch showing how vacant terminals are connected to intercepting trunks at terminal block on H.I.D.F. using strap wires.

Figure 62



Battery for dialing and for talking is furnished the calling station through relay A at 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 the A relay of each successive incoming selector and finally through the A relay of the connector at the terminating office.

The called station's talking battery is furnished through the D relay at the connector just the same as on calls not trunked through a Repeater. The holding circuit is controlled by means of an electrically polarized relay in the Repeater. Repeater switches consist only of relays and condensers and do not have the switching mechanism of selectors and connectors.

A schematic circuit drawing of the repeater is shown in Figure 64. Figure 65 is a picture of the Repeater with cover removed.

The average outgoing repeater will not always re-transmit 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 will 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.

5.20 ROTARY EXTENSION SWITCHES (TOLL APPLICATION)

Rotary type switches, very similar to those covered in Paragraph 5.15, are used in connection with toll trunking to gain access to large groups of trunks. As explained before, these switches, with associated banks and relays, are provided in units of either ten or twenty banks (usually the former) and are equipped with rotary switches as required to meet the estimated traffic flow. The proposed trunking scheme to these switches is usually covered in the traffic order.

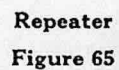
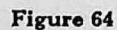
Where switch access is had on the banks of either the through selectors or the auxiliary selectors to groups of approximately 12 or more intertoll, tributary, or community dial office trunks, the provision of rotary switches makes it possible to secure access to all of the trunks in a large group on a step-by-step selector level of ten terminals. This rotary switch is provided with noble metal contacts to reduce noise and provides access to 22 trunks. This switch is of the pre-selecting stay-put type, and, therefore, hunts over the terminals in order from low numbered to high numbered trunk and then repeats.

A separate series of switches is necessary for each level of a group of through selectors or auxiliary selectors on which access is to be had to a large group of trunks. Thus, for example, a through selector group may provide access to eight groups of less than ten trunks without the aid of rotary switches and to two large groups with the aid of two sets of rotary switches, one for each level.

The method of associating the rotary switches with the terminals of a level provides for bringing the bank cabling of all of the selectors in a group to a terminal strip on the end of the selector frame where access is had either to one rotary switch on each of as many terminals as there are simultaneous connections to the intertoll trunk groups or the tributary trunk groups in question, or to trunks, intertoll or tributary, on some of the terminals and to switches on the remaining terminals. With the first of these two plans the first switch is connected to the first terminal on a level, the second switch to the second terminal of a level and so on. If there are 22 or less trunks in an intertoll trunk or tributary trunk group, each rotary switch will provide access to all of the trunks. With this same plan if the number of trunks in the group is between 23 and 44, the first switch will provide access to half of the trunks and the second to the remaining half. The switch associated with the third terminal will again have access to the first half of the trunks and the fourth switch to the second half and so on. Larger groups can be accommodated in this same manner.

With the second plan which is for use for groups having perhaps 12 to about 17 or 18 trunks, seven or eight intertoll or tributary trunks are directly connected to the terminals of a selector level and the last few terminals of this level are used to secure access through as many rotary switches as are required for the remaining trunks, perhaps, six or seven in number. This plan permits, to a considerable degree, the selection of trunks in different order at the two ends of the group, is more economical from the standpoint of switch provision, and in the case of groups having both one-way and two-way trunks or terminal and common trunks for instance, permits the hunt over the group in the proper sequence. It does not, however, lend itself to additions as readily since terminals used for individual circuits may have to be cleared to make room for rotary switch additions and the average hunting time is increased because a large percentage of connections are established on the high numbered terminals. This increases the possibility of clipping of digits on calls to dial trunks. For large groups having both one-way and two-way trunks access to a considerable number of rotary switches is necessary and therefore the use of the first plan is necessary and it will not be possible to give the one-way trunks preference.

With only 11 trunks in an intertoll or tributary trunk group, it does not appear necessary to provide these rotary switches. In this case the eleventh trunk would appear on the switchboard but not on the switches. For somewhat larger



groups of short haul trunks, it again may not be economical to provide these switches. However, for the longer haul groups, consideration is given to the provision of these switches if the size of the groups is 12 or more.

It is not necessary to set aside terminals for overflow circuits which function with intertoll trunk groups appearing on the banks of the selectors in the through train, this feature being provided by means of a supplementary switch which is part of the intertoll through selector.

5.21 CONNECTOR ACCESS TO TOLL STATIONS

Where a large number of toll stations are served by an office, 40 to 50 or more stations, it is sometimes economical to arrange for switch access to these toll stations so that incoming calls to them may be handled on an intertoll dialing basis. A terminal - per - station code ringing connector reached from a level of an auxiliary second selector which in turn is reached from level 8 of the auxiliary first selector would be provided for this purpose. The toll station numbering plan would provide for numbering the stations in numerical order with the prefix 18 added so that uniformly throughout the System "18" would help operators to identify toll stations (the code "181" or the prefix 18).

The toll station operator would be reached on level "1" of the auxiliary second selector by dialing "181" on assistance calls and on calls to stations whose lines cannot be placed on the connectors as indicated below. Therefore 100 stations numbered 18200 to 18299 could be reached in one connector group. If more than 100 such stations were served by an office, one or more additional groups of code ringing connectors would be provided. The following types of toll stations could be reached on such a code ringing connector:

An individual line magneto toll station reached on a direct ringdown trunk.

A party-line magneto toll station with arrangements for code ringing reached on a direct ringdown trunk.

Magneto toll stations, one or more per line, arranged for code ringing bridged on a ringdown intertoll trunk connecting two toll centers with, however, no direct signaling between stations on the trunk.

Magneto stations, one or more, bridged across operator trunks between the operator office and a CDO. AC ringing, code in the case of party lines, is on a loop signaling basis and the signaling between the common battery subscribers at the community dial office and the operator office is on a simplex signaling basis. Arrangements for operation over phantom circuits are not available.

Any toll stations reached through ringdown tributaries of the toll center instead of direct from the toll center, cannot be reached on a dialing basis. Similarly it may be necessary to leave

stations with an extra long haul on a manual basis. In these cases the toll center operator will be reached instead by dialing "181".

5.22 POWER EQUIPMENT

Much has been said in the preceding paragraphs with respect to the functions of the many types of equipment used in a SXS dial office. The mechanical portion of the equipment and the switches are controlled by electrical circuits (electro-magnets, etc.). These electrical circuits, to function properly, must become energized and, to become energized, some source of electromotive force must be connected to the circuits either by direct connection or through inductive relations. In the case of a direct current, the circuit must be energized by the actual connection of the conductors to the terminals of the source of E.M.F., but in the case of an alternating current, the circuit may be energized either by such a connection or by inductive effects due to magnetic interlinkages or capacity relations.

In a telephone office, the principal source of E.M.F. is the storage battery. This supplies the D.C. power to energize the electromagnets, etc. Since we use batteries, we must have the associated equipment to keep them charged to full voltage. The charging equipment may either be a standard rectifier (tube type usually) or a motor-generator set or a combination of both. The motor-generator set will require 110 Volt or 220 Volt A.C. Commercial power to drive the motor. Also we need a source of ringing current to cause the telephone to ring. We need alarm circuits to indicate equipment and circuit failures; we need facilities to produce the various tones and flashes used. All of these items are essential to the provision of telephone service and we might classify them under one common heading, "POWER EQUIPMENT". The principal items of "Power Equipment" will be discussed briefly in the following paragraphs.

5.2201 STORAGE BATTERIES

The telephone central office power plant must not only be absolutely reliable at all times but must meet other exacting requirements. Modern practice has led to the standardization of a common source of E.M.F. for the majority of the telephone (talking) circuits, as well as for the operation of telephone relays, vacuum tube filaments, small motors and numerous other apparatus units. We make general use of the 24 Volt battery, the 48 Volt, the 65 Volt and the 120 Volt batteries as the common sources of E.M.F. in a typical telephone office. The 24 Volt battery is associated primarily with toll, the 48 Volt with dial, the 65 Volt for message register service and the 130 Volt supply, both positive and negative, for telegraph repeater operation, and for pay station coin box operation.

The common batteries result in a number of plant economies but, on the other hand, they impose certain exacting electrical requirements.

Probably the most essential of these requirements is low internal resistance. Unless the central office source of E. M. F. has negligible resistance, including both the internal resistance of the battery and that of the supply leads from the battery to the bus bars where individual circuit leads are connected, there will be ever changing current values in the individual circuits. This would result in noise and crosstalk in all talking circuits and unreliable operation of various other telephone apparatus.

With some knowledge of simple electrical circuits, the above facts may be verified and possibly a more clear understanding of why the above is true regarding the central office power supply. In Figure 66 we have a single source of E.M.F. and a number of resistances connected in parallel. The current in any single resistance is independent of that in any other resistance provided all resistance branches are connected directly to the terminals of the battery as indicated. This follows naturally from the application of Ohm's Law to a single branch since the E.M.F. impressed on any single branch is the E.M.F. of the source and, theoretically, is independent of current flowing through other branches. This assumes, however, that the battery is a perfect source of E.M.F. without internal resistance.

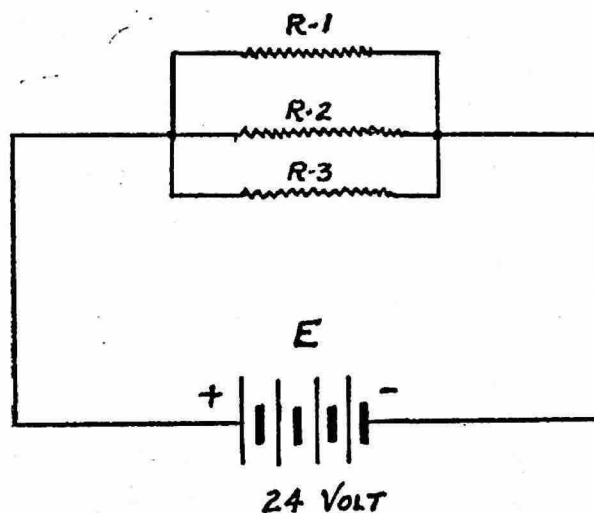


Figure 66

it cannot in any way affect the total current supplied by the battery or the current in any individual circuit that may be connected to the bus bars.

Returning to Figure 66 in which the current in any one resistance branch was seen to be independent of that in any other, let us assume, on the contrary, that the battery has an internal

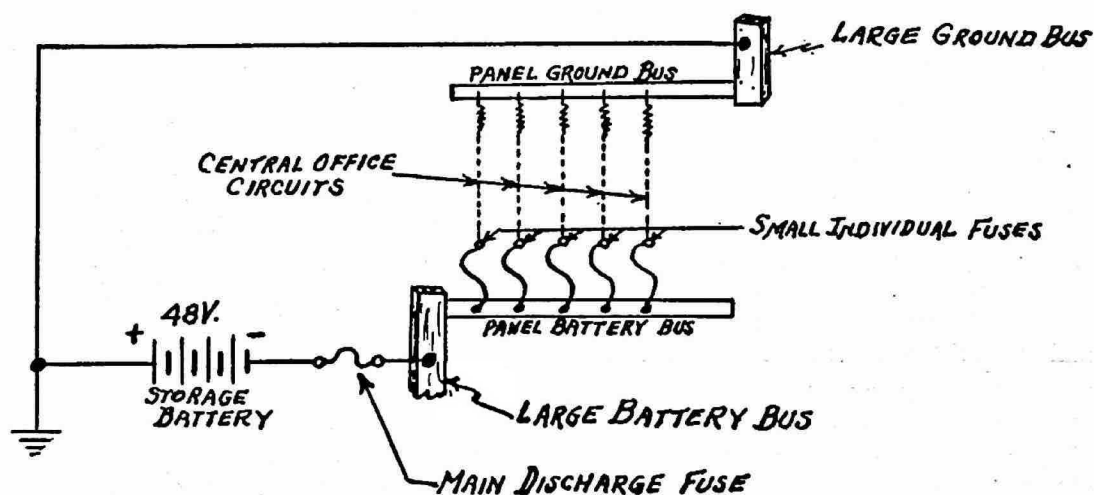


Figure 67

Figure 67 represents the central office storage battery connected to bus bars at the fuse panel. The central office circuits are cabled to this fuse panel and receive their battery supply through taps to the small panel busses. Thus hundreds of circuits of varying resistance are connected in parallel to a common battery, and we have in practice a circuit arrangement identical to that shown in theory by Fig. 66, excepting that as indicated in Figure 67, fuses for protection against excessive currents due to short circuits or overload are used and the positive terminal of the battery is connected to ground. This ground connection stabilizes the potential of all circuits in the central office by short circuiting their capacities to ground. It also simplifies the central office wiring and affords circuit protection, but

resistance of R' and that the circuit is actually that shown except that it be supplemented by this internal resistance of the battery. The latter would be in series with the battery and the resistances $R-1$, $R-2$ and $R-3$ would be parallel resistances. Due to resistance R' , the current in one branch is no longer independent of that in the other branches. Let us assign values as follows:

- $R' = 2 \text{ Ohm}$
- $R-1 = 5 \text{ Ohm}$
- $R-2 = 4 \text{ Ohm}$
- $R-3 = 3 \text{ Ohm}$
- $E = 24 \text{ Volt}$

If we solve this network, we shall find that the current through R-1 is 1.87 Amperes. If we should suddenly open resistances R-2 and R-3 it will change immediately to 3.43 Amperes.

What are Batteries? If any device maintains an E.M.F. and sustains a current of electricity in a circuit, energy is supplied to the circuit, but the law for the conservation of energy states that energy cannot be created or destroyed. Any source of E.M.F. may then be defined as a device for supplying electrical energy by converting it from some other form. The battery directly converts chemical energy into electrical energy, the generator likewise converts mechanical energy into electrical energy, and the thermocouple directly changes heat into electrical energy. A rectifier in one sense is a source of direct E.M.F. but converts A.C. energy into direct current energy, changing it from one electrical form to the other rather than from some other form to the electrical. Energy is defined as the capacity for doing work.

Chemical Batteries are divided into two classes, the primary and the secondary. A primary battery is one that generates an E.M.F. by virtue of certain chemicals coming in contact with submerged metals or other substances which constitute the positive and negative terminals. A secondary battery stores electrical energy but does not directly generate an E.M.F. unless a current is first passed through the battery in a direction opposite to that in which it will flow when supplying energy to an external circuit.

The unit of a battery is the CELL, consisting of a single couple of submerged positive and negative poles or plates. Cells may be connected in parallel or in series, depending upon the value of the E.M.F. desired and the value of current to be sustained. When connected in series, the E.M.F.'s of the individual cells are added, the resultant voltage of the battery is this total. If they are connected in parallel, the E.M.F. of the battery is that of a single cell, but the current supplied to the circuit is divided between the several cells.

The **DRY CELL** is the most common type of primary cell. Its negative terminal consists of a zinc container in which is centered a bar of carbon as a positive terminal. The carbon is surrounded by a porous medium consisting principally of graphite and manganese dioxide, and this mixture is saturated with a solution of zinc chloride and sal ammoniac. A layer of absorbent material similar to "blotting" paper separates the zinc chloride from the mixture but is porous to the liquid solution which generates an E.M.F. when it comes in contact with the zinc. The top is sealed with an insulating cover for the zinc. Fahnestock connectors, which are securely fastened to the zinc and carbon electrodes, form suitable terminals. The Blue Bell dry cell is standard for the Bell System.

When new, the dry cell gives a voltage of 1 to $1\frac{1}{2}$ volts, which decreases with age. For aver-

age use, its capacity may be roughly estimated at 20 to 30 Ampere-hours but this will vary considerably depending upon conditions. For example, the capacity when connected to a high resistance circuit may be several times the capacity when connected to a low resistance circuit. Intermittent use is also an important factor.

Dry cells are commonly used in the telephone plant for practically all service where connections to a central office storage battery are not feasible or cannot be used because the storage battery is grounded. In addition to transmitter batteries for magneto subscriber stations, such uses include battery supply for telegraph sounders on subscriber's premises, Wheatstone Bridge testing battery for testboards, plate batteries for vacuum tube circuits, testing batteries for portable testing sets, etc.

Storage Batteries—A chemical battery that is capable of storing electrical energy delivered to it from some other source, and delivering this energy to a electrical circuit at some later time, is called a secondary battery. These are more commonly referred to as "storage batteries". The two general types of storage batteries are the "lead-acid-lead" and the Edison Cells (iron-potassium hydroxide-nickel). On account of its low internal resistance and more constant terminal voltage, the "lead-acid-lead" type more nearly meets the exacting requirements of the telephone central office.

A complete chemical theory of the "lead-acid-lead" battery is beyond the scope of this course, so will be omitted.

The Capacity of a Storage Battery Cell is the number of ampere hours it is capable of giving at 70° F. when discharging at the normal rate before its voltage falls to some limiting value usually taken as 1.8 volts for the stationary type of cells. Capacity depends upon many things, such as: type of plates, density of electrolyte, temperature and rate of discharge. The 8-hour rate is Standard for stationary type. No standard rate has been adopted for the other types. The capacity of a plate varies with the amount of active material (lead peroxide on the positive plate and spongy lead on the negative plate), but not directly because its mass initially does not hold enough acid to convert it to lead sulphate. Diffusion of acid into the mass is quite slow, so that the higher the discharge rate, the more nearly is the plate surface the determining factor. The capacity of a cell at the higher rates of discharge depends, therefore, on the area of its plates, their number, and to a minor extent, on the thickness of the plates. (Storage batteries used in telephone offices will average about 2.15 volts per cell.)

The dial central office equipment is designed to operate on a battery voltage ranging from 46 to 49 volts. The 48 Volt office storage battery usually consists of either 23 open tank type or 23 enclosed cell (jar type) batteries supplemented

with 2 counter electromotive force cells connected to the negative end of the battery. The latter is used to keep the voltage on the discharge bus bars between the above voltage limits. In some offices these counter E.M.F. cells are cut in or out automatically, in other offices (earlier installations) this must have been done manually. 2 to 4 Emergency cells are usually furnished with each battery. These are sometimes known as "End Cells".

Counter E.M.F. cells are composed of lead plates, placed in the same type electrolyte as is used in the regular cells; they have no current capacity but set up an opposing E.M.F. of approximately 2 volts per cell when current is passed through them. A more recent counter E.M.F. cell is the Nickel Alkaline (N.A.K.) type.

The 24 volt office supply is usually obtained by making a tap between the 12th and 13th cells of the 48 volt (23 cell) battery.

The electrolyte used in telephone storage batteries is of 1.210 specific gravity at a temperature of 70° F. The storage batteries provided are of such size to carry the office load and allow some reserve for emergencies.

As mentioned above, the unit of storage battery capacity is the ampere-hour with the rated charge and discharge based on the 8 hour rate. If the battery has a capacity of 240 ampere-hours it will supply 30 amperes for 8 hours which equals 240 ampere-hours. In this case the charging rate would be 30 amperes and it would be necessary to charge 8 hours to replace the capacity. (These are theoretical figures).

The normal open-circuit voltage of each cell varies from 2.06 to 2.15, according to the strength of the electrolyte and temperature and is independent of the size of the cell.

PILOT CELL: A readily accessible and well lighted cell of the central office battery is selected and used as a guide in the operation of the battery as a whole and is called the "Pilot Cell". If a battery has been subjected to considerable change such as replacement of plates, the pilot cell is usually one with the oldest plates to insure a test representative of the weakest link in the chain.

ELECTROLYTE: The electrolyte is the solution in which the plates of a storage cell are immersed and which in combination with the active material of the plates determine the E.M.F. or voltage of the cell. This solution consists of a specially purified sulphuric acid and approved water, the specific gravity at any time after the initial filling being dependent upon the type of cell and the amount of charge in it. Water which is evaporated from the electrolyte must be replaced to keep the proportion of water to acid practically constant. If this were not done, the hydrometer (Instrument for reading sp.gr.) readings would reflect the variation of electrolyte density due to water evaporation and could not be relied upon as an accurate indication of the condition of the charge.

BATTERY ARRANGEMENTS: After batteries have been partially discharged, it is necessary to charge promptly, so they will be in condition for further use. During the charging, however, the voltage across the battery must be somewhat higher than when "floating". To prevent this higher voltage from reaching the central office discharge circuits, it has been necessary either to employ two batteries, one of which would be on charge while the other was discharging, or to employ counter E.M.F. cells, between the battery and the load, which reduce the potential to the desired value. It was the practice to employ duplicate batteries in the larger power plants, but the present practice is to use the "single string battery" arrangement. The duplicate arrangement with emergency ("end") cells and generators is shown in Figure 68. The single string battery arrangement is shown in Figure 69.

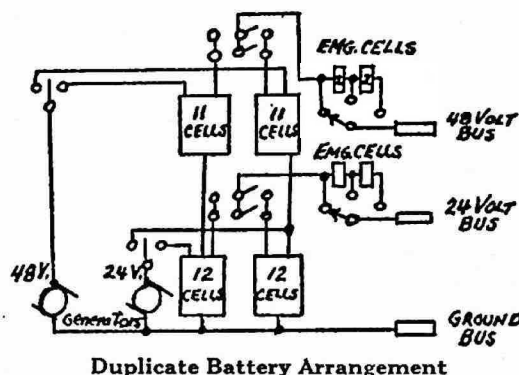


Figure 68

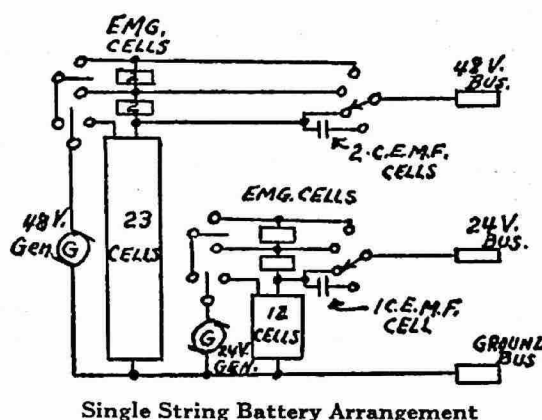
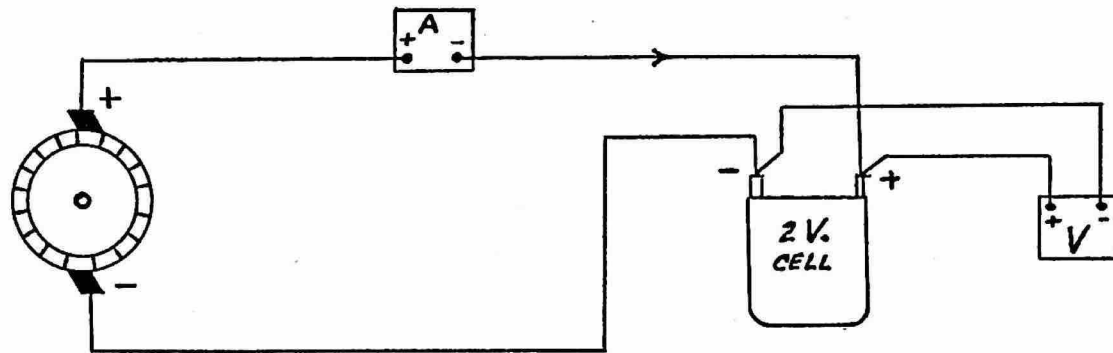


Figure 69

5.2202 BATTERY CHARGING EQUIPMENT

If a resistance load is connected across a battery, current will flow immediately from the positive terminal of the battery and will return to the battery through the negative terminal. The battery terminal voltage will be slightly less than its open-circuit value, due to the current flowing through the internal resistance of the battery. Under these conditions, the battery is a source of energy and is acting as a generator, that is, it delivers energy, as covered previously in Paragraph 5.221.



GENERATOR CHARGING A BATTERY

Figure 70

If current is forced to enter at the positive terminal of the battery, the battery will no longer be supplying energy but will be receiving energy. This energy must be supplied from some other source, as from another battery, or, as is more common, from a generator. The cell shown in Figure 70 has an E.M.F. of 2 volts, and a voltmeter V, connected across its terminals, indicates 2 volts when no current flows. If another source of electrical energy, such as a direct-current generator, supplies a potential difference of just 2 volts and its + terminal be connected to the + terminal of the battery and its - terminal connected to the - terminal of the battery, as shown in the figure, the voltmeter V will still read 2 volts and the ammeter A will read zero. That is, the battery neither delivers nor receives energy and no effect is noted other than those observed when the battery stood open-circuited. Under these conditions the battery is said to be "floating". If, however, the voltage of the generator be raised slightly, the ammeter A will indicate a current flowing from the + terminal of the generator into the + terminal of the battery, a direction just opposite to that which the current has when the battery supplies energy. The voltmeter will no longer read 2 volts, but will indicate a potential difference something in excess of 2 volts.

Thus, no current will flow until voltage in excess of the 2 volts is produced by a generator. If the generator voltage is raised to 2.4 volts, 2.0 volts of this is utilized to "buck" the 2.0 volts of the cell and 0.4 volt is effective in sending current into the cell. Under this condition the cell is receiving electric energy, as is the case when a storage battery is being charged.

Batteries are usually "charged" from generators, rectifiers, or other batteries. The term "charger" has sometimes been used to mean a rectifier as distinguished from a generator but is now used interchangeably with **charging equipment** whenever information as to the type of charging source is not pertinent.

Depending on plant design, the control of starting and stopping the charge may be either manual or automatic and the control of charging voltage and current may be either manual or automatic.

Before getting into the general description of charging equipment we might make a brief review of the various types of **Charging Methods** employed by our Plant Maintenance people:

1. **Float Method**—the battery terminals are held at a specified voltage so that proper trickle current is furnished to the cells. Maximum cell life is expected with continuous float.
2. **Constant Current charge**, the charging current is held as nearly constant as practicable. The voltage will increase as the charge progresses until final voltage is reached.
3. **Variable Current charge**, the charger setting remains fixed for the duration of the charge or is infrequently adjusted. The current tends to reduce as the battery voltage builds up and in addition the current to the battery varies as the office load changes.
4. **Charge by Load** is a type of variable current charge used on emergency cells. With this system the cells are in series with the charger so that all current furnished by the charger to the load or to the main battery passes as charging current through the cells being charged by the load. This method is not used if the charger output exceeds the cells' nominal charging rate.
5. **Constant Voltage charge**, the voltage is brought up to a pre-determined value and is then held at this value for a fixed time. The current tapers off to a small value toward the end of the charge so that heavy gassing is avoided.

CHARGING EQUIPMENT: The term "charging equipment" applies to the motor-generators or rectifiers used to convert the primary power service supply into direct current (usually at 24 or 48 volts) for operating the central office. It is called "charging" equipment because storage batteries are usually connected across this current supply and the charging equipment serves to keep the batteries charged, in addition to supplying the current necessary to carry the central office operating load.

MOTOR-GENERATOR CHARGING SETS: The motor-generator charging set consists of a direct-current generator directly coupled to either an alternating current induction motor or synchronous motor, or to a direct current motor. Commercial power (A.C.) is used

as the primary power supply for operating the motors. The latter drives the generator.

As mentioned previously, a generator is a machine which converts mechanical energy to electrical energy. This is accomplished by means of an armature carrying conductors upon its surface, acting in conjunction with a magnetic field. Electrical power is generated by the relative motion of the armature conductors and the magnetic field.

In the direct-current generator the field is usually stationary and the armature rotates. In most types of alternating-current generators the armature is stationary and the field rotates. Either the armature or the field is driven by mechanical power applied to its shaft.

Three types of charging generators are in common use, the "M" type charging set which has been replaced by the "commercial" type charging set for new installations and the "diverter pole" charging set.

Since storage batteries decrease in voltage when discharging and as they require a voltage considerably higher than the normal or "floating" voltage to bring them up to a fully charged condition, it is necessary that the charging generators have a controllable wide voltage range. The "M" type and commercial generators for charging 24 volt batteries have a voltage range of about 22 to 33 volts and are generally referred to as "33 volt generators" while those for charging 48 volt batteries have a range of about 44 to 65 volts and are generally referred to as "65 volt generators". The diverter pole generators, which are self-regulating as to voltage output, are generally referred to as 25 volt or 50 volt generators, although they may be set (by means of a field rheostat) for a voltage output within about the same range as the "M" and commercial type sets.

"M" Type Charging Sets

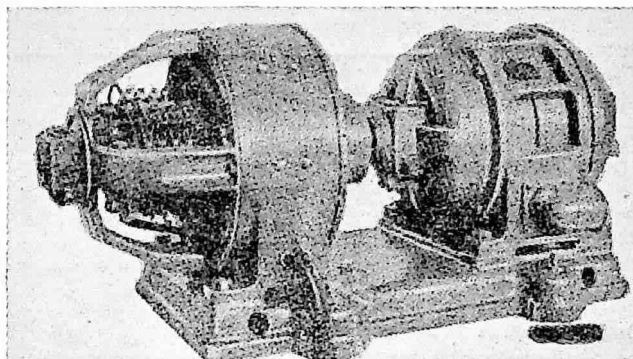
The "M" type charging sets were specially designed for telephone service and were made in various sizes up to 1500 amperes. They were designed to provide a practically noiseless direct current output and operate with a minimum of mechanical noise. The pulsations or ripples in the generated current which are recognized as "noise", were effectively reduced by the use of a smooth core armature, a large number of commutator segments and the use of brass gauze brushes. The ripples or noise in the generated current was thus reduced to such a low value that the storage batteries (which are connected in parallel with the generator while it is running) would absorb or bypass the remainder resulting in a current supply suitable for talking circuits. The "M" type sets operate at comparatively low speeds (600 to 1200 RPM) which contribute to their quiet mechanical operation.

While the "M" type sets have served their purpose well for long period of years they had the disadvantage of being very expensive compared with "commercial" type sets, they took up more floor space and the use of the brass gauze brushes required frequent lubrication of the commutator (about every hour) to avoid undue commutator wear.

Commercial Type Charging Sets

The commercial type charging sets are appreciably smaller and lighter than the "M" type and operate at

comparatively high speeds (1200 to 1800 RPM). They derive the term "commercial" from the fact that they employ the same frameworks and general construction characteristics as other direct current generators offered for sale commercially by the manufacturers. The motor generator sets are of the three bearing type, whereas the "M" types are of the four bearing type. They are usually furnished in sizes ranging from 100 to 750 amperes although sizes as large as 1200 amperes have been made available.

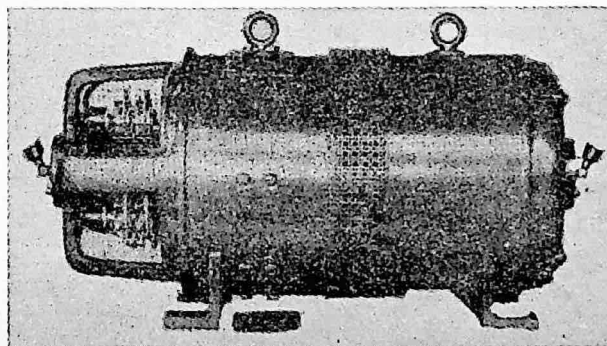


Commercial Motor-Generator Set—300 Amp. 65 volt generator, 31 HP Induction Motor.

Figure 71

The commercial generators are of the interpole shunt wound type employing field rheostats for controlling the output voltage. The interpoles (also called commutating poles), with their windings, are located between the field poles to aid in giving good commutation over the entire voltage and load range without the necessity of shifting the position of the brushes as the load varies. Self-lubricating carbon brushes are employed which require little attention and reduce commutator wear.

Due to the higher speed, increased windage and undercut mica on the commutator, these generators are not as quiet in mechanical operation as the "M" type. Also, the character of the armature and commutator is such as to produce pulsations or ripples (noise) in the generated current to a marked degree and it is therefore necessary to employ a filter, comprising of a choke coil and condensers, to suppress the noise when the current is used for talking current supply. Filters are described later in this section.



Diverter Pole Motor-Generator

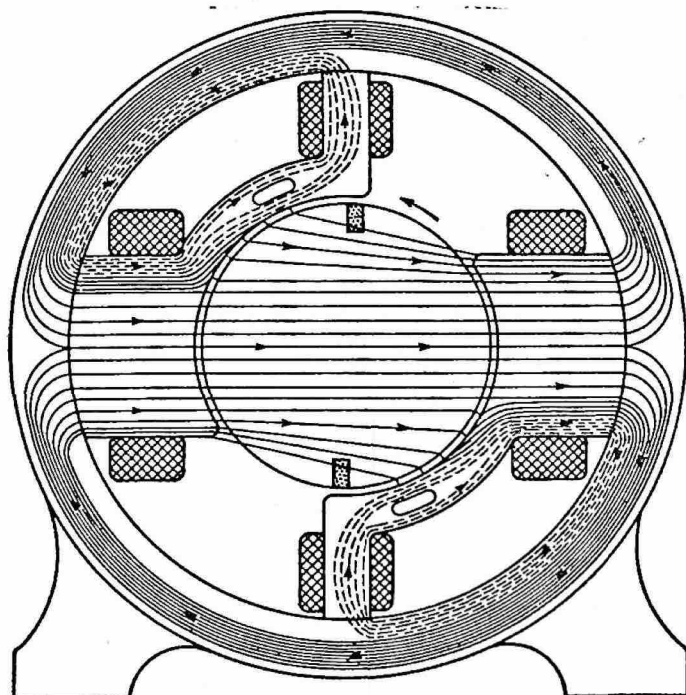
Figure 72

Diverter Pole Generators

For the continuous floating of batteries, a constant d-c supply voltage is desirable. With a constant supply voltage the drop in battery voltage, when current is taken out of the battery, is just about enough to make the charging rate increase in the proper proportion to restore the charge to the battery.

So called diverter pole generators are the most recent method used by the Bell System for charging and floating batteries, particularly at small central offices. These machines have been selected not only because they automatically maintain a constant output voltage over a wide load range but also because they maintain safe speeds should the driving motor fail at the same time that the reverse current circuit breaker to the battery fails to operate. Under these latter conditions other types of machines tend to draw current from the batteries and run at very high speeds which may cause mechanical damage to the machine itself.

Diverter pole generators are essentially motor-generator sets with the a-c line motor directly connected to the diverter pole generator which in turn is provided with two sets of field windings. The first set of windings is shunted across the output of the generator and each winding is on a main pole. The second set of windings is connected in series with the output and all windings in this group are on so called diverter poles placed midway between the main poles. Between each main pole and the diverter pole adjacent to it in the direction contrary to the rotation of the armature is a so called magnetic bridge which tends to aid the flow of magnetic lines of force between the two poles.



Magnetic Flux Distribution at No Load.

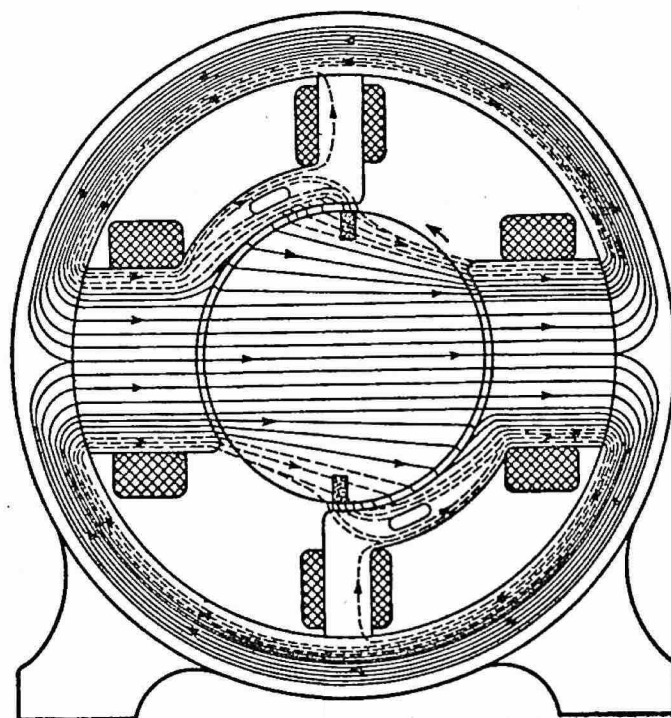
Figure 73-A

When such a machine is running under no load conditions part of the flux caused by the shunt winding on the main poles is diverted from its normal path across the armature air gap to a supplementary path through the

magnetic bridge and diverter pole and then back through the frame of the machine as shown in Fig. 73-A. The bridge and diverter pole thus act as a shunt to the main pole flux, and decrease the flux in the main gap and thus the voltage generated in the armature.

Under no load conditions no current flows in the series winding. However, when the diverter pole generator is charging, the flux due to the series windings on the diverter poles opposes the flux leaking over from the main pole and thus forces more of the main pole flux across the armature air gap and consequently increases the generated voltage. With proper design the increase in generated voltage just compensates for the increased losses in the machine due to the increased load. Thus the output voltage remains constant.

Eventually the series current flux may become strong enough to force all the main pole flux across the armature air gap as shown by Fig. 73-B. In this case the generated voltage is a maximum. Any further increase in the series current now has the tendency to decrease rather than increase the flux across this air gap and consequently the generated voltage is decreased.



Magnetic Flux Distribution at Full Load.

Figure 73-B

In actual operating conditions, machines of this type will maintain a constant voltage within $\pm 1\%$ between $\frac{1}{4}$ and $\frac{3}{4}$ of full load. At lighter loads the voltage rises slightly so that at no load the voltage may be increased by .5 volt for 25 volt generators and 1.0 volt for 50 volt generators. Above $\frac{3}{4}$ of full load the voltage begins to drop slightly so that at $1\frac{1}{4}$ full load the voltage can be expected to be down by at least 10%.

With voltage characteristics of this sort, diverter pole generators can safely be used at unattended dial offices. Even after a prolonged power failure, when the battery voltage has been appreciably reduced by the office drain, the machine on restoration of the power service will

automatically charge the battery without overloading to a dangerous extent. Under all conditions the machine will charge the battery, automatically raising its own voltage until floating values are achieved again. The slight rise in voltage at zero or very light loads prevents the current from reversing and discharging the battery.

Over and beyond the good voltage characteristics of the diverter pole generators there is still a second reason for their use at unattended central offices. This reason is associated with the fact that if the a-c supply fails and at the same time the reverse current relay connecting the generator to the battery fails to operate, the generator draws current from the battery and runs as a d-c motor. Under these conditions ordinary compound wound generators, which are sometimes used for battery charging, have a tendency to reach very high speeds. This is due to the fact that the current in the series winding reverses when the generator starts to run as a motor and produces a very weak field flux. However, in the diverter pole generator sets the magnetic bridges, between main and diverter poles, are so designed and constructed that they soon become saturated and do not permit the passage of large amounts of flux. With this type of construction and the generator running as a motor the series windings at first tend to increase the amount of flux diverted away from the main gap across the armature. This results in an increase in speed but before this increase becomes objectionable the diverter bridge becomes saturated and the main gap flux is not weakened any further. The generator, acting as a motor, then maintains a safe speed.

Diverter pole generators have a third advantage based on the fact that the diverter poles are placed midway between the main poles. In this position the diverter poles permit larger currents to be taken from the commutator of the generator without excessive burning or sparking. This advantage is, however, somewhat incidental as voltage regulation is the main reason for placing the diverter poles between the main poles.

5.2203 MOTORS

Since alternating current is the type of primary electric power supply furnished in nearly all communities, the motors for driving the generators are usually either induction or synchronous motors operating from 200 to 230 volt, 3 phase, 60 cycle current. Motor starters (starting compensators) are used with the larger motors to limit the starting current, as described later in this section.

Induction Motors

Induction motors are the most commonly used type for driving charging generators. In the sizes up to 12 horsepower (with 200 ampere 33 volt or 100 ampere 65 volt generators) the "high reactance" type of induction motors are used. These motors limit the starting current sufficiently to permit the omission of a starting compensator.

Induction motors larger than 12 HP are usually of the "squirrel cage" type which have low reactance short circuited windings on the

rotors. Starting compensators are employed for starting them in order to hold the starting current down to less than $1\frac{1}{2}$ times the rated full load current.

Synchronous Motors

Synchronous motors are used in certain communities for purposes of "power factor" correction.

A synchronous motor may be operated at unity power factor, or with a leading power factor to balance a lagging power factor introduced by other associated equipment, by controlling the field strength of the rotating d-c field. As the rotating d-c field (the rotor of the motor) must be excited from an external source, a small d-c generator or exciter is mounted on the shaft at the end of the motor frame. An exciter field rheostat is furnished to adjust the output of the exciter, which in turn controls the rotating field strength.

Starting a synchronous motor is accomplished through a special squirrel cage winding on the rotor. When the motor gets up to normal speed (operating as an induction motor) an automatic switch connects the exciter to the d-c field winding after which the motor runs in synchronism with the impressed current. The starting winding, together with the automatic d-c field switch (also called "automatic field control panel") and a starting compensator makes the starting or stopping of a synchronous motor as simple as that of the squirrel cage induction motor.

Power Factor is the term used to indicate a relationship between the a-c current wave and voltage wave. If these waves are in phase with each other, this condition is known as "unity power factor". If the current wave lags behind the voltage wave, due to the reaction of inductive loads (such as motors, etc.) this is termed as "lagging power factor", and when the current wave leads the voltage wave it is termed a "leading power factor". Since the technical explanation of power factors is quite complicated it will, therefore, merely be pointed out here that a low power factor results in "wattless" current or current which does no useful work, but heats up the conductors and increases the voltage drop.

Motor Starters

The various types and sizes of motors used in power plants necessarily require different types of starters. For small motors, the starter may consist simply of a tumbler switch associated with thermal cut-outs, or fusetrans, to protect the motor against overloads or abnormal currents. From this simple starter, the types progress to apparatus of a complex nature, such as the manual and automatic starting compensators for polyphase a-c motors.

5.2204 RHEOSTATS

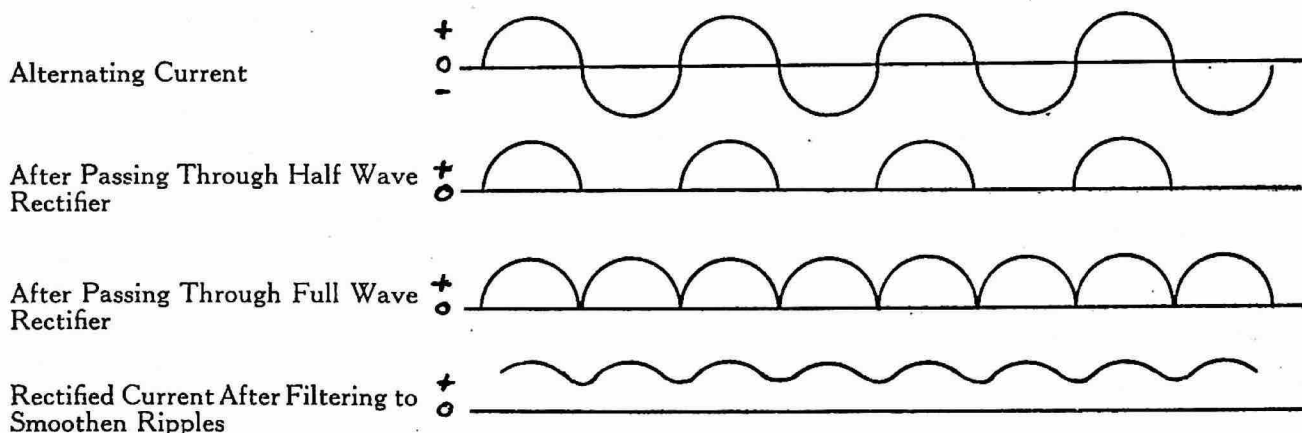
Field rheostats are used for controlling the

current output of generators by regulating the generator field current. Each rheostat is made up of one or more circular plates on which are contact buttons for terminating the resistance elements. Movable arms with contact shoes are provided for varying the amount of resistance in the circuit. The apparatus is not enclosed and space is provided to permit the dissipation of heat generated when the rheostat is carrying current. They are furnished in hand operated or motor-driven types.

5.2205 RECTIFIERS

Rectifiers are used to convert alternating current to direct current. They are free of rotating parts and therefore most of the operating and maintenance problems present in the operation of motor generator sets are eliminated. Although there are many types of rectifiers in general use, they function similarly in one respect; they all employ a rectifying element of some kind which allows the passage of current only in one direction. Alternating current is made up of successive waves, half of each cycle being positive and

the other half negative. Therefore, when alternating current is impressed on the rectifying element it permits the flow of current in one direction during part of each cycle, but impedes the flow of current during the remainder of the cycle while the potential is in the opposite direction. The resulting rectified current is pulsating unidirectional current. When only one half of each cycle is rectified, the rectifier is termed a "half wave" type. When the rectifier is so designed (by the use of two or more rectifying elements or tubes functioning as two elements) that both the halves of the a-c cycle are rectified into unidirectional current, the rectifier is termed a "full wave" type. This is shown graphically in Figure 74. The ripples of the pulsating direct current are filtered by means of a choke coil or by the combination of a choke coil and condenser where a high quality of filtering is required. The desired voltage of rectified current is obtained by stepping down the primary power voltage to the proper value, through a transformer, and then rectifying the transformed current. The four types of rectifiers generally used in telephone power plants are the Mercury Arc, Tungar, Regulated Tube and Copper Oxide types.



WAVE FORMS OF RECTIFIED CURRENT

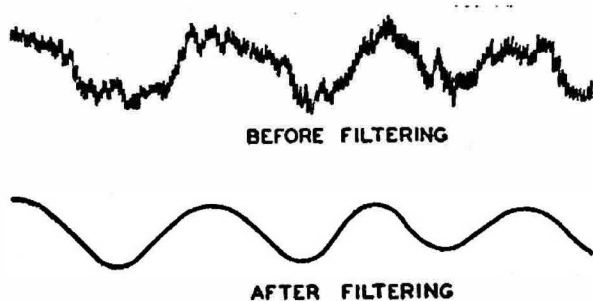
Figure 74

The detailed description and method of operation of each of the above types of rectifiers is quite complex and will be omitted from these notes. However, any one so interested may obtain this information from Library References.

5.2206 NOISE FILTERS

Broadly, the direct current required in a central office falls into two classes, "signaling" current which is used to operate all the various types of electro-mechanical apparatus such as relays, etc., and "talking" current which supplies the medium for voice transmission. Since practically all equipment for generating direct current, such as motor-generators and rectifiers, introduce ripples or noise in their output it is necessary that noise filters be employed to keep

"talking" circuits free from such disturbances. Figure 75 indicates graphically the effect of a filter on an irregular wave form having high frequency ripples or noise. Noise filters comprise a combination of inductance (choke coil) and capacitance (condensers) which may range in size and type from a small retardation (choke) coil and condenser, to care for the output of a small rectifier, up to a large choke coil weighing one or two tons associated with a group of electrolytic condensers to filter the talking current for a large central office. The choke coil impedes, or chokes, the fluctuations in the generated current and the condenser prevents the flow of direct current but offers little resistance to high frequency ripples, and, therefore, bypasses them.



Effect of a filter on an irregular wave form.

Figure 75

5.2207 RINGING, TONE AND SIGNALING EQUIPMENT

General: In the operation of a telephone plant, ringing, tone and interrupted currents are of almost equal importance to those obtained from the charging machines and their associated batteries. These currents, which are supplied by the "ringing power plant," are used to operate the bells at subscribers stations, to signal from one office to another for establishing trunk or toll connections and for providing the various kinds of tone and signaling current necessary in the operation of the central office. The ringing power plant output is, therefore, designed to provide continuous service and reserve equipment is usually provided to serve in case of failure of the primary power supply, or in other emergencies.

The kind of ringing current, tones and interrupted signals required depends upon the type of central office, as the requirements differ for manual, dial, toll and repeater equipments. Further, the type of ringing equipment required to furnish this current is influenced by the size of the central office supplied. Broadly, the output of the ringing power equipment usually embraces the following types of current, or combinations including part of them.

Ringing current at a frequency of approximately 20 cycles is furnished for ringing subscribers' bells. For passing ringing signals over long toll lines 135 cycle or 1000 cycle ringing current is employed.

Tone current is used to audibly transmit circuit conditions such as "busy signals," "dial tone" and the like to subscribers or to the operating forces.

Interrupted signaling current is employed for such functions as providing the ringing and silent intervals for machine ringing, flashing supervisory lamp signals such as for the flashing recall feature in manual cord circuits and trunk busy signals, and for other purposes where periodically interrupted or timed pulses will aid in performing central office operating functions. Interruptions of 60 IPM (interruptions per minute) and 120 IPM are commonly used in many types of central offices, and in addition, interruptions of one, two, three or four seconds,

and combinations of these, are used in central offices arranged for machine ringing.

Coin control current is generated by the larger sizes of ringing machines for controlling the "coin collect" and "coin return" features of pay stations. Positive and negative 120 volt direct current is used for this purpose. In the smaller central offices dry batteries are used to provide the coin control current.

Ringing Systems

Manual Ringing Systems Manual ringing systems are employed in the smaller manually operated central offices and several types of PBX's where the subscribers' bells are rung by operating a key in the operators' keyshelf. The duration of the ringing period and the method of ringing, that is, whether it is a steady long ring or an intermitten series of short rings is entirely under control of the operator. For this service the ringing equipment provides a steady flow of alternating or superimposed ringing current to the switchboard.

Machine Ringing Systems The term "machine ringing" indicates that after ringing is started it continues automatically until the subscriber answers or the call is abandoned. It is employed in dial central offices and in the larger manual and toll exchanges. In manual central offices the ringing is started by the depression of a key controlled by the operator, or by the operator plugging into a jack. In dial offices the ringing starts as soon as the connection is established to the called subscribers line. The ringing current flows through a "tripping relay" in the operators cord circuit, or in an equivalent circuit in dial exchanges, and when the subscriber answers the tripping relay operates and discontinues the flow of ringing current to that line.

The ringing current supplied for machine ringing is interrupted into ringing and silent intervals. These intervals vary somewhat in different types of ringing plant equipment, but in the larger plants the ringing interval is two seconds and the silent interval four seconds. For semi-selective ringing where "one-ring" and "two-rings" are employed the two-rings are one second ring, one second silent, one second ring, and three seconds silent. (See Figure 46) These interruptions are provided by the slow-speed interrupters which are usually driven by worm gears on the end of the ringing machine shaft, although in small plants separate motor-driven interrupters are sometimes used.

In order that the tripping relay may function the instant the subscriber answers, tripping battery is furnished (also through the low-speed interrupters) during the silent interval. This silent interval tripping battery may be furnished by the central office battery or by separate cells. The direct current component

of the superimposed ringing current, where this type of ringing current is employed, assists in the operation of the tripping relay during the ringing interval.

"AC-DC ringing" is employed to improve the operation of the tripping relays in machine ringing circuits where straight a-c ringing was formerly used. This current is obtained by connecting a small battery of about 18 volts in series with the a-c ringing generator. The d-c component of the AC-DC ringing increases the tripping range and assures that positive tripping will occur during the ringing interval as well as during the silent interval.

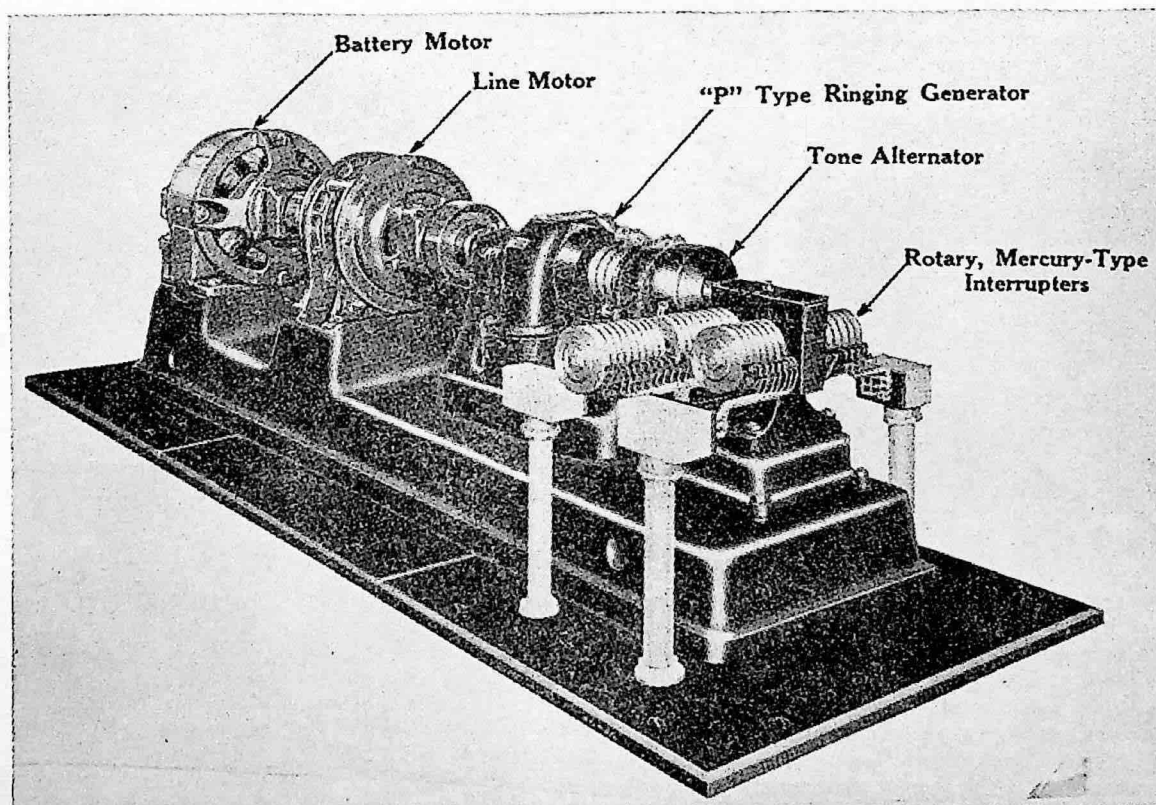
The **"pick-up"** circuit arrangement, where one-ring and two-ring semi-selective machine ringing is used, is devised to avoid the false ringing of the two-ring subscribers. The operators cord circuits, or equivalent dial exchange circuits, include pick-up relays which control the starting of the ringing interval and these relays are in turn controlled by the **"pick-up"** slow speed interrupter (PKU) on the ringing machine. By means of the pick-up circuit the ringing is always started so that both rings of the two-ring code are sounded initially as well as during the remainder of the ringing period.

Tones and Interrupted Signaling Current

The Tones, which are used to audibly transmit circuit conditions to subscribers or to

the operating forces, are usually furnished as **"high tone"** at about 480 to 500 IPS (interruptions per second) and **"low tone"** at about 120 or 160 IPS. For certain purposes they are furnished as continuous tones, such as for **"dial tone," "number checking"** and the like; and for other purposes the tones are uniformly interrupted by means of the motor-driven low speed interrupters, such as for subscribers **"busy back," "trunks busy"** etc. The interrupted tones not only have a distinctive sound but the low-speed interruptions are frequently used to distinctively operate lamp signals, such as for **"busy back"** on trunks. Howler tone, used for attracting the attention of subscribers where the receiver has been left off the switch hook, is provided by the high tone frequency. In the larger sizes of modern ringing power plants the tones are produced by a **"tone alternator"** which is provided as part of the ringing machine, and in the smaller plants the tones are produced by a high-speed split ring interrupter which is either mounted on the ringing machine shaft or separately driven by a small motor.

The **tone alternator**, which replaces the high-speed split ring interrupter used on the larger ringing machines in the past, consists of three inductors and is wound for three different tone channels. One tone channel produces, low tone, a second channel produces high tone and a third channel produces audible ringing tone.



A TYPICAL LARGE RINGING MACHINE WITH TONE ALTERNATOR
AND ROTARY MERCURY TYPE INTERRUPTERS.

Figure 76

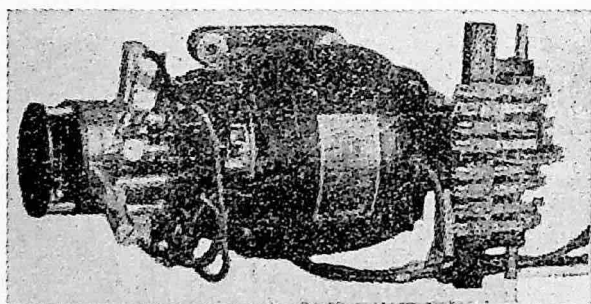
The audible tone, when used in connection with suitable repeating and retardation coils, impresses upon the ringing circuit a tone which is audible to the calling subscriber during ringing.

The tone alternator consists of a frame, which houses the stator coils and a rotor which is driven by the shaft of the ringing machine. Formerly a magnetizing flux was obtained by field windings. Now the flux is produced by a permanently magnetized field. The flux through the stator poles changes as the teeth of the rotor rotate past the poles and thus generates the alternating voltages in the windings on the poles.

Figure 76 shows the tone alternator mounted between the ringing generator and the low-speed interrupters on a typical large ringing machine.

The tone alternator possesses the advantage over the high-speed split ring interrupter of producing a uniform induced tone which is taken from the stator windings without brushes, thus reducing the maintenance and cleaning required with those interrupters.

The low-speed interrupter, which serves to control the ringing and silent intervals for machine ringing and for providing variously timed interruptions or signals for many other purposes, consists of a worm driven reduction gear assembly and the necessary interrupting units. In the smaller plants the interrupting units may consist of contact springs operated by cams and the reduction gear may be driven by the ringing machine shaft or by a small motor. Figure 77 shows a 25 watt ringing machine with cam-and-spring type low-speed interrupters at one end and the high-speed (tone) interrupters at the other end.



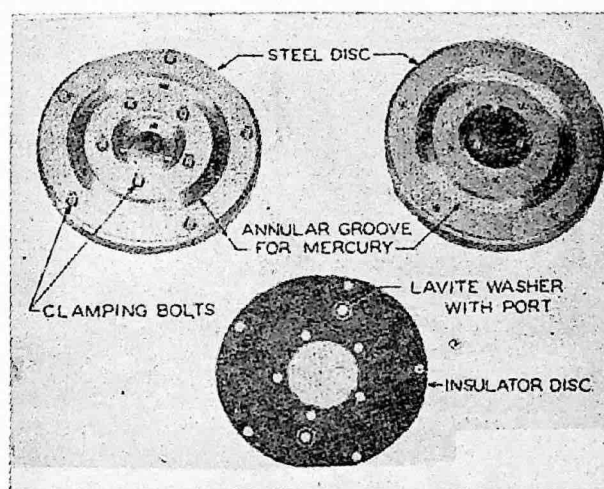
A 25 Watt Ringing Machine with High-Speed and Low-Speed Interrupters

Figure 77

The rotary mercury-type interrupter consists of one or more interrupter units mounted on the low speed shafts of a reduction gear driven by a ringing machine, and replaces the "segment and brush" type low-speed interrupter rings formerly used with the larger machines. The rotary mercury-type interrupter units, as shown in Figure 78, consist of either two or three steel discs separated by insulators placed between the discs and the

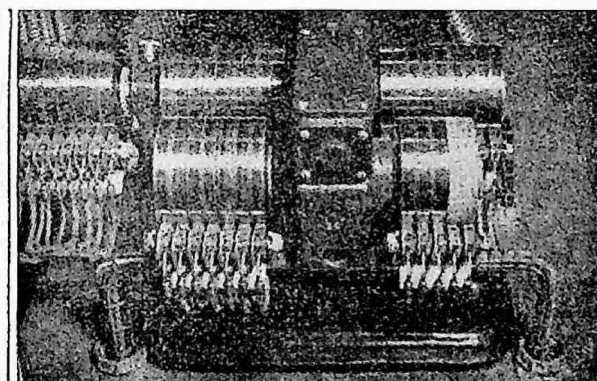
whole clamped tightly together. Annular grooves or channels are cut in one side of the discs and the units are so assembled that the channel of one disc is adjacent to the channel of the next disc with the insulator separating them. The insulators have one or more openings or ports connecting adjacent channels. The grooves are partially filled with mercury and, when the units are rotated, contact is made from one disc to the other by means of the mercury when a port of the insulator dips into the mercury pool. The port openings are provided with Lavite washers to withstand the arcing during operation. On interrupter units having three discs, channels are cut on both sides of the center disc. The number of ports and their spacing around the insulator, the amount of mercury in the channels, and the speed of rotation determine the timing of each interrupter unit. Since the rims of the discs against which the brushes bear, present a continuous surface, longer wear with less maintenance is obtained than with the segment interrupted units formerly used. Fig. 79 shows a group of rotary mercury-type interrupter units as assembled on the types of ringing machines illustrated in Figure 76.

A cross-section of the Double-Interrupter Unit is shown in Figure 80.



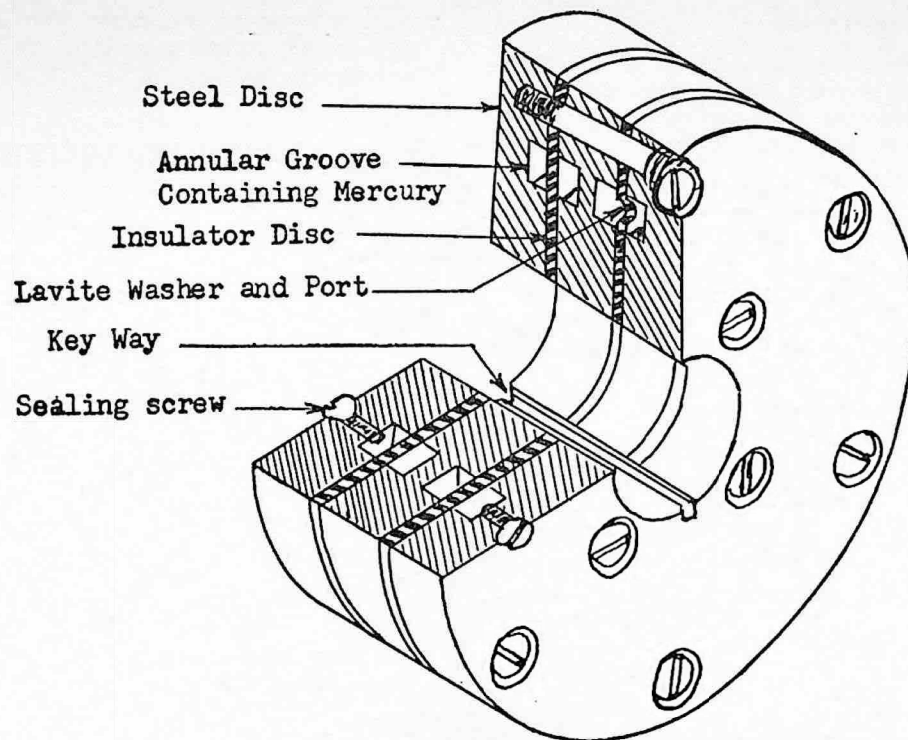
Assembly of a Rotary Mercury-Type Interrupter Unit.

Figure 78



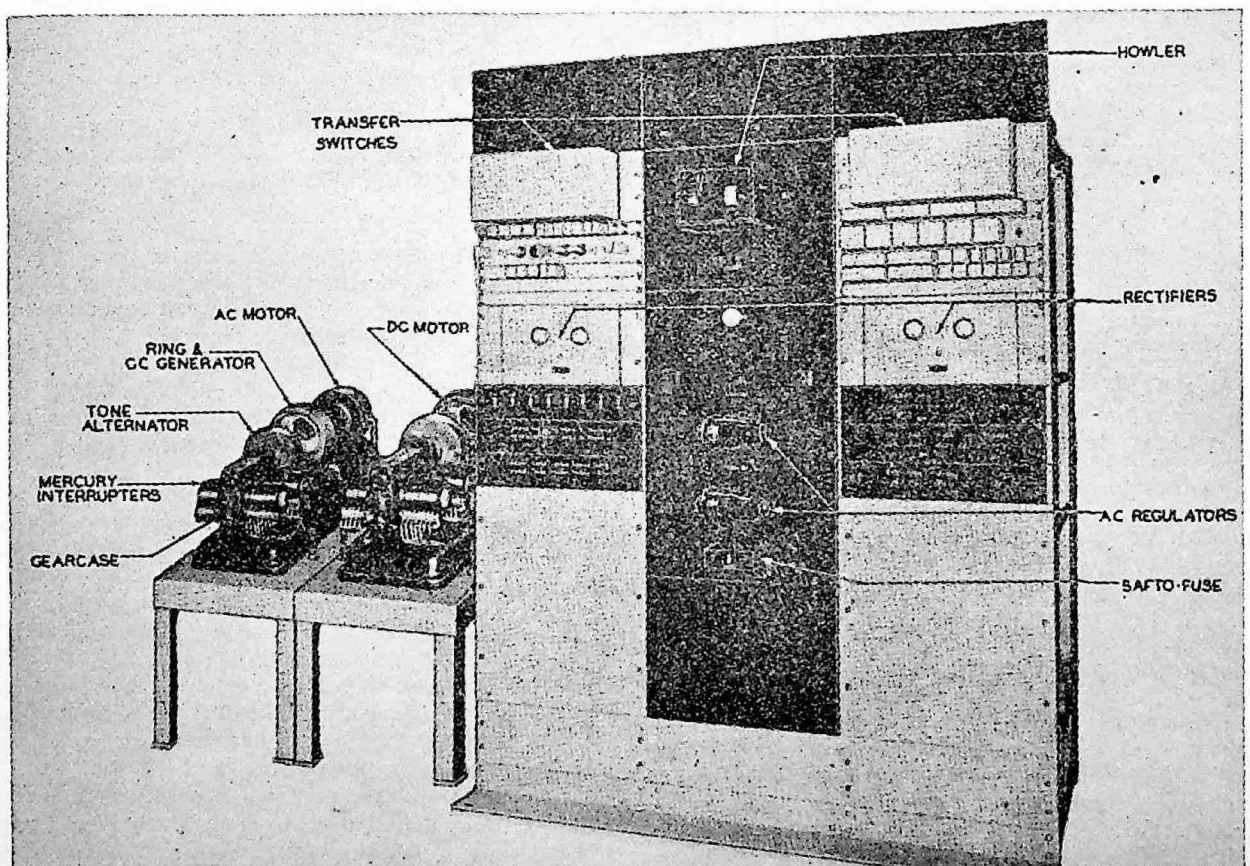
A group of Rotary Mercury-Type Interrupter Units.

Figure 79



DOUBLE INTERRUPTER UNIT (Cross-Section)

Figure 80



RINGING POWER PLANT FOR A LARGE CENTRAL OFFICE

Figure 81

Ringing Generators

The three principal methods of generating ringing current are by means of pole changers, static ringing generators and motor-generators. Space does not permit describing all the types of ringing generators in common use.

Motor Driven Howler Interrupter

This apparatus consists of a d-c motor and a drum type interrupter to furnish high tone by interrupting battery at the rate of 480 interruptions per second at a motor speed of 1200 RPM. The unit is complete with a sub-base and enclosing cover all arranged for vertical mounting on a panel.

Small Motor-Driven Ringing Machines

In some of the smaller central offices which require a continuous ringing current supply for manual ringing, motor-driven ringing generators are used either as the reserve source of ringing current or for both the regular and reserve sources.

Ringing Machines with Tone and Interrupter Features

In central offices employing machine ringing, the ringing machines are usually equipped for producing tones and low-speed interruptions, and the larger machines also produce coin control current.

Figure 81 shows a ringing power board for a large central office together with the regular and reserve ringing machines mounted on sheet metal machine tables located adjacent to it.

RINGING PLANT OPERATING FEATURES

The division of the ringing load in machine ringing offices is accomplished by means of the slow-speed interrupters. Since the ringing interval is usually only one half as long as the silent interval (2 seconds and 4 seconds) it is possible to utilize three slow-speed interrupter units in an arrangement whereby one-third of the office is supplied ringing current during a two-second ringing period, another third of the office during the next two-seconds and a third during the following two-seconds. Thus the ringing generator can carry three times the load it could handle if the whole office were supplied during the same two-second ringing period.

Automatic switching from the regular to reserve ringing supply is employed in most of the larger plants. While the detailed circuit arrangement may differ with various sizes and types of plants this feature provides for starting the reserve battery driven machine when the voltage of the regular a-c driven machine falls below a predetermined value, caused by a primary power supply failure or other trouble. The ringing supply, tone and interrupted signal circuits are transferred from the regular machine to the reserve machine by means of a multi-pole electrically operated transfer switch. When ringing current of the proper voltage from the regular

machine becomes available, the supply circuits are automatically transferred back to it and the reserve machine stopped.

5.2208 CONTROL AND DISTRIBUTION EQUIPMENT

General

This item describes the principal items of equipment and apparatus employed to control the operation of a power plant, and for switching and controlling the power plant output. Some of the apparatus which might be considered in this category, such as motor starters and rheostats, has been previously mentioned on account of its close association with the operation of motors and generators. Most of the apparatus described in this section is mounted on the power board or machine control panels.

The recent trend towards the automatic operation of power plants, and the use of various automatic features such as emergency cell switching, voltage regulation and the like in manually operated plants, has led to the use of many devices not found in the earlier power plants. Due to the wide variations in size and operating characteristics which practically every type of apparatus must be supplied to meet, the following descriptions are necessarily restricted to a brief outline of the purpose and basic operation of each type.

Power Boards

The power board serves to centralize and accessibly locate the miscellaneous equipment used in the operation and control of the power plant.

In the early types of power boards, large slate panels were used on which the required equipment was mounted. Recent practices make use of unit panels, of impregnated asbestos composition, each of which either carries the switches or other apparatus required for a certain function or is associated with one or more other panels arranged for accomplishing the result.

The types of frameworks used for power boards have gone through a process of evolution. The early types employed job fabricated angle iron, which was replaced by job fabricated pipe framework and fittings, for supporting the panels. Both of these types were fastened to the floor, and were either braced to a wall, or uprights were extended to ceiling supported auxiliary framing. With the recent trend towards lower basement ceilings in new buildings, the use of enclosed storage batteries which eliminate the necessity for separate battery rooms, and the use of machine control panels associated with the machines, the changed conditions have resulted in the present design of welded angle iron power board frameworks which are entirely floor supported.

CIRCUIT BREAKERS

Circuit breakers are connected between each charging machine and the batteries to protect the generator against abnormal conditions such as power failure or overloads. The circuit breaking device serves as a switch to complete the circuit from the generators to the batteries, and to break the circuit, by the operation of auxiliary devices, under abnormal conditions.

The manually operated circuit breakers are of the single pole type operated by a hand lever. The circuit breaker is held closed mechanically, against the pressure of a spring, and is opened by the spring when the locking mechanism is tripped. The tripping mechanism is controlled by the electro-magnetically operated reverse current or overload devices which are parts of the assembly. Ordinarily these circuit breakers are provided with both overload and reverse current devices, but occasionally only one feature is required and furnished. A bell ringing attachment (to operate an alarm circuit) is provided to indicate the operation of the circuit breaker.

They are furnished for use on direct current circuits in capacities up to 1600 amperes, and are usually mounted on machine control panels associated with the charging set.

The solenoid operated circuit breaker, is similar in construction and operation to the manually operated type except that it is equipped with a solenoid operated mechanism so that it may be closed or opened by the operation of a remote control switch located on the front of the power board. In the larger manually operated power plants this permits the attendant to start the machine, then go to power board where the meters and generator field rheostats are located, bring the generator up to proper voltage and close the circuit breaker by means of the remote control switch.

Automatic reverse current switches are used in most of the recently developed power plants, instead of the circuit breakers just described. The function of the automatic reverse current switch is to connect a charging generator to a battery at a predetermined voltage and to disconnect the generator from the battery when current flows from the battery to the generator (on reverse current). The term "automatic reverse current switch" usually embraces the combination of an electrically operated contactor and a reverse current relay.

FUSING OF POWER PLANT OUTPUT CIRCUITS

All of the power supply circuits leading from the power plant to other parts of the central office are fused to protect the wiring and the power plant equipment. The carrying capacity of each fuse must be limited to a value which will protect the wire connected to it against overheating in case of a short circuit or ground. Where a large lead supplies current to a number of smaller leads, each of the smaller leads is also fused to protect that size of wire. In many cases the capacity of the fuses specified may be lower than would be required to protect the wiring, in order to safeguard the apparatus in the circuit.

N.E.C. (National Electrical Code Standard) fuses are used for the supply leads. W.E. No. 35 type (grass-hopper) alarm fuses are used for individual central office circuits or small groups of circuits, and are furnished in capacities of 5 amperes or less. The alarm

fuses (35 Type) are so designed that when the fuse wire melts, a small visual signal (consisting of a glass bead on the end of a short wire) is displayed on the top, and a flat spring on the bottom makes contact with an alarm bar. This alarm bar is connected through the central office alarm circuit which rings a bell and displays a lamp signal.

Where a N.E.C. fuse is used on a central office supply lead it is the usual practice to connect an alarm fuse in parallel with it so that when the main fuse blows the alarm fuse also operates, thereby displaying a signal and operating a central office alarm to indicate which circuit has failed. Since some part of the central office is out of service when a fuse fails, the alarm fuse serves a very important function in sounding the alarm and enabling the maintenance people to locate the fault and correct it immediately.

5.2209 SWITCHES

Broadly, the term "switch" applies to any device used for opening and closing a circuit, or for transferring the continuity of a circuit from one path to another.

Knife Switches

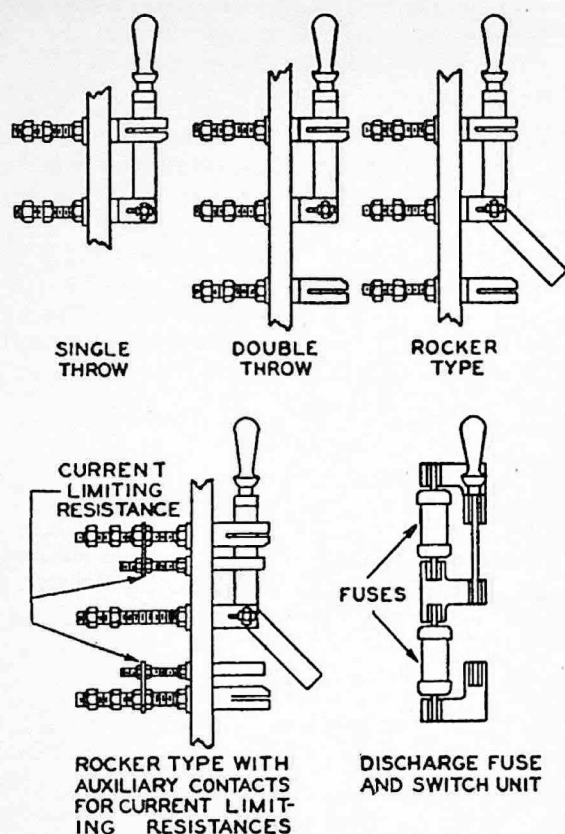
The size of the switch is controlled by the current flow as there must be sufficient copper in the knife blades and jaws, and suitable contacts to provide adequate carrying capacity. Knife switches are usually mounted on unit type power board panels arranged to perform specific functions; such as discharge fuse and switch panels, battery transfer switch panels, emergency cell switch panels and the like. Figure 82 shows the types of knife switches most generally used.

Battery transfer switches, for transferring the discharge leads from one battery to another, where duplicate batteries are used, are of the rocker (angle blade) type. This type of switch permits a very quick transfer from one position to another. The battery transfer switches are usually of the circuit-maintaining type; that is, the blades make one set of contact clips before breaking the other.

Emergency cell and CEMF cell switches are also of the rocker type but include additional features. The switches are equipped with auxiliary contacts and current limiting resistances, to limit the flow of current, as the emergency cells are momentarily short circuited through these resistances while being switched. The switches are mechanically interlocked so as to prevent an improper sequence of operation which might short circuit the cells and injure them.

A discharge fuse and switch unit consists of a double-throw knife switch associated with two fuses. The two fuses are connected in series with the discharge lead but the knife switch short circuits one of them. Should the other fuse operate the switch can be thrown, thereby short circuiting the operated fuse and placing the good

fuse in the circuit. After the operated fuse is replaced, the switch blade may be returned to its normal position.



Commonly used Types of Knife Switches.

Figure 82

Safety type switches consist essentially of knife type switches mounted on an insulating panel and enclosed in a metal cabinet. A handle on the outside of the cabinet operates the switch. They are furnished in single throw and double throw types, the single throw type having fuse clips of the proper capacity mounted on the panel. They range in capacities of 30 to 1200 amperes, and are used principally for controlling circuits carrying primary power supply voltages.

Motor-Driven Emergency Cell Switches

These switches are used in either manual or automatic power plants, where it is desired to have the emergency cell switching performed automatically, under control of a voltage relay. The "knife blade type" motor-driven emergency cell switches are most generally used, although the "rotary type" has been used to some extent. These switches are mounted on the front of the power board.

Emergency Lighting Relay Switches

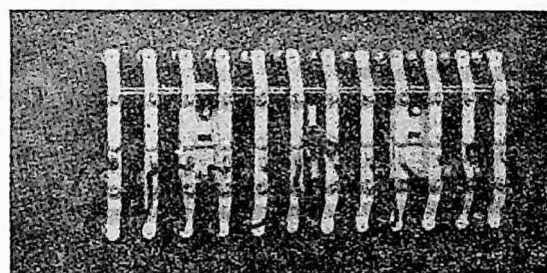
In most central office buildings provision is made so that if a primary power service failure occurs, thereby interrupting the regular building lighting service, a limited number of emergency lights are automatically lighted from the 24 or

48 volt central office storage batteries. The regular lighting as well as the separate emergency lighting equipment is usually provided by the telephone company as part of the building. However, the "emergency lighting relay switch" for switching the emergency lights to and from the battery circuit is normally installed as part of the central office power plant.

The emergency lighting relay switch is essentially a magnet switch of the contactor type with a self-contained closing coil and an undervoltage device. When the regular lighting voltage falls below a predetermined value the undervoltage device causes the magnet switch to close, and lock closed mechanically, thus lighting the 24 or 48 volt emergency lamps. When the regular lighting voltage returns to a predetermined value the mechanical locking device is tripped, allowing the magnet switch to open the emergency lighting circuit. The emergency lighting relay switches for use on polyphase service are similar to those for single phase, except that additional undervoltage relays are included for the extra phases.

Multi-Pole Electrically Operated Transfer Switches

This type of switch, as shown in Figure 83, is used on ringing power boards to transfer the ringing, tone and signal leads from the regular ringing machine to a reserve machine in case of a primary power failure or other emergency affecting the output of the regular machine. It is operated by electro-magnets, and transfers 12 circuits from one set of 12 contacts to another set of 12 contacts. The switch is held closed on one throw when the operating coils of the magnets are energized, and held closed on the opposite throw by springs, when the coils are de-energized.



Multi-Pole Electrically Operated Transfer Switch

Figure 83

5.2210 METERS

In order that the power room attendant may know at any time the characteristics and amount of current flowing in the power circuits, meters are provided for permanent or temporary connection to them. They are usually mounted either on the power board or machine control panels. A brief description of these instruments and their use follows.

Ammeters

Ammeters are used to indicate the current flow

in amperes between the batteries and distributing fuse panel, between the generators and battery or at other points where such information is useful in operating the plant.

Voltmeters

The voltmeter is used to indicate the voltage (or potential) of a circuit. It is connected directly to the sides of the circuit to be measured by means of fused leads. An instrument switch is sometimes used to connect one meter to more than one circuit, such as to one or more generators or to a battery to which the generators may be connected.

Wattmeters

Wattmeters are occasionally used at emergency engine driven alternator installations when it is necessary to know the actual kilowatt output of the alternator when carrying the office load.

Frequency Meters

This type of meter is used to indicate the frequency of alternating current. When furnished with an emergency engine driven alternating current generator (alternator) it serves to indicate the frequency of the alternator output and also as a check on the engine speed which is directly proportional to the frequency.

Ampere Hour Meters

In certain types of automatic power plants a contact-making ampere-hour meter is used to control the charging of the batteries. The mechanism and contacts are so arranged that charging starts whenever the batteries have discharged approximately ten per cent of their rated ampere-hour capacity, and stops when the ampere-hours replaced exceed the preceding discharge by a predetermined amount sufficient to compensate for the conversion losses of the battery. An additional contact is provided to operate an alarm when the batteries have discharged thirty-five per cent of their ampere-hour capacity, in case the charger failed to function when the battery had discharged ten per cent. The present trend is to control the operation of automatic power plants by a voltage method, instead of by the use of ampere-hour meters.

Power Factor Meters

This type of meter is used on those installations where the commercial power company imposes a penalty for operating at a low power factor, and where either synchronous motors or static condensers are provided for "boosting" the power factor. Since the power factor equals the ratio of the true power to apparent power, it is necessary to compute the condition from a combination of ammeter, voltmeter and wattmeter readings where a power factor meter is not supplied. This meter is usually mounted on the power board associated with an ammeter and a voltmeter.

5.2211 AMMETER RELAYS

In automatic power plants, ammeter relays are connected in the output circuit of the charging machines as part of the control circuit equipment for the starting and stopping of individual machines as the exchange load varies. The ammeter relay resembles a conventional ammeter in appearance but the moving pointer is equipped with contacts which make on "high" and "low" stationary contacts.

5.2212 VOLTAGE RELAYS

Voltage relays are used to operate alarm circuits, or control the operation of apparatus, when the voltage reaches a predetermined high or low value. Each voltage relay is furnished for a specified voltage range, that is, the relay is so designed and adjusted that the "low" contact will make at its rated low voltage limit, and the "high" voltage limit. The contacts are also adjustable to a limited extent, within the range of the particular relay, the method of adjustment depending on the type of voltage relay used.

5.2213 AUTOMATIC VOLTAGE REGULATION

The purpose of a voltage regulator is to control the output voltage of a generator within narrow limits in order that the exchange supply may be held to a uniform level, or so that storage batteries may be floated at a value where they will take a slight charge to keep them in a charged state, while the variation in load is balanced by corresponding changes in the generator output. Since the voltage and output of a commercial generator is dependent upon its field strength, it is necessary to change the field strength as the load and voltage tends to vary in order to keep the output at a constant voltage. An automatic voltage regulator, which responds to changes in voltage is, therefore, used to control the field strength of the generator to accomplish this purpose. Several types of automatic voltage regulators are used depending on the size and characteristics of the generators involved.

5.2214 RESERVE POWER EQUIPMENT

General

Reserve power equipment for telephone central offices includes generators driven by internal combustion engines, instead of by electric motors, thereby creating a source of power supply which is independent of the primary electric power normally supplied to the telephone building. Such equipment, including the engine, alternator or generator, and the control and switching facilities for them is termed a "reserve power plant".

It is essential in the design of telephone power plants that provisions be made to assure an uninterrupted source of power. The batteries provide reserve for a short period, but in case

the primary power provided by the utility company is subject to interruption for periods of time exceeding the battery reserve, reserve power plants are generally provided unless two independent sources of commercial power are available. Even in communities where there are two independent sources of commercial power it is possible that a reserve plant would be preferable. The question of which plan is preferable is determined by the telephone company; and the reserve plant, when required, is specified by them.

Types of Generators

For the smaller plants, engine driven direct current generators which may be connected in parallel with the regular charging sets, if desired, are usually used. In larger plants, where more than two engine driven direct current generators would be required, engine driven alternators (a-c generators) are usually employed. The alternator has the advantage of entirely replacing the commercial service if desired, and, in addition to operating the telephone plant, the lighting and other electrical equipment in the building may be operated during the failure of the commercial service.

Many types of internal combustion engines, alternators, generators and control equipment have been supplied for reserve power service over a period of years. Some of the representative types furnished are described to indicate the character of the equipment.

SMALL ENGINE DRIVEN D-C GENERATORS

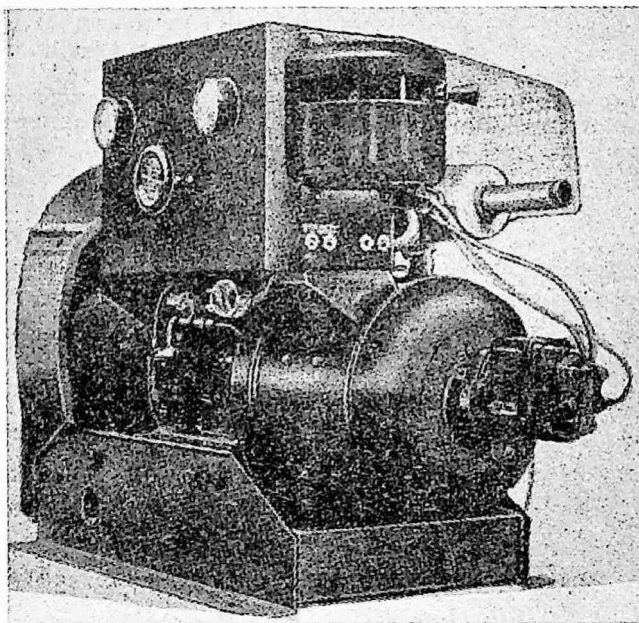
Fig. 84 illustrates an engine driven generator complete with control cabinet. The engine is of the four cycle two cylinder type, radiator cooled, runs at 1850 RPM and uses kerosene for fuel. Ignition is provided by a high tension magneto. A centrifugal type governor controls the speed by throttling the fuel mixture to the cylinders, and an overspeed trip of the centrifugal type shuts down the set, by grounding the ignition, if the engine reaches an abnormally high speed (about 2100 RPM). A diaphragm pump lifts the fuel from the fuel tank in the base of the engine to the carburetor. A flexible metallic hose is used for connecting the engine to the exhaust pipe running to the roof. The engine is started by a push button. The battery operates the generator as a motor, a series winding having been provided in the generator field coils for starting only.

The d-c generator is of the selfexcited (shunt wound) type and is rated at 1.5 KW. The engine and generator are wired at the factory, to the control equipment located in a steel cabinet mounted above the generator. The meters, field rheostat handwheel and control switches are located on the cabinet where they are accessible for operating the set, and the rheostat, control relays, etc., are inside the cabinet. A double pole double throw switch on the cabinet is provided for connecting the battery leads for charging.

LARGER ENGINE DRIVEN ALTERNATORS AND GENERATORS

Some of the old reserve power plants employed heavy slow speed gas engines to drive the generators by means

of belts. Due to the progress in the development of internal combustion engines, higher speeds made practicable the use of direct connected engine generators. Further development toward engines of still higher speed made possible the use of the modern types which are more compact, lighter and smaller, and permit the use of smaller generators, than the older types of the same output.



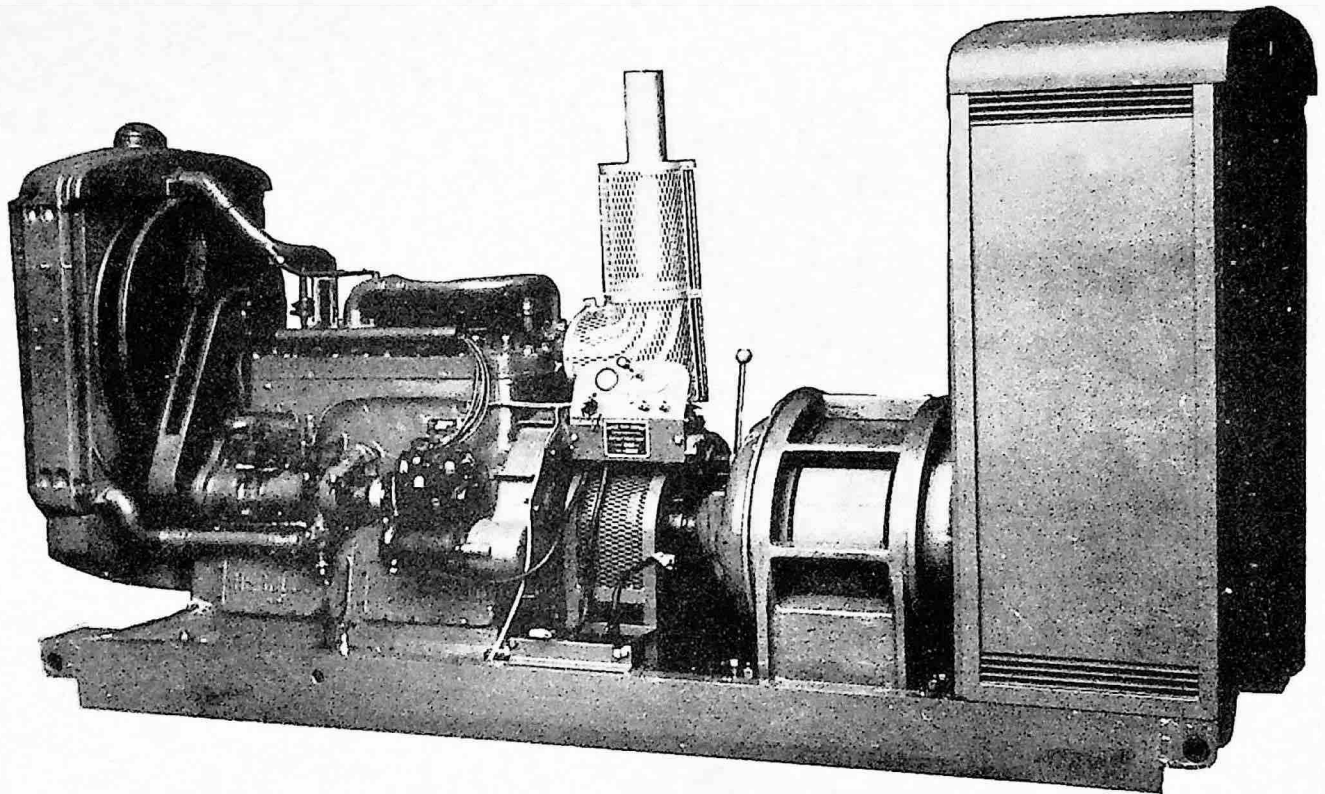
A 1.5 KW Engine Generator Reserve Power Plant.

Figure 84

Engines of the gasoline type as shown in Figure 85 or diesel (fuel oil) engines as shown in Figure 86 each operating at 1200 RPM are being used. These are self contained plants. Each type has a battery driven starting motor, a governor to automatically control the speed, a centrifugal overspeed device and other accessories necessary to insure safe, reliable and efficient operation.

Water cooling the engines may be accomplished either by means of city running water or by a radiator and fan similar to that employed on automobiles, depending on local conditions as determined by the telephone company. Where city running water is used it is piped from the building supply through flexible hose connections. The cooling water supply is regulated by valves to maintain proper temperature, the overflow running to a funnel connected to waste pipes. In some instances a heat exchanger is used. This feature consists of pipe coils immersed in the engine cooling system water. Water flowing through the coils under city water pressure uniformly cools the water in the engine cooling system without introducing sediment into the engine cooling system.

The fuel supply for gasoline engines is stored in tanks located under the basement floor or buried outside the building and is pumped from the tanks by fuel pumps on the engine, over flow pipes being provided to return the excess fuel. In addition to the above, fuel oil for diesel engines can be stored in a tank which may be in the engine base or in the room close to the engine. Suitable gauges are provided for reading the level of the fuel in the tank. Liquid fuel stored on the premises is



GASOLINE ENGINE ALTERNATOR WITH RADIATOR AND CONTROL CABINET

Figure 85

usually used for reserve power plants instead of natural or artificial gas because the same emergency, such as a flood or explosion, which causes failure of the commercial power supply might also affect the public gas supply.

The exhaust equipment includes a flexible metallic exhaust hose connection at each engine and a silencer located over or close to the engine. At gasoline engine installations pipe is provided from the silencer to the roof. This practice is usually followed at diesel installations though it is permissible to exhaust into a building flue known to be tight and adequately strong.

The alternators or generators which are directly connected to the engines usually through suitable flexible couplings are supplied in a variety of sizes up to 70 KW or higher depending on size of office and load to carry. The d-c generators are of the commercial self excited type with a voltage output suitable for the type of power plant with which it is associated.

The alternators used in the reserve power plants are usually furnished for an output of nominally 220 volts, 60 cycle, 3 phase current to correspond with the local normal commercial power supply. The frequency is controlled by the speed of the engine which can be regulated by adjusting the governor when required. Each alternator has a rotating field excited by a direct connected direct current generator commonly called an exciter. Each alternator control panel includes an automatic voltage regulator and necessary controls to insure the desired voltage by manual or automatic control as desired. When more than one alternator is required to carry the emergency load they can be

operated in parallel when the detailed instructions furnished to installations of this type are followed. The instructions cover the procedures necessary to insure identical alternator voltages, frequencies and phase rotation.

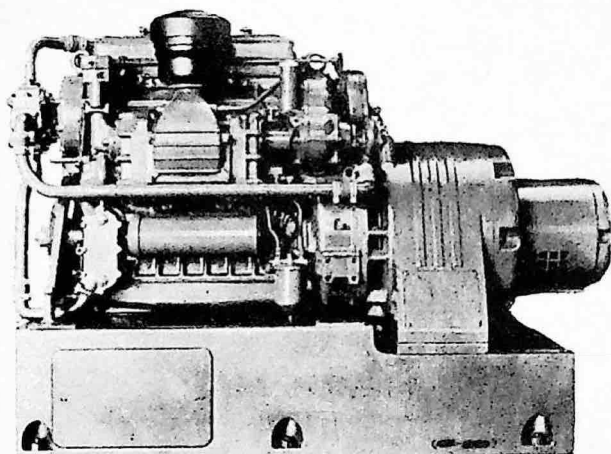
The control equipment which is mounted in a control cabinet located over the alternator or generator (See Figures 84, 85 and 86) includes the equipment necessary for the operation of the alternator or generator. As will be observed from the above figures it may also include most of the engine control equipment. The control equipment is placed and wired at the factory so that running and connecting the output leads and connecting the starting battery leads at an installation involves a comparatively simple operation. A transfer switch mounted on a wall or column near the reserve plant is furnished for switching from the regular to the reserve service.

Portable Reserve Power Plants

Experience has proven that portable reserve power plants are required under certain conditions. For example a flood may not only cause the regular primary power source to fail but also inundate the central office reserve plant. Self-contained portable reserve plants have, therefore, been developed which may be transported by motor truck. Figure 87 shows a 70 KW portable engine alternator reserve plant which includes essentially the same features as the engine alternator radiator cooled plants previously described except for the fuel supply and exhaust facilities. The silencer is

mounted on top of the housing and a separate welded steel fuel tank, arranged for mounting on pipe legs, is provided for location near the plant during operation. Automobile batteries (12 volt) are used for starting the engine.

Each complete set is mounted on skids to facilitate handling and transportation, and is covered with a weather proof hood.



Diesel Engine Alternator Set 40 KW 1200 RPM

Figure 86

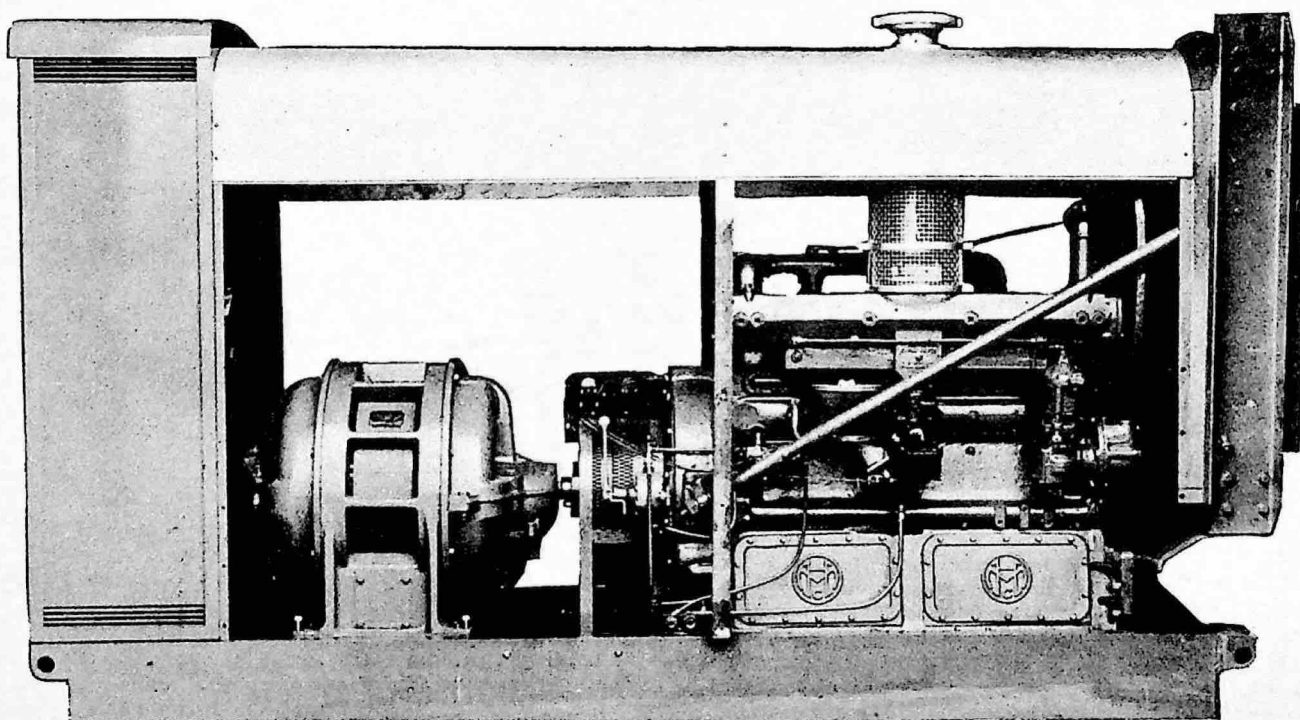
5.2215 POWER CABLING AND WIRING

General

This item describes the conductors used for extending the outside power supply circuits to charging, ringing and other machines, including

rectifiers, and to lighting outlets, as well as for distributing the converted currents to the telephone equipment. The conductors may be insulated, solid or stranded wires, which are armored or run in conduits where necessary, or they may be bare bus bars which depend upon spacing and non-conducting supports, for their insulation. The sizes of conductors used are determined by the following considerations:

- (a) **The safe carrying capacity** which is the amount of current a conductor will carry without becoming overheated. An open bus bar of a given sectional area will safely carry more current than an equivalent insulated wire or cable, because the bus bar, being directly exposed to the air, radiates heat more readily than does an insulated wire or cable.
- (b) **The permissible voltage drop** which is the amount that may be lost in a pair of conductors, and still supply sufficient potential at the end of the loop to insure that the apparatus served will not fail to operate. This is computed at the maximum current to which the conductors are expected to be subjected. In some instances the allowable drop is one-tenth of a volt but is more often a quarter or a half volt.
- (c) **The limitation of cross talk**, which is accomplished by making the conductors, which are a common source of supply to a number of circuits including telephone transmitters and receivers, sufficiently low in reactance or effective resistance so that what is being transmitted in one of the



A 70 KW Portable Reserve Power Plant

Figure 87

telephone circuits cannot be overheard in others.

- (d) **The size of the fuse to which the conductor is connected.** Main discharge fuses are frequently selected which will carry indefinitely somewhat more current than the expected peak load. This is done as an extra precaution against service interruptions in case some unusual conditions arise. The conductors connected to those fuses must then be made sufficiently large to be protected by the fuses. This means that they must be larger than would be required on account of carrying capacity determined by the maximum load, and, in the case of very short discharge leads, larger than needed to meet the voltage drop and crosstalk requirements.

A power calculation chart is shown on the job wiring list drawing, which gives the calculated load in amperes, the calculated voltage drop, and the terminations of the leads. The purpose of this chart is to preserve the data for use in subsequent checking, and the engineering of additions and changes.

For convenience in handling, and in stocking the conductors as well as the terminals and bus bar clamps used with them, power cables are limited in our work to 800,000 circular mils in area, and bus bars to $\frac{1}{2}$ inch by 12 inches in sectional area. Where more conductivity than would be provided by using these maximum sizes is required, parallel cables or laminated bus bars are used. In many instances space considerations require the use of laminated bus bars less than 12 inches in width.

5.2216 PRIMARY POWER SERVICE LEADS

Primary power service supply leads are brought into the building and terminated on a service panel which is equipped with fuses and with lightning arrestors if required. From the service panel, circuits are extended to various parts of the building for lighting, electric heating and other power services not directly associated with the telephone equipment. All of this work is customarily arranged for by the telephone company prior to the start of the telephone installation work. The power service supply for the telephone power plant is then picked up at the power service panel by the installer, and extended, through suitable fusing to the various machines, etc., with their control apparatus. Electric power service for frame and aisle lighting and for convenience outlets at frames and switchboards is usually picked up by the installer at the lighting panel boxes previously provided by the telephone company. All wiring which is either normally or intermittently connected to outside power supply sources or to equivalent sources such as house plants located in the telephone buildings, is either run in conduit or is done with flexible steel covered wire and cable.

5.2217 INDUCTIVE INTERFERENCE IN POWER WIRING

Precautions which are necessary in power plant wiring, to insure that the currents flowing in or the voltages maintained on certain wires do not cause objectionable reactions on other circuits through inductive and capacity effects are:

- (a) **Pairing of leads**, that is, locating the conductors of a circuit side by side, and where several circuits follow the same route, locating the pairs in best relation to each other for minimum inductive effect.
- (b) **Providing separation between the conductors** which supply talking circuits, and those which supply signaling circuits. The former are known as "quiet" leads, and it is the usual practice to provide a minimum separation of 3 inches between them and the signaling leads. In some instances, such as amplifier power supply the separation may be as much as five feet. The spacing requirements applying to charge and discharge leads vary with the circuits of which they are parts. These leads are classified as charge, talking, filament, plate, etc., on the circuit drawings and in the requirement table in the installation handbook. This is to enable the installer to provide the necessary spacing.
- (c) **Providing metallic shielding** for leads which carry currents having relatively high voltage peaks, such as ringing and tone leads, as well as leads carrying high frequency currents. Also, leads which feed amplifiers are shielded because any disturbing inductive effects which they may pick up would be amplified along with the useful currents carried by the leads, with resultant bad effect on the transmission. Metallic shielding to be effective must be grounded at both ends.

5.2218 BUS BARS

Where the available space permits, as in runs between charging machines, power boards and batteries, aluminum bus bars are now used extensively. For any given current carrying requirement, an aluminum bus bar must be one and one half times as large as a copper bar which would carry the same load, but owing to the relatively lighter weight of the aluminum, its weight would be about one-half of that of the equivalent copper bar.

In addition to the weight advantage which makes aluminum bus bars easier to handle than copper, it requires no protective finish even when located in rooms with open type storage batteries, and presents a very good appearance in a telephone office where most of the ironwork and apparatus is finished with aluminum colored paints and enamels.

To insure satisfactory contacts when aluminum bars are joined together, or to other metals, it is

customary to apply petrolatum to the aluminum surface which is to form the connection before cleaning the surface by means of an abrasive. The reason for this is that this metal oxidizes rapidly on exposure to the air, and if not coated with some material which will exclude the air, satisfactory connections would not be obtained.

5.2219 FLEXIBLE STEEL COVERED CABLE

Service leads in a central office power plant are generally flexible steel covered or FSC cable. This cable is similar in construction to what is known as BX wire and cable. It is used in many applications where braided rubber covered wire run in rigid metal conduit was previously used.

5.2220 CENTRAL OFFICE GROUNDS

Earth connections or central office grounds, perform several important functions. One of these is the provision of a low resistance path to earth, for dissipating lightning and other strong currents intercepted by lightning arrestors and protectors. Another function is that it is necessary to ground one terminal of the central office common battery to minimize the trouble encountered in case of a cross with a high potential line. Usually this is the positive (+) end of the batteries. If this were not done, that is, if a common battery telephone exchange were insulated from the earth, and some portion of the wiring became crossed with the wiring of an electric light, power or railway current distribution system, the potential of the telephone system would be raised to that of the other system. The insulation of the telephone apparatus and wiring might then be subjected to voltages which it is not designed to withstand, and all users of, as well as people working on the telephone system, might be exposed to electric shocks.

Similarly all frames, racks, etc., which support equipment which is connected to service voltage are grounded, since if they were insulated and became crossed with electric light or power wiring they would be sources of danger to the people working in the Telephone central office, as well as to the telephone system apparatus and wiring.

Other uses for ground connections are that shielding of conductors and apparatus, to be effective, must be grounded; and metal mounting plates, etc., if not grounded would, if they became crossed with circuit wiring, become sources of noise and other circuit troubles which might be hard to locate.

Some of the circuits in the telephone plant, such as those which operate the ringing on selective party lines, and some toll line and telegraph signaling circuits, make use of the earth as part of their operating paths.

Because of the importance of these grounds, it is customary to make use of the piping of water supply or gas distribution systems which can usually be depended upon to be adequate as to low resistance and carrying capacity. In some

instances, such as at repeater stations and small manual and dial offices, where water or gas system piping is not available, what are known as made grounds must be utilized. Several methods of producing these have been used. The present standard method is to drive several pipes or rods into the ground, preferably in the basement of the building housing the telephone plant. The pipes or rods are spaced five to ten feet apart, and are bonded together so as to form a unit.

5.23 EQUIPMENT ALARMS

The No. 1 SXS offices are provided with a complete alarm system, the purpose of which being to indicate to the Plant Maintenance personnel that some part of the equipment has failed in its performance of the function, or functions, for which it was designed. Some reference has already been made to these alarms in the previous paragraphs. Supplementary alarm circuits are also provided, such as the "Emergency Alarm System" to sound an alarm in case of fire, serious injury or other emergency.

Separate alarm circuits are provided for each type of equipment, as follows:

Line Finder Frames—Call Blocked	
	—Release
	—48 V. Fuse
Selector Frame	—Permanents
	—Release
	—48 V. Fuse
Connector Frames	—Permanents
	—Release
	—48 V. Fuse
Power Equipment	—Low Voltage
	—High Voltage
	—Fuse
	—Ringing Machines
	—Machine Transfer, etc.

Visual and audible alarms are also provided for switch shelves, power frames and miscellaneous relay rack units.

Visual Signals

Fuse and No Voltage	—Red
Miscellaneous Trouble	—Green
Service Calls	—Amber
Permanents	—White

Audible Signals

Power Failure	—Vibrating Bell
Major Alarm	—Vibrating Bell
Minor Alarm	—Single Stroke—
	Tone Bar
Alarm Circuit Alarm	—Sub-set (AC Bell)
Permanent Signal	—Buzzer
Service Calls	—Sub-set—AC Bell
	(Swmn Talk)

Aisle and cross-aisle visual signals are provided to direct the maintenance personnel to the shelf or fuse panel upon which the failure has occurred.

Associated with and located near the Office Foreman's desk (or Report Center) is the office alarm panel. This panel offers a visual indication of the general location of the failure, e.i., that the failure has occurred in a line finder frame, a selector frame, a connector frame, power plant, etc. In a multi-floor office, a lamp in the alarm panel will indicate upon what floor the failure has occurred.

5.2301 LINE FINDER ALARMS

Visual and audible alarm signals are given under each of the following conditions existing in a line finder unit.

- (a) Originating call not picked up within 18-48 seconds:—RED call block (CB) lamp lights and sounds minor audible alarm.
- (b) All finders busy but no trouble condition—operates ATB register—no alarm given as (a) will take care of this.
- (c) All finders busy due to ground on Start Lead—Operates ATB register (if trouble is not cleared promptly, register may operate several times) RED ground alarm and aisle pilot lamps light and a bell rings continuously until key AR is operated by attendant.
- (d) Chain circuit trouble—ground or cross with battery: WHITE ground alarm and aisle pilot lamps light and sounds audible. (This may result in a traffic delay should all finders become busy, in which case (a) only would give the alarm)
- (e) Peg Count register operates each time that a finder moves "off normal" and subsequently releases. If delay of from 18 to 48 seconds from start of release to return to normal occurs then: —GREEN release lamp and aisle pilot lamps light and audible alarm is sounded. (Minor Alarm)
- (f) A group fuse alarm circuit gives an audible and visual signal if the battery supply is interrupted.

5.2302 LINE SWITCH EQUIPMENT ALARMS

An alarm circuit is provided for each primary line board to indicate:

- (a) Delayed release of the A, B and D relays. Audible and visual signals.
- (b) Should the locking arm become stuck and not fall back in a slot of the locking segment.
- (c) Fuse alarm—audible and visual.

Secondary Line Board

- (a) Same as (a) above.
- (b) Grounded Open Main lead.
- (c) Fuse alarm.
- (d) Oscillating Master Switch.
- (e) Grounded pick-up leads.

Out Trunk Boards

- (a) Slow release of A and B relays.
- (b) Stuck locking arm.
- (c) Overheating of 85 ohm winding of B relay.

5.2303 SELECTOR FRAME ALARMS

- (a) **Permanents**—A selector seized but not stepped off vertical normal after a pre-determined time interval, will cause WHITE permanent lamp to light on shelf. Also lights aisle pilot lamp and causes buzzer to sound.
- (b) **Release**—Failure of a selector to return to normal after release of the "A" relay will cause the GREEN shelf and aisle pilot lamps to light and sound a minor alarm audible.
- (c) **Fuse**—One fuse per selector shelf (20 switches) is provided. The operation of one of these fuses causes the RED shelf and aisle pilot lamps to light and it causes minor audible to sound. (Later installations may have 5 switches per fuse)

5.2304 CONNECTOR FRAMES

- (a) **Permanents**—Failure of calling party to hang-up after completion of a call causes the WHITE "Supv. 1" lamp on shelf and the aisle pilot lamps to light after a period of 3-7 minutes, a signal on single stroke bell is operated.
- (b) **Release**—Failure of a switch to restore to vertical normal after release of the "A" relay will cause the GREEN shelf and aisle pilot lamp to light after 18-48 seconds. The minor alarm audible will sound.
- (c) **Fuse**—Each connector switch on a shelf is fused. The operation of one, or more, of these fuses will cause RED shelf and aisle pilot lamps to light. Audible (minor) alarm signal is sounded.
- (d) **Ringing Fuse**—The ringing supply to each connector shelf is fused at the shelf. The operation of one of these fuses causes the RED "Gen" lamp to light and bring in the audible and aisle pilot signals. (Minor Alarm)

5.2305 RELAY RACKS

Generally, the only alarm circuit associated with a relay rack is the FUSE alarm. The operation of one, or more, of these fuses causes a RED panel lamp to light and it brings in the visual and audible alarms.

5.2306 CEILING LAMP PANELS

Originally, ceiling lamp panels were provided for the dial central offices; however, these have, in most instances, been replaced with the relay rack type alarm panel.

5.2307 EMERGENCY ALARM SYSTEM

As mentioned previously, emergency alarm systems are used in central office buildings to sound an alarm in case of fire, serious injury or other emergency.

Three systems are available. Two of these are used in multi-office buildings and in central offices large enough to warrant division of the equipment into "zones", a "zone" being that portion of the building or floor area treated as a unit by the alarm system. The third is a simple system for use in offices small enough so that zoning appears to be unnecessary.

In one of the multi-zone systems, the zone where the alarm originates is indicated by means of codes sounded on horns or single stroke gongs. The sounding apparatus is operated under the control of code sending devices, one of which is associated with each zone. The capacity of this system is fifty zones and forty sounding devices.

The other multi-zone system employs lamps to indicate the zone in which the alarm originates. The zone indicating lamps are mounted in cabinets so distributed throughout the installation that persons responding to an alarm may readily observe them. The alarm is sounded on horns or vibrating bells operated continuously. This system has a capacity of five zones and six sounding devices.

The System used in unzoned offices employs two loud ringing bells operated from the central office ringing supply. These ring steady in the event of an alarm.

In partially unattended offices, the emergency alarm signal is extended to the operator or Main office.

Automatic fire detection is afforded in all three systems by the use of an insulated (red covering) fusible wire, known as "Fire Detection Wire", which is installed on the various frames and racks and which, in the event of fire, melts to open the circuit and thereby cause the alarm equipment to function.

For Manual Operation, alarm boxes known as "Station Boxes" are provided as required in

all systems. They are mounted at convenient locations to afford suitable means for an employee to cause the alarm to be sounded. Alarms may also be set off by cutting or breaking the "detection" wire.

Zones—each zone is assigned a particular code in order that the Plant personnel may know the approximate location of trouble just as soon as the audible signal is sounded.

Alarms—Off-normal conditions or troubles in the emergency alarm system other than those which result in regularly sounding the alarm, are indicated by supervisory alarms and signals.

5.2308 SMALL DIAL OFFICE ALARMS

The small dial offices are also provided with an audible and a visual alarm system, but on a greatly reduced scale. Aisle pilot lamps are not usually provided and the audible alarm is associated with a cut-off key. The purpose of this key being to open the audible sounding device (buzzer) circuit during the periods that the office is unattended.

The various shelf and power alarms in these offices are, generally speaking, similar to those in the No. 1 office. The principal difference in the system being the provision of what is known as an "Alarm Sender".

The alarm sender is associated with two Operator Office Trunks. When an alarm condition occurs, the sender circuit is caused to function and light one of the two incoming 0.0. trunk lamps at the 0.0. Switchboard. (Two 0.0. trunks are assigned as a safe-guard against a "single" trunk arrangement whereby the single trunk might be busy at the time the sender functions). An operator upon answering the trunk signal will hear nothing and, if she disconnects the trunk lamp will relight, thus indicating a trouble condition at the distant office. She is instructed to immediately notify Plant of the alarm. They may determine the extent of the trouble by dialing an alarm checking terminal and then listening to the type of tone, if any, on the line. The tone indications are as follows:

Alarm	Indication	Trouble Indicated
Major	No Tone	Main Fuse, High or low voltage, charge alarm, Grounded start lead, call block, Ringing machine failure.
Multiple Perm. Signal	Dial Tone	Permanent Lines (6 or more)
Minor	Busy Tone	Individual Fuse, Release Alarm, or Ringing Machine Transfer.
Permanent* Minor	Code 1 Audible	Permanent Lines (Less than 6)
None	Code 2 Audible	No trouble on test.

*One less than multiple P.S. setting.

There may be slight variations in the above table depending upon the type and/or age of the offices.

The trunk signal at the switchboard will not retire until the checking terminal has been dialed.

In offices not equipped with alarm senders, the alarms are extended to the Main office plant quarters on a separate trunk and with the terminations at an alarm cabinet, the incoming circuit being associated with an audible alarm circuit.

5.24 MECHANICAL ADJUSTMENTS—SXS— DIAL EQUIPMENT

Good telephone service depends upon a great many things all of which are essential in the sense that, should any one be omitted, either service could not be given at all or its quality would be impaired.

Among these things there are two of vital importance; namely, the correct design, manufacture and installation of the mechanism; and the mechanical and electrical adjustments necessary to the faithful performance of their assigned functions.

Design, manufacture, and installation are terminable proceedings; but maintenance continues as long as the mechanism remains in service.

The maintenance of any modern telephone office, with its vast numbers of relays, switches and other pieces of apparatus operating on small amounts of energy and on close margins, is very largely a matter of mechanical adjustment.

When telephone mechanism was in a less advanced stage of development the adjustments were determined by the experience of the maintenance men; and the practices in any office depended almost entirely upon the skill and resourcefulness of the one in charge.

Gradually as design and manufacture advanced, as more precise performance became possible, as more thought was given to adjustment problems, and as more knowledge of correct procedure became available, adjustment procedures became an exact science.

Today the vast experience of the older maintenance men who had to devise their own methods and learned much by the trial and error process, supplemented by the contributions of laboratory and operating engineers has been preserved in print and is available to all in the Bell System whose work requires it.

This information is issued under the name of BELL SYSTEM MAINTENANCE PRACTICES—CENTRAL OFFICES and is most specific.

These practices describe what are considered the most effective methods and procedures for maintaining central office equipment operating under standard conditions.

These practices already include an enormous amount of information essential to the installers and maintenance men and additions and revisions to keep pace with the rapid advance in the telephone art are being made constantly. The aim is to have them ultimately comprise all the latest

information needed for the maintenance of standard equipment, and to have each central office supplied with such portions of these Practices as are needed by the plant men in that office.

All our present step-by-step offices are now well supplied with this information and each new office as it is made ready for service will be equally well supplied. A definite routine is in operation for keeping this information up to date.

The indexing of this information is of great importance; for, it is evident, should a switchman want to know how much tension to put on a particular set of contact springs on any one of the numerous kinds of relays in his office, or what clearance to provide between the vertical teeth and the vertical pawl on a certain selector, the rapidity with which he can get that information largely determines its value to him.

Manifestly, it is impracticable to include in these notes the information contained in the Practices, but an outline of how they are made up and an illustration of how a switchman might go about getting the facts as to the adjustment of a selector, for example, are included for such help as it may prove to be for Traffic people.

5.2401 DESCRIPTION AND STRUCTURE OF B.S.M.P.'S

General

- (a) The practices included under the general title, "Bell System Maintenance Practices—Central Offices," are descriptive of what are considered the most effective methods and procedures for maintaining central office equipment operating under standard conditions.
- (b) They are prepared primarily to serve as working manuals for the forces on the job who are directly responsible for the maintenance of equipment, and it is intended that these practices together with the supplementary Bell System central office maintenance information described in other sections, will include ultimately all the maintenance information required by these forces.
- (c) The plan provides uniform and definitely located information for use throughout the System, and the effective application of these standard practices will aid materially in the furnishing of satisfactory service at minimum cost. The general use of standard maintenance practices tends also to establish uniform educational programs.
- (d) In the adoption of a plan which would provide the desired uniformity, the required flexibility was also kept in mind. Therefore provision was made for the inclusion of special practices required by local companies as well as for future practices which may be required by the development of new equipment.

- (e) "Bell System Maintenance Practices—Central Offices" are divided at present into eight major divisions as follows:

- 100—General
- 200—Routine Tests and Inspections.
- 300—Operating Methods and Non-Periodic Routines.
- 400—Apparatus Requirements and adjusting Procedures.
- 500—Methods of Performing Various Work Items.
- 600—General Troubles.
- 700—Description of Testing Equipment and Tools.
- 800—Educational Information.

DIVISION 100—GENERAL

Division 100, "General", deals with the description, scope and structure of the plan and other items of general nature. The various indices are also included in this division.

DIVISION 200—ROUTINE TESTS AND INSPECTIONS

Division 200, "Routine Tests and Inspections", included those sections which describe the procedures to be followed in the performance of routine tests and inspections which may be scheduled at certain frequencies. This information is grouped according to types of offices except for those items which are common to all offices and which are grouped in separate subdivisions.

It is expected that this division will be used as a working manual by experienced men, and also as information which can be used in the instruction of new men not familiar with the routine tests and inspections.

The index of this division provides a means for scheduling of routines; in some cases the tests and inspections have been further subdivided below the section number into parts designated alphabetically in order to facilitate the scheduling of particular parts of a routine where it is desirable to make only a part of the test or inspection at one time.

DIVISION 300—OPERATING METHODS AND NON-PERIODIC ROUTINES

Division 300, "Operating Methods and Non-Periodic Routines", covers operating routines and other practices associated with the day by day activities of the plant forces, such as the following:

- Operation of Power Plant.
- Interdepartmental Routines.
- Emergency Routines.
- Operation of Plant Desks.
- Records and Reports.
- Main Frame Protection Practices.

DIVISION 400—APPARATUS REQUIREMENTS AND ADJUSTING PROCEDURES

Division 400, "Apparatus Requirements and Adjusting Procedures", includes those sections which cover the requirements and adjusting procedures for the various types of adjustable central office apparatus.

DIVISION 500—METHODS OF PERFORMING VARIOUS WORK ITEMS

Division 500, "Methods of Performing Various Work Items", deals with methods of performing work such as running cross-connections on distributing frames, soldering, repairing switchboard cords, etc.

Information covering piece part data and replacement procedures for central office apparatus are included in this division.

DIVISION 600—GENERAL TROUBLES

Division 600, "General Troubles", describes certain typical troubles and approved methods for locating and clearing such troubles.

DIVISION 700—DESCRIPTION OF TESTING EQUIPMENT AND TOOLS

Division 700, "Description of Testing Equipment and Tools", includes descriptive and education information on standard testing equipment, testing circuits, tools and gauges.

DIVISION 800—EDUCATIONAL INFORMATION

Division 800, "Educational Information", includes sections descriptive of various systems and apparatus, and also other fundamental information considered essential in the training of central office forces.

5.25 MISCELLANEOUS CENTRAL OFFICE APPARATUS

The preceding paragraphs have been devoted primarily to Step-by-Step type switches and associated equipment. It may be of interest to those traffic people who are not completely familiar with central office equipment to review briefly some of the other equipment and apparatus incidental to a complete central office.

In Section 4 we covered the general theory of relays. Many types of relays are used in Telephone Plant, some of the more common will be described briefly in this section. Various items, other than relays, will also be discussed, such as indicating, transmission and protective devices.

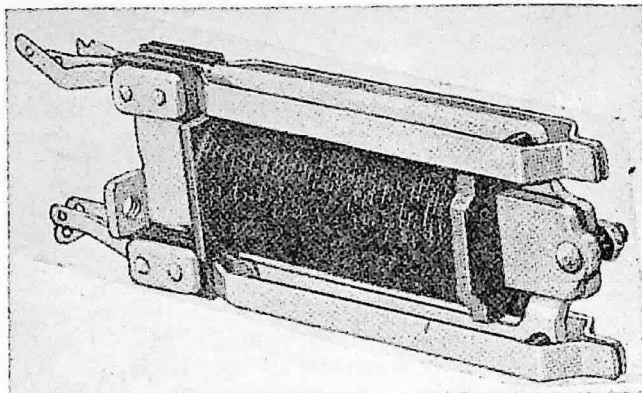
5.2501 RELAYS

Direct Current Relays

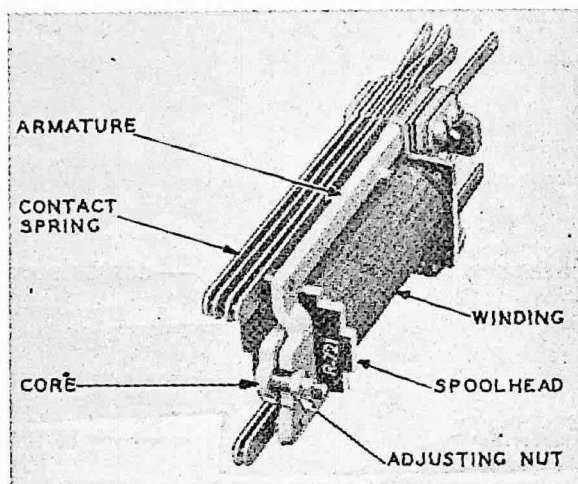
(A, AB, E, F, H, R and T Type Relays)

These relays are known as "Flat Type Relays" because the major parts of the relay, that is, the core, armature and contact springs are punched out from flat stock. They have upper and lower spring assemblies.

The A type relay is used primarily for line and cut-off relays on manual installations.



"A" Type Relay

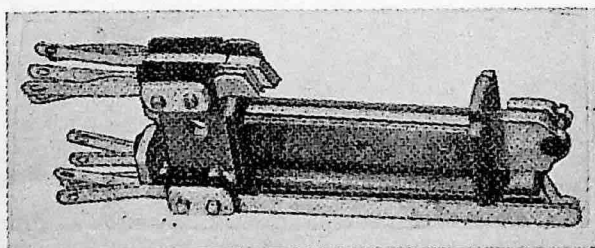


"R" Type Relay

The E type relay is a general purpose relay and replace practically all the old barrel type relays.

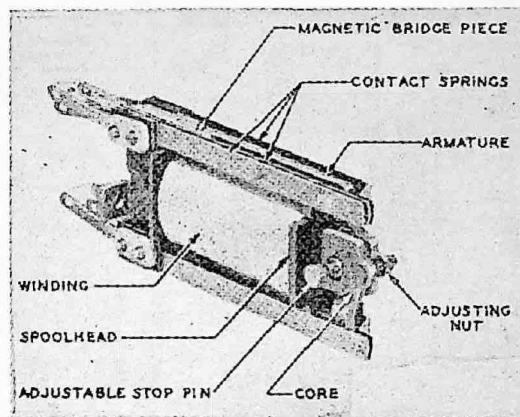
The R type relay differs from the E type only in the use of "swaged" core and slightly larger spoolheads. The term "swaged" denotes a pressing operation at the time of manufacture which changes the normally rectangular shape of a flat type relay core (under winding space only) to an oval shaped core.

The AB type relay resembles the R type relay except that the core and armature are made from a thinner stock. It was designed to replace the A type and has the advantage of greater stability due to the greater number of turns on the "swaged" core.



Core of "H" Type Relay

The F type relay is a slow releasing relay. The T type differs from the F only in the use of a swaged core.



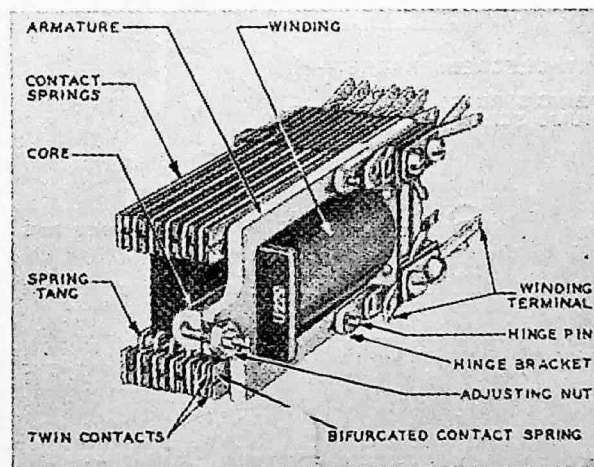
"F" Type Relay

U and Y Type Relays

These relays are similar to flat type relays, but have a round core and are somewhat longer. The outstanding differences are the use of double or "bifurcated" contact springs and the ability of the relay to operate larger spring assemblies (as many as 24 contact springs to a relay).

B and G Type Relays

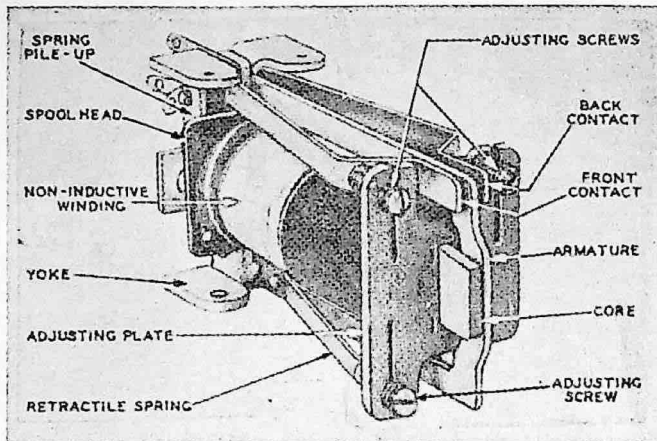
Are used for supervisory purposes in trunk and cord circuits.



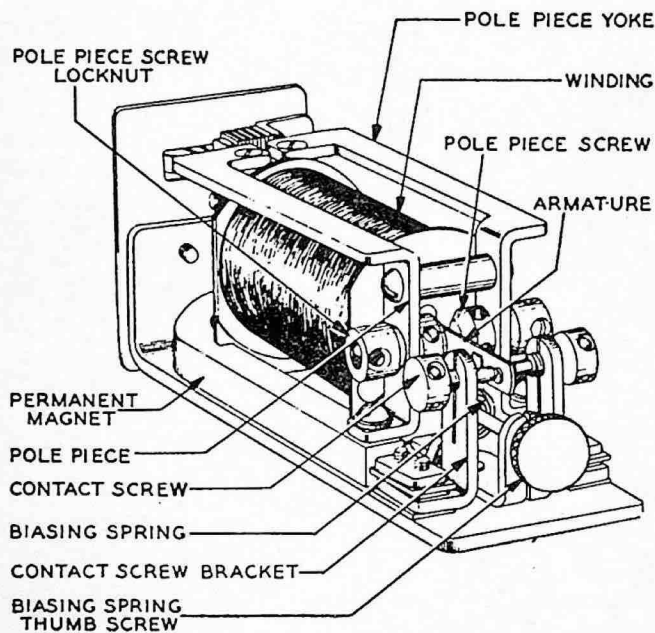
"U" Type Relay

200—Type Relays (Polarized Relays)

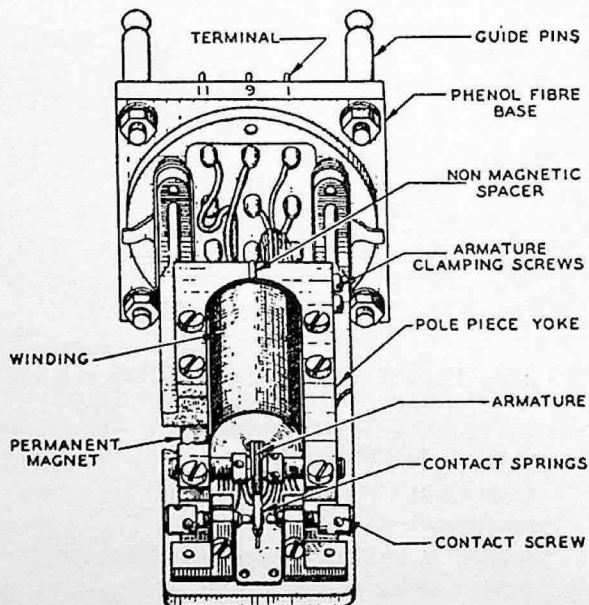
The term "polarized relays" is used to designate a relay whose armature and core are kept permanently magnetized, usually by means of a permanent magnet. The object of polarizing a relay is to make it respond to currents of a certain polarity only, and to make it more positive.



"B" Type Relay



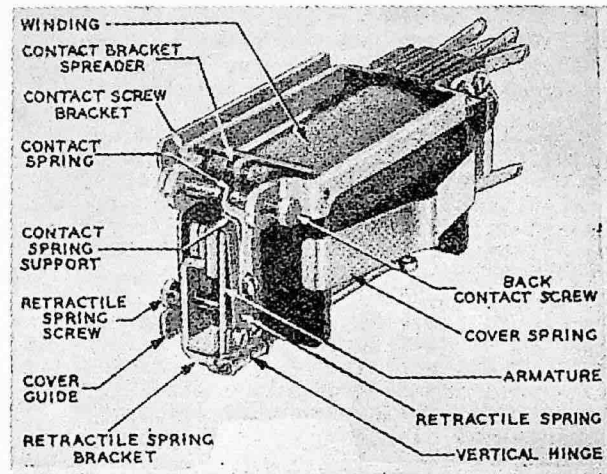
206 Type Relay



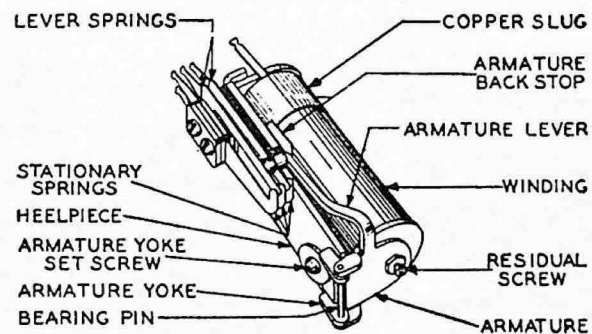
209 Type Relay

L, N and S Type Relays

These are pulsing relays of the flat punched type. They are practically identical in design, except the N and S types are provided with a removable crosstalk-proof cover and cap and that a laminated core is used on the N Type.



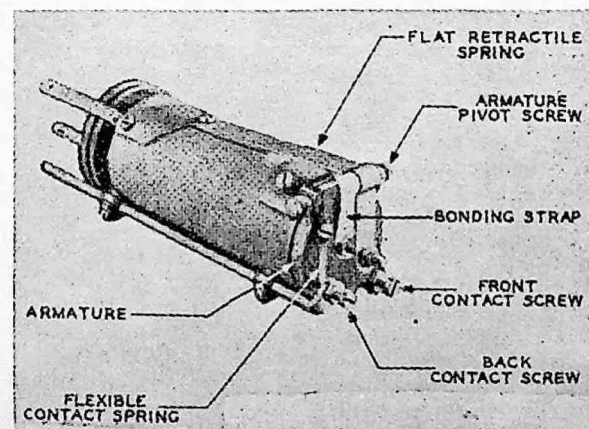
"S" Type Relay



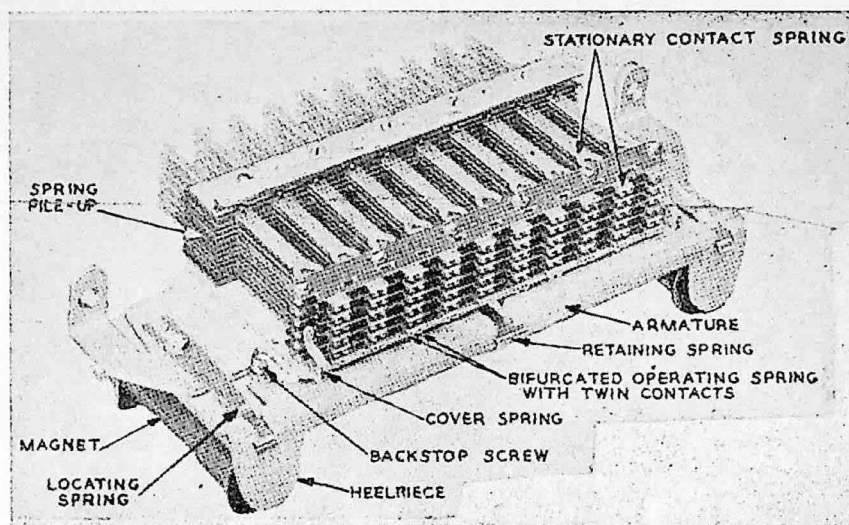
221 Type Relay

221, 222, 223, 224, 225, 247, 251 and 252 Type Relays (SXS Relays)

These relays are known as Step-by-Step relays because they are largely associated with Step-by-Step equipment.



114 Type Relay



245 Type Relay

114 Type Relays

The 114 type relay is tubular in shape because a round iron shell is used as the return pole piece. Most of these relays are used as "trip" relays in incoming trunk circuits to trip or cut off the ringing current when the called subscriber lifts the receiver off the telephone.

245 Type Relays (multi-contact)

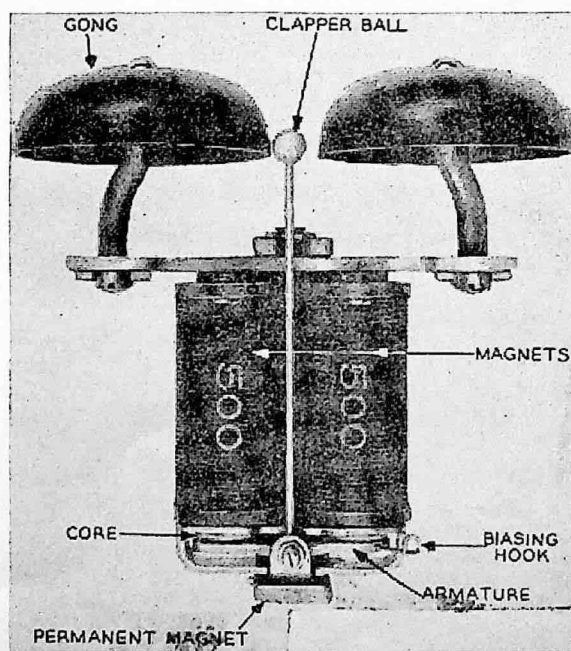
The 245 type relay is of fairly new design and is used primarily in crossbar dial systems.

KS-7802 Relay

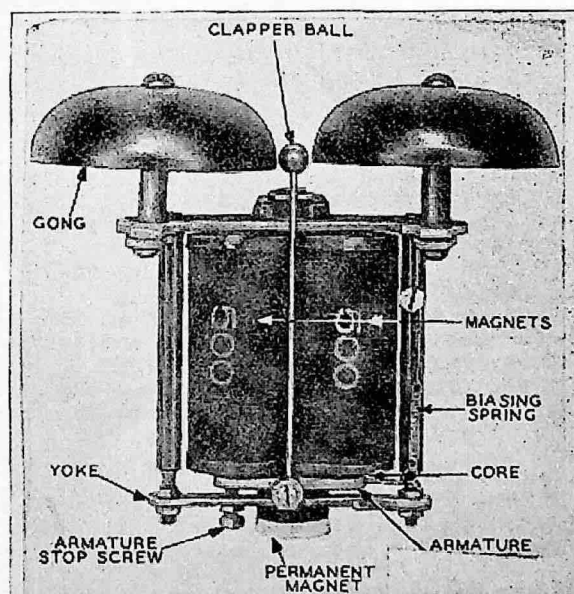
These relays are used where time delays of relatively large duration are required. The operating mechanism is completely sealed in a glass tube. This tube which is surrounded by the winding contains a hollow cylindrical iron plunger floating on mercury. The tube also contains two electrodes, one of which is always in contact with the mercury. A small cup of insulating material which contains mercury is mounted at the top of the insulated electrode thus providing the mercury to mercury contact. No adjustments can be made to these relays in the field.

5.2502 RINGERS AND BUZZERS

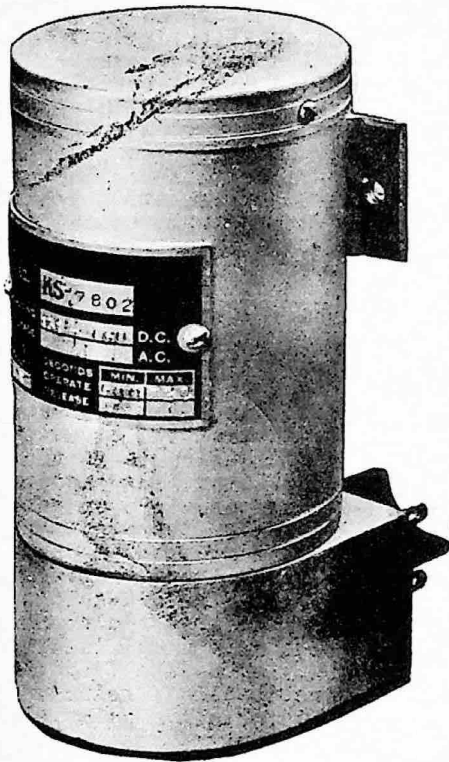
Unbiased Ringers are intended for use on alternating current only. Biased Ringers are used in all cases where superimposed current (direct current superimposed on alternating current) is used for ringing.



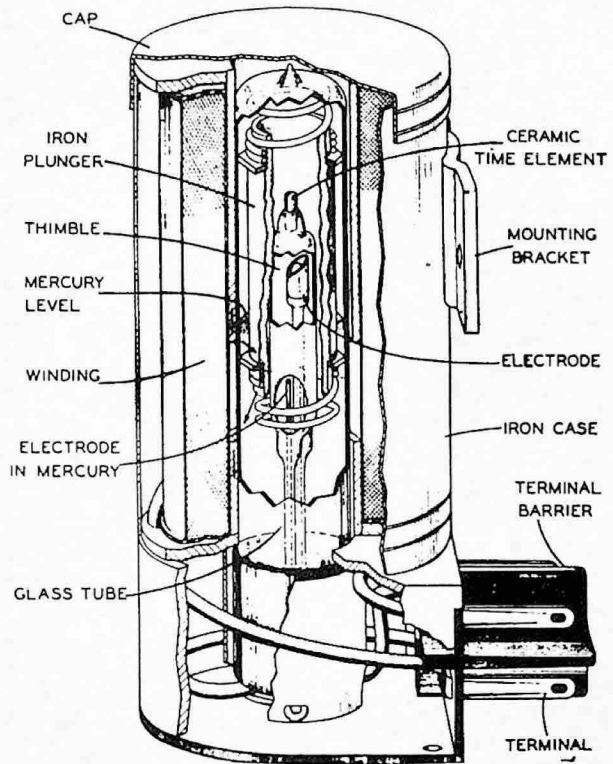
UNBIASED RINGER



BIASED RINGER

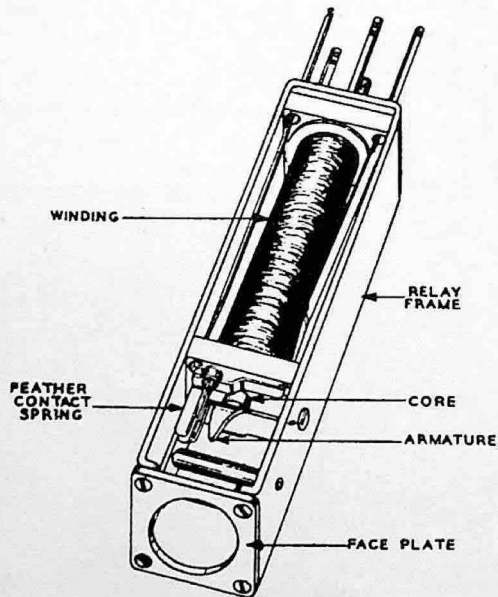


KS-7802 RELAY (ADLAKE)

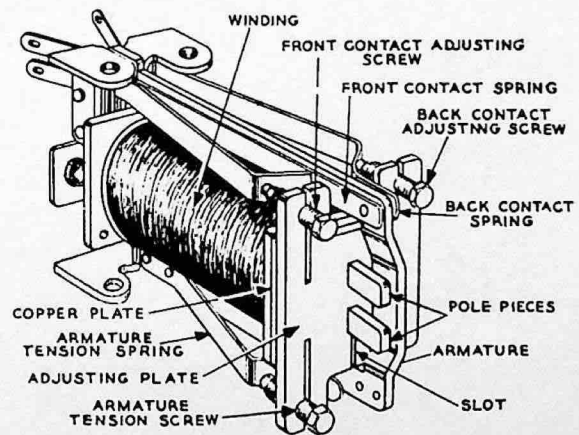


SECTIONAL VIEW OF KS-7802 RELAY

ALTERNATING CURRENT RELAYS—186 and J TYPES

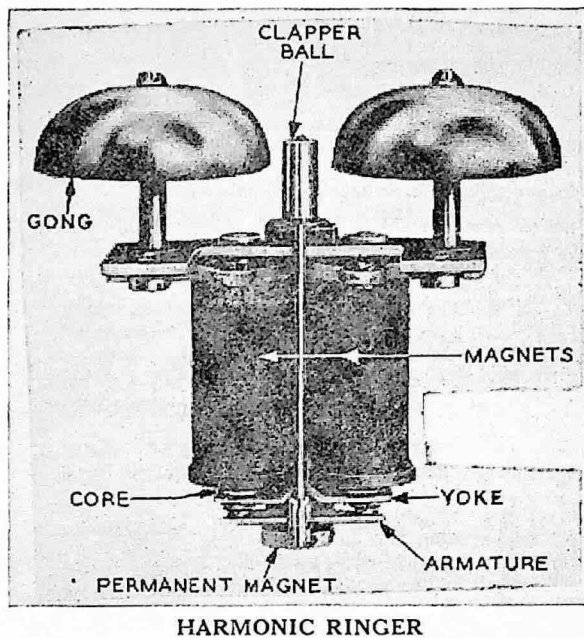


186 TYPE RELAY



J TYPE RELAY

Harmonic Ringer is a type of alternating current ringer, usually designed to operate on a certain frequency (16, 33, 50 or 66 cycles).



5.2503 REPEATING COILS, INDUCTION COILS, RETARDATION COILS

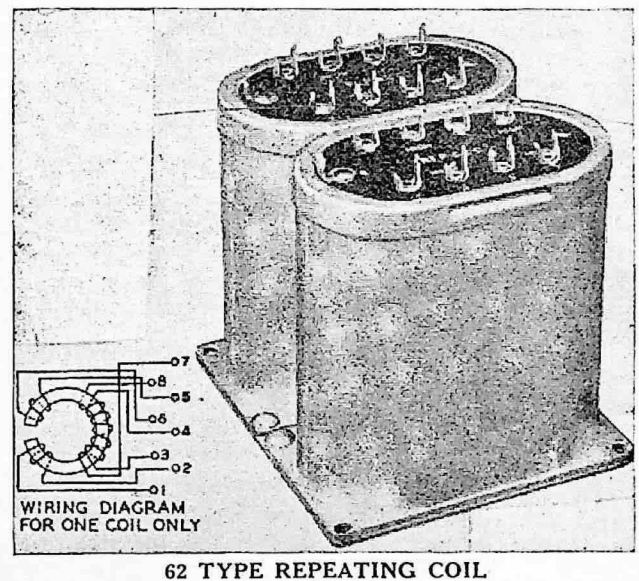
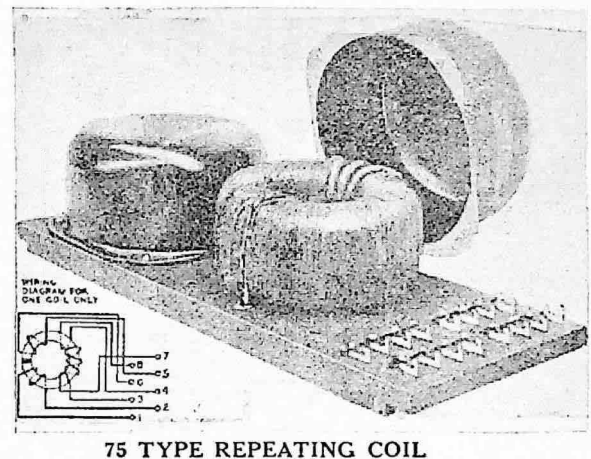
Repeating coils and induction coils are terms used to designate certain types of transformers. A telephone transformer is generally called a repeating coil when it has a low ratio of transformation, and is not used in connection with vacuum tubes, where the terms input transformer and output transformer are used.

An Induction coil is a special name given to certain types of repeating coils which generally are associated with telephone sets and use either the straight core or shell type of construction.

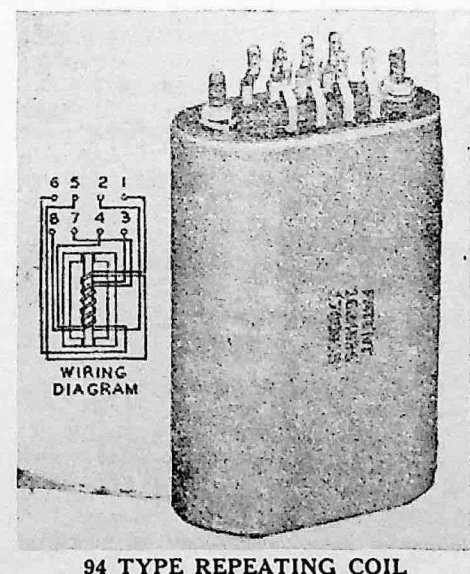
According to their mechanical construction, repeating coils may be of the toroidal, shell, or straight core type.

The core of the torodial type of repeating coil consists generally of a ring of silicon steel laminations, or pressed permalloy dust rings. After being wound, the coil is impregnated to make it waterproof. It is then sealed or potted with rosin into a pressed steel cup or cast or sheet iron case. This cover makes the coil cross-talk proof and provides protection against mechanical injuries. The unit (sometimes two coils) is generally mounted on a wooden base. Repeating coils of the 75, 77 and 85 types are examples of this type of construction.

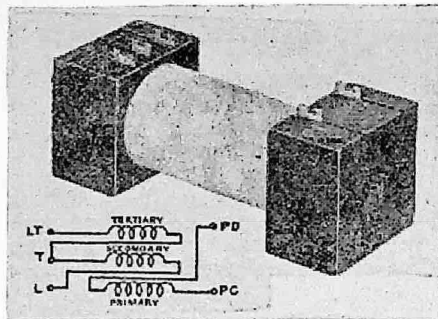
The 62, 74 and 93 type coils are of later design and utilize a cast or sheet iron case as a housing.



The core of a shell type repeating coil consists of silicon steel or permalloy laminations of various shapes. A number of laminations are riveted together, forming butt joints when assembled. The windings are generally on a spool which fits



over the center leg of the core. The 94 and 120 type repeating coils are examples of this type of construction.



62 TYPE INDUCTION COIL

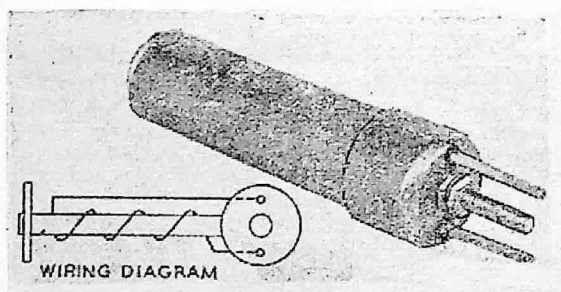
The straight core type of repeating or induction coil has an open magnetic circuit core of silicon steel strips. The windings are brought out to terminals attached to the spool head. The 62 and 72 type induction coils are examples of this type of construction.

RETARDATION COILS

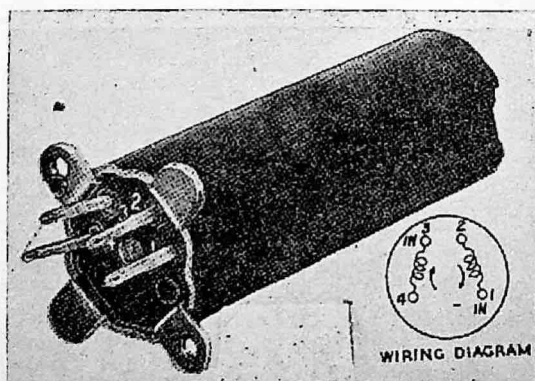
Retardation coils, also known as impedance or choke coils, are electromagnetic coils used to retard or choke back the flow of rapidly varying currents, but at the same time allow the comparatively free passage of direct current.

Among the most commonly used retardation coils are the 47 and 54 types. The coils are small tubular coils of the straight core type, having a solid core of soft iron. A tubular shell of soft iron surrounds the coil, completing the magnetic circuit and making the coil cross-talk proof.

The toroidal type core, as used for repeating coils, is also used considerably for retardation coils.



47 TYPE RETARDATION COIL



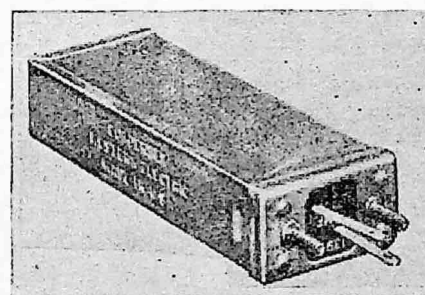
54 TYPE RETARDATION COIL

5.2504 CONDENSERS

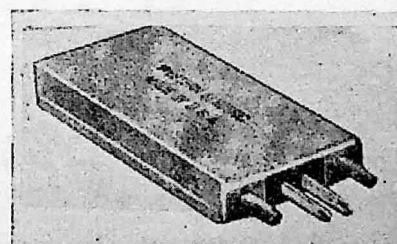
A condenser consists essentially of two plates or sheets of conducting material separated by a dielectric or an insulator. Such a device when placed in a circuit acts as a barrier to the flow of direct current but permits the easy passage of alternating current.

The majority of the condensers used in the telephone plant are of the paper insulated type. In these condensers, the conducting material consists of long strips of tin foil approximately .0003" thick and the insulators are strips of very thin high grade tissue paper about .0005" thick. To make a paper condenser, two strips of tin foil and four strips of paper are wound together so that each foil strip is insulated from the other by two paper strips.

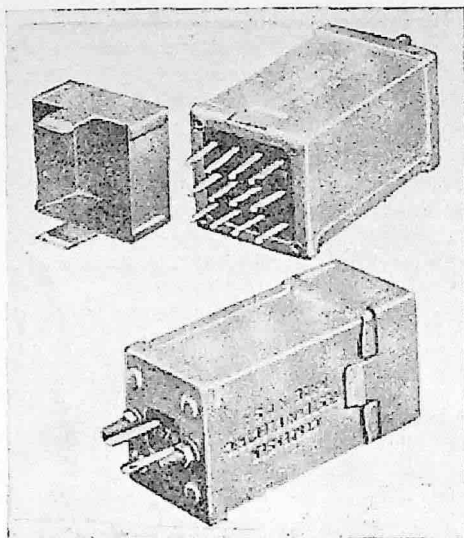
After the proper number of turns have been wound together into cylindrical form, the form is removed from the winding machine, baked for a number of hours in order to exclude moisture and then impregnated with wax in a vacuum tank. While still hot, the condenser is flattened to remove excess wax and to raise the capacity. The condenser is next tested for breakdown strength and capacity and then sealed into a metal container with an asphalt preparation. Typical condensers of the types most commonly used in telephone equipment are shown below. The 187 type shown is a multi-unit type condenser, that is, it has more than one capacity sealed into the same can.



139 TYPE CONDENSER



141 TYPE CONDENSER



187 TYPE CONDENSER

5.2505 JACKS AND JACK MOUNTINGS

Jacks are used in a great variety of circuits and consequently require considerable variation in construction. Several hundred different jacks have been coded, but only a few general types

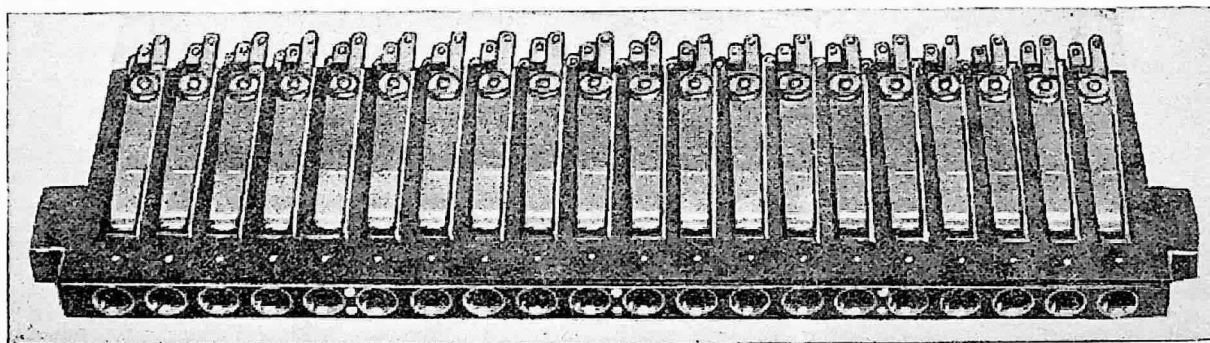
will be shown below. Fundamentally, jacks, together with plugs and cords, are a flexible switching device with as many choices as there are jacks.

Besides provision for making connections with the cord conductors attached to the plug, a number of auxiliary springs and contacts are often part of the jack, so that other connections are made or broken by means of make, break, or transfer contacts. The various uses of jacks are too numerous for detail in these notes.

Jacks are divided into two general physical classes, those mounted in strips and those which can be mounted individually. The strip jacks are usually manufactured as an integral part of the mounting with which they are associated. The sleeves of the jack are fastened into a hard rubber strip which forms the face of the jack strip. The contact springs are separated by insulators and assembled in a pile-up at the rear of the jack strip. Individually mounted jacks have a sherardized iron frame with a brass sleeve fastened to its front face.

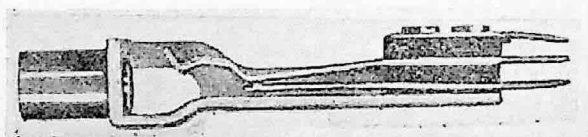
Jack strips are used principally on switchboards, where the jacks serve either as multiple jacks or answering jacks.

The following pictures show typical jacks used in our business.

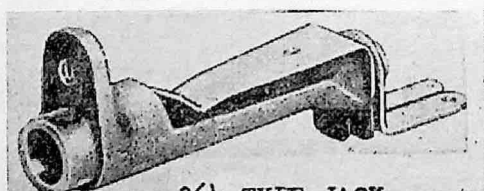


114 TYPE JACK MOUNTING EQUIPPED WITH 49 TYPE JACKS

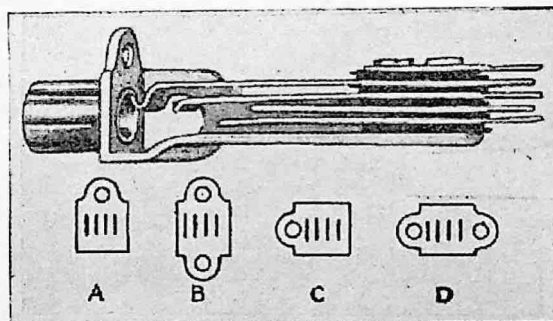
NOTE: The 92 type jack is the smallest switchboard jack made by the Western Electric Company.



218 TYPE JACK



364 TYPE JACK



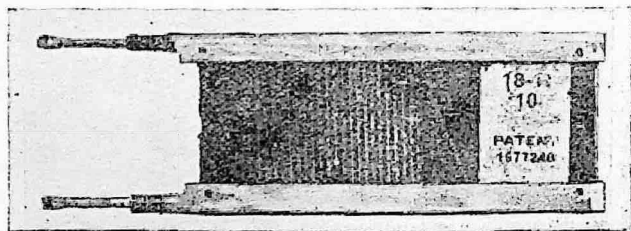
227 TYPE JACK

The 364 type jack shown is used alone as well as in pairs. This type of jack is mounted in pairs to form the operator's telephone jacks on a switchboard. They are two conductor type jacks.

5.2506 RESISTANCES

Resistances are one of the most commonly used devices in the telephone plant. In the majority of cases they are used to control the flow of current in a circuit, such as lighting of switch-board lamps, regulating current values through relay windings, etc. There are a number of different types of resistances, but all consist essentially of the resistance element proper and a suitable mounting.

Two types of resistances similar in construction and used very extensively are known as the 18 and 19 types. The 18 type shown below is a single resistance while the 19 type has a third connection to an intermediate point of the resistance winding. These resistances consist of bare high resistance wire wound on a card of micanite, the windings so spaced that the turns are not in contact with each other. The winding is covered with micanite and the whole bound in place by metal strips which give mechanical strength to the edges and serve as terminals for the winding. Each terminal is equipped with two clamping nuts and insulating washers for mounting on a standard steel mounting plate. 18 and 19 resistances are made with resistance values from less than one ohm to nine thousand ohms and have a safe carrying capacity of approximately five watts.

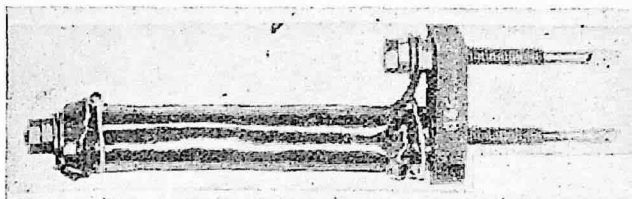


18 TYPE RESISTANCE

Another type of resistance used quite frequently in cases where the required current carrying capacity is above the maximum rating of the 18 or 19 type is shown. This is a vitrohms resistance of the 59 type, consisting of a porcelain spool and a resistance winding which is completely covered with vitreous enamel. The resistance unit is mounted on a small mounting plate by means of a metal rod passing through the center of the unit. The ends of the winding are connected to terminals similar to those used for 18 type resistances. Other examples of resistances using vitreous enamel units are the 44, 60, 70 and 71 types. Units of this type are also sometimes equipped with an Edison base for mounting in lamp sockets.

A typical high resistance of small size, known as the 38 type is shown. This resistance consists of either a carbon filament or silk core mandrelated resistance wire placed in the spiral groove of a cylindrical core of porcelain. Brass caps with mounting lugs on each end of the porcelain core serve as mounting and terminals. 38 type resistances are practically non-inductive and are used chiefly in connection with vacuum tube circuits.

Resistances tubular in shape and having a low reactance, similar in appearance to the familiar pig-tail resistors in radio circuits, are also used in the telephone plant, primarily in carrier equipment. The 106, 107, 108 and 112 type resistances are examples of this kind, consisting essentially of a coil impregnated with bakelite and placed in a phenol fibre tube. Short pieces of tinned wire extending from both ends serve as terminals and are also used to support the resistance.



59 TYPE RESISTANCE



38 TYPE RESISTANCE

For the protection of ringing and battery supply leads against short circuits and overloads, **Resistance Lamps** are placed in series with these circuits. The resistance of the tungsten filament in a resistance lamp increases considerably with the applied voltage, thus protecting the apparatus against abnormal current flow. These lamps have the general appearance of a vacuum tube.

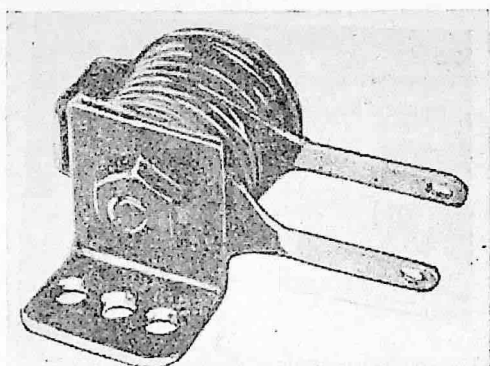
Other types of resistance lamps are known as **Ballast Lamps**. These are used as current regulators to maintain an approximate constant current within a rated voltage range. The filament is made of iron, the resistance of which increases much more rapidly at certain temperatures than at others. By designing the filament so that it operates at the point where this rapid increase in resistance takes place, the current through the filament (which is in series with the device to be controlled) is held very nearly constant even though the applied voltage may increase rapidly.

Ballast lamps are usually equipped with either a screw base (8 type) or a four prong radio base (120 type).

5.2507 VARISTOR

A typical varistor of the copper oxide type used for the reduction of clicks in operators' telephone circuits is shown below. It consists of two sets of three $\frac{3}{4}$ " diameter copper discs, oxidized on one side and bolted to a mounting bracket. The unit is covered with either a gray or black moisture proof varnish to increase its useful service life. The two sets of discs are connected in parallel so that a voltage of given polarity impressed across the unit will cause current to

flow in the conducting direction through three of the washers, while with an opposite impressed polarity, current flows through the other three.



3 TYPE VARISTOR

Since the direct current resistance of a copper oxide varistor decreases as the impressed voltage increases, the varistor when connected in shunt with an Operators' receiver will by its operation effectively limit the amount of current which would otherwise flow thru the receiver.

5.2508 LAMPS, LAMP CAPS AND LAMP MOUNTINGS

Lamps are used for signaling purposes on switchboard as line lamps and pilot lamps and as supervisory lamps in cord circuits. They are also used extensively in dial offices for alarm purposes on switchshelves, various lamp panels, in test sets, etc.

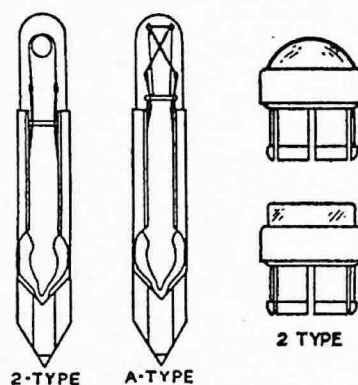
Associated with the lamps are "lamp caps", these lamp caps being available in several sizes and color.

Switchboard lamps are approximately $1\frac{3}{4}$ inches long and $\frac{5}{16}$ inch in diameter. The lamp

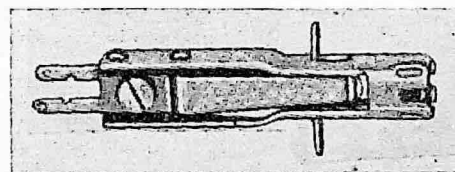
proper is mounted between two tinned brass terminals attached to a wooden block which is V-shaped at the end to facilitate insertion into the lamp socket. The terminals make contact with the springs in the lamp sockets and carry the current to the filament.

The lamp caps consist of a hemispherical lens and a brass sleeve. The lens is slightly clouded or cut in facets in order to distribute the rays of light so that the signal may be seen from all angles. The sleeve serves to confine the light so that no light will reach other lenses than the one directly in front of the lamp.

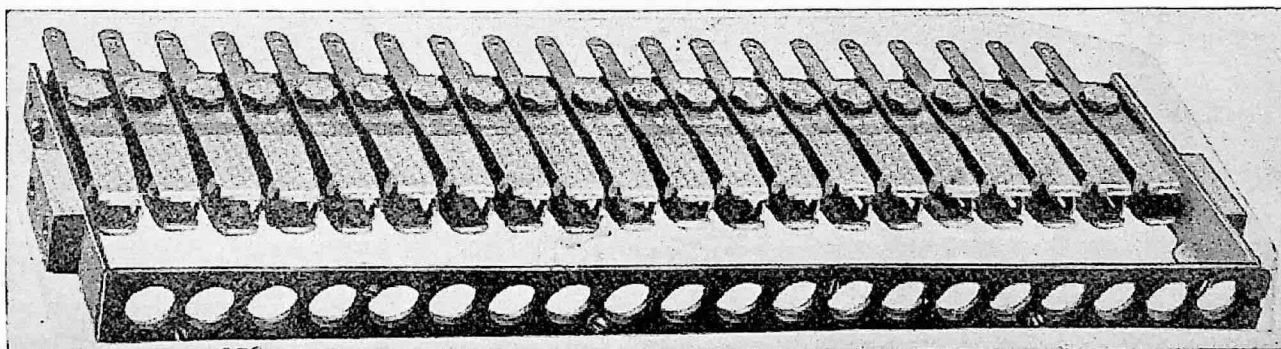
The lucite lamp cap is of more recent design and is currently the most popular.



SWITCHBOARD LAMPS AND LAMP CAPS



13 TYPE LAMP SOCKET



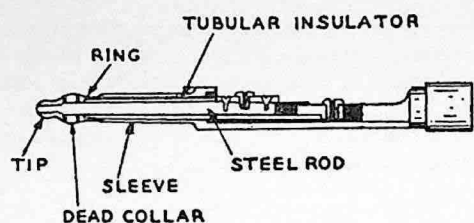
278 TYPE LAMP SOCKET MOUNTING EQUIPPED WITH 43 TYPE LAMP SOCKETS

5.2509 PLUGS AND CORDS

There are about four general types of plugs. These are the two conductor plug, the double plug, the small three conductor plug, and the large three conductor plug. These plugs are each associated with jacks designed for them. Following are examples of the more commonly used plugs in a telephone office.

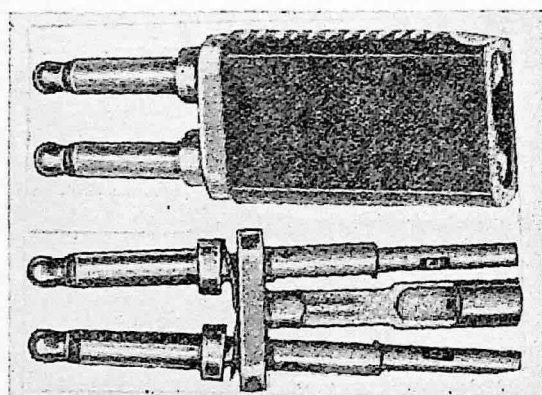


47 TYPE PLUG

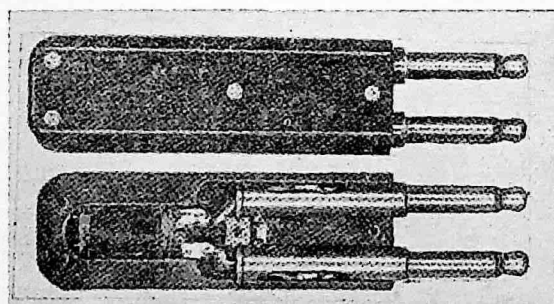


CROSS SECTION OF 109 TYPE PLUG

The 47 Plug is used on magneto switchboards, test boards, and P.B.X.'s. The 109 and 110 plugs are three conductor types and are associated with 92 and 49 type jacks, respectively. Double plugs are of the type associated with the operator's telephone set. The 217 plug is unique in that the shell encloses a resistance which is bridged across the tip of the two plugs. Several different size resistances are used with these plugs, the smallest, 400 ohms, the largest, 1800 ohms. They are used for balancing toll circuits during tests.



241 TYPE PLUG

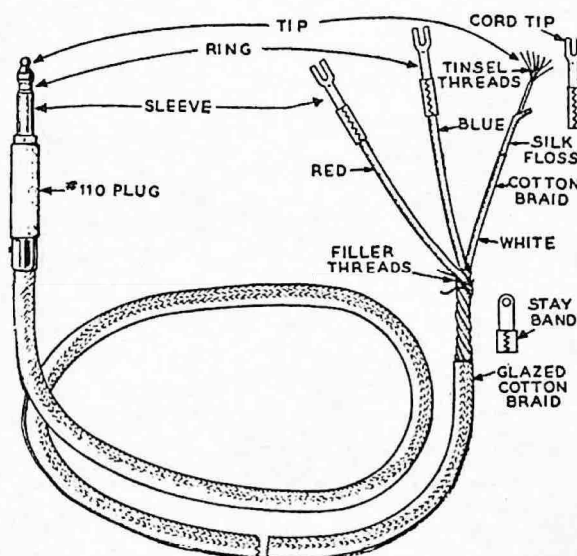


217 TYPE PLUG

CORDS

Switchboard cords are manufactured with from one to four conductors. Nearly all are furnished in red, slate or green and some of them in black. The usual length is 6 feet, but this will vary depending upon the specific need of the cord.

The conductors are of tinsel to secure the greatest flexibility without danger of breaking. A covering of silk floss is then wrapped around the conductor and a cotton braid is put over this. The cotton braid is a different color for each conductor, the tip being white, ring blue and sleeve red. The outside cotton cover is braided on and is glazed to make it moisture proof and to lessen the tendency for wear. Solderless cord tips are fastened to the ends of the conductors for plug and terminal terminations.



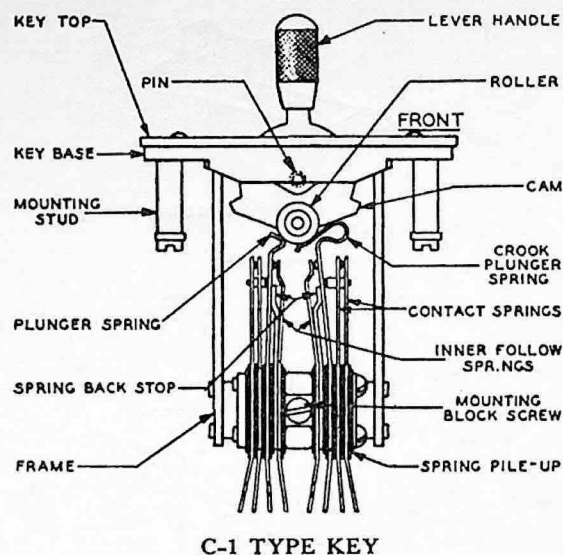
SWITCHBOARD CORD

5.2510 [KEYS

Keys are manually operated devices for closing or opening telephone or telegraph circuits. There are a great many different kinds of keys, but all consist essentially of a number of contact springs operated by a lever or a plunger. While a number of keys consist of just a single lever or plunger unit with various spring combinations, a considerable number of keys are equipped with two or more lever or plunger units, or consist of a combination of both mounted on a common base.

A typical lever type key, known as the C-1 type is shown below. These keys may be of the two position or one position type. In a two position key, the lever handle may be moved to either side of the normal (up) position, while in a one position key, the lever can be moved to one side only. Since there is a roller on each side of the cam, a maximum of four spring pileups may be used for this type of key.

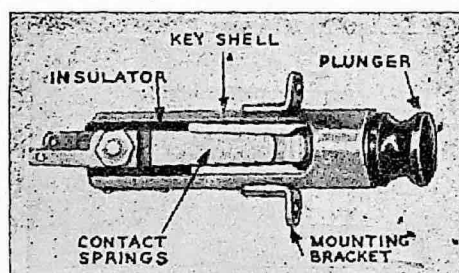
The B-1 type key consists of two lever units, each having a locking spring combination on one side and a non-locking on the other.



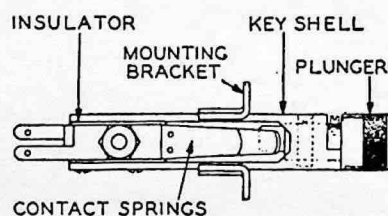
C-1 TYPE KEY

PLUNGER TYPE KEYS

Among the most commonly used plunger type key is the 92 type. The key is operated by depressing the plunger which actuates the spring combination. These may be either the locking or the non-locking type.



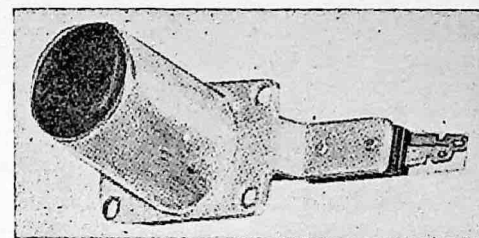
92 TYPE KEY



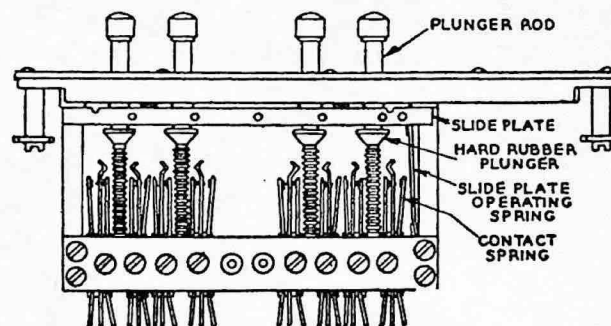
498 TYPE KEY

The 498 type key is similar to the 92 type, except that a rotating plunger button is used for operating the contact points. The end of the plunger is rectangular in shape and when turned, forces the plunger springs outward.

The 520 type key is another of the plunger variety but is similar in appearance to a push button. The "button" is about 1 inch in diameter. These keys are commonly installed on switchboard key-shelves and associated with positional peg count circuit.



520 TYPE KEY



A-6 TYPE KEY

The A-6 type key shown is a typical four-party ringing key consisting of four plunger units arranged to operate the key contacts when depressed all the way down. Each plunger, when released from the "way down" position, is held in an intermediate position by means of a slide plate engaging with a projection on the plunger rod, thus indicating the party called. Any plunger locked in this semi-depressed or indicating position is released by the operation of any other plunger.

5.2511 PROTECTORS AND FUSES

Earlier in this section we have made reference to protectors and fuses. Following is a more detailed explanation of these items.

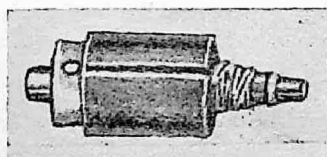
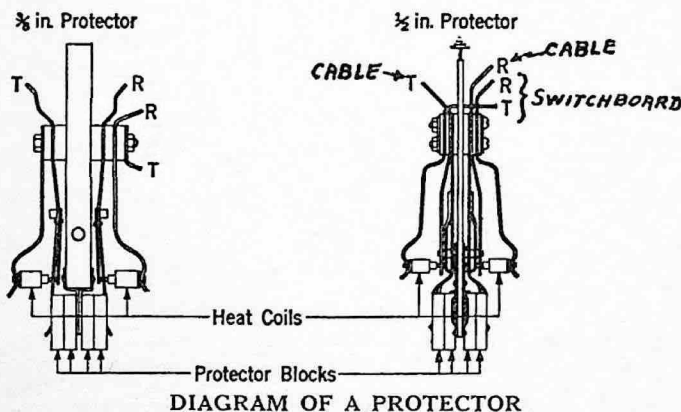
Practically every telephone circuit in the central office must be equipped with some form of protection which is sufficiently sensitive to operate before any damage to the equipment is done, but is not too sensitive to cause an unnecessary number of service interruptions. For the protection of the inside equipment, telephone lines enter the central office through protectors mounted on the main frame. These protectors consist of a protector mounting equipped with protector blocks and heat coils.

A diagrammatic view of such a protector unit with protector blocks and heat coils is shown below. The protector blocks on each side of the line, as shown in this figure, consist of a plain carbon block and a porcelain block. A small carbon block is mounted in the center of the porcelain block by means of a fusible cement. When held in the protector, the plain carbon block and the carbon insert of the porcelain block are separated by a gap of approximately .003". Any lightning or other high voltage discharge will jump across this small gap between the two carbon blocks and follow the framework of the protectors to ground. Sparking will cause

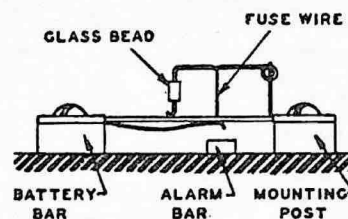
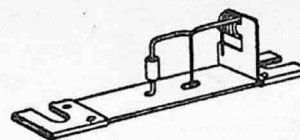
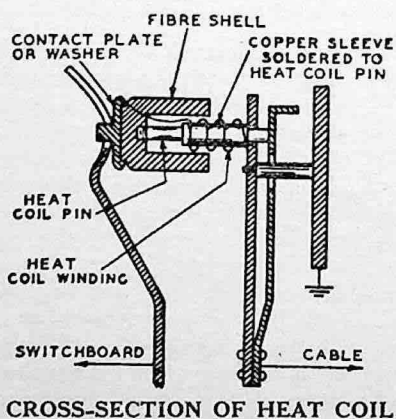
the fusible cement in the porcelain block to melt, thus permitting the small carbon insert to make direct and permanent contact with the larger block and ground.

The heat coils associated with the protector are for protection against damage which may be caused by a subscribers line coming in contact with a power line. A 76 type heat coil, also shown below, consists essentially of a winding of fine alloy wire on a copper sleeve which is soldered to a pin. When any excessive electric current passes through the winding of the coil, the soldered joint inside the coil will melt. Upon melting, the pressure of the protector spring on the head of the coil causes the pin to slip through the sleeve. An auxiliary contact spring resting against the free end of the heat coil pin is thereby brought in contact with the frame thus grounding the line. A cross-sectional view of a heat coil mounted in a protector is shown.

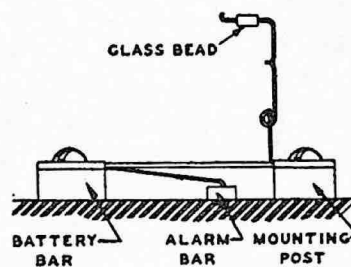
In large cities, where incoming cables are all underground, it is the practice to omit protector blocks and heat coils and replace them with dummy apparatus. The only function the protector mounting serves in this case is to provide a means for opening the lines for test purposes.



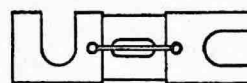
76 TYPE HEAT COIL



35 TYPE FUSE



35 TYPE FUSE BLOWN



24 TYPE FUSE

FUSES

For the protection of local circuits in the central office against abnormal current values due to a short circuit or similar causes, fuses are used. The operation of a fuse is based upon the melting of an alloy at a low temperature. A fuse is usually constructed with a small wire or ribbon of the alloy, either encased in a fireproof container or arranged for mounting on fireproof panels.

Fuses used for local telephone circuits are usually of the open type. One of the most commonly used fuses, known as the 35 type, is shown above. This fuse is of the indicator alarm type and is generally referred to as a "grasshopper" fuse. It consists of a thin piece of mica with slotted tinned terminals at each end. The fuse wire is held taut between a small coil spring on top and a leaf spring on the bottom.

When the fuse blows, the springs are released and take up a position as shown. The released leaf spring underneath the fuse now makes contact with the contact bar on the fuse board, thereby closing an alarm circuit which notifies the maintenance man by the ringing of a bell that a fuse has operated. In order to facilitate the location of an operated fuse on the fuse board, a glass bead is placed at the end of the coil spring. When the fuse operates, the beaded end projects beyond the line of the other fuses in such a way as to be readily located. 35 type fuses are made in various capacities and in order to facilitate selection, different colored beads are used with each separate capacity. A recent redesign of the 35 type fuse replaces the glass bead with a metal "flag".

Another open type of fuse used quite extensively is the 24 type. This fuse is of the non-indicating type, consisting merely of a piece of mica with slotted copper or tinned copper terminals at each end and a piece of fuse wire strapped between the two terminals.

Cartridge type fuses are used extensively, particularly in connection with Power Equipment.

5.2512 ROTARY OUT TRUNK SWITCH—206 and 209 TYPES

GENERAL

This type of apparatus acts as a rotary switch, and may be made to hunt for the proper connection or may operate from pulses received from some such source as a dial or a relay. Rotary type selectors are used in manual and dial switchboards, on panel, Step-by-Step, crossbar frames, and on nearly all automatic test and routine frames.

206 and 209 type selectors are almost identical in construction, except for the addition of a pawl guide to guard against overstepping and a few other minor changes on the 209 type.

GENERAL CONSTRUCTION

The selector consists of a bank having from two to six arcs with either 22 or 21 phosphor bronze terminals and a phosphor bronze feeder brush in each arc. A set of rotor brushes, also of phosphor bronze and corresponding numerically to the number of arcs in the bank, is mounted on a shaft with a 44 tooth ratchet wheel. The rotor is made to revolve by means of a driving pawl acting on this ratchet wheel. See Figure. The rotor brushes form a connection between the feeder brushes and the bank terminals. The driving pawl is an extension of the magnet armature. When the magnet is energized, the armature is drawn against the magnet core, at the same time distending a heavy retractile spring. When the current is cut off, the retractile spring pulls the armature away from the core, causing the driving pawl to plunge forward with considerable force against a tooth on the ratchet wheel. This plunge of the driving pawl causes the brushes to step from one set of terminals to the next. A pair of interrupter springs is also actuated by the driving pawl. The contacts open each time the armature operates and close when the armature is released. This feature permits wiring of the interrupter contacts in the magnetic circuit so that the selector may be made to rotate under self interruptions. The operating principal of a rotary type selector is shown below for the "Released" and the "Operated" positions.

ROTOR BRUSHES

Rotor brushes have two types of contacting surfaces,

bridging and non-bridging. The bridging brush has a contacting face approximately .110" long. These brushes are in continual contact with a terminal of the bank at all points in the rotation of the selector. There is usually a relay in series with this type of brush which would de-energize if there was even a momentary break in the circuit while the brush was passing from one terminal to the next. The non-bridging brushes have only a line contact face. These brushes, as well as the bridging brushes, have two contact fingers on each side of the brush. The object of the additional contact fingers is to increase the probability of contact. If one finger rides up over a dust particle the other finger is not lifted out of contact with the terminal.

206 and 209 type selectors have a percentage of lead in the phosphor bronze brushes and terminals. This lead acts as a lubricant which makes the brushes slide along over the terminals with less friction and consequently less wear.

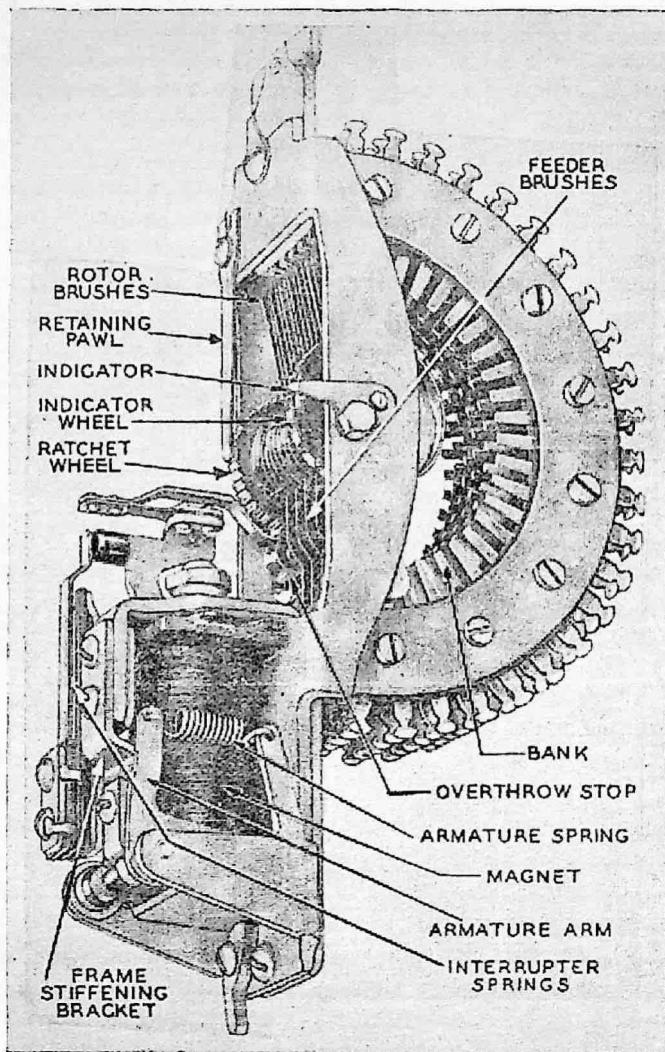
There are several different arrangements of rotor brushes aside from the various combinations of bridging and non-bridging brushes. The ordinary rotor brush is double ended so that as soon as the brushes step off the last row of terminals at the top of the arcs, the brushes at the opposite end step onto the first row at the bottom of the arcs. Since there are but 22 terminals in an arc, the maximum circuit choices with a doubled ended brush are 22. By using pairs of single ended brushes pointing in opposite directions the number of circuit choices can be increased to 44. The example shown as A is the brush arrangement for the 206-M selector. The 206-AS, BA, BF, BP and BU selectors use the arrangement shown in B. These selectors are used in trunk hunting circuits in dial and manual offices.

FEEDER BRUSHES

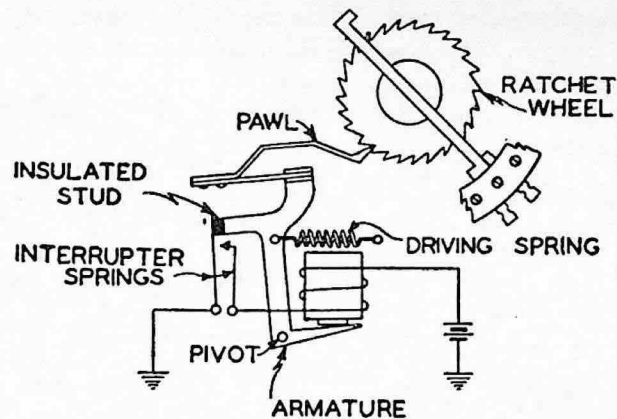
The feeder brushes are fork shaped. They are situated in front of the first terminal of each arc and extend up to the rotor brush hub where each prong of the fork contacts with the hub. To reduce the possibility of harmful high resistance contacts developing between the feeder brushes and the rotor, some selectors are equipped with a detachable feeder brush unit. This unit clamps on to the selector at the top and the feeder brushes reach downward to the rotor hub.

NON-RIGID MOUNTING

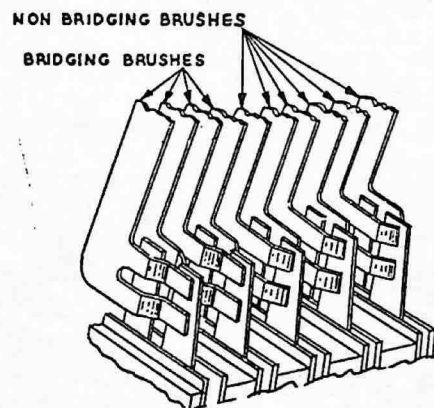
When 206 type selectors mounted adjacent to each other have talking circuits running thru the rotor brushes, they are usually mounted on heavy shock absorbing felt pads. An adjacent selector while rotating may set up enough vibration to cause noisy lines if the pads are not used.



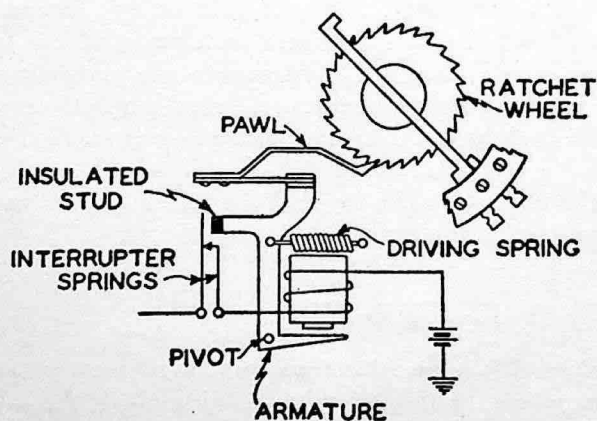
206 TYPE SELECTOR



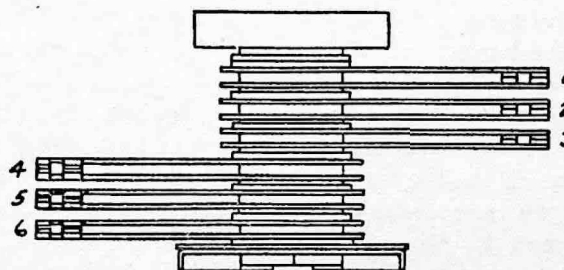
OPERATED
OPERATION OF ROTARY SELECTOR



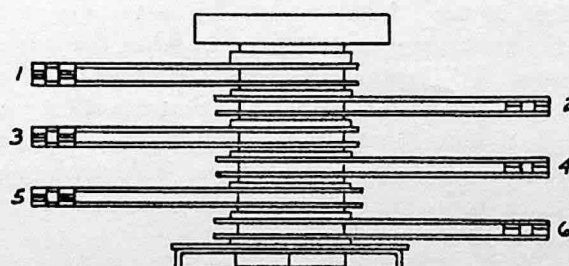
BRIDGING AND NON-BRIDGING BRUSHES



RELEASED
OPERATION OF ROTARY SELECTOR



A



B

BRUSH ARRANGEMENTS

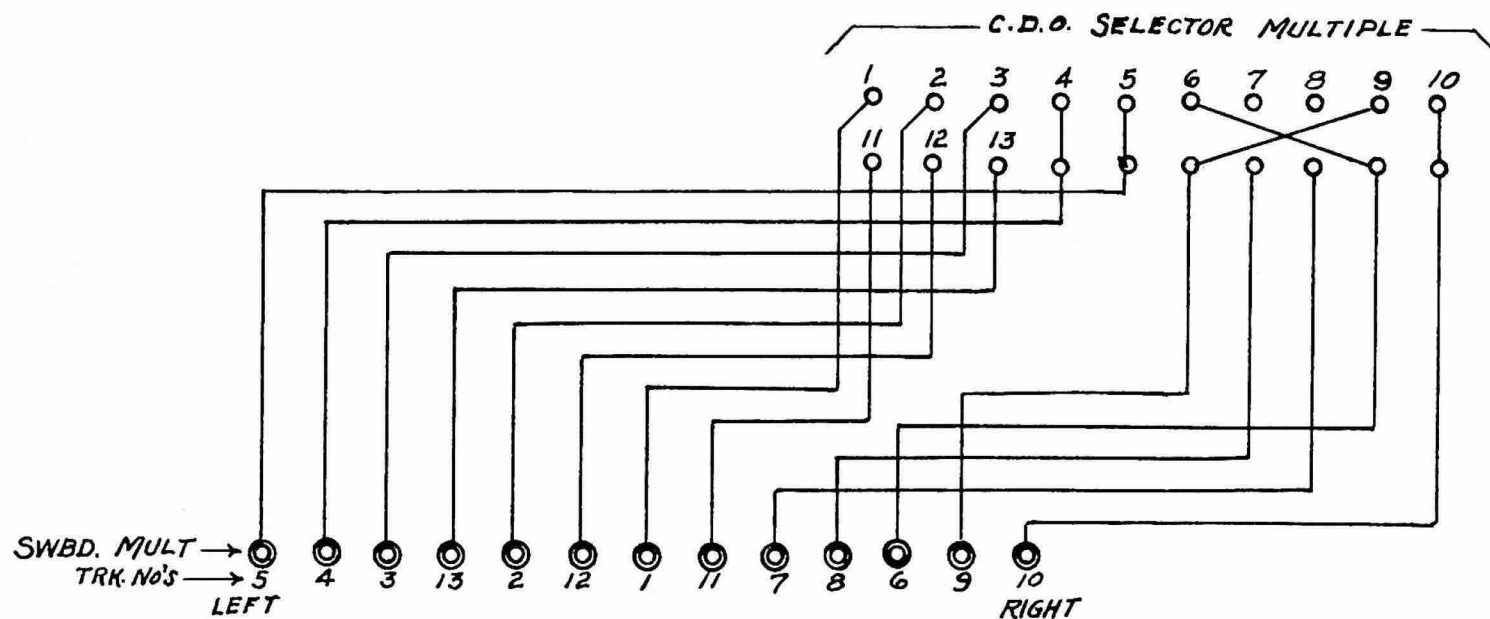


FIG. 88-A

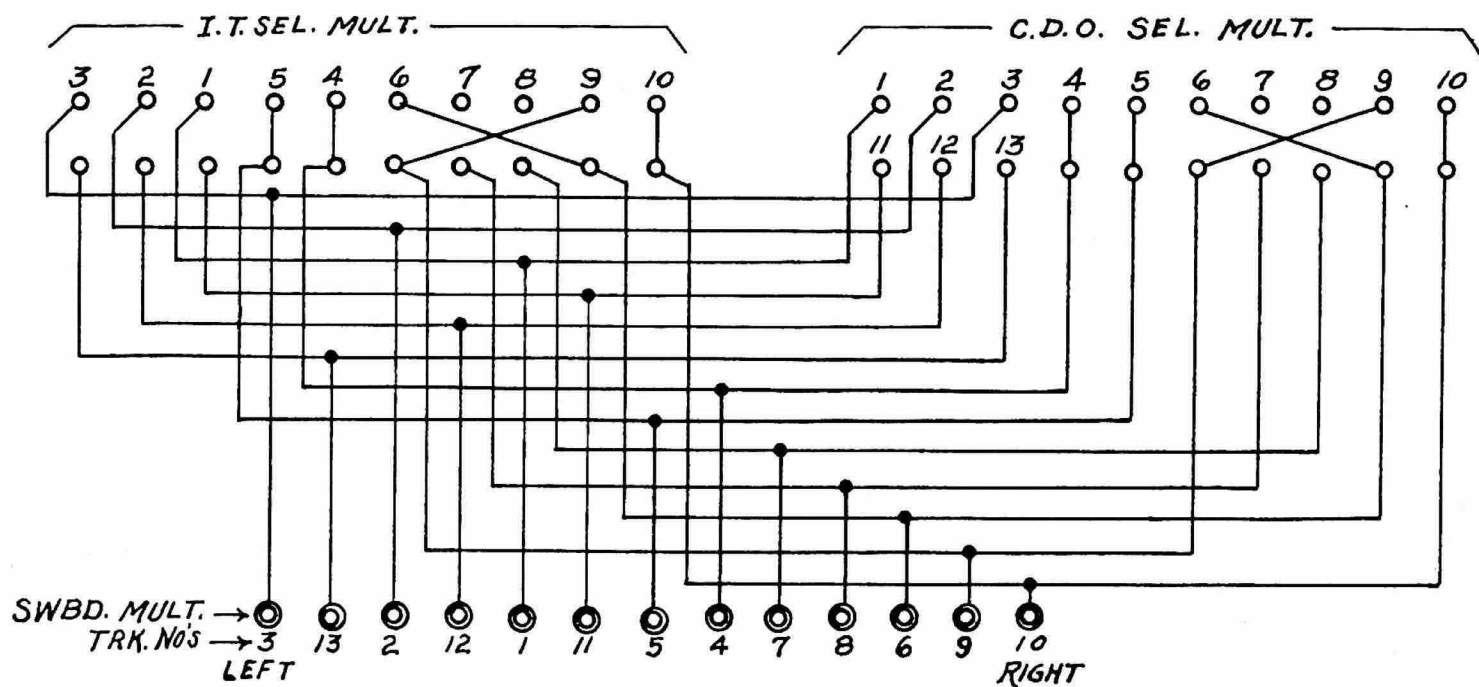


FIG. 88-B

In Section 5, we covered the purpose and functions of the various items of equipment incidental to the establishment of a subscriber-to-subscriber call using Step-by-Step type equipment. We will now, primarily as a matter of review, trace the progress of a call through the equipment.

Suppose, for example, that the calling subscriber's number is FRanklin 6-5678 and that the called number is BLackstone 3-1234, both the Blackstone and the Franklin units being in the same building. The Traffic Diagram for the office is shown in Figure 1.

NOTE: This double digit absorbing (DDA) selector is of the type described in P.E.L. 4749 and is arranged, by means of the normal post cams, to absorb the first digit dialed into it repeatedly and the second digit once. Should the calling customer dial an incorrect 2nd or 3rd digit into the switch, busy tone will be returned on the calling line. Figure 2 shows the fourth selector normal post cam adjustments on the DDA fourth selectors in the Blackstone (example) office. After a level is dialed that is set to absorb once, the switch "unlocks" and all succeeding digits are effective regardless of whether they are set to be absorbed once, repeatedly, or set to return a busy signal.

STEP-BY-STEP SYSTEM
TRAFFIC DIAGRAM FOR OFFICE IN A SEVEN DIGIT
SINGLE OFFICE AREA. (with 2nd letter of prefix and office
numeral absorbed)

TCI Library: <http://www.telephonecollectors.info>

The connector steps vertically to the third level as the station dial returns to normal. The connector being a two-digit switch (as explained in Section 5) does not rotate at this time, but remains at vertical off-normal opposite level 3. The customer now dials the units digit "4" and as his dial returns to normal the connector will rotate to the fourth contact (counting left to right from front of bank) of its associated bank. Dialing has now been completed by the calling party. If the called number (BL 3-1234) is idle the called station will be rung and the audible ringing signal comes back to the calling station.

If the called station (or line) is busy at the time that the connector makes connection, busy tone will be heard by the calling customer.

From the above we might say that the train of selection through the switches is, therefore, essentially a progressively built-up connection, the switches being held until the receiver is replaced by the calling customer, at which time all switches restore to vertical normal.

CLR and Assistance Operators are reached by the customer dialing a single digit "0" (single channel operation) in which case the first selector will step to level "0" and automatically "cut-in" and rotate to an idle trunk.

Information and Repair operators are reached by dialing 3-digit codes 113 and 114, respectively. See Figure 1.

On calls to CLR and assistance Operators (Code "0") the equipment is released and restored to normal only when both the operator and the subscriber have disconnected.

Figure 3 shows a typical trunking schematic for a six digit numbering plan, no digits being absorbed. Other Figures included in this Section are:

Figure 4—Typical Floor Plan

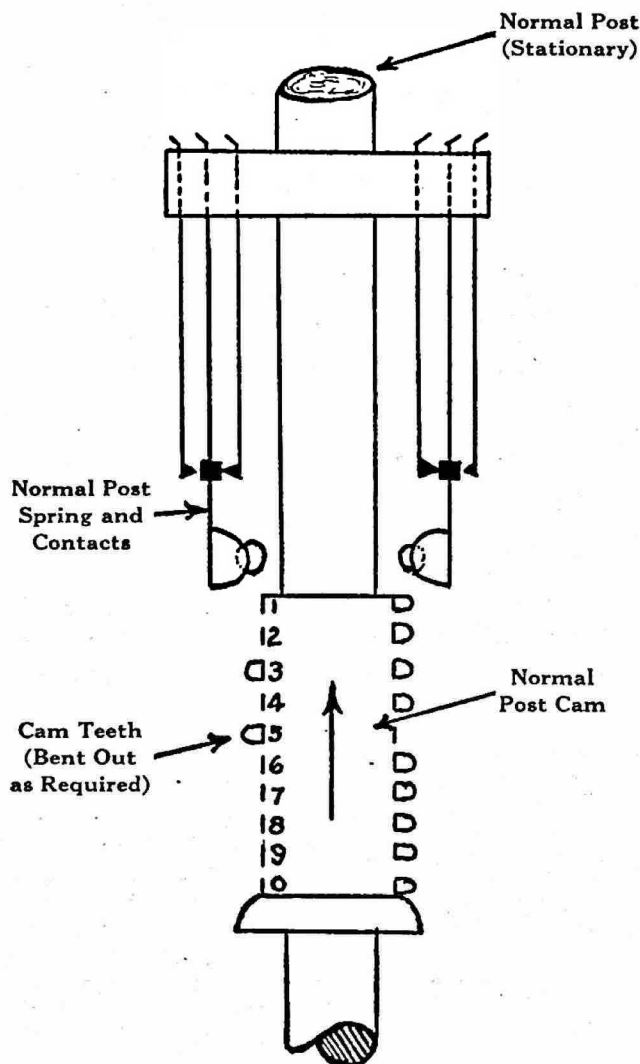
Figure 5—Frame Aisles

Figure 6—Schematic of Cable Runs

Figure 7—Frame Schematic of Originating Equipment

Figure 8—Frame Schematic of Terminating Equipment

DDA SWITCH FEATURES AND ADJUSTMENT



Note: Cam teeth are bent out to actuate normal post springs and control features as follows:

1. Absorb Repeatedly—Left Normal Post Springs
2. Absorb Once—Left and Right Normal Post Springs
3. Return Paths Busy—Right Normal Post Springs

Figure 2

NO. 1 STEP-BY-STEP SYSTEM TYPICAL TRUNKING SCHEMATIC - SIX DIGIT NUMBERING PLAN

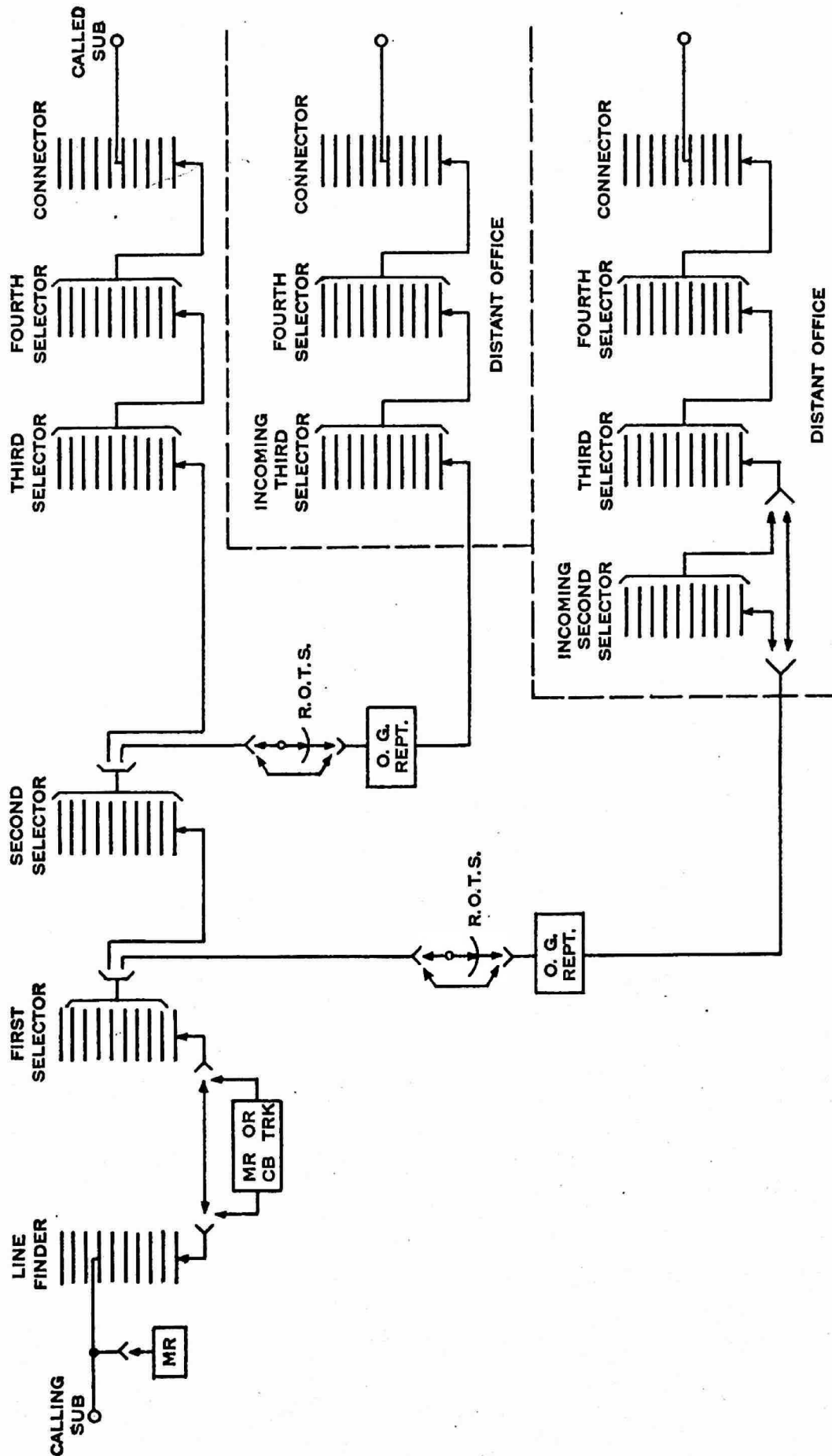


Figure 3



NO. 1 STEP-BY-STEP SYSTEM FRAME AISLES

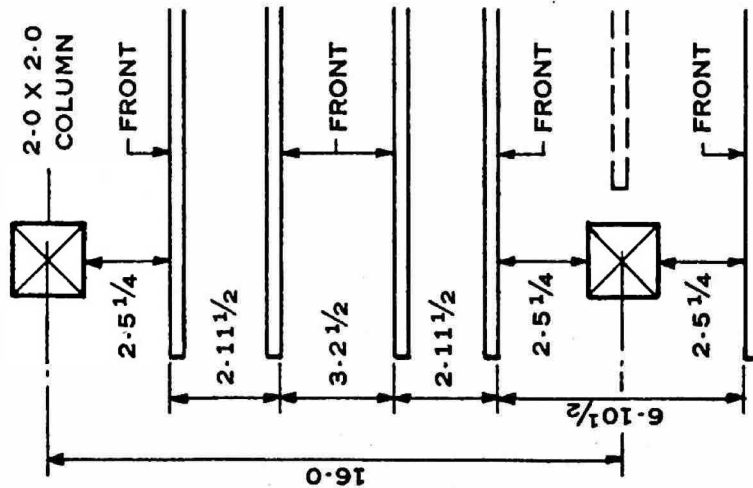


FIG. A

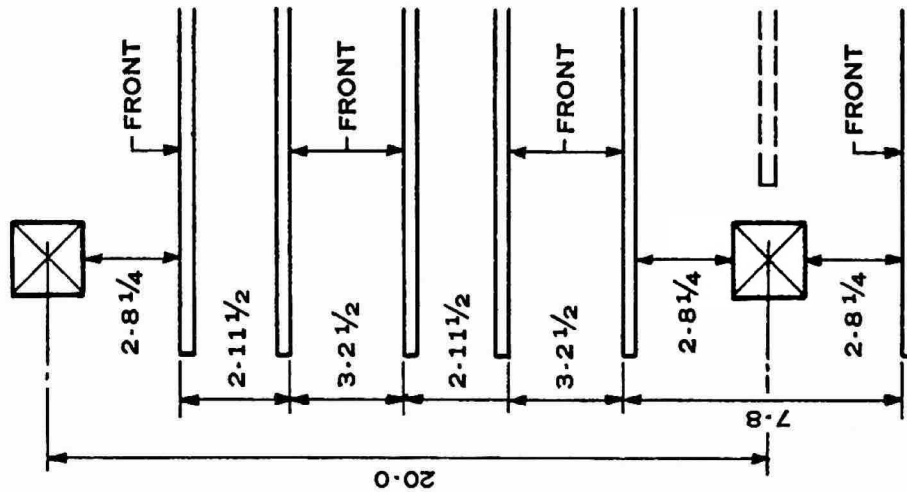


FIG. B

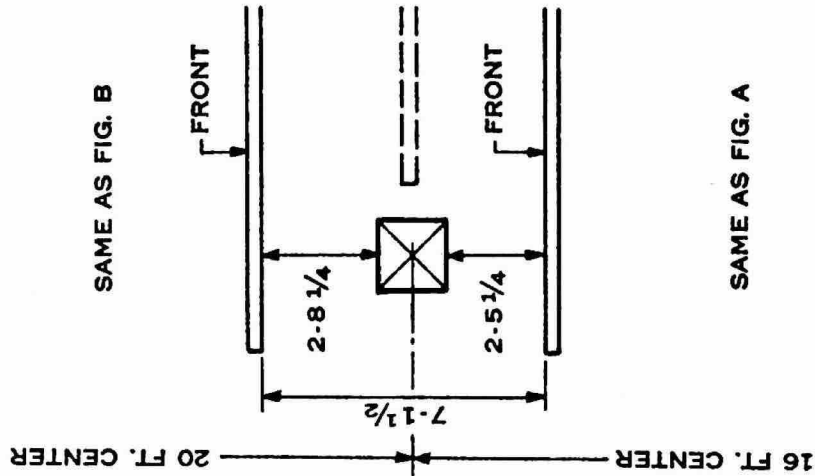


FIG. C

Figure 5

NO. 1 STEP-BY-STEP SYSTEM
SCHEMATIC OF CABLE RUNS

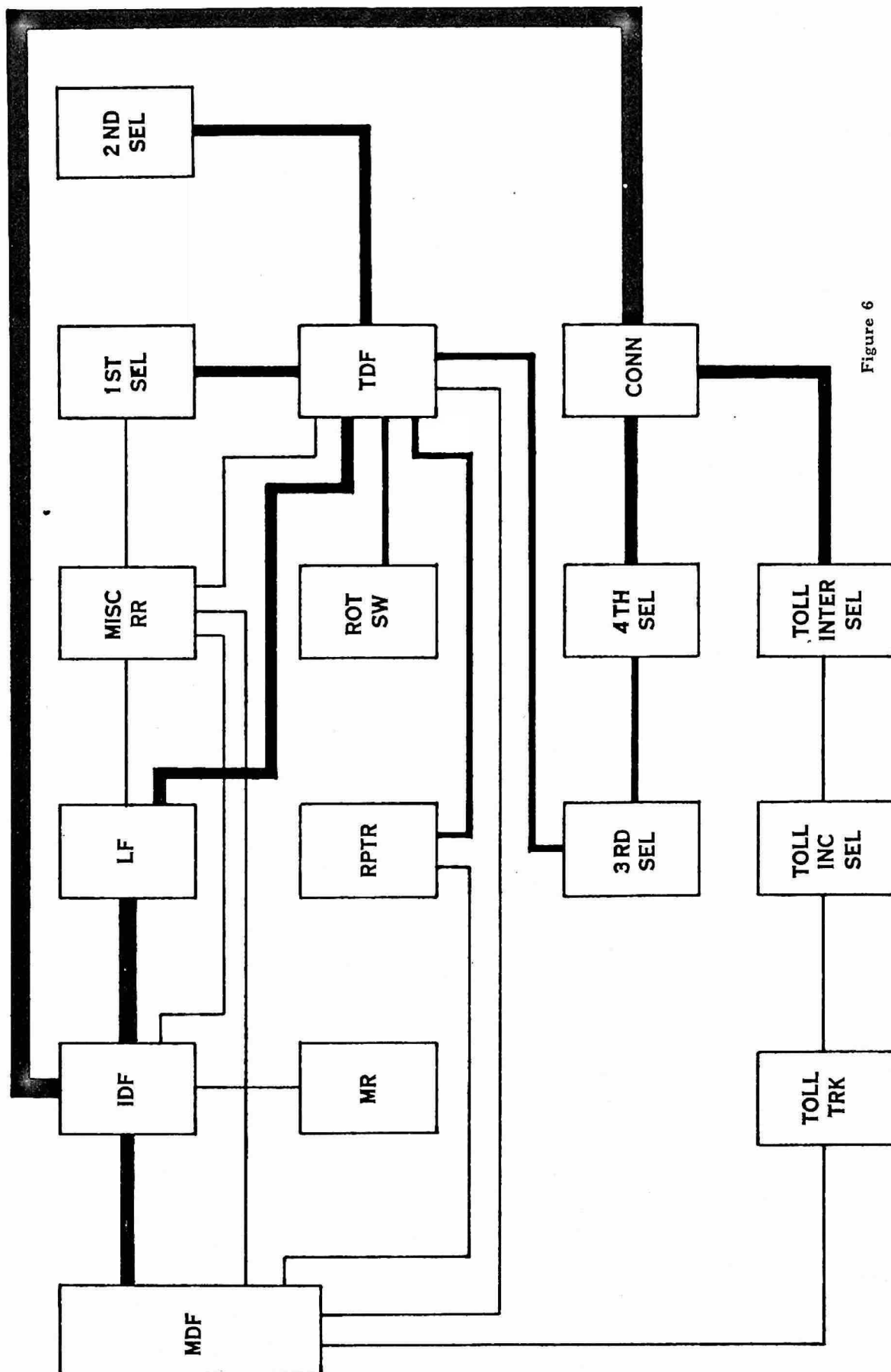


Figure 6

NO. 1 STEP-BY-STEP SYSTEM FRAME SCHEMATIC OF ORIGINATING EQUIPMENT

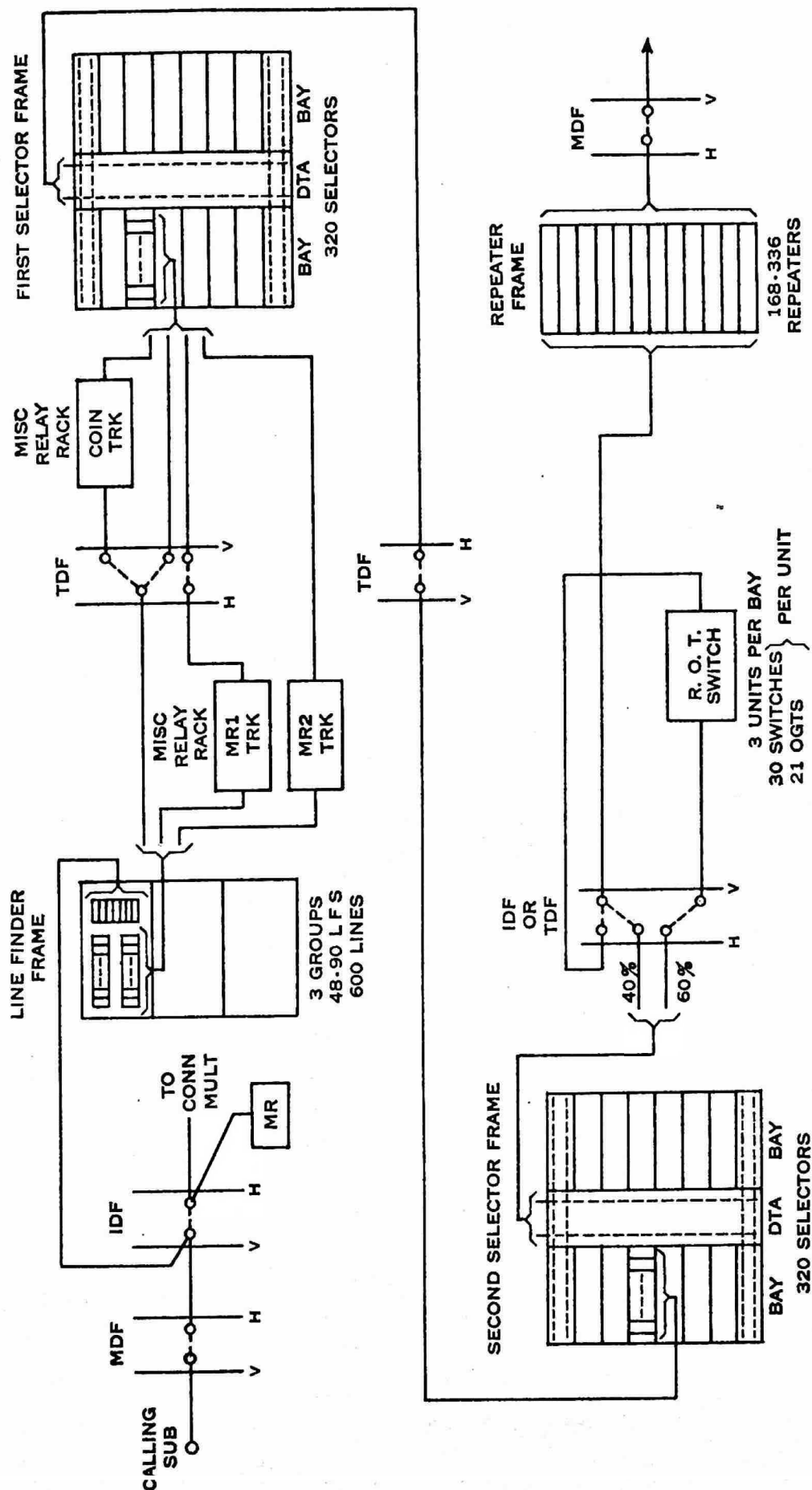


Figure 7

NO. 1 STEP-BY-STEP SYSTEM FRAME SCHEMATIC OF TERMINATING EQUIPMENT

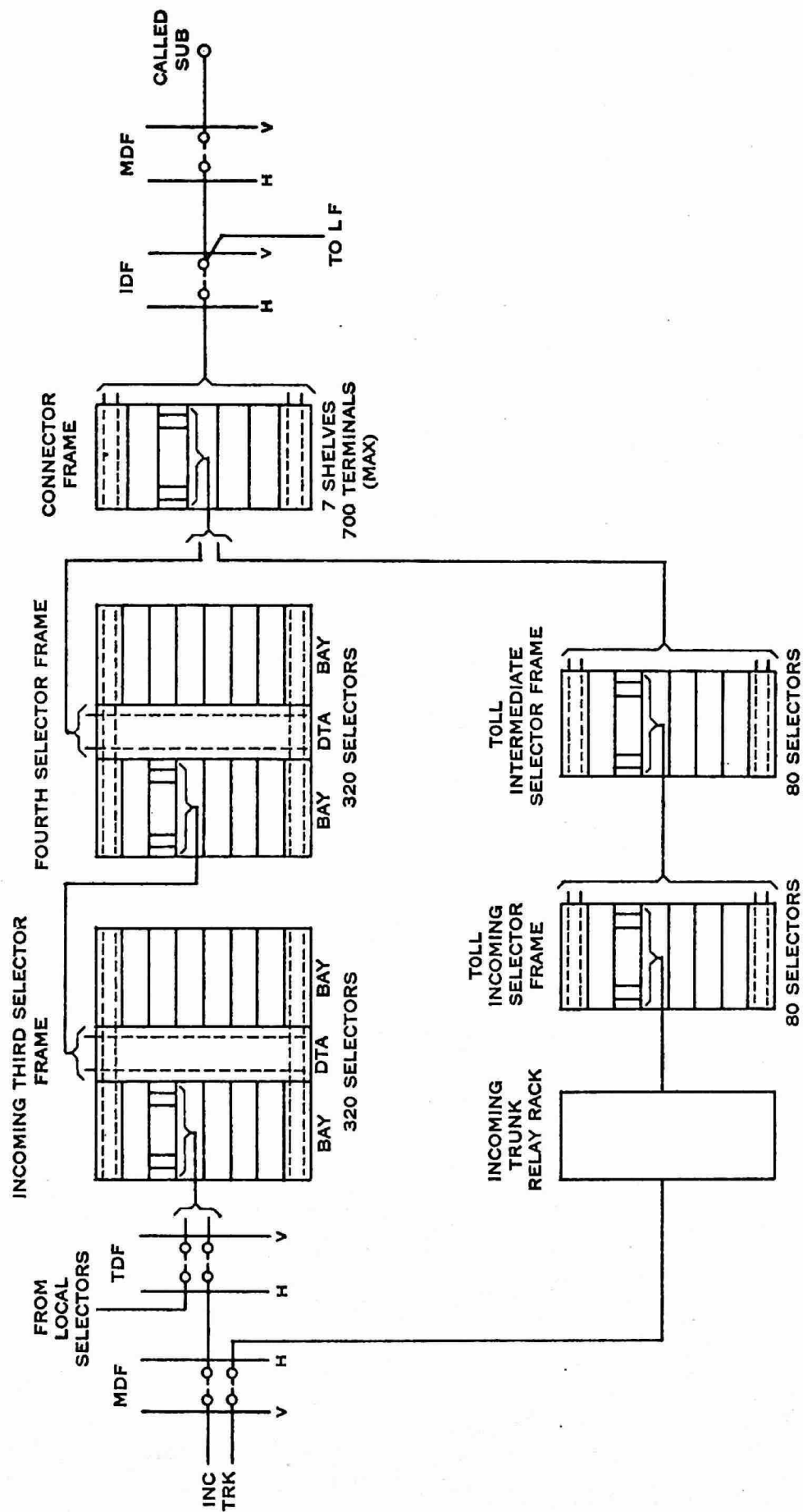


Figure 8

7.0 EQUIPMENT SPECIFICATIONS AND DRAWINGS

PREFACE

This Section is included to provide general information regarding both job and standard specifications and drawings for central office equipment.

The illustrations of specifications and drawings included herein are intended only to show the customary form of such information.

The contents of this Section are of a purely descriptive nature and may not in all respects, be up to date with current procedures.

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1. TELEPHONE COMPANY PROCEDURE IN ORDERING EQUIPMENT

The Commercial Department of the Telephone Company forecasts the demand for additional telephone service. Using this information as a basis, together with data they have compiled on calling rates, the Traffic Department estimates the amount of additional central office equipment required. The Equipment Engineering Department of the Telephone Company prepares specifications and drawings in outline form covering the switchboard equipment required for each office and also prepares a schedule showing when the additional equipment will be required.

Requisitions for the equipment are sent accompanied with their specifications and drawings to the Western Electric Company together with the date on which completion of installation is desired. Figure 1 shows the progress of an order from the time of its origin by the Telephone Company until the installation has been completed and accepted by them.

2. TYPES OF SPECIFICATIONS AND DRAWINGS

The specifications and drawings prepared by the Equipment Engineering Departments can be divided into two classes;

Job specifications and drawings order the equipment required for a specific order.

Standard specifications and drawings cover detail information for manufacturing those items of equipment which are used repeatedly on different orders. They are prepared in order to avoid the expense of duplicating the manufacturing information for identical equipment on each individual order and to avoid variations in design which would occur if engineering was performed in detail on each order. They facilitate the manufacture of equipment in quantities for stock, from which job orders may be filled as required.

3. DIVISION OF EQUIPMENT ENGINEERING FUNCTIONS

The orders for Dial Equipment are engineered at Hawthorne and those for Local Manual, Toll, Repeater and Associated Equipment are engineered at Kearny. The papers issued by the Equipment Departments of both plants are in the same general form except where variations are necessary due to the differences in the design of dial and manual equipment.

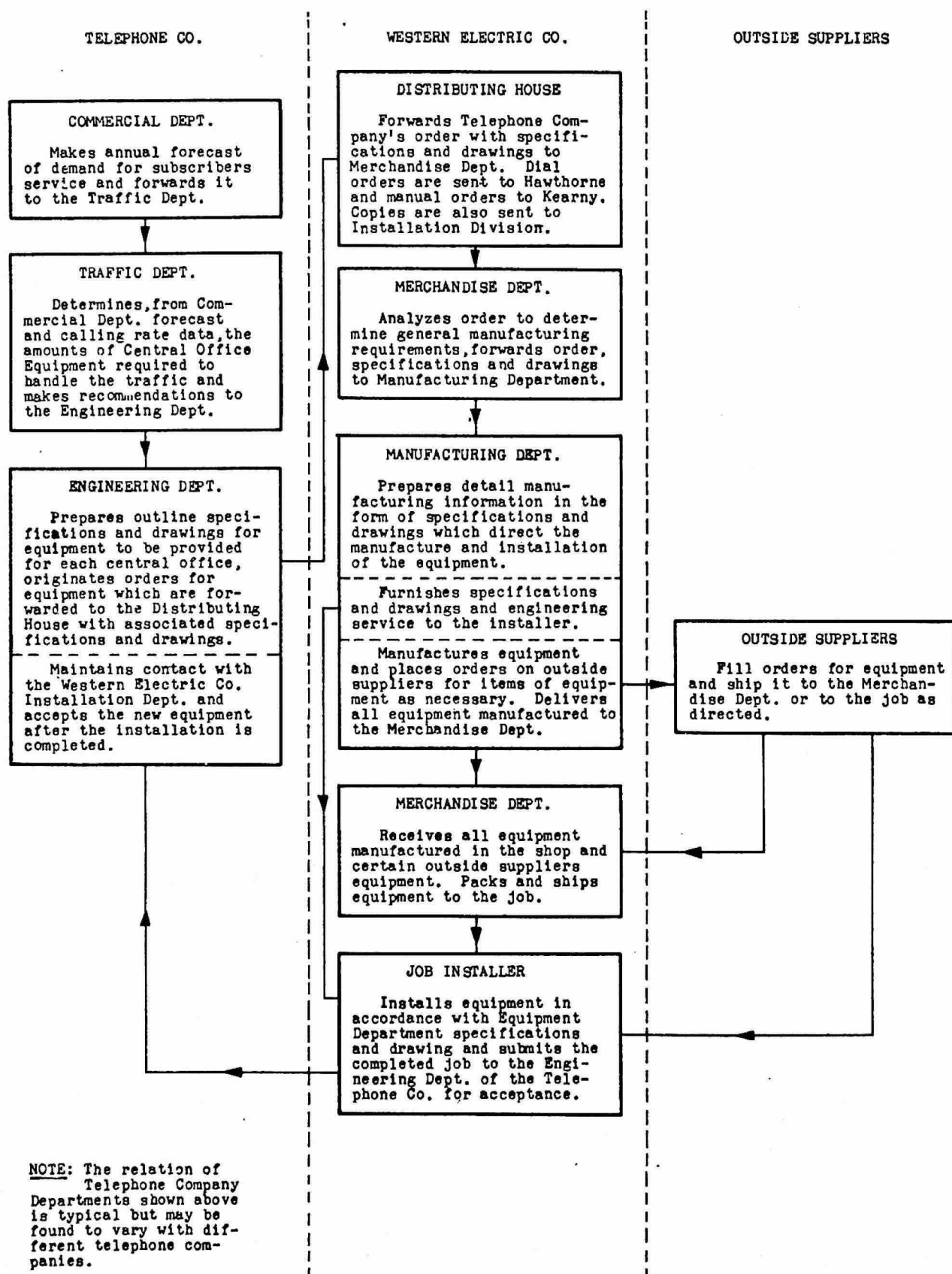


FIG. 1 - ORIGIN AND PROGRESS OF AN E, F, AND I ORDER FOR CENTRAL OFFICE EQUIPMENT

7.02 STANDARD SPECIFICATIONS AND DRAWINGS

1. EQUIPMENT CODES

Standard specifications and drawings prepared by the Equipment Engineering Departments are usually based on similar Bell Telephone Laboratories specifications and drawings.

The Equipment Coding plan provides for the same base number being used by all organizations for any unit of standard central office equipments covered by a "J" specification. By the use of this numbering plan, equipment units (relay rack units, sections, bays, desks, etc.) are priced in the Western Electric price book by code numbers and can be ordered by the Telephone Companies in the same manner. The same code number is used in placing the order in the factory and in designating the packed unit. The installer can therefore readily identify the unit whether specified by the Telephone Co. on an "Install Only" order or in the Western Electric Co. Specifications on an "E, F, and I" order.

Code numbers have also been assigned in accordance with an arrangement that allows for grouping associated equipments in the same numbering series for further convenience. In detail the plan is as follows:-

Bell Laboratories engineering information is prepared in specifications known as "J" specifications. Each "J" specification covers certain portions or types of equipment and is subdivided into smaller equipment units or parts which constitute the individual codes. Typical codes for the No. 11 Switchboard are as follows:-

J12801A	List 1	Blank End Position - Lower Unit
J12801B	List 1	Trouble Position for Small Offices - Lower Unit
J12801D	List 1	Outward Toll Position, Common Equipment - Lower Unit
	List 2	Apparatus added to List 1 to equip the position for coin control with ground potential less than 8 volts.

The code number remains the same when changes are made as long as the equipment it covers can be used interchangeably with equipment which the code number originally covered. If changes in design are so radical that the equipment cannot be used interchangeably, or if an entirely new design is developed, a new code number is assigned.

Manufacturing Department "J" specifications are prepared in drawing form from corresponding Laboratories specifications and bear the same numbers as the codes except that a dash number is added. An example is J12801A-1. The dash number is added to indicate the number of the Manufacturing Department specification. It also allows for the replacement of their specifications while retaining the same Laboratories code number. The second specification for the example cited is numbered J12801A-2 and is issued when more or less minor design changes are made but where it is desirable to have a separate record of the offices using J12801A-1 and J12801A-2.

A separate Manufacturing Department specification is prepared for each code number bearing a different code letter. The aforementioned Laboratories codes are included in one Laboratories specification but in separate Manufacturing Department specifications as follows:-

Bell Laboratories Number	Manufacturing Department Number
J12801A List 1	J12801A-1 List 1
J12801B List 1	J12801B-1 List 1
J12801D { List 1 List 2	J12801D-1 { List 1 List 2

Lettered lists (List A, List B, etc.), not regarded as codes, are shown in Manufacturing Department specifications for ordering variable and optional apparatus which cannot be included in the fixed code.

Figure 2 shows the numbering scheme employed in the Equipment Coding plan.

A variation in the coding plan is made for non-wired frameworks, cable turning sections and distributing frames being examples, and for wired units that are wired entirely from one circuit. These are coded by the drawing number of their assembly, for example ED-27564-30 Group 1, rather than with a "J" specification code.

2. ESSENTIAL PARTS OF A "J" SPECIFICATION

Figure 3 shows the usual arrangement of a "J" specification drawing.

The Stock List orders the framework and all of the apparatus for the equipped circuits. It usually consists of several lists which provide for a selection of circuit features to meet the various traffic requirements.

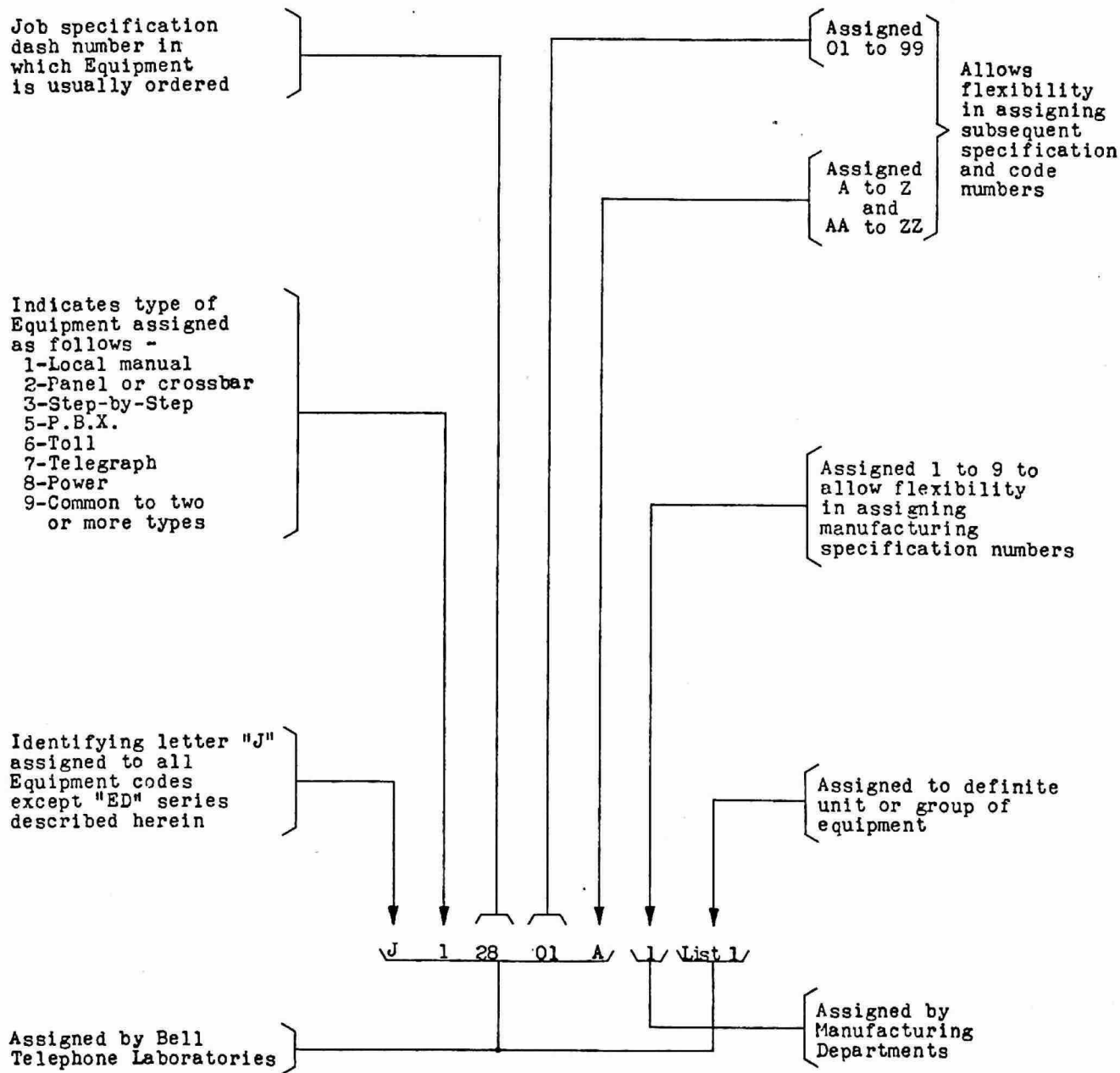


FIG. 2 - ANALYSIS OF NUMBERING SCHEME EQUIPMENT CODING PLAN

The Wiring List specifies all circuits wired in the local cable. The issue numbers listed are those in effect at the time the specification is issued but may be changed by Class A or B changes to require later issues.

Table "A" gives a short description of the features and the extent equipped, as covered by each list in the Stock List.

The Drawing List specifies the principal standard drawings, except circuits, required for manufacture and installation.

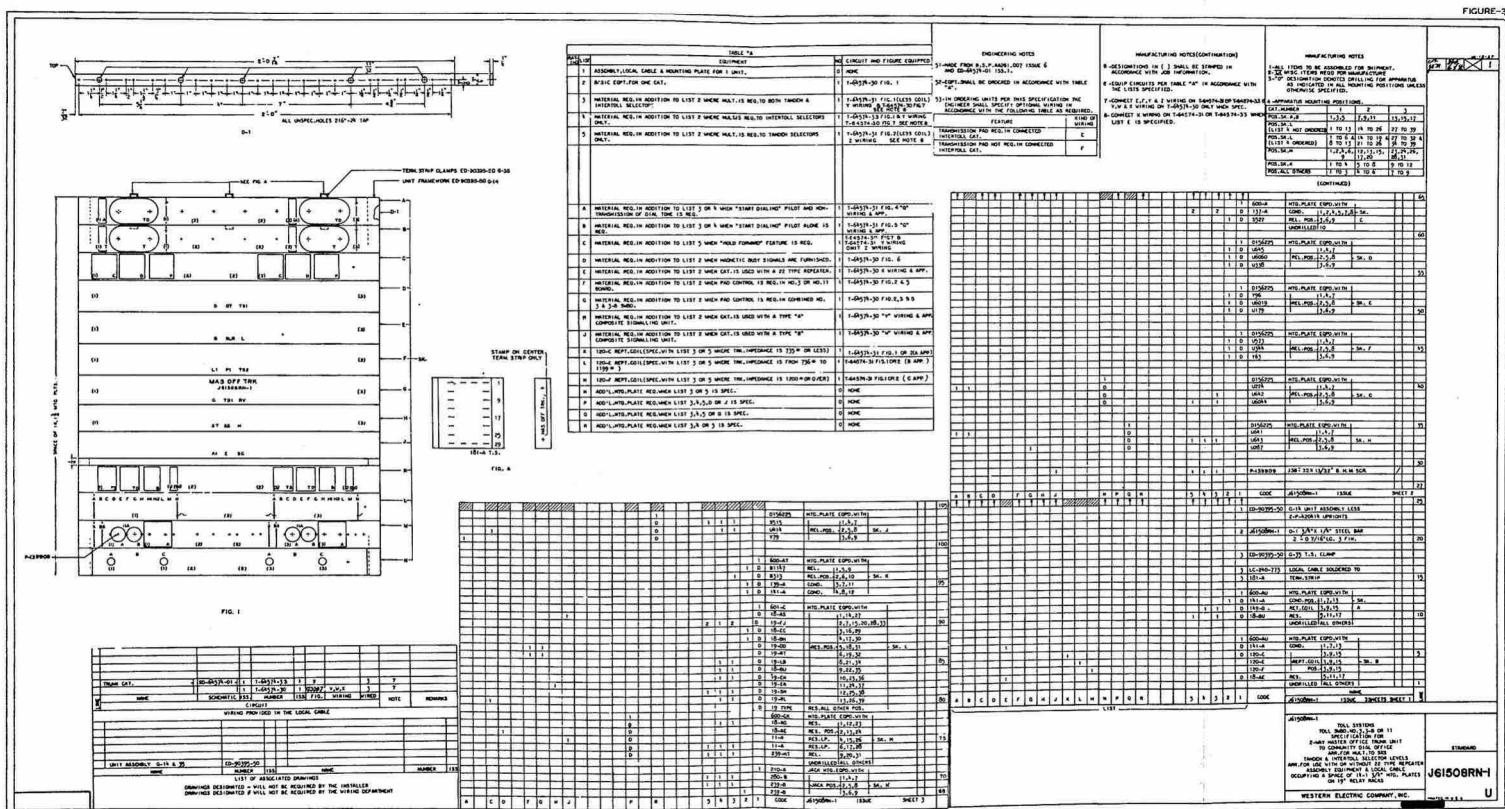
In order that the job wiring list will cover completely all wiring installed in an office, the "J" specification wiring list is duplicated on the job wiring list drawing.

Drawings specified in the Drawing List and Wiring List are listed in the job specification in which the equipment is ordered.

Manufacturing Notes cover shop and field instructions.

Engineering Notes cover job engineering information.

Equipment Views show apparatus arrangement, framework, functional designations and numbering. Some designations are for wiring information only, while others are to be stamped on the equipment.



3. STANDARD DRAWING NUMBERING SYSTEM

Standard drawings are numbered in accordance with a plan that, in addition to being a means of identification, indicates the kind of equipment covered. They are also numbered so as to be readily identified with the Laboratories drawings from which they are made. Following is an analysis of the numbering plan:-

Bell Laboratories Drawings

Type	Prefix Note 1	Base Number Note 2	Suffix Note 3
Circuit (Schematic)	SD	- 11437	- 01
Circuit Description	CD	- 11437	- 01
Equipment	ED	- 11239	- 01

Western Electric Drawings

Type	Prefix Note 1	Base Number Note 2	Suffix Note 4
Wiring Diagram	T	- 11437	- 11
Circuit Description	None Prepared		
Equipment	ED	- 11239	- 10

NOTE 1: Prefix indicates type of drawing. "Equipment Drawings" includes other types of drawings as Assemblies, Equipments, Details, Plans, etc.

NOTE 2: Base number is assigned by Bell Laboratories.

NOTE 3: Serial suffix 01 to 09. Large drawings requiring two or more sheets are numbered with suffixes 011, 012, etc.

NOTE 4: Serial suffix 10 to 89.

Base Numbers are assigned in the following groups as a convenient means of designating the System to which the drawing belongs:-

Manual	10,000 to 19,999
Panel	20,000 to 24,999
Crossbar	25,000 to 29,999
Step-by-Step	30,000 to 39,999
Toll	60,000 to 64,999
Toll	67,000 to 68,999
P.B.X.	65,000 to 66,999
Station	69,000 to 69,999
Telegraph	70,000 to 79,999
Power	80,000 to 89,999
Common	90,000 to 99,999

Standard drawings in some cases have no corresponding Bell Laboratories' drawings and are referred to as "H" drawings. A typical drawing number of this type is as follows:-

H-200-114

The base number, ("200" in the example) represents the System to which the drawing belongs as follows:-

Manual	200 to 299
Panel and Crossbar	500 to 599
Step-by-Step	900 to 999

The suffix is assigned serially from 100 up.

4. CIRCUIT SCHEMATICS AND CIRCUIT DESCRIPTIONS

Circuit schematics are prepared by the Laboratories. Apparatus conventions and connections on these drawings show only electrical characteristics in order to facilitate tracing the circuit operation. Functional designations are assigned to apparatus for identifying different pieces of apparatus in the circuit description, wiring diagram and equipment drawing. Apparatus code numbers are not sufficient for this purpose as several pieces with the same code may be used in the same circuit. A typical circuit schematic is shown in Figure 4. The issue column on this type of drawing lists not only the issue number of the circuit schematic, but also the corresponding issue number of the associated circuit description (CD sheet).

A circuit requirement table is shown on the schematic drawing or on an associated sheet of the same drawing and gives the electrical values for adjusting apparatus.

Circuit Description (CD) sheets are issued by the Laboratories for the schematics. They outline the functions of the circuit and give a detail description of its operation.

Circuit Description changes are made by means of appendices or, where changes are rather involved, by rewriting the entire set of sheets and assigning another issue number. In the upper right corner of the schematic drawing are shown the issue number and appendix number of the circuit description that applies to any issue of the schematic.

Figure 5 shows the circuit description for the schematic shown in Figure 4.

5. CIRCUIT WIRING DIAGRAMS

Circuit wiring diagrams are prepared from schematic drawings to facilitate the manufacture of local cables, the soldering of apparatus and the running of cable or leads to various frames and racks. They show apparatus conventions with the relative locations of all terminals, as well as the color, size and pairing of leads.

Figure 6 shows a typical wiring diagram.

Numbered and lettered figures are shown on wiring diagrams. Numbered figures in general include a complete circuit division and include a descriptive title such as "Relay Equipment" or "Key Equipment". Lettered figures include optional or variable

wiring and apparatus and are supplementary to numbered figures. Wiring diagram figure numbers are not always assigned to agree with the same figure numbers on the schematic, however, although this is done wherever it is practical.

Manufacturing Notes cover shop and field instructions and explanations of symbols used on the drawing.

Engineering Notes cover job engineering information for applying various figures and optional wiring conditions on the circuit as well as other engineering information not required by the shop or field. Under this heading, is included a table (usually as Note #51) which indicates the issue of the corresponding schematic (SD) with which the wiring drawing agrees.

Terminal Assignment Lists (commonly known as power punching lists) are required in connection with some wiring diagrams. They are required when punching designations (usually letters) on the circuit cannot be stamped on the local cable terminal strips. The majority of equipments do not require terminal assignment lists.

The wire to be used is indicated by abbreviations as follows:

Enameled	E
Silk	S
Cotton	C
Lacquered	L
Tinned	T
Double (serving)	D
Braided	B

In forming abbreviations, the letters are arranged from left to right in order of the application of the insulation from the wire out. The abbreviation D preceding "S" or "C" indicates a double serving of that material, otherwise a single serving is applied. The abbreviation "B" follows the material used for braid. For example, Double Silk, Single Cotton is D.S.C. and Single Silk Cotton Braid is S.C.B. The abbreviation "T" is only used when necessary to avoid confusion, tinned wire being assumed.

Wiring Conventions of apparatus are intended to show the relative location of the terminals as the apparatus appears when being wired.

6. CIRCUIT MODIFICATION DRAWINGS

Circuit Modification Drawings are wiring diagrams and are prepared when extensive modifications are to be made in wiring previously installed. They are usually prepared from corresponding Laboratories schematic drawings and have their own circuit description sheets. A feature of these modification wiring diagrams is the tables showing a list of the apparatus, wire and cables required to make the change and the leads to be removed or reconnected.

Figure 7 shows a typical circuit modification table.

7. FRAMEWORK ASSEMBLY DRAWINGS

Framework Assembly Drawings cover views showing the manner in which all parts of a frame, section, desk, or rack are assembled. The framework may be either metal or wood or a combination of both. Assembly views are limited in number to those actually required to show manufacturing and installing information. In some cases individual parts are shown in complete detail in assembly views. More often, however, they are shown in separate sketches either on the assembly drawing itself or on supplementary drawings.

Figure 8 covers a framework assembly drawing.

The Stock List orders material and parts for a complete assembly or a portion of the assembly. Some groups may care for the different mounting arrangements and other groups may cover supplementary framework parts. ED drawing numbers and "P" numbers shown in the stock list of most assembly drawings, indicate the drawing on which that framework part is shown. In the column at the right of the description of the parts, symbols are shown to indicate the extent the parts are assembled in the shop. The screws, nuts, bolts and washers required by the installer for portions of the layer dial job are ordered from a screw list. Such parts are designated by the symbol X, indicating that if a screw list is specified for that particular order, the parts so designated should not be ordered in the various items specifying the framework drawings. The parts designated / are ordinarily assembled in the shop before shipment.

Piece Part Drawings, shown as 6-digit "P" numbers, are prepared for detail parts of framework assemblies where the demand will be heavy enough to warrant stocking the parts. Generally these parts can be used for different assemblies and more elaborate manufacturing tools are provided than is done for details with a limited demand.

Manufacturing Notes and Engineering Notes are shown on assembly drawings for the same reason they are shown on other drawings: to cover manufacturing and installing instructions and engineering information, respectively. Symbols and letters in one of the stock list columns are defined in Manufacturing Notes.

8. DRAWING CHANGES

Whenever any part of a drawing is changed, a new issue number is assigned in the issue column at the right side of the drawing. Details of the change are briefly recorded in this column for each issue and the class of the change is designated by a letter.

The issue numbers listed in job specifications are effective for that job but later issues may also apply depending on their classification.

Drawing changes are classified as follows:

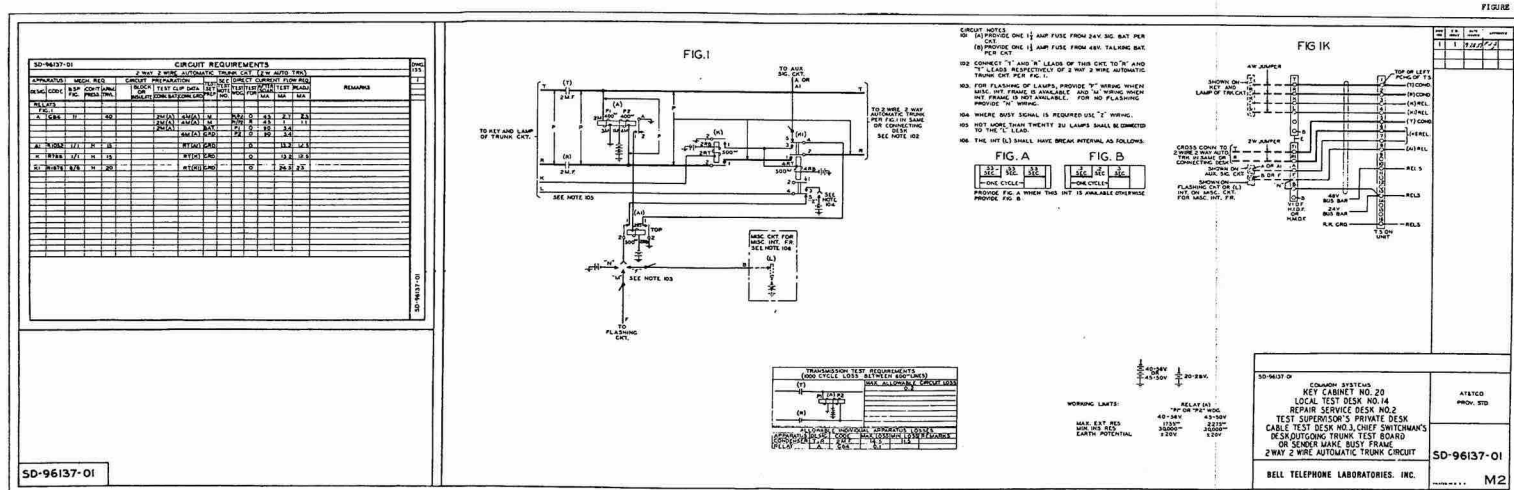


FIG. 4 - CIRCUIT SCHEMATIC

CIRCUIT DESCRIPTION
SYSTEMS DEVELOPMENT DEPARTMENT
PRINTED IN U.S.A.

CD-96137-01
Issue 1
September 28, 1937
(4 Pages) Page 1

COMMON SYSTEMS
KEY CABINET NO. 20
LOCAL TEST DESK NO. 14
REPAIR SERVICE DESK NO. 2
TEST SUPERVISORS' PRIVATE DESK
CABLE TEST DESK NO. 3, CHIEF SWITCHMAN'S
DESK, OUTGOING TRUNK TEST BOARD
OR SENDER MAKE BUSY FRAME
2 WAY 2 WIRE AUTOMATIC TRUNK CIRCUIT

1. PURPOSE OF CIRCUIT

- 1.1 This circuit is designated to provide a 2 way talking connection, which is automatic in operation, between two maintenance desks in the same building or different office buildings over a 2 wire circuit.

2. WORKING LIMITS

- 2.1 Relay (A) - 40-56V 45-50V
Max. Ext. Res. - 1735 ohms 2275 ohms
Min. Ins. Res. - 30,000 ohms 30,000 ohms
Earth potential - $\pm$ 20V $\pm$ 20V

3. FUNCTIONS

- 3.1 To provide a talking connection between two maintenance desks in the same building or different buildings.
- 3.2 To flash the associated lamp on an incoming call when "M" or "F" wiring is used.
- 3.3 To cause the associated lamp to light steadily on an incoming call when "H" wiring is used.
- 3.4 To cause the associated lamp to light steadily when a call is answered and until both ends have disconnected when "Z" wiring is used.
- 3.5 To extinguish the associated lamp when a call is answered and "Z" wiring is omitted.
- 3.6 To cause the auxiliary signal circuit to function on an incoming call.

CD-96137-01 - Issue 1 - Page 2

- 3.7 To retire the auxiliary signal when the call is answered.
- 3.8 To signal the distant when a call is originated over this circuit.
- 3.9 To cause the associated lamp to light steadily when a call is originated and "Z" wiring is used.
- 3.10 To prevent the extinguishing of the busy lamp signals in both connecting desks while either end remains connected and to extinguish the busy lamp signal when both ends have disconnected.
- 3.11 To restore to normal when both ends have disconnected at the termination of a call.
- 3.12 To restore to normal upon disconnection of a call that was not answered.

4. CONNECTING CIRCUITS

- 4.01 Key and Lamp of Tel. Ckt. - Repair Service Desk No. 2.
- 4.02 Key and Lamp of Tel. Ckt. - Test Supervisors' Private Desk.
- 4.03 Key and Lamp of Tel. Ckt. - Local Test Desk No. 14.
- 4.04 Key and Lamp of Tel. Ckt. - Cable Test Desk No. 3.
- 4.05 Key and Lamp of Tel. Ckt. - Key Cabinet No. 20.
- 4.06 Key and Lamp of Tel. Ckt. - Sender Make Busy Frame.
- 4.07 Key and Lamp of Tel. Ckt. - Chief Switchman's Desk.
- 4.08 Key and Lamp of Tel. Ckt. - Outgoing Trunk Test Board.
- 4.09 Auxiliary Signal Ckt.
- 4.10 Miscellaneous ckt. for miscellaneous interrupter frame.
- 4.11 2 Way 2 Wire Automatic Trunk Ckt.
- 4.12 Flashing Circuit.

DESCRIPTION OF OPERATION

5. GENERAL

This circuit is designed to operate with a circuit identical to this one. In connecting these two circuits together, the "R" and "H" leads of one is connected to the "R" and "T" leads, respectively, of the other.

CD-96137-01 - Issue 1 - Page 3

6. ORIGINATING A CALL

When the key in the associated telephone circuit is operated to the "TALK" position ground is connected to the "K" lead operating relay (K). The operation of relay (K) (a) closes the ring conductor in part and (b) causes relay (K1) to operate. Relay (K1) operating (a) connects battery ("Z" wiring) to lead "L" which causes the associated lamp to light as a busy signal and (b) closes the ring conductor causing relay (A) to operate in series with the (A) relay in the connecting circuit which as described above, is a circuit identical to this one. Relay (A) operating operates relay (A1) which closes a locking ground for relay (K1). The (A) relay in the connecting circuit at the other end also operates causing its (A1) relay to operate which signals the distant end of the incoming call.

7. CALL ANSWERED

When the call is answered at the other end, the (K) and (K1) relays in the connecting circuit operate. These relays operating close a circuit from battery thru the "P2" winding of relay (A) of the connecting circuit to ground thru the "P1" winding of relay (A) of the end originating the call. Both (A) relays have been already energized, as described above and this condition therefore is set up to take care of the disconnect feature as hereinafter described.

8. INCOMING CALL

When a call is originated at the other end relay (A) operates from battery received thru the tip conductor. Relay (A) operating causes relay (A1) to operate which connects intermittent battery supplied over the "M" lead from the flashing circuit ("M" wiring) or supplied from the miscellaneous interrupter frame ("F" wiring) or connects direct battery to the "L" lead ("H" wiring) causing the associated lamp to flash or light steadily as a signal that the call is incoming. The operation of the (A1) relay also connects ground to the "A" or "A1" lead causing the auxiliary signal circuit to function.

9. INCOMING CALL ANSWERED

When the key in the associated telephone circuit is operated, relay (K) operates causing relay (K1) to operate. Relay (K1) operating (a) retires the auxiliary signal (b) disconnects intermittent or steady battery from lead "L". (c) connects direct battery to this lead where "Z" wiring is used causing the lamp to light steadily as a busy condition or extinguishes the lamp where "Z" wiring is omitted and (d) looks to ground on a make contact of relay (A1).

CD-96137-01 - Issue 1 - Page 4

10. DISCONNECTION

When the key in the associated telephone circuit at one end of the trunk is restored to normal but the key at the other end is not restored, the following action takes place. The release of the associated key removes a ground from lead "K" causing relay (K) to release. Relay (K) releasing (a) opens the circuit consisting of winding "P2" of relay (A) at one end and winding "P1" of relay (A) at the other end and (b) opens the operating circuit to relay (K1). Relays (A) and (K1) however do not release as relay (A) is held operated over its "P1" winding and relay (K1) is held locked to ground on contact of relay (A1). Under this condition, the busy lamp signals at both ends remain unchanged.

If a call which is originated at one end is not answered, restoring of the associated key in the telephone circuit causes relay (K) to release as heretofore described. Relay (K) releasing causes relay (A) to release which in turn causes relay (A1) to release. Relay (A1) releasing causes relay (K1) to release thus restoring the circuit to normal.

In order to restore the circuit to normal after a completed connection has been set up, the associated keys at both ends of the trunk should be released. Under this condition the (K) relays at both ends of the trunk release opening both sides of the trunk. This allows both (A) relays to release, in turn permitting both (A1) relays to release. The release of the (A1) relays permit both (K1) relays to release. The (K1) relays released, extinguishes the lamps at both ends of the trunk thus restoring both circuits to normal.

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EJ/MB
JJS

FIG. 5 - CIRCUIT DESCRIPTION

- Class "A" - Changes to be made before cut-over on all equipment in stock or in process of manufacture or installation.
- Class "B" - A limited change which is issued to affect equipment in process of manufacture or installation as specified on the change supplement.
- Class "B" Future - A change to affect new orders but which should be applied without delay. Does not affect work already started.
- Class "C" - Changes to be made as soon as possible without incurring expense due to delays in delivery or the junking or conversion of equipment, parts or material. This class is used only where shop test sets or tools are affected.
- Class "D" - A change to affect new orders or for record only.
- Class "E" - A change to affect engineering information only.

Only Class "A" and "B" changes affect the installer and he is furnished with copies of the drawing change orders which serve as supplements to the job specification.

9. NEW DEVELOPMENT DESCRIPTIONS (NDD'S)

New Development Descriptions cover a general description of new equipment designs or major changes in existing equipments. They also describe the functions of the equipment, its relation to other equipments and the reasons for its development. They list the major drawings for the new design and the first job where the equipment will be in-

stalled. New Development Descriptions are furnished to the Installation Divisions for information purposes only so that the field may become familiar to a certain extent with the new equipment before the start of installation.

10. DRAWING RATINGS

The Rating of Drawings in the standard series is shown in the lower right corner of the drawing. A brief description of how the several ratings are used is as follows:

Standard - Indicates that the drawing covers the latest type of equipment which has been approved for general use.

Standard for A. and M. Only - Same as the "Standard" rating except the equipment for which the drawing is made has been rated A. and M.

A. and M. Only - Indicates the drawing is to be used for additions and maintenance only.

Mfr. Disc. - Indicates the drawing has been discontinued from use except to equip "wired only" circuits.

A. and M. for Mfr. Disc. - This is a special rating for new drawings and covers modification information for existing equipments that have been rated "Manufacture Discontinued."

Special - Indicates the drawing covers special features, usually for one job or Telephone Company, for which standardization is not planned.

The rating is shown on drawings simply as a matter of information and for convenience to the engineer in selecting one drawing from several when engineering a job.

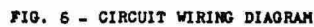


TABLE A							
ADDITIONAL WIRING REQ. TO MODIFY ----- TO AGREE WITH -----							
22 DCL							
COLOR	FROM			TO			REMARKS
	APP	LOC NO	TERM NO	APP	LOC NO	TERM NO	
R-BL-W	REL (RC)	17	2 RT	REL (OD)	36	YBI	Fig. 1
R-BL-W	JK (LINE)	8	-	JK (LINE)	8	-	Fig. 1 Hairpin Loop
22 EDC							
CA COND or 20 ESCB BK-R	KEY (TALK)	31	-	COIL (T)	14	6	Fig. 2 (T- -11)

TABLE B							
LEADS TO BE CUT DEAD ON ----- TO AGREE WITH -----							
COLOR	FROM			TO			REMARKS
	APP	LOC NO	TERM NO	APP	LOC NO	TERM NO	
R 22 GA	REL (RC)	17	4B	REL (OD)	36	3T	Fig. 1 (T- -11)
R 20 GA	REL (RC)	17	3T	REL (AC)	38	2B	Fig. 1

TABLE C				
LEADS TO BE RECONNECTED ON ----- TO AGREE WITH -----				
COLOR	LOCATION			REMARKS
	APP	LOC NO	TERM NO	
R-BL-W	REL (RC)	17	2T	Fig. 1 (T- -11)
R-G	REL (RC)	17	1B	Fig. 1
CA CONDUCT or 20 ESCB Y	REL (S2)	23	1M	Fig. 4

LIST OF MATERIAL REQUIRED FOR MODIFICATION				
AMT. OR FEET				MATERIAL
		2		22 DSCL R-0
			3	22 DSCL R-BL-W
	6			22 DSCL R & R-W
		1		1450 or 6182 CA (PER BAY)
9	4			22 EDSC CA CONDUCT (RR to HIDE)
			1	149 - P REL
			1	236-C JACK
Fig. 4	Fig. 3	Fig. 2	Fig. 1	

FIG. 7 - MODIFICATION CIRCUIT DRAWING TABLES



7.03 JOB SPECIFICATIONS AND DRAWINGS

1. DIVISION OF EQUIPMENT IN JOB SPECIFICATIONS

Job Specifications are prepared for all orders engineered by the Manufacturing Departments with the exception of certain miscellaneous and small orders where editing information can be shown on the order sheet.

Equipment for an order is grouped in different job specifications according to the various kinds of sections, frames and other equipment required. This grouping takes into account the time required for manufacturing so that those items requiring the longer period will be ordered early enough to permit of satisfactory deliveries to the installer. Shop wired equipments ordinarily require a longer manufacturing interval than do stocked frames, racks, cable, wire, and conduit, and for this reason these specifications are written as early in the engineering period as possible.

2. JOB SPECIFICATION NUMBERING SYSTEM

The Job Specification Number is made up of the job order number and a three digit dash (suffix) number. The letter "H" or "K" precedes the dash number and indicates that the specification was written at Hawthorne or Kearny. Example: 47708-K111.

Dash numbers are assigned in accordance with an established numbering plan for all job specifications. The first digit is 1 for Manual and Toll, 4 for Panel, and 7 for Step-by-Step equipments, except that 2, 3 and 8, respectively, may also be used for the first digit where it is desired to segregate orders for miscellaneous equipment for shop scheduling purposes. The last two digits are determined by the type of equipment ordered.

Some of the commonly used dash numbers are as follows:

Manual Panel Step-by-Step

101	401	701	Cabling
102	402	702	Cabling
111	411	711	"A" Switchboard
113	413	713	"B" Switchboard
165	465	765	Power Plant
168	468	768	Framework, M.D.F., I.D.F., etc.
170	470	770	Equipment, M.D.F., I.D.F., etc.
192	492	792	Installing

3. ESSENTIAL PARTS OF A JOB SPECIFICATION

The headings "General", "Engineering Reference Papers", "Installer's Reference Papers", etc., are provided in specifications for convenience in segregating the various kinds of information that make up the specification.

Under GENERAL is covered a general overall picture of the manufacturing and installation effort specified in the specification. This includes a list of the major equipment items requiring effort by these two general departments and usually is in terms of the number of new, reused or modified frames, sections, or desks, and their associated circuits. A brief description is given of major circuit modifications or conversions.

Under ENGINEERING REFERENCE PAPERS are listed any specifications, drawings, letters or papers that were of interest to the engineer in writing the specification but which are of no interest to the installer. These papers are not furnished to the field. The Telephone Company's specification for the current order is listed under this heading.

The heading INSTALLER'S REFERENCE PAPERS is for the purpose of listing drawings required by and furnished to the installer but which are not required by any other department or the Telephone Company. These drawings are given a limited distribution and for this reason they are not listed under the regular "Drawing" heading in the specification. Some examples are detail or partial assembly drawings listed in framework drawing stock lists, and circuits connecting to circuits modified on the current order. Apparatus drawings, "D" specifications, "KS" specifications and any other papers required by the installer only are listed under this heading. Issue numbers are omitted and supplements are not required or furnished to the field for any of these drawings.

Under DRAWINGS are listed the drawings required for the specification and they include the drawings listed in "J" drawings specified for the current order. These are subdivided into "Assembly and Equipment" drawings and "Circuits" for convenience in segregating the two classes of drawings and also because all circuits are to be listed in the -99 Specification to be turned over to the wire chief.

Not all drawings are required by the installer or shop and for this reason various symbols are shown in the drawing list to facilitate the furnishing of prints to those organizations actually requiring them. Drawing symbols are explained in the specification and the most common ones have the following meanings:

Drawings designated "=" are not required by the installer.

Drawings designated "#" are not required by the Wiring Department.

Drawings designated "\$" are required by the _____ Distributing House.

Drawings designated "\$\$" require Van Dykes to be sent to the Automatic Electric Company.

Drawings designated "J" are listed on "J" specification drawings.

Drawings designated "N" are ordinarily not required by the engineer as they show no wire, cable or equipment which is not ordered in the "ED" or "J" specification.

Circuit descriptions shall be furnished for all schematics except those marked "*".

Drawings designated "+" are not required by the Telephone Company.

Drawings designated "X" have previously been furnished to the Telephone Company Area file.

Drawings designated "-" have previously been furnished to the Telephone Company Division file.

Issue Numbers are omitted from some drawings in the drawing list. These drawings cover standard frameworks that are made up on a piece part (drawing) basis. Supplements are not written against these drawings and the frameworks for the most part have been so standardized as to require no changes in the field. If a change must be made in the field, it would be handled through correspondence.

The WIRING LIST covers a list of all of the circuits to be wired, equipped or changed on the current order. The wiring list may be either in the form of a drawing, supplementing the specification, or it may be shown completely in the specification. A typical Wiring List Drawing is shown in Fig. 13. When providing for extensive changes in existing offices the wiring list is usually included in the specification, the drawing showing only the condition after changes have been made. As an example, complete wiring will be covered in the specification where existing wiring is to be modified, or where wiring is to be added to existing frames or other units of equipment. Other examples are where wiring for a standard unit of equipment ("J" Specification) furnished on the current order is to be modified in the field, or where installer's wiring is required for the standard unit. Wiring list drawings have not been prepared for some of the older offices for cost reasons. In these cases complete wiring is always covered in the specification.

Various Wiring List terms, "Add", "Equip", "Remove", etc., are found in job specifications; their explanations are given below:

ADD: When adding wiring for a new circuit in a position at present wired.

EXTEND: When extending a circuit at present installed, through a position in which it does not appear.

TRANSFER: When taking a circuit out of one position or panel, and installing it in another position or panel.

RELOCATE: When the location of apparatus in a particular circuit is changed in the same panel, keyshelf or section.

REMOVE: When circuit is to be taken out of present position and is not to be reused again, including also the removal of equipment only, leaving the wiring in place.

DISCONNECT: When equipment is disconnected from service without removal of apparatus or wiring.

EQUIP: When adding or connecting apparatus where the wiring is at present in place.

MODIFY: When changing the present circuit, which change will allow the use of all or nearly all of the present wiring, or when changing and equipping same.

REWIRE: When wiring of present circuit is changed to such an extent that none or practically none of the wiring of the circuit can be reused.

General Notes and Installer's Notes are provided in specifications as instructions to the shop and field where information is required in addition to that covered on the drawings or where the drawings are to be disregarded in more or less minor respects. Reference is made to these notes in the wiring list in all cases. Installer's notes are confined to field operations alone but Shop Notes affect the shop and field alike.

Under the heading FRAMEWORK AND SUMMARY OF APPARATUS are listed framework, apparatus and other material ordered in the specification together with any ordering notes pertaining to items in the summary. The following illustrates the essential parts of a summary page.

Source	Item No.	Note	Quantity		Description
			Ordered	Shipped	
	3	Z	2		ED-90798-10G-1 Bus Bar Term. Support
H1547.1	3.1		2		P-422329 Support
H912	3.2		4		P-65746 Scr.
"	3.3		4		P-49430 "
"	3.4		8		P-69964 Washer
"	3.5		8		P-160742 "
"	3.6		4		P-65757 Nut
"	3.7		4		P-47983 "
H1557	27		1		J32306M-2 List 5 Eight Pty. Term. per Sta. Ring.Int.
H912	27.1		4		4-A Lamp Cap
"	27.2		24		2-Y Lamp
"	27.3		20		2-AY Lamp Cap

Under the heading Source is listed the factory department number where the part is made or taken from stock. H912 in the example indicates that the part is taken from Merchandise stock, and H1557 indicates that the interrupter unit is to be wired and assembled in wiring department #1557. The "H" indicates Hawthorne.

Item Numbers are assigned to the main unit or framework and sub-item numbers to those parts of the main item which are not assembled but which are shipped separately to the installer. Use is made of item numbers by the field in checking in material.

The Note column is for reference listing of any notes appearing in the Summary.

Quantity Shipped. This column is left blank on all copies of the specification except the one copy used for the installer's shipping summary. On this copy the column is left blank (understood to be the same as the "Ordered" column) except "BO" (Back Order) is indicated where shipment is not made.

The blank heading at the right is used only on the installer's shipping summary copy for the listing of box numbers, meaning that the items have been shipped in boxes or packages assigned with these numbers.

The Framework and Summary of Apparatus pages of the specification have been designed to serve, in addition to a medium for ordering, as the Installer's Shipping Summary. One copy is marked for this purpose at the factory and is used principally by the field storekeeper in checking in material. "Back Order" items and box numbers are marked on this copy.

4. CABLING SPECIFICATIONS

Switchboard cables required for a job may be furnished in bulk or shop formed. Formed cable is commonly soldered to jacks, terminal strips or other equipment before shipment.

Formed and bulk cables are normally ordered in separate specifications but may be combined in one specification where the number of items is comparatively small. On the larger jobs, cables are shipped on different dates in order to fit in with installation schedule for the job. Two formed cabling specifications may be written, the one having the earlier shipping date covering cabling for the frames that are shipped first. To accommodate the first shipment of frames, bulk cables for certain runs may be ordered in the first formed cabling specification.

Bulk Cable "Installer's Running Lists" are provided as illustrated in Fig. 9.

The Cable Symbol is shown in parenthesis immediately following the circuit name and number for which the cable is furnished. This symbol is shown in a table on the equipment drawings and assists the installer in finding the locations of terminal strips, fuses or mounting plates to which the cable should be run. Cable symbols are usually assigned only to miscellaneous runs, the quantity of equipment used for regular runs ordinarily making the identification comparatively simple.

The "Cable Run Sections" column at the right refers to cross-sections shown on the job cabling plan drawings through which the cables are to be routed.

An Item Number is assigned to each code of cable in the specification.

Sub-Items are assigned to each listing of the cable in the Installer's Running List.

In the Summary of Material following the Running List, all sub-items are grouped under the respective item numbers. With this arrangement, all sub-items ordering the same code of cable are consecutive, facilitating the shipment of longer lengths.

Long Lengths of bulk cable are ordered in separate items and are designated with an asterisk (*). This is important in the case

Item	Amt. in Ft.	No. Cag.	Code	From	To	Cable Run Sects.
Cable Associated with Spec. 411 Test Lines from Loc. Test Desk T-514150(11A)						
1.1	165	1	6079	Rear Eq. "A" Pos. 1	H.I.D.F.	B9,B7
1.2	167	1	6079	" " " " 2	H.I.D.F.	B6,G8,G9,H3,H4
Emergency Cord T-20377-11 (11B)						
2.1	164	1	6166	Rear Eq. "A" Pos. 1	V.I.D.F.	B9,B7,B6,B8
2.2	150	1	6166	"A" Bd. C. T. S.	Fuse Bd.202	
Cabling Associated with Spec. 418 Tie Lines T-20390 - 17 Figs. 1, 3, 5 (18A)						
3.14	55	1	6179	"A" Bd. & Misc.R.R.202	Fuse Bd. 202 - 24V Sig.	None

FIG. 9 - BULK CABLE SPECIFICATION - INSTALLERS RUNNING LIST

SOURCE	ITEM	AMT	CODE	
K-1561-1B	101	135 Runs	6084	135 Inter to Mult Subs "B" Bd Unit #3 - Cas (4545'-0") LG - Formed Per F-2108 on H-254-155 Runs Nbd 1 to 135 Incl Soldered to
			84-C	270 Short Mult Cas (1892'-0") Lg Formed Per H-254-153 Install Sects 1 to 3 Incl Equipped with
	1620	#92 Jks		#113 Mtg Nbd 0-19 with Holly Strip on Top
	1620	#92 Jks		#113 Mtg Nbd 20-39
	1620	#92 "		#113 " " 40-59
	1620	#92 "		#113 " " 60-79
	1620	#92 "		#113 " " 80-99
				(Subs Mult "B" Bd) (Unit #3)

FIG. 10 - FORMED CABLE SUMMARY

of the larger sizes especially, since the loss is greater for each foot of cable wasted and there is also a greater probability of short lengths being provided in the usual routine, provided they are not specially designated. With this arrangement the cables are selected from stock to fit the individual lengths specified. The symbols "&" and "#" are used in place of the asterisk to designate the odd and even numbered cables for dial equipments where a considerable number of such cables are ordered and for which detailed cross-sections are shown on the job cabling plan. The cables are listed in each group in consecutive order, the last cable of the group to be installed being listed first.

Formed Cable Specification Summary pages are illustrated in Fig. 10. It will be noted that the source, item numbers, code of cable, terminations, and apparatus to be soldered to the cable are listed. The total length of cable is listed in parentheses for billing purposes.

Runs as used in this illustration refers to the number of units to be shipped, each run consisting of the "inter to mult" cable together with all of the short multiple cables connected with that cable. In other cases the term "run" is used to refer to a group of cables having the same terminations at both ends and used for the same circuit.

Cutting Lists are provided as illustrated by Figure 11 for cases where the lengths of cable vary. This illustration is for a portion of the "inter to mult" cable covered in Figure 10. Each cable is assigned a number and is associated with a particular "Hundred" and "Jack Strip". The skinner length at the jack end is listed. In this case it is a "slanting" skinner, meaning that the skimmers are of unequal length and that the edge of the cable form nearest the jacks is slanting. In other cases the edge of the form is parallel to the face of the jack strip, and the skimmers are of equal length in which case the specification would refer to straight skimmers. The length of the "multiple stripper" is listed to facilitate manufacture and the "overall" length is listed for billing purposes.

Cutting, Soldering and Testing Lists are provided for short multiple cable in a different form than above described, since several short multiple forms may be of the same dimensions from a cutting and forming standpoint but they must be soldered to jacks in a definite sequence for each job. The arrangement is shown in Figure 12 which illustrates the information for short multiple listed in Figure 10.

The "Kind of Runs", shown in Figure 12 lists the sequence for soldering purposes, that is, the "Inter to Mult" cable, 1 "Reg" (Regular Short Mult), 1 RSE (Regular Special End), Sgl Jack (Single Jack-skinners).

INTER TO MULT SUBS "B" BD T-12040-30 FIG.2 - UNIT #3 (135 CAS) CODE 6084						
CA	HD	JK	SL. SKIN AT BUTT	BUTT TO END	MULT STRIPPER	OVERALL
1	0	19	-5 1/2	34-11 S	1-4	36-3
2	0	39	-5 1/2	34-5 S	1-4	35-9
3	0	59	-5 1/2	33-9 S	1-4	35-1
4	0	79	-5 1/2	33-3 S	1-4	34-7
5	0	99	-5 1/2	32-7 S	1-4	33-11
6	1	19	-6 7/8	33-9 S	1-5	35-2

FIG. 11 - FORMED CABLE CUTTING LIST

CUTTING, SOLDERING AND TESTING LIST - BD GROWS RT TO LT							
INTER TO MULT AND SHT MULT SUBS "B" BD T-12040-30 FIG 2 (405 CAS)							
MONTROSE UNIT #3 - CODE 84-C - INSTALL SECTS 1 TO 3 INCL							
FORMS	KIND OF RUNS			NO.OF RUNS	REG	NO.S.M. SPL E	NO.OF J.S.
2571	INTER	1 REG, 1 RSE	SGL	20	20	20	60
2572		1 REG, 1 RSE		20	20	20	60
2573		1 REG, 1 RSE		20	20	20	60
2574		1 REG, 1 RSE		20	20	20	60
2575	TO	1 REG, 1 RSE		20	20	20	60
2576		1 REG, 1 RSE		20	20	20	60
2577		1 REG, 1 RSE		20	20	20	60
2577		1 REG, 1 RSE	JACK	15	15	15	45
				135	135	135	405
FORMS							
	2571	2572	2573	2574	2575	2576	2577
	5 1/8"	6 1/2"	7 7/8"	9 1/4"	10 5/8"	1'-0"	1'-1 3/8"
0							
20							
40	(0)	(1)	(2)	(3)	(4)	(5)	(6)
60							
80							

FIG. 12 - SHORT MULT. - CUTTING, SOLDERING & TESTING LIST

The Number of Short Multiple cables is listed divided between "Regular" and "Regular Special End." The latter term refers to the extra length skimmers which must be provided at the last jack to facilitate future extension of the multiple.

Under No. of J. S. is listed the number of jack strips to be soldered to the short multiple in the shop.

Under Forms in the lower part of Figure 12 are listed the skinner length of each form and the "Hundreds" in parentheses in their relative arrangement in the face of the board. This information is included in the specification to assist in soldering the short multiple to the proper jacks, with the proper "inter to mult" cable.

5. INSTALLING SPECIFICATION (-92)

The Installing Specification -92 is a master specification for the job. All specifications are listed as are notes applying to the whole job. Material of a miscellaneous character not as a rule belonging in any of the other specifications is also ordered, wire being one example. Miscellaneous wiring sometimes is called for in the -92 Specification.

6. -99 SPECIFICATION

The -99 Specification lists the circuit and schematic drawings called for in all of the specifications for the job. It is prepared as late as possible in the installation period so that the latest drawing issues will be listed. This specification is used as a check against the wire chief's drawings and where his issues are out of date, the latest issue is turned over to him together with any new circuits specified on the order.

7. JOB SPECIFICATION APPENDICES

Appendices are written to job specifications whenever it is necessary to add, remove or change any of the information or equipment specified in the specification. Appendices are classified in accordance with the following:

Class "A" - Due to changes made by the Telephone Company or Distributing House.

Class "B" - Due to errors in the Equipment Engineering Branch.

Class "D" - Due to requests from departments within the Manufacturing or Merchandise Branch not to correct engineering errors but to facilitate manufacturing or to permit use of stock or standard equipment.

Class "EA" - Due to the result of Bell Telephone Laboratories development work which is billable to the Telephone Company.

Class "EE" - Due to the result of Bell Telephone Laboratories work which is non-billable.

Class "M" - Issued to cover changes not covered by the foregoing classes.

8. EQUIPMENT CHANGE NOTICES (C.N.'s)

An Equipment Change Notice, commonly referred to as a "C.N.", coordinates all information required for making a change in the field after installation work has started. Detail information for doing the work is covered by appendices and drawing supplements

and these are listed on the change notice. In general change notices are issued when the same change affects more than one job and they are written principally for Bell Laboratories changes.

9. JOB DRAWING NUMBERING SYSTEM

The Numbering System provides a convenient method for identifying job drawings. Each office is assigned a permanent base number to which different dash (or suffix) numbers are assigned for different types of drawings. An "Office Record Drawing" with the dash number 000 is sometimes prepared which lists all of the active job drawings for a particular office, with their titles. In the example, T-2212-150, the base number is "2212" and the dash number is "150." Dash numbers have been assigned in accordance with the following list, the lowest number in a group usually being assigned first:

Dash Number	Drawing
1	Key Sheet
*00 to 99	Floor Plans
	*Assigned to correspond with the floor number
xxx1 or 2	Wiring List
	"xxx" indicates the job specification dash number which is followed by "1" or "2"
000	Office Drawing Record
110 to 112	Front Eqpt. - "A" Swbds.
113 to 115	" " - "B" Swbds.
116 to 118	" " - Toll Swbds.
119	" " - Trouble Desk
120 to 129	Front Eqpt. - Desks
130 to 139	" " - Swbds. & Desks
	as req.
140 to 148	M.D.F. or Comb. M. & I.D.F. Eqpt.
149	Mezzanine Platform
150 to 169	I.D.F., D.D.F. & T.D.F. Eqpt.
170 to 199	Relay Rack Eqpt.
200 to 209	Relay Rack (or Coil Rack) Eqpt.
210 & 211	Fuse Board Assem.
212 to 229	Fuse Board Eqpt.
230	Traffic Reg. Rack Eqpt.
231	Line Mess. Reg. Rack Eqpt.
232 to 237	Other Mess. Reg. Racks
238 to 289	Miscellaneous, include Framework and Equipment Sketches and Schematics
290 to 299	Job Cross-Connection (Toll only)
500 to 512	Power Chg., Dischg. & Service Ckts.
513 to 519	Power Ring, Tones, Sig. & Alarm Ckts.
520 to 531	Power Bd. Front Eqpt. & Stk. Lists
532 to 539	Power Bd. Rear Eqpt. & Elev.
540 to 545	Power Bd. Details
546 & 547	Miscellaneous (for Power)
548 & 549	Stock Lists (for Power)
550 to 553	Batt. Cont. or Fuse Panel Front & Rear Eqpt. & Stock Lists
554 & 555	Batt. Cont. or Fuse Panel Dets.
556 to 561	Batt. Distg. Fuse Panels
562	Batt. Distg. Fuse Panel Dets.
563 to 567	Conduit Plans
568 to 570	Conduit Pull Box

Dash Number	Drawing
571 to 576	Conn. Bus Bars for Stg. Batt. Stock List, Elev. Hangers & Ins. through Floor
577 to 579	Conn. Bus Bars for Stg. Batt. Dets.
580	Miscellaneous (for Power)
581 to 583	Power Cable & Bus Bar Supp.
584	Power Cable and Bus Bar Supp. Dets.
585	Power Beam Clamp Layout
586 & 587	Nbg. of Dup. Drive Mot. Sw. Boxes
588 & 589	Gas Eng. Guard Rails
590 & 591	Power Eng. Alt. Ckt.
592 to 595	Power Bd. Eng. Alt. Plans. & Stock List
596 to 598	Power Bd. Eng. Alt. Pan. Dets.
599	Miscellaneous (for Power)
600 to 619	Cabling & Cable Rack Plans
700 to 719	Slip Mult. Diag. Sold. Inf. & Ca. Forms
720 to 749	Miscellaneous (for Cabling)
750 to 769	Cable Racks
770 & 771	Rolling Ladders
795 to 799	Unassigned

The following drawings are individual to Panel or Step-by-Step offices as indicated.

PANEL ONLY

300 to 303	Line Find. or Line Sw. Eqpt.
304 to 307	Line Rel. Eqpt.
308 & 309	Dist. Send. Sel. or Subs. Link Eqpt.
310 & 311	Dist. Send. Sel. or Subs. Link Table of Connection
312 & 313	Spl. "A" Pos. Send. & Send. Sel. Eqpt.
314 & 315	"B" Send. and Link Ckt. Eqpt.
316 to 319	Subs. Sender Eqpt.
320 & 321	Local Sender Eqpt.
322 & 323	Inc. or Dial Zero Send. Eqpt.
324 & 325	Inc. Send. Sel. Eqpt.
326 to 339	Unassigned
340 & 341	Translator Eqpt.
342 to 345	Dist. Fr. Eqpt.
346 & 347	Spl. "A" Pos. Dist. Sel. Eqpt.
348 to 351	Office Fr. Eqpt.
352 to 359	Incoming Fr. Eqpt.
360 & 361	Final Fr. Eqpt.
362 & 363	Misc. Int. Fr. Eqpt.
364	Dist. Int. Fr. Eqpt.
365 to 393	Unassigned
394 to 396	Alarm Eqpt.
397 to 399	Miscellaneous
400 & 401	Dist. Sel. Test Fr. - Dist. Loc. & Part. Ckt. Chart
402 & 403	Final Sel. Test Fr. - Final Loc. & Part. Ckt. Chart
404 & 405	Dist. Sel. Test Fr. - Strapping & Conn. of Gr. Banks Chart
406 & 407	Stuck Conn. Find. Fr. - Conn. Loc. Chart
408 & 409	Subs. Link Cross - Conn. Chart
410	Final Sel. Test Fr. - Cross-Conn. Chart
411	District Fr. - Cross-Conn. Charts
412	Chart - Method of Wiring Dist. Timing Fr. & Des. Cards
413 to 419	Misc. Charts
420 to 429	Term. Strip Numbering

PANEL ONLY (Cont'd)

<u>Dash Number</u>	<u>Drawing</u>
430 to 459	Unassigned
460 to 462	Cabling Schematic Line Find. to Dist. & Dist. to Link
463 to 474	Misc. Cabling Schematics
475 & 476	Mtg. Plate Eqpt.
477 to 479	Des. Strip Numbering
480 to 499	Unassigned

STEP-BY-STEP ONLY

394 to 396	Office Alarm Fr. Eqpt.
400 to 417	Cross-Conn. Charts
418 to 420	Traffic Schematics
421 to 499	Selector Frame Eqpt.
800 to 812	Connector Frame Eqpt.
813 & 814	Repeater Frame Eqpt.
815 & 816	Pick Up Test Panel Eqpt.

Wherever it is practical to do so, equipment views are shown on wiring list drawings and separate equipment drawings are not made. This practice is followed for many of the Panel and Step-by-Step frames.

The letter "N", as in T-2212-110N, is shown in some cases after the dash number on job drawings. If an order is being engineered at the same time as a previous order is being installed, the installer's drawings must not be disturbed by the order being engineered. The "N" scheme is employed to avoid any confusion of this kind and also to retain the same drawing number for a particular equipment throughout the life of the office. The operation of the plan is explained as follows:

Suppose that T-2212-110 is the front equipment drawing for a job being installed. A subsequent order, being engineered, involves a change in this drawing. A Class "A" Supplement is issued to change the number to T-2212-110N, notifying the installer that his drawing thenceforth will be known by that number and a tracing or Vandyke is retained to permit further blueprints to be made. Another tracing with the original number, T-2212-110, is used for the order being engineered. The scheme also allows for changes to be made in the "N" drawing and for furnishing of prints as desired for the order being installed.

10. WIRING LIST DRAWINGS

The Job Wiring List Drawings show a record of the equipment as it is wired and equipped after the installation work has been completed. Notes required by the Telephone Company for maintaining the equipment are covered on this drawing.

All types of equipment in the exchange, for example each line of switchboard, frames of the same kind, desks, and similar groups of equipment, have their own wiring list drawing. Miscellaneous wiring for the office not confined to any particular switchboard or group of frames is covered on a separate wiring list drawing. As a general rule each job specification has its own wiring list drawing. For this reason the wiring list drawing number is made up of the specification dash number and another digit.

Figure 13 shows a typical wiring list drawing.

11. EQUIPMENT DRAWINGS

Job Equipment Drawings are prepared in one form or another for all of the equipment in the office. Usually each type of equipment has its own equipment drawing. They are prepared in detail for relay racks, fuse boards, distributing frames, switchboards, power, and for a number of frames and bays. Quite frequently, however, where equipment is ordered from standard specifications as is the case for many Dial Systems frames and Toll bays, the equipment drawing is made up in tabular or chart form and reference is made to views on standard drawings. Equipment drawings are not prepared as separate drawings for many of the Panel System frames; a combination Wiring List and Equipment drawing being used. This has the advantage of having the equipment view and wiring shown on the same drawing.

Figure 14 shows a typical relay rack equipment drawing.

The Equipment Drawing shows the location, code numbers, circuit numbering and functional designations of apparatus. Functional designations correspond with those shown on wiring diagrams, schematics and circuit descriptions. The drawing shows designations that are to be stamped on the equipment as well as other information or designations (usually in parenthesis) for wiring information only.

Location of Equipment tables are shown on frames and racks equipment drawings (See Figure 14). They cover, in the case of a relay rack, the bay and mounting plate location and the cable symbol for any equipment to be located on the relay rack. By knowing the cable symbol (obtainable from the Cabling Specification, described on page 16 in this pamphlet) and referring to the location of equipment table, the installer can readily determine where equipment should be placed on the relay rack. The table on other equipment drawings refers to vertical, shelf, bay and row locations for terminal strips and fuses.

12. FLOOR PLAN DRAWINGS

A Floor Plan Drawing is prepared for every floor except that in the case of large buildings it may cover only a wing or a portion of a floor. Definite locations are given for all frames, racks, switchboards, machines and other equipments occupying space on the floor. Equipments located on walls are shown on the drawing. Columns, pilasters and partitions are also shown and sometimes rest rooms, locker rooms and vestibules. Aisles and passageways between frames, racks and switchboards are shown as are cable holes, slots and sleeves.

Cross sections are shown to cover such details as the type of floor fill, thicknesses of floors, ceiling heights, and the location and size of beams and girders.

Reference lines are an important feature on the floor plan drawing. They are lines drawn between markers permanently placed in

the floor or walls. All equipments, cable holes, slots and the like are located from reference lines rather than from walls as any slight irregularities in the walls might change the relative locations of equipment to such an extent that shop-formed cables would be too long or short for the runs.

Figure 15 covers a typical floor plan drawing.

13. "KS" SPECIFICATIONS

"KS" Specifications are prepared by the Bell Telephone Laboratories and cover engineering requirements, manufacturing limits, etc., for apparatus or material that is manufactured by outside suppliers. In a few cases in recent years the Western Electric Company has undertaken the manufacture of articles specified in "KS" Specifications but for the most part this work is placed on outside manufacturers. Usually "KS" Specifications cover commercial types of apparatus or equipment required in central offices.

14. "D" SPECIFICATIONS

"D" Specifications cover manufacturing information for special apparatus for which the demand or general application is not sufficient for assignment of a standard code.

15. "96" ORDERS

A "96" Order is either an "Engineer, Furnish and Install" or an "Engineer and Furnish" order not requiring a job specification but which contains complete manufacturing and installing information and apparatus summary on the order sheets.

16. INSTALL ONLY ORDERS

On Install Only orders, the specifications and drawings are provided by the Telephone Company. Some or all of the drawings may be Telephone Company drawings although usually some Western Electric Company drawings are specified. The form of the specifications and drawings issued by the Telephone Company varies in different areas so that no detailed description can be furnished.

APPARATUS AND WIRING SHALL BE PLACED IN POSITION IN ACCORDANCE WITH THE FOLLOWING:-

LINE NO.	TYPE OF CIRCUIT	DRAWINGS		FIG.	CONDITIONAL		CIRCUIT NUMBERS		POSITION	NOTES	REMARKS
		SCHEMATIC	CIRCUIT		WIRING	WIRING	WIRING	WIRING			
1	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
2	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
3	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
4	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
5	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
6	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
7	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
8	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
9	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
10	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
11	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
12	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
13	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
14	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
15	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
16	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
17	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
18	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
19	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
20	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
21	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
22	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
23	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
24	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
25	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
26	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
27	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
28	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
29	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
30	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
31	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
32	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
33	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
34	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
35	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		
36	REL. CTR.	EX-1056-01	P.1056-01	1	1	1	1	1	1		

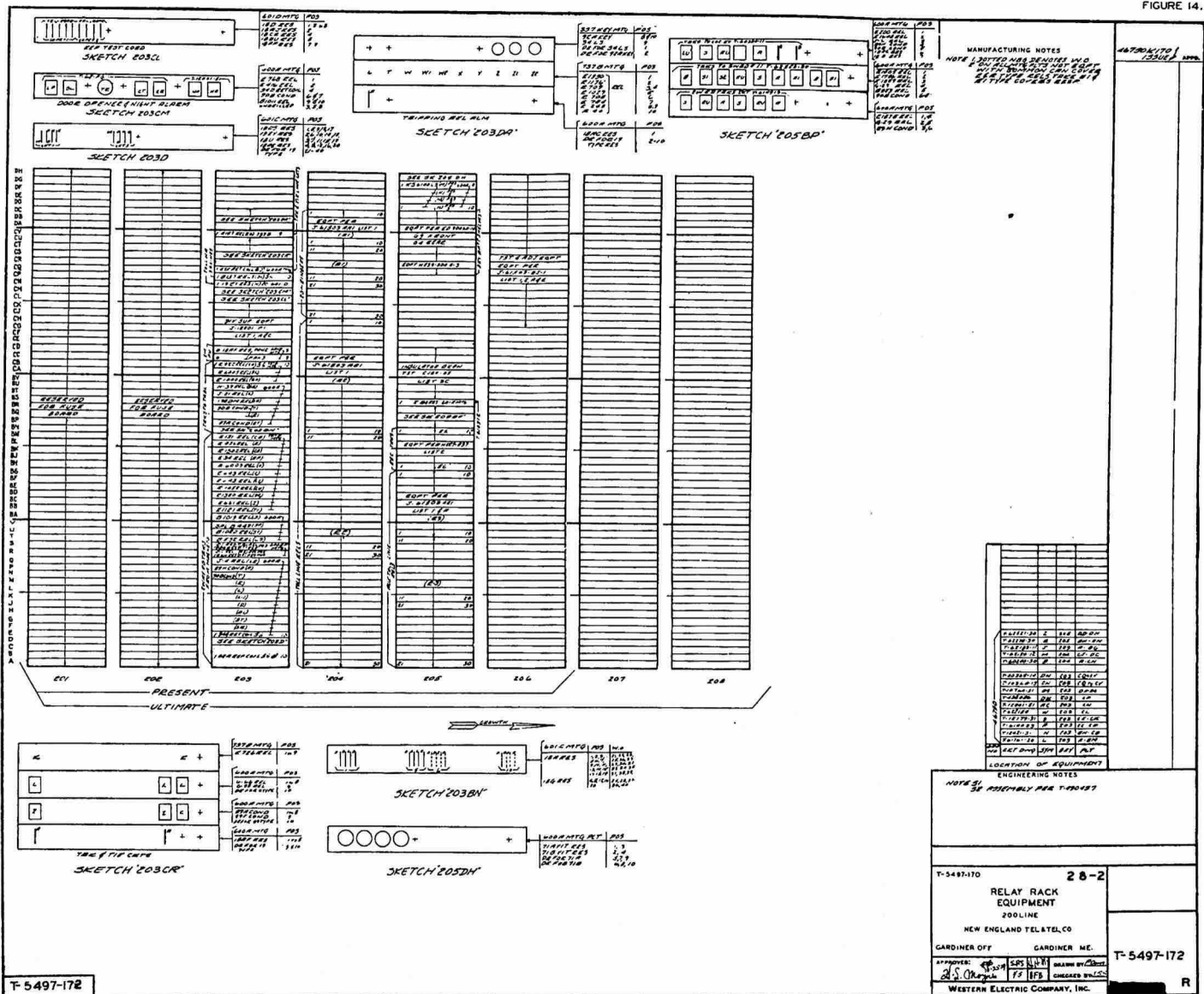


FIG. 14-JOB RELAY RACK EQUIPMENT
DRAWING

FIGURE 15



FIG.15-FLOOR PLAN DRAWING

7.04 ABBREVIATIONS

Abbreviation	Word or Term	Abbreviation	Word or Term
A		D (Cont'd)	
ADDL.	Additional	DIAM.	Diameter
ADJ.	Adjust	DIM.	Dimension
ADPT.	Adapter	DISC.	Discontinued
AL.	Aluminum	DISCHG.	Discharge
AM.	Ammeter	D.P.	Double Pole (Switch)
AMP.	Ampere, Amplifier	D.P.D.T.	Double Pole Double Throw (Switch)
AMT.	Amount	D.P.S.T.	Double Pole Single Throw (Switch)
ANN.	Announced, Announcement, Announcing	D.P.T.S.	Distributing Power Terminal Strip
APP.	Apparatus, Appendix	DR.	Drill, Decoder, Drum, Delayed Ringing
APPD.	Approved	DSC	Double Silk Single Cotton (Wire)
APPROX.	Approximate	D.S.C.L.	Double Silk Cotton Lacquered (Wire)
ARR.	Arranged, Arrangement, Arranging	D.T.	Double Throw (Switch), Dial Tone
ARM. TRVL.	Armature Travel	DWG.	Drawing
ASB.	Asbestos	E	
ASSEM.	Assembled or Assembly	E	Even, East, Enamelled
ASSOC.	Associated	EQPD.	Equipped
AUTO.	Automatic	EQPT.	Equipment
AUX.	Auxiliary	ESC.	Escutcheon
B		E.S.C.B.	Enamel Silk Cotton Braid (Wire)
B	Back, Braided, Brass	F	
BAT.	Battery	F	Fahrenheit, Finish, Flat, Front, Fuse
BD.	Board	F.A.	Fuse Alarm
BET.	Between	FAN.S.	Fanning Strip
BEV.	Bevel	FAST.	Fastener
B.F.P.	Battery Fuse Panel	F. BD.	Fuse Board
B.H.M.	Button Head Machine (Screw)	F.F.	File Finish
BK.	Bank	F.H.	Flat Head
B.P.	Binding Post	F.H.B.M.	Flat Head Brass Machine (Screw)
BRKT.	Bracket	F.H.I.W.	Flat Head Iron Wood (Screw)
B. & S.	Brown & Sharpe (Gauge)	FIG.	Figure
C		FIL. H.	Fillister Head (Screw)
C	Center, Centigrade, Cotton, Chamfered	FIN.	Finish
CA.	Center Line	FL.	Floor
CAB.	Cable or Cabling, Call Announcer, Cord Auxiliary	FLEX.	Flexible
CAT.	Cabinet	4 P.D.T.	Four Pole Double Throw (Switch)
CB.	Catalogue	4 P.S.T.	Four Pole Single Throw (Switch)
CB.	Coin Box, Common Battery, Counterbore	FR.	Frame, Flat Rate, Fundamental Ring
C.C.	Coin Collect	FRWK.	Framework
CD.	Cold Drawn, Cord, Counterdrill	FT.	Foot, Final Tens, Fundamental Tip
C.D.F.	Combined Distributing Frame	G	
CD. FAST.	Cord Fastener	GA.	Gauge
CD. HOOK	Cord Hook	GALV.	Galvanized, Galvanometer
C.E.M.F.	Counter Electromotive Force	G.F.	Grind Finish
CHAM.	Chamfered	GRD.	Ground, Grounded
CHG.	Charge, Charged, Charging	H	
CKT.	Circuit	HD.	Hard
CL.	Clearance, Clerk	HD. DR.	Hard Drawn (Copper)
C.M.	Circular Mils.	HD. RUB.	Hard Rubber
C.O.	Chief Operator, Cut Off,	HEX. H.I.CAP	Hexagon Head Iron Cap (Screw)
COM.	Commercial, Common	H.H.	Half Hard
COMP.	Compensator, Compound, Compromising	H.R.	Hot Rolled
COND.	Condenser	H.W.	Hand Wheel
CONDUCT.	Conductor	I	
CONN.	Connect, Connecting, Connector	I.D.F.	Intermediate Distributing Frame
CONT.	Contact, Continued	IN.	Inch, Input
CONT. PRES.	Contact Pressure	INCL.	Inclusive
COP.	Copper	IND.	Induction, Inductor
COP. PLT.	Copper Plate, Copper Plated	INS.	Insulator, Insulation, Insulating
C.R.	Cold Rolled	INT.	Interrupter
CS.	Countersink	IR.	Iron
C.T.S.	Cable Turning Section, Cut to Shoulder	ISS.	Issue
CX	Composite	J	
CXX	Composite Ringer	J	Jack, Joint
D		JCT.	Junction
D	Dial, Double (Serving), Drop	JK.	Jack
D. CONN.	Direct Connected	JK. SP.	Jack Space
D.C.L.	Double Cotton Lacquered	J.S.	Jack Strip
DECALC.	Decalcomania (Transfer)		
DESIG.	Designate, Designation		
DEV.	Developed		
DIAG.	Diagram		

<u>Abbreviation</u>	<u>Word or Term</u>
K	
KW. H.	Kilowatt Hours
L	
L	Lacquered
LAM.	Laminated
LB.	Pound
LEAD CA.	Lead Covered Cable
LG.	Long
LMP.	Lamp
L.S.	Lamp Socket, Low Speed
LTNG. ARR.	Lightning Arrester
M	
M	Meter, Molding
MA.	Milliammeter, Milliampere, Motor Stop Alarm
MACH.	Machine
MAH.	Mahogany
MAT.	Material
M.D.F.	Main Distributing Frame
MED.	Medium
MFG.	Manufacturing
MFR.	Manufacture, Manufacturer
MG.	Marginal, Motor Generator
MIXT.	Mixture
M.R.	Machine Ringing, Message Rate, Message Register
M. SCR.	Machine Screw
M.R.I.	Message Rate Individual
M.R.P.	Message Rate Party
MTD.	Mounted
MTG. PLT.	Mounting Plate
MULT.	Multiple
N	
N.A.	Night Alarm
N.E.C.	National Electric Code
NON. IND.	Non-Inductive
NOR. IR.	Norway Iron
N. PLT.	Nickel Plate
N.R.	Non-Reactive
O	
O	Odd
O.D.	Outside Diameter
O.G.T.	Outgoing Trunk
O.H.	Oval Head
O.H.B.M.	Oval Head Brass Machine (Screw)
OX.	Oxide
OZ.	Ounces
P	
PAN.	Panel
PAR.	Parallel
PAT.	Patent, Patented
PCHG.	Punching
P.D.	Pitch Diameter
PLAT.	Platinum
POL.	Polish, Polar, Polarized
POS.	Position
PREC.	Preceding
PRI.	Primary
PROV.	Provisional
R	
R	Radius, Rear, Return, Ring
READJ.	Readjust
RECP.	Receptacle
RECT.	Rectangular, Rectifier
REF.	Reference
REL.	Relay
REQ.	Required, Requisition
RES.	Resistance
RET.	Retardation
REV.	Revolution, Reversing
R.G.F.	Rough Grind Finish

<u>Word or Term</u>	<u>Word or Term</u>
R (Cont'd)	
R.H.	Round Head
R.H.I.M.	Round Head Iron Machine (Screw)
RHEO.	Rheostat
ROT.	Rotate, Rotating, Rotary
R.P.M.	Revolutions per Minute
R.R.	Relay Rack
RUB.	Rubber
S	
S	Silk, Sleeve, South
S. BOLT	Stove Bolt
S.C.	Slightly Chamfered, Single Silk Single Cotton (Wire)
SCR.	Screw
SDC	Single Silk Double Cotton (Wire)
SECT.	Section
SEG.	Segment
SEL.	Selector
SEP.	Separate
SEQ.	Sequence
SER.	Series
SH.	Sheet, Shunt
SIG.	Signal
SK.	Sketch, Skinned, Soak
SL.	Slate, Sending Leg
SPEC.	Specification, Specified
S.P.	Single Pole (Switch)
S.P.D.T.	Single Pole Double Throw (Switch)
S.P.S.T.	Single Pole Single Throw (Switch)
SPR. COMB.	Spring Combination
SQ.	Square
S.R.	Slightly Round, Supervisor, Supervisory
S.T.	Single Throw (Switch), Start
STD.	Standard
S.T. SCR.	Self Tapping Screw
SUCC.	Succeeding
SW.	Switch, Switching
SX.	Simplex
T	
T	Tinned
T.D.F.	Trunk Distributing Frame
TEL.	Telephone
TELEG.	Telegraph
TERM.	Terminal, Terminating
THD.	Thread
3 P.D.T.	Three Pole Double Throw (Switch)
3 P.S.T.	Three Pole Single Throw (Switch)
TRANS.	Transformer
TRNS.	Transfer
T.S.	Terminal Strip
TST.	Test
TTY.	Teletypewriter
T.W.	Tight Wrapped
TWX	Teletypewriter Exchange
U	
U	Shielded Wire
ULT.	Ultimate
U.S. STD.	United States Standard
V	
VAR.	Varistor
V.S.C.	Very Slight Chamfer
W	
W	West, Weld, Wood
WD.	Wound
WDG.	Winding
WT.	Weight
Z	
ZN.	Zinc

7.05 GLOSSARY OF TERMS USED IN CONNECTION WITH EQUIPMENT SPECIFICATIONS AND DRAWINGS

APPENDIX - Supplementary information to a job or standard specification which changes the original information.

BLUE LINE PRINT - A white print with blue lines made from a van-dyke.

BLUEPRINT - A blue print with white lines made from a tracing.

BULK CABLE - Lengths of switchboard cable which are shipped from the factory unformed.

CARD CATALOGUE - Cards furnishing a description of coded apparatus. Issued by the Bell Telephone Laboratories.

C.C. - Abbreviation for "Customer's Change".

C.D. - Abbreviation for "Circuit Description".

CHANGE NOTICE - A paper issued by the Equipment Department to the installation field for the purpose of coordinating all information required for making changes which affect several jobs in the process of installation.

CIRCUIT DESCRIPTION - A description of the operation of a particular circuit, which also provides a record of the circuit changes issued by the Bell Telephone Laboratories.

CIRCUIT REQUIREMENT TABLE - That part of a Bell Telephone Laboratories circuit drawing which contains the current flow adjustments required for the maintenance of a circuit.

CLASS NON-X MATERIAL - A designation used for items of equipment which are not assembled as parts of other units by the shop.

CLASS X MATERIAL - A designation used for items of equipment which are assembled as parts of other units by the shop.

C.N. - An abbreviation for equipment change notice.

CUSTOMER'S CHANGE - A term used when referring to a change which the Telephone Company requests in one of its job orders.

DRAWINGS

LETTER PREFIX USED IN DESIGNATING GENERAL GROUPS OF DRAWINGS

"A" DRAWING - A series of drawings covering standard switchboard equipment. Replaced by the "ED" series for new drawings.

"ED" DRAWING - A series of standard drawings covering all types of switchboard framework and equipment.

"H" DRAWING - A series of standard drawings covering all types of switchboard framework and equipment and modification drawings. Replaced by the "ED" series for drawings made from Bell Telephone Laboratories drawings.

"ITD" DRAWING - Drawings covering manufacturing information for installer's test sets.

"J" DRAWING - Specifications for standard units of equipment prepared in drawing form.

"LCT" DRAWING - Job local cable design drawings.

"M" DRAWING - Drawings covering standard moldings used on switchboards and desks. This drawing series is obsolete. Being replaced by "P" drawings.

"P" DRAWING - Drawings for switchboard piece parts. They may show either a single piece or several pieces assembled and carried in stock as one part.

"SD" DRAWING - Bell Telephone Laboratories circuit drawings

"T" DRAWING - A series covering all circuit drawings and job drawings.

"WRT" DRAWING - Drawings covering a list of wires with their terminating points, grouped by size and color. They are used by the shop in the making of local cables.

TYPES OF DRAWINGS

ASSEMBLY DRAWING - A drawing covering the design of framework units and includes a stocklist of all parts required for assembly. (ED Series)

CIRCUIT SCHEMATIC - A circuit drawing prepared in one of its simplest forms to facilitate tracing its operation. (SD Series)

DETAIL DRAWING - Drawings showing manufacturing information for individual parts of a framework assembly.

JOB DRAWING - Drawings showing equipment arrangements for a specific central office. (T Series)

LOCAL CABLE DESIGN DRAWING - Same as "LCT" drawing.

PIECE PART DRAWING - Drawings showing manufacturing information for individual parts of an equipment assembly where the part is used in sufficient quantities to justify stocking, as well as the preparation of permanent tools. (P Series)

SPECIFICATION DRAWING - Same as "J" drawing.

WIRING DIAGRAM DRAWING - A circuit drawing which shows the colors, size, and terminating points of leads and shows the associated apparatus in such conventional form as to facilitate soldering and wiring. (T Series)

WIRING LIST DRAWING - A job drawing listing the circuits specified for a particular central office. (T Series)

WIRING RECORD DRAWING - Same as "WRT" drawing.

FORMED CABLE - Switchboard cable which is stripped, butted, formed and sewed in the shop.

FUSE BOARD RECORD SHEETS - Sheets showing the fuse assignments on double row fuse panels.

GENERAL ENGINEERING CIRCULAR - A numbered series of papers abbreviated "GEC" formerly issued by the A. T. & T. Company on engineering matters. Replaced by "Plant Engineering Circulars" and "Plant Engineering Letters".

LOCAL CABLE - A cable which is made by hand and used for interconnecting apparatus in a shop wired unit of equipment.

PLANT ENGINEERING CIRCULAR - A numbered series of papers, abbreviated "PEC", issued to the operating companies by the A. T. & T. Company, covering engineering matters of major importance.

PLANT ENGINEERING LETTER - A numbered series of papers, abbreviated "PEL", issued to the operating companies by the A. T. & T. Company, covering engineering matters of minor importance or of a less permanent nature.

REPRODUCED TRACING - A reproduction of a tracing made on tracing cloth by photographic processes and is suitable for use as a duplicate of the original.

SCHEMATIC - See "Circuit Schematic".

SPECIFICATIONS

D-SPECIFICATION - Specification issued for the purpose of furnishing manufacturing information on special apparatus which is designed to care for conditions which cannot be met by existing standard apparatus.

ITE SPECIFICATIONS - Specifications covering the manufacture of installer's test sets.

JOB SPECIFICATION - Specifications covering manufacturing and installing information for a specific central office.

KS SPECIFICATION - Specifications issued by the Bell Telephone Laboratories covering engineering requirements for material manufactured by outside suppliers.

STANDARD EQUIPMENT SPECIFICATION - Specifications covering information for the manufacture of standard units of equipment commonly known as J-specifications.

SUMMARY OF APPARATUS - That part of a job specification which lists the apparatus and equipment.

SUPPLEMENT - Papers issued by the equipment engineer which cover information to the Drafting Department for making changes on drawings. Supplements designated class "A" or "B" authorize the shop and field to make changes on equipment in process of manufacture of installation.

SWITCHBOARD CABLE - A number of insulated wires made up into a cable by machine and covered with a braided textile covering.

TEMPORARY INFORMATION MEMORANDUM - A paper issued as an authorization for a limited time permitting the shop or installer to deviate from standard requirements in the manufacturing or installing of equipment.

TERMINAL ASSIGNMENT LIST (Formerly called Power Punching List) - An assignment list for associating numbered punchings on a power terminal strip with those leads on a circuit drawing which are shown terminating at power punchings and which have designations which cannot be stamped on the terminal strip so as to be legible for maintenance purposes.

T.I.M. - An abbreviation for "Temporary Information Memorandum".

TRAFFIC CIRCULAR - A numbered series of papers, abbreviated "TC", issued to the operating companies by the A. T. & T. Company, covering traffic matters of major importance.

TRAFFIC LETTER - A numbered series of papers issued to the operating companies by the A. T. & T. Company, covering traffic matters of minor importance or of less permanent nature.

VAN-DYKE - A transparent print of a tracing from which blue line prints are made.

SECTION 8

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8.0 TRUNKING

8.01 GENERAL DESCRIPTION

In Section 6 it was shown how a telephone connection is built up by joining, in progressive order, the several switches composing the dial train through the medium of trunks.

The word "trunk" carries with it the thought of being used in common by a number of people, as opposed to a customer's line, for example, which is for individual use.

This common use implies that enough trunks between any two switching points, such as First Selectors to Second Selectors, should be provided to meet the maximum number of simultaneous calls in that trunk group; otherwise too many delays, or "busies", would be encountered by our customers which would be poor service.

The maximum number of simultaneous calls in a particular trunk group is dependent upon the customers having access to the group and hence is subject to much fluctuation. In large groups of customers' lines these fluctuations are less abrupt than in small groups, therefore the larger the groups the more accurately one can predict the maximum number of simultaneous calls that will originate therein, and therefore the more accurately determine the number of trunks that will be required.

The idea then is to group the lines so that the trunk groups serving them will be large, in order that the latter may be worked to the greatest efficiency. The size of these groups are, however, limited by the number of trunks to which each group has access. For example, a line switch is limited to 10 trunks; therefore, the number of lines using those ten trunks in common must be such that the calls originating there-in will be within the capacity of those trunks to handle.

If, in any office, these groups are made up of say 50 lines each, no matter how carefully arranged as to calling rate and holding time, it is possible, that at times, some trunk groups will be overtaxed and others will be working much below their full capacity.

For this reason, we would never have as many first selectors in use at the same time as there are trunks from the primary line switches. This condition, is taken advantage of by interposing secondary line switches and the first selectors, as shown later on, and thus reducing the number of first selectors to the actual number which will probably be required under peak loads.

With this arrangement there may be as many as twenty-five trunks from different primary line switch groups to any one secondary subgroup out of which there are only ten trunks to first selectors. It does not reduce the number of trunks out of primary line switch groups but it does result in a more efficient use of the trunks to first selectors and the switches on which they terminate.

This higher efficiency is obtained in a simpler manner by the use of the line finder which permits subscriber line groups up to two hundred lines,

with trunk groups as large as thirty if required. Each line finder is a part of a trunk going direct to a first selector, the lines being multiplied to the line finder banks which have a capacity of two hundred lines. Therefore the number of trunks required to handle efficiently the traffic originating in any line finder group may be provided quite accurately.

In the earlier installations, the trunk groups from the secondary line switches to first selectors, first selectors to second selectors, second to third, etc. and from the last selectors to connectors are limited to ten trunks each, that is, to the number of terminals on each level, but the load on any such ten-trunk group may be adjusted by variation in the number of switches having access thereto so as to attain a fair degree of efficiency. In later installations, trunk groups between selectors have been increased to as many as forty-five trunks by the utilization of distributing type terminal assemblies and graded multiples.

It is evident that necessary changes in the number of the subscribers connected to any office and the amount of calls originated by them will cause frequent changes in the assignment and loading of lines to the various groups of line switches or line finders.

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

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

In a Step-by-Step office, there are usually either two or three types of Distributing Frames used, that is, there is the Main Frame, Line Intermediate Distributing Frame and a Trunk Distributing Frame. Quite often these are eliminated by the provision of a Combination Line and Trunk Distributing Frame. This is particularly true in the smaller offices. See Paragraph 5.03.

The principal use of each of these various type frames was covered previously in Section 5. Figure 1 shows the route of a local call (from an Individual flat rate station) through the distributing frames and succeeding equipment, using either line switch or line finder equipment. With this arrangement the telephone numbers appear on the H.M.D.F. as was usually done prior to the early thirties; after which, and in accordance with current new installations, the line circuits are terminated on the H.M.D.F. Where two and four-party lines are involved, grouping of telephone numbers to the line circuit is necessary. Figure 2 shows how 2-party lines are grouped at the V.L.I.D.F. and Figure 3 shows the grouping for 4-party lines by the utilization of 4-party bunching blocks.

There are at present two methods of connecting a subscriber's line with a first selector which is

necessary before dialing can begin. The first is the Line Switch system which is in use in the older type offices and the other is the Line Finder method which has superseded the former on account of its greater efficiency and simplicity of trunking. The lines using line switches terminate at boards that have a capacity of 100 lines each but those using line finder equipment terminate in 200 line groups. The trunking arrangement of the Line Switches will first be described and afterwards that of the Line Finder.

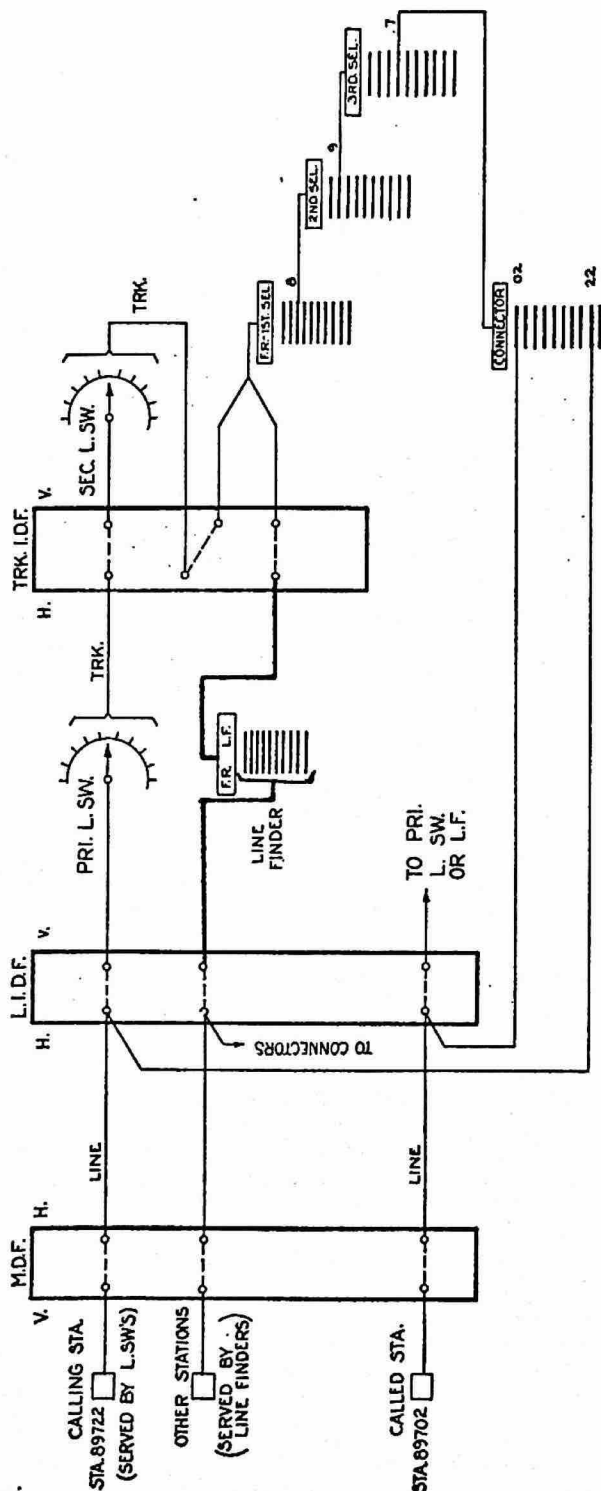
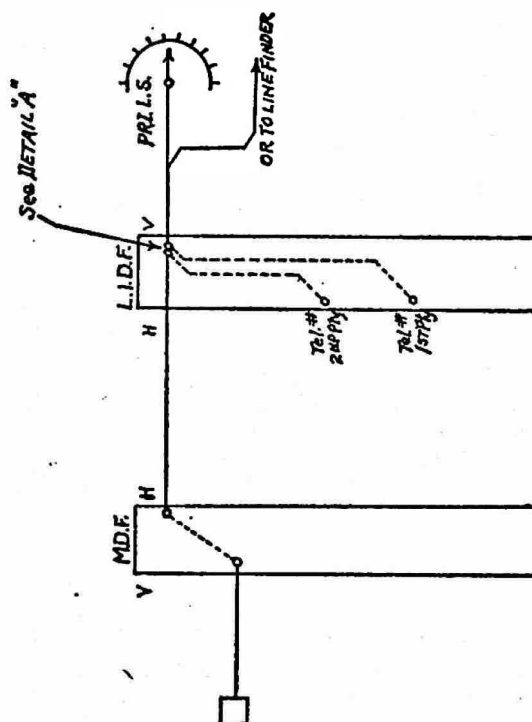
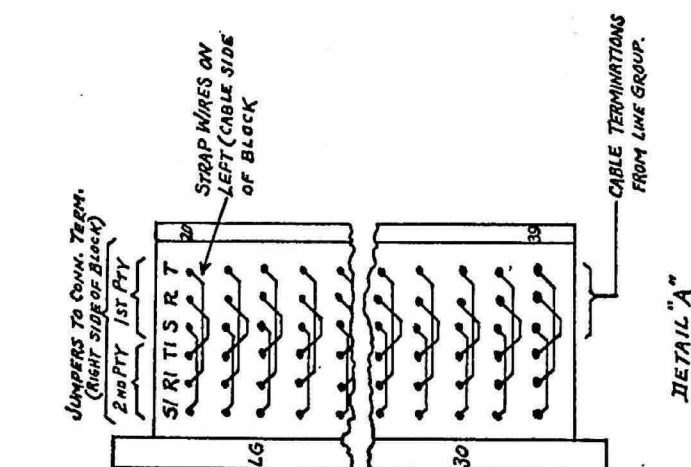


FIG. 1
ROUTE THRU CENTRAL OFFICE OF A LOCAL CALL
BETWEEN FLAT RATE STATIONS



SKETCH SHOWING HOW TWO-PARTY LINES ARE
GROUPED ON LINE TERMINAL BLOCK AT THE L.I.D.F.

Figure 2

The number of trunks required for every trunk group in an office is determined by the Traffic Engineer when the office is being engineered initially and when subsequent equipment additions are made to existing offices. In this Section, therefore, the method of determining the number of trunks required in each group will not be considered, but rather the physical or actual wiring of one group of switches to the various groups of switches by that group.

Dial systems may be considered as a series of trunks and switches or selectors arranged to give prompt and dependable service with an adequate but not excessive amount of equipment. These groups of trunks or paths may be relatively small

and of limited flexibility which makes an even distribution of the calls throughout the System essential to good service. When it is realized that upwards of 90 per cent of the traffic in a dial office passes through the equipment without the assistance of an operator, it is apparent that the provision of adequate paths for this traffic is one of the major responsibilities of the Traffic Department.

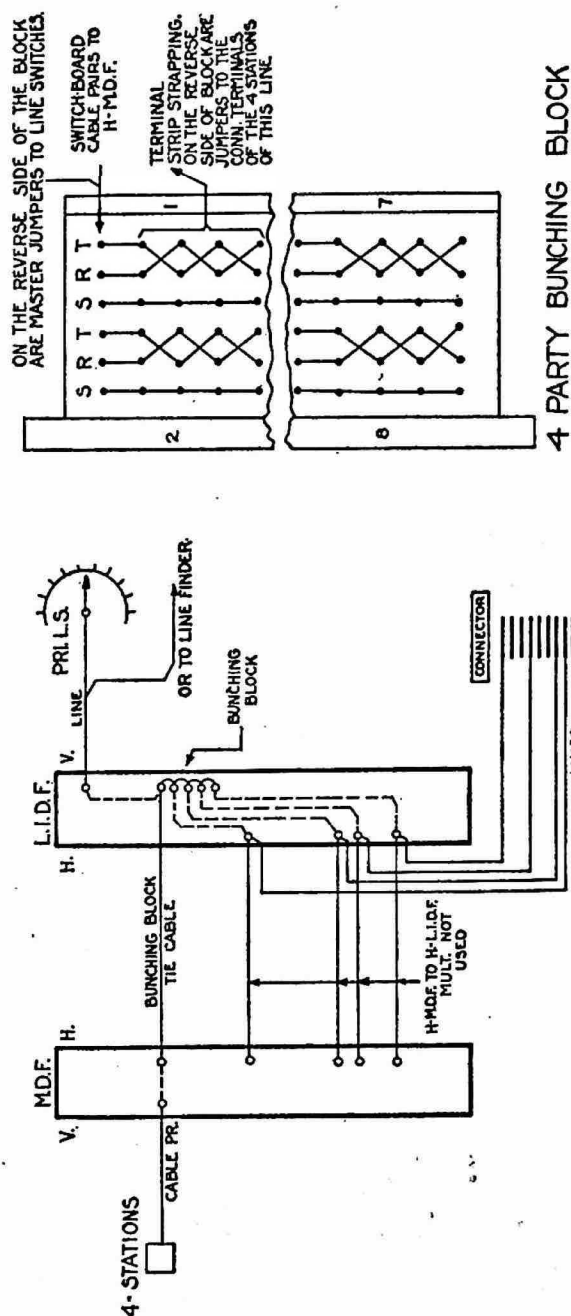


Figure 3

The dial equipment has been engineered to handle the estimated traffic offered without undue paths busy. The estimates of the engineers are based on data which generally are one or more years old when an office is cut over; and to protect service, provision is made in the equipment for possible changes in conditions. In order to properly administer a dial office, the traffic superintendent and his assistants need detailed knowledge of

equipment and trunk layouts as a basis of intelligent direction of the assignment of subscribers' lines in his offices and for ensuring at all times the loading of each trunk group with its proper proportion of traffic.

8.02 LINE SWITCH TRUNKING

The number of trunks that should be provided out of the primary line switches in any office depends primarily upon how many calls will be made from all the telephones involved during the hour of greatest use and how long each conversation will last. For any individual telephone or any one call such predictions are impossible; but it is possible to determine from records of traffic handled on similar telephones elsewhere made from time to time on days of normal activity about what the average use would be. These records are reduced to "calling rate" and "holding time", meaning that, should each telephone in the office under consideration make the number of calls indicated by the "calling rate" during a certain hour, the product of that calling rate times the number of telephones would represent the number of originating calls to be handled at this particular office during the "busy hour" of a normal day.

The "holding time" represents the average duration of each call. The longer the holding time, the larger will be the number of trunks required.

This calling rate and holding time are for the office as a whole and while they may be used to determine the number of first selectors required we will have to provide a larger number of trunks out of the line switches; because, as previously indicated, these trunks have to be arranged in groups of not more than ten each and the amount of traffic that can be handled over these small groups is considerably less per trunk than could be handled over the same number of trunks arranged in one large group.

Experience has shown that the number of first selectors required is usually somewhere around 8 to 10 percent of the number of the lines which they serve; while the number of trunks out of the primary line switches is usually about 20 per cent.

In a specific case of 1,000 lines, for example, we might require 200 trunks out of the primary line switches but need only 90 first selectors.

If we took these trunks direct to first selectors we would have to use 110 more first selectors than the traffic requires; but we may terminate these 200 trunks from the primary line switches on 200 secondary line switches, arranged in nine groups out of which 90 trunks would go direct to the 90 first selectors.

In such cases interposing the secondary line switches in between the primary line switches and the first selectors results in very considerable savings as the cost of the secondary line switches is much less than the cost of the excess of first selectors which this use of the secondaries does away with.

Figure 4 shows how a group of 50 lines is arranged in order that any one of the 50 may reach any one of the 10 selector trunks. It was shown above, however, that this is an uneconomical arrangement. Figure 5 shows the preferable arrangement with secondary line switches in groups of 25, each group having 10 trunks to selectors so that routing the ten primary line switch trunks to ten different secondary groups will enable each of the stations on the original 50 lines to have access to 100 selectors.

In order to make this trunking scheme more easily understood let us take for example, a group of 1,250 lines divided into 25 primary line switch groups; the ten outgoing trunks of each being cabled direct to individual sets of 10 selectors, thus making a total of 250 selectors.

In this case, each group's busy hour would probably be at a different time, and though the traffic through each group might give a full load to its ten trunks, the combined busy hour traffic through the 25 groups would not be apt to give a full load to the 250 selectors if arranged as a single unit.

Figure 6 illustrates how the trunks from the 25 groups might be arranged. The resultant gain in efficiency by using this method permits the satisfactory handling of the same amount of traffic over 100 trunks from secondary line switches to selectors. It should be noted that in order to distribute the originating calls as uniformly as possible over the entire group of selectors, the trunks from each secondary group are connected to selectors located on different parts of the selector bay. This method of using secondary line switches is also used for keeping at a minimum the number of inter-office trunks. In such cases Out Trunk Line Switches are placed between the selectors and repeaters as shown in Figure 7.

The foregoing description is just one example of how the primary and secondary line switch trunking might be arranged. Every office has its own individual traffic problems and the number and size of the trunking groups have to be taken care of accordingly.

8.03 LINE FINDER TRUNKING

When Line Finder equipment is used, groups of 200 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. With line finder type trunking there is always a first selector for each line finder. In most cases the line finders are cross-connected to the first selectors by means of jumper wire at the trunk distributing frame. In smaller offices this jumper arrangement is performed at the C.D.F. Wherever and as much as possible, the line finder assignments of any one line finder unit are "scrambled" over all selector shelves. That is, if any office were equipped with 20 first selector 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, too, guards against possible equipment trouble that might result in the failure of an entire selector shelf, such as a "blown" fuse.

There are at present three 200 line 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 calling rate of its associated lines. Small units are also available as required. These are the 100 line and 10 line finder capacity units and are usually installed in the smaller offices to care for as a particular class of service such as coin box or message rate service where the call capacity is not expected to exceed that of 10 line finders in the ultimate period. Units of 50 lines and 8 line finder capacity were also available at one time. 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.

All of the subscriber 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 subscriber to be connected to an idle selector and to 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 10 sub-groups (each consisting of 20 lines) each have a different first choice finder. The two first choice finders are usually referred to as the "home" finders. Figure 15 in Section 5, Paragraph 5.07, shows the "slip" arrangement in the banks. Thus, as explained previously, if a subscriber's line is assigned to either of 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 #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 be 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 10 sub-groups as the unit is being loaded. A table showing sequence of choice of line finders for calls from any line in the group is shown in Figure 16 of Section 5.

As mentioned above, 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:

1-11, 16, 14, 19, 12, 17, 13, 18, 15 and 20

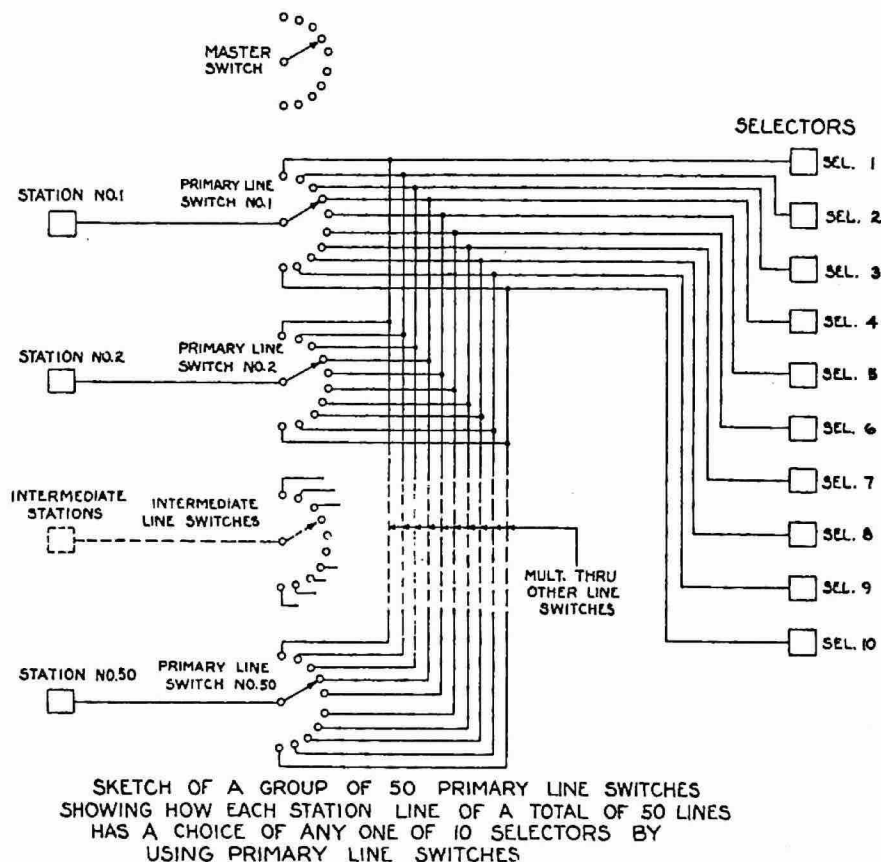


FIGURE 4

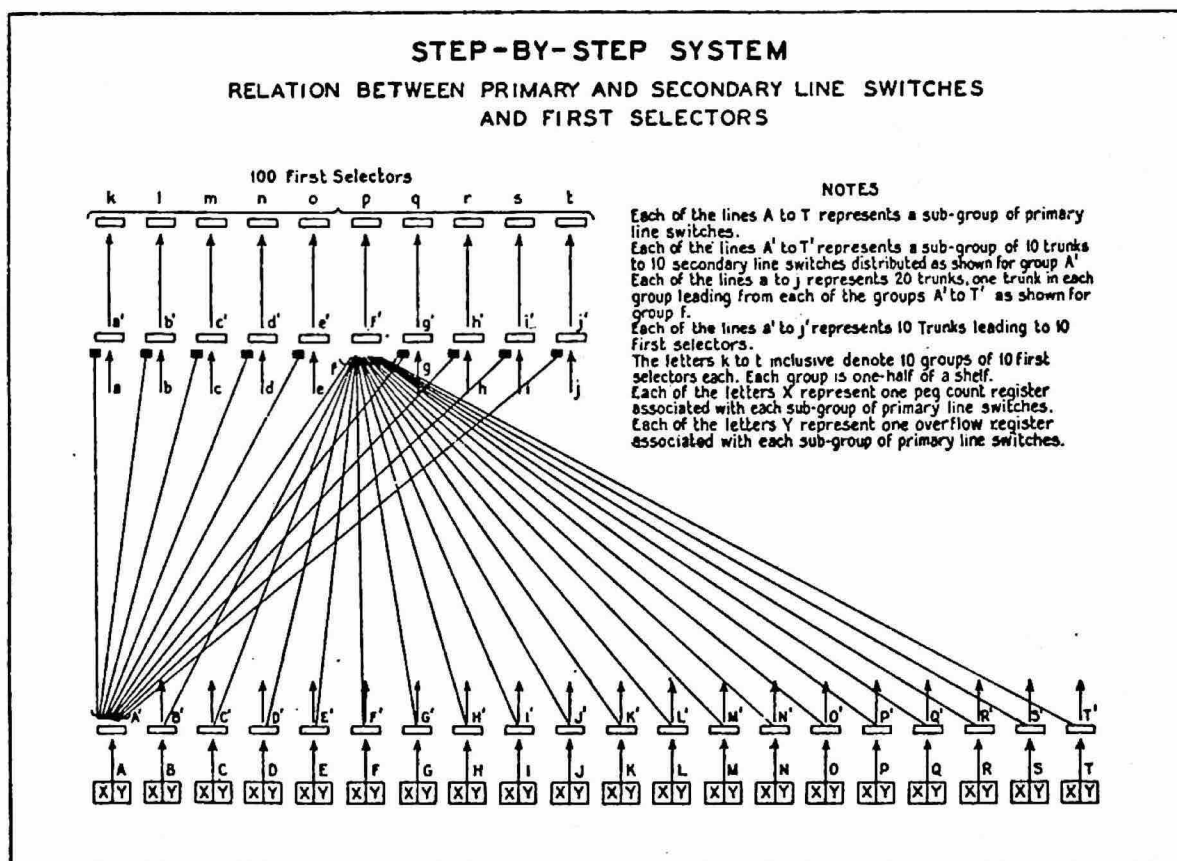
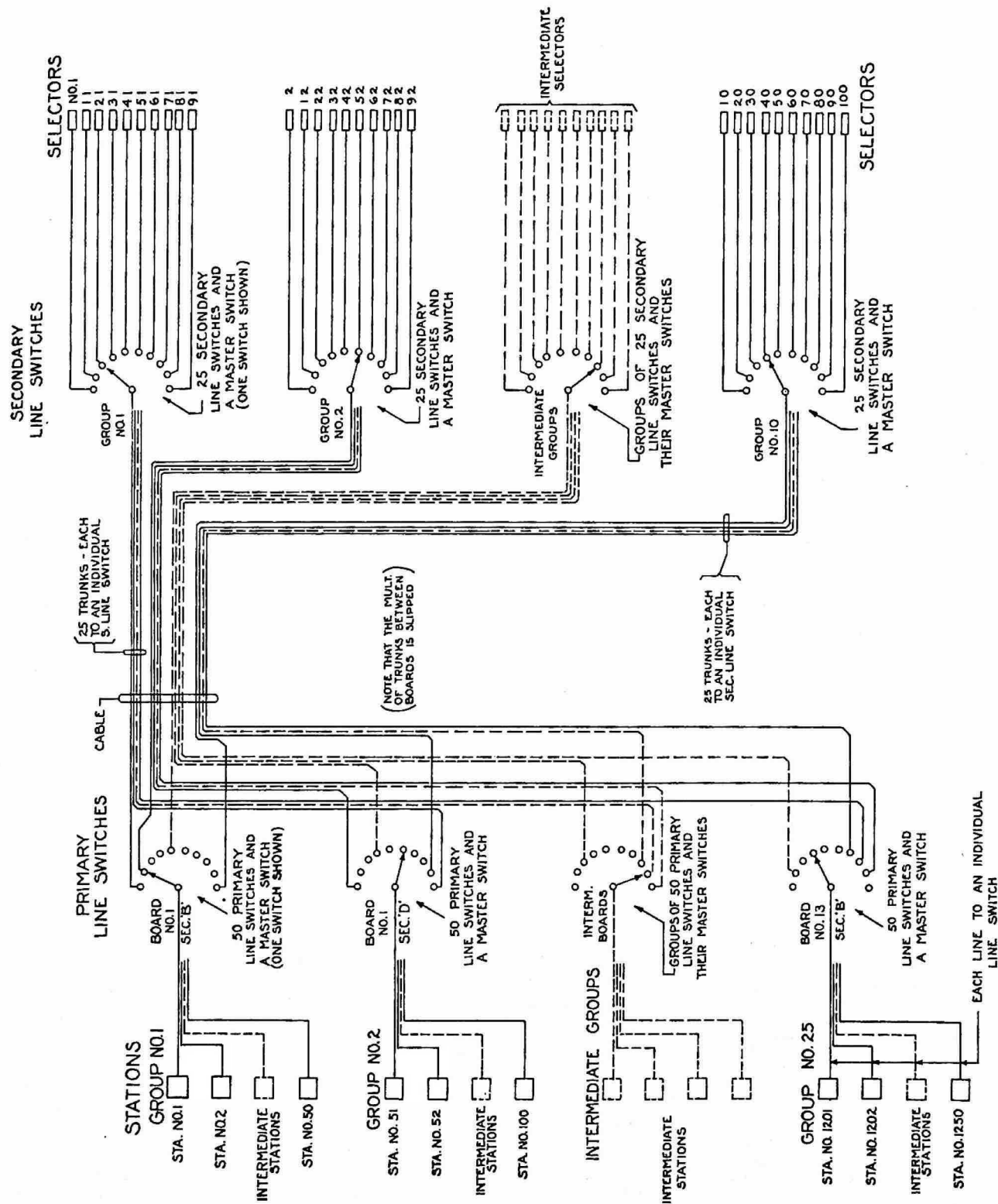


Figure 5



SKETCH OF A TYPICAL LAYOUT SHOWING HOW EACH STATION LINE OF A TOTAL OF 1250 LINES HAS A CHOICE OF 100 SELECTORS BY USING BOTH PRIMARY AND SECONDARY LINE SWITCHES

Figure 6

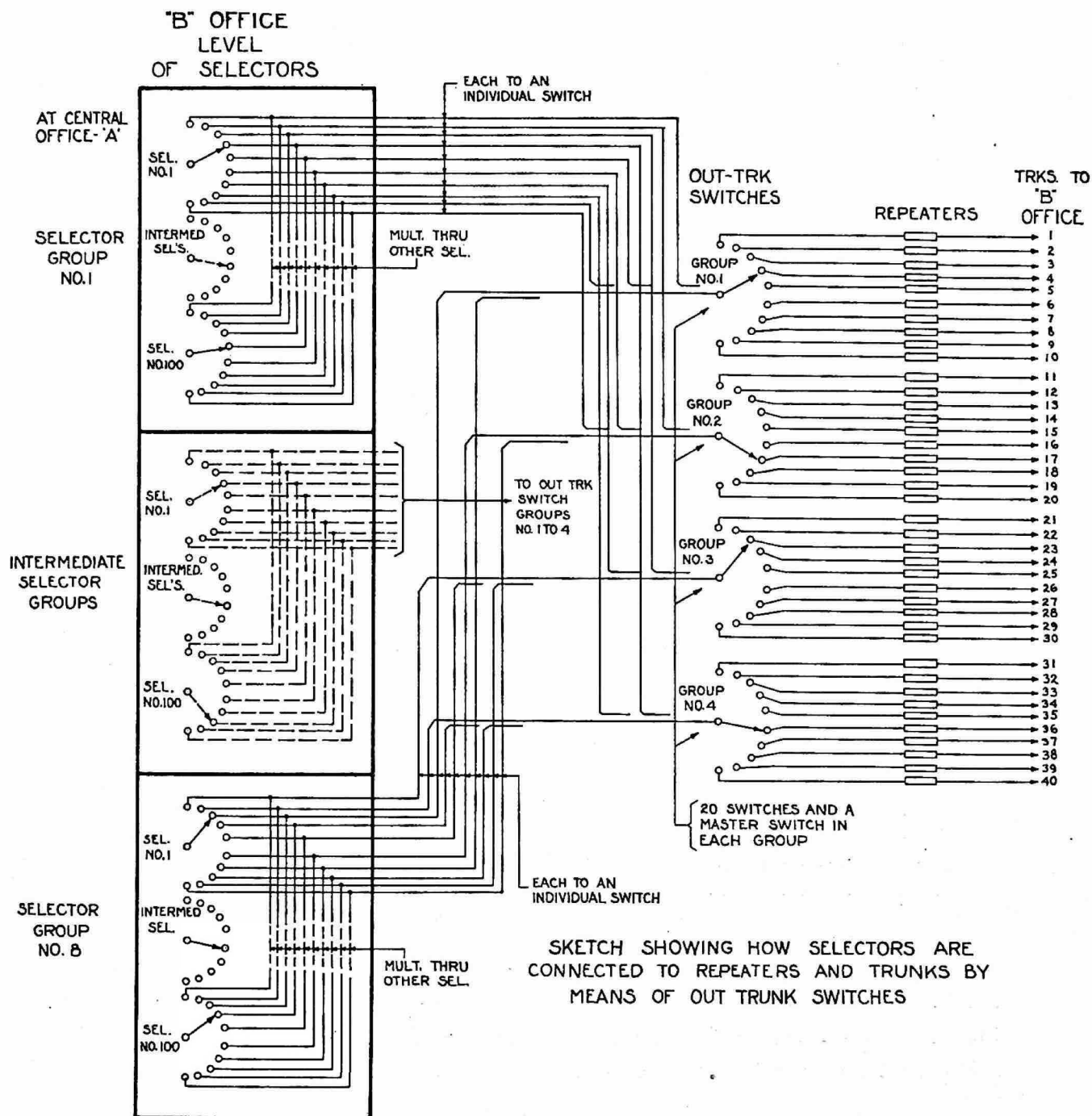


Figure 7

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 and 11-1.

Just as line finders are installed, or removed in a certain prescribed pattern, the subscriber line circuits are installed in a prescribed pattern (in groups of 10 lines) as follows:

To install read down, to remove read up:

200 Point*	100 Point**
01-00	01-00
11-19	11-19
21-20	21-20
31-30	31-30
41-40	41-40
51-50	51-50
61-60	61-60
71-70	71-70
81-80	81-80
91-90	91-90
101-100	
111-119	
121-120	
131-130	
141-140	
151-150	*Test Lines 10 and 100
161-160	**Test Line 10
171-170	
181-180	
191-190	

As a matter of interest, the order of installation of line finders in other than 20 L.F. Capacity Units is:

30 L.F. Cap. Unit: 1-21, 26, 24, 29, 22, 27, 23, 28, 25 and 30.

16 L.F. Cap. Unit: 1-11, 16, 12, 15, 13 and 14.

10 L.F. Cap. Unit: 1, 6, 4, 9, 2, 7, 3, 8, 5 and 10.

For removal the order is just the reverse for each unit.

Complete familiarity with this detail will be very beneficial to the Assistant District Traffic Superintendents in charge of the equipment, for job and equipment checking and too, it will be very beneficial to Traffic Assigning Clerks in the administration of their work.

Calls from measured 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 subscribers 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 measured rate service and still another group will be used for the pre-pay coin box service. Figure 8 shows the routing of the various classes of calls through a typical step-by-step office. Similar information for a particular office will be found on the office "-420" drawing.

8.04 SELECTOR SWITCH TRUNKING

Heretofore we have discussed only the means whereby our customers are connected to the apparatus which permits them to start dialing. It is at this point—the selectors—that the routing of an originating call actually begins.

It would be well at this time to get an idea as to how the selector switches, multiple bank, terminal assemblies, etc. are arranged and placed on the selector frames.

As we have already studied in Section 5, there are two types of selectors 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, and, too, a miniature power board.

The high type selector frame—which supersedes all previous kinds—also consists of two bays, but the bays are erected inline, with a distributing type terminal assembly between them. Each bay contains 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, thus the older type power board is eliminated. Figure 9 shows the floor plan arrangement of both types of boards.

8.05 SELECTOR FRAME TERMINAL ASSEMBLIES

There are two types of selector terminal assemblies, the older, known as the **Flat Type**, uses terminal strips similar to those used with line switches and the other is the **Distributing Terminal** assembly which uses 100-A type terminal strips. Some of the more recently installed low type selector frames have the latter type of assembly, but for the purpose of this description we will assume that the low type board uses the flat type strips and the high type board the 100-A terminal strips.

Selector banks are ordinarily wired in groups of 10, the 100 circuits of each bank being multiplied straight (not slipped as are those of the line finders). Therefore, in a fully equipped "low" type selector board it would be possible to have, if necessary, 24 different groups (10 per group) of selectors and in the "high" type, 32 groups; but that arrangement is rarely necessary except on boards which are assigned for miscellaneous trunk circuits only.

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 practical knowledge of selector trunking so the flat type assembly will be discussed first and the distributing terminal assembly afterwards.

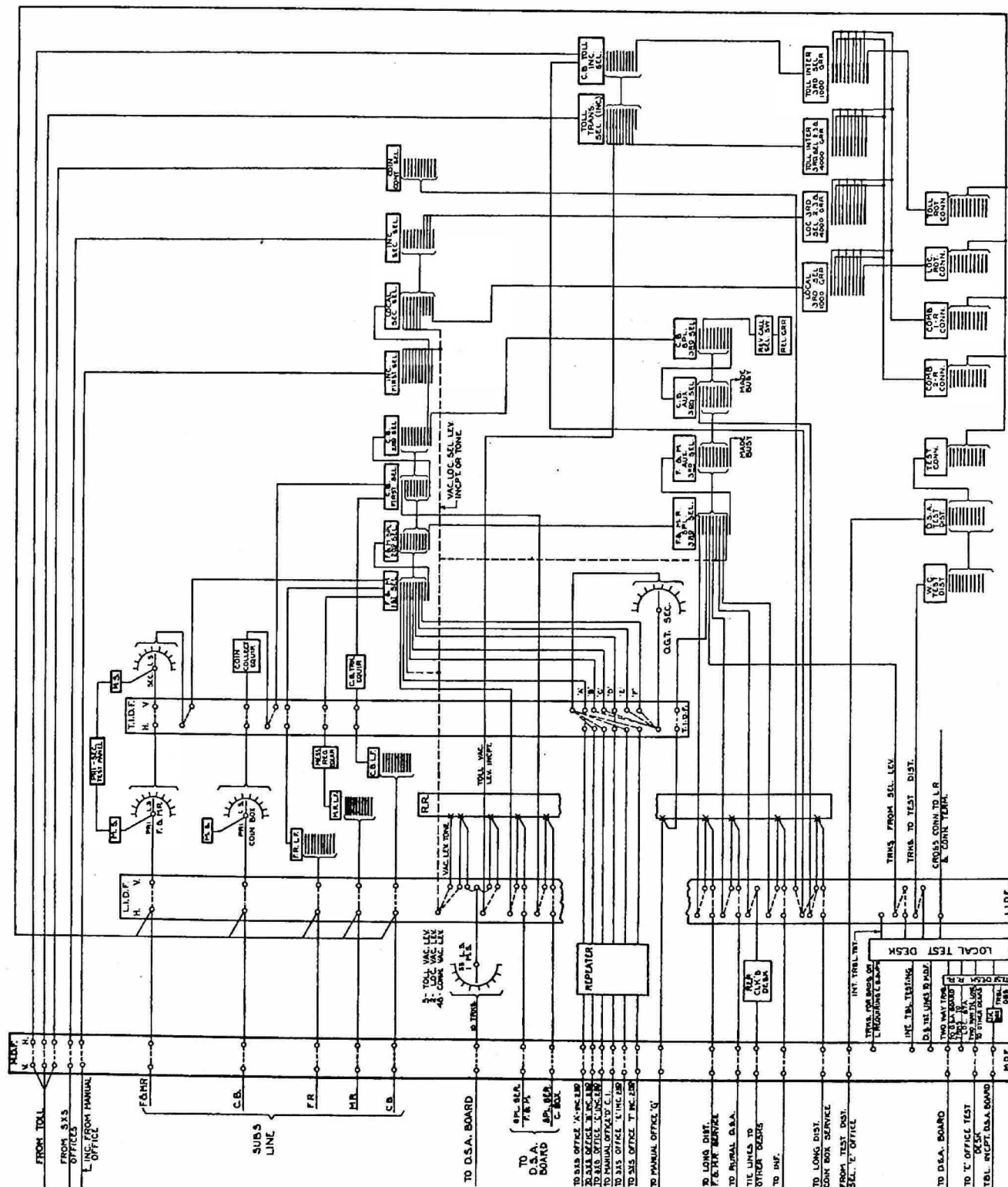


ILLUSTRATION OF THE TRAFFIC SCHEMATIC
IN A TYPICAL STEP BY STEP SYSTEM

Figure 8

8.051 Flat Type Selector Terminal Assemblies

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 terminals are enclosed by two doors.

The general wiring scheme of the selector banks is shown in Figure 10. The selector banks are wired to terminal strips of 100 contacts (See Figure 11) and assembled in three separate groups

on the terminal assembly, namely, sleeves (sometimes referred to as privates) 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 to that of the primary line switches where the T & R of the entire 100 circuits are arranged in regular order.

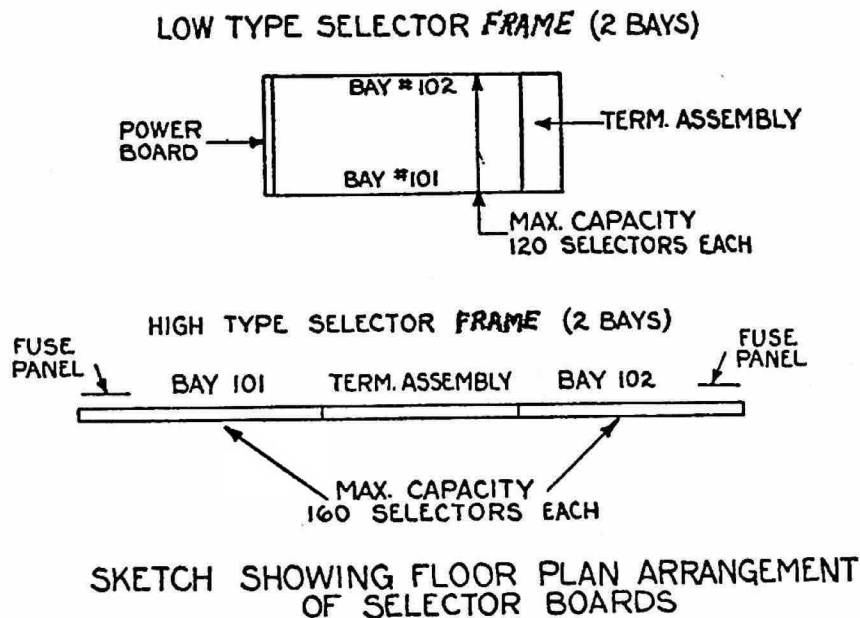
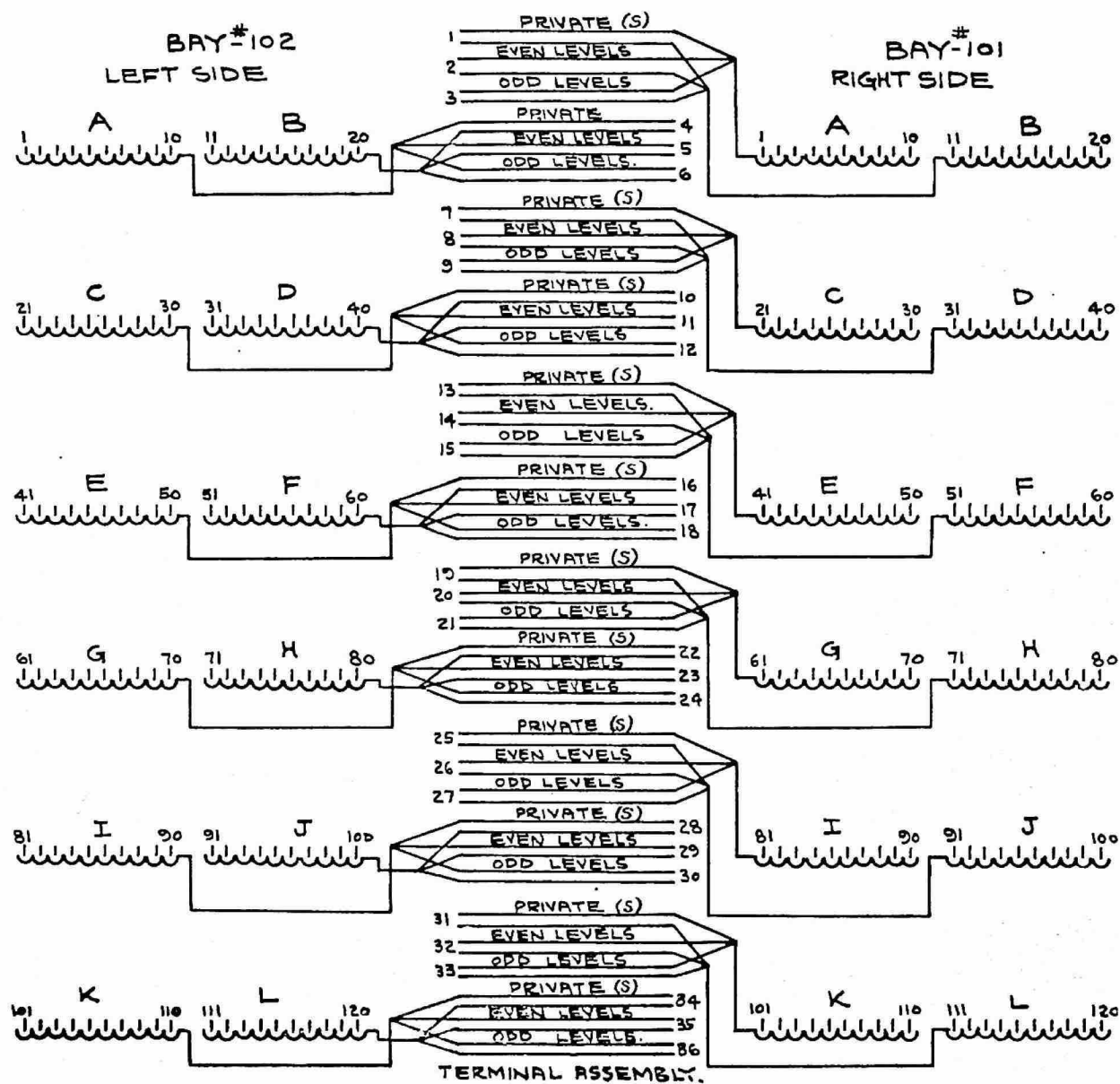


Figure 9

As previously indicated each bay of selectors consists of 6 shelves of switches. Each shelf has 20 switches and their associated multiple banks mounted on it. On the top shelf, the banks of the first ten switches are multiplied together and designated shelf A. The last ten banks are likewise multiplied together and these are designated shelf B, though both these groups are located on the top shelf. The other shelves are grouped in a similar manner and designated C,D,E,F, --- etc., in left to right order from top down when facing the front of the bay.

In order to make the necessary connections to the terminal strips mentioned above, they are mounted on three separate supports.

Let us first consider only the multiple banks of the switches in shelf A of, say Bay 101. As stated above, the terminals of the banks of these ten switches are multiplied together. In addition the terminals of the last bank are connected to three terminal strips in the terminal assembly as shown in Figure 10 and as detailed in Figure 11. The strip consisting of the 100 sleeve terminals is located on support Number 1 (see Figure 12). 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. Figure 11 shows just how the various levels are located along these terminal strips.



Selector bank wiring scheme

Figure 10

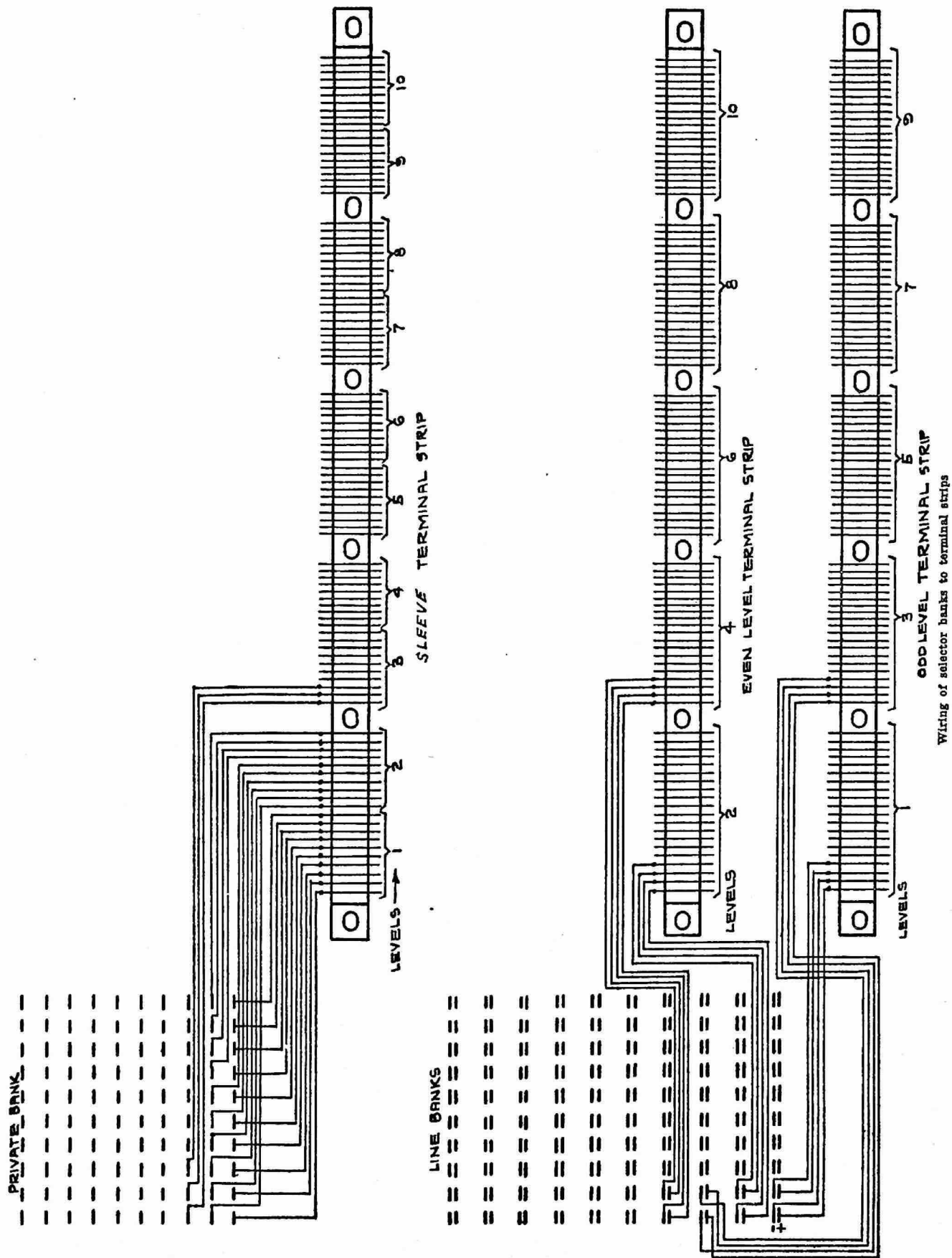


Figure 11-A

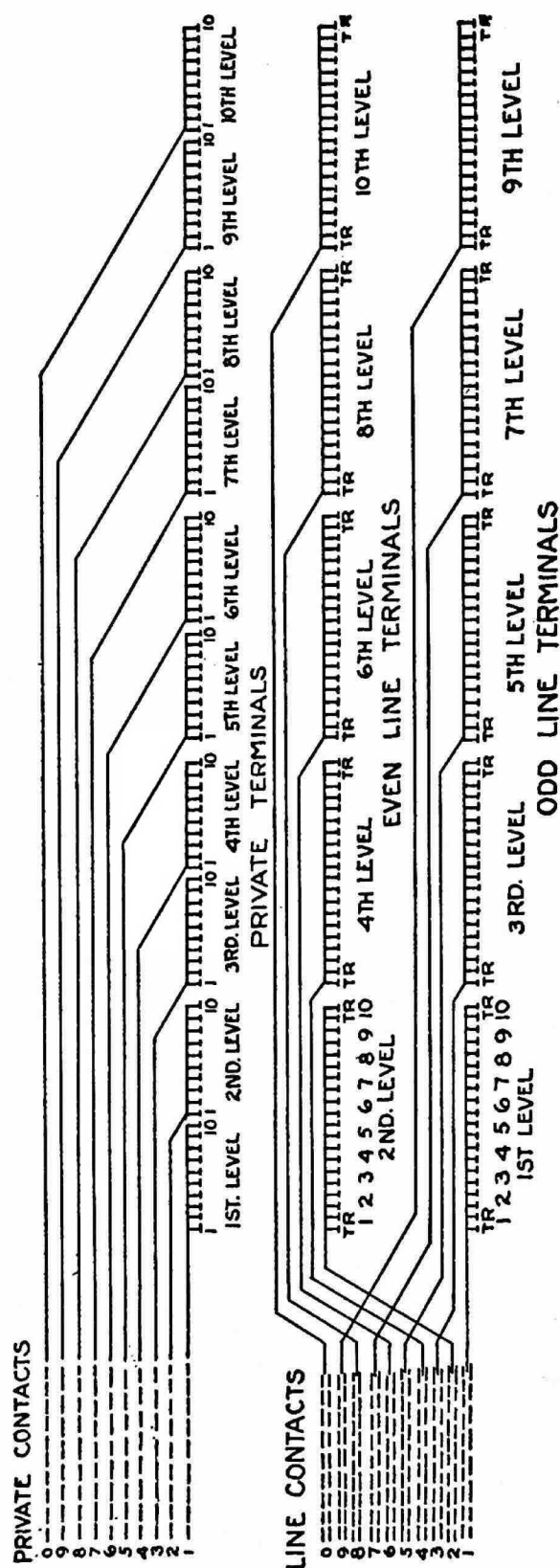
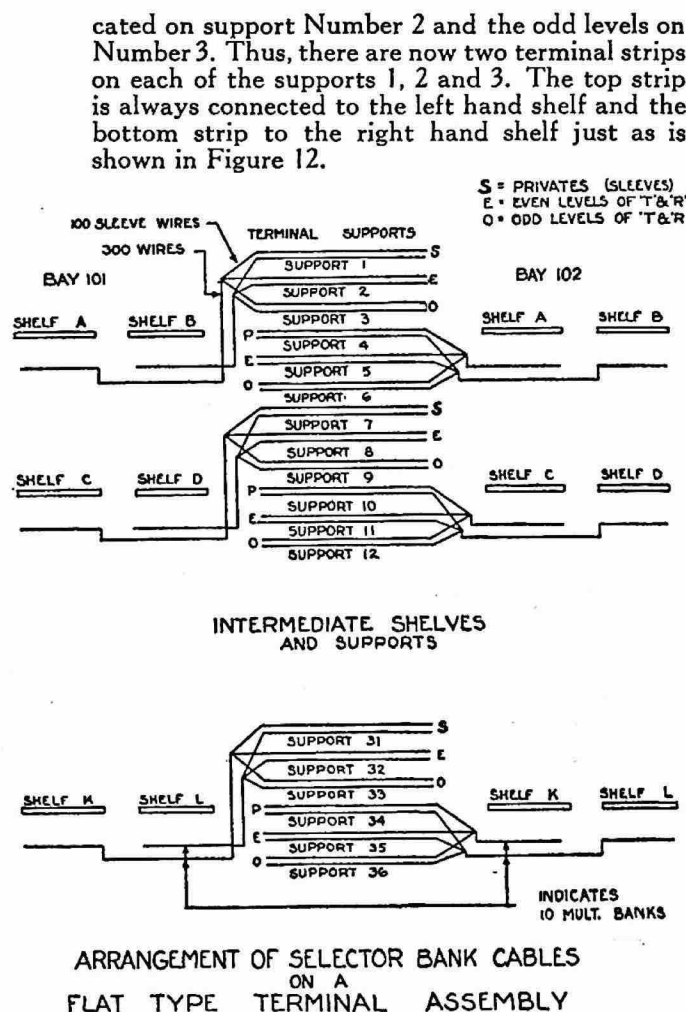


Figure 11-B

The ten terminal banks of the switches in shelf B are likewise multiplied together and the sleeve terminals of the last bank connected to the terminals of a terminal strip located on support Number 1. The even levels of T & R terminals are lo-

DETAILED SKETCH SHOWING FLAT TYPE SEL. BANK TERMINAL ARRANGEMENT



ARRANGEMENT OF SELECTOR BANK CABLES
ON A
FLAT TYPE TERMINAL ASSEMBLY

Figure 12

The above arrangement of terminal strips on supports makes it convenient to multiple the switches in shelf A with those in shelf B if desired. To do this the terminals of the two terminal strips on each support are bent together and soldered. (See Figure 13.)

The terminals of the switch banks on shelf A and B associated bay 102 are connected in the same way to terminal strips on supports 4, 5 and 6, etc. as shown in Figure 12.

The above has shown how it is possible to multiple 20 switches together. Let us now see how these terminals are connected to outgoing trunks to other switches. Figure 14 illustrates how this is shown on actual drawings. This figure is a combined picture of the multiplying and connections of the terminals on supports 1, 2 and 3 and also supports 4, 5 and 6. Each horizontal dash in the top line of terminals represents 30 terminals (10 sleeves, 10 tips and 10 rings) of ten trunk circuits in a particular group of trunks. As is indicated, the first ten go to the 1,000 group of selector switches. The second to the 2,000 group, etc. Each horizontal dash in the second line represents 30 terminals (10 sleeves, 10 tips and 10 rings) which are connected with a particular level in the multiple banks of the switches

on shelf A. The first dash from the left indicates the first level. The second dash the second level, etc. The third row of dashes represents the same thing except that these terminals are connected to switch banks on shelf B. The fourth row merely represents the terminals by means of which the above terminals are multipled through the short cable to the terminals on supports 4, 5 and 6. The vertical lines indicate that the terminals represented by the horizontal dashes which they connect are bent over and soldered together as shown in Figure 13.

If the switches from bay 201 shelf A (Figure 14) only are to use a certain group of trunks, only the shelf A terminals will be soldered to those of the outgoing trunks.

If the switches from shelf B are also to have access to the same trunks, their terminals must be connected to those of shelf A by soldering in a similar manner. Should the switches on a lower shelf on either of bays 201 or 202 also use the trunks, it is necessary to make up short multiple cables and place and connect them as was explained for shelves A and B of bay 202 and shown in Figure 14. By the use of the multiple cable the shelves may be arranged in as many groups as is necessary, each group using a different set of outgoing trunks.

The short multiple shown in Figure 14 is "straight", that is, each conductor and each pair of wires appears in the same numerical order on each support.

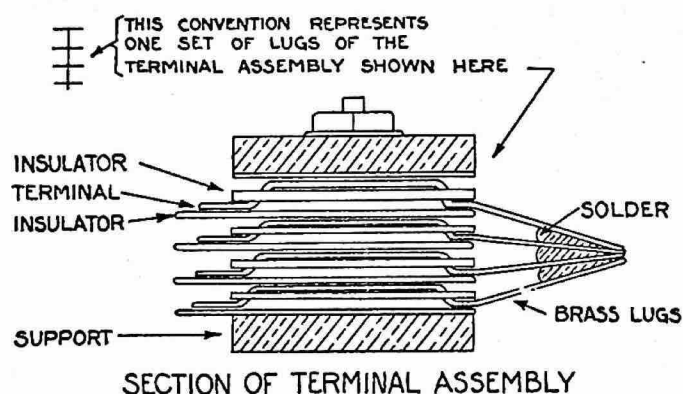


Figure 13

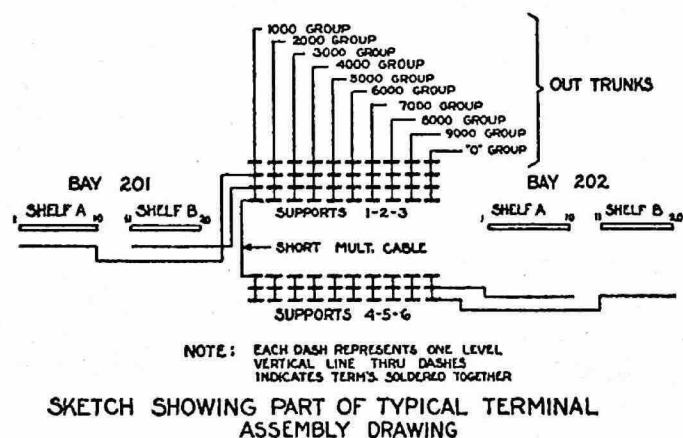


Figure 14

Using such a trunking arrangement as the one just described and illustrated by Figure 14, it will be seen that the first trunk of each level will be the first choice for all the switches which are multiplied together in this group; trunk 2, second choice; trunk 5, fifth choice, etc. and trunk 10, the last choice. Immediately the first trunk becomes busy, every other switch in the group has to rotate past it to find an idle trunk, likewise if five trunks are busy, the remaining switches must take six rotary steps before reaching an idle trunk.

In order to eliminate some of this rotation and consequent wear on the equipment and, what is more important, save the interval of time required for rotation, the switches are arranged so that some will have trunk 1 as first choice, others will use trunk 2 for first choice, a third group may have trunk 3 and so on. A multiple so arranged is said to be "slipped", which means that the trunks are slipped forward a certain number of contacts between banks.

The multiples can be wired to "slip" in numerous different ways. Figure 15 shows a few examples and the equivalent symbols as shown on the terminals assembly drawing. The SHORT MULTIPLE is for use between shelves on the same board, the "fish-back" is used between adjacent terminal strips mounted on the same support and the LONG MULTIPLE—not shown—connects a group that is split between two different boards, a trunk board being two bays associated with one upright.

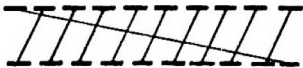
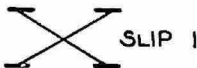
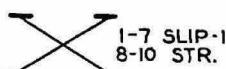
Most trunks in Step-by-Step offices have three conductors each, but those used for incoming calls from the Toll Board have four conductors, therefore, there is a slight difference in the arrangement of the terminal assembly.

The toll trunks each have a tip, ring and two sleeves, of which the latter are sometimes referred to as "privates" or P1 or P2 or S and C leads. The toll selector terminal assembly is similar to those of the local selectors and the 100 extra conductors are connected to a terminal strip which is mounted on the same support as the regular sleeves, see Figure 16.

The slips and multiples of toll trunks are similar to local trunks, except that they have four conductors each. All outgoing cables, both toll and local, are connected straight unless otherwise specified.

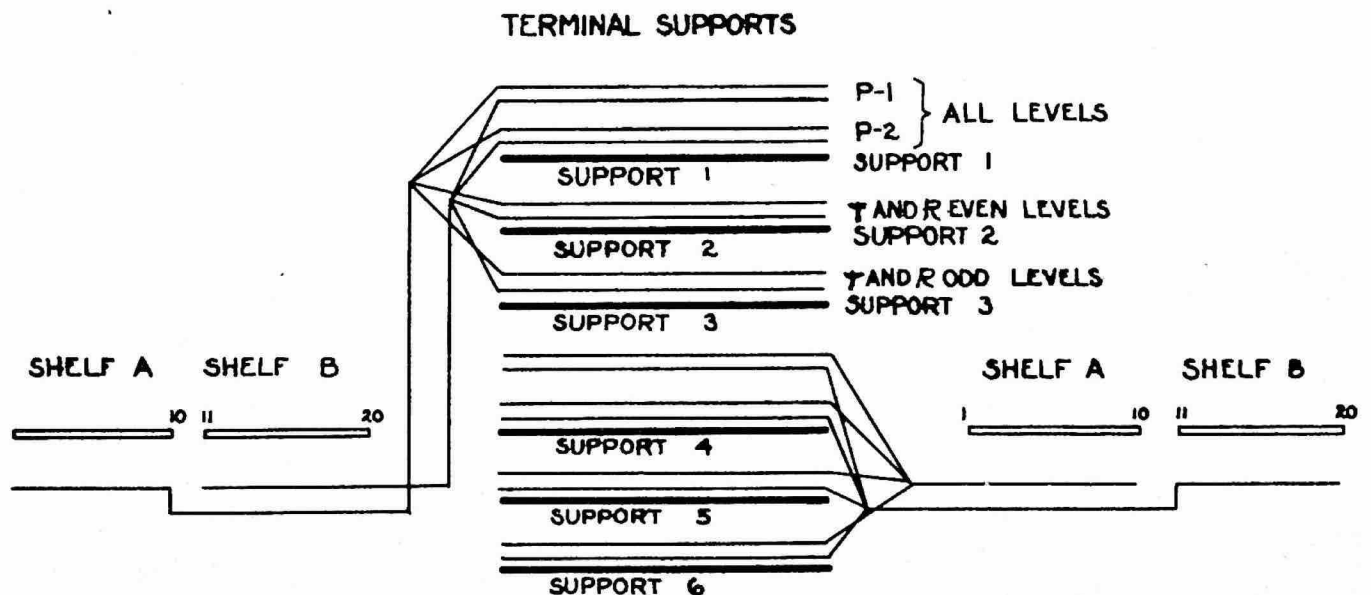
Figure 17 shows a typical first selector bay terminal assembly. It should be noted at this time that all selector bays whose bay numbers start with "1" are first selectors.

Second selector bay numbers begin with a "2"; thirds begin with a "3", etc. Toll and special selector bays are assigned number "6"; "R" would indicate repeater bays, "C" connector bays and "M" miscellaneous bays. Miscellaneous switches such as reverting call, test distributors, coin control selectors, etc. are usually installed on the latter.

TYPE OF MULTIPLING	SYMBOL	
	SHORT MULT.	FISHBACK
	[STR.	
	[SLIP 1	
	[REVERSE	
	[1-7 SLIP 1 8-10 STR.	

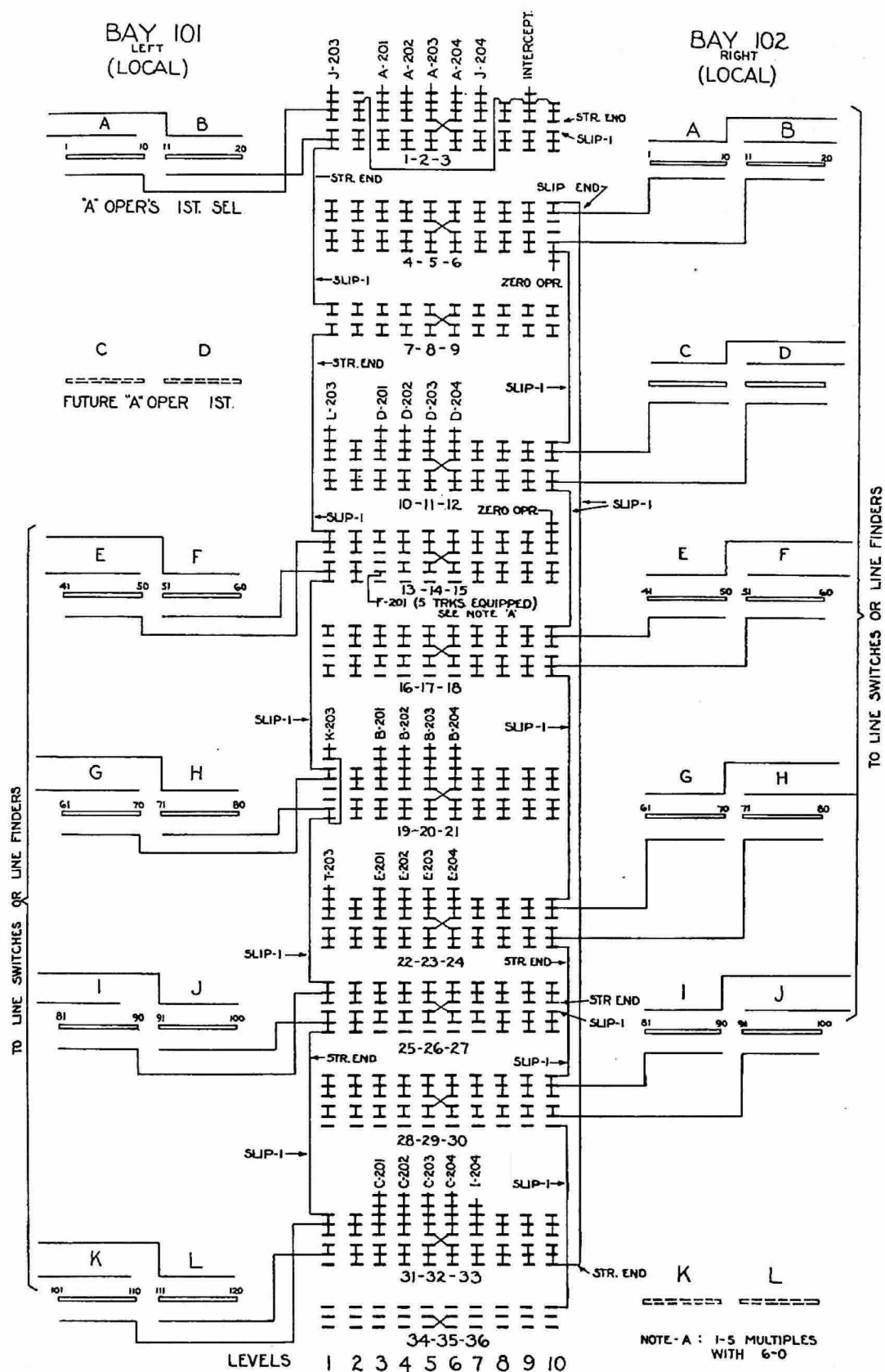
FLAT TYPE TERMINAL ASSEMBLY MULTIPLE CONVENTIONS
(ONLY ONE LEVEL SHOWN)

Figure 15



METHOD OF PLACING TOLL SELECTOR BANK CABLES
IN TERMINAL ASSEMBLY

Figure 16



TYPICAL FIRST SELECTOR BAY TERMINAL ASSEMBLY
(FLAT TYPE)

Figure 17

Referring to Figure 17, all multiple cable shown have a slip of one, the straight end being indicated in each case.

The support numbers under each group of terminals indicate that all the terminals on these supports are soldered to comply with the connection shown. The designation J-203 shown above the first level of shelf A, bay 101 shows the termination of the out trunks from that particular level to be at Shelf J of Second Selector Bay 203. The 20 T & R being found on support 3 (level 1 being an "odd" level) and the 10 sleeves on support 1.

Levels 2, 8, 9 and 10 of shelf A, bay 101 are not used, therefore they are strapped together and connected to intercepting. The tenth level of this shelf is intercepted because ordinarily the tenth level of the first selectors is reserved for trunks to Zero Operator and inasmuch as the originating calls on the switches of this particular shelf are from the Zero Operator, she would be dialing back to herself. Level 0 off shelves 101 E-L and 102 A-J is out trunked to Zero Operator

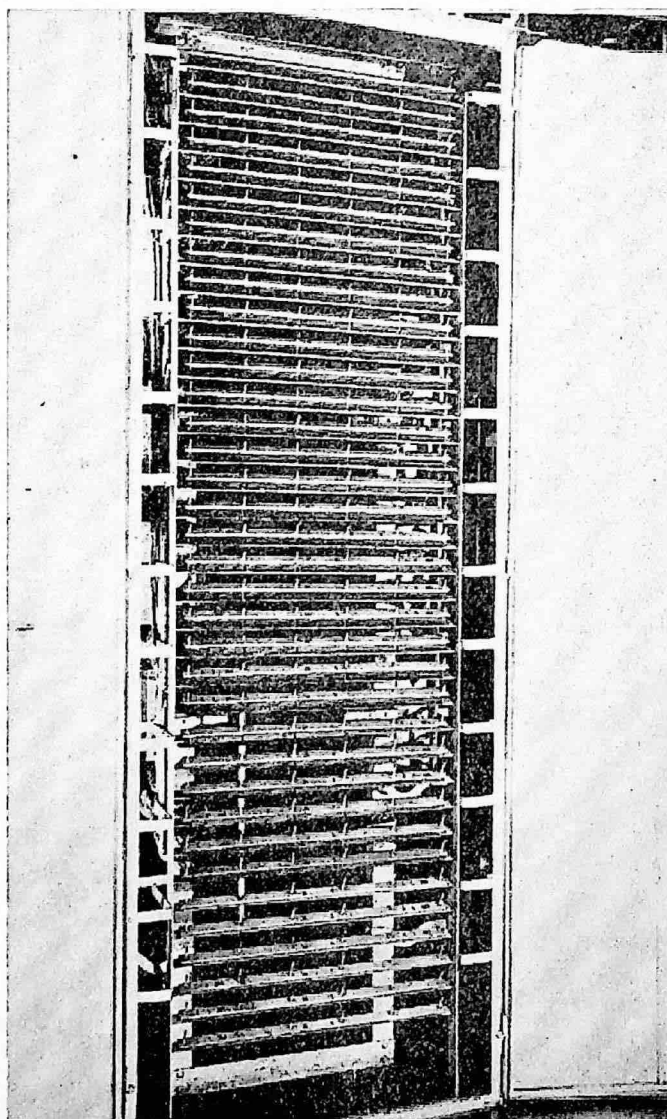


Figure 18

from two subgroups. Sub-group No. 1 consisting of shelves 102 B-C-D-E-F-G-H-I-J, whereas subgroup No. 2 consists of shelves 101 E-F-G-H-I-J-K-L and 102-A. The third level of shelf F, bay 101 has only five trunks equipped, therefore, should a call be originated on any switch from 56 to 60 it would be routed over one of the five trunks associated with switches 51 to 55 by means of a small multiple cable.

If a call is originated over the first trunk of level 1, shelf J, bay 101, it will be routed through the "fishback" multiple and the "short" multiple (both of which have a slip of 1) to shelf H and then through the outgoing trunk cable to shelf K, Bay 203. The call having passed over two slips, chooses the third switch of shelf K, bay 203, which is the first choice selector for level 1, shelf J, bay 101. Other calls can be traced in a similar manner.

Figure 18 is a view of a flat type terminal assembly associated with a bay of third selectors.

8.052 DISTRIBUTING TYPE TERMINAL ASSEMBLY

On a distributing type terminal assembly (d.t.a.), the 100 circuits from each multiple bank are terminated in one group instead of three as used in the flat type system. The bank terminal strips consist of small molded strips of insulating material, each containing 10 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 division or shelf of ten selectors.

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 32-10 switch shelves or divisions 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 & S terminals of one division of selectors will be in line vertically with the corresponding terminals of other selector divisions.

Each level may then be multiplied by means of vertical strap wires, using the front projection of the terminal pins, through as many divisions of selectors as may be required.

When it is necessary to provide a reversal between the trunks of adjacent levels, 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.

From the foregoing description it will be seen that one of the most important advantages of the "D.T.A." type assembly is the ease with which additions and rearrangements caused by traffic changes can be made.

Figure 19 shows some of the conventions most commonly used on the selector bay drawings for the new type assembly and Figure 20 shows how the arrangement of the terminals are grouped or graded on the assembly drawing. (New drawings

use the dot (•) instead of the vertical line (|) to represent the T,R and S or T,R,S and C leads)

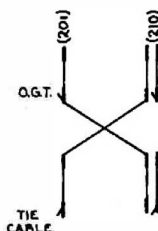
The multiple slip arrangement commonly used with the flat type terminal assemblies is not used with the D.T.A. types; however, the multiple reversal is retained.

In place of the slip, a type of multiplying called "graded multiple" is used, the new 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 divisions of selectors in such a way that some of the trunks are multiplied throughout all of the divisions of selectors involved while the remaining trunks are arranged in two or more groups, each group being multiplied to only a part of the divisions.

When a last-trunk busy record is required in any group, the last trunk is multiplied straight so as to be the last choice for all the selectors in order to obtain an accurate check.

Figure 21 shows the front and rear views of a distributing type terminal assembly.

REPRESENTS 3 TERMINALS $\begin{Bmatrix} I(T) \\ I(R) \\ I(S) \end{Bmatrix}$ FOR LOCAL SEL FRAMES
AND 4 TERMINALS $\begin{Bmatrix} I(T) \\ I(R) \\ I(S) \\ I(C) \end{Bmatrix}$ FOR TOLL SEL. FRAMES
DENOTES STRAPPING OF COMMON GROUPS



DESIGNATIONS IN PARENTHESES DENOTE THAT THERE ARE TWO SETS OF JUMPERS TAKEN OFF THE GROUP ONE TO THE O.G.T. AND ONE TO THE TIE CABLE.
O.G.T. TO TIE CABLE CROSS CONNECTION LIST IS FURNISHED ON TERMINAL ASSEMBLY DRAWING.



DENOTES COMPLETE REVERSAL BETWEEN A & B



DESIGNATES A JUMPER TO AN O.G. TRK. TERM. STRIP



DESIGNATES A JUMPER TO A TIE CABLE TERM. STRIP



DESIGNATES A JUMPER TO A TRAFFIC REGISTER PUNCHING



DENOTES HORIZONTAL STRAPPING OF CONTACTS (ON REAR OF LUGS)



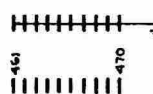
DENOTES GROUPS MULTIPLIED BY MEANS OF JUMPERS



DENOTES GROUPS MULTIPLIED BY MEANS OF JUMPERS AND A COMPLETE REVERSAL IN TRUNKS 1 TO 9 TRUNKS 10 BEING MULTIPLIED STRAIGHT.



DENOTES GROUPS MULTIPLIED BY MEANS OF JUMPERS AND NO REVERSAL.



DENOTES SLEEVE LEADS OF LEVEL ARE GROUNDED



DENOTES THAT THE TERMINALS OF THIS LEVEL ARE CROSS CONNECTED TO PUNCHINGS 461-470 ON O.G.T. TERMINAL STRIP.

CONVENTIONS USED ON DRAWINGS OF
DISTRIBUTING TERMINAL ASSEMBLIES

FIG. 19

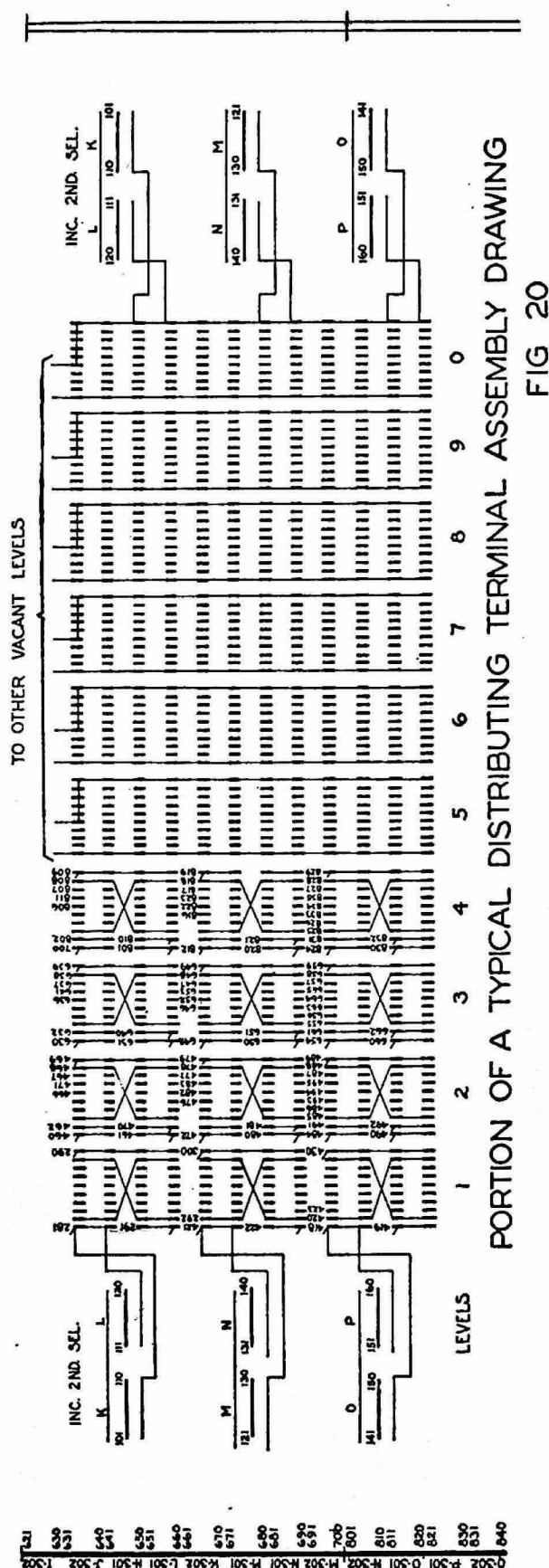


Figure 20

8.06 ASSIGNMENT OF FIRST SELECTOR BANK LEVELS

The top or tenth level of the first selector banks serving line switches or line finders is assigned to trunks to either (1) special service (assistance) operator, or (2) combined assistance and CLR (Long Distance) operator, which is usually referred to as single channel operation. Where (1) is used the Toll Recording is assigned to a three digit code "110". The tenth level of the selectors from the D.S.A. board and of incoming first selectors is usually unassigned.

The bottom, or first level is always assigned to or reserved for the group of trunks to auxiliary first selectors or to digit absorbing type Service Code Selectors, which are used in completing calls where three-digit codes beginning with 1 are dialed, for example 113 is Information, 114 Repair Clerk, 117 Test Desk and 110 Toll Recording where code '0' is assigned to Assistance Operator. The trunks from level 1 are also used in case a subscriber causes a preliminary pulse before beginning to dial. (A preliminary pulse is a short accidental break in the circuit loop which has the same effect on the selector as though the digit "1" had been dialed and is usually caused by the customer touching the switch-hook as the receiver or handset is being removed to dial a number).

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

In a multi-office area where any of the units are to be reached by dialing the first letter of an office name, the group of trunks to that office must be assigned to the particular level whose number corresponds with the location on the dial number plate of the first letter of the office name.

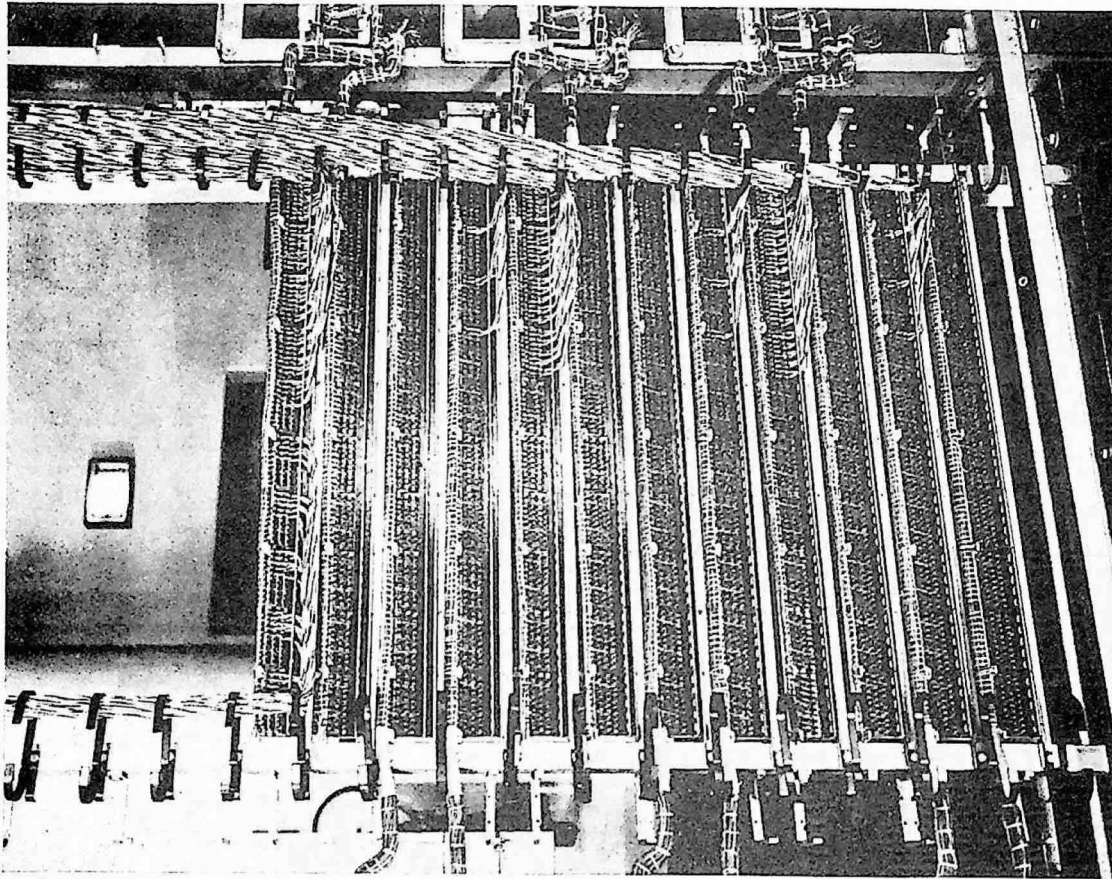
Levels that are not in use are connected either to the intercepting operator or to a "vacant" level tone (usually, "No Such Number Tone"). Should a customer accidentally dial into an unequipped level, he will either be informed of this condition by the operator or will hear the "tone", in both cases he must hang up and then dial the correct number.

8.07 SPECIAL TRUNK GROUPS

In paragraph 8.03 it was mentioned that different classes of service are segregated at the line finders. The traffic from these classes and from the "A" board may be combined over a group or subgroup of trunks from the first selector levels, except on the trunks from the first and tenth levels.

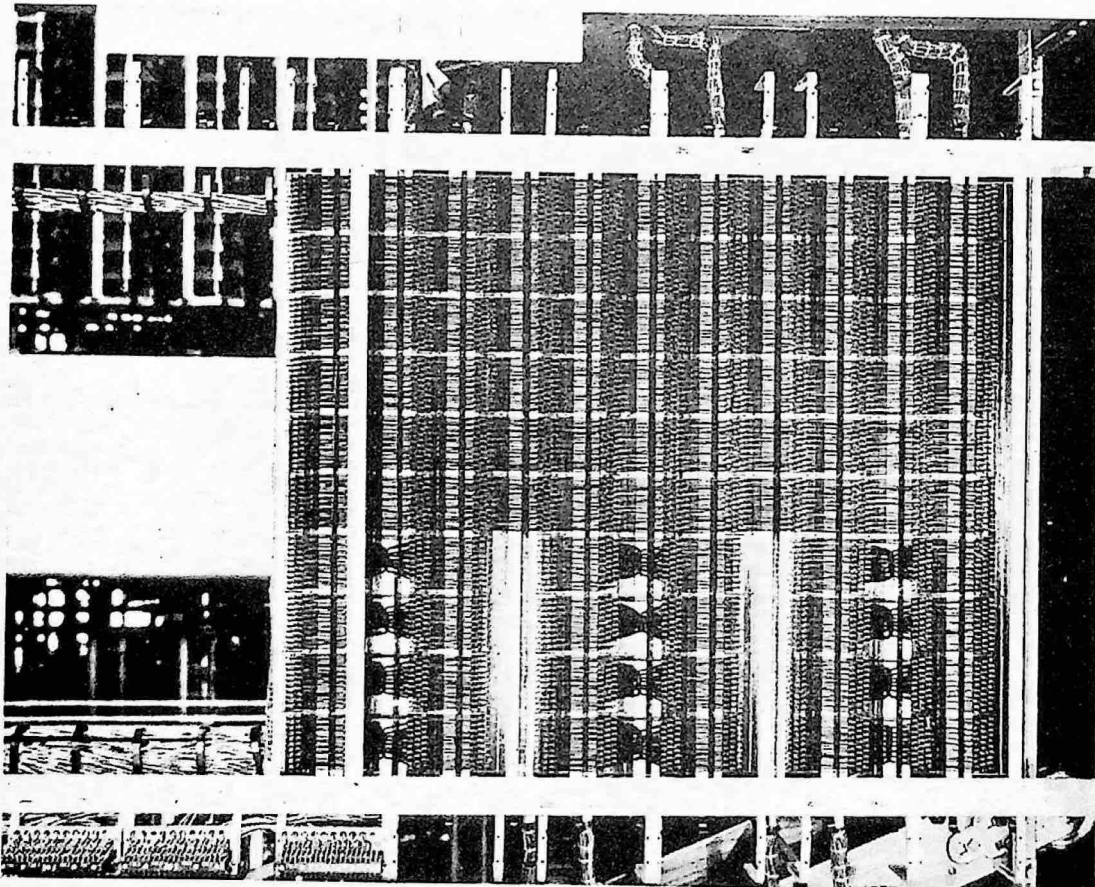
On account of differences in operating methods, separate trunk groups to the Assistance operator, or the Combined Assistance and Toll Recording Operator, and to the special second (Auxiliary First) selectors are required for certain classes of service, some of which are:

1. Flat Rate
2. Message Rate
3. Coin Box (Pre-Pay)



SELECTOR DISTRIBUTING TERMINAL ASSEMBLY
(REAR VIEW)

Figure 21-B



SELECTOR DISTRIBUTING TERMINAL ASSEMBLY
(FRONT VIEW)

Figure 21-A

8.08 USES OF THE VARIOUS SWITCHES

The number of switches required 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. (See Section 6) These plans could be 3,4,5,6 or 7 digit systems. In multi-office areas it is not uncommon to find a numbering plan in force whereby different numbering plans may exist between units. Regardless of the plan a 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). Occasionally digit absorbing selectors are used and this will reduce the number of selectors required corresponding to the number of digits absorbed.

For matter of explanation, assume the use of a five digit system, as follows:

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

The incoming trunks from SXS offices are cross connected at the main frame so that they can be distributed over the various shelves in such a way that as far as possible each subgroup of trunks to the third 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 on full shelf (a full shelf being 20 switches), this means that trunks from only one office should be assigned to any one section of shelf. Experience has indicated the desirability of "scrambling" local and incoming selectors (in this case, the second selectors) on alternate shelves in the same bay, as much as possible, in order to get more even distribution of traffic on the trunks between the seconds and thirds.

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 as just mentioned in the preceding paragraph whereby the locals and incomings are scrambled on the selector bay. In this case the trunks from local firsts are usually cabled to the T.I.D.F. for cross-connection to the local seconds.

The number of groups of second or third selectors to be provided in any unit, depending upon whether it is a 4 or 5 digit office, depends upon the number of connector terminals within the office, that is, there are as many groups of these switches as there are thousands of terminals. For example, a 4-digit office equipped for 8,000 terminals would require eight groups of second selectors and a 5-digit system with one of its first levels (sometimes called office levels) arranged to provide access to 8,000 terminals would require eight groups of third selectors.

Trunks to other offices from the levels of the first selectors of a 5-digit office may either be trunked to repeater switches or they may be trunked through either Rotary Out Trunk Switches or through Plunger Out Trunk Line Switches to repeaters and then cross connected at the Main Frame to the outside cable pairs. Cross connections are also made to the repeaters from concentrating switches.

The use of O.G.T. concentrating switches generally depends upon the number and size of the outgoing trunk groups. Until recent years, it was usually found expedient and economical to provide this equipment when trunk groups of 30 or more trunks would be required if trunked direct to repeaters. The introduction of 24 gauge cable conductors and less expensive loading facilities for trunk cables now permits direct trunking considerably higher than 30 trunks before it becomes more economical to provide concentrating equipment. The Rotary Out Trunk switches are a more recent development, of the early 30's, and have completely superseded the line switch type concentrator.

Plunger type switches are also used in some of the older offices as a means of concentration for intercepting trunks. Their use, in this connection, has now been discontinued in favor of the more modern trunk finder units.

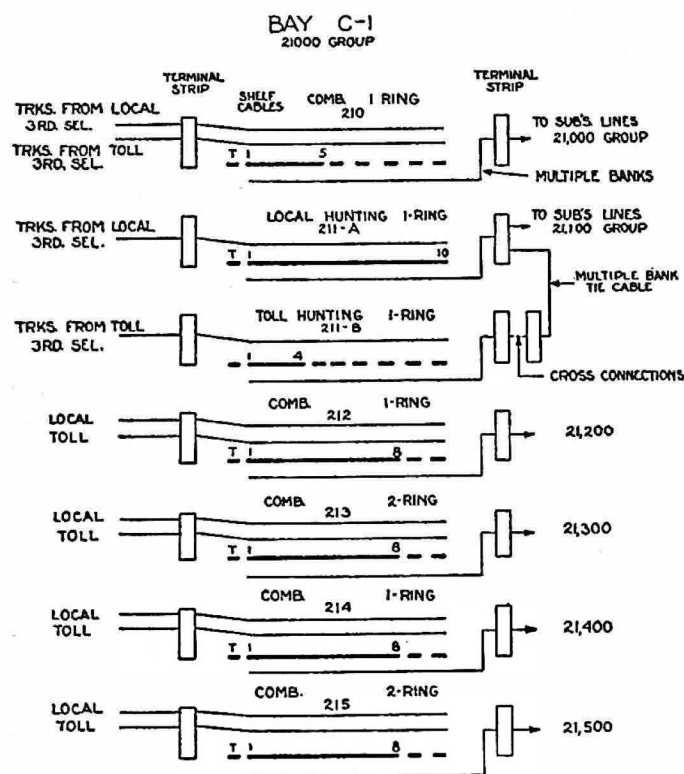
As outlined in Section 5, there are several types of connectors, among which are local regular, combination 1-ring and 2-ring, local rotary hunting, local level hunting, toll regular, toll rotary hunting, toll level hunting and rural local and rural toll and rural combination connectors. Local connectors 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 group (sometimes referred to as a connector board) and each group is assigned to a certain class of service (P.B.X., Regular, rural or coin box). The high type connector bays (11' -6") have a capacity of seven shelves of switches. Figure 22 shows how several different types of connectors might be arranged on a given bay of a 5-digit office. (Nine foot (9'-0") bays have a capacity of five (5) shelves.

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 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 relative inefficient. To reduce this



SHELF LOCATION TYPICAL CONNECTOR BOARD

Figure 22

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. This plan of combining the local and toll groups is not used for selector levels serving "hunting" connector groups, that is, groups which include P.B.X. trunks or associated lines. Only recently were combination connectors made available for Rural Connector Boards. (T/S Type)

8.09 TOLL EQUIPMENT

Thus far we have covered principally the trunking of local calls. Now the toll train will be briefly described.

Toll selectors are provided to handle the traffic incoming over toll switching trunks from toll switchboards and, too, the incoming toll traffic from intertoll dialing circuits. More recent developments have introduced additional selectors known as Tandem, Intertoll Auxiliary and Intertoll Thru selectors. For purposes of discussion in this Section, however, we will concentrate on those selectors which handle the traffic incoming from toll switchboard via toll switching trunks.

The arrangement of the toll train selectors depends upon whether the SXS office is 4,5,6 or 7 digit. The incoming switch may be either a first, second or third selector and is known as the toll transmission selector. For instance, in a 4-digit

office the incoming switch is a first selector, in the 5-digit office it is a second selector, in a 6-digit office it is a third selector, etc.

The toll transmission switches are divided into two classes, coin and non-coin, the coin selectors being used for completing connections from the toll board to pre-payment pay stations. The levels of both types of switches, however, may be multiplied.

For the purpose of this description a 5-digit toll train from a toll board equipped with dials will be discussed. The toll selectors (transmission and intermediate) are mounted in bays and the multiple banks are terminated on terminal assemblies similar to those of local selectors, with the exception that the circuits of the toll train are four-wire trunks.

In a 5-digit area, the toll operator dials the last four digits only of a subscriber's telephone number. The first digit being represented by a group of jacks in the toll board on which are terminated trunks to a particular Step-by-Step office, or Unit. For example, should all numbers beginning with a "2" (the 2nd level of the first selector in a five digit area) be assigned to office "A" and the operator desires to establish a connection to station 2-3456, she would insert a cord into one of the jacks of the group assigned to office "A" and then dial "3456".

The toll incoming selectors of offices A and B correspond to the local second selectors and the toll intermediates to the local thirds.

When the trunks from a level of the toll third selectors terminate on combination connectors, the wiring is, in many offices, so arranged that the order of choice of switches is opposite to that of the corresponding level of the local third selectors, that is, the order in which the local selectors would seize the connectors would be 1,2,3, and 4 to 10, while the toll thirds would choose connector 10 first, then 9, 8 and 7 to 1. This method is used to distribute the load as evenly as possible on the connectors by toll trunks is the same as that from the local selectors preceding the connectors. Exceptions to this practice are now frequent, however. (See Paragraph 8.11)

8.10 TESTING TRUNKS

Figure 8 illustrates the numerous traffic routes in a typical step-by-step office, the majority of which have already been mentioned in this section. It will be noted by referring to this drawing that the local test man at the test desk has access to all the connector terminals over a train of switches which is not available for use by the subscribers.

This is accomplished by providing test distributors and test connectors.

A test connector is provided for every 100 terminals in the SXS office, that is, there would be fifty test connectors for 5,000 terminals and 75 for 7,500 terminals, etc. Each test connector is cabled to the banks of the test distributors which have a capacity of 100 circuits. Should the test

BAY (101) SHELF C

	1	2	3	4	5	6	7	8	9	10	
03A	P-4 J-0	P-4 J-1	P-4 J-2	P-4 J-3	P-4 J-4	P-4 J-5	P-4 J-6	P-4 J-7	P-4 J-8	P-4 J-9	10
				VACANT	LEVEL	LEVEL	LEVEL	LEVEL	LEVEL	LEVEL	9
				VACANT	LEVEL	LEVEL	LEVEL	LEVEL	LEVEL	LEVEL	8
04A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	7
05A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	6
06A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	5
07A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	4
08A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	3
09A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	2
10A	T1-B 0	T1-B 1	T1-B 2	T1-B 3	T1-B 4	T1-B 5	T1-B 6	T1-B 7	T1-B 8	T1-B 9	1

SELECTOR BANK

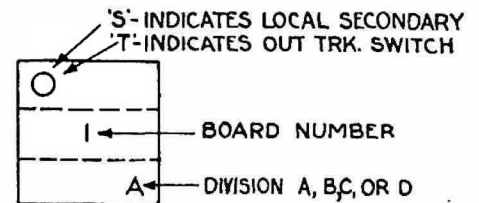
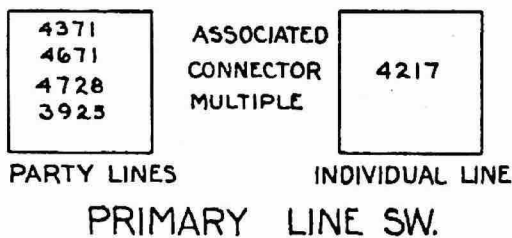
TRUNK	LI	1	2	3	4	5	6	7	8	9	10
IS		1	1	1	1	0	1	1	1	1	1
SWITCH	B	S-1 A	S-1 B	S-1 C	S-1 D		S-2 B	S-2 C	S-2 D	S-3 A	S-3 B
IN BAY											

PRIMARY LINE SWITCH BOARD

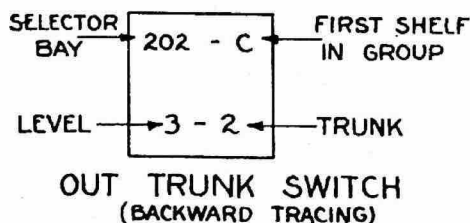
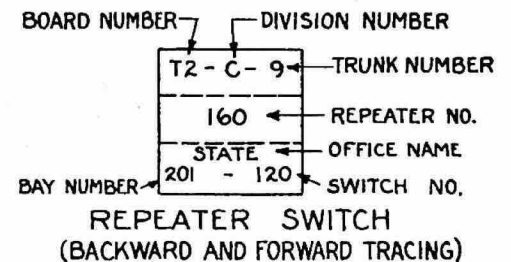
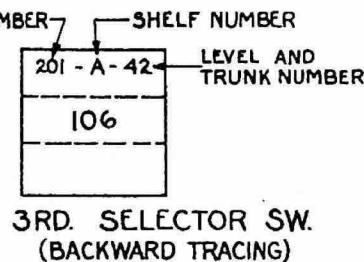
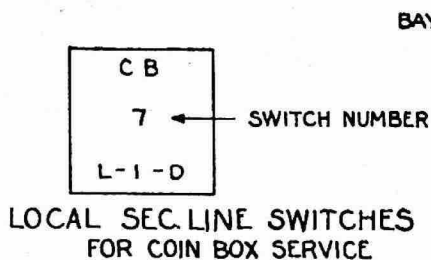
TRUNK	S3	1	2	3	4	5	6	7	8	9	10
IS		81	91	101	111	1	11	21	31	41	51
SWITCH	A										
IN BAY		108	108	108	108	109	109	109	109	109	109

SECONDARY LINE SWITCH BOARD

MASTER SWITCH CARDS
(FORWARD TRACING)



SECONDARY LINE SWITCH
CHAIN RELAYS



TRUNK DESIGNATION CARDS

Figure 23

man desire to make a test on station 2-3456, 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 of the 2-34XX group of connectors.

Verification test calls made from the toll board utilizes a switch train similar to that used by the test man. In this case, jacks in the multiple are associated with "operators" test distributors (2 digit) the banks of which are multiplied with those of the test distributors used by the test man. The test connectors are, therefore, used jointly by the operators and the test men.

Trunk designation cards are used in connection with all switches and the multiple banks of the selectors. These are provided principally for the use of the maintenance men in order that they may quickly back-trace or forward-trace circuits in trouble. Figure 23 shows some of the designation cards used in a typical office.

8.11 STRAIGHT AND GRADED MULTIPLE ARRANGEMENTS

This paragraph will cover briefly, the multiplying of selector trunks, employing straight and graded multiples on selector bays both with and without distributing type terminal assemblies. The latter type bays are used principally in community dial offices and on intertoll selector bays in our larger offices. Since grading is seldom, if ever, done on selector bays equipped with flat type terminal assemblies (See paragraph 8.051) the discussion in this paragraph will be restricted to installations with distributing type terminals assemblies. As such it will conform more closely to recent installations and current engineering practices.

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

Selectors have their banks multiplied in groups of ten and each such group is referred to as a **division of selectors**. The selectors of one or more divisions which are 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 multiplying between selector divisions is required. Larger selector subgroups are built up by multiplying together the required number of divisions 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.

Subgroups of ten or less trunks are known as **straight multiple subgroups** since each trunk is common to all divisions in the subgroup of selectors. Subgroups of more than ten trunks are known as **graded multiple subgroups** since part of the

trunks are common to all divisions and the remainder are individual to one or more divisions. Graded multiple arrangements are shown at the end of this paragraph (8.11).

Selector divisions on the same frame are multiplied together as required on a straight or graded multiple basis by means of strap wire or jumpers. For straight subgroups all trunks are multiplied to all divisions and for graded multiple subgroups, the common trunks are multiplied to all divisions and the individual trunks are multiplied to the divisions which they serve. See Figures 20 and 21 of this Section.

In order that all the selectors of a **straight multiple subgroup** having access to ten or less trunks shall not be required to rotary hunt over the trunks in the same order, all of the working trunks of each level (except the last) are usually reversed approximately in the middle of the subgroup of selectors having access to them. However, if there are four trunks or less equipped, no reversal is used and all trunks are multiplied straight.

In order that all of the selectors of a graded multiple subgroup shall not be required to hunt over the common trunks in the same order, the common trunks (except the last) shall be 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 bank terminals of the first division of the subgroup, the trunk numbers below the reversal being in the reverse order. These reversals are accomplished by the use of reversal forms 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 the case of either straight or graded multiple subgroups, the last working trunk is not reversed with the others but is carried through straight so that, where required, a last trunk busy register circuit may be accommodated.

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 following shelf or half-shelf. The lower choice trunks carry heavier traffic than the higher choice trunks and 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. The requirements for accomplishing this in graded multiple subgroups to selectors and connectors are covered in the Equipment Engineer's handbook. In the handbook are shown selector subgroups of various numbers of selectors having graded multiples of 11 to 45 trunks for use on trunk groups to

other selectors, repeaters, or trunks. Another section of the handbook describes other selector subgroups of various number of selectors having graded multiples of 11 to 31 trunks for use on trunk groups to connectors.

Subgroups of Less Than Ten Trunks

Where a subgroup of selectors will furnish a load for less than ten trunks, the working terminals are multiplied in the same manner as for a full subgroup of ten trunks, that is, the last working terminal is multiplied straight to the bank terminals for all of the selector divisions in the subgroup and the remaining working terminals are multiplied 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 multiplied straight through all of the divisions in the subgroup and the "T", "R", and "S" or the "T", "R", "S" and "C" punchings of the terminals are multiplied 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 on vacant levels to the terminals beyond the no-such-number tone or intercepting trunk circuits. In this case the outgoing jumpers will only occur on two levels, so that the horizontal strapping on the other levels shall be placed on a division where tie jumpers are located. If in any of the cases more than two unequipped bank terminal strips are bridged by loop 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.

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 boards.)

Where both local and combination connectors are required to serve the same "hundred" 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 connected 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.

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 thousands, a reversal is made in the multiple between these shelves in the trunk groups to toll rotary or toll level hunting connectors. This reversal includes 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 multiplied 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.

The toll transmission selector banks to these selectors are graded in accordance with the Engineer's Handbook for trunks to selectors, but the order of connecting the trunks to the toll intermediate selectors is usually revised to meet the desired balance for the particular job being engineered.

Vacant Levels

Vacant levels of local selector multiple are tied to "no such number" tone. Occasionally, however, because of number changes, or possible directory error, a vacant level, or levels, may be tied to vacant level intercepting trunks.

Five "no-such-number" tone trunks are usually provided for each 10,000 (one unit) terminals.

Vacant levels of toll selector multiple are wired to "Reorder" (120 I.P.M. Flash). These, too, may be tied to intercepting trunks for reasons mentioned above.

Subgroups Split Between Two Frames

In cases where, with graded multiple arrangements and distributing type terminal assemblies (see paragraph 8.052), it is desirable to split a subgroup between two selector frames, the jumpers from the DTA punchings to the tie cable terminal strips are taken from divisions lower in the multiple than those from which outgoing jumpers are taken and, in the case of common trunks, from a division 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 selector divisions 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.

Trunks to Connectors

The cabling for trunks to connectors as well as all other outgoing cables and tie cables are run straight regardless of the order of assigning connectors, the irregularities in assigning being provided for by jumpers at the DTA.

Mixing Local and Incoming Traffic

In areas having large PBX development, if local and incoming traffic is mixed in such a way that each subgroup of selectors (Third selectors in a 6 digit area for instance) 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.

Mixing of traffic, as above, is usually done in accordance with standard procedures at a TDF.

8.12 SELECTOR FRAMES WITHOUT DISTRIBUTING TYPE TERMINAL ASSEMBLIES

Selector frames without DTA, such as used in 355-A and 35-E-97 type offices as well as for inter-toll selectors in No. 1 offices, are equipped with shelves arranged to mount ten selectors per shelf. The bank multiple for these selectors terminates on a 137 or 163 type terminal strip at the right-hand end of the shelf.

For selector levels with graded multiple common trunks are jumpered as required between bank terminal strips of adjacent shelves. These common trunks as well as all individual trunks are then cross-connected to an auxiliary terminal strip which is provided to the right of the regular shelf bank terminal strip, where they are grouped for convenience in cabling as follows:

Since graded multiple does not provide even subgroups of ten trunks and since the individual trunks carry more traffic than succeeding trunks, trunks from different divisions are cross connected to outgoing cables on the auxiliary terminal strip in accordance with the standard arrangements for graded multiple.

One auxiliary outgoing terminal strip is always mounted on the top shelf of a frame and it will normally serve all graded levels on one frame. Each shelf, however, is drilled to accommodate an auxiliary terminal strip and additional strips are provided as required.

The auxiliary terminal strip on the top shelf of a frame also serves as a distributing point for no-such-number tone and intercepting circuits and ground. It is also used for terminating tie cables or any other condition where it will provide increased flexibility or easier maintenance.

For selector levels without graded multiple subgroups of selectors are formed by jumpering between the bank terminal strips of shelves on the same frame and cabling to associated shelves on preceding or succeeding frames as required.

All multiplying between shelves on the same frame with or without graded multiple and all multiplying to an auxiliary terminal strip on the same frame is done with 22 gauge jumper wire. Outgoing cable in the case of non-graded levels, and jumpers to outgoing cable at the auxiliary terminal strip in the case of graded multiple, is usually terminated on the highest shelf of each subgroup on the frame. Reversals are made in the jumpers between two shelves and requirements for the location of these reversals in both graded and non-graded subgroups follow the same general rules as for frames with a DTA.

Split Subgroups

Where a subgroup of selectors is located on two or more frames, a tie cable is run between the frames: Between bank terminal strips for non-graded levels and auxiliary terminal strips for graded levels. Tie cables (or jumpers to tie cables)

are run from the lowest division on the frame on the lower numbered frame or the highest division on the higher numbered frame.

Where the reversal is made between selector divisions on separate frames, this is done in the tie cable (or jumpers to tie cable at the lower numbered frame.)

8.13 ARRANGEMENT OF CROSS-CONNECTIONS FOR GRADED MULTIPLE TRUNK GROUPS TO OTHER SELECTORS, TRUNKS, OR REPEATERS

Selector Graded Multiple Arrangements

When checking or reading through a SXS dial Traffic Order you will note, on the multiple charts, that the 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, in general, more efficient trunk groups than the arrangements previously employed in engineering due to the larger numbers of trunks and more efficient types of grading in the subgroups. In the previous methods, graded subgroups of not more than 25 trunks were used.

The newer arrangements are entirely flexible and are applied to any of the present standard frames equipped with or without DTA. For subgroups of 40, 60, 80, 120, 160, 240, 320, or any number of selectors on 10 to 15 trunks, inclusive, the multiplying plan used is the same as that for 20 selectors on 10 to 15 trunks, inclusive, as shown on the charts following this paragraph 8.13. For trunk arrangements greater than 15 trunks, the plan, or arrangement for grading, will be as shown in the other portions of the charts. In general, fewer tie-cables are required if subgroups of 20, 40, 80, 160, or 320 selectors are used on selector frames 11' -6" high (320 Selector capacity size), while for 9' -0" high frames (240 Selector Capacity size) this will be true if subgroups of 20, 40, 60, 120, or 240 selectors are used. This practice, in general, is followed in the engineering of these subgroups except occasionally where it is desirable to use the 11' -6" frame subgrouping on 9' -0" frames or vice-versa in order to avoid future changes in the number of selectors per subgroup. Left-over, or partial, subgroups at the end of a group of selectors, must, of course, be given individual treatment. In these cases, it is essential, however, that the engineer provide as near as possible a smaller standard subgroup with sufficient out trunks to handle the traffic offered from the associated selectors.

Equalization of Traffic on Cables

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 IDF or TDF to repeaters either direct

or through out-trunk switches, outgoing trunks, DSA or toll board, 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 DTA are usually made in a left to right, top down order in each subgroup and to consecutive circuits of successive cables. Cross-connections for trunks from selectors to rotary and plunger type out-trunk switches follow a prescribed pattern set up by the Bell Laboratories (For reference, see drawing ED-30839-01 and ED-30302-01 respectively).

For selectors cabled directly to other selectors in the same building the equalization of traffic to cables is accomplished at the DTA through the use of standardized cross-connection plans for use with the new graded multiple arrangements described above. 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 switchboard 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, due to periodic changes in traffic. This is accomplished by the use of uniform cross-connecting patterns for most of the subgroups termed "fundamental" subgroups, and supplemented by a few "fill-in" subgroups. Occasionally trunks to the following selectors in the same office are cabled to the TDF or IDF for the purpose of mixing local and incoming traffic as discussed previously in this section. In such cases, where connections to the following local selectors can be made in groups of ten consecutive selectors on the same half-shelf, the standard cross-connecting plans at the DTA are used, the cross-connections at the TDF or IDF 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.

Figure 24 illustrates how the fundamental subgroups are repeated as many times as is required to complete the assignment of the outgoing trunks. In this figure it will also be noted that there are ten vertical rows of figures representing in order

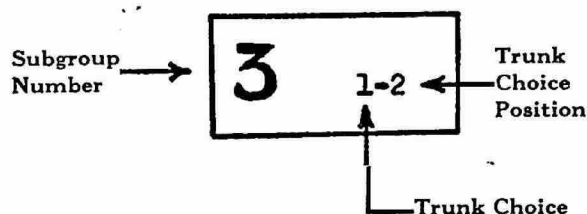
TRUNKS IN CABLE										CABLE NO.	
1	2	3	4	5	6	7	8	9	10		
1	1-1	1-2	2-1	3-2	5	6	4	8	9	10	1
	2-2	3-1	7	FI 3-1	1-1	7	5	7	3-1	2-2	2
2	1-1	1-2	2-1	3-2	5	6	4	8	9	10	3
3	1-1	1-2	2-1	3-2	5	6	4	8	9	10	4
	2-2	3-1	7	FI 2-2	1-2	10	8	7	3-1	2-2	5
4	1-1	1-2	2-1	3-2	5	6	4	8	9	10	6
5	1-1	1-2	2-1	3-2	5	6	4	8	9	10	7
	2-2	3-1	7	FI 3-2	2-1	6	9	7	3-1	2-2	8
6	1-1	1-2	2-1	3-2	5	6	4	8	9	10	9
7	1-1	1-2	2-1	3-2	5	6	4	8	9	10	10
	2-2	3-1	7	FI 4	F2 1-1	5	6	7	3-1	2-2	11
8	1-1	1-2	2-1	3-2	5	6	4	8	9	10	12
9	1-1	1-2	2-1	3-2	5	6	4	8	9	10	13
	2-2	3-1	7	F2 2-1	8	7	3-1	7	3-1	2-2	14
10	1-1	1-2	2-1	3-2	5	6	4	8	9	10	15
11	1-1	1-2	2-1	3-2	5	6	4	8	9	10	16
	2-2	3-1	7	F2 2-2	1-2	10	9	7	3-1	2-2	17
12	1-1	1-2	2-1	3-2	5	6	4	8	9	10	18
13	1-1	1-2	2-1	3-2	5	6	4	8	9	10	19
	2-2	3-1	7	F2 3-2	4	5	9	7	3-1	2-2	20
14 _(MOD)	1-1	1-2	2-1	3-2	10	6	4	8			21

Typical Example illustrating the Method of Repeating Fundamental Subgroups and a Modified Assignment of a Final Fundamental Subgroup to Connect Two of its Trunks Normally Connected with the Last Cable to Fill-in Positions 6 and 7 on Cable 20.

Figure 24

from left to right the ten circuits in the cables, while each horizontal row represents the particular trunks to be assigned to the ten trunks within a particular cable. In each of the spaces in the table (Figure 24), 1, 2 or 3 numbers may appear. The number in bold faced type designates the subgroup number. The number to the left of the dash designates the trunk choice, that is, the horizontal position of the trunk on the selector bank. The number to the right of the dash identifies the position of a particular trunk choice in the graded multiple pattern as on Figure 25 and 27. The position identification is required, since in any one pattern there may be several trunks of the same choice and they need to be specified by the engineer in order to save jumper changes on regrades. The trunk choice positions are numbered top down in each case.

For example.



Quite frequently we will find reference made to a particular "trunk choice" and "trunk choice position" in the multiple chart of a traffic order in a manner just explained. This reference is shown primarily as a definite instruction for the equipment engineer.

Many plans are available in the Equipment Engineer's Handbook pertaining to cross-connections for graded multiple trunk groups to other

selectors, trunks and repeaters. It is his responsibility to select the correct plan when preparing an equipment specification from a traffic order. To do so he must be familiar with the various plans.

The above covers the details of this subject only briefly, however, it will, no doubt, furnish sufficient details to permit one, not familiar with the engineering design requirements, to more readily understand and appreciate the fore-thought and reasoning that has been given to our intra-office trunking plans. Since these plans assume equal distribution of traffic, it is easy to see why it is so important that the originating traffic be equally distributed throughout the originating equipment. It is a traffic responsibility to see that this kind of distribution is maintained.

8.14 CAPACITY TABLES

The capacity tables in this section give the nominal trunk or circuit requirements corresponding with the service contemplated by each table. These tables should be looked upon as guides to the number of trunks or switches required in each particular path. Adequacy of equipment provision can be judged only on the basis of the resulting service. These tables are used principally by the Traffic Engineering group, however, they may be of considerable help to the traffic field men for administrative purposes. Capacity tables are included for Line Finders, Line Switch, Selector Graded Multiple, Connectors, Rotary Out Trunk Switch and Plunger Out Trunk Switches.

Section 10.0 of these notes will cover a more detailed explanation of the application of these Capacity Tables.

GRADED MULTIPLE ARRANGEMENTS FOR TRUNKS FROM SELECTOR MULTIPLE TO OTHER SELECTORS, TRUNKS OR REPEATERS

SELECTORS PER SUBGROUP

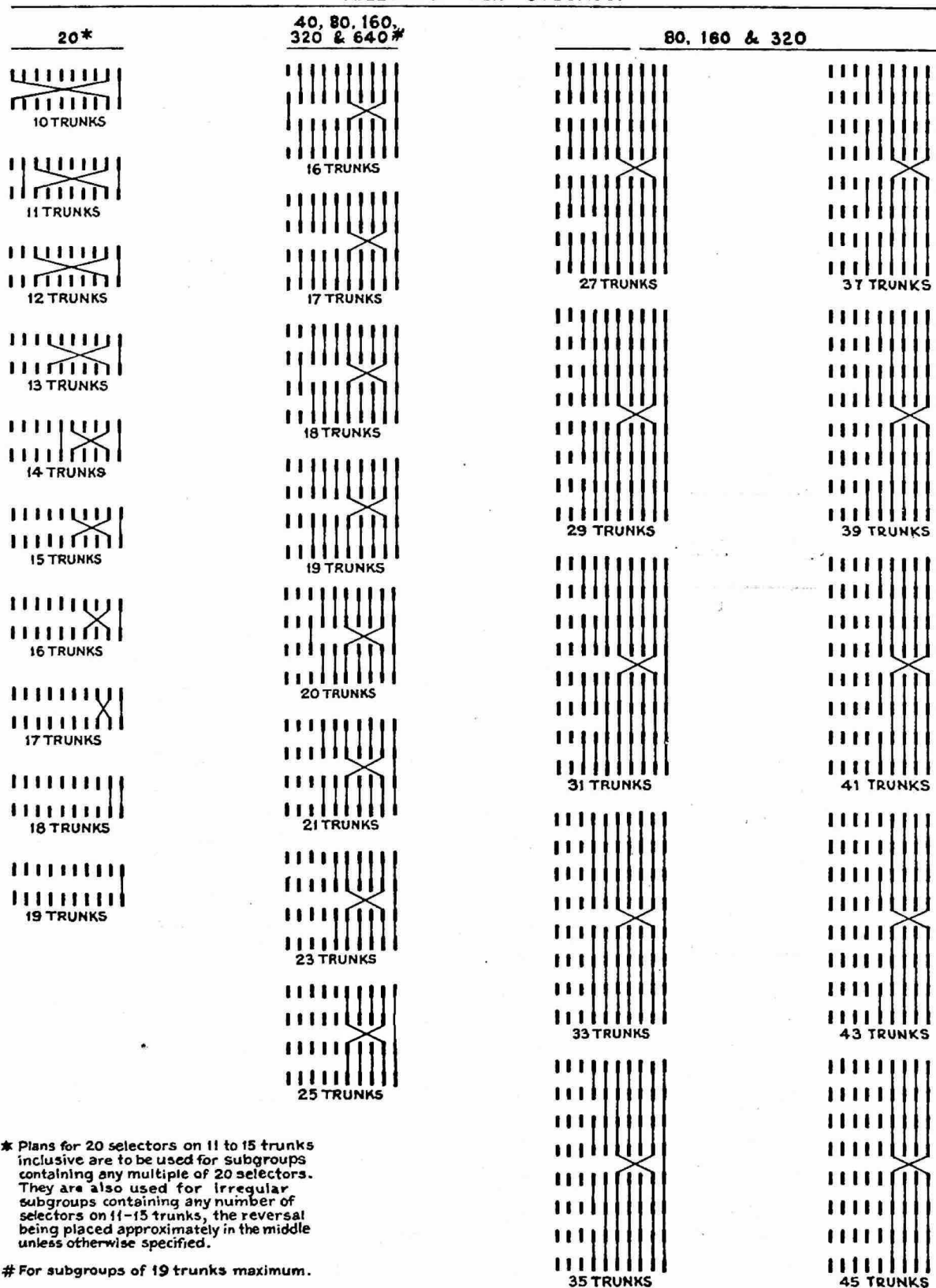


Figure 25

GRADED MULTIPLE ARRANGEMENTS FOR TRUNKS FROM SELECTOR MULTIPLE TO OTHER SELECTORS, TRUNKS OR REPEATERS

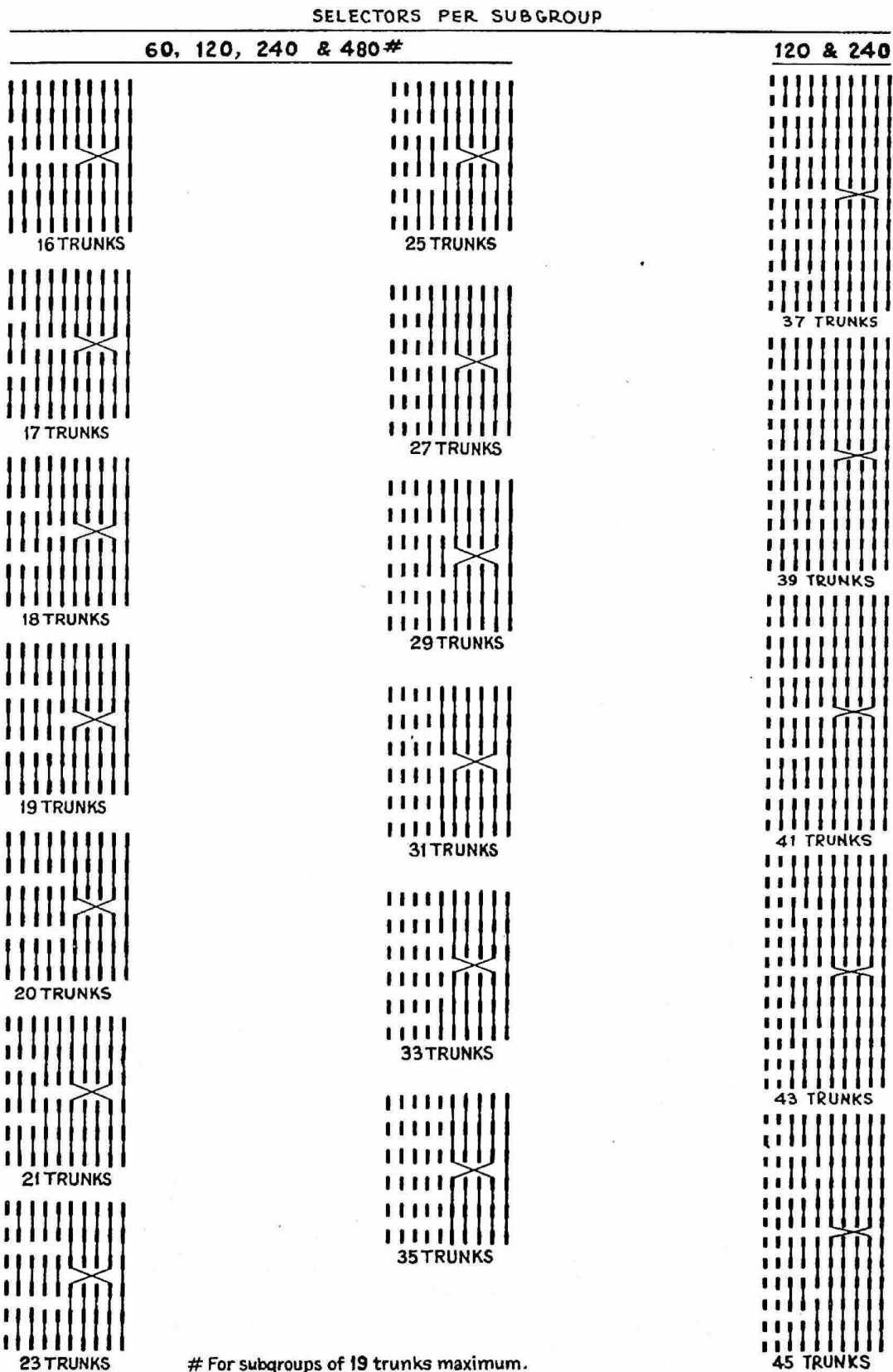


Figure 26

STEP-BY-STEP DIAL FACILITIES

TABLES

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STEP-BY-STEP LINE FINDER CAPACITY TABLES

NO. OF LINE FINDERS	PER CENT DIAL TONE IN EXCESS OF THREE SECONDS						NO. OF LINE FINDERS
	0.5%		1.5%		5.0%		
	CCS PER		CCS PER		CCS PER		
	LINE*	GROUP	LINE*	GROUP	LINE*	GROUP	
5	.21	40	.28	55	.37	72	5
6	.30	58	.40	77	.49	96	6
7	.40	77	.51	98	.63	122	7
8	.50	97	.63	122	.77	150	8
9	.61	118	.74	144	.92	178	9
10	.72	140	.87	168	1.07	208	10
11	.85	164	.99	192	1.20	232	11
12	.96	186	1.12	218	1.36	264	12
13	1.08	210	1.25	242	1.51	292	13
14	1.21	234	1.39	270	1.66	322	14
15	1.34	260	1.53	296	1.80	350	15
16	1.46	284	1.67	324	1.96	380	16
17	1.60	310	1.81	352	2.11	410	17
18	1.73	336	1.96	380	2.27	440	18
19	1.87	362	2.10	408	2.42	470	19
20	1.99	388	2.25	436	2.58	500	20
21	2.13	414	2.38	462	2.73	530	21
22	2.28	442	2.55	494	2.89	560	22
23	2.41	468	2.68	520	3.07	595	23
24	2.56	496	2.84	550	3.22	625	24
25	2.71	525	2.99	580	3.38	655	25
26	2.83	550	3.14	610	3.53	685	26
27	2.99	580	3.30	640	3.71	720	27
28	3.14	610	3.45	670	3.87	750	28
29	3.30	640	3.61	700	4.05	785	29
30	3.43	665	3.76	730	4.20	815	30

* ASSUMES 194 WORKING LINES PER GROUP.

PRIMARY AND SECONDARY LINE SWITCHES
CCS CAPACITY TABLES

PRIMARY LINE SWITCHES					
TRUNKS PER PRIMARY MASTER SWITCH	TRUNKS TO SECONDARY LINE SWITCHES			DIRECT TRUNKS TO FIRST SELECTORS	
	TABLE 1	TABLE 1 PLUS 10%	TABLE 1 PLUS 15%	TABLE 5	TABLE 10
8	71	-	-	92	105
9	88	97	-	113	126
10	107	118	123	134	149

SECONDARY LINE SWITCHES			
TRUNKS TO FIRST SELECTORS	TABLE 1 AT 85%	TABLE 1 AT 85% PLUS 10%	TABLE 1 AT 85% PLUS 15%
	(A)	(B)	(C)
70	1,390	1,520	1,590
80	1,630	1,790	1,880
90	1,880	2,070	2,170
100	2,140	2,350	2,460
110	2,350	2,580	2,700
120	2,560	2,820	2,950
130	2,780	3,050	3,190
140	2,990	3,290	3,440
150	3,200	3,520	3,680
160	3,420	3,760	3,930

- (A) FOR SYSTEMS WITHOUT ALLOTTER AND WHEATSTONE BRIDGE CIRCUITS.
- (B) FOR SYSTEMS WITH ALLOTTER AND WHEATSTONE BRIDGE CIRCUITS BUT WITH ONLY NINE TRUNKS PER PRIMARY SUBGROUP.
- (C) FOR SYSTEMS WITH ALLOTTER AND WHEATSTONE BRIDGE CIRCUITS AND TEN TRUNKS PER PRIMARY SUBGROUP.

STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 1

T R U N K S	SELECTORS PER SUBGROUP																T R U N K S
	320		240		160		120		80		60		40		20		
	CCS CAPACITY PER																
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	
10	.33	106	.45	108	.69	110	.92	110	1.40	112	1.90	114	3.00	120	6.80	136	10
11	.38	122	.52	124	.79	126	1.05	126	1.60	128	2.20	132	3.45	138	7.90	158	11
12	.43	138	.58	140	.89	142	1.18	142	1.80	144	2.50	150	3.90	156	9.10	182	12
13	.48	154	.65	156	.99	158	1.32	158	2.00	160	2.80	168	4.40	176	10.20	204	13
14	.53	168	.71	170	1.08	172	1.45	174	2.20	176	3.07	184	4.85	194	11.40	228	14
15	.57	182	.77	184	1.16	186	1.57	188	2.40	192	3.33	200	5.30	212	12.40	248	15
16	.61	196	.83	198	1.25	200	1.70	204	2.60	208	3.60	216	5.75	230	13.30	266	16
17	.66	210	.88	212	1.34	214	1.82	218	2.80	224	3.90	234	6.25	250	14.20	284	17
18	.70	224	.94	226	1.43	228	1.95	234	3.00	240	4.20	252	6.75	270	15.00	300	18
19	.74	238	1.01	242	1.53	244	2.08	250	3.23	258	4.50	270	7.30	292	15.70	314	19
20	.78	252	1.07	256	1.61	258	2.22	266	3.43	274	4.80	288	7.85	314	-	-	20
21	.83	266	1.13	270	1.71	274	2.35	282	3.63	290	5.10	306	8.35	334	-	-	21
23	.92	294	1.24	298	1.90	304	2.60	312	4.05	324	5.70	342	9.40	376	-	-	23
25	1.01	322	1.36	326	2.09	334	2.85	342	4.48	358	6.30	378	10.50	420	-	-	25
27	1.09	348	1.48	354	2.28	364	3.10	372	4.90	392	6.97	418	-	-	-	-	27
29	1.19	374	1.60	384	2.46	394	3.37	404	5.33	426	7.67	460	-	-	-	-	29
31	1.26	402	1.72	412	2.65	424	3.65	438	5.78	462	8.34	500	-	-	-	-	31
33	1.34	430	1.84	442	2.85	456	3.93	472	6.23	498	9.17	550	-	-	-	-	33
35	1.44	460	1.97	472	3.05	488	4.21	505	6.69	535	9.75	585	-	-	-	-	35
37	1.53	490	2.08	500	3.25	520	4.50	540	7.25	580	-	-	-	-	-	-	37
39	1.63	520	2.21	530	3.47	555	4.79	575	7.81	625	-	-	-	-	-	-	39
41	1.72	550	2.33	560	3.66	585	5.08	610	8.38	670	-	-	-	-	-	-	41
43	1.81	580	2.46	590	3.84	615	5.38	645	8.88	710	-	-	-	-	-	-	43
45	1.91	610	2.58	620	4.06	650	5.67	680	9.38	750	-	-	-	-	-	-	45
	320		240		160		120		80		60		40		20		

NON-GRADED GROUPS

TRUNKS	1	2	3	4	5	6	7	8	9
CCS CAPACITY	.1	1.6	6.9	15	27	40	55	71	88

STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 5

T R U N K S	SELECTORS PER SUBGROUP																T R U N K S
	320		240		160		120		80		60		40		20		
	CCS CAPACITY PER																
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	
10	.42	134	.57	136	.85	136	1.15	138	1.75	140	2.37	142	3.70	148	8.30	166	10
11	.48	154	.64	154	.98	156	1.32	158	2.00	160	2.70	162	4.25	170	9.60	192	11
12	.54	172	.72	172	1.09	174	1.47	176	2.25	180	3.07	184	4.80	192	10.90	218	12
13	.59	190	.79	190	1.20	192	1.62	194	2.50	200	3.40	204	5.35	214	12.20	244	13
14	.65	208	.87	208	1.31	210	1.77	212	2.73	218	3.73	224	5.90	236	13.50	270	14
15	.70	224	.93	224	1.43	228	1.92	230	2.94	236	4.00	242	6.40	256	14.70	294	15
16	.75	240	1.01	242	1.53	244	2.07	248	3.16	254	4.37	262	6.95	278	15.80	316	16
17	.80	256	1.08	258	1.64	262	2.22	266	3.37	272	4.70	282	7.50	300	16.80	336	17
18	.85	272	1.15	276	1.74	278	2.37	284	3.61	292	5.03	302	8.10	324	17.70	354	18
19	.91	290	1.23	294	1.85	296	2.52	302	3.83	310	5.40	324	8.70	348	18.60	372	19
20	.96	306	1.30	312	1.96	314	2.67	320	4.07	330	5.73	344	9.30	372	-	-	20
21	1.01	324	1.37	328	2.08	332	2.80	336	4.31	350	6.07	364	9.95	398	-	-	21
23	1.12	358	1.51	362	2.30	368	3.13	376	4.79	390	6.80	408	11.15	446	-	-	23
25	1.22	390	1.64	394	2.51	402	3.43	412	5.27	430	7.53	452	12.35	494	-	-	25
27	1.32	422	1.78	428	2.73	436	3.73	448	5.75	470	8.23	494	-	-	-	-	27
29	1.42	454	1.93	464	2.94	470	4.07	488	6.23	510	9.00	540	-	-	-	-	29
31	1.53	488	2.08	498	3.16	505	4.38	525	6.77	555	9.83	590	-	-	-	-	31
33	1.63	520	2.23	535	3.38	540	4.71	565	7.25	595	10.67	640	-	-	-	-	33
35	1.73	555	2.38	570	3.63	580	5.04	605	7.79	640	11.50	690	-	-	-	-	35
37	1.84	590	2.50	600	3.88	620	5.38	645	8.39	690	-	-	-	-	-	-	37
39	1.95	625	2.65	635	4.13	660	5.71	685	8.99	740	-	-	-	-	-	-	39
41	2.06	660	2.79	670	4.34	695	6.04	725	9.59	790	-	-	-	-	-	-	41
43	2.17	695	2.94	705	4.59	735	6.38	765	10.13	835	-	-	-	-	-	-	43
45	2.28	730	3.08	740	4.84	775	6.71	805	10.67	880	-	-	-	-	-	-	45
	320		240		160		120		80		60		40		20		

NON-GRADED GROUPS

TRUNKS	1	2	3	4	5	6	7	8	9
CCS CAPACITY	.2	3.7	12	24	39	55	73	92	113

STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 10

T R U N K S	SELECTORS PER SUBGROUP																T R U N K S
	320		240		160		120		80		60		40		20		
	CCS CAPACITY PER																
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	
10	.47	149	.63	150	.95	152	1.28	154	1.95	156	2.63	158	4.10	164	9.10	182	10
11	.52	168	.71	170	1.08	172	1.45	174	2.20	176	3.00	180	4.65	186	10.50	210	11
12	.59	188	.79	190	1.20	192	1.62	194	2.47	198	3.37	202	5.25	210	11.90	238	12
13	.65	208	.87	210	1.33	212	1.78	214	2.73	218	3.73	224	5.85	234	13.20	264	13
14	.71	228	.96	230	1.45	232	1.95	234	2.98	238	4.10	246	6.45	258	14.50	290	14
15	.77	246	1.03	248	1.56	250	2.12	254	3.23	258	4.33	266	7.00	280	15.80	316	15
16	.82	264	1.11	266	1.68	268	2.27	272	3.48	278	4.77	286	7.60	304	17.10	342	16
17	.88	282	1.18	284	1.80	288	2.43	292	3.73	298	5.13	308	8.20	328	18.20	364	17
18	.94	300	1.26	304	1.91	306	2.60	312	3.98	318	5.50	330	8.80	352	19.20	384	18
19	.99	318	1.34	322	2.03	324	2.77	332	4.25	340	5.90	354	9.45	378	20.20	404	19
20	1.05	336	1.43	342	2.15	344	2.93	352	4.50	360	6.27	376	10.10	404	-	-	20
21	1.11	354	1.50	360	2.27	364	3.08	370	4.77	382	6.63	398	10.75	430	-	-	21
23	1.22	390	1.65	396	2.51	402	3.42	410	5.32	426	7.40	444	12.20	480	-	-	23
25	1.33	426	1.80	432	2.74	438	3.75	450	5.88	470	8.17	490	13.25	530	-	-	25
27	1.44	462	1.95	468	2.96	474	4.08	490	6.44	515	9.00	540	-	-	-	-	27
29	1.56	498	2.10	505	3.19	510	4.42	530	7.00	560	9.92	595	-	-	-	-	29
31	1.67	535	2.27	545	3.44	550	4.75	570	7.56	605	10.75	645	-	-	-	-	31
33	1.78	570	2.44	585	3.69	590	5.13	615	8.12	650	11.58	695	-	-	-	-	33
35	1.89	605	2.58	620	3.94	630	5.46	655	8.69	695	12.42	745	-	-	-	-	35
37	2.02	645	2.73	655	4.22	675	5.79	695	9.31	745	-	-	-	-	-	-	37
39	2.14	685	2.90	695	4.47	715	6.17	740	10.00	800	-	-	-	-	-	-	39
41	2.25	720	3.04	730	4.72	755	6.54	785	10.63	850	-	-	-	-	-	-	41
43	2.36	755	3.19	765	4.97	795	6.87	825	11.25	900	-	-	-	-	-	-	43
45	2.48	795	3.35	805	5.25	840	7.25	870	11.87	950	-	-	-	-	-	-	45
	320		240		160		120		80		60		40		20		

NON-GRADED GROUPS

TRUNKS	1	2	3	4	5	6	7	8	9
CCS CAPACITY	.4	5.4	16	30	46	64	84	105	126

STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 20

T R U N K S	SELECTORS PER SUBGROUP																T R U N K S
	320		240		160		120		80		60		40		20		
	CCS CAPACITY PER																
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	
10	.52	166	.70	168	1.06	170	1.42	170	2.18	174	2.93	176	4.55	182	10.10	202	10
11	.58	186	.79	190	1.20	192	1.60	192	2.45	196	3.30	198	5.15	206	11.50	230	11
12	.65	208	.88	212	1.34	214	1.78	214	2.73	218	3.70	222	5.80	232	12.90	258	12
13	.72	230	.97	232	1.48	236	1.97	236	3.03	242	4.10	246	6.40	256	14.40	288	13
14	.78	250	1.05	254	1.60	256	2.15	258	3.30	264	4.50	270	7.05	282	15.80	316	14
15	.84	270	1.13	272	1.73	276	2.32	278	3.58	286	4.87	292	7.65	306	17.20	344	15
16	.91	290	1.23	294	1.85	296	2.50	300	3.83	306	5.23	314	8.30	332	18.50	370	16
17	.97	310	1.31	314	1.98	316	2.67	320	4.10	328	5.63	338	8.90	356	19.70	394	17
18	1.03	330	1.39	334	2.10	336	2.85	342	4.38	350	6.04	362	9.55	382	20.80	416	18
19	1.09	350	1.48	354	2.23	356	3.03	364	4.65	372	6.44	386	10.25	410	21.80	436	19
20	1.16	370	1.56	376	2.36	378	3.22	386	4.93	394	6.67	410	10.95	438	-	-	20
21	1.22	390	1.64	392	2.49	398	3.38	406	5.23	418	7.20	432	11.65	466	-	-	21
23	1.34	430	1.81	434	2.74	438	3.75	450	5.80	464	8.04	482	13.00	520	-	-	23
25	1.47	470	1.97	472	3.00	480	4.08	490	6.38	510	8.84	530	14.38	575	-	-	25
27	1.59	510	2.13	510	3.25	520	4.46	535	6.94	555	9.75	585	-	-	-	-	27
29	1.72	550	2.31	555	3.50	560	4.83	580	7.50	600	10.67	640	-	-	-	-	29
31	1.84	590	2.48	595	3.78	605	5.21	625	8.13	650	11.50	690	-	-	-	-	31
33	1.97	630	2.67	640	4.03	645	5.58	670	8.75	700	12.42	745	-	-	-	-	33
35	2.09	670	2.83	680	4.31	690	5.96	715	9.44	755	13.34	800	-	-	-	-	35
37	2.22	710	3.00	710	4.59	735	6.29	755	10.13	810	-	-	-	-	-	-	37
39	2.34	750	3.17	760	4.88	780	6.67	800	10.81	865	-	-	-	-	-	-	39
41	2.47	790	3.33	800	5.16	825	7.08	850	11.50	920	-	-	-	-	-	-	41
43	2.59	830	3.50	835	5.44	870	7.46	895	12.13	970	-	-	-	-	-	-	43
45	2.72	870	3.67	880	5.72	915	7.88	945	12.75	1020	-	-	-	-	-	-	45
	320		240		160		120		80		60		40		20		

NON-GRADED GROUPS

TRUNKS	1	2	3	4	5	6	7	8	9
CCS CAPACITY	0.7	7.9	20	37	56	76	97	119	142

STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 30

T R U N K S	SELECTORS PER SUBGROUP																T R U N K S
	320		240		160		120		80		60		40		20		
	CCS CAPACITY PER																
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	
10	.56	178	.75	180	1.14	182	1.52	182	2.33	186	3.13	188	4.85	194	10.70	214	10
11	.63	200	.84	202	1.28	204	1.72	206	2.60	208	3.53	212	5.50	220	12.10	242	11
12	.69	222	.93	224	1.41	226	1.92	230	2.90	232	3.93	236	6.15	246	13.60	272	12
13	.76	244	1.03	246	1.55	248	2.10	252	3.20	256	4.33	260	6.80	272	15.10	302	13
14	.83	266	1.12	268	1.69	270	2.28	274	3.50	280	4.73	284	7.45	298	16.60	332	14
15	.90	288	1.21	290	1.83	292	2.47	296	3.78	302	5.13	308	8.10	324	18.10	362	15
16	.96	308	1.29	310	1.96	314	2.65	318	4.05	324	5.53	332	8.75	350	19.40	388	16
17	1.03	328	1.38	332	2.09	334	2.83	340	4.35	348	5.94	356	9.40	376	20.60	412	17
18	1.09	350	1.48	354	2.23	356	3.02	362	4.63	370	6.37	382	10.10	404	21.80	436	18
19	1.16	370	1.57	376	2.36	378	3.20	384	4.93	394	6.80	408	10.80	432	22.80	456	19
20	1.23	392	1.65	396	2.50	400	3.38	406	5.23	418	7.24	434	11.50	460	-	-	20
21	1.29	412	1.73	416	2.64	422	3.57	428	5.53	442	7.67	460	12.20	488	-	-	21
23	1.43	456	1.92	460	2.91	466	3.95	474	6.13	490	8.50	510	13.63	545	-	-	23
25	1.56	500	2.08	500	3.19	510	4.33	520	6.75	540	9.34	560	15.00	600	-	-	25
27	1.69	540	2.25	540	3.44	550	4.71	565	7.31	585	10.17	610	-	-	-	-	27
29	1.81	580	2.44	585	3.69	590	5.08	610	7.94	635	11.09	665	-	-	-	-	29
31	1.94	620	2.63	630	3.97	635	5.50	660	8.56	685	12.09	725	-	-	-	-	31
33	2.06	660	2.81	675	4.25	680	5.92	710	9.19	735	13.09	785	-	-	-	-	33
35	2.20	705	3.00	720	4.56	730	6.29	755	9.88	790	14.00	840	-	-	-	-	35
37	2.34	750	3.17	760	4.88	780	6.67	800	10.56	845	-	-	-	-	-	-	37
39	2.48	795	3.35	805	5.19	830	7.08	850	11.31	905	-	-	-	-	-	-	39
41	2.61	835	3.52	845	5.47	875	7.50	900	12.00	960	-	-	-	-	-	-	41
43	2.73	875	3.69	885	5.75	920	7.88	945	12.69	1015	-	-	-	-	-	-	43
45	2.88	920	3.88	930	6.03	965	8.29	995	13.38	1070	-	-	-	-	-	-	45
	320		240		160		120		80		60		40		20		

NON-GRADED GROUPS

TRUNKS	1	2	3	4	5	6	7	8	9
CCS CAPACITY	1.1	9.7	24	42	62	83	105	129	153

SELECTORS PER TEN TRUNKS
10 TERMINAL ACCESS

SELECTORS PER TEN TRUNKS	TABLE 1	TABLE 5	TABLE 10	TABLE 20	TABLE 30
	CCS CAPACITY PER SELECTOR				
200	.54	.68	.76	.85	.91
190	.57	.72	.80	.89	.95
180	.61	.76	.85	.94	1.01
170	.64	.80	.89	.99	1.07
160	.69	.85	.95	1.06	1.14
150	.73	.91	1.01	1.13	1.21
140	.79	.98	1.09	1.21	1.30
130	.85	1.06	1.18	1.31	1.40
120	.92	1.15	1.28	1.42	1.52
110	1.01	1.25	1.40	1.55	1.66
100	1.11	1.39	1.54	1.72	1.83
90	1.24	1.56	1.72	1.92	2.04
80	1.40	1.75	1.95	2.18	2.33
70	1.61	2.02	2.24	2.50	2.67
60	1.90	2.37	2.63	2.93	3.13
50	2.32	2.90	3.20	3.56	3.80
45	2.60	3.24	3.58	3.98	4.27
40	3.00	3.70	4.10	4.55	4.85
35	3.46	4.29	4.74	5.26	5.60
30	4.13	5.10	5.63	6.23	6.63
25	5.12	6.32	6.96	7.68	8.20
20	6.80	8.30	9.10	10.10	10.65
18	7.72	9.45	10.33	11.39	12.00
16	8.88	10.81	11.81	13.00	13.69
14	10.43	12.65	13.79	15.15	16.00
13	11.46	13.85	15.08	16.45	17.45
12	12.67	15.25	16.59	18.16	19.16
11	14.27	17.09	18.55	20.27	21.28

NOTE: IF THE CCS PER SELECTOR IS LOWER THAN THE ABOVE TABLE COVERS, DIVIDE THE FOLLOWING VALUES BY THE CCS PER SELECTOR TO DETERMINE THE NUMBER OF SELECTORS THAT MAY BE MULTIPLIED BEFORE TEN TRUNKS:

TABLE	VALUE
1	107
5	134
10	149
20	166
30	178

CONNECTOR CAPACITY TABLE

NUMBER OF CONNECTORS	CCS CAPACITY	
	TABLE 10	TABLE 20*
5	46	56
6	64	76
7	84	97
8	105	119
9	126	142
10	149	166
11	168	186
12	187	206
13	205	228
14	223	248
15	241	268
16	259	288
17	276	308
18	294	326
19	312	346
20	329	366
21	347	386
23	382	424
25	417	462
27	451	500
29	485	540
31	519	575

* TABLE 20 TO BE USED ONLY FOR MIXED
CLASS SELECTOR GRADES AS COVERED
IN T.E.P. DIV. D, SEC. 4-C AND
WHERE TABLE 20 IS APPLICABLE.

ROTARY OUT TRUNK SWITCH TABLES

TRUNK GROUP CAPACITIES

T R U N K S	CCS		T R U N K S	CCS		T R U N K S	CCS	
	TABLE			TABLE			TABLE	
	10	20		10	20		10	20
22	425	455	72	1820	1890	122	3330	3410
23	450	480	73	1850	1920	123	3360	3440
24	475	510	74	1880	1950	124	3390	3470
25	500	535	75	1910	1980	125	3420	3490
26	530	560	76	1940	2010	126	3450	3520
27	555	590	77	1970	2040	127	3480	3550
28	580	615	78	2000	2070	128	3500	3580
29	605	645	79	2030	2100	129	3530	3600
30	635	670	80	2060	2130	130	3560	3630
31	660	700	81	2090	2160	131	3580	3660
32	690	725	82	2120	2190	132	3610	3690
33	715	755	83	2150	2220	133	3640	3720
34	740	780	84	2180	2250	134	3660	3740
35	770	810	85	2210	2280	135	3690	3770
36	800	840	86	2240	2310	136	3720	3800
37	825	865	87	2270	2340	137	3750	3830
38	850	895	88	2300	2370	138	3770	3860
39	880	925	89	2330	2400	139	3800	3880
40	910	950	90	2360	2430	140	3830	3910
41	935	980	91	2390	2460	141	3850	3930
42	965	1010	92	2420	2500	142	3880	3960
43	990	1040	93	2450	2530	143	3900	3990
44	1020	1070	94	2480	2560	144	3930	4020
45	1050	1100	95	2510	2590	145	3960	4050
46	1080	1120	96	2540	2620	146	3990	4070
47	1100	1150	97	2570	2650	147	4010	4100
48	1130	1180	98	2600	2680	148	4040	4130
49	1160	1210	99	2630	2710	149	4070	4160
50	1190	1240	100	2660	2740	150	4100	4190
51	1210	1270	101	2690	2770	151	4120	4210
52	1240	1300	102	2720	2800	152	4150	4240
53	1270	1330	103	2750	2830	153	4180	4270
54	1300	1360	104	2780	2860	154	4200	4300
55	1330	1390	105	2810	2890	155	4230	4330
56	1360	1420	106	2840	2920	156	4260	4350
57	1380	1450	107	2870	2950	157	4290	4380
58	1410	1480	108	2900	2980	158	4310	4410
59	1440	1500	109	2930	3010	159	4340	4440
60	1470	1530	110	2960	3050	160	4370	4460
61	1500	1560	111	2990	3080	THE CCS CAPACITY OF GROUPS IN EXCESS OF 160 TRUNKS MAY BE DETERMINED BY MULTIPLYING THE NUMBER OF TRUNKS BY 27.3 FOR TABLE 10 AND BY 27.9 FOR TABLE 20.		
62	1530	1590	112	3020	3110			
63	1560	1620	113	3050	3140			
64	1590	1650	114	3080	3170			
65	1610	1680	115	3110	3200			
66	1640	1710	116	3140	3230			
67	1670	1740	117	3170	3260			
68	1700	1770	118	3200	3290			
69	1730	1800	119	3230	3320			
70	1760	1830	120	3260	3350			
71	1790	1860	121	3290	3380			

ARRANGEMENT OF
TRUNKS FROM
SELECTOR LEVELS

TRUNKS PER SUBGROUP FROM SELECTOR MULTIPLE	DIRECT TRUNKS	TRUNKS TO ROTS
1	0	1
2	0	2
3	0	3
4	0	4
5	2	3
6	2	4
7	3	4
8	3	5
9	4	5
10	4	6
11	5	6
12	5	7
13	5	8
14	6	8
15	6	9
16	7	9
17	7	10
18	8	10
19	8	11
20	8	12
21	8	13
23	9	14
25	10	15
27	11	16
29	12	17
31	12	19
33	13	20
35	14	21
37	15	22
39	16	23
41	16	25
43	17	26
45	18	27

PLUNGER OUT TRUNK SWITCH TABLES

TRUNK GROUP CAPACITIES

T R U N K S	CCS		T R U N K S	CCS		T R U N K S	CCS		T R U N K S	CCS	
	TABLE			TABLE			TABLE			TABLE	
	10	20		10	20		10	20		10	20
20	320	348	56	1190	1240	92	2130	2200	128	3000	3100
21	342	370	57	1220	1270	93	2150	2230	129	3020	3120
22	366	392	58	1240	1300	94	2180	2250	130	3040	3150
23	388	416	59	1270	1320	95	2210	2280	131	3070	3170
24	410	440	60	1290	1350	96	2230	2300	132	3090	3190
25	434	464	61	1320	1370	97	2260	2330	133	3110	3220
26	456	488	62	1340	1400	98	2290	2360	134	3140	3240
27	480	510	63	1370	1430	99	2310	2390	135	3160	3270
28	500	535	64	1390	1450	100	2340	2420	136	3180	3290
29	525	560	65	1420	1480	101	2360	2440	137	3210	3310
30	550	585	66	1450	1510	102	2390	2470	138	3230	3340
31	570	610	67	1470	1530	103	2410	2490	139	3250	3360
32	595	635	68	1500	1560	104	2440	2520	140	3280	3390
33	620	660	69	1520	1590	105	2460	2540	141	3300	3410
34	645	685	70	1550	1610	106	2480	2570	142	3320	3440
35	670	710	71	1580	1640	107	2510	2590	143	3350	3460
36	690	735	72	1600	1670	108	2530	2610	144	3370	3480
37	715	760	73	1630	1690	109	2550	2640	145	3390	3510
38	740	785	74	1650	1720	110	2580	2660	146	3420	3530
39	765	810	75	1680	1750	111	2600	2690	147	3440	3560
40	790	835	76	1710	1770	112	2620	2710	148	3470	3580
41	815	860	77	1730	1800	113	2650	2730	149	3490	3600
42	840	885	78	1760	1830	114	2670	2760	150	3510	3630
43	865	910	79	1780	1850	115	2690	2780	151	3540	3650
44	890	935	80	1810	1880	116	2720	2810	152	3560	3680
45	910	960	81	1840	1900	117	2740	2830	153	3580	3700
46	935	985	82	1860	1930	118	2760	2860	154	3610	3730
47	960	1010	83	1890	1950	119	2790	2880	155	3630	3750
48	985	1040	84	1920	1990	120	2810	2900	156	3650	3780
49	1010	1060	85	1940	2010	121	2830	2930	157	3680	3800
50	1040	1090	86	1970	2040	122	2860	2950	158	3700	3820
51	1060	1110	87	2000	2060	123	2880	2980	159	3720	3850
52	1090	1140	88	2020	2090	124	2900	3000	160	3740	3870
53	1110	1170	89	2050	2120	125	2930	3020			
54	1140	1190	90	2080	2150	126	2950	3050			
55	1160	1220	91	2100	2170	127	2970	3070			

TRUNK CAPACITY TABLES
Hundred Call-Seconds and Per Cent.
Use at Various Service Levels for
Trunk Groups of 1 to 50

The Table Number Indicates the Number of Calls per 1000 Encountering All Trunks Busy

Trunks	Table 1		Table 5		Table 10		Table 20		Table 30		Table 40		Trunks
	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	
1	.1	.1	.2	.5	.4	1.0	.7	2.0	1.1	3.1	1.5	4.2	1
2	1.6	2.3	3.7	4.8	5.4	7.5	7.9	10.9	9.7	13.5	11.3	15.7	2
3	6.9	6.4	12.2	11.3	15.7	14.5	20.4	18.9	24.0	22.2	26.9	24.9	3
4	15.4	10.7	24.2	16.8	29.6	20.6	36.7	25.5	41.6	28.9	45.7	31.8	4
5	26.6	14.8	38.9	21.6	46.1	25.6	55.8	31.0	61.6	34.2	66.6	37.0	5
6	40.0	18.5	55.4	25.7	64.4	29.8	76.0	35.2	82.8	38.3	89.3	41.3	6
7	54.7	21.7	73.4	29.1	83.9	33.3	96.8	38.4	105	41.7	112	44.4	7
8	70.9	24.6	92.5	32.1	105	36.5	119	41.3	129	44.8	137	47.6	8
9	88.2	27.2	113	34.9	126	38.9	142	43.8	153	47.2	162	50.0	9
10	107	29.7	134	37.2	149	41.4	166	46.1	178	49.4	188	52.2	10
11	126	31.8	156	39.4	172	43.4	191	48.2	204	51.5	214	54.0	11
12	146	33.6	178	41.2	195	45.1	216	50.0	230	53.3	240	55.6	12
13	166	35.5	201	42.9	220	47.0	241	51.5	256	54.7	267	57.1	13
14	187	37.1	224	44.4	244	48.4	267	53.0	283	56.1	295	58.5	14
15	208	38.5	248	45.9	269	49.8	293	54.3	310	57.4	322	59.6	15
16	231	40.0	273	47.4	294	51.1	320	55.6	337	58.5	350	60.8	16
17	253	41.3	297	48.5	320	52.3	347	56.7	365	59.6	378	61.8	17
18	276	42.6	322	49.7	346	53.4	374	57.7	392	60.5	407	62.8	18
19	299	43.7	347	50.7	373	54.5	401	58.6	420	61.4	436	63.8	19
20	323	44.9	373	51.8	399	55.4	429	59.6	449	62.4	465	64.6	20
21	346	45.8	399	52.8	426	56.4	458	60.6	478	63.2	494	65.3	21
22	370	46.7	424	53.5	453	57.2	486	61.4	507	64.0	523	66.0	22
23	395	47.7	451	54.5	480	58.0	514	62.1	536	64.7	552	66.7	23
24	419	48.5	477	55.2	507	58.7	542	62.8	564	65.3	582	67.4	24
25	444	49.3	504	56.0	535	59.4	571	63.4	593	65.9	611	67.9	25
26	469	50.1	531	56.7	562	60.1	599	64.0	623	66.6	641	68.5	26
27	495	50.9	558	57.4	590	60.7	627	64.5	652	67.1	671	68.9	27
28	520	51.6	585	58.0	618	61.3	656	65.1	682	67.7	701	69.6	28
29	545	52.2	612	58.6	647	62.0	685	65.6	711	68.1	731	70.0	29
30	571	52.9	640	59.3	675	62.5	715	66.2	741	68.6	762	70.6	30
31	597	53.5	667	59.8	703	63.0	744	66.7	771	69.1	792	71.0	31
32	624	54.2	695	60.3	732	63.6	773	67.1	801	69.5	822	71.4	32
33	650	54.7	723	60.8	760	64.0	803	67.6	831	69.9	852	71.7	33
34	676	55.2	751	61.4	789	64.5	832	68.0	861	70.3	883	72.1	34
35	703	55.8	779	61.8	818	64.9	862	68.4	891	70.7	913	72.5	35
36	729	56.3	807	62.3	847	65.4	892	68.8	922	71.1	944	72.8	36
37	756	56.8	836	62.8	876	65.8	922	69.2	952	71.5	975	73.2	37
38	783	57.3	864	63.2	905	66.2	952	69.6	982	71.8	1006	73.5	38
39	810	57.7	892	63.5	935	66.6	982	69.9	1013	72.1	1037	73.9	39
40	837	58.1	921	64.0	964	66.9	1012	70.3	1043	72.4	1069	74.2	40
41	865	58.6	950	64.4	993	67.3	1042	70.6	1074	72.8	1099	74.4	41
42	892	59.0	979	64.7	1023	67.7	1072	70.9	1104	73.0	1130	74.7	42
43	919	59.4	1008	65.1	1052	68.0	1103	71.3	1135	73.3	1161	75.0	43
44	947	59.8	1036	65.4	1082	68.3	1133	71.5	1166	73.6	1192	75.3	44
45	975	60.2	1066	65.8	1112	68.6	1164	71.8	1197	73.9	1223	75.5	45
46	1003	60.6	1095	66.1	1142	69.0	1194	72.1	1228	74.2	1255	75.8	46
47	1030	60.9	1124	66.4	1171	69.2	1225	72.4	1259	74.4	1286	76.0	47
48	1058	61.2	1153	66.7	1201	69.5	1255	72.6	1291	74.7	1317	76.2	48
49	1086	61.6	1183	67.1	1231	69.8	1286	72.9	1322	74.9	1349	76.5	49
50	1115	61.9	1212	67.3	1261	70.1	1317	73.2	1353	75.2	1381	76.7	50

TRUNK CAPACITY TABLES
Hundred Call-Seconds and Per Cent.
Use at Various Service Levels for
Trunk Groups of 51 to 100

The Table Number Indicates the Number of Calls per 1000 Encountering All Trunks Busy

Trunks	Table 1		Table 5		Table 10		Table 20		Table 30		Table 40		Trunks
	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	
51	1143	62.3	1241	67.6	1291	70.3	1348	73.4	1384	75.4	1412	76.9	51
52	1171	62.6	1271	67.9	1322	70.6	1378	73.6	1416	75.6	1444	77.1	52
53	1200	62.9	1301	68.2	1352	70.9	1410	73.9	1447	75.8	1475	77.3	53
54	1228	63.2	1330	68.4	1382	71.1	1441	74.1	1478	76.0	1507	77.5	54
55	1256	63.4	1360	68.7	1412	71.3	1472	74.3	1509	76.2	1539	77.7	55
56	1285	63.8	1390	68.9	1443	71.6	1503	74.6	1541	76.4	1571	77.9	56
57	1313	64.0	1419	69.2	1473	71.8	1534	74.8	1572	76.6	1602	78.1	57
58	1342	64.3	1449	69.4	1504	72.0	1565	74.9	1604	76.8	1634	78.3	58
59	1371	64.6	1479	69.6	1534	72.2	1596	75.1	1635	77.0	1666	78.4	59
60	1400	64.8	1509	69.9	1565	72.4	1627	75.3	1667	77.2	1698	78.6	60
61	1428	65.0	1539	70.1	1595	72.6	1659	75.5	1698	77.3	1730	78.8	61
62	1457	65.3	1570	70.3	1626	72.9	1690	75.7	1730	77.5	1762	78.9	62
63	1486	65.5	1599	70.5	1657	73.1	1722	75.9	1762	77.7	1794	79.1	63
64	1516	65.8	1630	70.7	1687	73.2	1752	76.1	1794	77.9	1826	79.3	64
65	1544	66.0	1660	70.9	1718	73.4	1784	76.3	1826	78.0	1858	79.4	65
66	1574	66.2	1690	71.1	1749	73.6	1816	76.4	1857	78.2	1890	79.6	66
67	1603	66.4	1721	71.3	1780	73.8	1847	76.6	1889	78.3	1922	79.7	67
68	1632	66.7	1751	71.5	1811	74.0	1878	76.7	1921	78.5	1955	79.9	68
69	1661	66.9	1781	71.7	1842	74.2	1910	76.9	1953	78.6	1987	80.0	69
70	1691	67.1	1812	71.9	1873	74.3	1941	77.0	1985	78.8	2019	80.1	70
71	1720	67.3	1842	72.1	1904	74.5	1973	77.2	2017	78.9	2051	80.3	71
72	1750	67.5	1873	72.3	1935	74.7	2004	77.3	2048	79.0	2084	80.4	72
73	1779	67.7	1903	72.4	1966	74.8	2036	77.5	2080	79.1	2116	80.5	73
74	1809	67.9	1934	72.6	1997	75.0	2067	77.6	2112	79.3	2148	80.6	74
75	1838	68.1	1965	72.8	2028	75.1	2099	77.8	2145	79.4	2181	80.8	75
76	1868	68.3	1995	72.9	2059	75.3	2130	77.9	2176	79.5	2213	80.9	76
77	1898	68.5	2026	73.1	2091	75.4	2162	78.0	2209	79.7	2245	81.0	77
78	1927	68.6	2057	73.3	2122	75.6	2194	78.1	2241	79.8	2278	81.1	78
79	1957	68.8	2088	73.4	2153	75.7	2226	78.3	2273	79.9	2310	81.2	79
80	1986	69.0	2118	73.5	2184	75.8	2258	78.4	2305	80.0	2343	81.3	80
81	2016	69.1	2149	73.7	2215	76.0	2290	78.5	2337	80.1	2375	81.4	81
82	2046	69.3	2180	73.9	2247	76.1	2322	78.7	2370	80.3	2408	81.6	82
83	2076	69.5	2211	74.0	2278	76.3	2354	78.8	2402	80.4	2440	81.7	83
84	2106	69.6	2242	74.1	2310	76.4	2386	78.9	2435	80.5	2473	81.8	84
85	2136	69.8	2273	74.3	2341	76.5	2418	79.0	2467	80.6	2506	81.9	85
86	2166	70.0	2304	74.4	2373	76.6	2450	79.1	2499	80.7	2538	82.0	86
87	2196	70.1	2335	74.6	2404	76.8	2482	79.3	2532	80.8	2571	82.1	87
88	2226	70.3	2366	74.7	2436	76.9	2514	79.4	2564	80.9	2604	82.2	88
89	2256	70.4	2397	74.8	2467	77.0	2546	79.5	2596	81.0	2636	82.3	89
90	2286	70.6	2428	74.9	2499	77.1	2578	79.6	2629	81.1	2669	82.4	90
91	2317	70.7	2459	75.1	2530	77.2	2611	79.7	2661	81.2	2702	82.5	91
92	2346	70.8	2490	75.2	2562	77.4	2643	79.8	2694	81.3	2735	82.6	92
93	2377	71.0	2521	75.3	2594	77.5	2674	79.9	2726	81.4	2767	82.6	93
94	2407	71.1	2553	75.4	2625	77.6	2706	80.0	2759	81.5	2800	82.7	94
95	2437	71.3	2584	75.6	2657	77.7	2739	80.1	2791	81.6	2833	82.8	95
96	2468	71.4	2615	75.7	2689	77.8	2771	80.2	2824	81.7	2865	82.9	96
97	2498	71.5	2646	75.8	2721	77.9	2803	80.3	2857	81.8	2898	83.0	97
98	2528	71.7	2678	75.9	2752	78.0	2836	80.4	2889	81.9	2931	83.1	98
99	2559	71.8	2709	76.0	2784	78.1	2868	80.5	2921	82.0	2964	83.2	99
100	2589	71.9	2740	76.1	2816	78.2	2900	80.6	2954	82.1	2996	83.2	100

TRUNK CAPACITY TABLES
Hundred Call-Seconds and Per Cent.
Use at Various Service Levels for
Trunk Groups of 1 to 50

The Table Number Indicates the Number of Calls per 1000 Encountering All Trunks Busy

Trunks	Table 50		Table 60		Table 70		Table 80		Table 90		Table 100		Trunks
	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	
1	1.9	5.1	2.2	6.2	2.6	7.3	3.0	8.3	3.4	9.4	3.8	10.5	1
2	12.9	17.9	14.2	19.7	15.5	21.7	16.8	23.3	18.0	25.0	19.1	26.7	2
3	29.4	27.2	31.7	29.4	33.9	31.4	35.9	33.3	37.2	35.0	39.6	36.7	3
4	49.1	34.1	52	36.1	55	38.3	58	40.3	60	41.7	63	43.9	4
5	70.9	39.5	75	41.7	78	43.3	81	45.0	85	47.2	88	48.9	5
6	94.1	43.5	99	45.8	103	47.8	107	49.4	110	50.8	113	52.2	6
7	118	46.8	123	48.9	128	50.8	132	52.5	136	53.9	140	55.6	7
8	143	49.7	149	51.7	154	53.6	159	55.3	163	56.7	168	58.3	8
9	169	52.2	175	53.9	181	55.8	186	57.5	191	58.9	195	60.3	9
10	195	54.2	202	56.1	208	57.8	214	59.4	219	60.8	224	62.2	10
11	222	56.1	230	58.1	236	59.7	242	61.1	248	62.5	253	63.9	11
12	249	56.9	258	59.7	264	61.1	270	62.5	277	64.2	282	65.3	12
13	277	59.2	286	61.1	292	62.5	299	63.9	306	65.3	311	66.4	13
14	305	60.5	314	62.2	321	63.6	328	65.0	335	66.4	341	67.8	14
15	333	61.7	342	63.3	350	64.7	357	66.1	364	67.6	370	68.6	15
16	362	62.9	371	64.4	379	65.8	387	67.2	394	68.3	401	69.7	16
17	390	63.7	400	65.3	409	66.9	416	68.1	424	69.2	431	70.6	17
18	419	64.7	429	66.1	438	67.6	446	68.9	455	70.3	462	71.4	18
19	448	65.5	458	66.9	468	68.3	476	69.7	485	70.8	492	71.9	19
20	477	66.3	488	67.8	498	69.2	506	70.3	516	71.7	523	72.8	20
21	507	67.1	517	68.3	528	69.7	537	71.1	546	72.2	554	73.3	21
22	536	67.7	547	69.2	558	70.6	567	71.7	577	72.8	585	73.9	22
23	566	68.4	577	69.7	589	71.1	598	72.2	607	73.3	616	74.4	23
24	596	69.0	608	70.3	619	71.7	629	72.8	638	73.9	647	75.0	24
25	626	69.6	638	70.8	650	72.2	660	73.3	669	74.4	678	75.3	25
26	656	70.1	669	71.4	680	72.8	691	73.9	700	74.7	710	75.8	26
27	686	70.6	699	71.9	711	73.1	722	74.2	731	75.3	741	76.1	27
28	717	71.1	730	72.5	742	73.6	753	74.7	763	75.6	773	76.7	28
29	747	71.6	761	72.8	773	74.2	784	75.0	794	76.1	805	77.2	29
30	778	72.0	792	73.3	804	74.4	815	75.6	826	76.4	836	77.5	30
31	809	72.5	823	73.6	835	74.7	846	75.8	858	76.9	868	77.8	31
32	840	72.9	854	74.2	867	75.3	878	76.1	890	77.2	900	78.1	32
33	871	73.3	885	74.4	898	75.6	909	76.4	922	77.5	932	78.3	33
34	902	73.7	917	75.0	930	76.1	941	76.9	954	78.1	964	78.9	34
35	933	74.1	948	75.3	961	76.4	973	77.2	986	78.3	996	79.2	35
36	964	74.4	979	75.6	993	76.7	1005	77.5	1018	78.6	1028	79.3	36
37	995	74.7	1011	75.8	1024	76.9	1037	77.8	1050	78.9	1060	79.6	37
38	1026	75.0	1042	76.1	1056	77.2	1069	78.1	1082	79.2	1092	79.7	38
39	1057	75.3	1074	76.5	1087	77.5	1101	78.4	1114	79.4	1125	80.1	39
40	1088	75.6	1105	76.8	1119	77.8	1133	78.7	1146	79.6	1157	80.4	40
41	1120	75.9	1137	76.9	1151	78.1	1165	78.9	1178	79.8	1190	80.6	41
42	1151	76.1	1168	77.2	1183	78.3	1197	79.2	1210	80.0	1222	80.8	42
43	1183	76.4	1200	77.5	1215	78.5	1229	79.4	1243	80.3	1255	81.1	43
44	1214	76.6	1232	77.8	1247	78.7	1262	79.7	1275	80.6	1287	81.3	44
45	1246	76.9	1263	78.1	1279	78.9	1294	79.9	1308	80.8	1320	81.4	45
46	1277	77.1	1295	78.2	1311	79.2	1326	80.0	1340	80.9	1352	81.7	46
47	1309	77.4	1327	78.4	1343	79.4	1358	80.3	1373	81.1	1385	81.9	47
48	1340	77.6	1359	78.6	1375	79.6	1391	80.5	1405	81.3	1417	82.0	48
49	1372	77.8	1390	78.8	1407	79.7	1423	80.7	1438	81.5	1450	82.2	49
50	1403	77.9	1422	79.0	1439	80.0	1455	80.8	1470	81.7	1482	82.3	50

TRUNK CAPACITY TABLES
Hundred Call-Seconds and Per Cent.
Use at Various Service Levels for
Trunk Groups of 51 to 100

The Table Number Indicates the Number of Calls per 1000 Encountering All Trunks Busy

Trunks	Table 50		Table 60		Table 70		Table 80		Table 90		Table 100		Trunks
	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	CCS	% Usage	
51	1435	78.2	1454	79.2	1471	80.0	1488	81.1	1503	81.9	1515	82.5	51
52	1467	78.4	1486	79.4	1503	80.3	1520	81.2	1535	82.0	1548	82.7	52
53	1499	78.6	1518	79.6	1536	80.5	1553	81.4	1568	82.2	1581	82.9	53
54	1531	78.8	1551	79.8	1568	80.7	1585	81.5	1600	82.3	1614	83.0	54
55	1563	78.9	1583	79.9	1601	80.9	1618	81.7	1633	82.5	1646	83.1	55
56	1595	79.1	1615	80.1	1633	81.1	1650	81.8	1666	82.6	1679	83.3	56
57	1627	79.3	1647	80.3	1666	81.2	1683	82.0	1698	82.8	1712	83.4	57
58	1659	79.4	1680	80.5	1698	81.4	1715	82.1	1731	82.9	1745	83.6	58
59	1691	79.6	1712	80.6	1731	81.5	1748	82.3	1764	83.1	1778	83.7	59
60	1723	79.8	1744	80.8	1763	81.7	1780	82.4	1797	83.2	1811	83.8	60
61	1755	79.9	1777	80.9	1796	81.8	1813	82.6	1830	83.3	1844	84.0	61
62	1787	80.1	1809	81.1	1828	81.9	1845	82.7	1863	83.5	1877	84.1	62
63	1819	80.2	1842	81.2	1861	82.1	1878	82.8	1896	83.6	1910	84.2	63
64	1851	80.3	1874	81.3	1894	82.2	1911	82.9	1929	83.7	1943	84.3	64
65	1884	80.5	1907	81.5	1926	82.3	1944	83.1	1962	83.9	1976	84.4	65
66	1916	80.6	1939	81.6	1959	82.5	1977	83.2	1995	84.0	2009	84.6	66
67	1948	80.8	1972	81.8	1992	82.6	2010	83.3	2028	84.1	2042	84.7	67
68	1981	80.9	2004	81.9	2024	82.8	2043	83.4	2061	84.2	2076	84.8	68
69	2013	81.0	2037	82.0	2057	82.9	2076	83.6	2094	84.3	2109	84.9	69
70	2046	81.2	2069	82.1	2090	83.0	2109	83.7	2127	84.4	2142	85.0	70
71	2078	81.3	2102	82.2	2123	83.1	2142	83.8	2160	84.5	2175	85.1	71
72	2111	81.4	2134	82.3	2156	83.2	2175	83.9	2193	84.6	2209	85.2	72
73	2143	81.6	2167	82.4	2189	83.3	2208	84.0	2227	84.7	2242	85.3	73
74	2176	81.7	2200	82.6	2222	83.4	2241	84.1	2260	84.8	2276	85.4	74
75	2208	81.8	2233	82.7	2255	83.5	2275	84.2	2293	84.9	2309	85.5	75
76	2241	81.9	2265	82.8	2288	83.6	2308	84.3	2327	85.0	2342	85.6	76
77	2274	82.0	2298	82.9	2321	83.7	2341	84.4	2360	85.1	2376	85.7	77
78	2306	82.1	2331	83.0	2354	83.8	2374	84.5	2393	85.2	2410	85.8	78
79	2339	82.3	2364	83.1	2387	83.9	2408	84.6	2427	85.3	2443	85.9	79
80	2372	82.4	2397	83.2	2420	84.0	2441	84.7	2460	85.4	2477	86.0	80
81	2405	82.5	2430	83.3	2453	84.1	2474	84.8	2493	85.5	2510	86.1	81
82	2437	82.6	2463	83.4	2486	84.2	2507	84.9	2527	85.6	2543	86.2	82
83	2470	82.7	2496	83.5	2519	84.3	2541	85.0	2560	85.7	2577	86.3	83
84	2503	82.8	2529	83.6	2552	84.4	2574	85.1	2593	85.7	2610	86.3	84
85	2536	82.9	2562	83.7	2585	84.5	2607	85.2	2627	85.8	2644	86.4	85
86	2569	83.0	2595	83.8	2618	84.6	2640	85.3	2660	85.9	2678	86.5	86
87	2601	83.1	2628	83.9	2652	84.7	2674	85.4	2694	86.0	2711	86.6	87
88	2634	83.2	2661	84.0	2685	84.8	2707	85.5	2727	86.0	2745	86.6	88
89	2667	83.3	2694	84.1	2718	84.8	2740	85.5	2761	86.1	2778	86.7	89
90	2700	83.3	2727	84.2	2751	84.9	2773	85.6	2794	86.2	2812	86.8	90
91	2733	83.4	2760	84.3	2784	85.0	2807	85.7	2828	86.3	2846	86.9	91
92	2766	83.5	2793	84.3	2817	85.1	2840	85.8	2861	86.3	2880	86.9	92
93	2798	83.6	2826	84.4	2851	85.2	2873	85.8	2895	86.4	2913	87.0	93
94	2831	83.7	2859	84.5	2884	85.2	2907	85.9	2928	86.5	2947	87.1	94
95	2864	83.8	2892	84.6	2917	85.3	2940	86.0	2962	86.6	2981	87.2	95
96	2897	83.8	2925	84.6	2950	85.4	2973	86.0	2995	86.6	3014	87.2	96
97	2930	83.9	2958	84.7	2984	85.4	3007	86.1	3029	86.7	3048	87.3	97
98	2963	84.0	2991	84.8	3017	85.5	3040	86.2	3062	86.8	3082	87.4	98
99	2996	84.1	3024	84.9	3050	85.6	3073	86.2	3096	86.9	3116	87.5	99
100	3029	84.1	3057	84.9	3083	85.7	3107	86.3	3129	86.9	3149	87.5	100

8.15 INTEROFFICE TRUNKS

In order to render the best possible telephone service in a multi-office city it is necessary to have available at all times an adequate number of trunk pairs and associated terminals to handle expeditiously the traffic from each office to every other office in the area. At the same time, to furnish the service at the lowest possible cost consistent with financial safety requires that the trunk plant must not be unduly large and must be so distributed that it may be efficiently used.

In the attainment of these objectives the trunk engineer must carefully analyze the past performance of the trunk plant in order to obtain a sound basis for his estimates of future trends and conditions. He must keep in close touch with the current and proposed central office and outside plant arrangements and must be continually alert to discover the most satisfactory and economical methods of handling the many individual items of traffic which make up the whole. In the larger cities, especially, the records of traffic and overflows on the many individual trunk groups represent a formidable total and the trunk engineer

should strive to simplify these records, wherever and whenever it can be shown that such simplification does not seriously hamper the efficiency of the trunk estimating and administrative work.

Much has already been written concerning the routine trunk engineering and administrative aspects of inter-office trunks. It seems unnecessary, therefore, to repeat the details and information already available at this time. Accordingly, it is suggested that each Traffic employee concerned with this item, study and familiarize himself with the contents of Traffic Circular No. 337 which covers "The Estimating and Administration of Interoffice Trunks", or refer to Traffic Engineering Practice (T.E.P.) Division A, Section 2-d-(1).

In offices having Rotary Out Trunk Switches, the traffic employee in charge of inter-office trunk administration in each District should also familiarize himself with the "Method of Changing Number of Interoffice Trunks" as outlined in Traffic Letter No. 174.

The above references are available in each District Office file.

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9.00 INTERTOLL DIALING

9.01 GENERAL

Intertoll dialing is a system designed primarily to enable the outward toll operator to complete calls, either by dialing or keying 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 2-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.

In the intertoll dialing system which we are using, all signals, either dial or supervisory, are transmitted over the intertoll trunks through the CX channels. The line equipment for the intertoll trunks always consists of a CX signaling circuit for receiving and sending the CX signals and the usual toll terminating equipment such as phantom and CX coils, repeaters and switching pads, as required. The drop equipment consists either of an outgoing trunk from the toll operator and a 2-way trunk which acts as an auxiliary to the outgoing operators' trunk for 2-way intertoll circuit groups or of a one-way trunk for the incoming end of one-way groups. The selection of the completing trunks is accomplished by a Step-by-Step selector switch (or switches) similar to a toll intermediate selector called the intertoll selector or, if two or more are connected in tandem, the 1st, 2nd, etc. intertoll selectors. For thru traffic other slightly different selectors are employed; namely, the auxiliary intertoll selector for connecting to intertoll and operator office trunks and the Thru Selector for intertoll trunks with overflow.

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

9.02 TWO-WAY INTERTOLL TRUNK GROUPS

One Way Dialing—One Way Automatic—No Thru Switching—Figure 1: 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 multiplied. 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 2-way trunk portion of the intertoll trunk.

2 Way Dialing—No Thru Switching—Figure 1: 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 2 way trunk group in the same manner as described for traffic between the manual area and the dial area in the preceding paragraph. In this case both ends are arranged as shown for the dial area end in Figure 1.

9.03 ONE WAY INTERTOLL TRUNK GROUPS

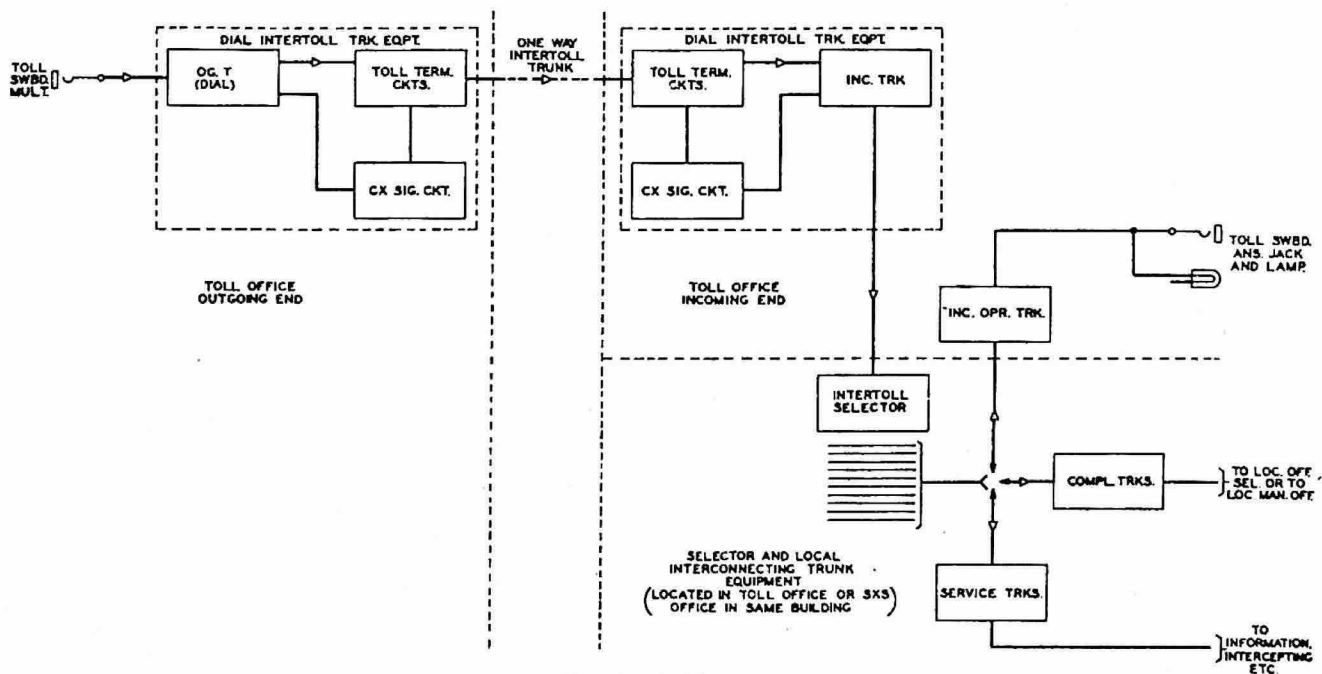
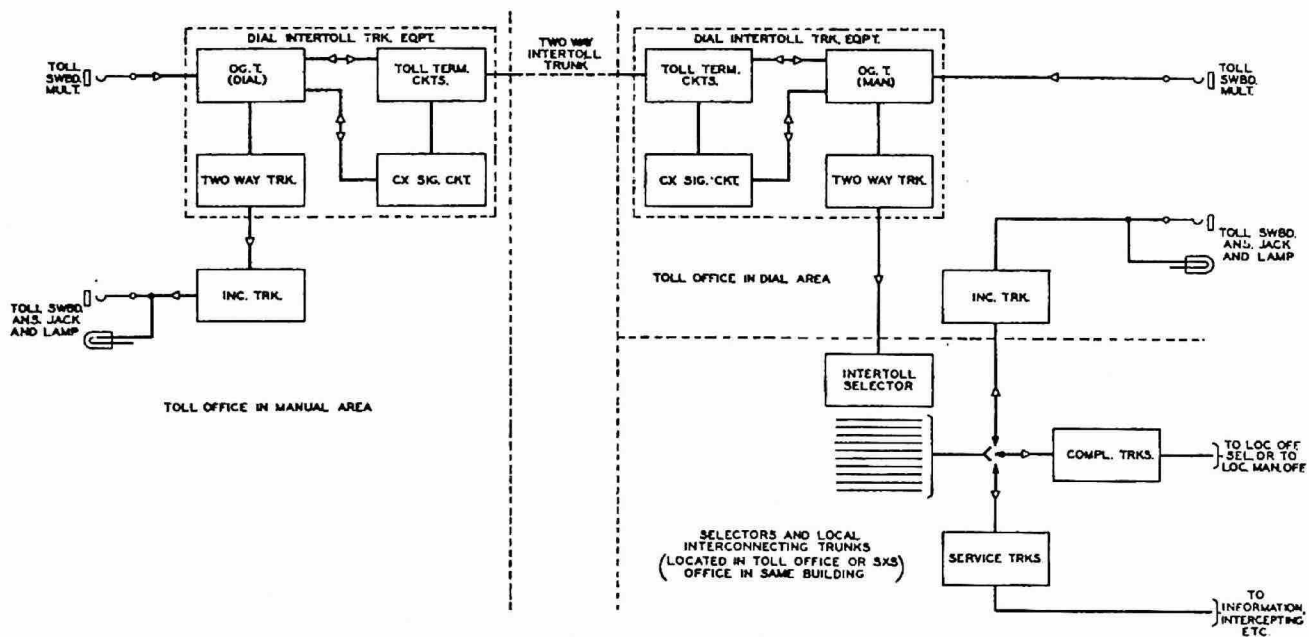
Outgoing End—No Thru Switching Fig. 2: For the larger circuit groups it may be more economical to divide the group into two one-way groups. The outgoing end of each group is equipped with the operator's outgoing trunk and CX signaling and toll terminating equipment as required. This provides the outward operator with facilities for dialing to lines or trunks in the distant exchange area as described before.

Incoming End—Fig. 2: The incoming end of the one way intertoll trunk is equipped with the usual toll terminating and CX signaling equipment and a one way trunk which connects to the 1st 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 thru the local office switch trains as described before.

9.04 THRU DIALING

9.0401 Dial Intertoll Trunk To Dial Intertoll Trunk—Fig. 3: In offices where intertoll 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 2 way trunk for outward multiple at the selectors.

When the originating outward operator wishes to establish a connection to a subscriber 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 as described before.



The auxiliary intertoll selector is used to establish thru 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 thru selector which operates as follows. If there is an idle trunk on the level to which a thru 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 thru selector will be prevented from rotary hunting and will return an overflow (30 IPM) flashing signal to the originating operator. When a circuit becomes idle the flashing rate changes

to 120 IPM to inform the originating operator to release and try again. When a specified number of selectors are waiting on a level (usually 4, or less), any additional selectors driven to that level will hunt to the eleventh rotary step and return an irregular 60 IPM flash to the originating operator to inform her to release and to dial the circuit request or call order operator for assistance or forward ticket to proper TX operator. An exception can be made to the overflow arrangement when the circuit group is large. In this case, 120 IPM is returned in all cases of all trunks busy, since in such groups a circuit should become available shortly and the calling operator should possibly make another attempt immediately.

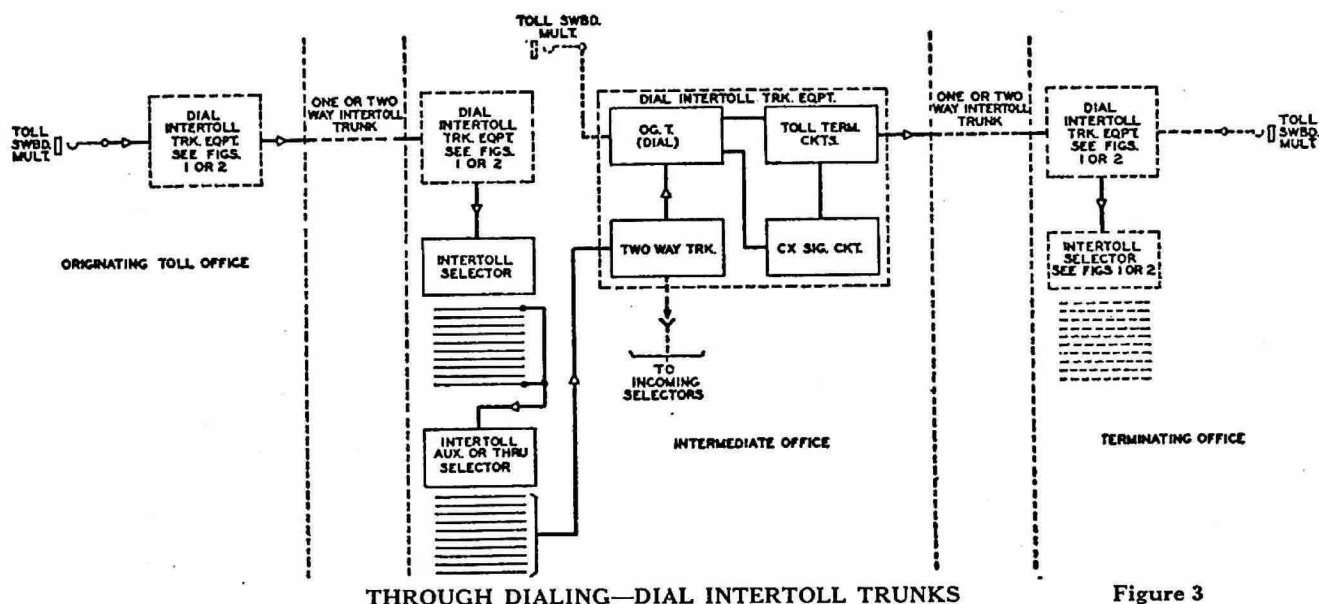


Figure 3

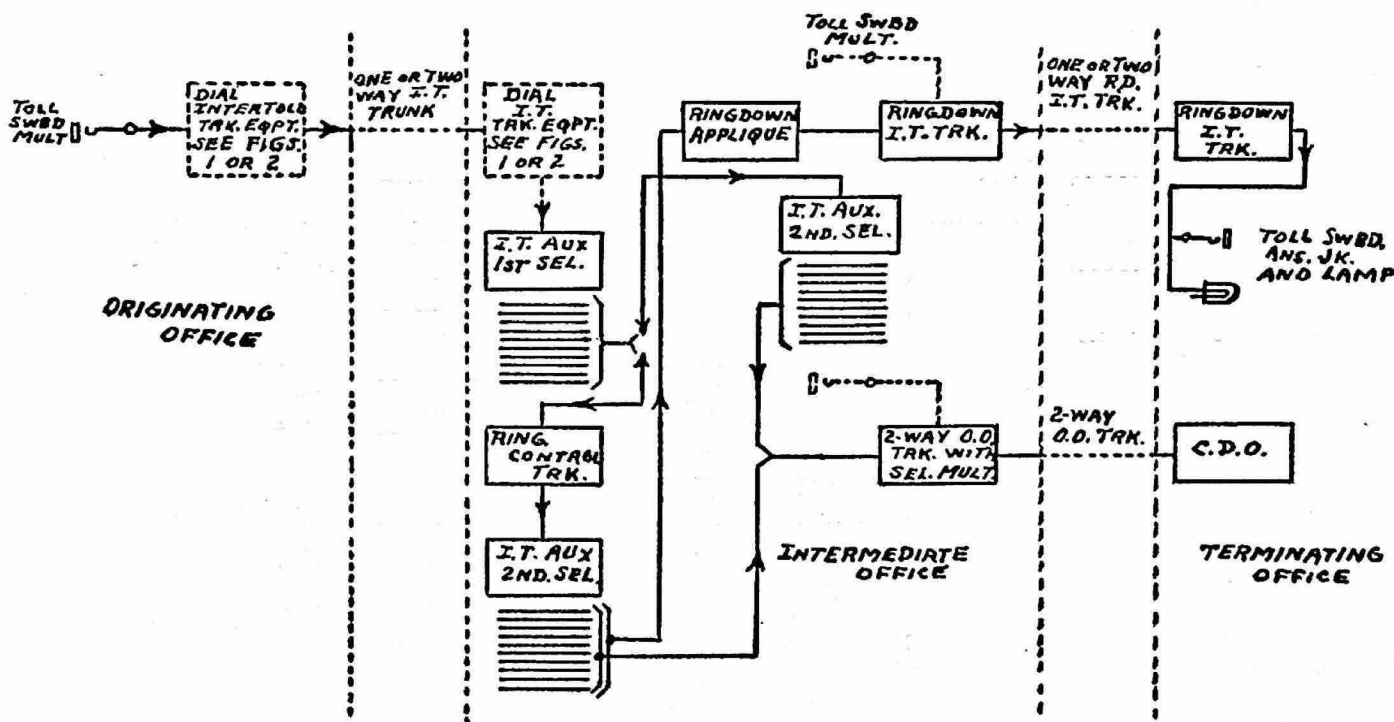


Figure 4

THROUGH DIALING—RINGDOWN TRIBUTARY AND COMMUNITY DIAL OFFICE TRUNKS

9.0402 Dial Intertoll Trunk To Ringdown Intertoll Trunk—Figure 4: Also 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 multiplied on certain levels of the auxiliary or thru intertoll selector. Preceding this selector is a trunk multiplied 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 thru selector. This signal is obtained from the selector right normal post springs which are adjusted to operate at levels on which ringdown appliques are multiplied.

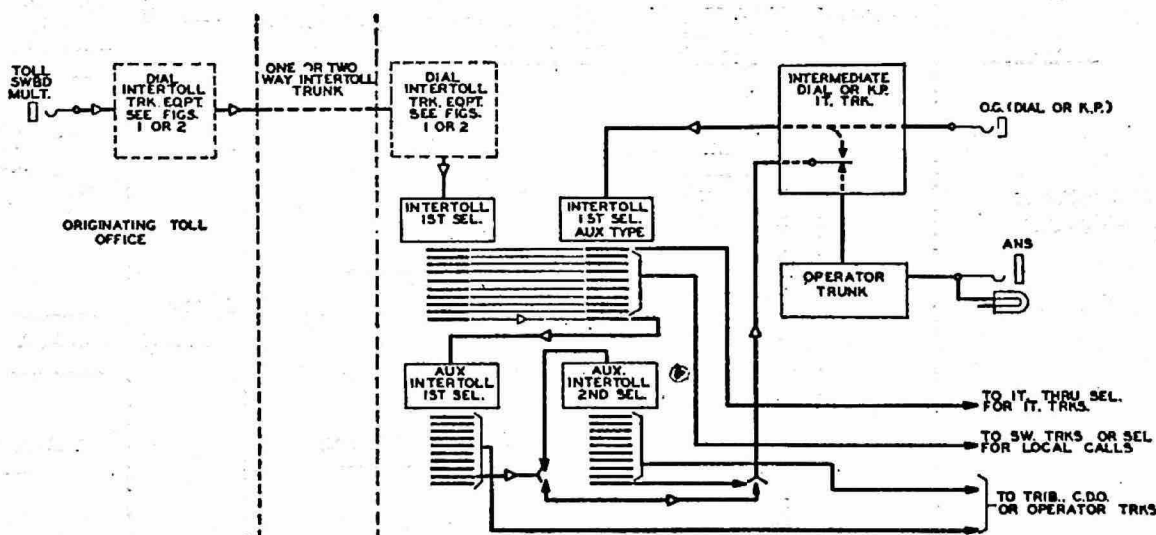
The originating operator, in making an intertoll call through an intermediate toll point to a ringdown tributary, dials over an intertoll dial trunk to the intermediate point. The first digit or digits dialed direct the selectors of the intertoll train to the level assigned to the trunk preceding the auxiliary or thru 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 2 second "spurt" of ring to bring in the called operator.

9.0403 Dial Intertoll Trunk to Community Dial Office Trunk—Figure 4: Also where intertoll selectors are furnished, community dial office trunks from the toll switchboard may be arranged to be multiplied 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 subscriber 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 subscriber or trunk.

9.0404 Intermediate Dialing—Figure 5: 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 subscriber 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 subscriber 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.



INTERMEDIATE DIALING OR KEY PULSING

Figure 5

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.

9.05 SELECTOR EQUIPMENT

Four types of selectors are used in the intertoll dialing system, the intertoll selector, the auxiliary intertoll selector, the thru selector and the combination intertoll and transmission selector. A typical arrangement of an intertoll selector train is shown in Figure 6.

The intertoll selector, as covered briefly in Section 5, 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 10 switches which in turn is arranged for mounting on the toll selector frame which has a capacity for 8 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 subscriber or trunk. The dial pulsing path thru the selector is from ground thru the pulsing contacts in the selecting trunk and then over the tip and ring in simplex directly thru the switch and banks to battery on the winding of the pulsing relay in the selected trunk.

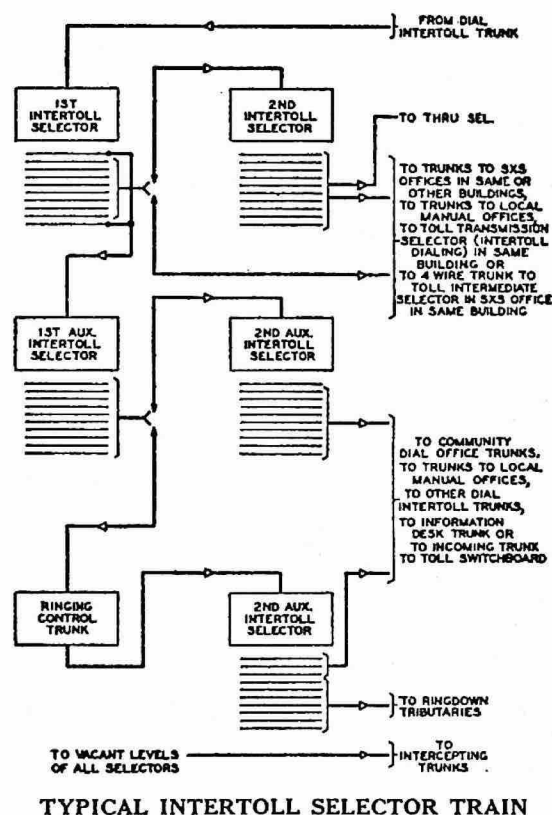


Figure 6

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 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.

The intertoll thru selector mounts on a double shelf and performs the same functions as the auxiliary intertoll selector and, in addition, supplies overflow and reorder signals as described under "Thru Dialing", Paragraph 9.04.

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 in simplex. The choice of functions for any specified level is under the control of normal post springs.

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

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.

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

9.06 TRUNK EQUIPMENT

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

The dial intertoll trunk consists of line equipment similar to that used by a straightforward CX signaling 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 2-way circuit groups, or the one-way trunk for the incoming end and the outgoing operator's trunk and in some cases the 2-way trunk for the outgoing end of one-way circuit groups.

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 office arranged for reverse battery supervision and the 4 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 in simplex over the tip and ring.

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

A trunk preceding the auxiliary intertoll selector is required to control ringing when ring-down circuits are selected by the auxiliary intertoll selector.

Intermediate dialing and key pulsing 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.

9.07 SWITCHBOARD EQUIPMENT

5L Type Dials are required at all switchboard positions arranged for intertoll dialing and start dialing pilots must be equipped in each position.

No. 1 Toll Switchboards where intertoll dialing is applied are modified for d-c supervision and dialing on both ends of the 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.

Toll Test Boards and Test and Control Board No. 8 are arranged for dialing equipment suitable for intertoll dialing.

9.08 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.

9.09 NATIONWIDE OPERATOR TOLL DIALING

The routing of toll calls under ringdown operation describes the route to be used by the outward operator in terms of the successive circuit groups over which the call is routed to the called office. Under the Nationwide Operator Toll Dialing Plan the route will be in terms of the called central offices, and where necessary by a numbering plan

area code, in which each combination of digits represents one, and only one, central office. For this plan the United States and Canada have been divided into "numbering plan areas". See Figure 7. Each numbering plan area has been assigned a three digit code which does not conflict with any other area or central office routing code. Within a numbering plan area a three digit code, which does not conflict with the code for any other central office within the numbering plan area nor with a numbering plan area code, is assigned to each central office.

Thirty-one of the 48 states will be served by one numbering plan area per state, fourteen are to be divided into two or more numbering plan areas and three states are incorporated in the contiguous areas of adjacent states. Thus, for the entire United States 74 numbering plan areas are required initially. Ohio will have four numbering plan areas. Canada will have a total of nine areas, two each for the Provinces of Ontario and Quebec in which the Canadian Bell operates and five areas for the remaining provinces which are served by Connecting Companies.

The area codes consist of three numerals characterized by having either "1" or "0" as the middle digit to distinguish them from central office codes.

As the greatest speed advantage of the toll dialing method can be realized only on those calls which can be advanced by the outward operator without reference to the route operator, the toll area codes have been assigned to minimize this reference work. Codes for single area states and provinces are identified by a "0" in the middle, while codes for multi-area states will have a "1" in the middle. If an outward operator finds in her position bulletin that the code for the called state has a "0" in the middle, she will know that it is a single area state and that she can use that code on any call into the state regardless of the location of the called city within the state. On the other hand, if the call is to a city in a multi-area state designated by a "1" in the middle of the code, the outward operator may be required to refer to the route operator for the correct area code for the portion of the state in which the called city is situated. Reference to the route operator may be kept to a minimum by listing on the bulletin the area codes of all single area states and area codes of frequently called cities in multi-area states. It is believed that outward operators will soon memorize the code of single area states, particularly those frequently called.

The three cases where a state is included in the numbering plan area serving a part of a contiguous state are, Rhode Island combined with a portion of Massachusetts, Delaware combined with a portion of Pennsylvania and Nevada combined with a portion of California. Each of these states is given a code with a "0" in the middle in order that operators may classify them as single area states. Similarly, a separate area code, with a "0" in the middle, is being given to the City of Washington even though it is included in the Maryland numbering plan area.

The use of area codes to the extent practicable, at No. 4 Toll Switching Offices, prior to the time when controlled Switching Point features are installed and the nationwide dialing plan is made fully effective, is being followed. For this interim period the area code at the No. 4 office is assigned to the dial circuit group terminating in the principal city in the area involved. Similar use of area codes is also being considered for some ringdown groups. Where there is both a terminal group and a via or common group to a given city, the area code is assigned to the via or common group. This procedure will facilitate the transition to the ultimate system.

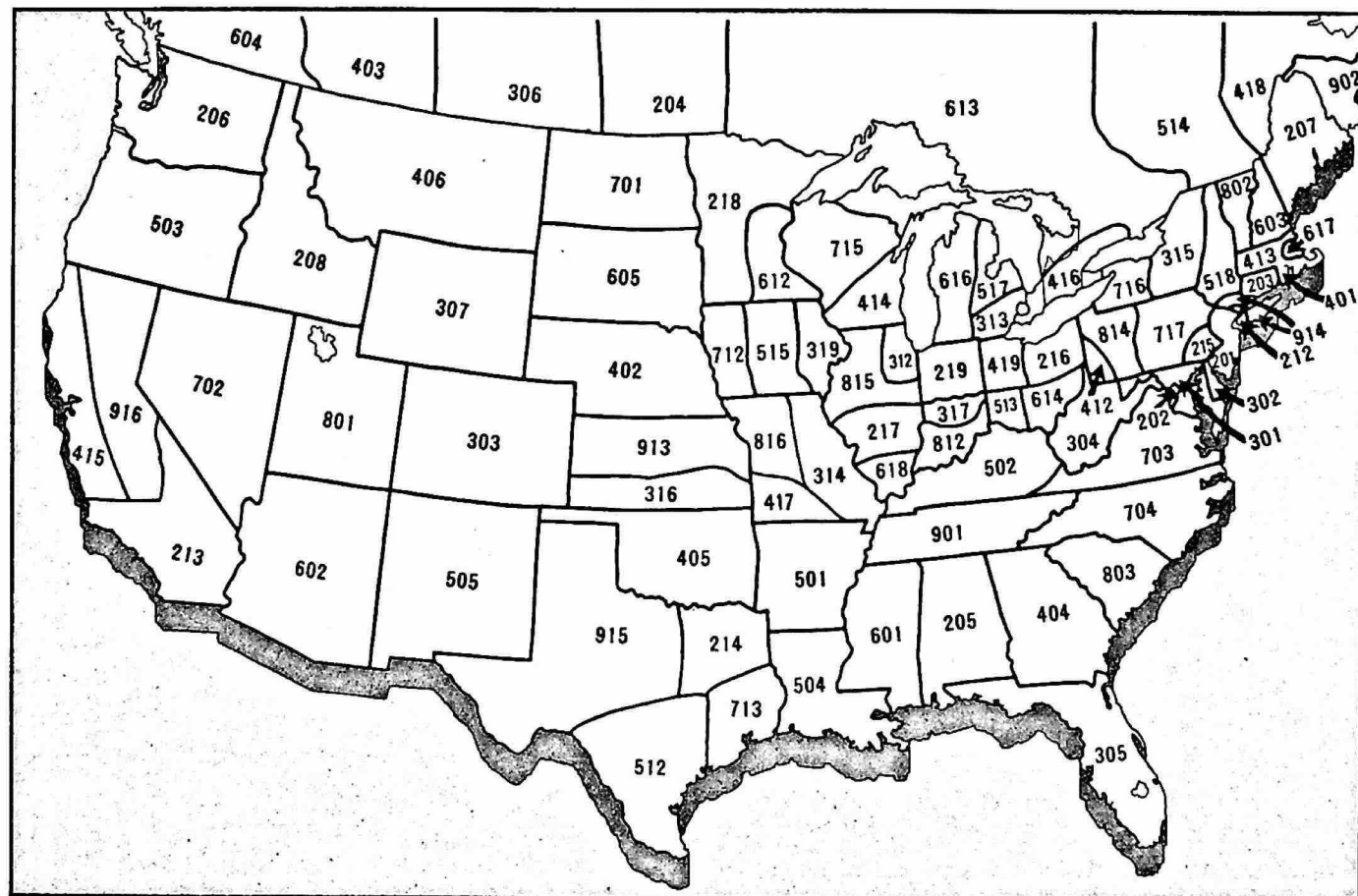
As previously mentioned Ohio is divided into four numbering plan areas. The principal city in each area and the area code are as follows:

City	Area Code
Cleveland	216
Columbus	614
Dayton	513
Toledo	419

Our time will not permit a discussion of all the considerations involved in the selection of office and town codes. The basic rules followed in the

determination for these codes may be briefly stated as follows:

1. On calls to cities with office names.
 - a. Where the called number has five numerals following the office name, dial the first two letters of the office name and the five numerals, i.e., UTah 1-2345 Dial UT 1-2345.
 - b. Where the called number has four numerals following the office name dial the first three letters of the office name and the four numerals, i.e., HEnderson 1234 Dial HEN 1234.
2. On calls to cities or towns without office names.
 - a. Where the called number has five or six numerals dial the first two letters of the city name and all the numerals, i.e., Richmond, Va. 4-1234 Dial RI 4-1234, and Richmond, Va. 84-1234 Dial RI 84-1234.
 - b. Where the called number has four or less numerals obtain the routing code from the position bulletin or the route operator, i.e., Salem, Ore. 5678 Dial 725-5678. The 725 is an arbitrary or flexible code and may or may not bear any relationship to the letters of the city name since the codes will be furnished by bulletin or route operator.



NATIONWIDE TOLL NUMBERING PLAN

Figure 7

9.0901 INTERTOLL TRUNK CODES

Nationwide Dialing Codes

Area and office codes cannot be used as described in the nationwide toll dialing plan until CSP (Control Switching Point) features are provided.

Interim Period Codes

During the interim period until the nationwide numbering plan is introduced, it is necessary to assign a three-digit code to each intertoll and tributary trunk group. For example, an operator in Cleveland to dial Saginaw, Michigan, will dial a code such as 029. An operator at Akron, Ohio to dial a tributary of Canton, such as Carrollton, will dial a code such as 173.

As previously mentioned, the codes for intertoll trunk groups generally have a "0" or a "1" in the first or second place to distinguish them from local office codes.

However, a few cities with a two-five numbering plan do not use the "0" or "1" in the third place for local offices and, when this is the case, the No. 4 equipment may be arranged to treat these codes as intertoll trunk group codes. In addition, there are some combinations of letters, such as WXY, which are rarely required for local office names and, therefore, can be used as intertoll trunk group codes for groups reached on the TC train.

The interim codes are divided into two classes:

- a. A code known as System code used universally by all No. 4 offices to reach the office to which the code is assigned.
- b. A non-universal code used by each No. 4 type office for an intertoll trunk group to a different city.

One or more of these interim codes are used to reach the called point. The operator follows the dialing of these codes by only the effective part of the local office code, as indicated by the routing information, and the called number.

System Codes

System Codes are assigned:

- a. To the principal city in each numbering plan area.
- b. To cities other than the principal city having six or seven—pull subscriber numbers—and to four or five pull cities having large volumes of incoming traffic to tributaries.

The object of System codes is to permit the spilling forward of a code on one-switch calls originating in A4A offices so that it can be used both in the selection of a trunk out of the originating office and again on a trunk out of an intermediate office. The 11-digit capacity of A4A senders will thus leave eight digits for the called number at the toll center or three digits for the tributary office code and five digits for the called number at the tributary office.

To use the spill forward feature the marker route relays for all cities whose traffic is routed over a particular group are tied together. For example, in the Los Angeles A4A office, the code 021 for Cincinnati, 513 for Dayton and 301 for Baltimore will select a trunk to Chicago. These codes will be spilled forward to Chicago. The Chicago code 312 on a call to Chicago will not be spilled forward.

System codes may in occasional cases be spilled forward more than once. San Francisco is reached from Oakland with code 220. To reach San Francisco from an A4A office in New Orleans switching through Dallas, the code is spilled forward to Dallas, then to Oakland, and used the third time to select a trunk from Oakland to San Francisco.

In the case of two-class groups, a System code is assigned to the group handling via traffic and a non-universal code is assigned to the group handling terminal traffic.

All No. 4 offices except Philadelphia, which has 11-digit senders, have 14-digit incoming senders and, instead of spilling forward the System codes, will precede the System code on one-switch calls with the code for the intermediate point.

Non-Universal Codes

The non-universal codes are assigned to:

- a. Intertoll trunk groups to four and five—pull cities which are not principal cities in the various numbering plan areas and which have small volumes of built-up circuit traffic to tributaries.
- b. Groups handling the terminal traffic in two-class groups.
- c. Broad band portion of groups carrying via traffic and having both broad band and narrow band circuits. The code is used to select the broad band circuits for picture, overseas and secrecy calls. These codes are not spilled forward except over main routes between large cities. In other cases, the 121 operator is reached at each intermediate point.
- d. Ringdown groups reached through a manual tandem board—one code being assigned to all such groups to points within the state in which the No. 4 office is located and a second code to all remaining groups.

Note: New York and Chicago are examples of such offices having manual tandem boards for reaching ringdown groups.

Local Office Codes for Intertoll Trunk Groups

Where step-by-step equipment permits, a few of the Associated Companies will assign ultimate office codes to intertoll trunk groups to dependent toll centers of primary outlets. This facilitates conversion to the ultimate dialing plan.

The limited variable spilling feature incorporated in the A4A equipment is thus brought into use. It will spill forward either none of this office code to a four-pull office, a single-digit to a five pull office or three digits to a six or seven-pull office. In the six-pull case, it is necessary to absorb a digit in the step-by-step office equipment.

All of the Southern California numbering plan area is arranged for the assignment of local office codes to intertoll trunk groups leading to dependent toll centers of Los Angeles.

On calls from other cities reaching the dependent toll centers through Los Angeles, the Los Angeles code precedes the local office code and is, therefore, not used for circuit selection in a city like Cleveland. Accordingly, it does not conflict with codes in the originating toll center area.

Tributary Office Codes

Tributaries of step-by-step toll centers are generally assigned codes in the IXX series and the trunks reached on the auxiliary selector train.

The use of IXX codes for this purpose does not interfere with their use for intertoll trunk group codes because the operator dials the code for the group to the toll center and follows with the tributary code. The tributary code is passed forward for use for the first time in the selection of a trunk to the tributary office.

Tributaries of panel and step-by-step cities provided with No. 4 equipment generally use local office types of codes. These should not conflict with city local office codes. In cases where conflicts cannot be eliminated in time for initial intertoll dialing, it is necessary to indicate in the routing information that a special or arbitrary code is used for the tributary and that the operator cannot decide in the usual way the office code or digits to dial.

Operator Codes

Operator codes for Systemwide use are as follows:

- 121 Inward Operator
- 131 Information Operator
- 141 Route Desk
- 151 Call Order Operator (Delayed RX)
- 181 Toll Stations (None in Northeastern Area)
- 191 Transfer to CLR Operator
- 101 Toll Test
- 102 Milliwatt Supply

	Office with 2-Digit TX Numbers	Office with 3-Digit TX Numbers
Universal TX	1150	11501
Conference Operator	1151	11511
Mobile Service and Marine Operator	1152	11521
Charge Operator	1153	11531
Toll Terminal Operator	1154	11541

Summary

The tributary and operator codes will not require change with the introduction of the nationwide toll dialing plan. Similarly the code for the principal city in each area does not need change although the local office code will need change some time during the period before the nationwide dialing plan is adopted if the ultimate codes are not used today. For the great majority of offices, a change in codes to be dialed to reach a city will be required.

This interim plan will require considerable attention to insure that the proper code information is on hand at all offices in time for the addition of intertoll trunk groups to the dialing network or for changes in the characteristics of such groups which involve a change in the code.

Operators will dial whatever codes are shown on the bulletin or furnished by the route operator and, therefore, they should not find it difficult to use the plan.

9.0902 BASIC FEATURES OF CONTROL SWITCHING POINTS (CSP'S)

Under the nationwide dialing plan it is necessary that the equipment at important through switching points, designated Control Switching Points (CSP'S) have certain features characteristic of common control switching equipment.

Numbering Plan

For toll dialing purposes each subscriber in the United States and Canada will have a distinctive number not conflicting with that of any other subscriber. It will consist of his listed directory number plus some extra digits for toll routing purposes. The extra digits will need to be known only to operators. For local calls subscribers will in all cases dial only the digits listed in their directories. The national number will not exceed eleven digits, and in a few cases be only nine digits but will in the great majority of the cases be ten digits.

In order to accomplish this, the two countries have been divided into the various numbering areas and three digit codes assigned to each area as previously described.

For a call originating and terminating in the same numbering plan area the operator will omit the area code and dial only the office code and the numerals. It is to permit omission of the area code on many calls that the distinguishing mark between office and area codes is supplied.

Of the three digit codes available those used for toll dialing are divided into classes which are used in a uniform manner in accordance with the following table.

Class*	Use
ABX	Local Office and TC **
1B1	Operators, information, etc.
101,102,103	Toll Test
11 ¹ ₉ XX or XXX	TX Operators
A1 ² ₀	Area codes come from this group
A0X	
0XX	These and part of the area code class are available for individual city codes during the transition period.
1B ² ₀	
10 ⁵ ₀	

* The symbols have the following significance:

A or B = any digit from 2 to 9 either letters or numerals

1₉ = any digit from 1 to 9 numerals

2₀ = any digit from 2 to 0 numerals

X = any digit

**A TC code identifies a particular toll center. It is used for reaching operators.

Switching Plan

Switching areas are being established in addition to the numbering plan areas. They will be independent of the numbering plan areas although coincidence of switching and numbering plan area boundaries will be preserved as far as practicable.

The classes of toll offices in ascending order of importance will be ordinary toll centers (TC's), primary outlets (PO's), sectional centers (SC's) and regional centers (RC's). A basic backbone network interconnecting all offices will be established by provision of a toll circuit group from each TC to one PO, from each PO to one SC, from each SC to one RC and from each RC to every other RC. The switching area of a PO includes all TC's homing on it in this basic network. The switching area of a SC includes the switching areas of all PO's homing on it and that of an RC includes the areas of all SC's homing on it. In addition to this basic network

direct circuits between individual offices of all classes will be provided as justified by the traffic. These groups will far exceed in number the basic network groups.

Ultimately the basic network groups will be liberally engineered and will be called "Final Groups". Other groups will be tightly engineered and will be called "High Usage Groups". Traffic offered to a high usage group and finding the group busy will be automatically offered to other groups in succession until a liberally engineered final group in the backbone network is reached. These groups are called "Final Groups" because alternates for them are not provided.

With this arrangement in effect it would be possible to establish a connection consisting of seven links but not more. Figure 9-A depicts in simplified form the basic switching network.

The features demanded at ordinary toll centers for operation under the nationwide dialing plan are quite simple and can be supplied with step-by-step equipment operating in the normal manner without the aid of directors or with any other type of switching equipment having similar operating characteristics. These will constitute the great bulk of places which will have toll dialing facilities.

CSP Features

About 200 places in the United States and Canada will be through switching points suitable for routing multi-switched traffic to and from the nationwide network. These are the control switching points (CSP's) and consist of the Primary Outlets, Sectional Centers and Regional Centers.

Figure 9-B shows the tentative layout of CSP's.

In addition to having all the features required for TC's the CSP's will have the following additional features:

1. Storing and variable spilling of digits

A CSP will be able to accept a number, use it for switching to the proper outgoing trunk and pass along whatever part of it may be needed at the next point to which the call is switched. Selection of the outgoing trunk and determination of the digits to be passed along must be made from the routing digits received. In some cases they will be only the office code and in some cases both the area and office codes. The digits spilled forward may be the entire number, only the four numerical digits, the office code plus the four numerical digits or part of the office code plus the four numerical digits. The storage capacity of the device for storing digits is arranged for eleven digits so that once it has started to receive digits it will be able to take all that may come without a pause.

The sending equipment will be able to take one stop signal after spilling has started. After such a stop signal and the receipt of a new start

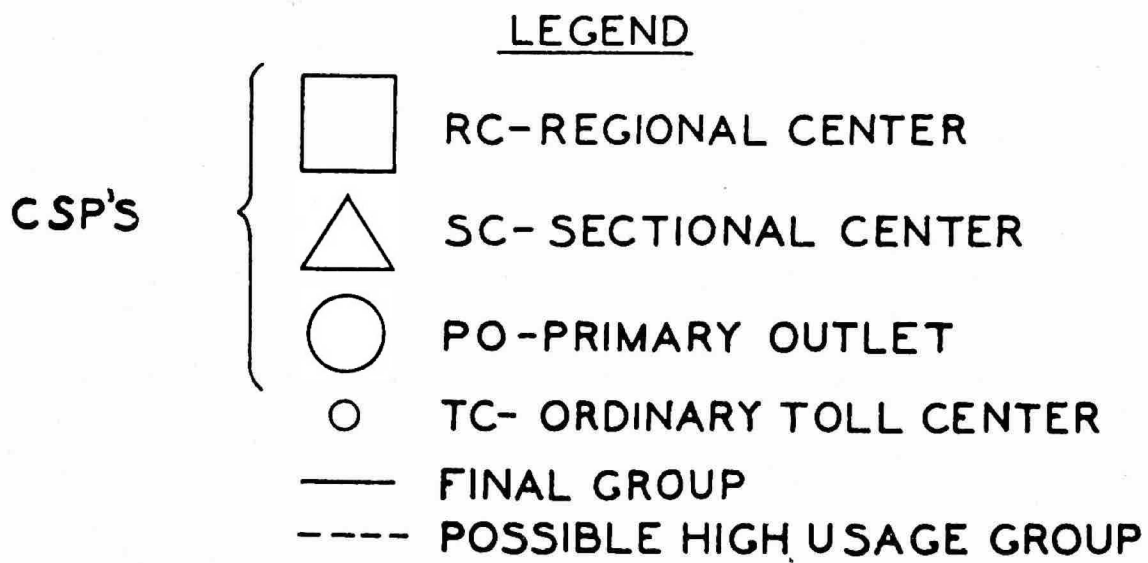
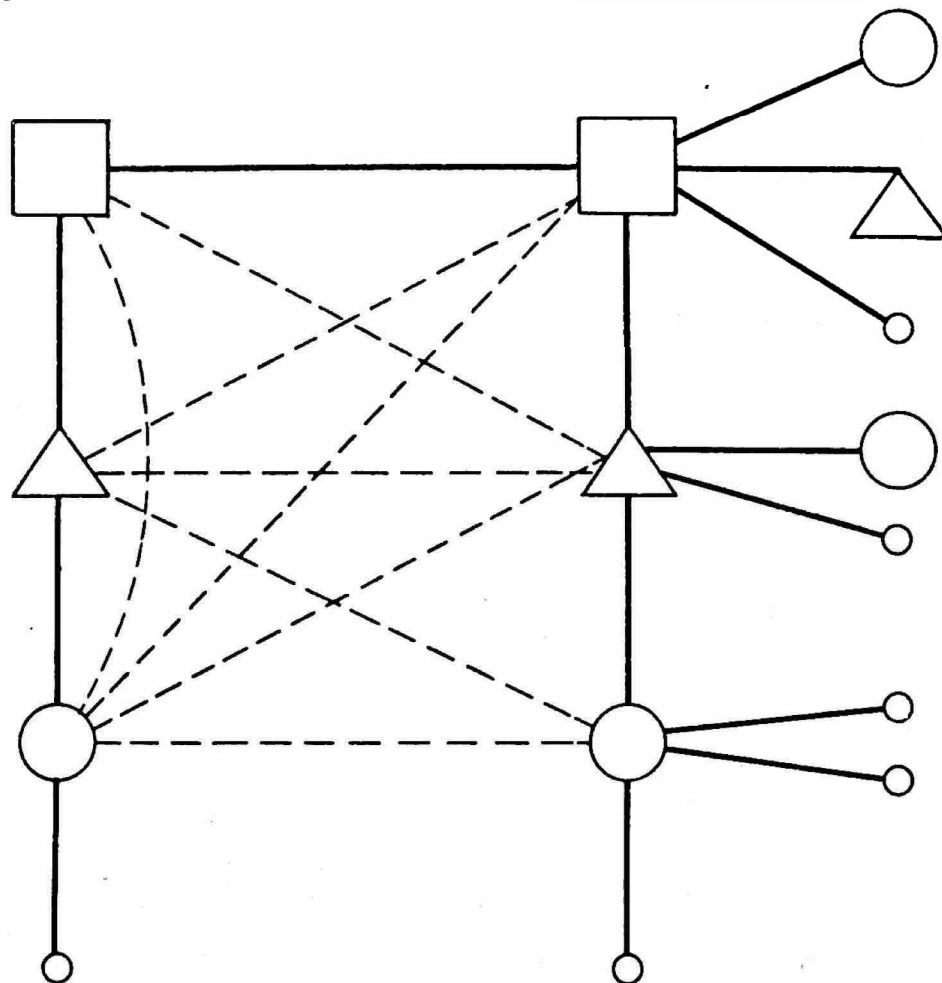


Figure 9-A

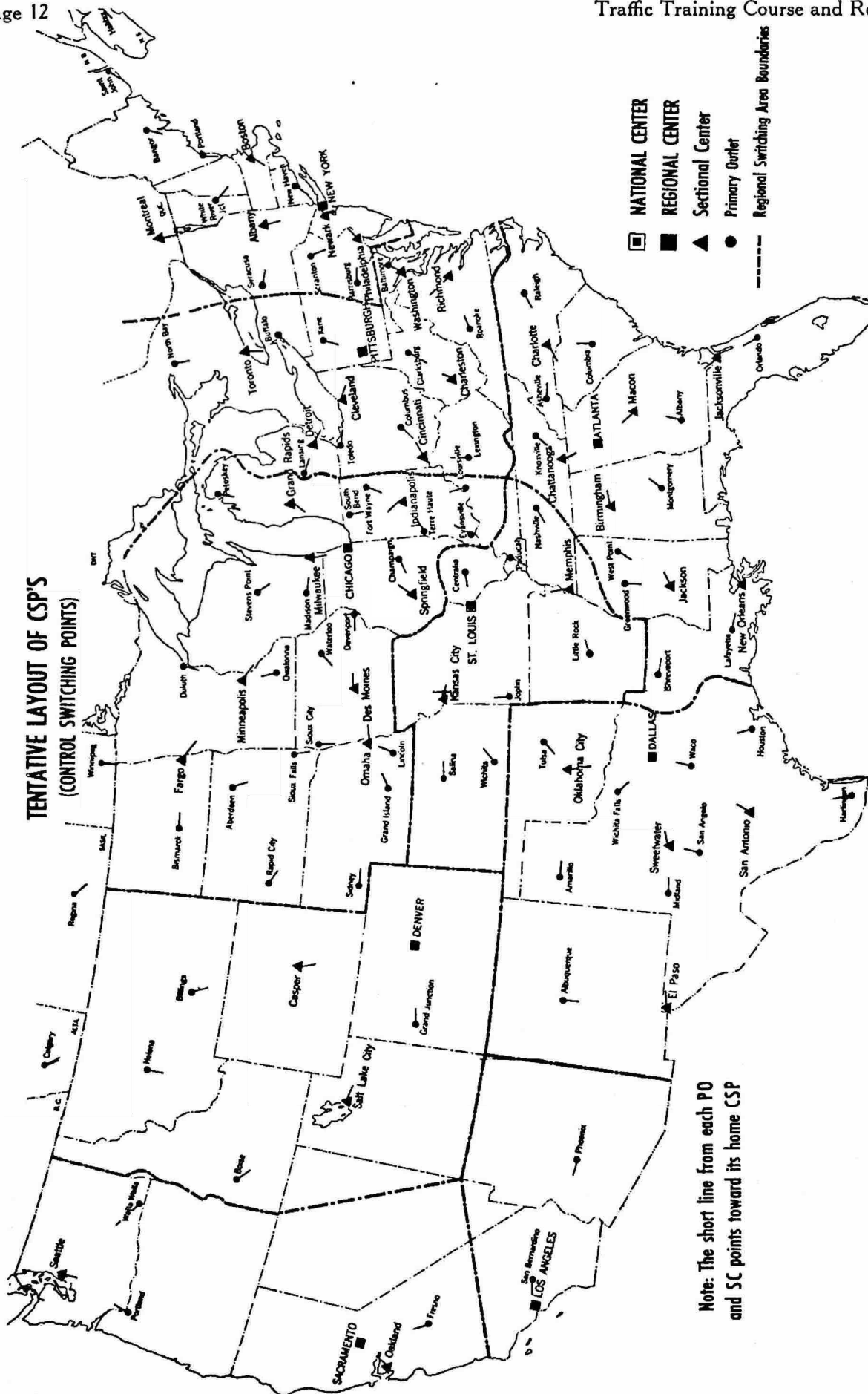


Figure 9-B

indication, it will start spilling digits at the point where it had previously been stopped. This permits reaching a link type CDO or a sender office through a Step-by-Step TC. It also permits reaching a link type CDO through another CDO not of the link type. A stop signal before spilling is started is not considered a stop, but a delay start signal. This makes it possible to extend a call through two link type offices in series only where the first is reached by a direct trunk from the CSP.

2. Code Conversion

This is a term for the substitution of a different set of digits for the received code. This feature is used for handling calls to tributaries of step-by-step TC's. For example, let us assume that Redwood is a tributary of Greenfield, a step-by-step TC. The call for a Redwood subscriber would come to the CSP in the same numbering area in the form RE 3-2345, the actual numerals being 733-2345. If this number were sent to Greenfield it would conflict with the Greenfield subscriber's number 7332. In order to avoid this conflict it would be necessary to send the Greenfield office code ahead of calls to the Greenfield subscribers. This would require extra selectors at Greenfield.

By providing code conversion facilities at the CSP the digits 125 might be substituted for the received 733. These digits would guide the switches at Greenfield to the Redwood trunk group. There would be no conflict with the Greenfield numbers because they never begin with "1".

If Redwood were in a different numbering area from the CSP the area code would be sent ahead of the RE 3-2345. The translation would then take place at the CSP in the other numbering area.

3. Automatic Alternate Routing

Facilities capable of selecting as many alternate routes as the circuit layout makes desirable will be provided.

4. Six Digit Translation

Facilities for translating both the area code and the office code will be provided. This feature is not used where the call is destined for a point in the numbering area in which the CSP is located, since it will never receive its own area code except in error. When it is received a reorder signal is returned.

The value of translation of both area and office codes lies in the ability it affords to make a selection of the proper route to an office in a foreign area when there are two or more routes to choose from. With translation restricted to the first three digits received it would be necessary to forward all traffic to a particular foreign area by the same route. This would result in uneconomical routings with respect to

both outside plant and switching equipment, an extra switch being forced unnecessarily on many items of traffic.

For example, it is desired to reach a subscriber in Akron, Ohio from Pittsburgh which is a CSP. Akron and Cleveland are in the same numbering area; direct trunk groups to both points are amply justified by the traffic. The CSP equipment in Pittsburgh must translate both the area code and the office code for the Akron subscriber in order to be able to route the call over the direct trunk group to Akron. If six-digit translation were not provided it would be necessary to route the call through Cleveland since only one route could be chosen from the area code alone and the route selected for this purpose would be the one over which the greatest volume of traffic would flow with a choice of routes available.

9.0903 ROUTING OF CALLS—USE OF SYSTEM CODES

Present Arrangement

To understand the requirements during the transition period, when there is a mixture of ringdown and dial it seems advisable to review briefly the present arrangements for assembling and disseminating routing information on an all ringdown basis:

Class 1 offices: About 350 toll centers which are most useful in the routing structure have been designated by the Long Lines Department as Class 1 offices, i.e., Akron, Canton, Cleveland, Chicago. There is a prescribed route from each Class 1 office to every other Class 1 office. These routes form a nationwide backbone network. See Figure 10.

Class 2 offices: All of the remaining toll centers are designated Class 2 offices and routing instructions for them merely designate the point or points of access to and departure from the basic network.

If a toll center has only one point of access, it is a Single Outlet Class 2 office, i.e., Medina, Wellington, Oberlin, Orrville, Lancaster. If the geography and facilities are such that it is advisable to have two or more points of access it is a multi-outlet Class 2 office, i.e., Bucyrus, Coshocton, East Liverpool, Uhrichsville. See Figure 10.

Routing information is assembled and disseminated as follows:

The associated companies keep the Long Lines

FIGURE 10

SCHEMATIC OF CLASS 1 AND CLASS 2 OFFICE ROUTING SYSTEM

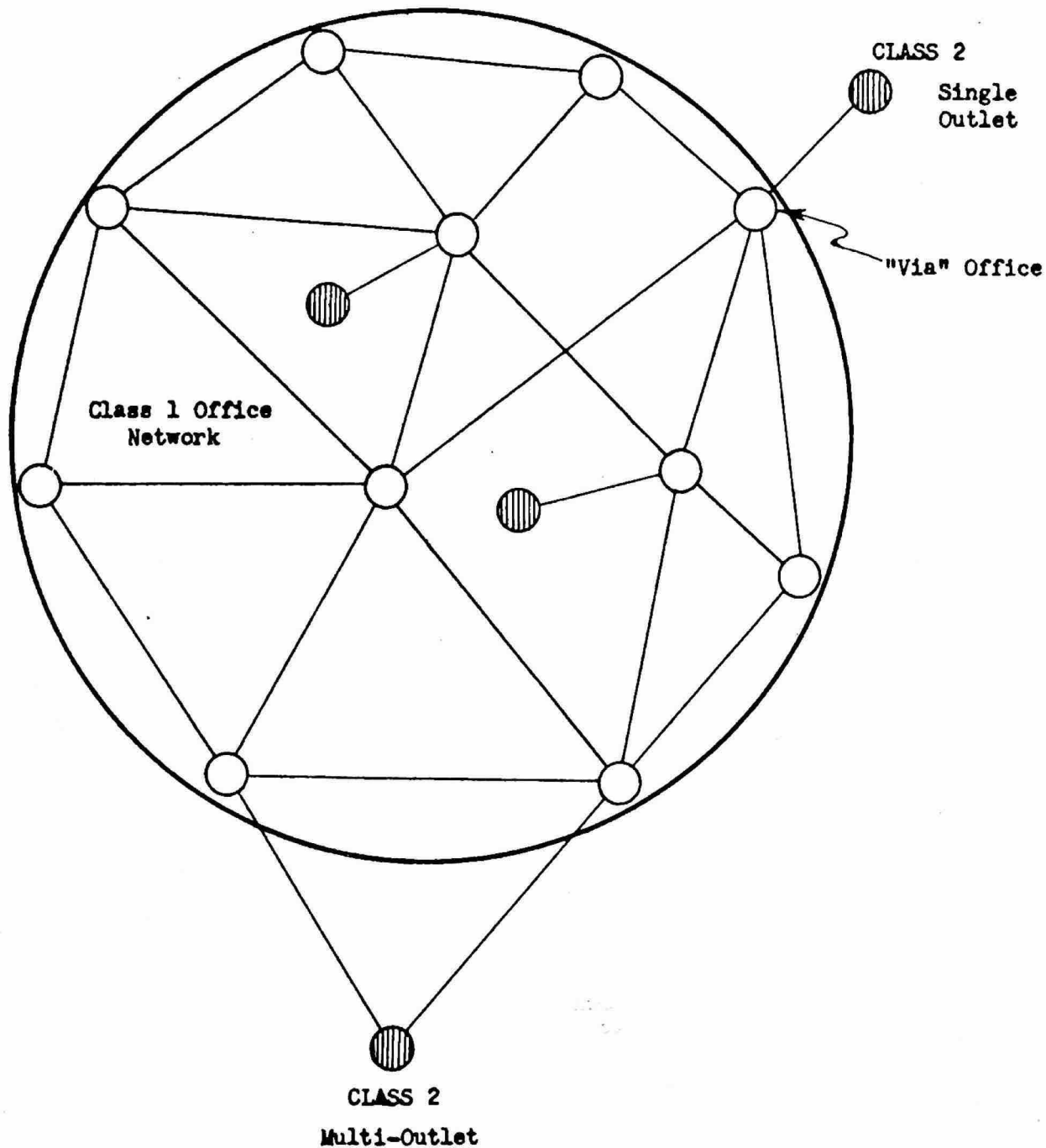


Figure 10

informed of changes in toll centering arrangements, new groups, etc., by means of monthly reports.

The Long Lines prepares and distributes:

- a. **Class 1 route sheets**—prepared individually for each Class 1 office. These show the routes to all other Class 1 offices. Figure 11.
- b. **Toll Rate and Route Guide—white pages.** These show for each tributary the name of its toll center and for each single outlet Class 2 office the name of its "via" office; and for each multi-outlet Class 2 office a reference to the yellow pages. Figure 12.
- c. **Toll Rate and Route Guide—Block Route Sheets—yellow pages**—show which "via" office to use. Figure 13.

To determine a route from Albany N.Y. to Smithton Mo., for example, the procedure is:

Look up Smithton in the rate and route guide—white pages—and find that its toll center is Sedalia.

Look up Sedalia in the toll rate and route guide—white pages—and find that it is a Class 2 multi-outlet office.

Look up Sedalia in rate and route guide—yellow pages—and find that St. Louis is the via office.

Look at the Albany Class 1 route sheet and find that the route to St. Louis is through Cleveland.

The procedure may seem involved but it is only necessary on the small percent of calls to infrequently called points. For all frequently called points the routings are determined once and made available to the operators by means of bulletins at the switchboard and first reference lists at the toll rate and route desk.

Ultimate Arrangement

To understand what is required during the transition period we must not only look at the present system, but know where we are heading, —the ultimate where all calls are handled by dialing.

The operator's procedure and requirements for routing information will be greatly simplified. She will dial the other numbering plan area code (if the called point is outside her own numbering plan area), the office code and the called number.

Codes are spilled forward along the routes selected by the switching mechanism. Figure 14.

While the operating procedure will be simplified, the information required by the Plant Department to set up the route or routes in the switching mechanism must be furnished in detail.

Transition Period

The description which follows applies to the early stages of the transition period. As experience is gained there will undoubtedly be changes

and improvements and each office will be kept advised. For the cutover of the first few No. 4 offices, the following arrangements will be followed:

The plan is basically the same as at present:

It retains the Class 1 and Class 2 offices; does not affect the present method of quoting non-dial routes; and requires no change in the rate and route guide.

Each Associated Company furnishes the Long Lines Department with up-to-date information regarding the dialing possibilities in its own area. The Long Lines Department coordinates and distributes this information to all Companies in the same fashion as at present, except that—

The Class 1 route sheets will show dialing information for all direct and one-switch calls which can be dialed.

They will also issue a routing pamphlet listing the Class 1, Class 2 and Tributary Office dial information, arranged by states.

Ultimately the distribution of dial routing information will probably become as much a matter of routine as the present distribution of ringdown information. However, during the intermediate stages each Associated Company Routing Engineer has the added responsibility in adapting the dialing information as received from the Long Lines Department and distributing it to his dialing offices.

Dialing Possibilities

As the dial route is determined by the digit capacity of the senders in the No. 4 offices, it seems advisable at this time to review the dialing possibilities.

With the exception of Philadelphia (possibly others by the time these notes are reviewed) the No. 4 crossbar office senders have a capacity of 14 digits, resulting in the possibility of two or three trunk group selections depending upon the number of digits in the called number.

3 digit code+3 digit code+8 digit number, (or 7+pty line letter).

3 digit code+3 digit code+3 digit code+5 digit number, (or 4+pty line letter).

In the Philadelphia No. 4 office the senders have capacity for only 11 digits and only one or two trunk group selections can be made.

3 digit code+8 digit number.

3 digit code+3 digit code+5 digit number.

At offices equipped with senders, other than in cities having No. 4 switching systems, the number of digits for which the senders are arranged to register may otherwise limit the number of codes that may precede the called number.

All these considerations must be kept in mind by the Routing Engineer in establishing the dialing routes for the various offices in his territory.

CLASS 1 ROUTES

ALBANY N Y

OFFICE	ROUTES			OFFICE	ROUTES			OFFICE	ROUTES		
	1st	1st A	2nd A		1st	1st A	2nd A		1st	1st A	2nd A
MDTN-N	MDTN			PT HN	DET			STN	WASH		
MILW	CLEV			PTLD-M	BOS			STEUB	PITB		
MPLS	CLEV			PTLD-O	CLEV			S PT	CGO		
MINOT	CLEV			PORTS	CLEV			SDBG	NWRK		
MOBI	N Y			POUGH	POUGH			SYR	SYR		
MRO-L	NWRK			PRCT	CGO						
MRO-M	DET			PROV	PROV			TPA	N Y		
MTGY	N Y							T HT	CGO		
MONTI	MONTI			QUE	MTRL			TOL	BUF		
MTRL	MTRL			QCY	CGO			TOP	CGO		
MORGN	PITB							TORO	TORO		
MRSTN	NWRK			RAC	CGO			TORR	HFD		
MUN	DET			RLGH	N Y			TREN	NWRK		
MUSK	DET			RPD CY	CGO			TRND	CLEV		
MSKGE	CGO			RDG	NWRK			TROY	TROY		
				REG	TORO			TSN	N Y		
NHVL	N Y			RHINE	CGO			TULSA	N Y		
NWRK	NWRK	PROV		RICH-I	CGO						
N BED	HFD			RICH-V	WASH			UTI	UTI		
N BTN	HFD			ROAN	N Y						
N BWK	N BWK	NWRK		ROCH-M	CGO			VAN	TORO		
NWB	NWB			ROCH-N	ROCH			VICK	N Y		
N CAS	PITB			ROCH-P	PITB			VINC	CGO		
N HN	N HN			RKFD	CGO						
N LN	HFD			RI	CGO			WRN-O	CLEV		
N O	NWRK			RUTL	RUTL			WRN-P	BUF		
NEWP	HFD	PROV						WASH-DC	WASH		
N NEWS	N Y			SAC	CLEV			WASH-P	PITB		
N Y	N Y			SAG	DET			WBY	WBY		
NIA	NIA			ST J	BOS			WLOO	CGO		
NORF-N	CGO			ST JO	CGO			WTWN	WTWN		
NORF-V	NWRK			ST L	CLEV			WKN	CLEV		
N AD	N AD			ST P	CLEV			W P B	NWRK		
NHAM	NHAM			ST PBG	PHLA			WHLG	PITB	* N Y	
NORT	N Y			SAL	BOS			WH P	WH P		
NWLK	N Y			SLNA	CGO			W R JC	WR JC		
NWCH	HFD			SALIS	PHLA			WICH	CGO		
				S LK	CGO			WC FS	CGO		
OAK	N Y			S A	N Y			WK BR	SCRN	*BNGTN	
OIL C	BUF			S D	CLEV			WMPT	ELMI		
OK CY	N Y			SDKY	CLEV			WMTC	HFD		
OLEAN	BUF			S F	NWRK			WILM	PHLA		
OMA	CGO			ST S	ST S			WPG	MTRL		
ORL	N Y			SVAN	N Y			W SAL	N Y		
OTWA	MTRL			SAYB	HFD			WORC	WORC		
OTUM	CGO			SCDY	SCDY						
				SCRN	SCRN	BNGTN		YON	YON		
PDUCT	CGO			SEAT	CLEV			YORK	N Y		
PKBG	PITB			SHRN	CLEV			YGTN	BUF		
PAT	PAT	N Y		SHRV	N Y						
PEEK	PEEK			SID	CGO			ZAN	CLEV		
PEOR	CLEV			SX CY	CGO						
PTRBG	N Y			SX FS	CGO						
PTKY	DET			S BD	CLEV						
PHLA	PHLA			SPBG	N Y						
PNX	CGO			SPD	N Y						
PITB	PITB	NWRK		SPFD-I	CGO						
PTFD	PTFD			SPFD-M	SPFD						
PLAT	PLAT			SPFD-MO	CGO						
POCA	CGO			SPFD-O	CLEV						
PON	DET			STAM	STAM	N HN					

(*) Indicates that the Alternate Route is suitable for use on originating or through calls terminating at, or routed through the distant Class 1 Toll Center.

☐ Indicates Associated Company's circuits are used to reach the called office.

AM. TEL. & TEL. CO. LL DEPT.

TARIFF F.C.C. No. 93
31st Revised Page 20
Cancels 30th Revised Page 20

Issued: October 7, 1948

(1) Original effective date October 20, 1948.

(8) Debiting change effective September 12 1948

By H. H. Carter, General Commercial Manager

100 William Street New York 7 N. Y.

Printed in U. S. A.

Effective: November 10, 1948

TOLL RATE AND ROUTE GUIDE CLASS 2 BLOCK ROUTES

MISSOURI

A. T. & T. Co.

Block	TOLL CENTERS AND ROUTES	Block	TOLL CENTERS AND ROUTES
4502	MEXICO Via Kansas City (4580); 1563, 1566. 4548—4859, 4920, 4923, 4932—4998. 5004, 5031—5051, 5063—5095, 5120—5486, 5507. 5531—5551, 5777, 5789, 5868, 5869. Via St. Louis (4507); all other blocks.		MONROE CITY—Cont'd Via Quincy, Ill. (4545); 1570. 4242, 4250, 4255—4260, 4270, 4282, 4545—4557. 4579—4590, 4628, 4635, 4653, 4683—4712, 4723, 4745 —4751, 4770—4780, 4823, 4850—4859, 4933, 4945, 4967, 4969, 4983—4985. 5031, 5033, 5038—5041, 5051, 5067, 5068, 5150, 5165, 5183—5219, 5246—5261, 5276—5448, 5476— 5483, 5498, 5499, 5531, 5533, 5540, 5866—5869, 5876. Via St. Louis (4507); all other blocks.
4540	MOBERLY Via Kansas City (4580); 1563, 1566. 4075, 4076, 4080, 4470, 4548—4859, 4920, 4923, 4932 —4998. 5004, 5031—5051, 5063—5095, 5120—5486, 5507 —5519, 5524—5560, 5590—5644, 5667—5840, 5868, 5869. Via St. Louis (4507); all other blocks.	4493	+ SEDALIA Via Kansas City (4580); 1563, 1566. 4073—4076, 4080, 4255—4258, 4267, 4270, 4479, 4489, 4548—4866, 4884—4907, 4920, 4923, 4933— 4998. 5004, 5031—5051, 5063—5123, 5126—5495, 5505— 5519, 5524—5566, 5598—5665, 5667—5840, 5868, 5869, 5872. Via St. Louis (4507); all other blocks.
4544	MONROE CITY Via Chicago, Ill. (4192) (Hannibal); 347, 372, 404, 409, 461, 462, 476, 533—586, 617, 619, 712, 724—729, 765—779, 809, 811, 815—827, 847, 858, 860, 863, 865, 869, 875, 876, 878—883, 894, 903, 968, 986, 989, 991. 1051, 1061, 1093, 1147, 1158, 1161, 1162, 1169, 1202, 1208, 1217, 1218, 1231, 1235, 1244—1260, 1301, 1310, 1361, 1387, 1389—1391, 1406, 1412, 1418, 1437, 1440, 1444, 1478—1481, 1485, 1526, 1623, 1847, 1886, 1897, 1915, 1916, 1921, 1923, 1927—1930, 1939, 1940, 1947, 1954—1966. 2033, 2037, 2069, 2098, 2099. 3004—3009, 3011—3027, 3032—3054, 3068, 3074, 3077—3096. 4002—4009, 4012—4022, 4034—4081, 4086, 4092, 4102—4112, 4125, 4137—4139, 4141—4196, 4221— 4241, 4243—4248, 4251, 4262, 4265, 4267, 4271—4275, 4283—4290, 4299, 4311, 4335, 4798, 4986—4988. 5000—5025, 5035, 5044, 5063, 5125, 5136, 5148, 5151, 5175, 5230, 5270, 5459, 5484—5495, 5500, 5507, 5536, 5551—5566, 5644—5689, 5701—5722, 5786— 5800, 5811—5840, 5865, 5870, 5872. (Continued in next column)	4469	+ SKESTON Via Memphis, Tenn. (1669); 1143, 1147, 1154, 1155, 1158, 1161—1175, 1178, 1182, 1192, 1197—1218, 1231 —1390, 1406—1419, 1433—1755, 1762, 1766, 1822, 1838, 1866, 1867. 4452—4465, 4708—4780, 4798—4907, 4911, 4914, 4923, 4932—4968, 4968—4988. 5004—5012. Via St. Louis (4507); all other blocks.
		4557	STANBERRY Via St. Joseph (4562); 4562. 5213, 5219, 5322—5359, 5414—5416, 5540. Via Kansas City (4580); all other blocks.

NOTE: This page normally yellow in Route Book.

ULTIMATE ROUTING ARRANGEMENT

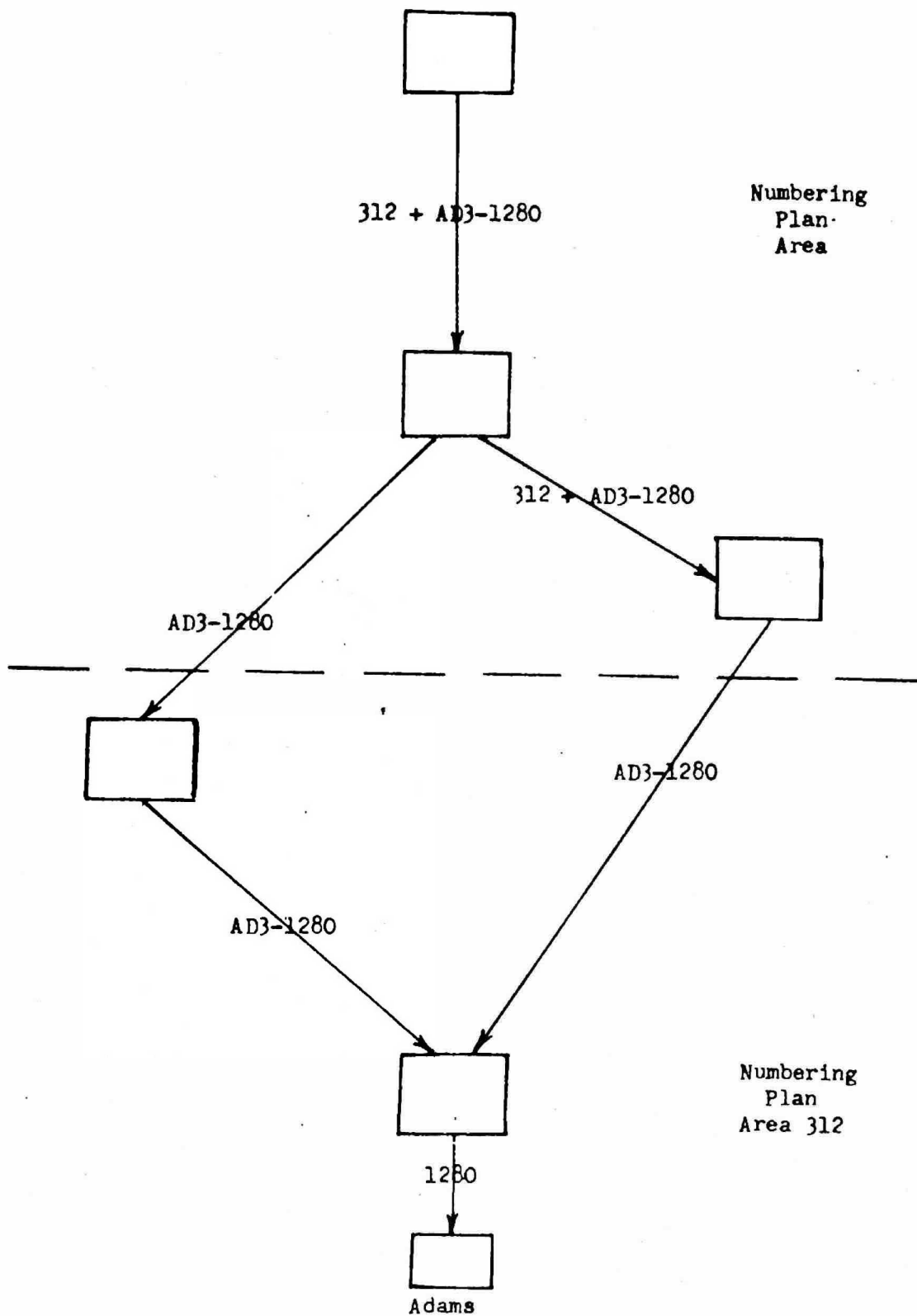


Figure 14

9.0904 DISSEMINATION OF INFORMATION

Information Furnished by Associated Companies

A routine for keeping the Long Lines Department currently informed of the dialing possibilities in each Associated Company area was initiated early in 1948.

For each toll center which can be reached or is scheduled to be reached by dialing, these reports, which are kept up to date monthly show:

A list of all central offices and tributary offices, served by the toll center showing the subscriber numbering plan (2-5, 3-4, 2-4, 5-digit, etc.) for each and the coin box number series if other than the 7, 8, 9 or 0 thousands.

A list of all intertoll and tributary groups which can be reached by dialing through the toll center and the codes assigned to each group.

The date when each item is scheduled for dial operation if not already in service.

These data are reported regularly in a uniform manner (See Figure 15) by each Associated Company.

Information to be Disseminated by Long Lines Department

As previously stated the Long Lines Department will assemble and coordinate the information received from each Associated Company and make it available to all Companies.

In addition to the Toll Rate and Route Guide, which will be continued in its present form, they will issue Class 1 Route Sheets (Figure 16 and a Dial Routing Pamphlet (Figure 17).

Class 1 Route Sheets

The particular Route Sheet for each Class 1 office is sent to that office as at present.

The Routing Engineer of each Company receives copies of these sheets for all of the Class 1 offices in his area, and for any Cl. 1 offices outside of his area which are used as outlets by any of his dialing Cl 2 offices.

For all crossbar toll offices the routes are based on the assumption that the toll lines do not appear in the multiple and must be reached through the switches over tandem trunks.

In addition to the ringdown routes the Class 1 sheet shows the codes to be dialed for all direct and one-switch dial calls and the numbering plan, i.e., 1L, 2L, 3L, or just +, of the distant Class 1 office.

See Figure 18 for examples of typical dial calls between Class 1 offices. The complete dial route between Class 1 offices will be shown on the Class 1 Route Sheets.

Dial Routing Pamphlet

While the Class 1 Route Sheets show the dialing routes within the basic network, further

information is required to determine to what extent calls may be dialed between this basic network and the Class 2 offices and tributary offices.

This information is shown in the Dial Routing Pamphlet, copies of which are sent to each Routing Engineer and kept up to date as new dial routes are added.

The material in the Pamphlet is arranged by States, and for each state shows:

List of all Class 2 and tributary offices which can be reached on a dialing basis; the code to dial; the numbering plan of the office; and if there are any coin box numbers outside of the 7, 8, 9 or 0 thousands series.

Also, until such time as the Class 1 Route Sheets can be arranged to show the codes for multi-switch dial routes the Routing Pamphlet contains a list of the direct groups from each Class 1 office which can be reached by dialing and the associated codes. See Figure 17. The date scheduled for dial operation is shown for each office or group, if it is not already dial.

The type of completion is also indicated, as "SF" for straight-forward and "cd" for community dial offices which do not have intercept facilities and/or no "flashing" busy.

Lists of system codes, universal codes and cities having 3-digit TX numbers are included for the information of the Routing Engineer.

Adjustments by Associated Company Routing Engineers

From the Class 1 Route sheets and the Routing Pamphlet the Associated Company Routing Engineer combines and adjusts the material for each of his toll centers that have dialing access to the network. This information is forwarded to the Toll Centers under a form entitled "Dial Routing Instructions", Figure 19, or, in the case of the N. E. Area of the Ohio Bell Telephone Company, on a 5" x 8" card, a sample of which is shown in Figure 20.

He must prefix any routing information which may be required ahead of that shown on the Class 1 Route Sheet.

A Class 2 office operator who can dial over trunks appearing in her multiple into the crossbar switches has the same dialing possibilities as the No. 4 city toll operator who dials through the same switches, i.e. Medina, Ohio. Such routings can be taken directly from the Class 1 office Routing Sheet, prefixing the name of the group to be selected in the multiple.

Examples:

Cleveland to Philadelphia

215+2L+ (From Cleveland Class 1 Route Sheet)

Medina to Cleveland to Philadelphia:

Cleveland 215+2L+

Date: 10-1-51
Toll Center: CANTON
System Code: 064

INTERTOLL DIAL ROUTING INFORMATION
Company: Ohio Bell Tel. Co. - N.E.

<u>Name and Toll Center, Offices and Trunk Groups</u>	<u>Sub.No. Plan</u>	<u>Trunk Group Code</u>	<u>Special Considerations</u>	<u>Date Dial</u>
A. <u>CANTON T.C. CLASS I</u>	4N&5N	+		
B. <u>OFFICES IN T.C.</u>		+		
9xxx or 9xxxx Numbers - Exception - See Trib. North Canton				
C. <u>TRIBUTARIES OF T.C.</u>				
Beach City	Manual	175		
Bergholz	Manual	173 (Carrollton)		
Brewster	Manual	174		
Canal Fulton	4N	177+		
Carrollton	Manual	173		
Dalton	4N	179+	* # ∅	
Dellroy	Manual	173 (Carrollton)		
East Rochester	Manual	172 (Minerva)		
Harlem Springs	Manual	173 (Carrollton)		
Hartville	3N&4N	161+	* # ∅	
Louisville	3N&rN	162+	* # ∅	
Magnolia - Waynesburg	4N	171+	* #	
Malvern	3N	173 (Carrollton)		
Massillon	4N&2+4N	14+		
Mechanicstown	Manual	173 (Carrollton)		
Minerva	Manual	172		
Navarre	4N	178+	* ∅	
New Harrisburg	Manual	173 (Carrollton)		
North Canton	9+3N&4N	+	# ∅	
Paris	Manual	176		
Pattersonville	Manual	172 (Minerva)		
Petersburg	Manual	173 (Carrollton)		
Wilmot	Manual	175 (Beach City)		
D. <u>INTERTOLL TRUNK GROUPS ON THROUGH TRAIN</u>				
Alliance		012+		
Cambridge Test Sta.		014+		
East Liverpool		025		
Mansfield		121		(022 1-7-49)
New Philadelphia		121		(013+4Q50)
Orrville		024		
Steubenville		121		(015+6-11-49)
Toledo		121		(016+3-17-49)
Uhrichsville		026		
Wooster		121		(021 Indef.)
Youngstown		011+		
Zanesville		023		(+4Q49)
<u>Other Direct T.C. Dial Groups Not on Switches</u>				
Akron Term		121		
Akron Via		121		(1-9-49)
Cleveland Term		121		(6-25-49)
Cleveland Via		121		(6-25-49)
Columbus		121		

* No 60 I.P.M. Line Busy Flash

No complete intercepting

∅ Coin Box series other than 0,9, 8 and 7xxx

CLASS 1 ROUTES

AKRON, OHIO

ABER-HZTN

OFFICE	ROUTES		181 OPR CODE	OFFICE	ROUTES		181 OPR CODE
	1st	A			1st	A	
ABER	CGO 152°			CLBA	WASH		
AKR	-			COLS	COLS 2LT		
ALBY	CLEV 518			C'CH	ST L		
ALBQ	CGO 152°			COVI	WASH		
ALTWN	PITB			CUMB	PITB		
ALNC	LCLT			DLS	CLEV 214		
ATOON	PITB			DANB	NY 124		
AMAR	ST L			DANV-I	CGO 135°		
AND	IPLS	DET		DANV-V	WASH		
ANNP	BALT	WASH		DVPT	CGO 152°		
ANN	DET			DAYT	DAYT 2LT		
APPL	CGO 013+			DEC	IPLS	CGO 165+	
APK	PITB			DNVR	CLEV 303		
ASVL	CIN			DES M	CLEV 515		
ASHO	COLS 090	CHAS		DET	DET		
ASHTA	CLEV 084			DODGE	DAYT 083 KC		
ATLA	ATLA	LSVL		DBQ	CGO 152°		
ACY	PHLA 132+			DULH	CLEV 218		
AUB-I	TOL 077			DNK	CLEV 169	BUF	
AUB-N	BUF			DHAM	PITB		
AUG	WASH			ESTN	PITB	PHLA 144+	
BALT	BALT	PITB		EU CL	CGO 715+		
BANG	NY 122°			ELK	DET	CGO 152°	
BT RU	ATLA			ELML	BUF		
BCK	TOL 042+			ELP	CGO 152°		
BHR	DET			ERIE	CLEV 176		
BLG	CLEV 612 MPLS			EVSVL	CLEV 812		
BNGTN	BUF			FRMT	PITB		
BHAM	CLEV 205			F RIV	NY 126+		
BIS	CLEV 612 MPLS			FGO	CGO 152°		
BLM-IL	CGO 135°			FDLY	TOL 024		
BLM-IN	IPLS			FLT	CLEV 046		
BLUE	CHAS	CIN		FLRC	ATLA		
BSE	CGO 152°			F DUL	CGO 152°		
BOS	PITB			FT D	CGO 152°		
BRFD	PITB			FT SM	ST L		
BPT	PITB			FT WN	CLEV 081		
BRIS-C	NWRK			FT WH	CGO 152°		
BRIS-T	WASH	NY 122°		FRED	BALT		
BUF	BUF			FR LK	LSVL		
BURL-I	CGO 152°			GALES	CGO 135°		
BURL-V	NY 333°			G CY	NY 482°		
BTE	CGO 152° HLN			GARY	CGO 152°		
CAL	CGO 123° WPG			GLF	NWRK		
CTS	CTS+			GLBO	NY 333°		
CNAN	NY 122°			G IS	CLEV 402 OMA		
CANT	TCANT+ VCANT+			G RPS	DET		
CPR	CLEV 303 DNVR			GT BN	NY 122°		
CED R	CGO 152°			GT FS	CLEV 612 MPLS		
CENT	CGO 135°			GN BY	CGO 152°		
CHAM	IPLS			GNFD	NY 017+		
CHAS-S	BALT			GNBO	WASH		
CHAS-W	CHAS	CLEV 304		GNVL	NY 333°		
CHLOT	PITB			HGRSTN	PITB		
CHARVL	WASH			HFX	NY 333°		
CHATT	CIN			HAM-O	COLS 023+		
CGO	CGO 2LT			HAM-ON	BUF		
CIN	CIN			HAMD	CGO 152°		
CLKSBG	CLKSBG	PITB		HBG	PITB		
CLEV	CLEV 2LT			HFD	PITB		
CLIN	CGO 152°			HZTN	PHLA 519	NWRK	

AMER. TEL. & TEL. CO.
L.L. DEPT.

DIAL ROUTING PAMPHLET

PENNSYLVANIA

1st Revised PAGE 3

Cancels Original Page 3

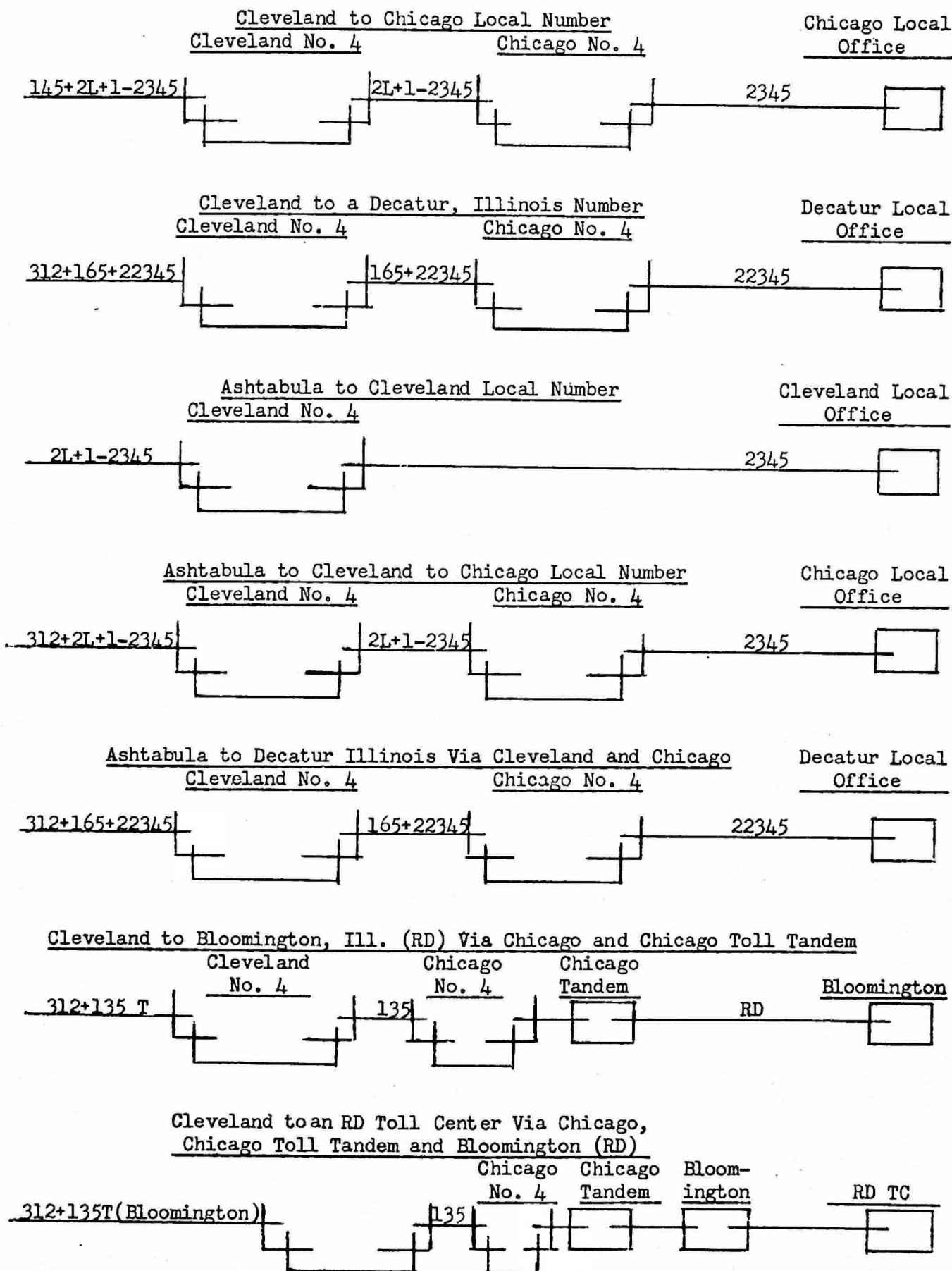
PLACE - OFFICE	DIAL CODE	DATE DIAL	PLACE - OFFICE	DIAL CODE	DATE DIAL
LANSDALE (Cont'd)			PHILADELPHIA CL. 1 (Cont'd)		
<u>Tributary Offices</u>			<u>Toll Centers Reached by Dialing</u>		
Lexington	cd 16+		Akron, Ohio	042	1Q '49
X North Wales	ed 17+		Albany, N.Y.	518	
X Perkasio	ed 18+		Allentown, Pa. T	531D	
X Sellersville	ed 18+		Allentown, Pa. V	071D	
X Souderton	ed 19+		Altoona, Pa.	814	
			Annapolis, Md.	120D	
			Asbury Park, N.J. V	194	
			Atlanta, Ga.	404	
			Atlantic City, N.J. T	221D	
			Atlantic City, N.J. V	132D	
NORRISTOWN			Baltimore, Md. V	301	
Via Philadelphia	+		Barneget, N.J.	152D	
Via others (rd)			Bay Shore, N.Y.	810	
<u>Tributary Offices</u>			Bel Air, Md.	310	
Conshohocken	sf 7		Bellefonte, Pa.	167	
Plymouth Meeting	sf 7		Berlin, N.J. V	710	
X Phoenixville	ed 9+		Berwick, Pa.	813	
Schwenkville	ø cd 5+		Beverly, N.J. V	714	
			Binghamton, N.Y.	179	1Q '49
			Bloomsburg, Pa.	818	
			Boston, Mass. V	617	
			Bridgeport, Conn.	033	1Q '49
PHILADELPHIA CL.1	2L+		Buffalo, N.Y.	716	
<u>Tributary Offices</u>			Burlington, N.J. V	169	
New Jersey Tributaries	2L+		Cambridge, Md.	819	
Pennsylvania Tribs.	2L+or3L+		Carlisle, Pa.	140	
<u>Exceptions</u>			Chambersburg, Pa.	168	
X Ambler	181	✓	Charleston, W.Va.	304	1Q '49
Chapel Hill	275+		Charlotte, N.C.	704	
Cheltenham	244+		Chestertown, Md.	159	
X Chester	ed 277+		Chicago, Ill. T	831D	
X Cornwall	181	✓	Chicago, Ill. V	312	12-11-48
X Hdtboro	181	✓	X Churchville, Pa.	158	✓
Malvern	658+		Cincinnati, Ohio	021	
Narberth	672+		Cleveland, Ohio	216	
X Newtown Square	181	✓	Coatesville, Pa.	124D	
Ridley Park	775+		Columbia, S.C.	803	
Willow Grove	954+		Columbus, Ohio	614	
			Cumberland, Md.	089	1Q '49
			Dallas, Tex.	214	
			Dayton, Ohio	513	1Q '49
			Detroit, Mich.	313	

ISSUED: September 7, 1951

X Indicates Change

EFFECTIVE: December 1, 1951

FIGURE 18
EXAMPLES OF TYPICAL DIAL CALLS BETWEEN CLASS 1 OFFICES



DIAL ROUTING INSTRUCTIONS

DATE Issued Nov. 1, 1951

FIGURE 19

TOLL CENTER AKRON

CALLED POINT	TOLL CENTER	1ST ROUTE	VIA 151 OPR	ALTERNATES
PENNSYLVANIA (Cont'd)				
Madison	PHLA	PHLA + 3L +		
Malvern	PHLA	PHLA 658 +		
MAUGH CHINK		NY 122 T		
MEADVILLE				
Media	PHLA	PHLA + 2L +		
Melrose	PHLA	PHLA + 3L +		
Merion	PHLA	PHLA + 3L +		
MILTON		PHLA 817		NY 122 T
Morrisville	LANGHORNE	PHLA 085 + 17 +		
Mortonville	COATESVILLE	PHLA 124 +		
Narbeth	PHLA	PHLA 672 +		
Nazareth	EASTON	PITB		PHLA 144 + 114
NEW CASTLE				
New Hope	cd DOYLESTOWN	PHLA 134 + 19 +		
Newton	cd LANGHORNE	PHLA 085 + 16 +		
Newtown Square	PHLA	PHLA 121		
NORRISTOWN		PHLA 153 +		
North Wales	cd LANSDALE	NY 136 + 17 +		
Ogontz	PHLA	PHLA + 3L +		
OXFORD		PHLA 719		
Paoli	PHLA	PHLA + 3L +		
Pen Argyl	EASTON	PITB		PHLA 144 + 119
Pennsburg	cd POTTS TOWN	PHLA 163 + 17 +		
Perkasie	cd LANSDALE	NY 136 + 18 +		
PHILADELPHIA		Dir + 2L +		
Phoenixville	cd NORRISTOWN	PHLA 162 + 9 +		
PITTSBURGH				
Plymouth Meeting	sf NORRISTOWN	PHLA 162 + 7		
Portland	EASTON	PITB		PHLA 144 + 112
POTTS TOWN	sf	PHLA 163 + 4		
POTTSVILLE		PITB		PHLA 039 + 14 sf
QUAKERTOWN		PHLA 128		
Ridley Park	PHLA	PHLA 775 +		
Riegelsville	EASTON	PITB		PHLA 144 + 14 +
Schwenkville	cd NORRISTOWN	PHLA 162 + 5 +		
Sellersville	cd LANSDALE	NY 136 + 18 +		
SHAMOKIN		NY 122 T		
SHARON				
Sharon Hill	PHLA	PHLA + 3L +		
Sharpsville	SHARON			
Souderton	cd LANSDALE	NY 136 + 19 +		
STROUBSBURG				
Sunset	PHLA	PHLA + 3L +		
Swarthmore	PHLA	PHLA + 3L +		

OTE 89 (REV. 7-11-80)

DATE 11-25-51

CARD NO. 1

DIAL ROUTING INSTRUCTIONS

STATE TEX

T.T.C. JACKSONVILLE

ABBR. _____

CL. VIA DLS

BLOCK ROUTE NO. 4823

EFFECTIVE DATE	BLOCK #	ORIGINATING TOLL CENTER	1ST ROUTE	TOLL CENTER CODE	ALTERNATE ROUTE	SPECIAL INSTRUCTIONS
	2048	AKRON	CLEV 214+524			
	2037	CANTON	" " "			
	858	YOUNGSTOWN	" " "			
	854	WARREN	PITB 214+524			
	2033	MANSFIELD	CLEV 214+524			
	2039	ALLIANCE	" " "			
	2053	ASHTABULA	" " "			
	2056	ASHLAND	" " "			
	2056	MEDINA	" " "			
	2056	MILLERSBURG	" " "			
	2056	NORTHFIELD	" " "			
	2056	OVERLIN	" " "			
	2056	PAINESVILLE	" " "			
	2056	WELLINGTON	" " "			
	2060	ELYRIA	" " "			
	2058	LORAIN	" " "			
	2042	SHELBY	" " "			
	2042	WOOSTER	" " "			
	854	CORTLAND	" " "			
		KENT	AKR 023+214+524			
	2048	ORRVILLE	CLEV 214+524			
		SALEM	YGTN 022+214+524			
	2056	CLEVELAND	214+524			

FRONT SIDE 

FIGURE 20

BACK SIDE 

SPRINGFIELD TRIBUTARIES

T.T.C. ROUTE _____

STATE 0
BLOCK ROUTE NO. 1897

EFFECTIVE DATE	TRIBUTARIES	SPECIAL INSTRUCTIONS	DIAL CODE	EFFECTIVE DATE	TRIBUTARIES	SPECIAL INSTRUCTIONS	DIAL CODE
	Catawba	rd	172 Mechanicsburg		Woodstock	rd	172 Mechanicsburg
	Christiansburg	ø cd	147+				
	Donnelsville	ø cd	14+				
	Mechanicsburg		172				
	New Carlisle	ø cd	173+				
	North Hampton	ø cd	17+				
	Pitchin	ø cd	145+				
	South Charleston	cd	17+				
	South Solon	ø cd	177+				
	South Vienna	ø cd	16+				
	Tremont City	ø cd	143+				

In the case of a step-by-step Class 2 office which must dial through an intermediate office to reach a Class 1 office it is necessary to prefix the name of the group as just outlined and the intermediate office code.

There will be direct trunks to only two toll center offices, Akron and Painesville, appearing in the toll line multiple in the Cleveland Main Toll Office. However, the trunks to tributary offices having trunks of the Operator Office or Toll Switch Class will appear in this multiple and the operators will have access to them without going through the switching equipment. The routing information to be furnished the Cleveland Toll Office will indicate this arrangement.

Two (2) tandem trunk groups are being established from the Cleveland Toll Offices to the No. 4 switching equipment. One of these groups will terminate on the Intertoll (I.T.) Train and the other on the Toll Completing (T C) Train.

From the Class 1 Route sheets and the Dialing Pamphlet the Routing Engineer is in a position to determine all the dialing possibilities for each toll center in his area. In determining how far a call may be dialed he must keep in mind the digit limitations previously mentioned of the various No. 4 switching systems.

Miscellaneous Considerations

If a trunk group is split functionally into terminal and via groups a separate code is required for the terminal group and the listing will be so designated in the routing instructions.

Operators will be furnished a list of special codes for the direct groups out of their offices which have some wide band (XA) and some narrow band (XB) trunks. These codes will cause selection from among the wide band circuits only. In establishing conference, picture and overseas calls an operator will be called in on the connection at each intermediate point and she will establish the next link in the connection.

If there is a code conflict between two or more offices, one will be assigned its natural letter code, and the others will be assigned arbitrary numerical codes. For example: Chestnut Hill, a local central office of Philadelphia, will be assigned the natural code CH 7. Chester, a tributary of Philadelphia, will be assigned an arbitrary code.

Some customers are in the habit of placing calls to tributary points in metropolitan areas as if they were local offices of a large city, as Philadelphia Chester 12345 for example. To reduce the chance for error, tributaries which conflict with a local central office are listed as

exceptions under the toll center in the Dial Routing Instructions.

As the Dial Routing Pamphlet is not furnished to the individual toll centers, the Route Operator will use the following procedure to quote a route to a point so infrequently called that it is not shown on the Dial Routing Instruction list.

If the called point is shown in the Toll Rate and Route Guide as a tributary office she will obtain the name of the toll center. If the toll center appears on the Dial Routing Instruction List, she will quote the route as given and if the toll center has a + sign she will add "+ 121".

If the toll center does not appear on the Dial Routing Instruction List, she will obtain the name of the via Class 1 office and turn to the Class 1 Route sheet. If the via office has a + sign she will quote the route as given and add "+121" (or if it ends in 2L+ (or 1L or 3L) she will substitute 121).

Community Dial Offices which have both a flashing busy signal and intercept facilities do not require special treatment and appear on the Dial Routing Instructions in the same manner as a regular step-by-step central office.

Community Dial Offices which:

- a. Do not have either intercept facilities or flashing busy, or
- b. Have intercept facilities but not flashing busy signal, or
- c. Have flashing busy signal, but not intercept facilities

will be listed on the Ohio Dial Routing Instruction List followed by the abbreviation "cd", indicating that the outward operator is to listen for the busy tone or ringing signal. For interstate traffic, only Community Dial offices that have a flashing busy signal will be listed on the Dial Routing Instruction List. Offices without this feature (a or b above) will be routed to the TTC Inward operator (code 121) for completion.

Miscellaneous Considerations

On the Dial Routing Instruction List is a column headed "Via 151 Opr.". To leave a call order at the first intermediate office the operator will dial the code shown in this column followed by 151.

At offices having the circuits to the first intermediate switching point in the multiple, no code will be shown in this column; it being understood that it is necessary for the operator to dial only the "151 code" on these groups.

9.0905 HOW CALLS ARE HANDLED

Refer to Toll Operating Practice for your Central Office.

SECTION 10

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10.0 TRAFFIC ENGINEERING

10.01 GENERAL

Traffic Engineering is that part of the Traffic Department work that has to do with the provision of equipment and the interconnecting trunks. Some of the considerations are:

1. Assemble basic data and project it into the future.
2. Assist Chief Engineer's people in making studies to determine the proper types of equipment for specific locations.
3. Determine the quantities and arrangement of equipment and trunks required to maintain the desired service level, and arrange for the provision of these facilities at the required time.
4. Determine operating room and other Traffic Quarters space requirements to insure proper working conditions.

The overall job of Traffic Engineering may be defined as:

"The process of determining and arranging for the provision at the proper time of adequate quantities of the proper types of equipment and trunks so located and arranged that, when used in accordance with accepted operating and force adjustment practices, the desired balance between quality and cost of service will be achieved."

10.02 THE TRAFFIC ENGINEER'S JOB

In view of the above, we might say, therefore, that the Traffic Engineer's job is to see that facilities of the **right** kind and of the **right** amounts are in the **right** place at the **right** time to give the **right** grade of telephone service. His job might be likened to that of a highway system to meet the requirements of vehicular traffic.

With regard to the provision of equipment, the Traffic Engineer must first select the appropriate grade of service, i.e., the speed of dial tone or operator answer and per cent of calls encountering busies on local and intertoll trunks and on switching facilities. This requires a consideration of community needs, the relative costs of different service levels and a familiarity with the relationship between loads and service.

To determine the amount and arrangement of facilities to meet expected service needs requires a consideration of the past and present volumes and directions of flow of traffic. The traffic engineering data include calling rates, holding times, trunk overflow and point-to-point records. The sources and uses of these data will be covered later.

From these past and present data, estimates for the future must be made since it requires months or perhaps a year or so after equipment is ordered before it is in place to give service. In addition the equipment should be adequate for a

suitable "Engineering Period" during which no additions are ordinarily contemplated. The Commercial Engineer's furnish, for this future period, an estimate of the growth in lines and stations and this must be reflected in the estimates of traffic volumes.

Future trends can be influenced by a great many factors such as level of business activity, changes in rates and changes in volumes of traffic flow between communities. Estimates either by Commercial or Traffic which are too high result in unjustified expense and those which are too low can cause service impairment. Good judgment in making these estimates is therefore very important.

The Traffic Engineer prepares a Traffic Order showing the types, amounts and arrangement of equipment to meet the service demand for the period under consideration taking into account the expected traffic volumes.

The Traffic Order is used by the Chief Engineer's people (Equipment Engineers) for writing the specifications to be sent to the manufacturer.

The Traffic Engineer must follow the progress of the project. Manufacturing or installation delays may require consideration of alternative arrangements to avoid service deterioration; or unforeseen changes in traffic characteristics and volumes or line and station estimates may require revision of the original order.

After a project has been placed in service the Traffic Engineer keeps closely in touch with its operation to determine if it is furnishing the best service of which it is capable and whether service could be improved upon by any changes or rearrangements of facilities. Discharge of this responsibility frequently requires visiting the project and discussing its operation with the field people, including Plant Maintenance personnel.

In many cases there is more than one way to do a given job. Where two alternatives will produce the same service results it is the Traffic Engineer's responsibility to select the most economical method. If the more expensive method will produce the better service he must weigh the additional expense against the service betterment. In cases of this type, the cost figures are usually provided by the Equipment Engineers.

Also, the Traffic Engineer plays an important part in programming replacements since these involve the cost of traffic operations, the amounts of equipment required to produce a desired grade of service and other service considerations. In this connection he furnishes traffic information for studies which are initiated by the Plant Extension Engineer. These replacements may involve proposals to replace a local manual office (or older dial office) or inward and through toll switchboards with dial equipment, etc.

In conjunction with other Departments the Traffic Engineer determines numbering plans, operating arrangements such as decentralization of toll, intertoll dialing, etc. all of which have

important bearing on the convenience and usefulness of the service. Particularly, he works closely with the Commercial Department so that he may anticipate in equipment design any proposed changes in rate structures.

The Traffic Engineer must also keep up to date on new developments and facilities so that he may be in a position to specify them where appropriate to secure better service for less money.

Other responsibilities of the Traffic Engineer, in most areas, concern the working conditions of the traffic personnel in that he arranges for adequate space for operating rooms, traffic offices, lounges, cafeterias, locker and quiet rooms and for the decorating, lighting and ventilation of them.

He is also responsible for:

1. Certain elements of separation studies for Division of Revenues and for rate case purposes.
2. Studies to establish the basis of payments to and from Connecting Companies for work done and facilities provided for handling interchanged business.
3. Development of arrangements of facilities which will best meet operating requirements and the objective of the best possible service at the lowest practical cost.
4. Assigning items of toll traffic to appropriate routes and keeping the operating people informed of routing changes.

10.03 RELATION BETWEEN LOADS, SERVICE AND THE TRAFFIC ENGINEER

It is contemplated that, in general, those reading these notes will not necessarily be concerned with the theoretical approach to the solution of traffic problems.

Their concern may be with the field of traffic operating methods and practices or of central office supervision as well as with traffic engineering.

Knowledge of the effect of basic traffic factors on facilities and switchboards with which they may later deal, should assist them in solving service or other problems that may be encountered.

Capacity tables are prepared for the use of the traffic engineer in estimating quantities of all types of equipment for the provision of which he is responsible. These are so designed that there can be predicted, with a reasonable degree of confidence, the grade of service that will be obtained when the equipment is loaded to its rated capacity.

It is not necessary that the new traffic man, or for that matter, the traffic engineer, intimately understand the derivation of the capacity tables he is called upon to use. It is helpful, however, for him to acquire a knowledge of some of the fundamentals upon which they are based.

Such a knowledge, together with an understanding of the significance of the gathered data

which enter into the provision of central office and other facilities, tend to strengthen the traffic engineer's judgment in properly appraising the final results of his computations.

As mentioned previously the interconnection of subscribers in a telephone system is a major problem which has increased in complexity as the number of subscribers has increased. The difficulty of designing efficient and economical systems of interconnection has been overcome by methods of approach to traffic problems which over the years have quite generally provided satisfactory solutions.

Engineering methods have been developed with the objective of definitely relating amounts of facilities to the quality of service they will produce. It appears reasonable, therefore, that the service potential of a certain quantity of equipment be appraised in terms of some measure of the things most important in the subscriber's mind concerning the service.

Aside from good mechanical and electrical performance in the setting up of calls and freedom from error where the human element is involved, none of which is a function of the quantity of facilities, customers are interested in two principal phases of their service.

The first is the frequency with which connections can be made on the initial attempt to the telephone they wish to reach.

The second is the length of time required to reach it.

The aggregate of calls made by a group of subscribers in a unit such as the central office follows a varying pattern throughout the day. It is the business of the traffic engineer to provide sufficient facilities throughout the system of intercommunication that the grade of service, measured by appropriate standards, shall be satisfactory to the subscriber. Facilities must be sufficient to care satisfactorily for the maximum demand.

The subscriber himself, no doubt, would be unable to predict accurately for one hour in advance, not to mention a day or a year, the exact times that he would call upon the Telephone Company to complete a call or calls for him. The traffic engineer, however, must do this for groups of subscribers if he is to satisfactorily perform his function.

In order to perform that job then, he must rely on some use of the laws of probability to help in solving his problems. He must analyze the components of the commodity with which he is working and combine them with what mathematical laws he can adapt to his use. The results are interpreted in terms of quantities of facilities and numbers of operators.

The basic factors of a quantity of calls as they originate from a group of subscribers and as treated by the traffic engineer are:

1. The elapsed time of each call as it occupies facilities or requires handling by operators.

2. The number of talking channels or operators that are available in one group to handle the total of the calls offered to them.
3. The efficiency of the group of channels or operators that handle the calls.
4. The service potential for a given call load having certain characteristics as listed under the three foregoing items.

These combine in various ways and in numerous places along the path comprising the train of connection. The effect of these combinations is to produce a certain grade of service.

The fundamental approach consists of compounding known variables into some form of probability formula to determine the resultant grade of service.

The holding time and work time vary among calls.

The elapsed time of a call which occupies facilities during its existence is called the **holding time**. When a call requires the services of an operator, that time is usually spoken of as the work time.

The number of talking channels or operators available to handle calls varies with the type of facility.

In the case of dial central office facilities the number of talking channels or trunks to which a given call has access varies with the type of dial equipment.

For example, in step-by-step dial equipment, the maximum access to trunks for any one call is largely limited to ten. Certain types of switches with larger access also are used to some extent.

The efficiency of a group of channels, auxiliary facilities, or operators, varies with the service requirement.

The efficiency of a group of trunks is the per cent of time during an hour that the trunks of a group are engaged on the average in carrying calls. This also is called the per cent usage. It is obtained by dividing the capacity of the group in hundred call-seconds by the product of the number of trunks in the group and 36.

The capacity of a trunk group is the amount of traffic expressed in terms of the number of hundred call-seconds (CCS) of load which, when offered to the group will receive a specified grade of service.

One hundred call-seconds of load, usually designated, 1 CCS, consists of a potential occupation of one trunk or channel for a period of one hundred seconds. Arithmetically a load expressed in CCS is the product of the number of calls and their average holding time in seconds, divided by one hundred.

The maximum CCS load that could be handled by one trunk in an hour is 36 since there are 3600 seconds in an hour.

The amount of facilities provided, ordinarily is governed by the volume of traffic that is offered during the hour of the day when that volume is a maximum; that is, during the busy hour.

The service potential for a given traffic load and equipment situation is measured in terms of the appropriate criterion.

By service potential is meant, the grade of service that can be rendered for a given load in a situation where the basic factors have been ascertained.

A load of 149 CCS is offered to a group of ten trunks. The traffic is between two local offices and every call has access to all ten trunks.

A grade of service can be expected in this example where, on the average, only ten calls out of every thousand offered to the group will find all ten trunks busy at the instant they are offered.

The foregoing example illustrates the method of evaluating grade of service on most groups of local trunks.

When the service objective is such that only a small proportion of calls cannot be advanced on the initial attempt because all paths are busy, the criterion is the percentage of offered calls which finds all trunks busy.

Intertoll trunks, since they interconnect cities which usually are widely separated geographically, are much more expensive than interlocal trunks and therefore ordinarily are provided on a less liberal basis.

From the above, therefore, an increase in holding time or work time causes the grade of service to deteriorate, provided there is no change in group or team size.

It is assumed in this case that the number of calls offered per hour also does not change.

An increase in holding time or work time, under the condition that an offsetting decrease in number of offered calls keeps the load constant, causes no change in the grade of service where the criterion is the percentage of offered calls which finds all trunks busy. Group size is assumed to remain the same.

In order that the traffic engineer may translate estimates of future traffic levels into quantities of facilities that will produce the desired grade of service it is necessary that he be furnished with suitable capacity tables or their equivalent.

As referred to in Section 8, capacity tables for practically all types of facilities with the exception of switchboards, are expressed in terms of hundred call-seconds of capacity or CCS, coupled with the grade of service in appropriate terms that it is expected will be achieved with those loads. Further discussion seems unnecessary at this time.

10.04 INFLUENCE OF EXCHANGE RATE STRUCTURE ON FACILITIES

Rate structure is the basis of charging for

telephone service. It involves the establishment of classification of telephone service with appropriate differentials between the rate for the different classes.

The rate structure vitally affects the design of every central office. Facilities for party-line ringing, for charging on message rate lines and for coin handling on coin lines must be provided where these services are to be given. The effect of the various classes of service on facilities is much less for a manual than for a dial office. In dial offices, in addition to the need for providing the appropriate equipment for meeting the class of service requirements, such as message, coin, party, etc., with or without timing and charging facilities, the lines must ordinarily be segregated by service classes on the switching equipment.

In dial offices particularly, it may be a costly procedure to make changes in the service classes, both as to types and proportions, especially if these changes are from a simple to a more complex service class, as from flat to message or from message individual to message party. It is, therefore, important that any changes in the rate structure should be anticipated wherever possible well in advance of the time when they are to be made effective so that the alterations and rearrangements of equipment can be accomplished in an orderly manner and without causing undue service deterioration during the process.

The rate structure has only a moderate influence on the facilities in manual offices. Flat rate individual lines require no special equipment in the positions, but to serve flat rate party lines, ringing facilities are required to send out the proper ringing for calls to the different stations on the line. The principal effects of rate structure on these types of facilities are the determination of the number of switchboard positions to be equipped with keys for message and coin operation as well as the amount of message register equipment. If the rate structure is changed to message service for example these facilities must be added and the increased amount of work time per call reflected in the number of switchboard positions. In addition, changes in rates affect the basic traffic characteristics, i.e., station calling rates and holding times, and this fact must also be reflected in the amounts of equipment required to give a desired grade of service.

With respect to dial offices, these must be designed to furnish the classes of service comprehended in the rate structure. Party lines must be given appropriate types of ringing equipment. Message and coin lines must be provided with the necessary facilities for register operation and for coin collection and return. Where customer dialing of zone or toll calls is involved the necessary equipment for charging and timing on such calls must be provided. Numbering arrangements must be established which customers can use conveniently in reaching all points within their dialing scope. Any change in rates which affects volumes and direction of flow of traffic such as the substitution of an extended service

rate for a toll charge with resultant stimulation of traffic must be taken into account to avoid service deterioration.

Changes in the rate structure frequently necessitate alterations in types of equipment, in the grouping of lines and in the trunking arrangements.

From the above an idea can be formed of the amount of preliminary planning, as well as installation and rearrangement work, which is involved in a change of this kind.

10.05 NUMBERING ARRANGEMENTS

By numbering arrangements, often referred to as "Numbering Plans," is meant the system of identifying each telephone or station in a city or calling area by a distinctive designation to be used in calling that particular telephone. This designation or number appears on the number plate of the telephone and in the directory; it also represents a specific location on the switching equipment through which a connection is established to the telephone. In short, it is the telephone address of the station.

Numbering arrangements have an important influence on the grade of service rendered. This is particularly true where dial operation is involved since the customer dialing performance is influenced to a considerable extent by the type of number to be dialed. The customer receives the best service which the facilities are able to furnish when he dials the number he wants to reach with convenience and without error. Dialing errors result in misrouted calls to the annoyance not only of the calling customer but also of the customer called in error when, as is frequently the case, the call is routed to a wrong station. In addition, a numbering system which is not clearly understood by the customers results in an unduly large number of calls being referred to operators for assistance with resultant delays in completion.

It is therefore essential in the interest of good service and good public relations that the customer be provided with a numbering system which he can use with the greatest degree of convenience and accuracy so that he will avoid dialing errors as far as possible. This objective can best be met by a plan which—

- (a) Is similar to the numbering arrangements which are used in other places where the customer frequently uses the service. Customers take their dialing habits with them and variations in the types of numbers which they are called upon to dial can be source of confusion.
- (b) Lends itself to good directory treatment so that the customer can easily and without confusion find in the directory the method of calling the number he wishes to reach.
- (c) Can be left unchanged for a long period of time. Changes in numbering arrangements

are a source of annoyance and inconvenience to the customers and result in service deterioration for months or even years until the customers become entirely familiar with the new system.

- (d) Provides the fewest number of digits for the customer to dial on calls to his community of interest area. The greater the number of digits in the number the greater the likelihood, other things being equal, that the customer will make an error in dialing one or more of the digits.

These objectives will frequently conflict so that a high degree of judgment is required in selecting the arrangement which will produce the best service. In general a plan which is uniform with that of other nearby areas, which can be clearly shown in the directory and which can reasonably be expected to be permanent, is to be preferred.

The numbers for the larger cities contain office names while those for the smaller cities and towns have numerals only; in general those places requiring six or seven digits in the number are those in which office names are employed, and those with fewer than six digits use numerals. The reason for this is to a degree historical but principally in line with the objective of employing numbering which customers can remember and use most conveniently and accurately.

Universal Numbering vs. Directing Codes: A universal numbering plan is a system of numbering all of the telephones in a given geographical area so that no telephone number will be duplicated within that area. It includes all telephones which might be considered within the business and social environment of the calling customers where the vast majority of their calls are directed.

In calling points beyond the area included within a universal numbering plan some identification must be given to the called telephone other than the number itself. In the case of manual service this may be the name of a town or city. Where customer dialing is involved this identification is a so called "directing code" which the customer dials before he dials the listed number, the purpose of the code being to direct the call into another numbering area. The use of such a code must, of course, be described in the telephone directory.

From their nature, directing codes are a source of inconvenience to the dial customer particularly when any substantial portion of his calls require their use. This is because customers frequently omit the code where it should be used and use it where it is not required which tends to react adversely on the service. This is especially true where there is a multiplicity of these codes since the possibilities of error are greatly increased. The disadvantages are mitigated somewhat where the areas involved are separated by a geographical barrier such as a body of water or a range of mountains, a political boundary or a section of open country which may assist in fixing in the minds of the customers the proper dialing procedure.

On the other hand there are situations where due to limitations in existing equipment or other reasons the use of a directing code or codes appears to be the only practical way to enable the customer to dial certain other telephones to which he may have dialing access. The use of a directing code or codes may be a service improvement as compared to having these calls handled by operators since the speed of connection where the customer dials his calls directly will be considerably greater.

Changing Existing Numbering Arrangements: As numbering systems require change, it is highly desirable to work toward a more uniform pattern of numbering than is encountered today. The use of fewer varieties will tend to simplify the dialing procedure for the customer. This objective assumes increased importance as dial service becomes more and more universal.

This uniform pattern will be two-five numbering for the larger centers and their immediate environs. The two-five system furnishes the largest number of central office codes (about 500) and is the most flexible of any system in use. While there are many technical obstacles, particularly in those cities served by step-by-step equipment, which will prevent its adoption for a number of years, this form of numbering will be the ultimate objective.

Selecting Office Names: The selection of central office names has a considerable influence on the quality of the service. Names which are hard to understand, particularly over a telephone connection and names which are difficult to spell lead to customer confusion and dialing errors which might be avoided by a more judicious choice.

Service Codes: Service codes are an important consideration in achieving a numbering system which dial customers can use conveniently and accurately. This is especially true since many of the calls to service operators are of an emergency nature which emphasizes the need for codes which are uniform, short, easily found and easily used.

Resume: The subject of numbering arrangements assumes increasing importance as dial service becomes more and more universal and as the customer dialing radius is expanded through the extension of local service areas and the use of facilities for timing and charging of toll calls.

The problem is one of providing numbering arrangements which the customers can use with the maximum degree of convenience and accuracy. The quality of the service which the dial system furnishes will, to no small degree, depend upon how successful we are in meeting this objective. This is a further responsibility of the Traffic Engineering group.

10.06 TRAFFIC SPACE REQUIREMENTS

Another function of the Traffic Engineering Group is that pertaining to the Traffic Space

Requirements for new buildings as well as those for additions to existing building both of which must be estimated before the buildings plans are completed.

Traffic Space requirements are not determined on the basis of fixed factors such as square feet per position or employee but are governed principally by the equipment, facilities and furniture needed in the particular building concerned. When such needs are established, exact space requirements are determined by allowing certain areas per unit of equipment, and certain clearances between objects, which have been developed by experience as essential in providing suitable space and arrangements.

In making estimates, careful consideration is given to the ultimate requirements in order that a minimum of building changes and rearrangements of space are necessary as the office grows. It is extremely important that all Traffic people concerned be consulted before presenting the initial and ultimate requirements to the Chief Engineer's organization.

Traffic Space requirements fall, generally, into three categories: operating rooms; service observing, training and administrative rooms, including conference and picture projection space; and operators' quarters. Cafeteria space is also a Traffic responsibility.

Aside from the space requirements, consideration is given to ventilation, lighting and the appearance of the traffic quarters. Operating rooms need good ventilation as this is conducive to personal comfort and health, which in turn, helps to improve efficiency and accuracy in a person's work. Air conditioning is, of course, desirable, however, the provision of this is not always practical because of existing building design and space limitation.

Lighting is important. The work of the average operator involves a considerable amount of close eye work, such as writing tickets, reading tickets, bulletins, designation strips, etc. At outward toll positions, this close work amounts to approximately half of the operator's occupied time. The provision of good operating room, as well as clerical space, lighting, which involves adequate light levels and general freedom from glare, shadows and reflections is essential.

Fluorescent lighting is generally used in all new operating rooms or rooms where lighting must be changed. Light levels recommended are 12 to 14-foot candles on switch board keyshelves, about $\frac{1}{3}$ less on the face equipment and 20 to 30-foot candles on auxiliary and clerical desks. The usual procedure is to locate the light fixtures slightly back of the operators or clerks in order to avoid glare in the eyes.

As for the appearance of the traffic quarters, most operators spend about 90 per cent of their time in the telephone building in the operating room and this per cent is even higher for the clerical forces with respect to their locations. It is axiomatic that the average employee's happiness

and contentment in his work is directly affected by the environment in which he performs his work. Bright, cheerful, attractive rooms and quarters, with a reasonable amount of color, have proved to be a definite aid in recruiting and retaining employees, whereas dull, drab, unattractive quarters and operating rooms have all too frequently had the opposite effect. The Traffic Engineer must, therefore, consider such things as wall colors, floor and window treatment, size of rooms, location of head set racks, Chief Operator Interview rooms, class and discussion rooms, auxiliary and miscellaneous desks, wash rooms, locker rooms, powder bars, smoke rooms, lounges, lounge-dinettes, quiet rooms, nurse's quarters, etc. in addition to ventilation and lighting.

Clerical space is usually assigned to floor space designed for the ultimate equipment frame requirements. It is very difficult, therefore to provide the many desirable features mentioned above for this space for reasons of economy as well as permanency.

10.07 SEPARATION STUDIES

Another function commonly placed under the jurisdiction of the Traffic Engineering group is that pertaining to Toll Separation Studies.

Telephone Companies are engaged in furnishing both intrastate and interstate communication services. The intrastate services include both exchange (local) and toll services. Exchange and state toll services are, in nearly all states, subject to the jurisdiction of state regulatory commissions, and interstate services are subject to the jurisdiction of the Federal Communication Commission. One of the more significant elements required by a commission in considering the adequacy and reasonableness of telephone rates is the rate of return on the property used in providing the service subject to its jurisdiction. Since local calls, state toll calls, and interstate toll calls are all handled, at least in part, over the same facilities and by the same forces, special studies are required to "separate" or apportion the costs of plant used and expenses incurred in rendering these services between intrastate and interstate. Revenues are, in general, directly assigned, although in certain instances special analysis are required for their apportionment. In any rate proceeding, upon request of a commission or on Company initiative, separations of property, expenses and revenues between intrastate and interstate are made so that the rate of return on the intrastate or interstate segment under review, can be established.

From the gross interstate revenues each Company recovers the expense it incurred in giving interstate service and the remaining amount is divided among the Companies in proportion to the amount of plant each uses for interstate business. The amounts involved are determined from separation studies similar to those made for rate cases except that only a two-way separation between interstate and all other is required.

The expenses which must be separated between exchange, state toll, and interstate toll include all

operating expenses and taxes. These expenses are principally wages (including those for supervision, employment and training for operating switchboards, maintaining the plant, preparing the bills, operating the commercial offices, and administering the business) and depreciation. They also include the expense of stationery, printing, advertising, rest and lunch rooms, house service, rents, and other items. In addition, the expense of operating the Plan for Employee Pensions, Disability Benefits, and Death Benefits is included.

Traffic Unit Factors are developed from peg count data. The number of units of traffic operating work per state message, per interstate message and per local call are determined for each switchboard. These units per message or call are multiplied by the respective volumes of messages or calls handled during a selected study period, and the percentage relationship of the units for each service to total units is calculated.

Subscriber Line Use Factors (SLU) are developed from special "holding time" studies and message and call volumes. By means of visual observations or measurements with recording devices and simultaneous peg counts and ticket records, the actual minutes of use per local call and per toll message are determined. These holding times are applied to the respective volumes of local calls and toll calls handled during a selected study period to determine the minutes of use for local and toll purposes. The toll minutes of use are separated between state and interstate in the same proportion as the toll units handled at the local and toll switchboards. The percentage that each of these three elements is of the total minutes of use is computed.

All exchange revenues of an Associated Company and revenues from state toll calls, that is, those which originate and terminate within the same state, are retained by the Associated Company since this business, because of its intrastate nature, is not included in the Division of Revenue contracts.

All of the revenues from interstate message toll telephone calls, that is, those which cross state boundaries, are included in the Division of Revenues contract between the Associated Companies and the Long Lines Department.

Most of the toll plant crossing state boundaries is owned by the Long Lines Department, but the Associated Companies and their connecting companies furnish all the terminal plant to reach subscribers, and, in addition, toll lines for completing connections to and from points not reached directly by Long Lines circuits. In addition these Companies perform most of the operating and do all of the billing and collecting. This jointly handled business is called Long Lines business and the revenues therefrom must be divided between the participating parties.

The method of dividing interstate message toll telephone revenues is covered by contracts between the American Telephone and Telegraph

Company and each of the Bell System Companies. There are, in addition, other contracts relating to certain plant (relatively minor in amount) which the Associated Companies furnish to Long Lines.

Each Company prepares a monthly statement (Final Settlement Data) showing the book costs assignable to L.D.I., the amount of expenses incurred in handling this business, and the amount of revenue received from Associated Company Long Distance Interstate business.

Each month the total number of dollars received by all of the Companies for interstate message toll telephone service is totaled.

The Long Lines Department totals the expenses for all Companies and deducts this total from the total revenue.

The Long Lines Department determines the percentage that each Company's book cost assignable to L.D.I. is of the total such cost for all Companies.

The money remaining after deduction of expenses is then apportioned to the Companies in accordance with the percentage each Company's L.D.I. book cost is of total L.D.I. book costs.

Each Company receives an amount equal to its expenses for handling L.D.I. business plus its share of the remainder.

The procedures which have been described briefly are designed to produce a separation of the book costs of plant, expenses, and revenues between intrastate and interstate service for the purpose of establishing rates or to provide an equitable basis for the division of interstate revenues between all the Companies which participate in the handling of this business. Essentially they are cost studies.

The fundamental basis on which the separations are made is the actual use of the telephone plant for each service. This actual use is determined from special studies which result in the direct assignment of certain book costs and expenses between two or more services on the basis of factors derived from traffic units, minutes of use of subscriber lines, conversation minute miles, and other special analysis. Revenues are separated by direct assignment or on the basis of special studies or analysis.

Thus, in any rate proceeding, separations of property, expenses, and revenues are made so that the rate of return on the intrastate or interstate segment under review can be established to assist in the determination of the prices to be charged for the service. Under the Division of Revenues contracts, similar separations are made to determine how much each Company should recover from the gross interstate revenues for its expenses in handling interstate business, and how the remaining portion of the interstate revenues is to be divided among the Companies.

10.08 ENGINEERING DATA AND ESTIMATES

The traffic engineering procedure is to obtain records of past traffic volumes and characteristics; to summarize them in most useful form; to select representative data from these records; and to project these representative figures, direct or modified as necessary, to the future period in which the engineer is interested.

Good judgment is essential in the selection of representative data and the projection of data. Errors of judgment at this stage are not compensated for at any later stage in engineering, so an estimate that is too high or too low will result in excess cost or in poor service when the installation is completed.

A valuable aid to good judgment is close acquaintance with the office for which estimates are being made. Not all the characteristics of an office are apparent from routine records. For example, susceptibility to sudden peaks of traffic may not be reflected in any available peg count data.

The engineering data, and the process of estimating, are different for different types of offices. The discussion in this course will be confined to dial offices, however.

The type of information required for engineering dial offices varies greatly with the types of central office facilities used. The discussion will therefore be in broad terms. More detailed discussion for Step-by-Step type offices will follow in paragraph 10.09.

The data required for engineering dial offices are more detailed than those required for engineering manual switchboards. Lines are in most cases segregated on the frames, so that busy hour engineering data for each segregated class of service are required. The equipment for handling incoming traffic is normally segregated (or partly segregated) from the originating equipment so that estimates of incoming traffic are required. Selector multiples must be arranged to accommodate the particular numbers and sizes of trunk groups encountered, and therefore trunk estimates are required.

The numbers of selectors and other equipment items required in dial offices are determined by reference to the capacity tables discussed in Section 8. In most cases these capacities are expressed in terms of CCS: for example, the tables used for engineering step-by-step line finders, selectors and connectors. The traffic estimates used in dial office engineering must therefore be in terms of originating and terminating busy hour CCS.

The records kept for step-by-step offices are in the form of calling rates and holding times, or directly in CCS since all step-by-step capacity tables are in terms of CCS.

When manual offices are to be converted to dial, special records must be taken to obtain the necessary engineering data which are, of course, more detailed than those ordinarily obtained in

manual offices. Holding times or CCS by classes of service are obtained by plug counts, and calls by classes of service are recorded by special peg counts. The traffic engineering and central office people work out the exact method to be followed in obtaining the data, keeping in mind the amount of detail and accuracy required in the data and the effect on force requirements during the period when the records are being taken.

Dial office peg counts are taken on a regular basis and the originating data may be plotted in the form of busy hour calling rates by classes of service and for the total office. Dial office peg counts are obtained by reading traffic registers. These readings are not in all cases in terms of manual peg count calls. In such cases the counts may be used as recorded or may be converted into equivalent manual peg count calls, by using established ratios, before being plotted as calling rates.

The terminating data may be plotted in the form of calling rates, CCS per terminal, or as a per cent terminating of originating. Special records of terminating calling rates for the classes of main stations served by hunting, coin and rural connector groups, respectively, are kept for step-by-step offices.

The selection of calling rates from the calling rate curves, and their projection to the future, require sound judgment. Where the basic engineering records are kept in terms of CCS instead of calls and holding times, the CCS are obtained from selector usage counts made in the central office. Records of CCS are taken on a regular schedule, during enough days in the busy season months to insure a reliable record for engineering purposes. These counts may be made manually, or by means of automatic or semi-automatic devices.

Total office and class of service busy hour CCS per line, main station or total station may be plotted, and the CCS calling rate projected for future estimates in the same way as other types of calling rates.

The more important basic data are trunk estimates; line and station data; and calling rates and holding times (or CCS) by classes of service obtained from peg count records and special records taken in the central office.

10.09 STEP-BY-STEP TRAFFIC ENGINEERING

The purpose of this paragraph is to acquaint the Traffic assistant with the fundamentals of engineering a No. 1 step-by-step office by briefly following through the various steps required to estimate the quantities and arrangements for a simple four-digit single wire-center exchange office.

Before going into the detailed considerations of the Traffic Order that follows for the typical office, we might review the Engineering Service Bases used for the example as well as those which would be used in the preparation of a traffic order for a 5, 6, or 7-digit office.

The engineered grade of service in a step-by-step system is represented by adding together all the delays engineered into each step of the train. Thus, if each step in the train of a 4-digit system were engineered for the same delay as each step in a 7-digit system, a considerable differential in

the over-all grade of service would result. Some equalization of the overall grade of service is desirable and may be approached by using the following table as a guide for local intraoffice trunking.

SELECTOR STAGE	CAPACITY TABLES APPLICABLE			
	4-Digit System	5-Digit System	6-Digit System	7-Digit System
1st to 2nd	20	20	10	10
2nd to 3rd	—	10	10	10
3rd to 4th	—	—	10	10
4th to 5th	—	—	—	5
Sel. to Conn.	Conn 10	Conn 10	Conn 10	Conn 10
1st to S. Code	10	10	10	10
S. Code to Rev. Call	10	10	10	10
Any Selector to Rotary or Plunger O.T.S.	1	1	1	1

The above table assumes full effective trunking. Should digit absorbing selectors be employed, thereby eliminating some trunking stages, appropriate adjustments may be made. For example, if the first and second digits in a 7-digit system be absorbed, the stage of selection from the digit absorbing "first, second and third" selectors to fourth selectors may be engineered on Table 20, from fourth to fifth selectors on Table 10 and fifth selectors to connectors on the connector table. This is equivalent to that shown for a 5-digit system.

Table 10 is regarded as generally satisfactory for toll switching trunks, for trunks to "A" Board Completing Selectors, and for trunking between the various toll selector stages in the local office.

Consideration of individual office characteristics, such as pronounced and recurring peaks, may indicate the desirability of variations from the engineering service bases suggested above.

10.091 SAMPLE TRAFFIC ORDER

Preparation of Basic Traffic Data

Description of Office to be Used as an Example

The classes of service, calling rates, holding times and types of equipment used in the example should not necessarily be considered as typical of what might be found in practice in any particular area.

The office selected has 4872 working lines and 6165 working terminals (main stations). The flat rate lines amount to 4700, the individual message rate seven and prepay coin 165.

The office will operate initially on a four-digit basis. Ultimately combined four- and five-digit directory numbers will be required.

Rural line service will be on a divided code ringing basis.

A No. 3CL toll switchboard will be located in the building with the dial equipment, as will a No. 23 type information and intercept desk.

The code zero will be used to reach the CLR operator as well as for assistance.

Assistance calls requiring completion to local numbers will be routed over the group of toll switching trunks.

A small dial office is included in the local service area. A two-digit code is dialed to reach the group of two-way trunks to the small dial office. From the small office the local service trunks terminate on incoming first selectors.

(No intertoll train will be included in this "Example" office.)

Commercial Estimate—Figure 1

The information contained in the Development Forecast, Figure 1, will be used to develop the working lines and main stations (connector terminals) as required for the tables in Figures 2 and 3. (In Traffic Order)

Lines, Main Stations and Originating Busy Hour Traffic—Figure 2.

In Figure 2 the number of lines and main stations are determined from the Development Forecast. The calling rates and holding times on a dial peg count basis are developed as discussed in 10.08. The information in this figure will be used in developing the distribution of traffic from first selectors and also to engineer the line finder equipment.

Connector Terminal Requirements— Figure 3

The working connector terminals (main stations as determined from the Development Forecast, Figure 1) are classified into groups corresponding to the different types of connector groups which will be provided. Different types of connectors are required for P.B.X. and associated lines, for multi-party lines, and for individual, two-party lines. In addition, the coin terminals are segregated in separate consecutive number series to permit identification of coin stations on inward collect calls.

To determine the number of connector groups of each type the total number of equipped connector terminals must first be determined. This is the sum of the working main stations and the spare required for each class of connector terminal. (Including Test Terminals).

The total connector terminal requirements for the office used as an example are shown in Figure 3.

Terminating CCS at Connectors—Figure 4

The CCS for each connector group must be estimated to serve as a basis for determining connector requirements. These same data are also used for estimating the traffic to each thousand group from first selector levels 3 to 9.

The local and toll CCS per connector terminal is estimated in accordance with local practice. Applying this estimate to the number of working terminals per group and the number of connector groups shown in Figure 3, the Table in Figure 4 is derived.

Assignment of Connector Groups—Figure 5

In assigning connector groups to an office it is desirable to have as far as possible the same proportion of the different types of groups within each thousand. Having different types within each thousand has an advantage since the peak load in the various classes may occur at different times. There are certain restrictions to prevent an even distribution, such as, coin numbers must be assigned with the 0000, 9000, 8000 or 7000 series so toll operators can recognize calls to these numbers. In addition the number of groups in the different classes will not be an even multiple of thousands groups available. In the example there are only four rotary hunting groups and eight rural connector groups to be spread over the seven thousand groups. The connector groups arranged for two-ring ringing on four-party semi-selective lines and other types of groups might be assigned as shown in Figure 5.

Distribution of CCS for Local First Selector Levels—Figure 6

As an example of the method used in developing the distribution of traffic by classes over the first selector levels the requirements for level 3 are estimated as follows:

For level 3 (the 3000 group) in Figure 5 eight regular, one rural and one rotary hunting connector group are assigned. The local traffic to each regular group will be $5886 \text{ CCS} \div 54 \text{ groups} = 109 \text{ CCS}$. The rural group will receive 69 CCS ($552 \div 8$) and the rotary group 270 CCS ($1080 \div 4$). The total for level 3 of the local and incoming first selectors is 1211 CCS. The CCS for the remaining levels 4 to 9 are estimated in the same manner.

The 100 CCS incoming from the community dial office are distributed over the levels 3 to 9, in proportion to the totals developed above.

From the total traffic, 1211 CCS, to level 3 the 16 CCS from the CDO is subtracted and the remainder is divided between the F&M and coin first selectors in the same proportion as the total office busy hour originating CCS, that is 7878 F&M and 235 coin CCS, from Figure 2.

The traffic for each of the other levels, 4 to 9, divided between F&M, coin and incoming may be determined as for level 3.

Estimates of traffic for level 0 to operators and for level 1 to service code trunks are developed according to the practices used in the local Area or Company. The preliminary pulse traffic from F&M first selectors is assumed to be one per cent of the originating CCS.

The distribution of traffic as determined above may be set up in table form as shown in Figure 6.

The CCS in the column headed "Coin B.H." in Figure 6 is the distribution of the total originating coin busy hour traffic, 445 CCS (Figure 2). The traffic to level 0 is determined from special records and the remainder is distributed over the other levels in the same proportion as the traffic shown under "Total."

Distribution of CCS from Toll First Selector Levels—Figure 7

The distribution of toll traffic to the thousand groups is determined from the incoming traffic to the various connector groups assigned to each thousand as explained above for local traffic. Figure 7 shows the estimated distribution derived from the data shown under "Terminating CCS at Connectors," Figure 4, and "Assignment of Connector Groups," Figure 5.

Second Selector Multiple Traffic to Connectors—Figure 8

As an example, the local and toll traffic for the 10 connector groups assigned to the 3000 series, as estimated for Figure 6, is shown in Figure 8.

Distribution of CCS from Levels of Service Code Selectors—Figure 9

It is assumed that the 120 CCS to service code trunk groups, as shown in Figure 6, is distributed as shown in Figure 9.

Engineering of Equipment

Line Finders

In the preceding section the number of lines, main stations and originating busy hour traffic were developed for the typical office used as an example. The number of working lines and originating CCS by classes will be used to illustrate the methods used in engineering line finder equipment.

There are three classes of lines, flat rate, message rate and coin, which ordinarily require segregated line finder groups as special trunk equipment is required between line finders and first selectors for coin and message rate groups. In addition the associated first selectors for the different classes may have to be segregated as separate trunk groups may be required to operators from level 0 or from the service code selectors reached from level 1 of the first selectors. However, in this case there are but seven individual message rate lines and it will be more economical to provide a combined group with enough flat rate lines to fully load the group. This combined group will be the first line finder group and from a traffic engineering standpoint will be treated as a flat rate group. From an equipment point of view it requires special treatment in that a special auxiliary message rate line circuit must be provided for each of the seven lines.

The following three other plans for handling a small number of message rate lines are available but each one is less attractive for the above case as explained for each case:

Combined flat and message rate line finder group with message rate trunk circuits in each line finder-first selector trunk instead of the special auxiliary message rate line circuits. If there had been more message rate lines, probably 20 or more, this plan would have been preferable from a cost standpoint.

Separate line finder group for the message rate lines, using 22-point rotary switches as line finders. Units for 10 lines and three line finders are available. The message rate trunk circuits would also be required in each line finder-first selector trunk. This arrangement would be attractive for a small number of lines where a separate group of trunks is required from one or more of the first selector levels for the exclusive use of the message rate lines, as for reaching the operator from level "0".

A third plan for a small number of lines would be to terminate each line on a first selector specially arranged to furnish message rate charge features. This plan might be attractive for high calling rate lines and it also permits the provision, where required, of a separate group of trunks from first selector levels. Generally, this plan is not too attractive.

In order to balance the load between line finder groups it is the practice to engineer 200-point line finder groups for 194 working lines with two

per cent spare line terminals. In addition two line terminals are required for testing purposes. The flat rate line finder requirements for the example are estimated as follows, assuming that 1.5 per cent of the originating calls will encounter a delay in receiving dial tone of over three seconds during the busy hour of the busy season.

$$\text{(FR)} \frac{7861 \text{ CCS}}{4700 \text{ lines}} = 1.67 \text{ CCS per working line.}$$

There are seven message rate lines originating 17 CCS to be operated in the first line finder group with 187 flat rate lines. This group will therefore have 187×1.67 (CCS per line) = 313 CCS plus 17 CCS from message rate lines for a total of 330 CCS. To determine the number of line finders required reference is made to the Line Finder Table for 1.5 per cent dial tone interval over three seconds. It is found that 17 line finders will be required for this combined group having 330 originating CCS.

The remaining flat rate lines 4513 (4700-187) will deliver $194 \text{ lines} \times 1.67 \text{ CCS per line}$ or 325 CCS per line finder group. From the table for 1.5 per cent dial tone delay referred to above it will be found that 16 line finders will be required for each full group. Therefore $4513 \text{ lines} \div 194 \text{ lines per group}$ results in 23 full groups with 194 lines and 16 line finders.

The 51 remaining lines will originate 51×1.67 CCS per line or 85 CCS. With the table used above for the full groups, the 85 CCS would require that seven line finders be provided to serve the 51 lines.

Where a small number of lines remains beyond the last full group of line finders as in this case of 51 lines, two alternatives are usually considered. If the number of lines left over is small it may be practical to scatter these lines over the full groups rather than to engineer an additional partial group, especially when they would require an additional frame. This reduces the spare line terminals for load balancing. The other alternative is to provide a fully equipped line finder group. The latter plan has a number of advantages especially in larger offices where growth is expected.

The 165 coin lines originate 235 CCS in the office busy hour but line finders must be provided with capacity to handle the traffic during the hour of maximum load which probably occurs during the evening hours. This traffic is estimated to be 445 CCS for the 165 lines. Again referring to the line finder table for 1.5 per cent dial tone delay we find that 21 line finders will be required. All other full size line finder groups in the office require 17 line finders and 20 size units will be provided. Therefore it would be desirable to use a 20 size unit for the 165 coin lines. The question is what delay to dial tone might be expected if only 20 line finders were provided for the coin group. Referring to the line finder capacity tables it appears that about two per cent of the calls would receive dial tone delays over three seconds. While this

quality of service is slightly below the standard set, the cost of any alternative arrangement would seem to justify the use of 20 line finders.

Any further growth in the number of coin lines will require the provision of a second group, unless there is a reduction in the CCS per line. Had there been several groups of coin lines in the above case the use of line finder units having capacity for 30 line finders (with 24 line finders equipped in each group) would have been considered. For one or two groups in an office where all other groups use frames for 20 size units it would be objectionable to use 30 size frames from a floor plan layout standpoint, since the 30 size units require a longer frame.

To summarize the line finder equipment required for the office: there will be, for flat and message rate lines, 23 full groups with 194 working lines and 16 line finders plus a partial group of 51 working lines with seven line finders and a F&M group of 17 finders or a total of 392 line finders. The one coin line finder group will have 165 working lines with 20 line finders.

Local First Selectors

The number of local first selectors in the office is as follows:

One for each flat and message rate line finder as estimated—392.

One for each coin line finder as estimated—20.

One for each two-way trunk from the small dial office—14.

The assignment of trunk groups to the first selector levels is as follows:

The zero or top level is assigned to trunks terminating at the toll board for use by customers when they dial "Operator" to place a long distance call or to ask for assistance.

The first or bottom level is assigned a group of trunks used in completing calls to the 11X codes, such as 113 for information. These trunks from level 1 are also used in case a customer sends in a preliminary pulse before beginning to dial. Level 1 trunks from the F&M first selectors terminate in auxiliary first selectors. The first selectors for coin subscribers in the example absorb the first digit "1" since only a few selectors are involved and trunks from level 1 terminate in service code selectors.

The remaining eight levels are available for assignment to subscriber numbers. Levels 3 to 9 are arranged for 1000 numbers on each level except 9 where only 800 are assigned initially with reserve for growth for 100 numbers. Instead of assigning the tenth hundred, a group of trunks to an outlying small office is assigned in its place. Level 2 is reserved for a future five-digit office in the same building.

Local First Selector Multiple

In arranging selector multiple subgrouping, it is important that the Traffic Engineer know, if

possible, the arrangement of selectors on the frames in order that the best and most efficient trunking can be provided. The arrangement of selectors on frames is generally determined by the equipment engineers. It is assumed that the selectors in this example will be arranged on two frames, the miscellaneous selectors and 72 flat and message rate selectors on the first frame and the remaining 320 F&M selectors on the second frame. Note that space is left on the first frame for growth from 72 F&M selectors to 160 with sufficient space left for growth in the miscellaneous classes.

Selectors have capacity for 10 trunks on each of the 10 levels and since selectors are mounted in units of 10 the most simple plan of providing trunks, say to second selectors, would be by providing a separate group of trunks for each division of selectors as follows:

Assume that the 392 flat and message rate first selectors deliver 1160 CCS to level 3 second selectors. (See Figure 6). Dividing the 1160 CCS by 392 selectors indicates that each selector delivers 2.96 CCS and 10 selectors or one division would deliver 29.6 CCS. If a group of trunks is provided for each unit of 10 selectors, using the Trunk Capacity Table, Table 20, four trunks would be required for each 10 first selectors. The total trunks required to handle the 1160 CCS would be 39.2×4 or 157.

Since facilities are provided at the distributing terminal assembly on each selector frame to multiple together any number of selector divisions (10 selectors), a more efficient arrangement would be to multiple together enough selector divisions to load to capacity the 10 trunks the selectors have access to. Under this plan the arrangement of the 392 selectors to carry the 1160 CCS would be determined as follows:

Since each selector delivers 2.96 CCS to level 3, by dividing 166 CCS, capacity of 10 trunks, (Table 20 of Trunk Capacity Tables) by 2.96 CCS, it is found that 56 selectors would be required to load 10 trunks. Since the selectors are mounted in units of 10 instead of 56 it will be necessary to use 60 selectors to load the 10 trunks. Dividing 392 by 60 results in six subgroups or 60 selectors on 10 trunks with 32 selectors left over. These 32 selectors originate 95 CCS (32×2.96) and from Table 20, 7 trunks would be required or a total of $6 \times 10 + 7$ or 67 trunks.

The second plan illustrated above would result in a large saving of second selectors and this general plan was used for equipment installed prior to 1927. Since that time the use of graded multiple, as described previously has been developed so that trunk groups much larger than 10 can be employed for trunking from selector levels. The procedure, according to the present Traffic Engineering Practices, is to subgroup the 392 selectors to provide capacity for 1160 CCS, as follows:

The flat and message rate first selectors will deliver 1160 CCS and dividing by the number of

selectors, 392, each selector will deliver 2.96 CCS. Referring to the tables "CCS per Selector Tables" Section 8, from Table 20 it is found by examining the calling rate per selector columns that the largest number of selectors that should be used with a calling rate of 2.96 per selector is 160. Since frames of 320 selector capacity are used one of the subgroupings as shown in the table of 320, 160, 80, 40 or 20 should be selected. In the column for 160 selectors it is found that the calling rate of 2.96 is between 2.74 and 3.00, thus, 25 trunks will be required for this subgroup. The second frame of 320 selectors will therefore be arranged in two subgroupings of 160 selectors arranged before 25 trunks each.

On the first frame the remaining 72 flat and message rate first selectors will deliver 214 CCS (72 x 2.96). From the same table referred to above in the bottom half of the page it will be found that for selector subgroupings slightly larger than 72, that is 80, the capacity of 12 trunks should be adequate for this subgroup.

The other selectors will deliver 86 CCS, made up of 58 from coin, 16 from incoming and 12 CCS from flat rate auxiliary first selectors for preliminary pulse calls. These selectors will be combined to form a subgroup of seven trunks as determined from the Trunk Capacity Tables, Table 20.

The total trunks to second selectors for level 3 will be 69, made up of two subgroupings of 160 F&M selectors on 25 trunks, one subgroup of 72 F&M selectors on 12 trunks and the miscellaneous selectors on seven trunks.

Another plan is sometimes used to advantage where a small number of selectors are left over, as follows:

Multiply the CCS per selector applicable by the number of left over selectors. By reference to the non-graded trunk capacity tables shown at the bottom of the "Selector Multiple Capacity Tables" in Paragraph 8.12, determine the total trunks that would be required for the left-over selectors as indicated by the "Non-Graded Groups" table shown at the bottom of the "Selector Multiple Tables". If eight or more trunks, treat the left-over group as a separate subgroup. If seven, or less, refer to the table below to determine the number of individual first choice trunks to be provided for the exclusive use of the left-over selectors. The remainder of the ten terminals are multiplied to the corresponding terminals of the last selector division in the last full subgroup.

Trunks Required	Individual First Choice Trks. Req'd.
Less than 2	0
2	1
3	2
4	2
5	3
6	4
7	5

On this basis let us now take another look at Level 3. As before, the F&M CCS per selector is 2.96, thus requiring the same two subgroupings of 160/25 trunks. Also as before, the remaining 72 F&M selectors offer 214 CCS to level 3, coin box 58 CCS, Incoming 16 CCS and the Aux. 12 CCS. These "left-over" F&M firsts plus the miscellaneous are installed on 140 banks, as follows:

F&M	72 Sels.	80 Banks
Coin	20 "	20 "
Inc.	14 "	20 "
Aux.	14 "	20 "
		140 Banks Total

The nearest standard subgroup is 120 banks. Therefore, if we group the 80 F&M banks, the 20 Coin and the 20 Incoming banks we can establish a standard subgroup of 120 banks. The total CCS offered to level 3 from these 120 banks is 288 CCS (214 F&M + 58 Coin + 16 Inc.). From the Selector Multiple Tables under column "120 Selectors Per Subgroup" we find that 16 trunks will be required. Now for the 12 Auxiliary first level 3 CCS, the non-graded table (for approximately 12 CCS) indicates that 3 trunks would be necessary. Referring to the above table, we find that 2 individual first choice trunks would suffice if the remaining 8 contacts were multiplied to the last half shelf of the 120 banks. The total "3000" second selectors required under this plan would be, therefore:

$$50 + 16 + 2 = 68 \text{ 2nd Selectors}$$

From the above we determine that one less second selector is required. The "Local and Incoming First Selector Multiple Chart" of the Sample traffic order will indicate the latter arrangement.

It will be noted that only flat rate auxiliary first selectors are used in this case to care for preliminary pulse calls since the coin first selectors are arranged to absorb the initial digit "1" and trunks from level 1 of these coin first selectors terminate directly on service code selectors.

The work sheet showing the arrangement of selectors and trunks for all first selector levels is shown on Figure 10, and the arrangement to be specified in the traffic order Multiple Chart for "Local and Incoming First Selectors."

Toll Switching Trunks and Selectors

The trunks from the toll board for the completion of incoming toll calls, delayed originating toll calls, and assistance completed calls terminate in toll transmission first selectors. Since these toll switching trunks operate in a common group, the Trunk Capacity Table No. 10 is used to estimate the number required. The estimated traffic of 802 CCS for this group will require 35 trunks, using Table 10. The number of selectors to be provided for these trunks will be 37 since five per cent spare selectors are provided to care for some fluctuation in the number of trunks that can be operated.

There is no rigid rule for estimating the number of switching trunks to be equipped for coin operation but an adequate number will ordinarily be provided by establishing the percentage of coin CLR traffic to the total CLR traffic and applying double this percentage to the total switching trunks. In the example the total CLR traffic is 434 CCS and the coin 73 or 16 per cent and $16 \times 2 = 32$ and 32 per cent of 35 is eleven. Therefore, 10 out of the 35 will be equipped for coin operation.

Toll First Selector Multiple

Level	To	CCS	Toll 2nd Selectors
9	9000	84	7
8	8000	94	8
7	7000	94	8
6	6000	128	9
5	5000	134	10
4	4000	134	10
3	3000	134	10

In the above table the number of selectors in the last column is provided on the basis of the estimated CCS and Table 10. In this case the number can be read from the Trunk Capacity Tables since 10 selectors or less are required for each level. However, had more than 10 trunks been required in any case the 37 toll first selectors would have been arranged before a graded multiple group of trunks to toll intermediate selectors and the CCS per Selector Tables would be used to determine the number. (See Multiple Chart in Traffic Order).

Connectors

In the office being used as an example the following types of connectors are required.

Combination Local and Toll, Regular
Local, Rotary Hunting
Toll, Rotary Hunting
Combination Local and Toll, 10-Party Terminal-per-Station-Code Ring.
Test

The combination local and toll regular connectors are arranged to send out either one or two rings to the called station during each ringing cycle of six seconds. The connector hundreds to be equipped with two-ring connectors must be specified. Combination local and toll regular connectors are used generally for all regular and coin groups and are designed to serve individual, two-party and four-party stations.

In the rotary hunting connector groups are assigned P.B.X. and associated lines. In addition, individual and two-party line stations may be assigned in these groups. A group of local hunting connectors must be provided from the preceding local second selectors and, for the toll traffic, a separate group is provided from the corresponding level of the toll second selectors.

The combination 10-party Code Ring terminal-

per-station connectors serve lines having more than four stations and generally rural line stations are assigned to these groups. A terminal in these groups is used for each rural station and divided code ringing is used so that parties on each side of the line hear the code ring of any other stations on their side of the line. As discussed earlier in this course, reverting call selectors are not required for calls made between parties on the same line as these connectors are arranged to complete reverting calls.

Each connector group must be provided with a test connector which is mounted on the connector shelf, at left end, and has access to the 100 terminals in the group. These connectors are used by operators to verify busy lines and certain tests are made through them from the test desk.

For the 3000 group of local and toll selectors the basic data under "Second Selector Multiple Traffic to Connectors"—Figure 8 was prepared and from this information the number of connectors for each of the 10 groups is determined as follows:

Level 38 for the one group of rural connectors (10 Party Terminal-per-Station) is expected to receive 73 CCS and from Table 10 of the Connector Capacity Tables seven connectors are required.

Level 37 for the local rotary hunting group is estimated to receive 270 CCS and referring to the "Connector Capacity Table" 17 connectors are required arranged in one graded group. For the toll rotary hunting connectors for this group 50 CCS are estimated and from Table 10 of the Connector Capacity Tables it will be found that six connectors are required.

The remaining eight levels for regular groups are estimated to receive 119 CCS each, and from Table 10 of the Connector Capacity Tables it will be found that nine connectors per group are required.

A multiple chart for only the Local and Toll fourth selectors to connectors for the 3000 group is included.

Auxiliary and Service Code Selectors

Auxiliary first selectors are usually provided at the terminating end of trunks from the first level of the subscriber first selectors. These selectors are operated when the second digit of the service codes 11X is received. Calls handled by these selectors include those to information, repair desk, reverting, etc. In addition, in order to absorb a preliminary pulse made by a subscriber before dialing, levels 2 to 0 of the auxiliary first selectors are multiplied to the corresponding levels of the first selector multiple as in the example previously covered.

As an exception to the arrangements described above, auxiliary first selectors are not required if the first selectors of any one class are small in number and are equipped with the digit absorbing feature to absorb the initial digit "1". This

was illustrated for the coin first selectors in the example where the trunks from level one of these selectors were terminated directly on service code selectors.

In the example (Figure 6) the flat and message rate first selectors were expected to originate 117 CCS to the service code selectors and 79 CCS for preliminary pulse calls. The 79 CCS will be completed from levels 2 to 0 of the auxiliary first selectors. From level 1 nine trunks will be required to service code selectors for 117 CCS according to Table 10 of the Trunk Capacity Tables. The coin first selectors absorb preliminary pulse calls and as previously determined for the first selector multiple three trunks will be provided to service code selectors directly from level 1 of the coin first selectors.

The arrangement of the multiple from the nine flat and message rate and three coin service code selectors is determined from the traffic data previously estimated under "Distribution of CCS from Levels of Service Code Selectors—Figure 9 as follows:

Level 9, (Code 119) the 38 CCS will require five trunks to reverting call selectors according to Table 10 of the Trunk Capacity Tables.

Level 8, (Code 118) the 3 CCS will require three trunks to dial and ringer test circuits.

Level 7, (Code 117) the 20 CCS will require five trunks to the Test desk according to Table 1 of the Trunk Capacity Tables.

Level 4, (Code 114) the 20 CCS will require five trunks to the repair clerk's desk according to Table 1 of the Trunk Capacity Tables.

Level 3, (Code 113) the 39 CCS will require six trunks to the information desk, located in the building with the dial equipment, according to Table 1 of the Trunk Capacity Tables.

Level 1, Service code selectors are arranged to absorb the digit "1".

Note: The latest optional arrangement is to eliminate auxiliary first selectors and provide digit absorbing service code selectors off Level "1" of the first selectors. See P.E.L. 4525.

Miscellaneous Items

Test Distributors

Operators' test distributors are provided as a means of obtaining connection to a particular test connector. The test distributor is a two-digit switch and its operation is similar to a regular connector in that it is capable of selecting any one of 100 trunks to test connectors. For a full office of 100 connector groups four or five test distributors will be sufficient for the operators' use. In the office used as an example with 6800 terminals three should be adequate.

Intercepting

Intercepting trunks from connectors are used

for intercepting calls to vacant terminals, changed and discontinued numbers and lines denied incoming service for non-payment of bills.

For this purpose in the office used as an example 68 regular intercepting trunks, one per group, will be required. In addition 25 to 50 per cent or say 30 trunks will be sufficient for special intercepting of several P.B.X. trunks or lines in a group immediately after disconnection when the volume of traffic for these trunks or lines is appreciable.

Directory error intercepting trunks are for intercepting calls made to vacant selector levels as a result of directory errors. Two of these trunks are provided per office of 100 connector groups or less.

Toll vacant level intercepting trunks are used to intercept calls to vacant toll selector levels. Two trunks are provided per office of 100 connector groups or less.

Trouble intercepting trunks are used to intercept calls to lines in trouble. Ten of these trunks are usually provided for offices having 50 to 100 connector groups and in the office used as an example 10 would be specified.

The above four classes of intercepting trunks are concentrated by means of a 200-point trunk finder which is similar to the 200-point line finder used for subscriber lines. The intercepting trunks are terminated on the line terminals of the trunk finder. Each trunk finder is connected to a trunk which terminates at the intercepting positions. A call is extended to these positions in the same manner as a call from a subscriber is connected by a line finder to a first selector. The number of intercepting trunks estimated above totals 112 and one trunk finder unit will be required. The number of trunk finders required will depend on the number of intercepted calls and the holding time on these calls during the busy hour of the busy season. In this case assume 97 calls and a holding time of 35 seconds or 34 CCS. Referring to Table 10 of the Trunk Capacity Tables, five trunk finders and five trunks to the intercepting positions are required.

Traffic Registers

The traffic registers should be provided as explained in Paragraph 5.13.

Preparation of Final Traffic Order

The major items and the arrangements of dial equipment required for the office used as an example have been estimated and the traffic order in final form is prepared according to local practice followed in the Area or Company:

The "Sample" Traffic Order follows.

No. 1 Step-by-Step

DEVELOPMENT FORECAST

<u>CLASS OF SERVICE</u>		<u>Telephones</u>		<u>Lines</u>	
		<u>Present</u>	<u>End of Initial Period</u>	<u>Present</u>	<u>End of Initial Period</u>
Main	Residence Flat				
	1-Party	2047	2992	2030	2992
	2-Party	694	918	379	567
	4-Party	907	465	277	179
	Rural	522	727	81	102
	Total	4170	5102	2767	3840
	Business Flat				
	1-Party	716	746	716	746
	2-Party	25	25	16	16
	Rural	19	22	—	—
	Coin Msg.				
	1-Party	—	—	—	—
	Semi-Public	86	117	86	117
	Public	40	48	40	48
	Total	886	958	858	927
Total Main		5026	6060	3625	4767
Extensions Bus. PBX					
Flat		698	724	94	98
Message		144	144	7	7
Res. Flat		246	387	—	—
Flat		285	303	—	—
Message		—	—	—	—
Coin		11	12	—	—
Total P.B.X. & Ext.		1384	1570	101	105
Total Company		6440	7630	3726	4872

Dated Dec. 1, 1951.

Figure 1

TYPICAL EXCHANGE, MAIN OFFICE
TRAFFIC ORDER NO XXXX
DECEMBER 13, 1951

RECOMMENDATION SHEET

SERVICE DATE: December 31, 1952

END OF PERIOD: 7-31-53

BASIS OF RECOMMENDATION

NOTE: On this, the front sheet of all Traffic Orders, will be found a brief explanation as to the number of lines and terminals being provided, date of Development Forecast, Engineered Main Station Capacity of Office with completion, plus any other pertinent information relative to the job and/or office.

When approved (3 signatures) the Traffic Order is forwarded to the Dial Equipment Engineer who prepares necessary Equipment Specification.

APPROVED:

-----195-----
General Traffic Engineer

-----195-----
General Traffic Manager

-----195-----
Chief Engineer

TYPICAL EXCHANGE, MAIN OFFICE
TRAFFIC ORDER NO. XXXX
DECEMBER 13, 1951

Page 1

SUMMARY OF EQUIPMENT

<u>Classification</u>	<u>Initial</u>	<u>Ultimate</u>
<u>Connector Terminals</u>		
—Rotary	400	Not Included in these notes.
—Regular	5400	
—Rural	800	
—Coin	200	
—Total Office	6800	
<u>Line Finder Groups—20 L.F. Cap.</u>		
—Flat and Message Rate	1	
—Flat Rate	24	
—Coin Box (Pre-pay)	1	
—Total	26	
<u>Lines Equipped</u>		
—Flat and Message Rate	200	
—Flat Rate	4660	
—Coin Box	170	
—Total	5030	
<u>First Selectors</u>		
—Flat and Message	17) (400)	
—Flat Rate	375)	
—Coin Box (D-1-A)	20	
—Total	412 (420)	
—Incoming	14 (20)	
—Toll Transmission	37 (40)	
<u>Second Selectors</u>		
—Local	437 (450)	
—Toll	62 (70)	
<u>Connectors</u>		
—Rotary Hunting—Local	68	
—Toll	24	
—Combination —1 Ring (Incl. CB)	297	
—2 Ring	207	
—Code Ring	56	
—Test	68	
<u>Miscellaneous Switches</u>		
—Reverting Switches	5	
—Coin Control Selectors	3	
—Test Distributors—Plant	As Req'd	
—Traffic	3	
Auxiliary First Selectors	15 (20)	
Service Code Selectors—F&M (D-1-A)	9 (10)	
—Coin (D-1-A)	3 (10)	
<u>Intercepting Concentration Equipment</u>		
—Trunk Finder Unit (16 T.F. Cap)	1	
—Trunk Finders	5	

() Denotes Banks

TYPICAL EXCHANGE, MAIN OFFICE
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SUMMARY OF EQUIPMENT (CONT'D)

<u>Classification</u>	<u>Initial</u>	<u>Ultimate</u>
<u>Register Racks</u> —Traffic	1	
—Message	(On Relay Rack)	
<u>Registers</u> —Traffic	155	
—Line Message	10	
<u>Trunk Equipments</u>		
—CLR—FR and MR	29	
—Coin	9	
—Information	6	
—Repair	5	
—Intercepting	5	
—Trouble Obs. & Test (Plugging-Up Lines)	20	
—“No Such Number” Tone Circuits	5	
Coin Box Trunks (Preceding 1st Selector)	20	
—Message Rate Auxiliary Line Circuits	10	
—Two-Way Dial Trks. (Local Service)	14	
<u>Service Observing Equipment</u>		
—Multi-Line—Dial S.O.—Circuits	1	
—Shoe (and associated Rly. Eqpt.)	20	
<u>Miscellaneous</u>		
—Dial Tone Delay Test Buzzer	1	

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FUNDAMENTAL DATA—JULY 31, 1953

Lines, Main Stations and Originating Busy Hour Traffic—Fig. 2

Class	Lines	Main Sta.	Sta.	CR/MS	Calls*	H.T.*	CCS		
							Total	MS	Line
FR—PBX	98	98	724						
—1 B	746	746	746						
—2 B	16	25	25						
—1 R	2992	2992	2992						
—2 R	567	918	918						
—4 R	179	465	465						
—Rur-Res	102	727	727						
—Bus	—	22	22						
—Ext	—	—	702						
TOTAL	4700	5993	7321	1.11	6661	118"	7861	1.31	1.67
MR—PBX	7	7	144	2.13	15	110"	17	2.35	2.35
COIN BOX	165	165	165	1.24	204	115"	235	1.43	1.43
Grand Total	4872	6165	7630		6880		8113	1.32	1.67
Coin Box (Class)	165	165	165	2.21	365	122"	445	2.70	2.70

* Based on dial peg count registrations and corresponding holding times.

CONNECTOR TERMINAL REQUIREMENTS—FIG. 3

Regular Connector Terminals

1 FB	746
2 FB	25
1 FR	2992
2 FR	918
4 FR	465
Total	5146
Less Associated Lines	138
Total	5008
Less Res. in R.H. Groups	57
Total	4951

Loading 91+
Groups Required 54

Rotary Connector Terminals

P.B.X.—F	98
P.B.X.—M	7
Associated Lines	138
Residence	57
Total	300

Loading 75
Groups Required 4

Rural Connector Terminals

Rural Residence	727
Rural Business	22
Total	749

Loading 93+
Groups Req. 8

Coin Connector Terminals

Public Pay	48
Semi-Public	117
Total	165

Loading 90
Groups Required 1.8 Provide 2

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TERMINATING CCS at CONNECTORS—FIG. 4

Type of Connector Groups	Working Term. Per Group	CCS per Terminal		No. Groups	Total CCS		CCS/BD	
		Local	Toll		Local	Toll	Local	Toll
Regular	92	1.180	.105	54	5886	542	109	10
Coin	90	.578	.166	2	104	30	52	15
Rural	93	.750	.0435	8	552	32	69	4
P.B.X., Rot. Hunting	75	3.600	.660	4	1080	198	270	50
				68	7622	802		

ASSIGNMENT of CONNECTOR GROUPS—FIG. 5

Thousand Groups	Second Selector Levels									
	1	2	3	4	5	6	7	8	9	0
9000	C	—	1R	*	1R	2R	1R	RU	1R	C
8000	1R	2R	1R	2R	1R	2R	1R	RU	1R	2R
7000	1R	2R	1R	2R	1R	2R	1R	RU	1R	2R
6000	1R	2R	1R	RH	1R	2R	RU	RU	1R	2R
5000	1R	2R	1R	2R	RH	2R	1R	RU	1R	2R
4000	1R	2R	1R	2R	1R	RH	1R	RU	1R	2R
3000	1R	2R	1R	2R	1R	2R	RH	RU	1R	2R

* Free Service trunks to Eddyville first Selectors

1R=1 Ring Regular Connector Group

2R=2 Ring Regular Connector Group

C=Coin Regular Connector Group

RH=Rotary Hunting Connector Group

RU=Rural Connector Groups (T/S)

DISTRIBUTION OF CCS FROM LOCAL FIRST SELECTOR LEVELS—FIG. 6

Level	TO	F&M	Coin	Inc.*	Total	Coin B.H.
0	CLR & Spcl. Serv.	361	10	—	371	73
9	9000—Out to C.D.O.	786	23	9	818	38
8	8000	1006	30	14	1050	49
7	7000	1006	30	14	1050	49
6	6000	1122	34	15	1171	56
5	5000	1160	35	16	1211	58
4	4000	1160	35	16	1211	58
3	3000	1160	35	16	1211	58
2	Reserved for Growth (20,000 Series)					
1	Spcl. Serv. Codes and Prelim. Pulse	117	3	—		6
		79	—	—		—
		7878	235	100	8093	445

* Incoming from CDO. Included in the 818 CCS for Level 9 is 100 CCS outgoing to The CDO.

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DISTRIBUTION OF CCS FROM TOLL FIRST SELECTOR LEVELS—FIG. 7

<u>Level</u>	<u>To</u>	<u>CCS</u>
0	—	—
9	9000	84
8	8000	94
7	7000	94
6	6000	128
5	5000	134
4	4000	134
3	3000	134
2	—	—
1	—	—
		<u>802</u>

SECOND SELECTOR MULTIPLE TRAFFIC TO CONNECTORS—FIG. 8

<u>Group</u>	<u>To</u>	<u>CCS</u>		
		<u>Local</u>	<u>Toll</u>	<u>Total</u>
3000	Regular	109	10	119
3900	Regular	109	10	119
3800	Rural	69	4	73
3700	Rotary Hunt.	270	50	—
3600	Regular	109	10	119
3500	Regular	109	10	119
3400	Regular	109	10	119
3300	Regular	109	10	119
3200	Regular	109	10	119
3100	Regular	109	10	119
		<u>1211</u>	<u>134</u>	<u>1345</u>

DISTRIBUTION OF CCS FROM LEVELS OF SERVICE CODE SELECTORS—FIG. 9

<u>Level</u>	<u>To</u>	<u>CCS</u>
0	Vacant	—
9	Reverting	38
8	Dial Test	3
7	Test Desk	20
6	Spare	—
5	Spare	—
4	Repair Clerk	20
3	Information	39
2	Spare	—
1	(Dig. Absorb)	—
		<u>120</u>

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WORK SHEET FOR LOCAL FIRST SELECTOR MULTIPLE—FIG. 10

Class	Sels.	Banks	Class	Sels.	Banks
Flat and Mess (F)	392	400	F&M Aux. 1st.	14	20
Coin (C)	20	20	Incoming	14	20
		(D-1-A)			

* * * * *

Level 1 (Table 10)

(F) $\frac{196}{392} = .5$	CCS/Sel.	1 S-G	320/10	Total Trks.	10
$392 - 320 = 72 \times .5 = 36$	plus CCS (Bal)	1 S-G	80 Banks/5	" "	$\frac{5}{15}$

Level 3 (Table 20)

(F) $\frac{1160}{392} = 2.96$	CCS/Sel	2 S-G	160/25	Total Trks.	50
$392 - 320 = 72 \times 2.96 = 214$	CCS F&M				
plus 58 "	Coin	1 S-G	120/16	" "	16
plus 16 "	Inc.				
288 "	Total				
Left Over 12 "	Aux. =	2 Ind. Trks.	" "		$\frac{2}{68}$

Levels 4 X 5—Same as Level 3.

Level 6 (Table 20)

(F) $\frac{1122}{392} = 2.87$	CCS/Sel	2 S-G	160/25	Total Trks.	50
(F) Bal. $392 - 320 = 72 \times 2.87 = 206$	CCS				
Plus 56 "	Coin	1 S-G	120/15	" "	15
15 "	Inc.				
277 "	Total				
Left Over 12 "	Aux. =	2 Ind Trks	Total Trks.		$\frac{2}{67}$

Level 7—(Table 20)

(F) $\frac{1006}{392} = 2.57$	CCS/Sel	1 S-G	320/43	Total Trks.	43
(F) Bal. $392 - 320 = 72 \times 2.57 = 185$	CCS				
plus 49 "	Coin	1 S-G	120/14	" "	14
14 "	Inc.				
248 "	Total				
Left Over 11 "	Aux	2 Ind.	" "		$\frac{2}{59}$

Level 8—Same as Level 7

Level 9—(Table 20)

(F) $\frac{786}{392} = 2.01$	CCS/Sel	1 S-G	320/35		35
(F) Bal. $400 - 392 = 72 \times 2.01 = 145$	CCS				
plus 38 "	Coin	1 S-G	120/11		11
9 "	Inc				
192 "	Total				
Left Over 8 "	Aux	2 Ind. Trks.			$\frac{48}{59}$

(Note: The above information (Figure 10) is never included in a Traffic order. It is, however, retained in the Traffic Engineer's file under the assigned Traffic Order Number and office.)

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LINE FINDER ARRANGEMENT—INITIAL (SEE NOTE)

CLASS	No. of Grps.	Grp. No.s	Equipment per Group				Total Equipment			
			Lines		L. Fdrs.		Lines	L.F.	1st Sel	1st Sel Banks
			Cap	Eqpd	Cap	Eqpd				
F.R. & M.R.	1	2	200	200	20	17	200	17	17	
Flat Rate	23	3-25	200	200	20	16	4600	368	368	
Flat Rate	1	26	200	60	20	7	60	7	7	
Total	25						4860	392	392	400
C.B.	1	1	200	170	20	20	170	20	20	20

Note: On additions to existing offices, the Line Finder arrangement would be shown "Present" and the proposed (final arrangement) would be shown directly below and indicated "Proposed".

INTERCEPTING TRUNK FINDER UNIT—INITIAL

Type of Circuit	Terms	Ckts.	Term. No.'s	Trk. Fdrs.
Connector Terminals—Grp.	68)	98	11-19, 31-70, 81-89	
—Ind.	30*)		141-160	
Vacant Level—Local	2	—	131-132	
—Toll	2	2	135-136	
Trouble Intercept	10	—	21-20	
Test	2			
	114			5

* Includes 3 circuits for use by the Plant Department in connection with connector terminal test trunk.

Notes on Intercepting Equipment

- 200 Point—16 Finder Capacity Type—5 T.F. equipped 1, 3, 5, 7, 8.
- Vacant Level Trunks—Toll—Tone and flashing arrangements are to be provided on intercepted toll calls. Toll board supervision shall not be retired by the answer of the intercept operator. Trunk circuits will terminate in the Main Toll Office at the No. 23 type Rate and Route, Intercept and Information Desk arranged for call distribution and preferential treatment. These circuits to be arranged for tone removal and flash.
- Completion of intercept calls is not contemplated.

COIN CONTROL SELECTORS—INITIAL

The associated trunks to be assigned as follows.

GROUP	NO. OF TRUNKS	TERMINAL NO.
Coin Box—T. SW.	10	11-10
—CLR	7	21-27

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EQUIPMENT AS OF 19

DATE Dec. 13 1951

ISSUED 19

LOCAL AND INCOMING FIRST				SELECTOR MULTIPLE ARRANGEMENT—INITIAL								
	<u>Class</u>	<u>Sel.</u>	<u>Banks</u>		<u>Class</u>	<u>Sel.</u>	<u>Banks</u>					
Flat & Mess	(F)	392	400		F & M Aux. 1st. (FA)	15	20					
Coin	(C)	20*	20 (D-1-A)		Incoming (I)	14	20					
* Coin first selectors arranged to absorb the initial digit "1".												
Level	To	Sub-Grps. No.	Selectors Per Sub-Group						Trunks		Terminate	
				F	C	FA	I		Per S.-G.			Total
									Cab.	Eqpd.		

0	CLR & Ass't.	4	80				(Note 1)	10	—	40	
		1	72		15		(Note 1)	10	—	10	
		5	392							50	Toll Bd.—F
		1		20			(Note 1)	10	—	10	Toll Bd.—C
9	9000+Local Service Trks.	1	320						35	35	
		1	72	20	15*	14		11+2*	13	Form 120/11	
		2	392						48	2nd. Sels	

* 2 Ind. Trks. provided as first choice for 20 added banks (FA) with remaining terminals multiplied with last half shelf of 120 banks.

8	8000	1	320						43	43	
		1	72	20	15*	14		14+2*	16	Form 120/14	
		2	392						59	2nd Sels.	

* 2 Ind. Trks. provided as first choice for 20 added banks (FA) with remaining terminals multiplied with last half shelf of 120 banks.

7	7000	Same as Level 8									59	2nd. Sels.
6	6000	2	160						25	50		
		1	72	20	15*	14		15+2*	17	Form 120/15		
		3	392						67	2nd. Sels.		

* 2 Ind. Trks. provided as first choice for 20 added banks (FA) with remaining terminals multiplied with last half shelf of 120 banks.

5	5000	2	160						25	50		
		1	72	20	15*	14		16+2*	18	Form 120/16		
		3	392						68	2nd. Sels.		

* 2 Ind. Trks. provided as first choice for 20 added banks (FA) with remaining terminals multiplied with last half shelf of 120 banks.

4	4000	Same as Level 5									68	2nd. Sels.
3	3000	Same as Level 5									68	2nd. Sels.
2	Spare	(Reserved for future 20000 series)										

TYPICAL _____ EXCHANGE _____ MAIN _____ OFFICE #1 _____ UNIT _____
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LOCAL AND INCOMING FIRST (Cont'd)				SELECTOR MULTIPLE ARRANGEMENT—INITIAL			
	<u>Class</u>	<u>Sel.</u>	<u>Banks</u>		<u>Class</u>	<u>Sel.</u>	<u>Banks</u>
Flat & Mess	(F)	392	400		F & M Aux. 1st. (FA)	15	20
Coin	(C)	20*	20 (D-1-A)		Incoming (I)	14	20
* Coin first selectors arranged to absorb the Initial digit "1".							

Level	To	Sub-Grps. No.	Selectors Per Sub-Group							Trunks		Terminate
			F	C	FA	I				Per S.-G.		
										Cab.	Eqpd.	

1	Aux. & S.C.	1	320							10	10	
		1	72							5	5	
		2	392								15	F&M Aux. 1st.
		1		20						3	3	Ser. Code Sels.
		1			15					9	9	Ser. Code Sels.

Note 1: 10 Trunk subgroups cabled out straight, without reversal to distributing frames for grading down to required number of working trunks. L T B register is to be associated with the common trunk of terminal "O" for each group.

Total Local 2nd Selectors

437 (450)

() Number of banks.

TYPICAL EXCHANGE MAIN OFFICE UNIT

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TOLL FIRST				SELECTOR MULTIPLE ARRANGEMENT—INITIAL			
	<u>Class</u>	<u>Sel.</u>	<u>Banks</u>		<u>Class</u>	<u>Sel.</u>	<u>Banks</u>
Toll—Non Coin	(TN)	27	30				
—Coin	(TC)	10	10				
—Total		37	40				

Level	To	Sub-Grps. No.	Banks Per Sub-Group						Trunks			Terminate
			TN	TC					Per S.-G.		Total	
									Cab.	Eqpd.		

0 Vacant

9 9000 1 30 10 7 7 Toll 2nds

8 8000 1 30 10 8 8 " "

7 7000 1 30 10 8 8 " "

6 6000 1 30 10 9 9 " "

5 5000 1 30 10 10 10 " "

4 4000 1 30 10 10 10 " "

3 3000 1 30 10 10 10 " "

2 Vacant

1 Vacant

Total Toll 2nd Selectors 62 (70)

() Number of Banks.

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3000 LOCAL AND TOLL 2ND				SELECTOR MULTIPLE ARRANGEMENT—INITIAL			
	<u>Class</u>	<u>Sel.</u>	<u>Banks</u>		<u>Class</u>	<u>Sel.</u>	<u>Banks</u>
Local	(L)	68	70				
Toll	(T)	10	10				

Level	To	Sub-Grps. No.	Selectors Per Sub-Group								Trunks		Terminate
				L		T					Per S.-G.		
											Cab.	Eqpd.	

0	Regular	1	68		10					9	9	2R Comb. Conn.
9	"	1	68		10					9	9	1R " "
8	Rural	1	68		10					7	7	CR " "
7	PBX	1	68							17	17	Loc. RH "
		1			10					6	6	Toll RH "
6	Regular	1	68		10					9	9	2R comb "
5	"	1	68		10					9	9	1R " "
4	"	1	68		10					9	9	2R " "
3	"	1	68		10					9	9	1R " "
2	"	1	68		10					9	9	2R " "
1	"	1	68		10					9	9	1R " "

Total Connectors-Rot. Htg.—Local 17

—Toll 6

—Code Ring. Comb.— — — 7

—Two " " — — — 36

—One " " — — — 36

TYPICAL EXCHANGE MAIN OFFICE UNIT

MASTER RECORD

TRAFFIC ORDER NO. XXXX

SECTION PAGE

APPENDIX NO. PAGE 12

EQUIPMENT AS OF 19

DATE Dec. 13 1951

ISSUED 19

SERVICE CODE SELECTORS				SELECTOR MULTIPLE ARRANGEMENT—INITIAL			
	<u>Class</u>	<u>Sel.</u>	<u>Banks</u>		<u>Class</u>	<u>Sel.</u>	<u>Banks</u>
F & M	SF	9	10 (D-1-A)				
Coin	SC	3	10				

Level	To	Sub-Grps. No.	Selectors Per Sub-Group							Trunks		Terminate
			SF	SC						Per S.-G.		
										Cab.	Eqpd.	

0	Vacant											
9	Reverting	1	9	3						5	5	Revert. Sws.
8	Dial Test	1	9	3						5	3	Ringer Test
7	Test Desk	1	9	3						5	5	Loc. Test Desk
6	Spare											
5	Spare											
4	Repair	1	9	3						5	5	Repair Desk
3	Information	1	9	3						6	6	Inf. Desk
2	Spare											
1	(Digit Absorbed)											

TYPICAL EXCHANGE, MAIN OFFICE
TRAFFIC ORDER NO. XXXX
DECEMBER 13, 1951

Page 13

TRAFFIC REGISTERS DETAILS—INITIAL

Type and Class	Wired		Equipped	
	No	Location	No	Location
<u>P.C.</u> —Toll 2nd Selectors	7	21-27	7	21-27
—Toll 3rd Selectors	6	28-33	—	—
—Misc. Sel.—Ser. Code	2	34-35	2	34-35
—Rev't	1	36	1	36
—Inc.	2	37-38	1	37
—T. Switch	2	39-40	1	39
—Connectors	100	41-140	68	41-108
—Line Finder	39	141-179	26	141-166
—Timing	1	180	1	180
—Spare	10	11-20	—	—
<u>A.T.B.</u> —Line Finder	39	181-219	26	181-206
—Intercept	1	220	1	220
—Future	10	221-230	—	—
<u>LTB</u> —Out Trunk—CLR	3	231-233	3	231-233
—Loc. Ser.	1	234	1	234
—Inf.	1	235	1	235
—Repair	1	236	1	236
—Test Desk	1	237	1	237
—Future	43	238-280	—	—
—Busy Selector Study	20	281-300	10	281-290
<u>Overflow</u>				
—Busy Subscriber's Line	10	1-10	5	1-5
	<u>300</u>		<u>156</u>	

The "sample" traffic order preceding is, as mentioned previously, only a typical arrangement for a simple 4-digit step-by-step office. Many miscellaneous items such as Intertoll dialing trains, Local and Toll Tandem trains, rotary out-trunk units, inter-office trunk arrangements, etc. have been omitted, however, it is felt that this should cause no undue hardship on the new traffic man, since, if he understands the fundamentals of step-by-step engineering, as exemplified in this "sample" traffic order, he should readily interpret data pertaining to the above items should any appear in an order of which he is concerned. Traffic Orders written for offices in large multi-office exchange areas are usually much larger but only slightly more intricate.

Traffic Orders for additional equipment are prepared in the same manner as this "sample" order, except that both the "present" and the "proposed" equipment arrangements are shown. The "Summary of Equipment" shows "Present", "Additional" and "Proposed" columns.

The following optional items are included herewith as a matter of interest for this course. Immediately following these are the Terminal Assembly drawings for the First Selector bays associated with the multiple chart of the "sample" traffic order.

Five-Digit Office in a Combined Four and Five-Digit Area

To illustrate the methods used to engineer the second and third selector for a five-digit office in a single wire center area let it be assumed in the office used as an example that there are 5000 terminals or half of a unit to be provided in the 20,000 number series. Since the size of the office will be increased almost 100% the number of first selectors and auxiliary selectors will be assumed as:

<u>Selectors</u>		<u>Selectors</u>	
Flat & Message (F)	720	Flat & M. Aux. 1st. (FA)	26
Coin (C)	38	Incoming (I)	21

and the traffic F&M 5060 CCS, coin 250 CCS and incoming 70 CCS.

In engineering second selectors as explained previously for the four-digit office Table 20 was used and on this basis it would be expected that 20 calls per 1000 during the busy hour of the busy season would encounter a paths busy condition on trunks to second selectors. In this case of a five-digit office to provide a grade of service comparable to that received on calls to four-digit numbers Table 10 will be used in estimating the number of second selectors as

well as for the third selectors. On calls to five-digit numbers then out of each 1000 calls 10 calls would be expected to encounter paths busy at second selectors and 10 at third selectors to give a comparable grade of service on calls to all numbers within the office.

The procedure for determining the first selector multiple for the conditions assumed would be as follows:

The flat and message rate first selectors will deliver to level "2" 5060 CCS divided by the 720 selectors, or 7.03 CCS per selector. Referring to the CCS per Selector Tables and Table 10 a subgrouping of 80 selectors on 29 trunks would be used with a slight overload. The use of this subgrouping for the 7.03 calling rate per selector might be questioned due to the overload but as a rule it will be satisfactory to overload 20% of the increment to the next higher calling rate shown in the tables. That is, a calling rate of 7.12 would have required the use of 80 selectors on 31 trunks in this case.

The 720 first selectors would require nine subgroups of 80 selectors on 29 trunks. The 38 coin selectors would require 14 trunks from the CCS capacity table for 40 selectors.

The remaining 70 CCS from the 21 incoming selectors and 51 CCS for the 26 flat and message rate auxiliary selectors, 121 CCS, from the Trunk Capacity Tables will require nine trunks.

Total trunks to local second selectors from level 2; flat and message 261, coin 14, incoming and auxiliary first nine or a total of 284.

Assuming that the traffic from these 284 second selectors is evenly spread over five levels of the second selectors for the 5000 terminals, the selector multiple arrangement for each of the five levels to third selectors would be determined as follows, using Table 10:

The CCS to each level, $1076 (5060/5 + 250/5 + 70/5)$ divided by 284 selectors, results in a calling rate per selector of 3.79. Either 80 selectors on 18 trunks or 160 on 35 trunks can be used. The latter subgrouping is more efficient.

In this case it is assumed that the traffic estimate is accurate and 160 selectors on 35 trunks will be used. The remaining 124 selectors will deliver 470 CCS (124×3.79) or 120 will deliver 455 CCS. Referring to the CCS per Selector Tables, the capacity for 120 selectors and 455 CCS requires 25 trunks. The remaining four selectors will deliver 15 CCS. These remaining four selectors will be associated (tacked on) with the full subgroup of 120 selectors by providing two individual first choice trunks for

the four selectors and multiplying the remaining terminals with the last half shelf of 120 selectors.

Each of the five levels would be provided with 62 third selectors made up of 160 selectors on 35 trunks, 120 selectors on 25 trunks plus two trunks for four selectors.

The corresponding toll selectors for the "2" office would be determined as outlined previously for the four-digit office. A separate group of toll switching trunks would terminate on toll transmission second selectors and these would be arranged to trunk out to five groups of toll third selectors.

Remaining Optional Items for Course

The items listed below are omitted from this course, however, they may be covered in as much detail as the traffic men will require in their work after completion of the course. If they are not to

make use of this information soon after completion of the course it would be preferable that these items be taken up in either a review course or with his supervisor informally as required by the work assigned to the new men.

Engineering Five-Digit Offices for Out and In Trunks Only.

Level Hunting Connectors

Digit Absorbing

Arrangements for Six-Digit Offices

Intertoll Dialing

Community Dial Offices

Selector Repeater Branch Office

Dial Tone Delay Equipment

Trunk Usage Equipment, etc.

The same general procedure is followed for these items as covered by the sample Traffic Order.





SECTION 11

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11.0 DIAL OFFICE MANAGEMENT

11.01 DISTRICT MAN'S RESPONSIBILITIES

This Section is included in this course to briefly cover such administration matters as some of the District Man's responsibilities that are particularly applicable to step-by-step offices. General features of administration applicable to all types of dial equipment are covered in Letters and Circulars already available under the subject "Dial Office Management".

The District man in charge of a step-by-step office, or offices, should have detailed knowledge of the physical layout of the equipment, its method of operation, capacities of line and trunk groups, main station capacities of the offices, the provision of traffic registers, alarms, etc. He should have the ability to visualize the progress of a call from calling to called station and, too, be familiar with the critical points at which traffic congestion normally first appears. He should be able to "spot" service weaknesses such as might be reflected or indicated by Service Observing results, dial tone delay test results, A.T.B. and L.T.B. register readings, customer surveys, etc., since he is also responsible for the quality of service in his offices even though certain work in many cases is centralized in, or performed by Division and/or General Office personnel. Factors affecting dial service include:

- a. Adequacy and arrangement of equipment.
- b. Most efficient use of equipment with least reaction on service.
- c. Proper assignment of lines to insure even distribution of calls throughout the equipment.
- d. Provision of adequate intra- and inter-office trunks whenever and wherever possible (to the extent possible by facility and equipment availability).
- e. Initiate line transfers and changes in trunking in connection with equipment additions.
- f. Taking special records and studies required by the Traffic Engineers.
- g. Keep Division Traffic Engineer advised of equipment needs or "bottle necks."

Carrying out these responsibilities requires:

- a. Knowledge of management procedures and making sure they are being effectively followed.
- b. Method of Operation of the equipment.
- c. Understanding of local trunking plans.
- d. Keeping informed on traffic volumes and calling rates.
- e. Continuous review and analysis of results information as well as customer complaints.
- f. Determining causes for unsatisfactory results and initiating corrective action.
- g. Follow-up corrective action to see that it is effective.

- h. Knowledge of Central Office (Main Station) loading procedures and the controlling factors.
- i. Knowledge of scheduled equipment additions and rearrangements and checking planned equipment provision with estimates of future traffic.
- j. Ability to understand Traffic Order details.
- k. Knowledge of and the significance of traffic register readings.
- l. Knowledge of and the significance of central office alarms, such as Call Block, Permanent signals, etc.
- m. Knowledge of procedures and the significance of usage counts.

Assistance call tickets provide a District man with valuable information as they may reflect unsatisfactory service conditions. An analysis of these may indicate:

- a. Customers not using dial service to best advantage.
- b. Equipment overloads or failures.
- c. Need for increased or supplementary customer instruction.
- d. The need for ticket analysis to determine more detailed information.
- e. The desirability for reviewing the studies with Plant.

11.02 DIAL TONE SPEED TESTS are a valuable tool to assist in arriving at possible service levels, as well as being of great help when determining the office Main Station capacity (this may be set either above or below the engineered capacity). These tests avoid overloading of equipment and, too, they provide a means for uniform comparison.

These tests should be made at more frequent intervals as loads increase.

11.03 BUSY LINE STUDIES are helpful in locating excessively busy lines and they help to sell the customer on relief. They aid, also, in correcting load unbalance on terminating equipment (connector boards). See P.E.L. 1943 for Method of Procedure.

11.04 PERSONAL OBSERVATIONS made in the dial central offices are very helpful to the District man as they are a means:

- a. Of obtaining first-hand knowledge of conditions existing in the switch and operating rooms and they offer opportunity for Plant contact.
- b. Whereby discussions concerning maintenance may be held with Plant.
- c. Of observing the quantity of switches (line finders, selectors, connectors, etc.) which are busied out.
- d. Of observing the number of switches that are in use.

- e. Of viewing the central office alarm (call blocks, permanents, etc.) situation.
- f. Of determining number of trunks busied out at repeaters.
- g. Of quick checks on the "overflow" situation (by hearing and seeing switches go to the 11th rotary position.)
- h. Of getting the Plant man's views concerning "bottle-necks" in trunking, etc.

All observations should be of sufficient duration to be representative.

11.05 ASSISTANCE TICKETS BY TRAFFIC, as mentioned before, provide good evidence as to the quality of service being given as they indicate overloads, unbalance and defective equipment in first choice paths. They might also indicate difficulty being encountered by the customers, due to the number of reports, such as "no dial tone" or increased requests for coin refunds.

11.06 PLANT CONTACTS—Close association with plant forces is essential for the proper management of dial offices.

Develop a common service viewpoint by reviewing traffic objectives and stimulating a spirit of cooperation.

Discuss such items of mutual interest as:

- a. Frequency of overloads.
- b. Equipment failure alarms.
- c. Indications of apparent equipment shortages or surplus.
- d. Improper traffic distribution between groups or subgroups.
- e. General service difficulties.

Arrive at an understanding in regard to maintenance, testing, and keeping a minimum amount of equipment out of service, i.e., maintain close personal knowledge of all equipment conditions, or failures.

11.07 SPECIAL ANALYSIS AND TESTS—These are occasionally needed to supplement data regularly shown on routine records and reports. The frequency and extent of these tests is dependent upon local conditions and should be discontinued when they have served their purpose.

11.08 CONCLUSION—In conclusion let us review a few of the important points in Dial Office Management, some of which have already been mentioned while others have not:

- 1. Be sure to consider all sources of results information when looking for the cause of unsatisfactory results, giving particular attention to the following general items:
 - a. Facilities
 - b. Written Instructions
 - c. Organization
 - d. Provision of Force

- e. Personnel and Training
- f. Supervision in the Traffic organization, including the traffic superintendent.
- g. Coordination with other departments and offices.
- h. Do not jump at conclusions.

2. It is the Traffic man's job to create a feeling of responsibility in the other departments for service results, especially operating and equipment reactions, subscribers' education, and customers' faulty usage.

3. Training problems and facility unbalance may occur overnight due to a rapid "spurt" in business immediately following a depression or business recession. Difficulties will be enhanced by the fact that present supervisory personnel lacks experience under full loads, and possibly does not have a clearcut knowledge of management procedures.

4. Service that is satisfactory to the customer, or even better than he expects, should determine objectives to be maintained.

5. The District Superintendent should consider himself the owner of the valuable plant he is managing. He should hope for increasing traffic, full capacity, continued good will, and a fair profit.

6. The District man should have a definite item to check and review every time he visits a dial office building.

7. The General and Division Office staffs must also maintain close and unbroken interdepartmental coordination.

11.09 DIAL OFFICE MANAGEMENT—REFERENCE MATERIAL

T.C. 171—Special Traffic Records—Supplemented by T.C. 369.

T.C. 172—Traffic Engineers Routine Records.

T.C. 255—Dial System Local Peg Count, Overflow and All Trunks Busy Records.

T.C. 260—Performance of Dial System Equipment under Emergency Conditions.

T.C. 262—Central Office Management.

T.C. 279—Step-by-Step Method of Assignment, Supplemented by T.L. 167.

T.C. 337—Estimating and Administration of Inter-Office Trunks. Supplemented by T.C.'s 359, 364, 374 and 379.

T.C. 339—Dial Service—Emergency Calls for Fire, Police and Ambulance.

T.C. 340—Method of Operation—Step-by-Step Equipment. Supplemented by T.C. 367.

T.C. 341—Step-by-Step Traffic Engineering Practices. (These replaced by new T.E.P.—Division D)

T.C. 359—ATB Registers—Plunger and Rotary Out-Trunk Switch Groups.

T.C. 369—Step-by-Step Systems—Auxiliary Relay Circuits for use with No. 1B Holding Time Cabinets.

T.C. 399—Division B—Local Dial Service Observing Practices.

T.L. 113—Arrangements for Number checking in Dial Offices.

T.L. 160—Dial Offices—Reverting Calls on Party Lines.

T.L. 163—Assignment of Subscribers Message Registers.

T.L. 174—Step-by-Step Offices—Rotary Out Trunk Switch Equipment—Method of changing number of Inter-office Trunks.

T.L. 244—Step-by-Step Systems—Allotter Equipment for Reducing or Eliminating Line Switch Double Connections.

T.L. 268—Reassignment of Disconnected and changed numbers in Dial Offices.

T.L. 315—Local Completion—Use of Busy Line Records.

P.E.L. 650—Dial Systems—Number Checking on Non-Hang-up CLR service. Supplemented by P.E.L.'s 816, 1859.

P.E.L. 679—Step-by-Step Systems—Digit Absorbing Selectors. Supplemented by P.E.L. 4749.

P.E.L. 806—Common Systems—No. 1 B Holding Time Reorder—Improved Method of Attachment. Also see G.E.C. 1928.

P.E.L. 1002—SXS—Improved Peg Count Arrangements for Level Hunting Connectors.

P.E.L. 1191—Dial Systems—Operation of Coin Lines. Supplemented by P.E.L. 1615.

P.E.L. 1778—SXS—Temporary Connector Intercepting Equipment.

P.E.M. 299—SXS—All Trunks Busy Registers for Rotary Out-Trunk Switches.

P.E.M. 558—SXS—Arrangements for Reducing or Eliminating Double Connections in Plunger Type Line Switches.

P.E.M. 639—SXS—Permanent Signal Make-busy Arrangements for Line Switch Offices—No. 475 A Tool.

P.O.L. 324—How to Use the Telephone.

G.E.C. 1729—Machine Switching—Handling Directory Errors.

P.E.L. 3655—Emergency Manual Service for Dial Subscribers.

P.E.L. 3495—Improved Facilities for Completing Calls to Large P.B.X.'s.

P.E.M. 2712—Improvements in Toll Switch Train to minimize wrong numbers.

P.E.L. 1646—Rotary Out-Trunk Cross Connections.

P.E.L. 3962—Clearing Held Applications—Temporary Use of P.B.X. Positions in No. 1 and No. 350 A SXS offices.

P.E.C. 37—523-B Subsets for Commercial Offices— Supplemented by P.E.L. 2227 and P.E.M. 665.

P.E.L. 1943—SXS—Busy Subscriber Line Study Portable Set.

P.E.M. 3810—Coin Collectors—New Signal System for Hand Set Type.

P.E.L. 4525—SXS—Elimination of Auxiliary Selectors.

P.E.L. 4722—Common Systems—No. 23 Type Desk.

P.E.L. 4516—"Midget" Busy Trunk Counter.

P.E.L. 4880—Traffic Measuring Facilities.

P.E.L. 3847—SXS—Improved Graded Multiple Arrangements. Supplemented by P.E.L. 4897.

P.E.L. 4749—SXS—Double digit absorbing selectors.

P.E.L. 4897—SXS—Additional Graded Multiple Arrangements.

T.L. 464—Organization for Dial Office Management.

In addition to the above, the A.T.&T. Co. issued in February 1946 a course on "Dial Office Management". A revision to this course, dated January 1950, was issued by the General Traffic Engineer's Office of the Northeastern Area (The Ohio Bell Telephone Company).

12. EQUIPMENT NOMENCLATURE

12.1 GENERAL

These notes cover terminology which has been considered and approved by a committee on Equipment Nomenclature at the A.T. & T. Co. offices.

In a number of instances the terms contained in this list name equipment arrangements according to particular features of operation. Such terms must frequently be combined with other like terms to completely identify the arrangement in question.

Terms may change from time to time. Where this is done, they will ordinarily be effective immediately on new drawings and new issues of descriptive matter and will also ordinarily be applied to revisions or reissues of drawings and practices when these are undergoing revisions extensive enough to justify the change in the name.

Following are the terms most commonly used with reference to dial equipment, plus some of the more general terms. A complete list is covered in P.E.C. 777.

12.2 GENERAL TERMS

Manual Telephone System or Manual System

A telephone system in which telephone connections between customers are established manually by telephone operators in accordance with orders given verbally by the calling parties.

Dial Telephone System or Dial System

A telephone system in which telephone connections between customers are ordinarily established by electrical and mechanical apparatus controlled by manipulations of dials operated by the calling parties.

Panel Dial System

A type of dial telephone system in which the switching apparatus is generally characterized by the following features:

- (1) The contacts of the multiple banks over which selection occurs, are mounted vertically in flat rectangular panels.
- (2) The brushes of the selecting mechanisms are raised and lowered by motor driven apparatus.
- (3) The dial pulses are received and stored by controlling mechanisms which govern the subsequent operations necessary in establishing a telephone connection.

Step-by-Step Dial System

A type of dial telephone system in which the switching apparatus is generally characterized by the following features:

- (1) The wipers of the selecting mechanisms are moved both vertically and in horizontal circular arcs.
- (2) The selecting mechanisms are individually driven by a combination of electromagnet and ratchet mechanisms.
- (3) The dial pulses may either actuate the successive selecting mechanisms directly or may be received and stored by controlling mechanisms which in turn actuate the selecting mechanisms by pulses similar to dial pulses.

Central Office (May be abbreviated to Office)

A switching unit, in a telephone system providing service to the general public, having the necessary equipment and operating arrangements for terminating and interconnecting lines and trunks. There may be more than one central office in a building. The term "central office" applies to each unit of equipment having a separate office name or code and in addition having independent incoming trunks and terminating switching equipment.

Note: When a central office name is used to designate a building housing one or more central offices, the word "building" should be appended to avoid confusion.

Local Central Office or Local Office

A central office serving primarily as a place of termination for subscriber lines, and providing telephone service to the subscribers on these lines. A local central office may serve some subscribers on a theoretical office basis with additional office names or codes, and in this case for commercial or other reasons some separate incoming trunk groups may be provided for the traffic to these subscribers. The theoretical office arrangement is not, however, considered as a separate central office.

Tandem Central Office or Tandem Office

A central office used primarily as an intermediate switching point for traffic between other central offices. Unless qualified by a prefix or other explanation, this term is restricted by usage to an office employed primarily for the interconnection of local central offices.

Toll Central Office or Toll Office

A central office used primarily for completing and supervising toll calls.

Note: Certain types of toll calls are completed and supervised at local central offices.

Dial System Office (May be abbreviated to Dial Office)

A central office furnishing dial service.

Dial System Tandem Office

A tandem office employing mechanical switching equipment. The switching operation may be controlled by operators in the tandem office (**Operator Tandem**) or may be entirely mechanical (**Full Selector Tandem**). The tandem office may employ either or both of these methods of operation.

Panel Office

A dial system office where the switching apparatus is of the panel type. **Battery Cut-Off Relay Office** is the designation used to distinguish the newer type of panel office where the cut-off relays of the line circuits are connected to battery. **Ground Cut-Off Relay Office** is the designation used to distinguish the type of panel office where the cut-off relays of the line circuits are connected to ground.

Panel Tandem Office

Panel tandem offices are of two general types as follows:

(a) Sender Tandem

Tandem and completing office selections are controlled by a sender in the tandem office. This sender gets its setting either from a tandem operator's keyset (**Operator Tandem**) or from another office in the form of pulses (**Full Selector Tandem**).

(b) Office Selector Tandem

A group of distant office selectors controlled from the originating office or from a sender tandem.

Step-by-Step Office

A dial system office where the switching apparatus is of the step-by-step type.

Step-by-Step Tandem Office

Step-by-Step tandem offices are of the Full Selector Tandem type.

Community Dial Office

A dial office of comparatively small size which serves a separate exchange area having its own numbering plan and which has no operating or maintenance force located in its own building. The operating is handled and the maintenance is directed from conveniently located points.

Operator Office

A central office which serves as the operating center for assistance traffic for a community dial office.

Note: The operator office is usually, also, the maintenance headquarters and the toll operating point for the community dial office, but this is not necessarily the case.

Branch Office

An assembly of switching equipment (usually of the step-by-step type) located apart from the main office, but part of the main office so far as the numbering plan is concerned and at least partially dependent on it for its trunking.

Exchange

A unit of a communication company for the administration of communication service in a specified area which usually embraces a city, town, or village and its environs. It consists of one or more central offices together with the associated plant used in furnishing communication service in that area. Ordinarily an individual local tariff is filed for each exchange.

Exchange Area

The territory included within the boundaries of an exchange.

Local Service Area

The entire area within which are located the stations which a customer may call at local rates in accordance with the provision of the local tariff.

Local Call

Any call (attempted or completed) for a destination within the local service area of the calling station. A completed local call is frequently referred to as a local message.

Toll Call

Any call (attempted or completed) for a destination outside the local service area of the calling station. A completed toll call is frequently referred to as a toll message.

Manual System Subscriber

Any telephone subscriber whose line terminates in a manual office.

Dial System Subscriber

Any telephone subscriber whose line terminates in a dial office.

Manual Subscriber

A manual system subscriber or a dial system subscriber served by a central office line (or lines) arranged for originating calls on a manual basis.

Note: When a manual subscriber is served by a dial office and has dial incoming service he may be called a "Manual Subscriber with Final Multiple" or a "Manual Subscriber with Connector Multiple" as the case may be.

Dial Subscriber

A dial system subscriber served by a central office line (or lines) arranged to operate on a full dial basis.

Dial System Station

Any telephone station served by a dial system office.

Manual System Station

Any telephone station served by a manual system office.

Dial Station

A telephone station equipped with a dial.

Manual Station

A telephone station not equipped with a dial.

Dial Service

Telephone service furnished dial subscribers.

Measured Service

Service in connection with which message use is measured in terms of messages or message units for purposes of charging for the service.

Message Rate Service

A subscriber classification of measured local service in connection with which message use throughout the local service area is measured in terms of messages or message units for purposes of charging for the service; and in connection with which a coin collecting device is not included as part of the station equipment.

Coin Service

A subscriber, public or semi-public classification of measured local service in connection with which message use throughout the local service area is measured in terms of messages or message units for purposes of charging for the service;

and in connection with which a coin collecting device is included as part of the station equipment.

Prepayment Coin Service

A type of coin service requiring the deposit of the coin before the customer can place his order for the called number. Provision is made for holding the coin in suspension and for collecting or returning the coin as necessary.

Note: In dial systems prepayment operation is referred to as "Coin First" when it is necessary to distinguish from "Dial Tone First."

Postpayment Coin Service

A type of coin service requiring the deposit of the coin on request after the called station has answered. Provision is not made for holding the coin in suspension, nor for the operator to have control of the coin after deposit.

Flat Rate Service

A subscriber classification of local service in connection with which a stipulated monthly charge is made, covering all message use to stations within a specified area which may include all or a part of the local service area. In the latter case, message use to stations in the balance of the local service area is charged for on a measured service basis, such charges being in addition to the stipulated monthly charge.

Assistance Call

A call which the customer could dial directly, but on which he dials the operator for assistance.

Multiple Registration

The general term for the arrangement of operation of the subscriber message register wherein the register may be operated more than once on a completed call, the number of operations being dependent on (1) the conversation time, or (2) the combination of the destination and conversation time.

Zone Registration

Multiple registration based on both destination and conversation time.

Overtime Registration

Multiple registration based on conversation time only.

Zone (As applied to multiple registration)

An area or belt surrounding a specified central

office, in connection with which the local rate treatment for a particular class of service is uniform for all calls directed to offices in that area or belt from stations served by the specified office. Zones are numbered with respect to any given central office to correspond to the number of message units for the initial period of conversation for calls originating at stations served by that office.

Message Unit

The unit of measurement for charging for message use where a multiple registration method of charging is employed, either by the use of multiple registration equipment or by the translation into equivalent message units of ticket charges for calls within a specified area.

Subscriber vs. Subscriber's

It is recommended that in equipment nomenclature the term "Subscriber" be used rather than the possessive form "Subscriber's" as for example, "Subscriber Station," etc. This recommendation regarding the use of possessive forms does not apply to terms such as "Operator's Set," "Wire Chief's Desk," etc.

12.3 MECHANICAL SWITCHING EQUIPMENT

12.31 GENERAL

Selector Multiple

Parallel connected terminals of one or more selector banks, such as are used in dial offices. Selector multiples correspond in a general way to the various multiples in a manual switchboard. Specific types of selector multiples are "District Multiple," "Incoming Multiple," "Line Finder Multiple," "Connector Multiple," etc.

Terminal Hunting Group

A general designation for a group of lines in a dial system office so arranged that the switching equipment will search over the group to find an idle line.

Terminal Hunting

The function performed by the switching equipment in a dial office in searching for an idle line in a P.B.X. or other terminal hunting group.

Subscriber Line Overflow Circuit

An arrangement for counting the attempts to connect to a particular line or terminal hunting group while the line or group is busy.

Switch Room

That part of the central office building which houses the selectors and associated apparatus in a panel or step-by-step office.

12.32 STEP-BY-STEP DIAL EQUIPMENT

Step-by-Step Toll Train

The selector switches in a step-by-step office through which toll calls are completed. There are two ways necessary for designating the particular switches in this train. The first, used in traffic studies and on other occasions where the type of selector is not of interest but where its place in the train is the essential, uses numbers corresponding to the numbers of equivalent selectors in the local train as follows:

Toll First Selector
Toll Second Selector
Toll Third Selector
Toll Connector

Since these terms do not designate the types of selectors, names have also been assigned for use where such designations are necessary. These follow.

Toll Transmission Selector

A selector in the step-by-step toll train which furnishes toll grade transmission to the subscriber and controls the ringing.

Toll Preceding Selector

A selector in the step-by-step toll train ahead of the transmission selectors. Where necessary, two or more may be used in tandem.

Toll Intermediate Selector

A selector in the step-by-step toll train between the transmission selectors and the connectors. Where necessary, two or more may be used in tandem.

Toll Connector

One of the final switches in the toll train which connects with subscriber lines and which supplies machine ringing when started by a signal from a toll transmission selector.

Combination Local and Toll Connector (May be abbreviated to COMBINATION CONNECTOR)

A connector which will operate either as a toll connector or as a local connector depending on whether it is picked up by the toll train or the local train.

Hunting Connector

A connector in a step-by-step office which searches for an idle line in a P.B.X. group or other group of consecutive associated lines. There are two types as follows:

(a) Rotary Hunting Connector

Hunts over a maximum of ten lines all of which must be on the same bank level.

(b) Level Hunting Connector

Used for larger groups and will hunt over several consecutive bank levels.

Two Digit Rotary Hunting Selector

A step-by-step selector arranged for connecting to small groups of lines or trunks and requiring the dialing of two digits for its operation. The first digit steps it up and the second steps it in to the first trunk of the group and it then hunts for an idle trunk within the group.

Service Code Selector Train

The selector train in the step-by-step system which is used in reaching the service codes (112, 113, etc.) and to absorb preliminary pulses. The three switches in this train are:

- Auxiliary First Selector
- Service Code Selector
- Auxiliary Service Code Selector

Out-Trunk Switch

A selector or switch arranged to hunt over a single group of outgoing trunks and to connect to an idle one.

Rotary Out-Trunk Switch

An out-trunk switch utilizing a rotary type selector as its basic mechanism. A recently developed circuit of this type is the "Rotary Out-Trunk Switch Arranged for Preselection."

Line Concentrating Unit

An arrangement wherein a group of manual subscriber lines terminates on line switches or line finders which route their originating calls to a nearby switchboard and where calls to the lines are completed through connectors controlled by dials at the switchboard.

12.4 LINES AND TRUNKS

Line

A general term used in communication practice in several different senses the more important of which are:

- (a) The conductor or conductors and supporting or containing structures extending between subscriber stations and central offices or between central offices whether they be in the same or different communities.

Note: In accounting practice, "line" as used in the account "Pole Lines" refers only to the supporting structures, exclusive of the conductors.

- (b) The conductors and circuit apparatus associated with a particular communication channel.
- (c) Any communication channel between two points disregarding the method of its derivation.

Trunk

A communication channel used as a common artery for traffic between switchboards or other switching devices. This term applies to both exchange and toll plant.

Subscriber Line

A communication channel between a telephone station or P.B.X. and the central office which serves it.

Note: When taken from a station or subscriber point of view the term "central office line" may be used in a synonymous sense.

P.B.X. Trunk

A subscriber line used as a trunk between a P.B.X. and the central office which serves it.

Note: When taken from a P.B.X. point of view the term "central office trunk" may be used in a synonymous sense.

Dial System Subscriber Line

Any subscriber line terminating in a dial office, either on the regular dial equipment or on the dial system "A" board.

Toll Line

A line, between central offices in different exchange areas, which is used primarily for toll calls. The application of this term depends upon

the commercial usage of "toll call" and disregards the types of offices connected.

Note: In cases where this term might be used to refer to an individual communication channel it is considered preferable to use the term "toll circuit" or one of the more specific trunk terms.

Toll Circuit

A communication channel, between central offices in different exchange areas, which is used primarily for toll calls. The application of this term depends upon the commercial usage of "toll call" and disregards the types of offices connected. Channels used for "toll connecting trunks" are ordinarily excluded from this classification.

Interoffice Trunk

A trunk between two central offices regardless of type. This term has in the past been confined largely to trunks between local offices in the same exchange area.

Interlocal Trunk (an abbreviation of Inter-Local-Office Trunk)

A trunk between two local offices disregarding the type of call (local or toll) handled.

Intertandem Trunk

A trunk between two tandem offices.

Intertoll Trunk (An abbreviation of Inter-Toll-Office Trunk)

A trunk between toll switchboards in different offices.

Note: Where combined toll and local switchboards are involved the trunks are classed as intertoll or interlocal depending upon whether the switchboards in question are performing toll switchboard or local switchboard functions in handling the traffic over these trunks.

Tandem Trunk

A trunk incoming to a tandem office, tandem switchboard, or tandem position to a local office or local switchboard.

Tandem Completing Trunk

A trunk outgoing from a tandem office, tandem switchboard, or tandem position to a local office or local switchboard.

Toll Tandem Trunk

A trunk incoming to a toll tandem switchboard,

toll tandem position, or other position serving toll tandem functions, from either a local or toll switchboard.

Toll Connecting Trunk

A general classification of trunks between a local office and a toll office. It includes toll switching trunks, recording-completing trunks, recording trunks, and such toll tandem trunks as originate in a local office. It also applies to two-way trunks combining the functions of toll switching trunks and recording-completing trunks.

Toll Switching Trunk

A trunk outgoing from a toll office to a local office used for completing toll calls to subscriber lines served directly by the local office.

Recording-Completing Trunk

A trunk outgoing from a local office to a toll office used for communication with the toll operators and arranged for completing toll calls originated by subscribers of the local office.

Recording Trunk

A trunk outgoing from a local office to a toll office used only for communications with the toll operators and not arranged for completing toll connections.

Individual Line

A subscriber line arranged to serve only one main station although additional stations may be connected to the line as extensions. An individual line is not arranged for discriminatory ringing with respect to the stations on that line.

Party Line

A subscriber line arranged to serve more than one main station. Provision is made for discriminatory ringing with respect to the parties on that line.

Multi-Party Line

A party line arranged to serve more than four main stations. Although two and four party lines might be considered as multi-party lines, they are arbitrarily excluded from this classification.

Long Line Circuit

A circuit arrangement designed to extend the range of a subscriber line, P.B.X. trunk, or P.B.X. extension line with respect to one or more functions such as supervision, dialing or ringing.

P.B.X. Long Trunk Circuit

A circuit arrangement designed specifically to extend the range of a P.B.X. Trunk with respect to one or more functions such as supervision, dialing, or ringing.

Dial Long Line Circuit

A long line circuit designed to transmit dial pulses.

Manual Long Line Circuit

A long line circuit not designed to transmit dial pulses.

Pulse Correcting Long Line Circuit

A dial long line circuit which included pulse correcting features.

P.B.X. Tie Trunk

A trunk between two P.B.X.'s.

Dial Repeating Tie Trunk

A tie trunk arranged to repeat dial pulses.

Manual Tie Trunk

A tie trunk operated on a manual signaling basis, i.e., ringdown or automatic.

Ringdown Tie Trunk

A tie trunk arranged for signaling by means of ringing current transmitted over the trunk.

Manual Ringdown Tie Trunk

A ringdown tie trunk requiring the application of ringing current by the attendant.

Automatic Tie Trunk

A tie trunk arranged for signaling automatically by connection to or disconnection from the tie trunk. Signaling may be by alternating or direct current.

Automatic Ringdown Tie Trunk

An automatic tie trunk arranged for ringdown termination.

Dial Selected Tie Trunk

Any tie trunk arranged to be selected by dial operation.

Manual Selected Tie Trunk

Any tie trunk arranged to be selected by manual operation.

Dial and Manual Selected Tie Trunk

Any tie trunk arranged to be selected by both dial and manual operation.

Number Checking Trunk

The trunk which permits an operator to obtain a check of the calling subscriber's number.

Vacant Code Trunk

The trunk reached by a dial subscriber when he dials a code which is not in use.

Vacant Incoming Multiple Trunk Circuit

A circuit for intercepting calls routed in error to vacant incoming multiple terminals.

Loop-Back Circuit From Intercepting Desk

The arrangement added to a straightforward intercepting trunk to enable the intercepting operator to call back and talk to the "B" operator.

Trunk Equipment

A general term signifying the equipment directly associated with a trunk.

Note: In the case of certain manual trunk equipments, the arbitrary designations "Type A Trunk Equipment," "Type B Trunk Equipment," etc. have been assigned for the sake of brevity.

12.5 POWER AND SIGNALING ARRANGEMENTS

Talking Battery

The battery circuit which, because of special design precautions or the insertion of filters, is sufficiently quiet to be used as the power supply for transmission circuits. On some drawings the talking battery leads have in the past been labeled "Quiet Battery."

Tone Alternator

The tone generator of the inductor-alternator type which supplies dial tone, busy tone, audible ringing signal, order tone, etc.

Continuous Ringing

The designation for bus-bars, alarms, etc., for uninterrupted ringing current. This has been called "Manual Ringing."

Selective Ringing (Two or more parties)

A party-line ringing system wherein the bell or bells of the desired party only are rung.

Semi-Selective Ringing (Four or more parties)

A party-line ringing system wherein the station bells of two parties are rung simultaneously, differentiation being by a one-ring, two-ring code.

Code Ringing

A party-line ringing system wherein the number of rings or the duration, or both, indicate which party is being called. Although semi-selective ringing is one form of code ringing it is excluded from this classification in order to make the terms distinctive.

Multi-Party Ringing

Any ringing system which provides for ringing more than four parties. Two and four party ringing is arbitrarily excluded from this classification.

Bridged Ringing

A term applied to any party-line ringing system wherein all the ringers on a line are directly connected across the line.

Divided Ringing

A method of obtaining partial ringing selectivity by connecting one-half of the ringers from one side of the line to ground and the other half from the other side of the line to ground. This term is not ordinarily applied to selective and semi-selective ringing systems.

A.C.—D.C. Ringing

A ringing system utilizing a combination of an alternating current and a direct current, the direct current being provided to facilitate tripping.

Superimposed Ringing

A ringing system utilizing a combination of alternating and direct currents where both positive and negative d-c components are provided primarily to obtain selectivity.

Call Tone

Tone given to an operator to indicate that a call has been connected to her position and that she should announce herself. Examples of this tone are found at the No. 3 Information Desk and the No. 3 Order Turret.

Calls Waiting Signal Circuit

An arrangement, used primarily with call distributing switchboards, for indicating the presence of and in some cases the approximate number of waiting calls. Examples of its use are the circuits at the call distributing "B" board, the No. 3 information desk and the sender tandem board.

No Such-Number Signal

The tone given a subscriber when he reaches a Vacant Code or Vacant Level Trunk.

Order Tone

The tone sent back over a trunk to indicate: (a) To the originating operator—that the order should be passed and (b) to the receiving operator—that an order is about to be passed. For certain types of operation, such as call announcer and automatic display call indicator, the tone serves function (b) only.

Single Order Tone

An order tone consisting of one tone signal of relatively long duration (about $\frac{1}{2}$ second) indicating that the office name and desired number is to be passed.

Double Order Tone

An order tone consisting of two short tone signals in quick succession indicating that the desired number only is to be passed.

Triple Order Tone

An order tone consisting of three short tone signals in quick succession indicating that the office name only is to be passed and that the originating operator is to wait for a subsequent order tone.

Vacant Position Tone

Tone on a trunk terminating in a vacated position.

Warning Tone

Tone given to an operator to indicate that the circuit to which she is connected is not in a condition for normal operation. Examples of this tone

are, the tone given an operator at an automatic display call indicator position when she plugs into the wrong telephone set jack, and the tone received by a sender monitor operator when she plugs into a sender supervisory jack while the sender is connected to the test set.

12.6 MISCELLANEOUS

Observing

Noting the performance of equipment and employees in handling telephone connections, the performance of employees in handling customer contacts, and the transmission performance of established telephone connections, either separately or in combination with each other, for the purpose of measuring the quality of service rendered or of training the employee.

Monitoring

Listening on a telephone connection, for supervisory, observing, or similar purposes, by means of a transmission circuit which does not appreciably affect the normal transmission of, nor cause disturbances in the circuit listened on. The term "monitoring" may also be applied in a similar sense in connection with signaling circuit arrangements for checking signaling operations such as dialing or key pulsing.

Central Service Observing Equipment

Service observing equipment which permits the location of the observing desk in one building for observing on lines terminating in several central office buildings.

Non-Central Service Observing Equipment

Service observing equipment which requires the location of the observing desk in the same building in which the observed central office lines terminate.

Multi-Line Service Observing Equipment

An equipment arrangement for service observing which includes means for automatically associating any one of a number of subscriber lines or trunks with the observing desk either directly or via trunk conductors.

Single-Line Service Observing Equipment

An equipment arrangement for service observing which requires a separate set of conductors to the observing desk for each subscriber line or trunk under observation.

Repair Service Observing

The process of observing a representative number of telephone contacts between subscribers and repair service clerks or test deskmen for the purpose of measuring the quality of service rendered from the subscriber's viewpoint or for employee training purposes.

Cable Test Desk

The test desk designed primarily for making measurements on exchange area cables and similar outside plant to determine the location of crosses, opens, and grounds. A desk of this nature, has in the past, been called a "Central Cable Location Test Desk."

Test Trunk

The circuit arrangement which permits a test man to connect to a particular line or trunk in any local or toll office.

Step-by-Step Pulsing Test Set

A test set designed for testing the pulsing response of step-by-step selectors, connectors, repeaters, etc.

Plugging-Up Line Circuit

The arrangement used for handling lines in trouble due to outside plant or station difficulties. This term is recommended in place of "Plugging-Up Trunk Circuit" which has been used in some cases. In dial offices the plugging-up line circuit terminates in two jack circuits; (1) the "Trouble Intercepting Line" which is used in connection with intercepting calls to the line in trouble and intercepts terminating calls; (2) the "Trouble Observation and Test Line" which is provided for supervising the line in trouble and for obtaining access to it for test purposes.

Transfer Key

A key which moves a complete function from one location to another.

Grouping Key

A key which ties equipment together for more efficient operation during periods of light loads.

Alarm Grouping Arrangement

The alarm arrangement provided in offices having more than one alarm panel whereby the throwing of a key extends the alarms at one panel to another alarm panel. This arrangement is useful at night or at times when a full maintenance force is not on duty.

Amplifier

An unidirectional device which is capable of delivering an enlargement of the wave form of the electric current, voltage or power supplied to it.

Telephone Repeater

A combination of one or more amplifiers together with their associated equipment so arranged as to provide for two-way transmission in a telephone circuit.

Radio Frequency Suppressor

An arrangement for reducing radiation at radio frequencies arising from transient currents generated in the normal operation of switching, signaling, or power apparatus.

Teletypewriter Service

A communication service using teletypewriters which, by means of keyboards similar to the keyboard of a typewriter, transmit electrical impulses of such a character as to cause the direct reproduction of the messages in typed form by machines arranged for such reception. This service may be furnished on a one-way or two-way basis.

Teletypewriter Exchange Service

A form of teletypewriter service in which suitably arranged teletypewriter stations are pro-

vided with lines to a central office where connections may be established between any such station and any other similar station in the same city or in other cities at the request of the subscriber.

Teletypewriter Private Line Service

A form of teletypewriter service differing from exchange service in that it is limited to service between certain specified stations. The service may be contracted for on a full time or a part time basis.

Teletypewriter Operator

A central office employee who performs at the switchboard the functions required in establishing connections between teletypewriter stations and the other functions associated therewith.

Note: The corresponding person at a teletypewriter P.B.X. is usually called an "attendant."

Teletypewriter Station

An installed teletypewriter and associated wiring and apparatus in service for teletypewriter communication.

Note: In practice this term does not include the teletypewriter employed by central office operators and by other employees in operation and maintenance of a teletypewriter system.