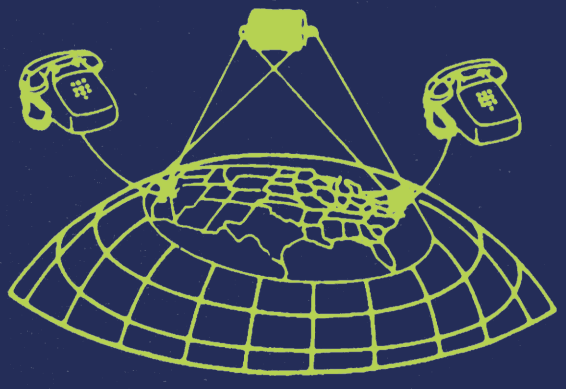
TELEPHONE COMMUNICATION SYSTEMS

VOLUME II

CROSSBAR SYSTEMS



GRADUATE ENGINEERING
AND
INFORMATION SYSTEMS EDUCATION

TELEPHONE COMMUNICATION SYSTEMS

PREFACE

Connecting any two phones among the millions of subscribers is accomplished by telephone switching systems. The process, although not simple, is normally taken for granted in our everyday use of telephone services. This is indeed a compliment to the Bell System people who have developed, engineered, and maintained the many types of telephone systems. The switching equipment in the Central office is considered by many to be the heart of the telephone highway, for without it the telephone never would have progressed to the highly developed and integrated entity it is today.

Although the switching equipments may be considered the "heart," the other parts of the telephone network are equally important. For without the connecting wires and cables, the subscribers' equipment and the power plant, there could be no universal telephone network and no Direct Distance Dialing.

Switching is a highly dynamic field. From the first crude switching arrangements developed by the Holmes Electric Company in Boston in 1877 to the highly sophisticated No. 1 ESS system developed by the Bell System Laboratories in the early 1960's, the telephone switching system has indeed come a long way. What the future holds can only be speculated upon: on the horizon, we now see new developments, such as the use of satellites, lasers, and holography in communications.

Each subject covered in this text could be developed much more extensively; however, our objective is not to print a comprehensive treatise on telephony, but rather to treat each subject briefly presenting a general technical explanation of its operation and function.

This text has been prepared for Graduate Engineering Education courses presented at the Western Electric Corporate Education Center. Its contents are the result of over 12 years of development, starting from a group of handouts given to students and leading to the book we have today. Although much of the material and ideas were taken from various Bell System sources, a great deal of the book can be attributed to the members of the Graduate Engineering Education staff. Acting as writers, instructors, and editors, each diligently worked in assembling a well organized telephone communications text. Their collective efforts are sincerely appreciated, and are hereby gratefully acknowledged.

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TELEPHONE COMMUNICATION SYSTEMS

VOLUME II
CROSSBAR SYSTEMS

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VOLUME II

CHAPTER 3

NO. 5 CROSSBAR SYSTEM

3.1 INTRODUCTION

The No. 5 Crossbar system was originally developed to fill a need for a system especially suitable for isolated small cities and for residential areas on the fringes of large cities. The design of the system was influenced by the special characteristics of telephone traffic in these regions. The percentage of calls completed to subscribers in the same office was expected to be relatively high. It was recognized that the system would have to interconnect with existing offices of all types. In addition, the tendency toward extension of dialing areas indicated that a local system with some provision for tandem or intertoll switching would simplify trunking, relieve the load on regular tandem offices, and reduce backhaul. This meant that where toll requirements are small, the No. 5 office could be established as a toll center with control switching point (CSP) features. Finally, the new concept of extended subscriber dialing demanded automatic recording of call details.

In addition to the requirements outlined above, the system also has built into it other features that adapt it to new concepts of telephone service. Improvements and added features have widened the application of the No. 5 equipment. It is presently being used to handle traffic that varies from large metropolitan business exchanges to small rural centers of a few hundred lines.

The No. 5 Crossbar system is first of all a highly efficient local telephone switching system which can operate with all present local, tandem, and toll switching offices, except that it cannot direct calls through a panel 2-wire office selector. Table 3-1 shows the usual kinds of pulsing, or manner of operation, for the various combinations of No. 5 Crossbar and connecting offices.

No. 5 Crossbar has several features that distinguish it from previous local systems. The more important ones are:

a. Utilization of common control to a higher degree than any other electromechanical system

TABLE 3-1

TYPE OF PULSING USED BETWEEN NO. 5 CROSSBAR OFFICES AND OTHER TYPE OF OFFICES.

Type of Connecting Office	No. 5 Crossbar Office	
	Type Received	Type Outpulsed
No. 5 Crossbar	MF DP RP FSP	MF DP RP FSP
No. 1 Crossbar	RP MF	MF RP DP
Crossbar Tandem	MF DP RP	MF DP RP PCI
No. 4 Toll Crossbar	MF DP	MF DP
Panel	RP MF	RP
Panel Distant Office Tandem	RP	No Provision
Panel Sender Tandem	RP DP	PCI
Step-by-Step Local	DP MF	DP MF
Step-by-Step Intertoll	DP MF	DP MF
Manual Local	MF	PCI Straightforward
Manual Toll	MF DP	Straightforward PCI

LEGEND: DP - Dial Pulsing PCI - Panel Call Indicator
MF - Multifrequency RP - Revertive Pulsing
FSP - Frequency Shift Pulsing

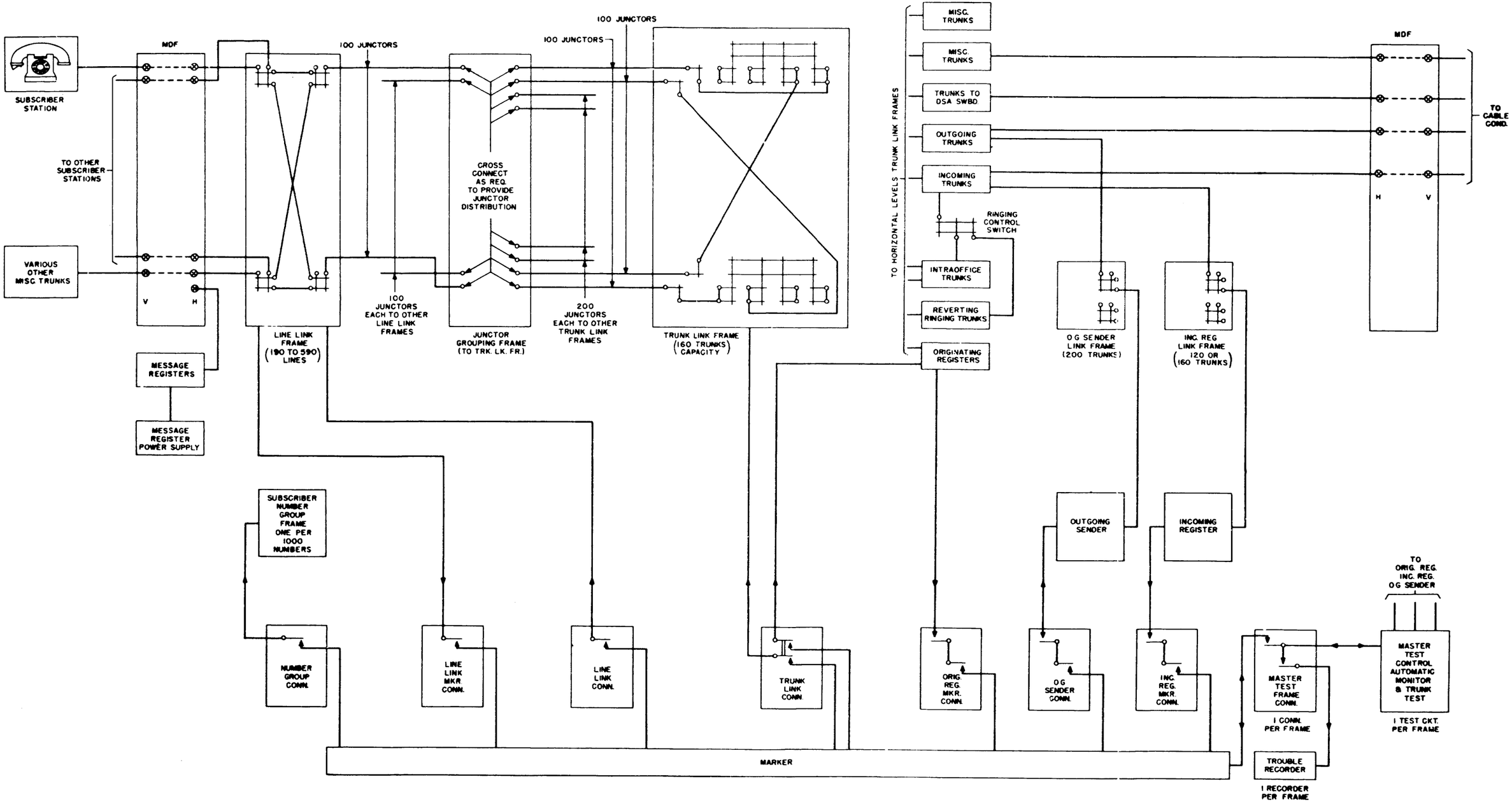


Fig. 3-1 - Equipment Schematic of No. 5 Crossbar Office

Figure 3-1

b. A unique switching plan. A single switching train is used for all traffic whether incoming or outgoing, or switched through.

c. Improved distribution of usage over various equipment units by means of rotating sequence and memory circuits.

d. Provision of toll and tandem switching features with the same common control equipment as is used for local traffic.

e. Improved trouble detecting features including automatic recording of failures on punched cards and automatic monitoring of pulsing circuits.

f. Provision of features essential to the expansion of operator and customer toll dialing; eleven digit capacity, alternate routing, code conversion, marker pulse conversion, six digit translation, and other similar features.

3.2 SWITCHING PLAN

The No. 5 system uses the fundamental two link frame, four-stage, switching network, but unlike other familar systems, employs a single switching network to handle all types of calls; incoming, outgoing or switched through. In addition, the connection of the subscriber to the dial register circuit is also made through this switching network. This eliminates the line link and sender link controllers, as well as the sender link frames required in the No. 1 Crossbar system. The functions of the controllers has been transferred to the markers while the function of the sender link frames has been consolidated with the switching network. A generalized block diagram is shown in Figure 3-1.

A. LINE LINK

The crossbar switches on the line link frame are divided functionally into line switches and junctor switches, as shown in Figure 8-2. Subscriber lines are connected to the line switch verticals. Line links, which are merely connecting wires, interconnect the line switches and junctor switches in a standard linkage pattern of 100 links. The basic line link frame provides 290 line terminations, ten no-test verticals and 100 junctor terminations. Since the calling rate and holding time

habits of subscribers may vary widely in different areas, provision is made for adding supplementary line switch bays of 100 or 200 line capacity in order to increase the line capacity of the frame to meet traffic requirements. These supplementary bays will increase the capacity of the basic frame from the 290 line minimum to 590 the line maximum. Figure 3-3 illustrates schematically a line link frame arranged for 490 lines. With the introduction of the wire-spring line link frame, a feature was added whereby line switch bays may be split between two line link frames. This feature along with the change in the size of the basic frame from a two-bay to a possible one-bay frame permits the line link frames to be furnished in sizes varying from a minimum of 190 lines and 10 no-test verticals to a maximum size of 590 lines and 10 no-test verticals, in increments of 50 lines. Line link sizes in 50 line increments are illustrated in Figure 3.4.

The line link frames just described are the frames that are used for two-wire subscriber lines or trunks. When it is necessary to switch four-wire traffic, a separate network, using line link frames of 190 line capacity using 5-wire switches is furnished.

Line links appear on the horizontals of the switches; ten line links on each switch. These ten line links are distributed among the ten junctor switches, one link to one horizontal on each of the ten junctor switches in a standard linkage pattern. This system of links permits each line on a line link frame to reach anyone of the 100 junctors serving that frame.

In addition, to the switches, line relays and control relays are also mounted on the frame. The hold magnets on the line switches are equipped with off-normal springs which serve as cutoff relays for the line circuit.

No. 5 Crossbar differs from earlier systems in that the same link frame can serve customers who have various classes of service. For example: flat rate, message rate, or coin. In the initial design, provision was made for a maximum of 30 classes of service on each line link frame and the associated marker group. As the system further developed and new features and services were introduced, the number of classes of service were also increased; first to 60 classes and ultimately to 100 classes, with 20 treatments for each class of service.

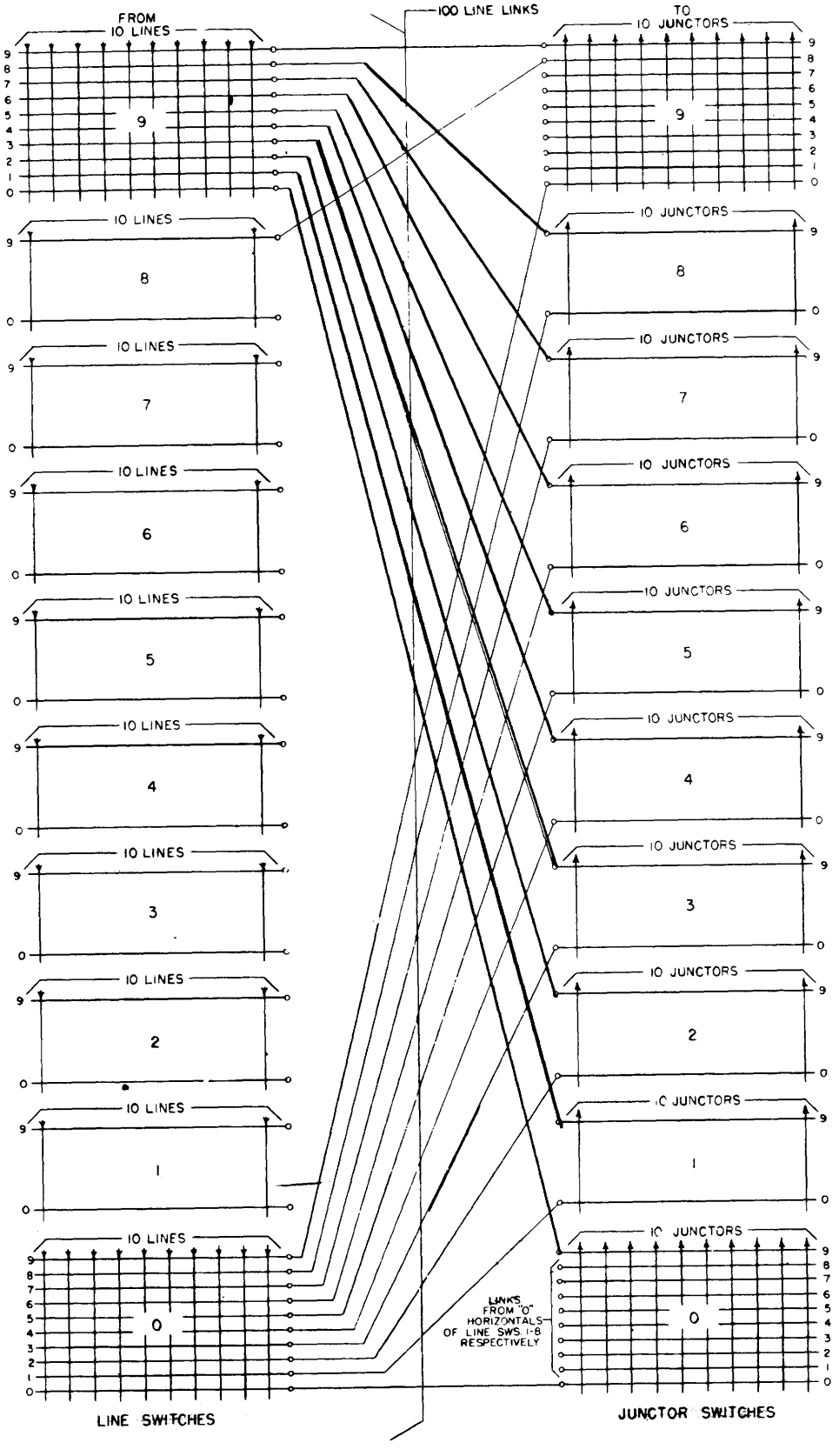


Figure 3-2 - Line Link Distribution

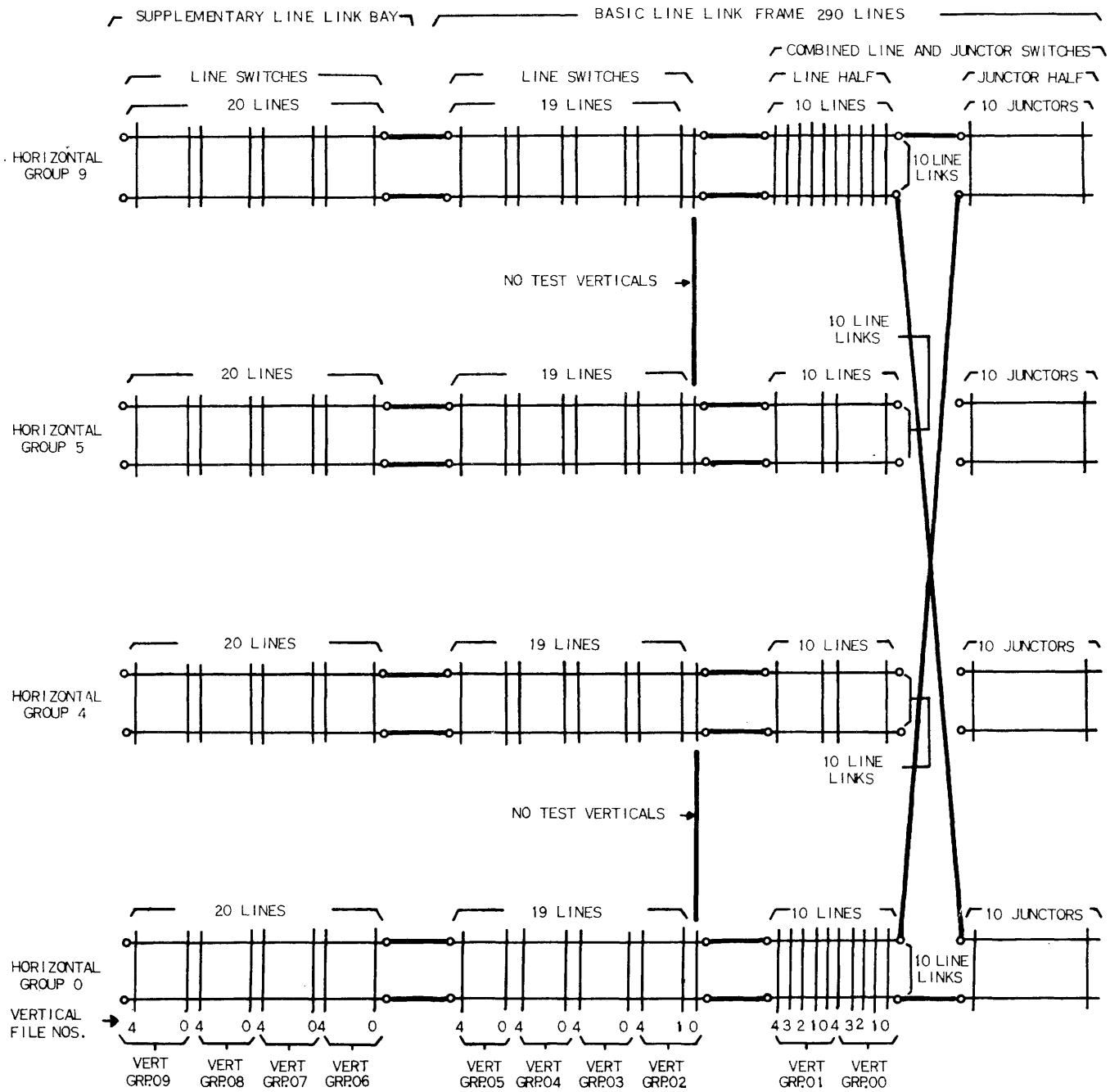


Figure 3-3 Line Link Frames Schematic Frame Arranged for 490 Lines

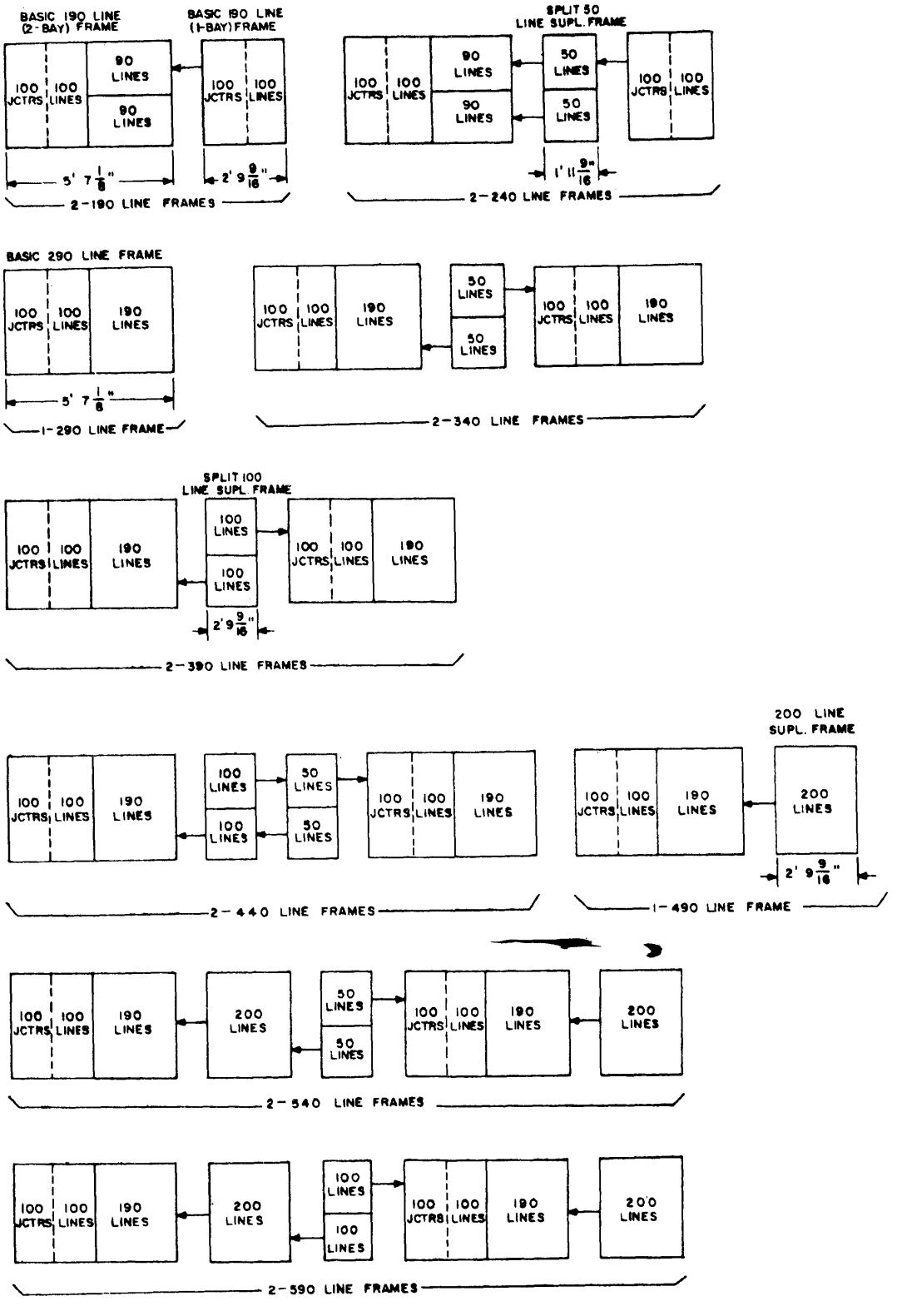


Figure 3-4 - Association of Line Link Basic and Supplementary Frames for 50-line Increments

B. TRUNK LINK

The crossbar switches on the trunk link frames are divided functionally into junctor switches and trunk switches, Figure 3-5.

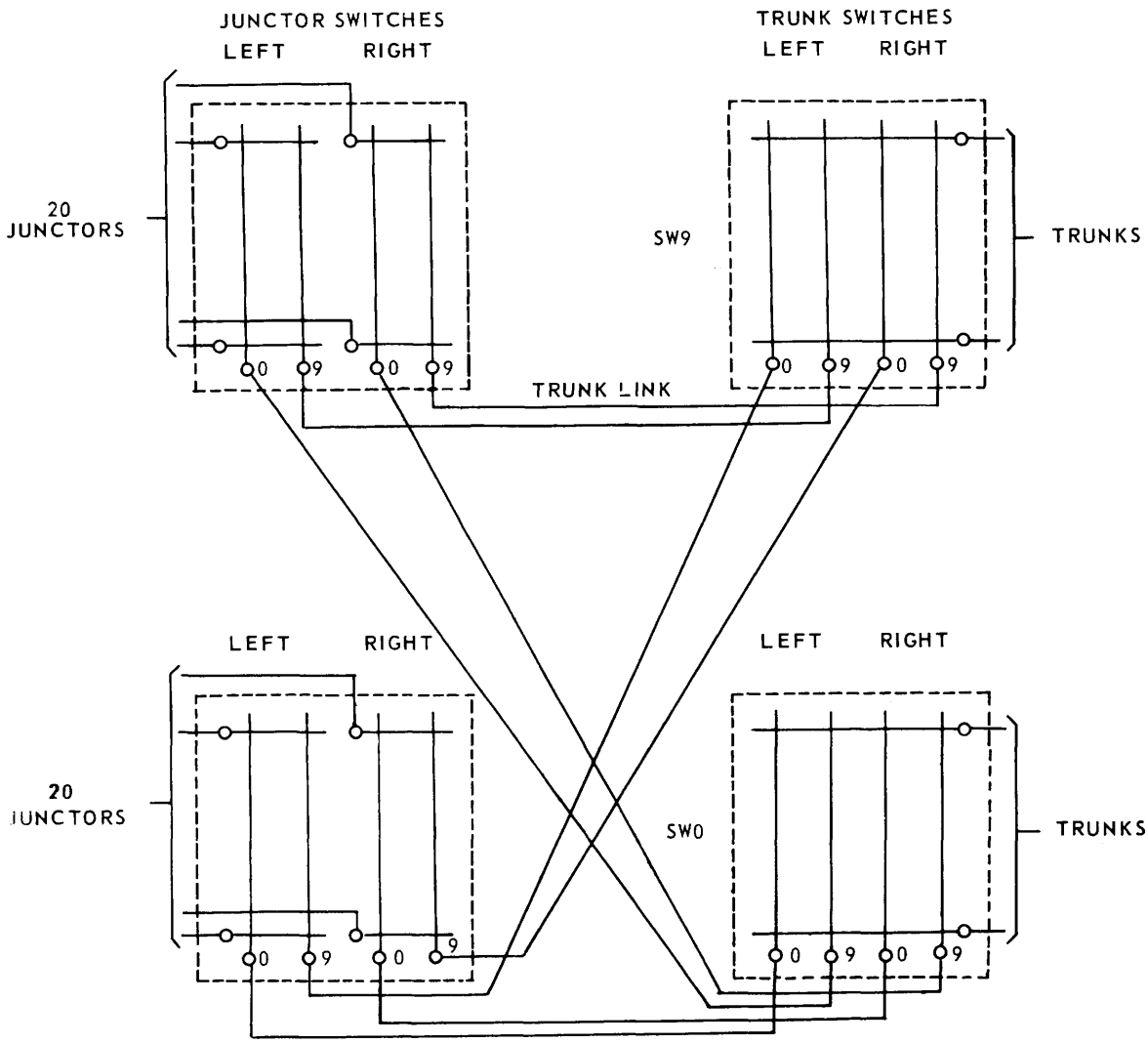


Figure 3-5 Trunk Link Distribution

Originating registers and trunks are connected to the trunk switch horizontals and junctors to the junctor switch horizontals. Trunk links, which are merely connecting wires, interconnect the junctor switches and the trunk switches.

The basic trunk link frame is a two-bay framework with each bay mounting ten 200 crosspoint switches. The 10 switches in one bay are six-wire switches and are used to provide terminations for 160 trunks.[1] The ten 200 point switches on the other bay are three-wire switches, used as junctor switches. While these switches are physically 200 crosspoint switches, their horizontals are split between the 10th and 11th vertical so that electrically there are 20 switches of the 100 crosspoint size. 200 junctors from the line link frame are terminated on the 20 horizontals of these 20 junctor switches. The junctor switches are designated 0 to 9, left and right.

The system of trunk links that permits any trunk on the trunk link frame to be connected to any of the 200 junctors serving that frame is similar in principal to that used on the line link frames. The links from the left junctor switches are terminated on the verticals on the left half of the trunk switches while the links from the right set of junctor switches are terminated on the verticals on the right half of the trunk switches.

Each line link frame has 100 junctor terminations which are used to connect to the trunk link frames in the office. Since each trunk link frame has 200 junctor terminations for connecting to the line link frames, the ratio of line link frames to trunk link frames in an office is generally 2 to 1. There are no half frames. In an office with 13 line link frames for example there would be seven trunk link frames.

The 100 junctors from each line link frame are divided into approximately equal groups, with one group going to each trunk link frame. The number of junctors in a group depends on the number of trunk link frames in the office. However, there will always be a minimum junctor group size of ten junctors for access from one line link frame to any particular trunk link frame.

When there are ten or fewer trunk link frames in an office, each junctor group has ten or more junctors. For example, in an office with eight trunk link frames and 16 line link frames, each junctor group contains either 12 or 13 junctors. Figure 3-6 illustrates the junctor distribution for two trunk link frames and four line link frames.

[1] The 160 trunk capacity is for two-wire trunks; however, when four-wire trunks are required, a 200 trunk capacity arrangement is used consisting of a basic 100 trunk frame and a 100 trunk buildout frame.

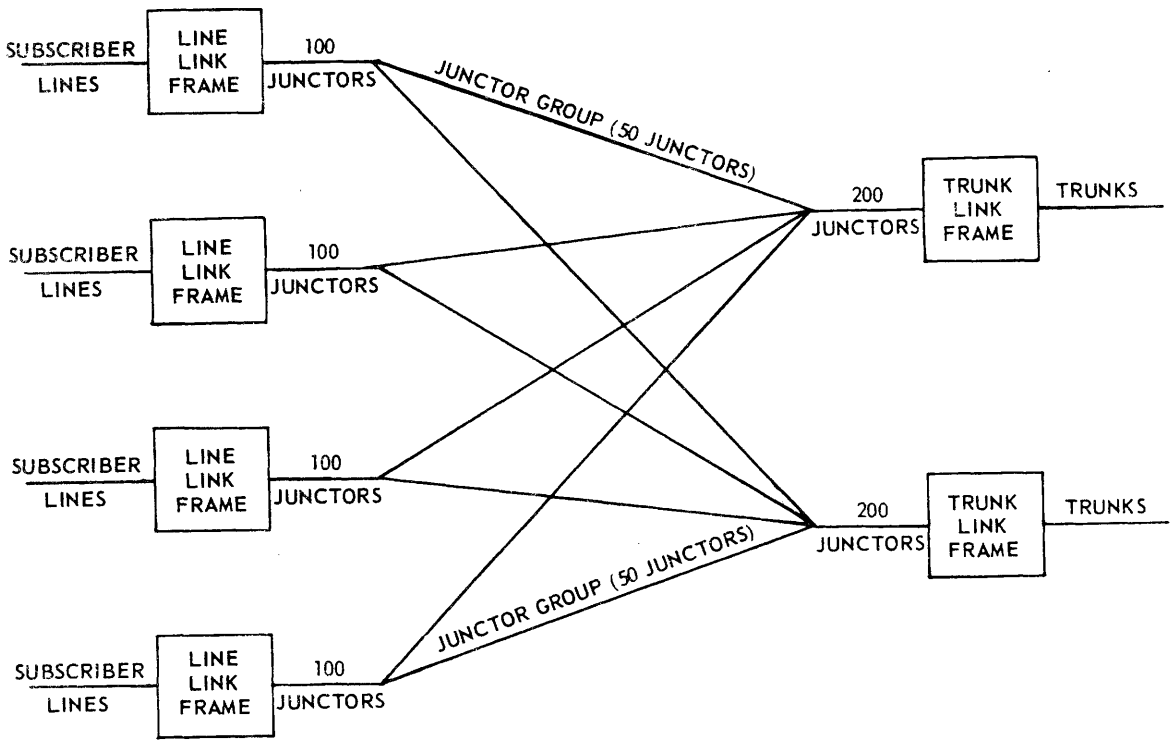


Figure 3-6 Junctor Distribution (4 Line Link and 2 Trunk Link Frame)

However, in an office with 11 to 20 trunk link frames, each junctor from the line link frames are multipled to two trunk link frames in order to have at least ten junctors per group. In order to accommodate the two appearances on the trunk link frames it is necessary to provide additional junctor switches, for the trunk link frames. These additional switches are mounted on the extension trunk link frame. In an office with 20 trunk link frames and 40 line link frames, each junctor group contains 10 junctors. Figure 3-7 illustrates the junctor distribution for 20 trunk link frames and 40 line link

frames. In this case, the number of junctors in a group is determined by dividing 100 by the number of pairs of trunk link frames. The maximum office size is 60 line link frames and 30 trunk link frames. In an office of this type the trunk link frames are furnished in groups of three.

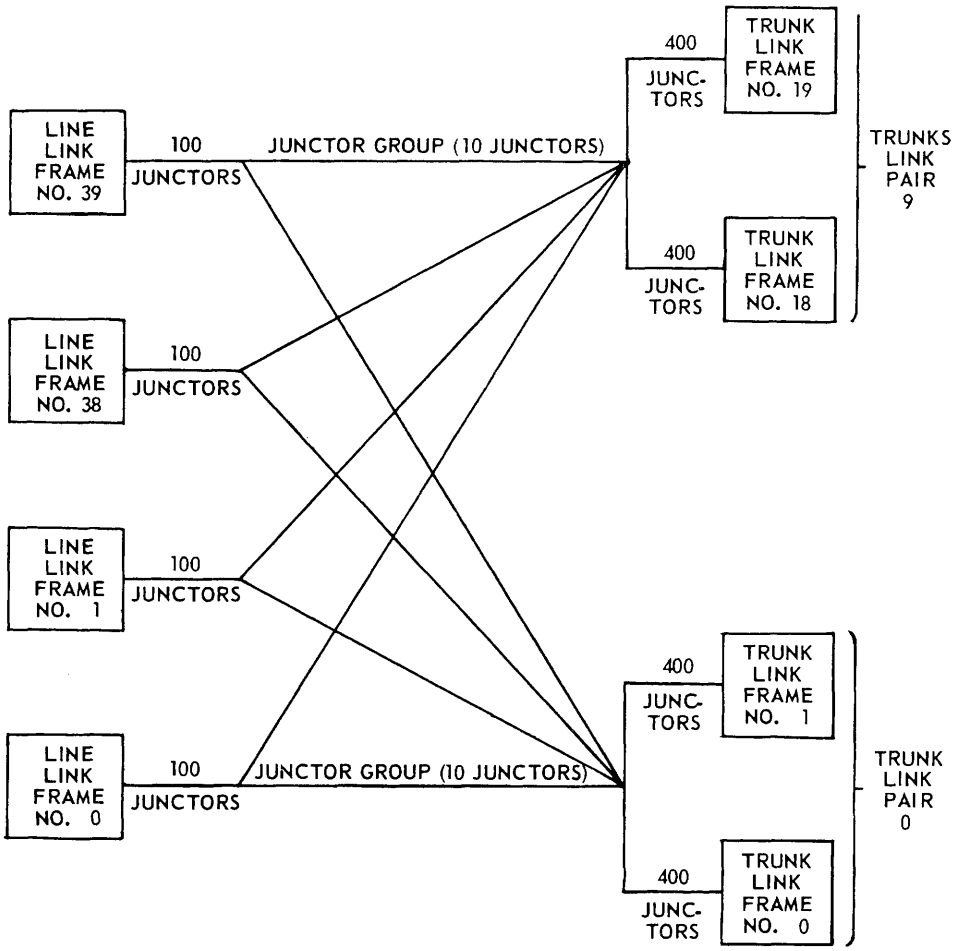


Figure 3-7 Pairing of Trunk Link Frame (40 Line Link and 20 Trunk Link Frames) Initial Installation.

C. EXTENSION TRUNK LINK

As stated previously, when 11 to 20 trunk link frames are involved, each junctor is multipled to two trunk link frames in order that each junctor group contain a minimum of ten junctors. This requirement reduces the junctor capacity of the basic trunk link frame by 50 per cent,

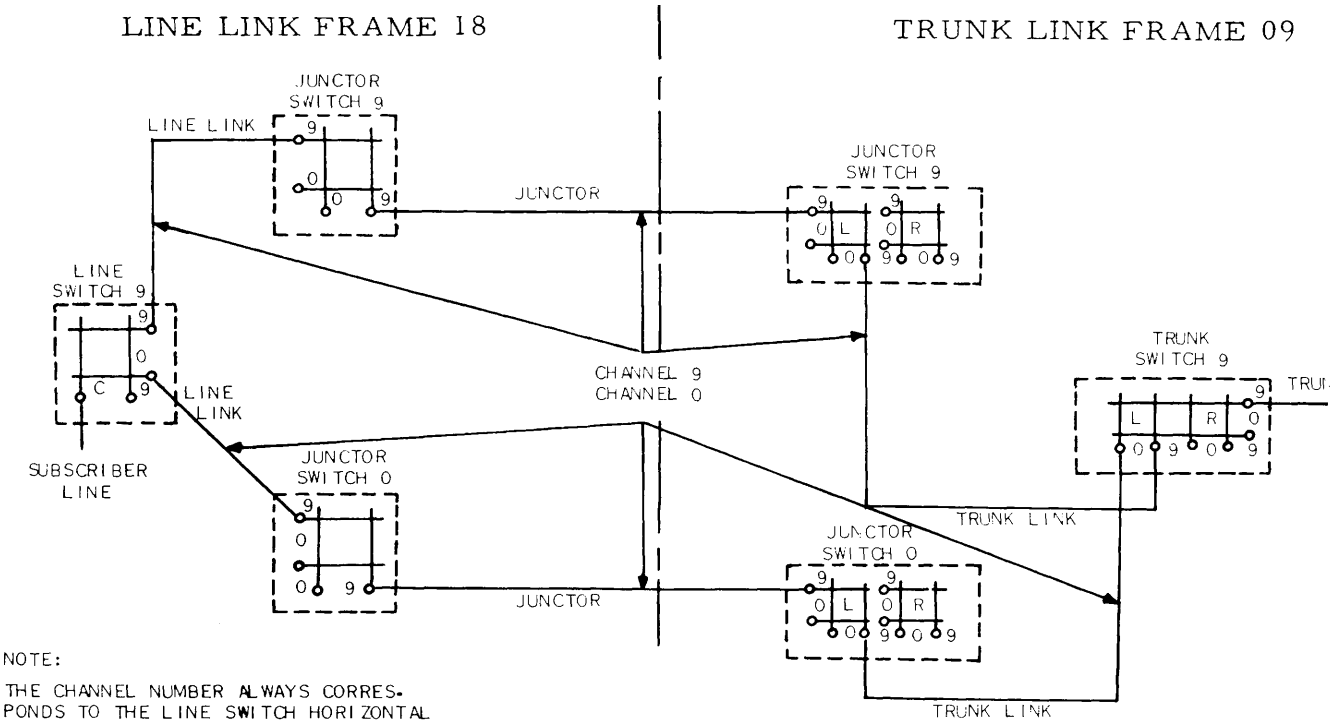
and it is therefore necessary to provide additional junctor switches for each trunk link frame in order to balance the traffic between junctors and links. These additional switches are mounted on the extension trunk link frames which, if possible, are located adjacent to the junctor switch bay of the trunk link frame. The extension frame consists of ten 200 point switches, the same as the junctor switches on the trunk link frame. These switches have their horizontals split and have a capacity for 200 junctors on the horizontal of the ten electrical switches. These 200 junctors and link terminations along with the 200 junctors on the trunk link frame provide a total of 400 junctors for the combination.

When an office has from 21 to 30 trunk link frames, two extension trunk link frames are associated with each trunk link frame; now by furnishing the trunk link frame in groups of three, there will be 600 links and 600 junctors per group. The 600 junctors from the ten groups of trunk link frames will accommodate the 6000 junctors from the 60 line link frames.

1. Channels

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

The ten or more junctors in a group connecting a line link frame with a trunk link frame are distributed over the ten junctor switches of both the line link and trunk link frames, the junctor switch number being the same on both ends of each junctor. There are ten line links serving each particular subscriber line on the line link frame, and these are also distributed over the ten junctor switches. A typical channel for a 20 line link arrangement is shown in Figure 3-8. The line link to trunk link channel distribution is shown in Figure 3-9.



NOTE:

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

Figure 3-8 Channels for 20 Line Link-10 Trunk Link Frames

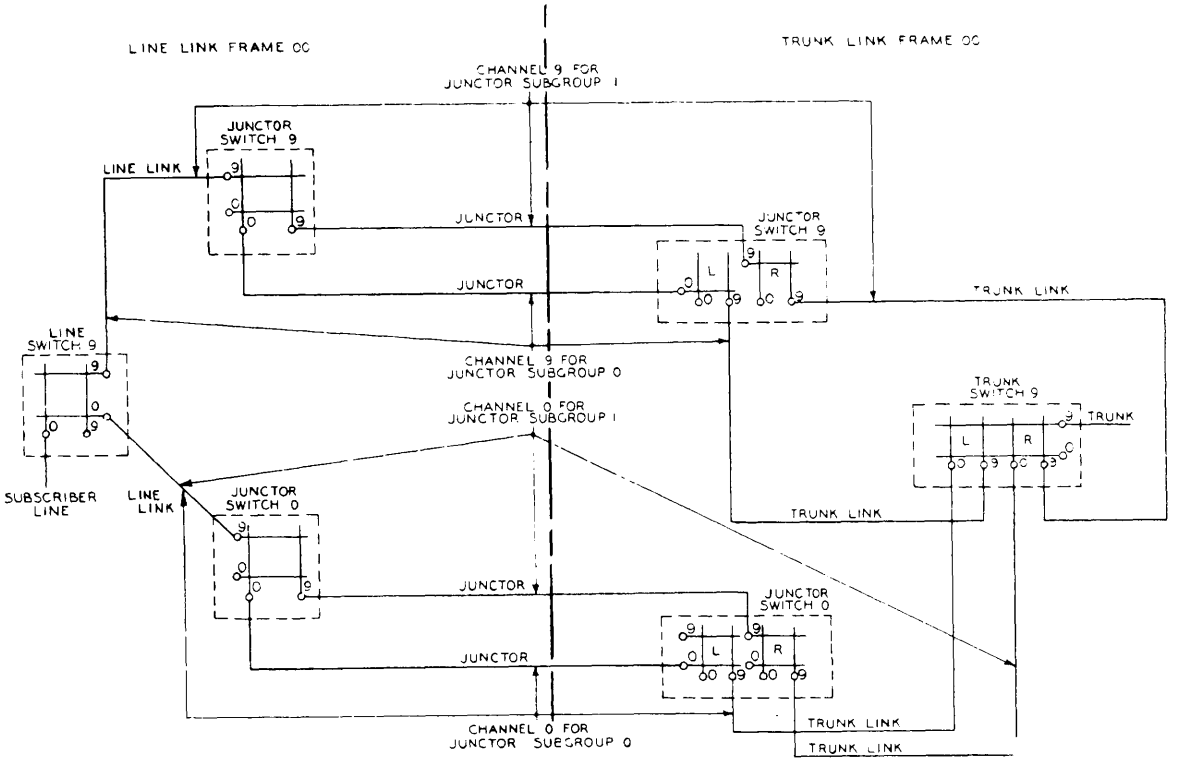


Figure 3-9 Channel Distribution -- Line Link to Trunk Link Frames

D. TRUNKS

The following is a list of principal categories of trunks. Many miscellaneous types are not listed.

(1) Intraoffice trunks handle traffic between customers served by the same marker group[1]. Each trunk requires two trunk link frame locations, an A appearance for the calling customer, and a B appearance for the called customer. These trunks are usually divided into three groups; message rate (AMA or message register), flat rate, and coin.

(2) Outgoing interlocal trunks are used to transmit calls outgoing from the No. 5 Crossbar office to a connecting office. The types of outgoing trunks used depend on the traffic in an individual office. Usually, there is one group of trunks for flat rate and message rate traffic and another for coin traffic.

(3) Incoming interlocal trunks carry the traffic incoming to a No. 5 office. There are two general types of these trunks, namely nontandem and tandem. The nontandem-type trunks carry only the calls completing to customers in the office, and these trunks have one location in the office. This location is on the trunk link frame. The tandem-type trunks carry calls completing to customers in the office and also calls which are switched through when the No. 5 office functions as a tandem switching point. Tandem trunks have two frame locations in the office, one on the line link frame for switching calls through, and the other on the trunk link frame for calls that terminate in the tandem office.

(4) Two-way interlocal trunks are provided on small trunk groups when it is uneconomical to use one-way trunk groups. The trunks are arranged for bylink operation with either loop or CX (E and M lead) signaling to SXS offices.

[1] A common group of markers which serve one or more central offices. A marker group is arranged to handle a maximum of six office code groups spread over six number series with a maximum of 40,000 numbers. The term marker group is also used to refer to the equipment served by a marker group.

(5) Intermarker group trunks handle traffic between two No. 5 Crossbar marker groups located in the same building. The following three types of trunks are used for this traffic.

(a) Customer to customer.

(b) Customer to trunk.

(c) Trunk to customer.

(6) Operator, special service, and recording completing trunks are used by DSA operators to handle assistance traffic. There are usually separate groups of trunks for various classes of service.

(7) Tone trunks are used to give line busy on intra-office call, overflow, (paths busy), partial dial, and vacant code tones. Again there may be coin and noncoin groups of these trunks.

(8) Common overflow trunks are provided as a final route when all permanent signal holding or non-coin combination tone trunks are busy or to return an announcement when dial tone delays are excessive under extreme conditions. This trunk returns a reorder (120 IPM) signal to a calling party.

(9) Intertoll trunks are used to switch toll calls between toll centers. These trunks are of three general types, as follows.

(a) One-Way Incoming Trunks: These have three frame locations in an office: two line link frame locations for calls switched through the No. 5 office as a toll center, and one trunk link frame location for calls terminating in the toll center.

(b) One-Way Outgoing Trunks: These have one trunk link frame location for calls outgoing from the No. 5 office as a toll center, and one jack location at the toll switchboard for operator-handled outgoing calls.

(c) Two-Way Trunks: These have all of the locations mentioned above.

Since interlocal and intertoll trunks employ different supervision and inpedance characteristics, one type may not be switched directly to the other type without conversion arrangements.

(10) Junctor Circuits: These circuits are combinations of outgoing and incoming trunks in the No. 5 office, permanently wired back-to-back, or their equivalent in design. Their functions are as follows:

(a) Operator Junctor: This circuit functions to complete calls on a tandem basis from a switchboard located in the same building as the No. 5 switches to customers located in other local offices.

(b) Operator Toll Junctor: The functions of this circuit are similar to those of the operator junctor, except that the trunks involved are of the intertoll type.

(c) Coin Junctor: This circuit functions to provide for coin operation (coin collect, coin return, coin test, etc.) for local coin calls to be routed over outgoing trunks not arranged for each coin service.

(d) Coin Zone Junctor: Besides being capable of performing the functions of a coin junctor, this circuit is arranged to call in an operator for the initial and overtime charges for coin zone customer-dialed calls.

(e) Message Register Junctor: This circuit functions to provide message register charging facilities for customer calls to be routed over trunks not arranged for message register service.

(f) AMA Junctor: This circuit functions to provide AMA charging facilities for customer calls to be routed over trunks not arranged for AMA service.

(11) Coin Supervisory Circuits

Coin supervisory circuits handle all the coin operations except those taken care of by the originating register. In operation, when required, one of these circuits is connected to a trunk that is serving a coin call. The duties of this circuit are to collect the coins at the end of a completed call for which a charge is made, and to effect coin return when the call is not completed or is one for which no charge is made.

In offices with coin overtime, this circuit makes coin test and collects the coin for the initial and subsequent periods. If a deposit is not made for an overtime period, the circuit signals for an operator to come in on the connection.

E. COIN SUPERVISORY LINKS

These links connect coin trunks to coin supervisory circuits. The frame is similar to the incoming register link frame, and the circuit arrangements are the same. However, because the holding times of coin supervisory circuits with coin trunks are very short, a group of ten coin supervisory circuits can serve as many as 480 trunks.

F. MESSAGE REGISTER

Calls involving one message unit may be recorded by AMA equipment or on message registers.

Message registration is accomplished over a single-sleeve lead which permits line link frames with 3-wire switches to serve all classes of lines. The message register service charging arrangement involves a cold-cathode vacuum tube. Selective operation of either a tip-party or a ring-party register on 2-party lines is obtained.

A distinguishing feature of the switching train is that, unlike other local systems, supervisory and charging circuits are not an integral part of the switching train, as in the case of the panel district selector or the No. 1 Crossbar district junctor circuit. The supervisory and charge features are functions of the various trunk

circuits which connect to the trunk levels of the trunk link frames. By this arrangement trunks may be provided in type and quantity as dictated by the requirements of a particular telephone company.

3.3 CONTROL EQUIPMENT

A. MARKERS

The marker is the most active piece of common control equipment in the office. It is used one or more times in the completion of every call. Different offices have various numbers of markers depending on the size of the office and the amount of traffic. All the markers and their associated equipment serve up to a maximum of 40,000 numbers, make up a marker group.

There are three types of markers: (a) combined (manfacture discontinued), (b) dial tone, and (c) completing. The combined marker performs all the marker jobs while the dial tone and completing markers divide the jobs of the combined marker between them.

The dial tone marker, as the name implies, is used exclusively on dial tone connections while the completing marker performs all the other marker jobs. Economic and traffic conditions determined whether an office had a single group of combined markers or a subgroup of dial tone and a subgroup of completing markers. In general, the combined marker proved more economical only for very small installations, such as those requiring three or less markers. Small installations now use an Originating Line Identifier Unit and its associated completing marker for establishing the dial tone connection.

Each marker normally completes each of its various functions in less than one second; therefore, a small number of markers can serve a large office.

The principal functions of the dial tone marker are:

(a) To respond to demands for dial tone by determining the location of the calling line on the line link frame.

(b) To establish a connection between the calling line and an originating register.

(c) To transfer the calling line location and customer class-of-service information to the originating register. (The register stores this information and after dialing is completed, passes it to a completing marker for use in routing and recording the call.)

The principal functions of the completing marker are as follows:

(a) To determine the proper route for the call from the area or office code digits of the called number and the class of service of the calling customer.

(b) To establish the connection from a calling customer to a trunk or from a trunk to a called customer.

(c) To connect to the proper number group to determine the location of the called line on the line link frame.

(d) To determine from the class of service and the destination the proper charge condition for the call.

(e) When outgoing pulsing is required, to select an outgoing sender of the proper type. The marker then passes information to the sender which the sender transmits when the connecting office equipment is ready.

(f) To recognize line busy, vacant numbers, and intercept conditions, and to control hunting operation in terminal hunting groups.

(g) To complete a call regardless of certain trouble conditions.

(h) To call in the trouble recorder which makes a record of the marker progress if its operation is abnormally delayed or if certain trouble conditions are encountered.

Special Features in the Marker

Two markers (0 and 1) in a group of combined or completing markers are usually equipped with special features for handling certain test calls. These calls are set up by operators, testmen, or maintenance men and are of the following types:

a. No-test calls originated at the test desk or a DSA switchboard.

b. No-hunt calls originated at the outgoing trunk test frame or the message register rack.

c. Special hunt test calls originated at the local test desk.

B. ORIGINATING REGISTERS

Originating registers furnish dial tone to subscribers and record the digits that are dialed. After dialing is completed, the called number is transmitted from the register to the marker. These registers also make party test to determine whether a tip or ring party is making the call. Originating registers appear on trunk link frames and are connected to the subscriber's line by the combined or dial tone marker when the customer lifts the receiver off the hook. A No. 5 Crossbar office which includes any coin lines must have all the originating registers in the office arranged for coin operation.

C. PRETRANSLATORS

Pretranslator circuits may be provided in offices located in areas where some calls require the dialing of more digits than others. The originating register circuit may be arranged to seize the pretranslator after either the second or third digit has been dialed. From these digits, the pretranslator determines how many more digits the register should expect before seizing a marker.

When the volume of calls of this nature is not great and the numbering plan is not too complex, pretranslation can take place in the originating register. The register can be arranged to determine how many digits it should receive from the first digit or from a limited combination of the first and second digits.

On calls to stations where a party letter is part of the directory number, the register has to wait for an extra digit. This situation is known as stations delay. The pretranslator recognizes stations delay from the dialed code and informs the register to wait for a possible additional digit. If the No. 5 office handled FACD (Foreign Area Customer Dialing) traffic, pretranslators are always required.

D. NUMBER GROUPS

The number group translates subscriber directory numbers into line equipment locations of subscriber lines. (The line equipment location identifies the line link frame location of a subscriber line.) The number group also supplies the proper ringing control information and other information concerning the called number, such as whether it is in a terminal hunting group or in a physical, theoretical or extra theoretical office.

A number group serves 1000 consecutive directory numbers. For example, one number group will serve directory numbers 2000 to 2999.

The number group is also used on tandem or toll through-switched calls. On these calls the number group supplies the marker with the line link location of the trunk seeking a path through the office. Each trunk requires two appearances in the number groups. Each trunk uses the same hundreds, tens and units numericals in each of the two number groups assigned to trunk numbers.

E. OUTGOING SENDERS

An outgoing sender is employed on all calls requiring pulsing to connecting offices. The marker transfers the required digits of the called number to a sender which is connected to an outgoing trunk. (The function of the sender is to furnish the pulses which control the operation of the switching equipment in the connecting office.) The type of connecting office (step-by-step, panel, manual, or crossbar) determines what kind of sender should be used to transmit the called number. Therefore, five different types of outgoing senders are provided in a No. 5 Crossbar office, as listed below:

a. Dial Pulse (DP)

b. Multifrequency (MF)

c. Revertive pulse (RP)

d. Panel call indicator (PCI)

e. Frequency Shift Pulse (FSP)

F. INTERMARKER GROUP SENDERS

The intermarker group sender is used for traffic between two different No. 5 Crossbar marker groups housed in the same building. It serves in two capacities; as an outgoing sender for the calling marker and as an incoming register for the called marker. These senders transfer information from one marker group to the other by means of connectors rather than by pulsing.

G. OUTGOING SENDER LINKS

Outgoing sender links connect outgoing and intermarker group senders to outgoing trunks. Information from a sender to a trunk is transmitted through this sender link.

One sender link frame mounts ten 200 point crossbar switches. All types of senders may be located on one sender link frame. The senders connect to horizontals, the trunks to verticals of the switches. Control is by the markers.

H. INCOMING REGISTERS

Incoming registers record the pulses on calls received over incoming trunks from operators or connecting offices. Since these pulses are incoming from various types of offices, the following different incoming registers are provided to record them:

a. Dial pulse (DP)

b. Multifrequency (MF)

c. Revertive pulse (RP)

I. INCOMING REGISTER LINKS

The incoming register links connect incoming trunks to incoming registers. This connection is made without the use of a marker. Information from incoming trunks to incoming registers is transmitted through these links.

The link frames use 200 point crossbar switches to connect a maximum of ten incoming registers of one type to trunks connected to verticals of the switches. The number of trunks served by a group of ten registers can be increased by associating several frames into a "link group."

Cross-connections associated with the individual trunks advise the selected register of the trunk's class and trunk link frame number. If the trunk is used for through switching, a trunk number will also be derived in the register. These facts about the trunk will be given to the marker to enable it to set up the call.

When the incoming register link frame handles calls dialed directly by subscribers in step-by-step offices, the connection from the trunk to the register through the crossbar switch may not be closed when pulsing of the first digit starts. For this type of call an early "by-link" path is provided through trunk and register preference relays to start registration of the first digit before closure of the final pulsing path through the link switch.

J. CONNECTORS

A connector is a relay-type switching device for interconnecting, for a short interval of time, two equipment elements by a relatively large number of leads.

A specific method is used in naming these connectors. If more than one type of equipment can originate action toward another type, the connector is named according to both the originating and terminating action; for example, in connectors such as the line link marker connector with the word "marker" in the title, the action terminates in the marker and is originated by the line link frame. The originating circuit must be mentioned because other circuits can originate action toward the marker. Other connectors of this class are the originating register marker connector and the incoming register marker connector. Eight principal types of connectors are shown in Figure 3-10.

Similarly, when only one type of equipment can originate action toward another type, the connector is named according to where the connector action terminates.

For this reason the connectors from markers to other frames do not contain the word "marker" in the title. Connectors in this class are the line link, trunk link, number group, and outsender connectors.

K. FOREIGN AREA TRANSLATORS

A foreign area translator frame and associated connectors contain circuits which operate in conjunction with the markers to permit routing calls to other national numbering areas if there is more than one trunk route available to the numbering area. Arrangements are provided for translation into a maximum of six foreign areas.

Where only one route is available to each numbering area, or one combined route is available for a number of areas, the marker can route calls to them without using the foreign area translator. However, if different AMA charge treatment is required for two or more destination codes reached over a single route to a foreign area, the foreign area translator will be required.

3.4 SYSTEM MAINTENANCE

The basic provisions for the maintenance of No. 5 Crossbar system offices consist of:

(a) Testing equipment for the various circuits and associated apparatus.

(b) Arrangements for providing evidence and information about failures occurring on service and test calls.

(c) Provisions for removing equipment from service.

The master test frame which incorporates all of the above features is located in the maintenance center. Included in the apparatus of this frame is a recording device which automatically provides, in the form of punched cards, both information concerning failures or service calls and the results of certain test calls.

Some of the other testing equipments used include:

(a) Test lines for use in making tests of the operating and signaling features of local and intertoll trunk circuits.

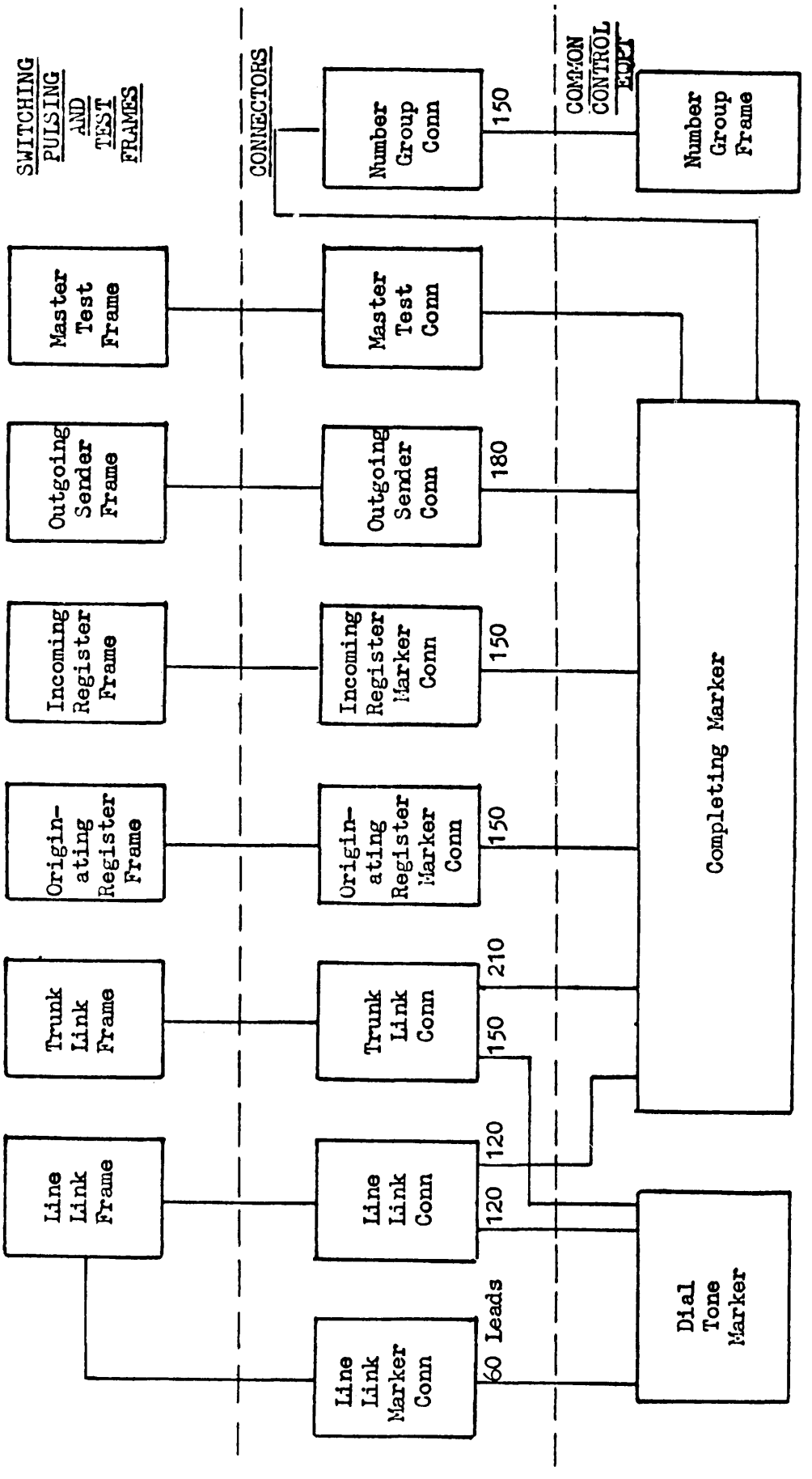


Figure 3.10 The Eight Principal Types of Connectors Used in the No. 5 Crossbar System

(b) Test circuits for checking foreign area translator code cross connections.

(c) Equipment for automatically testing intraoffice type trunks, customer to customer intermarker group type trunks, and outgoing interoffice type trunks.

(d) Several portable test sets.

An alarm system giving audible and visual signals is provided to alert the central office force of the occurrence of trouble conditions and to direct them to the proper location. The direction is accomplished by a pilot lamp indicating the floor involved and the pilot lamps at main aisles and cross aisles.

3.5 NO. 5 CROSSBAR SYSTEM SWITCHING TELEPHONE CALLS

The calls handled by a No. 5 Crossbar office are of four general types: intraoffice, outgoing, incoming and tandem or through switched.

All calls require the use of a register for counting and storing digit information. Originating registers are used to count and store digits from subscribers while incoming registers count and store digits from other offices.

A. DIAL TONE CONNECTION

The originating registers are assigned to the trunk switches of the trunk link frames. A connection from the subscriber lines to the originating registers requires the selection and closure of a channel. A marker is required for the channel selection as well as register selection and calling line identification.

See Figure 3-11 for the block diagram showing the sequence of connection for the dial tone job. When a subscriber removes the receiver from the switch hook, a line relay is operated which causes the line link frame to inform the line link marker connector that a marker is required. The line link marker connector selects an idle dial tone or combined marker, connection #1.

In order to establish a dialing connection between the subscriber's line and an idle originating register, the marker must determine the equipment location of the calling line, select an idle register and then determine that a channel between the line and the register can be obtained.

The marker tests for the calling line location through the connection set up by the line link marker connector. While the marker is recording this information, it is also selecting an originating register, connection #2. The originating registers are distributed as evenly as possible over all the trunk link frames. The selection of an idle originating register is a two-step operation. The first step consists of the marker selecting an idle trunk link frame that has an appearance of one or more idle originating registers. The second step is the selection of a particular register on the selected trunk link frame.

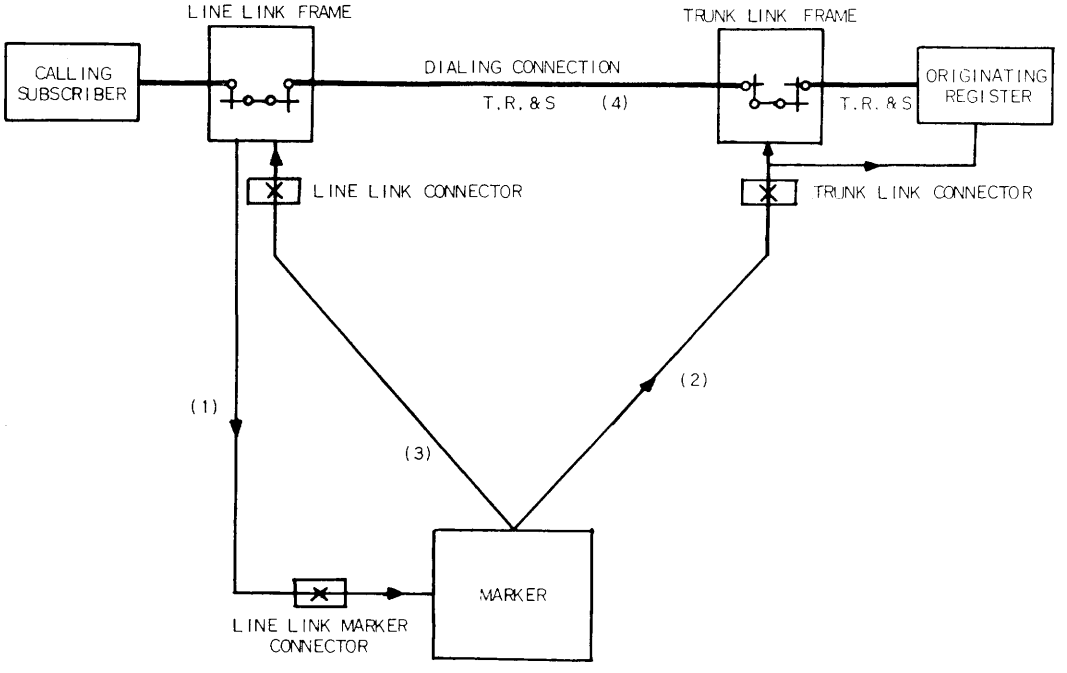


Figure 3-11 Establishing Dialing Connection

After the marker has selected the trunk link frame, the marker then returns to the line link frame via the line link connector, connection #3. Through this connection, the

marker will be able to complete the subscriber line identification and also control the closing of the contacts on the crossbar switches, for the selected channel.

The marker must select an idle channel between the subscriber's line and the selected originating register. When the marker finds an idle channel, it operates the select and hold magnet required for channel closure. The marker indicates to the originating register the identity of the line link used in the channel, the equipment location, and class of service of the calling line. The register stores this information for later use.

Before the marker transfers control of the channel to the originating register, it checks the connection for continuity, crosses or false grounds. The marker, upon satisfying itself that it has established a valid connection, releases its associated connectors and itself leaving the control of the channel with the originating register. The register furnishes dial tone to the subscriber and is now ready to receive the digit information from the subscriber's set.

This completes the dial tone connection. The digits which the subscriber dials or keys into the originating register are stored in the register for later marker use. As soon as dialing is completed, the register will seize a completing marker and transmit to it all registered information. This information consists basically of (a) class of service of the calling subscriber, (b) line link location of the calling subscriber and party identification, and (c) dialed digits.

The preceding operation is standard regardless of the type of call being initiated. Since the originating register initiates action to obtain a completing marker at completion of dialing it must be able to determine how many digits are to be dialed for each call. While most calls will consist of seven digits: three for an office code identification and four numericals, the register may be required to complete calls on the basis of 3 to 11 digits.

In order to determine the number of digits to be received on each individual call, a pretranslation of the dialed information is performed. Pretranslation is the process of determining from the first 1, 2, or 3 dialed digits, how many digits the register should expect to receive on that particular call. When the number of calls

that differ from the normal seven digits is small and the numbering plan is not too complex, pretranslation can take place in the originating register. For more complex numbering plans, or a large volume of calls using a variable number of digits, a separate pretranslator is provided. This circuit is called in by the originating register through the pretranslator connector after the first two or three digits have been set in the register. The pretranslator determines from these digits how many digits should be dialed and tells the register the number of digits that it should receive before calling in the completing marker.

B. OUTGOING CALL (INTEROFFICE)

Outgoing calls are established to connecting offices or to operators for some type of service assistance. It is necessary to establish a connection from the subscriber's line to one of the outgoing trunks that terminate in the connecting office or operator's position. It may also be necessary to determine what, if any, charge is to be made and how to send the digits of the called number to the connecting office. Figure 3-12 shows the sequence of connections for an outgoing call.

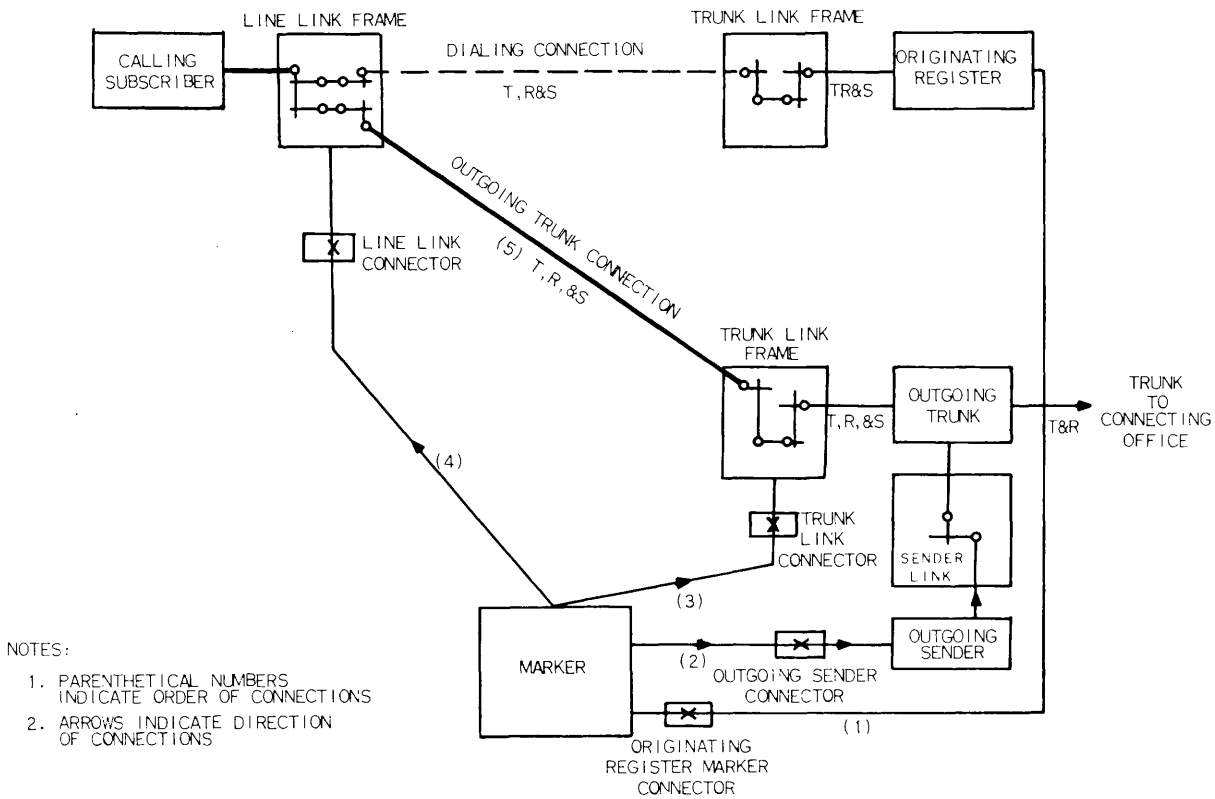


Figure 3-12 Outgoing Trunk Connection

After the originating register has recorded the proper number of digits, it signals its originating register marker connector that a completing marker is required. The originating register marker connector selects an idle completing marker and establishes a connection from the originating register to the marker (Connection #1). The originating register then transmits to the completing marker all of the stored information; class of service, line link location, party identification, channel number and digit information.

The marker obtains routing instructions from a route relay which is operated by relating the called office code to the calling subscriber's class of service. This route relay will instruct the marker as to what type of pulsing to use and which group of outgoing trunks are going to the proper termination. The marker then proceeds to test for and select an idle outgoing sender of the proper type (Connection #2). Once the marker has determined the availability of an outgoing sender, it then proceeds to test the office for location of idle outgoing trunks and idle trunk link frames serving those idle outgoing trunks. The marker then selects a particular outgoing trunk and trunk link frame to serve this call using the same technique as in the selection of an idle originating register (Connection #3). It then causes the sender link frame to set up a connection between the outgoing trunk and the outgoing sender. While this connection is being completed, the marker seizes the line link connector associated with the subscriber's line link frame (Connection #4). Information as to the equipment location of the calling subscriber was obtained from the originating register. The marker now tests for and selects an idle channel from the calling subscriber to the outgoing trunk. When the marker finds an idle channel, it operates a select and hold magnet required to close through the channel; testing the channel for validity. The marker then tests for continuity before transferring control to the outgoing sender (Connection #5).

While the marker was setting these latter connections, it was instructing the outgoing sender on how to handle this particular call. It informed the outgoing sender of the digits dialed, which digits if any are to be deleted, what digits, if any, to prefix, and the type of test or supervisory signals required by the connecting trunks. The marker then releases its associated connectors and itself, leaving the outgoing sender in charge of the call. The outgoing sender will test and outpulse to the terminating office in accordance with the class instructions it received from the marker.

C. INCOMING CALL

An incoming call is the completion, in a called office, of an outgoing call from a connecting office. In the called office, the trunk from the originating office is termed an incoming trunk. The incoming connection consists of a channel between the incoming trunk and the called subscriber. Refer to Figure 3-13 for the block diagram showing the sequence of connections for an incoming call.

As soon as the incoming trunk is activated by a call originating in a connecting office, it seizes an incoming register through an incoming register link, connection #1. As soon as the incoming register has been seized, it signals the connecting office that it is connected to the trunk and ready to receive digit information. As soon as the register has received the proper number of digits, it signals the incoming register marker connector that a connection to a completing marker is required, connection #2. The incoming register marker connector selects an idle completing marker and establishes a connection from the incoming register to that marker. The incoming register then transfers information from its memory circuit to the completing marker. This information consists of the dialed digits, the class of the incoming trunk, and the trunk link frame number on which this trunk is assigned.

The marker first seizes the connector of the trunk link frame associated with the incoming trunk, connection #3. From the trunk class indication and the digits received, the marker selects the number group frame in which the called number is assigned, connection #4. As soon as the connection is established the marker transfers the hundreds, tens, and unit digits information into the number group. The number group translates and returns to the marker information concerning the line link equipment location of the called subscriber, the type of ringing that will be required for this subscriber along with other information for the marker to establish the validity of the call.

The marker then seizes the connector associated with the called subscriber's line link frame, connection #5, and proceeds to test for and select an idle channel from the incoming trunk to the called subscriber. When this channel has been selected, closed, and tested, connection #6, it transfers control of the channel and of the call to the

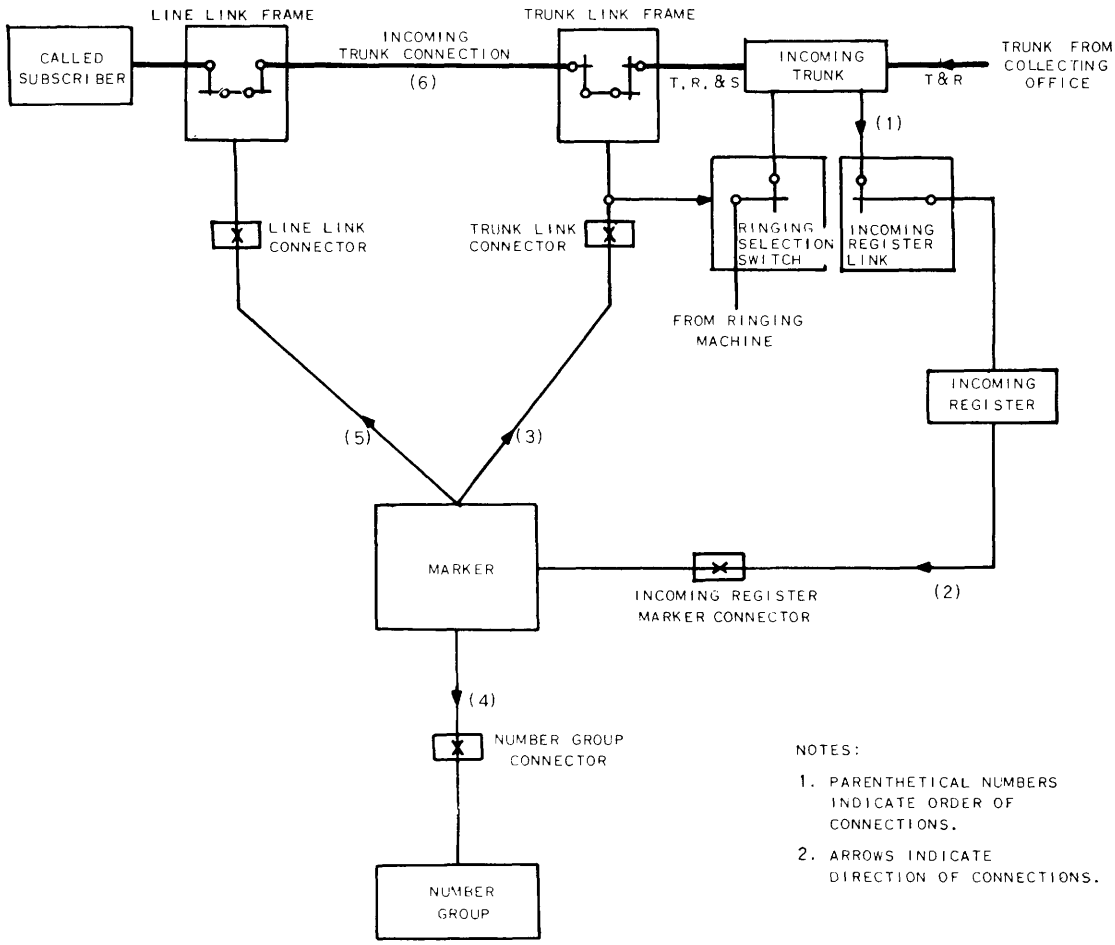


Figure 3-13 Incoming Trunk Connection

incoming trunk. The marker sets the ringing selection switch with the proper type of ringing for the called subscriber. The marker upon having completed its useful functions, releases itself and all control equipment leaving the path from the incoming trunk to the called subscriber under control of the trunk which will apply ringing tone to the called line.

D. INTRAOFFICE CALL

An intraoffice call is one that is placed from one subscriber to another subscriber within the same marker group. Since a channel can only be established between a line link termination and a trunk link termination, it will be necessary to establish two channels through the office. The trunk used for this purpose must have two trunk link appearances in order to terminate and form a loop around for the two channel connections; refer to Figure 3-14 for the block diagram showing the sequence of connections for an intraoffice call.

This call starts in the same manner as the outgoing trunk connection in that the originating register upon receipt of the proper number of digits, signals the originating register marker connector for a connection to a completing marker, connection #1. The information stored in the originating register is then transferred to the marker over this connection.

The marker upon examining the office code and subscriber's class of service for route relay operation, which will provide the marker with routing instructions, finds that the office code represents a call to its own equipment. The routing instruction gives the marker the location of the intraoffice trunks to be used for this call. It proceeds to test and select an idle intraoffice trunk on one of the idle trunk link frames, connection #2.

The marker then by using the office code and the thousands digits selects the proper number group and receives from the number group the line link location of the ringing combination of the called subscriber, connection #3. The marker then seizes the line link frame of the called subscriber by seizing the proper line link connector, connection #4, tests and selects a channel from the called subscriber to the B-appearance of the intraoffice trunk and sets the ringing selection switch for the proper type of ringing, connection #5.

The marker then proceeds to seize the line link frame of the calling subscriber, connection #6, testing for and selecting an idle channel from the calling subscriber to the A-appearance of the intraoffice trunk on the trunk link frame, connection #7. All required connections having now been established, the marker releases itself and all control circuits leaving the trunk in charge of the connection to the office.

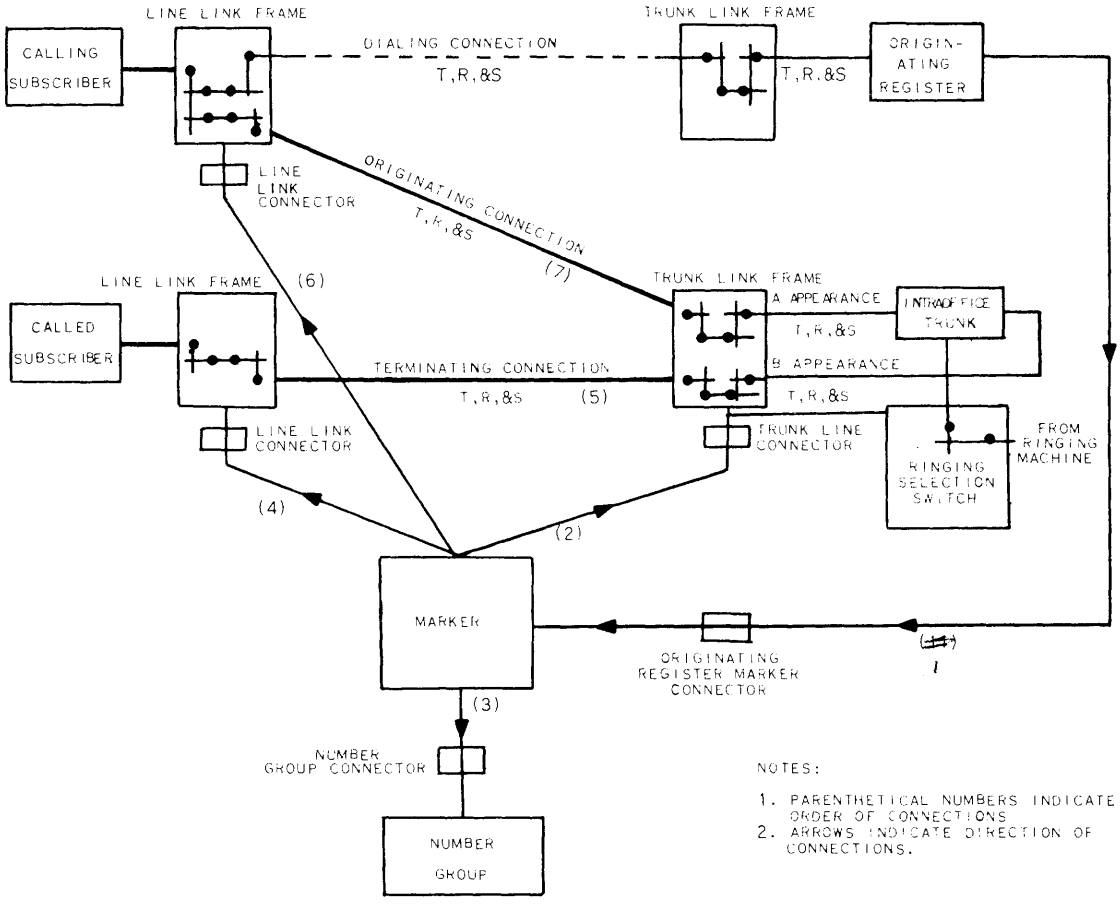


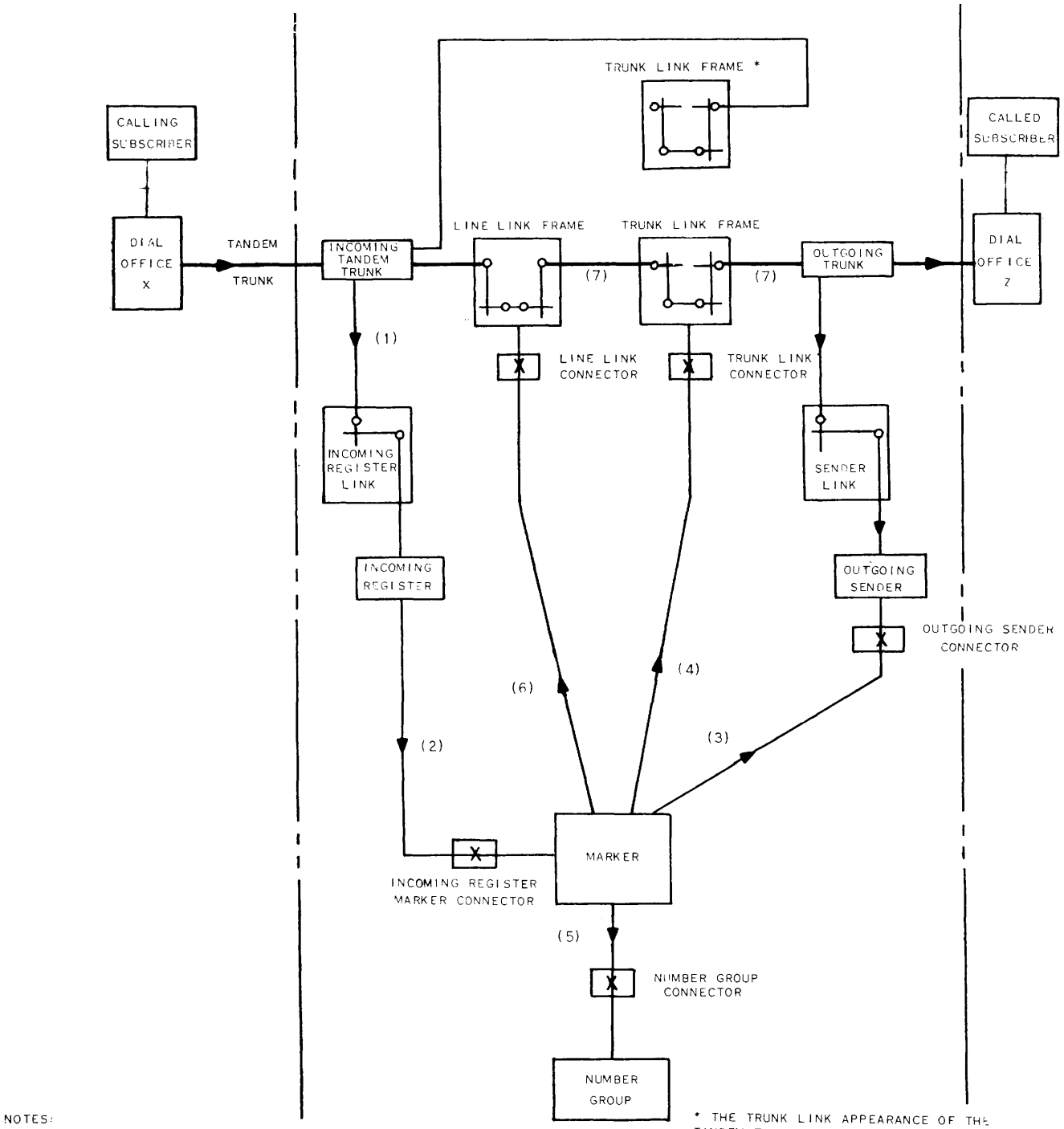
Figure 3-14 Intraoffice Trunk Connection

3.6 TANDEM OR TOLL THROUGH SWITCH CALL

Since it is not economical to have direct trunks between all central offices, intermediate switching points are provided to handle traffic between offices that have no direct connection. This type of operation is known as tandem or through switching. A local No. 5 Crossbar office may be arranged to serve tandem as well as toll center traffic for surrounding offices.

A No. 5 Crossbar office can be used to provide this tandem switching service in addition to its regular functions. An incoming trunk arranged for handling tandem traffic at a No. 5 Crossbar office with tandem switching features can also handle traffic for completion to this office, since it is generally economical to combine these two types of traffic over the same trunk group. To permit this dual use, it is necessary to provide such trunks with both trunk link and line link frame locations in the No. 5 office with tandem switching features. The trunk link frame location is used when a call coming in on a tandem trunk terminates in the No. 5 Crossbar office. When the incoming call is to be switched to a connecting office through the No. 5 Crossbar office, the line link frame location is used.

Figure 3-15 is the block diagram showing the sequence of a call through an office arranged for through switching. An incoming trunk is seized at the connecting office and in a manner similar to a regular incoming call. It, in turn, seizes the incoming register (Connection #1). Digit information is stored in the register as in other incoming calls. At completion of dialing the register seizes a marker and transfers all of the stored information to the marker in conventional fashion (Connection #2). The additional information that is transferred in this type of call are the three digits that represent the trunk identification. The marker upon looking at the office code and the class of the incoming trunk will go through route relay operation which will identify this call as a tandem type of call. The marker will then test for and select an idle outgoing sender (Connection #3). The next action by the marker is to test and select an outgoing trunk to the proper termination, (Connection #4), and establish the connection from the outgoing trunk to the outgoing sender through the outgoing sender link frame. Using the three digits of the trunk number, the marker seizes the number group frame assigned to trunk numbers (Connection #5), and receives from it the line link location of the incoming trunk. This location is always furnished in duplicate, in two separate number groups. To increase the possibility of completing a toll call, the trunk is assigned two separate line link locations. Each of the two number group locations of the toll trunk will translate one of the line link locations. If a marker has trouble in establishing a connection on its retrial, it will go to the other number group and thereby obtain the other line link location of this trunk. The tandem trunks have an identical line link location in both number groups.



NOTES:
1 PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTIONS

2 ARROWS INDICATE DIRECTION OF CONNECTIONS

* THE TRUNK LINK APPEARANCE OF THE TANDEM TRUNK IS USED FOR CALLS TERMINATING IN THIS NO. 5 CROSSBAR OFFICE.

Figure 3-15 Tandem or Through Switched Call

The marker now seizes the line link frame on which the incoming trunk is assigned as shown in connection #6. The marker now tests for and selects a channel in conventional manner from the incoming trunk assignment on the line link frame to the outgoing trunk assignment. Upon completing test of this channel and transfer of outpulsing information to the outgoing sender, the marker releases itself and all of its connectors; the call now proceeds the same as an outgoing call.

3.7 OTHER TYPES OF CALLS

With slight modifications in the techniques of handling calls, No. 5 Crossbar is able to perform many other useful types of call switching. Many of the functions performed in these calls are identical to the functions relating to the previously described calls.

A. REVERTING CALL

A reverting call is one that takes place between subscribers who share the same party line. A connection is set up to a reverting trunk for provision of talking battery and supervisory functions.

This call is very similar to an intraoffice trunk connection except that a trunk with only one trunk link appearance is required and only one channel is set up from the one line serving both parties, to the reverting trunk. The block schematic for this type of call is shown in Figure 8-16 and differs only slightly from Figure 8-14. After the marker has received the line link location of the called subscriber from the number group frame and it finds that this location matches the location of the calling subscriber, as given to it by the originating register, the marker then releases, connection #2 and proceeds to go through the trunk selection the second time; this time selecting an idle reverting trunk. After the marker seizes the line link frame and tests for and closes a channel in the usual manner, it releases itself and its connectors leaving the reverting trunk in charge of the call.

The operating procedure when multiparty lines are furnished is for a steady tone to be returned to the calling subscriber. This is the signal to the calling subscriber to dial the party code digit numerical that appears on his dial. Upon receiving this one-digit information, the reverting trunk now returns busy tone and sets up a ringing

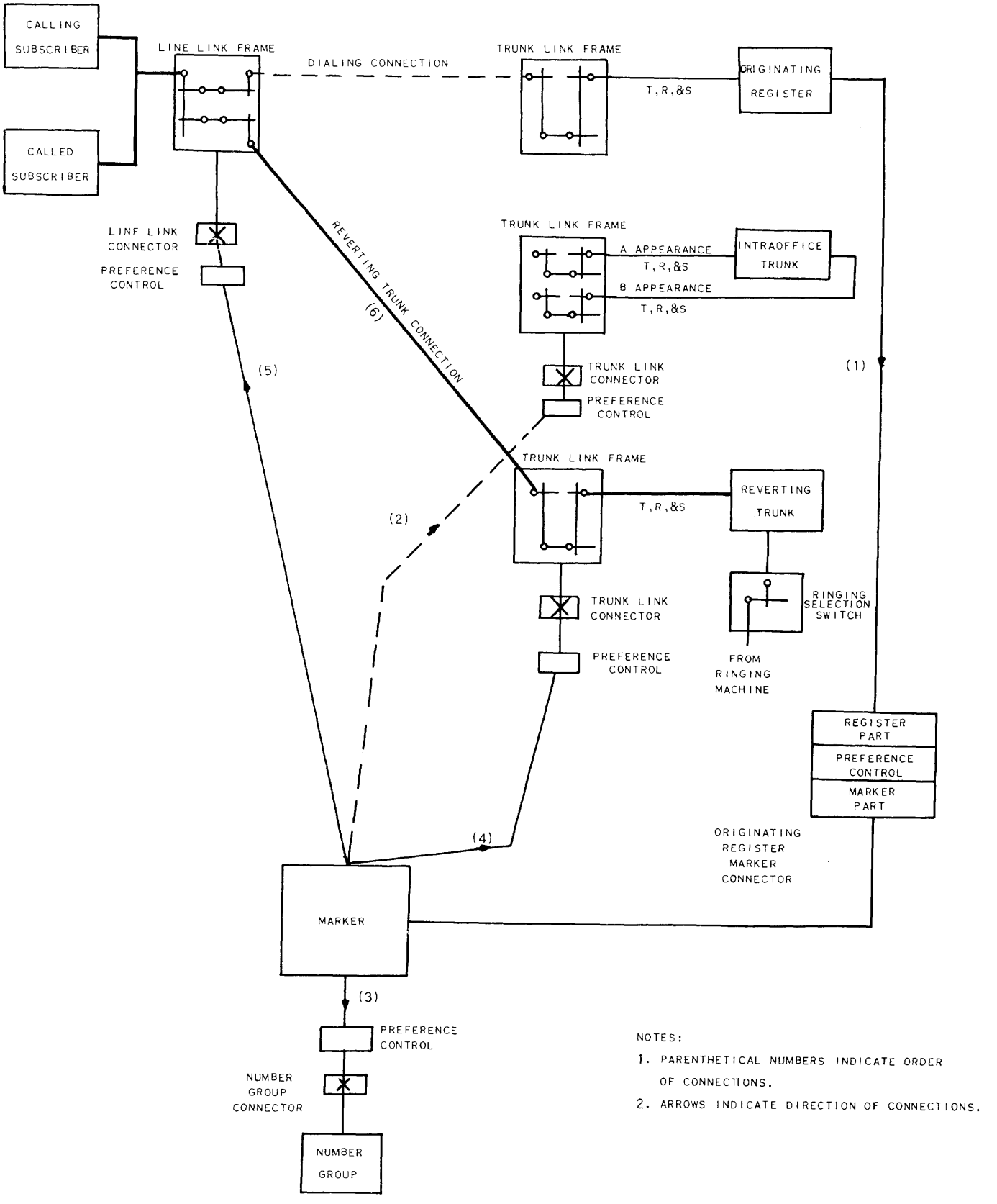


Figure 3-16 Reverting Trunk Connection

selection switch for the calling subscribers ringing code. The subscriber hangs up and the trunk will alternately ring the called and calling subscribers lines, tripping the ringing as soon as the receiver has been lifted at the called subscribers line.

B. INTERMARKER GROUP OPERATION

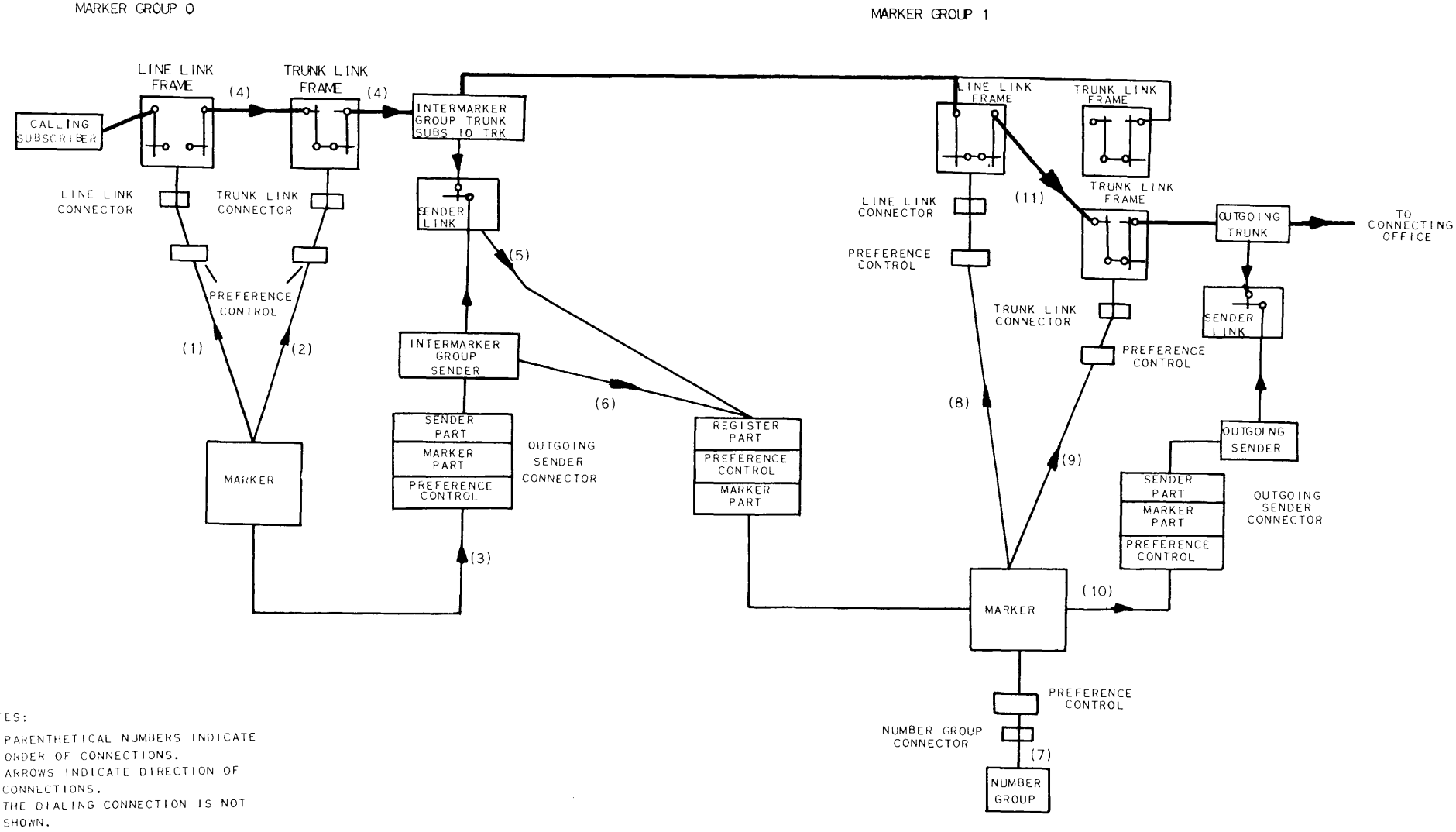
Intermarker group operation is where a call is completed from one marker group to another marker group within the same building. This call may be from a subscriber, from a subscriber to a trunk or from a trunk to a subscriber. For illustration we will use a call from a subscriber to a trunk. The block schematic for this call is shown in Figure 3-17.

By inspection of Figure 3-17 we will see that each intermarker group trunk appears in one marker group as an outgoing trunk and in the other marker group as an incoming tandem type of trunk, except for assignment to the incoming register link frame. This call differs from a regular outgoing or tandem call in the fact that the outgoing sender is replaced by an intermarker group sender which is assigned in the first marker group as an outgoing sender and used in the second marker group as an incoming register. With the intermarker group sender connected in this manner, it is not necessary to actually outpulse and again receive the pulsed digit information. It will simply take the information it receives from the completing marker and through the incoming register marker connector transmit this information to a completing marker in the second marker group.

This type of operation reduces the number of incoming registers and incoming tandem trunks that would be required in the second marker group. It will also permit the outgoing trunks to a particular connecting office to appear in only one of the marker groups within the building.

C. OPERATOR JUNCTOR OPERATION

Operator junctors are trunks that originate at the toll and DSA switchboards and terminate in the crossbar No. 5 office. These trunks are used by the toll and DSA operators to gain access to the outgoing trunks in the crossbar No. 5 office. Since the operator junctor is a type of tandem trunk, a No. 5 office must be equipped for tandem operation in order to use it. The block schematic for operator junctor operation is shown in Figure 3-18.



NOTES:

1. PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTIONS.
2. ARROWS INDICATE DIRECTION OF CONNECTIONS.
3. THE DIALING CONNECTION IS NOT SHOWN.

Figure 3.17 Intermarker Group Trunk Connection Customer to Trunk

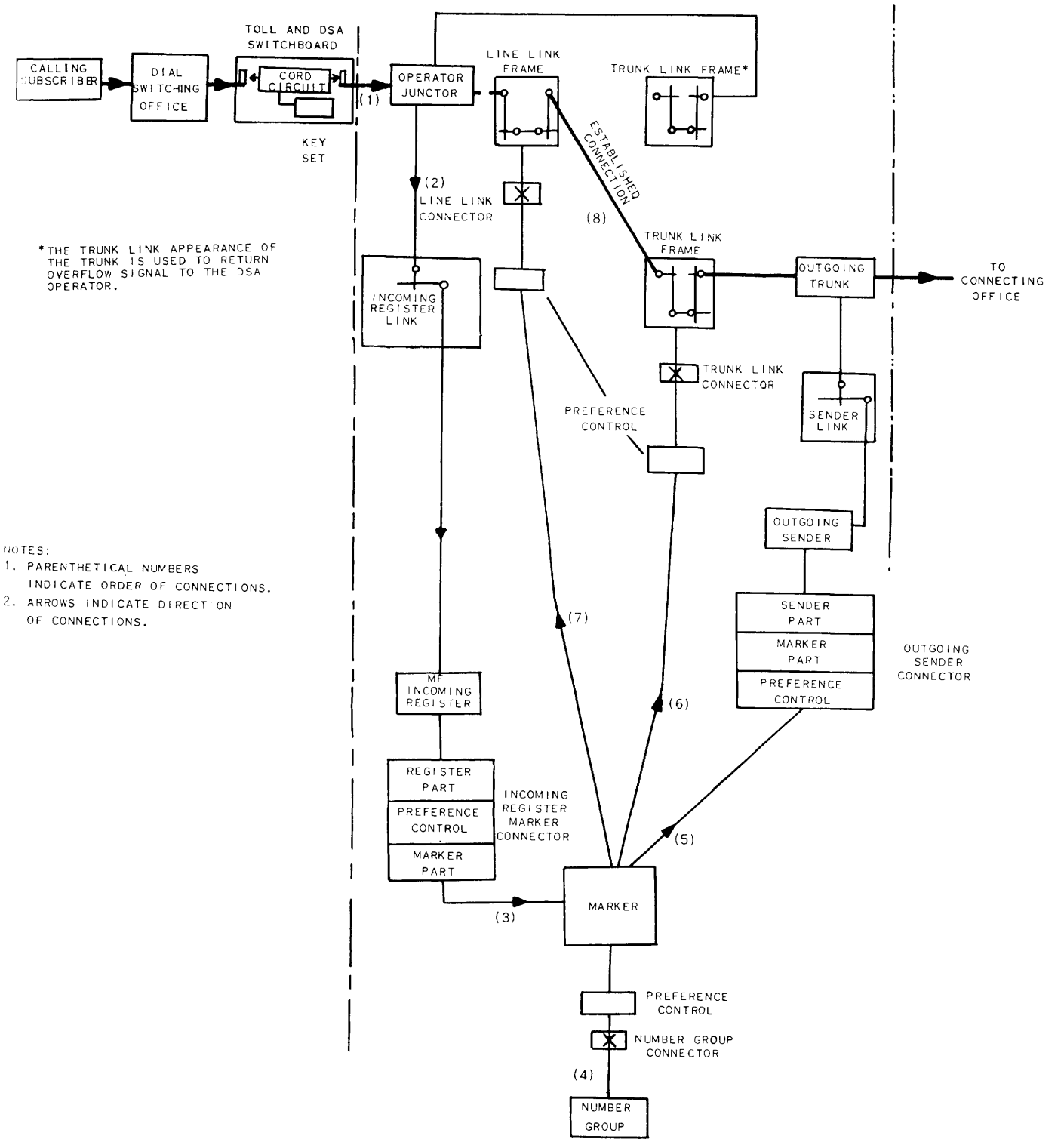


Figure 3-18 Operator Junctor Operation

In completing such a call the operator will always use multifrequency pulsing regardless of the type of pulsing required at the terminating office, since the crossbar No. 5 common control equipment will outpulse whatever is required.

D. COIN JUNCTOR OPERATION

The coin junctor is a unit of equipment used for handling outgoing interoffice and subscriber to trunk intermarker group coin traffic. Coin junctors can be used as alternate routes for groups of regular outgoing coin trunks. With this arrangement, outgoing trunks that handle coin and noncoin traffic do not need coin features. The block schematic of the coin junctor operation is shown in Figure 3-19.

This type of operation requires that two channels be selected through the switching network. One channel from the subscriber to a coin junctor, the second channel from a coin junctor to a noncoin outgoing trunk. It will be noted that the coin junctor acts as both an outgoing and an incoming trunk in the No. 5 office. One group of outgoing trunks will handle both coin and noncoin traffic.

E. PULSE CONVERSION OPERATION

The pulse conversion operation is an assistance to the operator in converting the multifrequency pulses from her key set to dial or revertive pulses as required for the terminating office. It does not require the selection of a path through the crossbar No. 5 office. The trunk selected by the operator terminates in the connecting office but has an appearance in the crossbar No. 5 office so the common control equipment in the No. 5 office is able to receive and transmit pulses over the trunk. The block schematic for this operation is shown in Figure 8-20.

The operator selects an outgoing trunk to the desired termination. However, the trunk does not close a path through to the connecting office. The trunk has an appearance on the incoming register link frame and signals it that a connection to an incoming register is desired. When the register is attached, it will signal the operator to start pulsing. After pulsing has been completed the register will seize a completing marker and transfer to it the stored information located in the register. From the class of the incoming trunk the marker will recognize this as a pulse conversion type of call and will act accordingly.

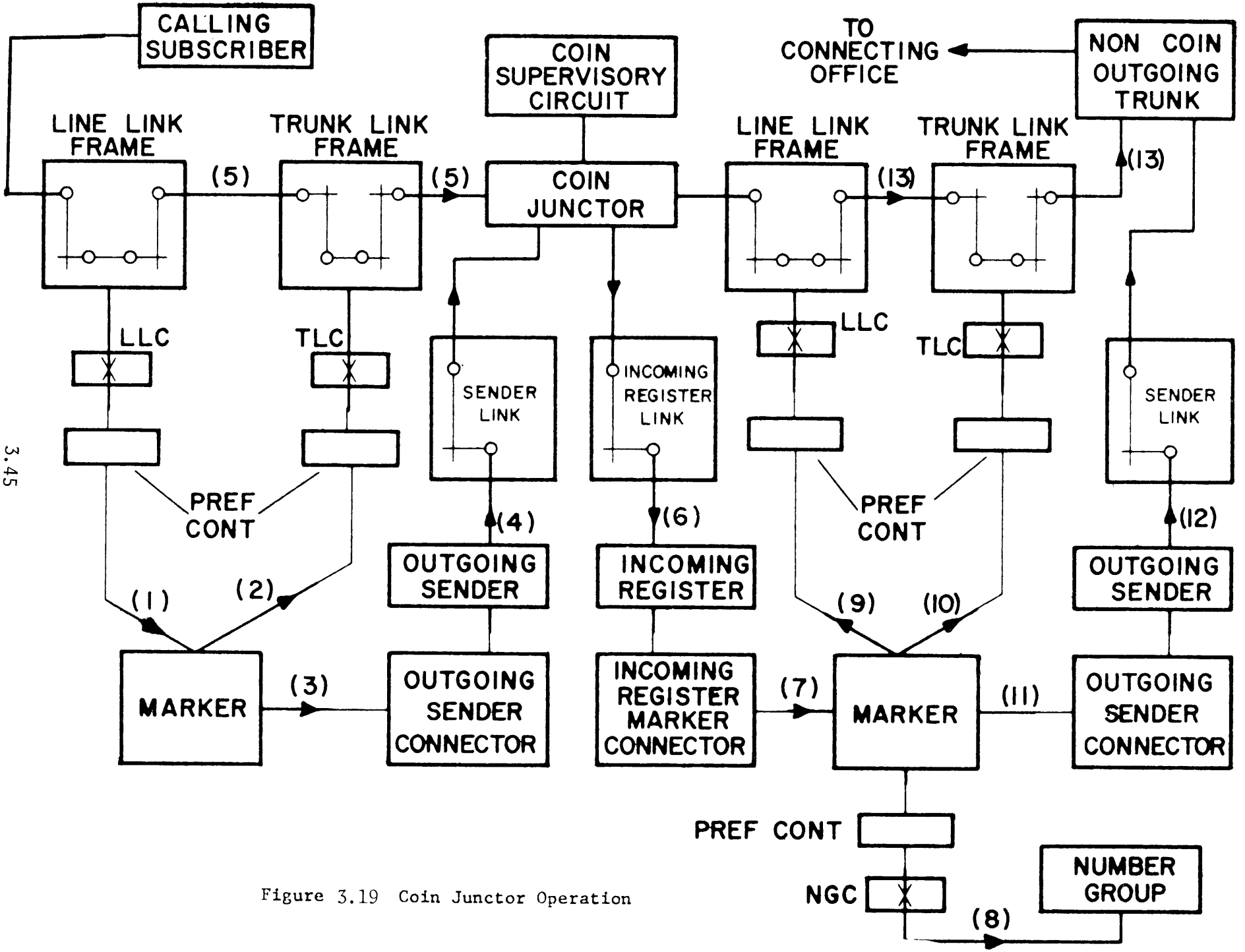


Figure 3.19 Coin Junctor Operation

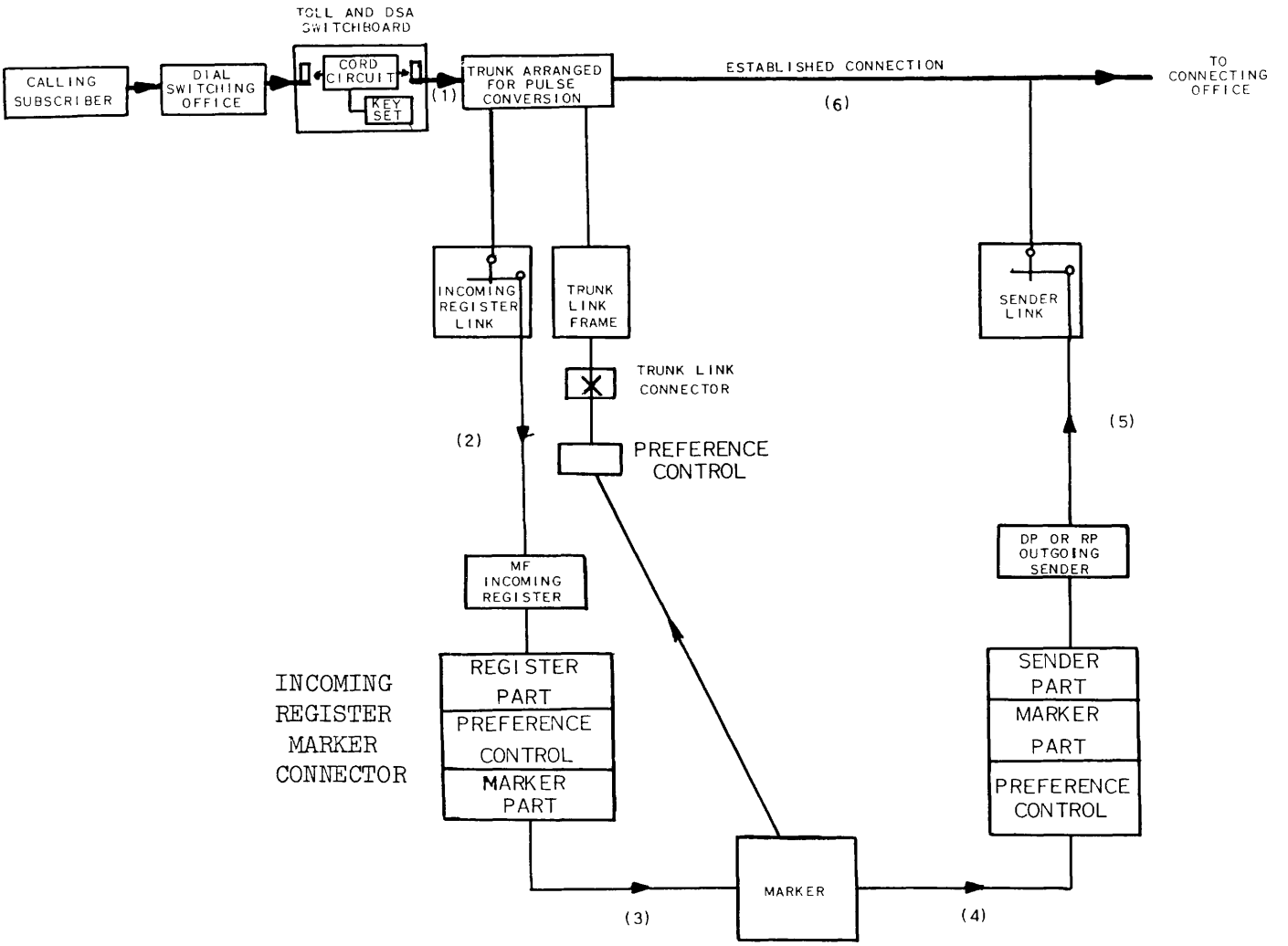


Figure 3-20 Pulse Conversion Operation

While the common control equipment of the No. 5 office was used to convert MF pulsing to RP or DP pulses, no use was made of the switching network.

3.8 NO. 5 CROSSBAR OFFICE ARRANGED FOR CENTREX SERVICE

Centrex for No. 5 Crossbar offices has gone through three basic phases of development. These phases are defined in the following steps.

a. Phase I circuits contain centrex features developed with attendant transfer as the basic mode of operation.

b. Phase II circuits were developed on a standard basic with attendant transer as the basic mode of operation with several additional features.

c. Phase III circuits were developed with dial transfer as the basic mode of operation enabling more efficient operation and considerable savings over Phases I and II. Figure 3-21 shows Phase III circuits for use only in new centrex offices or in existing No. 5 Crossbar offices arranged for 100 classes of service that may be used to provide centrex service.

Centrex facilities enable a PBX customer to obtain a flexibility of operation previously unobtainable with normal PBX facilities. Centrex facilities permit incoming calls to be completed to an extension without the aid of an attendant (direct-inward-dialing); permit calls to be transferred from one extension to another without the aid of an attendant (dial transfer); and also enables direct distance dialed calls to be automatically billed to individual extensions.

In the No. 5 Crossbar system these facilities are divided into two general categories. Centrex CO enables the PBX customer to use No. 5 Crossbar switching equipment located on telephone company premises whereas Centrex CU provides for the equipment to be located on his own premises.

In this specification, the extensions associated with one customer which are served by a Centrex CO are referred to as Centrex stations and constitute a customer group.

A. METHOD OF OPERATION - GENERAL

The method of operation, described in this section, covers the dialing arrangements which are required to initiate and to transfer calls from Centrex lines as well as the No. 5 Crossbar system operation which is required to handle calls originating from and completing to Centrex CO and Centrex CU lines.

In addition to the operation described in this section of the specification, a Centrex CO can be arranged to transfer incoming calls automatically to an attendant when the call encounters a Centrex line which is either busy or doesn't answer. It also can be arranged to transfer the listed directory number (LDN) calls to a Centrex line when the attendant's position is not occupied.

B. DIALING ARRANGEMENTS

This section covers only the dialing arrangements which are required to initiate a call in order to gain access to the No. 5 Crossbar switching equipment. The arrangements which are required for transferring calls are covered in the transfer portions of the description of system operation. These dialing arrangements are used with both the rotary dial and TOUCH-TONE sets.

The Centrex line dials "O" when he requires the assistance of a Centrex operator; "9" when he calls a party whose line terminates outside of his customer group or when he requires the assistance of a DSA or toll operator; and a IXX code when he calls a party whose line terminates in a distant PBX or Centrex office which is connected by direct tie lines to the customer's Centrex CO or CU. The 1XX codes may also be used for special services. The Centrex station dials four- or five-digits of the called number when he calls a party whose line terminates in the same customer group. (Four-digit numbers restrict the Centrex CO to 7000 Centrex numbers since digits 0, 1 and 9 cannot be used as the thousands digit. Five-digit numbers enable the Centrex CO to use the full 40,000 number capacity of a marker group for Centrex numbers.)

C. CENTREX CO SYSTEM OPERATION

In Centrex CO operation, Centrex lines are assigned line link frame appearances with a class of service and rate treatment identification which enables the dial tone marker to identify them as Centrex lines and also to determine their associated customer group.

All Centrex lines have directory numbers assigned to them but the attendant's number or numbers are normally the only ones which are listed in the telephone company's directory.

Although the full seven digits of the directory number are required for direct-inward-dialed calls, only the last four or five digits are dialed for calls between Centrex lines in the same customer group (intracustomer group calls).

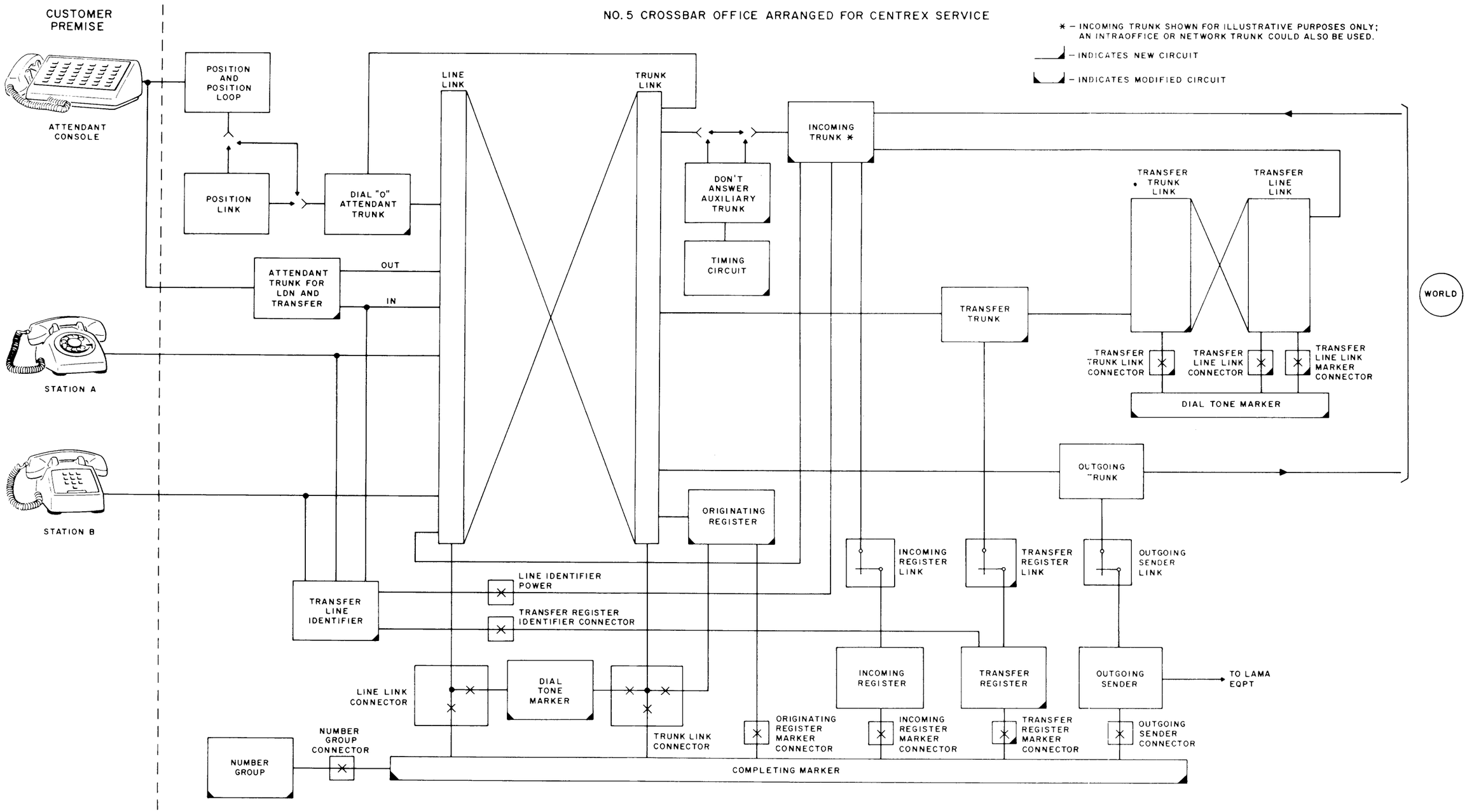


Figure 3.21 - Phase III Offices

In Centrex operation, the originating register assumes that the calling line is a Centrex line and that only four digits will be dialed unless it receives information to the contrary.

If the customer group is arranged for five digit numbers, the originating register receives an appropriate indication from the dial tone marker.

If the originating register receives the digits 0, 1 or 9 as the first digit, it realizes that the call is not an intracustomer group call and takes the required action.

If a regular customer line is connected to the originating register, the originating register recieves an indication from the dial tone marker that the calling line is not a Centrex line.

D. OUTGOING, INTRAOFFICE, INTERMARKER GROUP CALLS

Outgoing, intraoffice, and intermarker group calls from Centrex lines are handled in essentially the same manner as they are handled for basic customer service. However, originating register request and dial tone connection are handled differently.

The signal generated by the calling Centrex line causes the line link frame to ask the dial tone marker for a connection to an originating register. When the connection is established, the originating register sends dial tone to the calling Centrex line as a signal to begin dialing.

The calling Centrex line dials "9" into the originating register and waits for a second dial tone or will continue to hear the initial dial tone.

The originating register determines, from the digit 9, that the call will complete outside of the customer group and will not break dial tone or send a second dial tone as a signal to start dialing the number of the called party. The remainder of the operation is the same as for the basic customer services. When these calls require the use of automatic message accounting facilities, they are handled the same as any other call which requires the use of these facilities.

E. DIRECT-INWARD-DIALED CALLS (INCOMING AND INTRAOFFICE)

Direct-inward-dialed calls, both incoming and intraoffice, are handled the same as regular incoming and intraoffice calls.

F. INTRACUSTOMER GROUP CALLS

Intracustomer group calls are handled essentially the same as intraoffice calls. For intracustomer group calls, however, the calling Centrex line dials only the four or five digit number of the called Centrex line. When the originating register receives the digits of the called number, it connects to a completing marker and passes the digits to it along with a translation mark which informs the completing marker that it will receive only four or five digits. At the same time, the originating register line memory frame passes the calling Centrex line's line link frame termination and class-of-service to the completing marker. Then the completing marker which receives the digits, selects an intraoffice trunk and proceeds to establish the transmission path the same as for an intra-office call. Before the transmission path connection is established, however, the completing marker matches the class of service of the calling line. If both classes of services are identical, the completing marker is satisfied that the called line is in the same customer group as the calling line and establishes the transmission path connection.

G. LISTED DIRECTORY NUMBER CALLS (LDN)

LDN calls originate from a customer outside of the customer group and complete to a Centrex attendant.

The customer places an LDN call when he wished to obtain the number of a Centrex line; when he wishes to be connected to a Centrex line and doesn't know the seven digit number required for direct-inward-dialing; and when he wishes any of the various services previously available from a PBX operator. In Centrex CO operation the attendant may be assigned to an attendant console or a 608 type switchboard.

I. LDN CALLS TO AN ATTENDANT EQUIPPED WITH A CONSOLE

These calls are handled similar to direct-inward-dialed calls. However, the incoming or intraoffice trunk is connected to an attendant trunk instead of to a Centrex line.

The attendant trunk is assigned two link frame appearances and may connect either to a specific console or through the Centrex position link frame to any of a number of consoles. One of the line link frame appearances enables the attendant to receive LDN calls, and to initiate the dial transfer operation, and the other appearance enables the attendant to originate calls from the console.

(a) Attendant trunk connects to a specific console.

When the connection between the attendant trunk and the incoming or intraoffice trunk is established, the attendant trunk signals the attendant by flashing a lamp at the console.

(b) Attendant trunk connects to a console through the Centrex position link frame.

When the connection between the attendant trunk and the incoming trunk is established, the attendant trunk requests the Centrex position link frame to connect it to a console. The Centrex position link frame selects an idle console and connects the attendant trunk to it. The attendant trunk then signals the attendant by flashing a lamp at the console.

J. TRANSFER CALLS

In Centrex CO operation several types of transfer calls can be handled. These types of calls include dial transfer by a Centrex line to another Centrex line, dial transfer by a Centrex line to an attendant, and attendant controlled transfer.

K. CALL TRANSFER INDIVIDUAL - BY A CENTREX STATION TO ANOTHER CENTREX STATION

This type of transfer enables a called Centrex line (station B) to transfer a call from the calling customer (station A) to another Centrex line (station C) without the aid of an attendant.

This section divides the method of operation for dial transfer calls into the following five segments:

1. Transfer Request Connection.

2. Transfer Register Request.

3. Line Identification.

4. Transfer Dial Tone Connection.

5. Transfer Transmission Path Connection.

Incoming and intraoffice calls can be transferred but intermarker group calls cannot. Since the method of operation is the same for transferring both incoming and intraoffice calls, only incoming calls will be discussed.

1. Transfer Request Connection

The transfer request connection includes both the original transmission path connection between the incoming trunk and station B and a connection between the incoming trunk and a transfer trunk through the transfer line link and transfer trunk link frames. When station B desires to transfer a call to station C, he flashes his switchhook as a signal to the incoming trunk that the call is to be transferred. (The incoming trunk has both a trunk link frame appearance and a transfer line link frame appearance.)

Upon receipt of the signal, the incoming trunk causes the transfer line link frame to connect to a dial tone marker through a transfer line link marker connector. The transfer line link frame, through this connection, asks the dial tone marker for a connection to a transfer trunk.

The dial tone marker connects to the transfer trunk link frame through the transfer trunk link connector and selects an idle transfer trunk (the transfer trunk also has a regular trunk link frame appearance). The dial tone marker then connects the transfer trunk to the incoming trunk through the transfer trunk link and transfer line link frames. (Junctor grouping frames are not used

with transfer line link and transfer trunk link frames.) The transfer line link frame also passes the trunk link frame number of the incoming trunk to the dial tone marker which in turn passes it to the transfer trunk where it is stored for subsequent use.

2. Transfer Register Request

The transfer trunk requests its associated transfer register link frame to connect it to a transfer register. When the connection is established, the transfer trunk passes both its own trunk link frame number and the incoming trunk's trunk link frame number to the transfer register where they are both stored for subsequent use.

3. Line Identification Connection

The line identification connection includes the original transmission path connection between the incoming trunk and station B, a connection between the line identification power supply and the incoming trunk, and a connection between the line link frame which contains station B's line termination and the transfer line identification frame.

The transfer register connects to the transfer line identifier frame through the transfer register identifier connector and requests an identification of station B's line termination on the line link frame. At the same time, the transfer register causes the transfer register identifier connector to signal the transfer trunk that a line identification is to be made.

The transfer trunk signals the incoming trunk, through the transfer trunk link and transfer line link frames, to connect the line identification power supply to station B's line link frame termination through the original transmission path connection.

The line identifier power supply then supplies an identifying signal to the line link frame termination of station B. The line link frame uses this signal to connect to the transfer line identifier frame. The transfer line indentifier

frame scans the terminations on this line link frame and when it detects the signal through a termination, it passes the location of it to the transfer register frame.

When the line identification connection is established, the transfer trunk causes the incoming trunk to remove station A from the transmission path and place him on hold.

4. Transfer Dial Tone Connection

When the transfer register receives the location of station B's line link frame termination, it connects to a completing marker through the transfer register marker connector and passes both this information and the trunk link frame number of the transfer trunk to it.

The completing marker now releases the original transmission path connection between the incoming trunk and station B and establishes the transfer dial tone connection between the transfer trunk and station B through the trunk link, line link, and junctor grouping frames. When the completing marker establishes this connection it receives the class of service of station B's line link frame termination and passes it to both the transfer trunk and transfer register where it is stored for subsequent use. The completing marker then releases from the call and prepares to handle other calls.

The transfer register, having previously been connected to the transfer trunk through the transfer register link frame, sends dial tone over the transfer trunk to station B as a signal to begin dialing the number of station C.

5. Transfer Transmission Path Connection

The transfer transmission path connection is between the incoming trunk and station C through the trunk link, line link, and junctor grouping frames.

This connection along with the portion of the transfer request connection between the incoming trunk and the transfer trunk and the portion of the transfer dial tone connection between the transfer trunk and station B, will permit private consultation between stations B and C.

When the transfer register receives all the digits of the number, it again connects to a completing marker through the transfer register marker connector. The transfer register then passes station C's number, station B's class-of-service and the trunk link frame number of the incoming trunk to the completing marker. The completing marker obtains the line link frame termination of station C from the number group frame and establishes the transfer transmission path connection. The completing marker then causes ringing to be applied to station C and releases from the call. Although the transfer transmission path has been established, station A is retained on hold by the incoming trunk and is unable to talk to station C. Private consultation, however, is possible between stations B and C.

Station B informs station C that station A wishes to talk to him. If station C agrees to talk to station A, either station B or C flashes the switchhook as an indication to the incoming trunk to remove station A from hold and to add him to the transmission path (add-on).

Station B now either releases from the call or remains in the path and engages in a three-way conversation with stations A and C. If station C does not answer or his line is busy, station B flashes his switchhook as an indication to the incoming trunk to remove station A from hold and reconnect his to station B. This connection is established through the path used by station B for private consultation with station C. The transfer transmission path connection between the incoming trunk and station C, however, is released.

If either station B or station C disconnects from the call during conversation, the associated portion of the transmission path is released. If station C wishes to transfer station A to another Centrex line, he flashes his switchhook and the complete dial transfer operation is repeated.

If station B wishes to retransfer station A to another Centrex line, when station C disconnects from the call, he flashes his switchhook as a signal to the transfer trunk to originate the retransfer. Since the identification of the line termination of station B has already been accomplished during the first request, that portion of the operation is not repeated.

L. CALLS TRANSFERRED TO AN ATTENDANT

This type of transfer enables station B to transfer a call to an attendent. Like an LDN call, the attendant may be equipped with a call director, a regular station set, or a console.

1. Calls Transferred to an Attendant Equipped with a Call Director or Regular Station Set

Station B initiates a transfer to the attendant in the same manner as a transfer to station C. However, when the transfer dial tone connection is established and dial tone is returned to station B by the transfer register, station B dials the digit "0" instead of the last four or five digits of the listed directory number.

The completing marker, when it receives the digit "0", generates the last four or five digits of the attendant's listed directory number and obtains from the number group frame both the line link frame termination and an indication that this termination is a listed directory number. The completing marker signals the incoming trunk to remove station A from hold and establishes the transfer transmission path between the incoming trunk and the attendant.

Station B informs the attendant that station A wishes to be transferred and disconnects from the call.

The attendant flashes her switchhook and completes the transfer the same way a regular Centrex line (station C) completes a second transfer.

2. Calls Transferred to an Attendant Equipped with a Console

These calls are handled similar to the calls transferred to an attendant equipped with a call director or regular station set.

The transfer transmission path connection, however, is between the incoming trunk and the attendant trunk. The attendant trunk connects to the console and flashes the attendant the same as during an LDN call.

Also, the attendant, instead of flashing the switchhook, to initiate the second transfer, depresses a start in key on her console.

M. ATTENDANT CONTROLLED TRANSFER CALLS

A Centrex CO office may serve customer groups which permit calls to be transferred only by an attendant. Although Centrex lines in these customer groups cannot use the dial transfer method to transfer a call to an attendant or other Centrex lines, they can transfer a call to an attendant by merely flashing the switchhook.

When station A requests to be transferred, station B flashes his switchhook as an indication to the incoming trunk that he wishes to make a transfer. The transfer request, line identification, and transfer dial tone connections are established the same as for a regular dial transfer call.

When the completing marker establishes the transfer dial tone connection, it determines from station B's class of service that he is unable to complete the transfer by dialing and signals the transfer register that the call will be transferred by an attendant. The completing marker then releases from the call.

When the transfer register receives the signal from the completing marker, it withholds dial tone from station B and again connects to a completing marker through the transfer register marker connector.

The transfer register then generates a digit "0" and passes it to the completing marker along with the trunk link frame number of the incoming trunk and station B's class of service.

When the completing marker receives the digit "0" it establishes the transfer transmission path in the same way it establishes the path when station B initiates the transfer by dialing "0". The remainder of the call and the subsequent transfer by the attendant, also are handled the same as when station B indicates the transfer by dialing "0".

N. CENTREX CU OPERATION

In Centrex CU operation, a PBX is located on the customer's premises and functions with a No. 5 Crossbar marker group to provide the Centrex facilities.

The PBX, however, must be arranged to accept direct-inward-dialing before it can realize the full capacities of these facilities.

Calls from Centrex lines that are assigned to a Centrex CU are handled the same as calls from PBX extensions assigned to a PBX which does not have access to the Centrex facilities.

The PBX may be assigned either a separate office code or groups of four or five digit numbers within an office code which is shared with other PBX's or regular customers.

At the present time, only the PBX attendant can transfer calls.

O. PBX ASSIGNED A SEPARATE OFFICE CODE

This arrangement permits direct-inward-dialing calls, either incoming, intraoffice, or LDN calls, to be switched through the No. 5 Crossbar marker group similar to a tandem call. The outgoing dial pulse sender passes the digits to the selectors of the PBX over regular outgoing trunks.

However, the number of PBX's which can be served by a No. 5 Crossbar marker group is limited by the marker group capacity of six office codes.

P. PBX ASSIGNED GROUPS OF NUMBER WITHIN A SHARED OFFICE CODE

This arrangement requires line link pulsing facilities which are described in another section of this specification. The number of PBX's which can be served by a No. 5 Crossbar marker group is limited only by the marker group capacity of 40,000 numbers.

3.9 ADDITIONAL CUSTOMER SERVICE - LINE LINK PULSING

Line link pulsing (LLP) facilities enable PBX's which are served by a No. 5 Crossbar marker group to receive direct-inward-dialed calls to the individual PBX extensions.

These facilities are used in marker groups which are not arranged for Centrex operation and also may be used in marker groups arranged for Centrex operation when a PBX customer desires to retain his PBX and use it as a Centrex CU.

The fundamental capacity of a No. 5 Crossbar marker group arranged for line link pulsing is essentially the same as a marker group arranged for basic customer service. However, a maximum of 30 customer line appearances per line link frame may be used for line link pulsing lines to PBX's.

Two methods of operation are used to handle calls which require line link pulsing facilities. When the PBX extensions are not indentified in groups of one hundred or one thousand numbers, the completing marker uses the number group frame twice. However, when the PBX extensions are identified in groups of one hundred and one thousand numbers, the completing marker uses the numbers group frame only once.

3.10 CALLS WHICH REQUIRE THE NUMBER GROUP FRAME TO BE USED TWICE

The transmission path for these calls is between the incoming trunk (intraoffice or intermarker group trunks may also be used) and a line link pulsing line through the trunk link, line link, and junctor group frame.

This path is established the same as the paths for calls to regular customer lines. However, additional signaling paths are required to pass the digits of the called PBX extension to the PBX.

When the completing marker receives the digits of the dialed number it proceeds to obtain a translation of it from the number group frame the same as if the call were to complete to a regular customer line.

The number group frame, however, determines that the called number terminates at a PBX and requires the use of the LLP facilities. It then passes to the completing marker the proper route to the PBX and the number of digits that are to be outpulsed.

The completing marker with the aid of its LLP frame generates a four-digit number that represents a group of line link pulsing lines which connect to the PBX and passes it to the number group frame.

The number group frame, upon receipt of this number selects an idle LLP line in the group and passes its line frame location, along with an identification of its associated LLP sender group, back to the completing marker.

The completing marker connects to an idle LLP sender within the sender group through the outgoing sender connector frame and passes to it both the last four-digits of the called number and the number of digits to be outpulsed to the PBX. If the four-digit number is an LDN number, the number group frame signals the completing marker that no digits are to be outpulsed. The completing marker generates a digit "0" and passes it to the LLP sender with instructions to outpulse it instead of the four-digits which were previously passed.

The completing marker also establishes the transmission path between the incoming trunk and the LLP line and connects the LLP sender at the LLP sender link frame. The completing marker then releases from the call.

When the PBX signals the LLP sender that it is ready, the LLP sender outpulses the proper number of digits to it. (The LLP sender will outpulse the full four-digits or the last one-, two-, or three-digits.)

3.11 CALLS WHICH REQUIRE THE NUMBER GROUP FRAME TO BE USED ONCE

These calls are handled the same as calls to PBX's which place restrictions on terminating service with the exception that the completing marker uses the number group frame only once.

Instead of passing the called number to the number group frame, the completing marker determines, from the called number that the call requires LLP facilities. It also determines from the called number the proper route to the PBX and the number of digits to be outpulsed to the PBX.

The completing marker, with the aid of its LLP frame, generates the four-digit number which represents the group of LLP lines to the PBX and passes it to the number group frame.

The remainder of the call is handled the same as a call which requires the number group frame to be used twice.

3.12 NO. 5 CROSSBAR SYSTEM - FOUR-WIRE NETWORK

The four-wire network shown in Figure 8-22 is primarily a private switching network which enables calls to be handled over high-quality four-wire transmission paths through the No. 5 Crossbar equipment. It may be used to handle normal voice, encrypted voice, and high speed data traffic and, when used for special instructions, can be arranged to handle calls on either a camp-on or preemption basis.

The traffic handling capacity of an individual four-wire or a combined two-wire four-wire marker group is essentially the same as the capacity of a two-wire marker group. Although the total equipment capacity of a combined marker group is the same as a two-wire marker group, the capacity of an individual four-wire marker group is smaller.

A. TRANSMISSION FACILITIES

Two grades of transmission are available in the four-wire network. Voice-grade transmission is used for the basic types of calls while special-grade transmission is required for encrypted voice and data machine calls and may also be used for the basic types. Voice-grade trunk groups connect to conventional carrier and repeater facilities while special-grade groups connect to more sensitively balanced and equalized facilities.

B. METHOD OF OPERATION

Both the four-wire and two-wire networks handle the basic types of call essentially the same. The dialing and transmission paths in the four-wire network, however, require four-wire line link, trunk link, and junctor grouping frames as well as four-wire originating and incoming registers, trunks and outgoing senders instead of the corresponding two-wire frames and units. The other frames and units are used in both networks.

In addition to the basic types of calls, the four-wire network can be arranged to handle encrypted voice and data machine calls for all customers and can be arranged to handle calls on a camp-on or preemption basis for special customers.

An encrypted voice or a data machine call requires the use of a trunk assigned to a special grade trunk group for access to the proper carrier and repeater facilities. The originator may or may not dial a control digit before he dials the directory number when he desires to place these types of calls.

The control digit indicates to the marker that a trunk to the connecting office is to be selected from the special grade trunk group. The originator may or may not also dial a control digit if he desires preemption or camp-on treatment of this call.

If this digit indicates that the call required preemption treatment and the marker finds that all trunks are busy it will disconnect an existing call between the two offices and seize the idled trunk to establish the required transmission path.

If this digit, however, indicates that the call requires camp-on treatment, the marker will attempt to select an idle trunk to the connecting office. If it finds that all trunks are busy, it will return the call to the originating register and establish a connection at the register priority link frame between the originating register and all trunks in the group. The register monitors the trunks and, when one becomes idle, seizes a completing marker and again requests a transmission path. The marker will attempt to select the idle trunk and if successful will proceed to establish the transmission path. If however, the

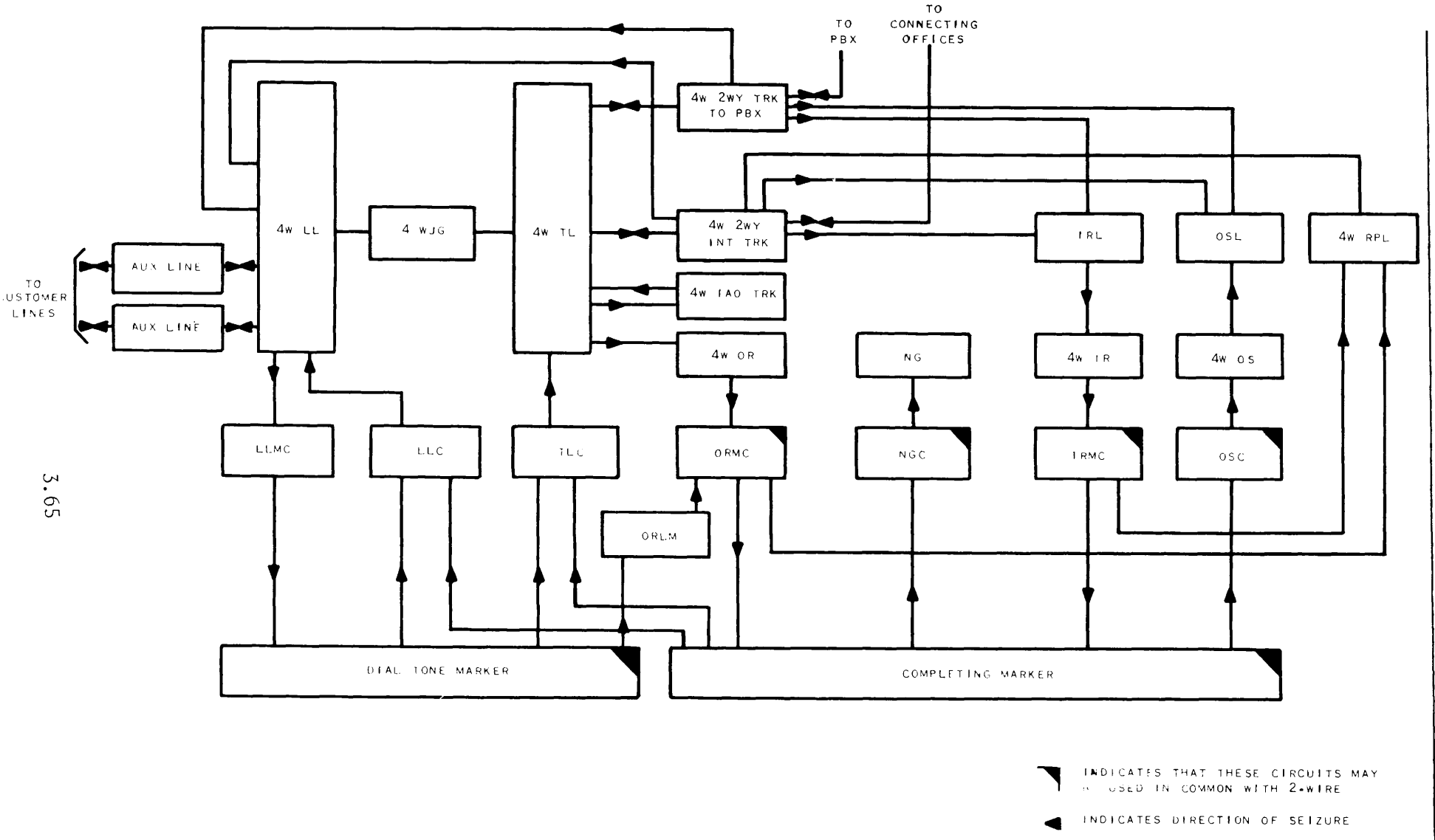


Figure 3.22 Additional Customer Service 4-wire

marker finds that all trunks are still busy it will again return the call to the register and reestablish the connection at the register priority link frame. This process will be repeated until the marker successfully selects a trunk.

The same basic operation is used for calls from a connecting office which are to be switched through a four-wire office. In this type of call, however, the marker returns the call to the incoming register and establishes the connection at the register priority link frame between the incoming register and the trunks of the group to the connecting office.

When an idle trunk is finally selected the marker establishes the transmission path between the line link frame appearance of the incoming trunk and the trunk to the connecting office.

C. FOUR-WIRE FRAME DESCRIPTIONS

The four-wire frames are divided into the same groups as the frames used for basic customer services in the two-wire network (two-wire frames).

This section describes briefly only the equipment used specifically in the four-wire network.

Connectors, dial tone and completing markers, and various test and maintenance frames are used in both networks. Variations in this equipment for operation in the four-wire network are optional features in the equipment specifications.

D. FRAMES IN THE TRANSMISSION PATH

1. Four-Wire Line Links

The function of the four-wire line link frames is the same as the function of the two-wire line link frames. The four-wire line link frame, however, uses two pairs of leads in the transmission path instead of a single pair. Each pair is used for transmission in only one direction.

The lines or trunks, with line link frame appearances, terminate on verticals of line switches and the junctors terminate on verticals of junctor switches. The horizontals of line and junctor switches are connected in a standard crossbar link pattern which gives the lines full access to junctors.

Both basic 190 line (two-bay) and basic 190 line (one-bay) four-wire line link frames are available.

The basic 190 (two-bay) four-wire line link frame is a double bay frame which contains crossbar switches and surface wired units of general purpose and line relays. This frame gives 190 lines access to its own 100 junctors and an additional 90 lines access to the 100 junctors on the basic 190 line (one-bay) frame.

The basic 190 line (one-bay) four-wire line link frame is a single bay frame which also contains crossbar switches and surface wired units of general purpose and line relays. This frame gives 100 lines access to 100 junctors.

Although the two-bay frame may be used by itself when an odd number of line link frames is required, the one-bay frame must be associated with a two-bay frame to attain its full capacity of 190 lines.

2. Four-Wire Trunk Links

The function of the four-wire trunk link frames is the same as the function of the two-wire trunk link frames. The four-wire frames, however, use two pairs of leads in the transmission path instead of a single pair. Each pair is used for transmission in only one direction.

The trunks and originating registers terminate on the horizontals of trunk switches and the junctors terminate on the horizontals of junctor switches. The verticals of the trunk and junctor switches are connected in the standard crossbar link pattern which gives all junctors full access to all trunks.

The basic four-wire trunk link frame is a double bay frame which contains crossbar switches, small fields of cross connection terminal strips, units of multicontact relays, and surface wired units of general purpose relays. This frame gives 100 four-wire trunks access to 200 junctors.

The four-wire supplementary trunk link frame is a single bay frame which contains crossbar switches, units of multicontact relays, and surface wired units of general purpose relays. This frame gives an additional 100 trunks access to the 200 junctors of the basic frame.

The four-wire extension trunk link frame is a single bay frame which contains primarily crossbar switches. This frame gives the trunks assigned to the basic and supplementary frames access to an additional 200 junctors.

3. Four-Wire Junctor Grouping Frames

The four-wire junctor grouping frames consist of pairs of two-wire junctor grouping frames. The frames in the pair used for single trunk link frame operation are designated four-wire junctor grouping frames and four-wire extension junctor grouping frame. The frames in the pair used for paired trunk link frame operation are designated four-wire supplementary junctor grouping frame and four-wire supplementary extension junctor grouping frame. The four-wire junctor grouping and four-wire supplementary junctor grouping frames terminate the T, R and S leads of the junctors and the four-wire extension junctor grouping and four-wire supplementary extension junctor grouping frames terminate the T1 and R1 leads.

These frames are single bay frames which contain terminal strips and jumper rings for retaining the wire used for running the jumpers.

4. Four-Wire Trunks

Various four-wire trunks are available for use specifically with the four-wire switching network. These trunks include four-wire intraoffice trunks and four-wire two-way intertoll trunks.

Four-wire trunks are surface wired units consisting of from one to eight mounting plates of general purpose relay equipment.

E. FRAMES IN THE CONTROL PATH

1. Completing Marker Four-Wire

The function of the four-wire frame is to provide the additional control and translation facilities which enable the completing marker to perform its functions in the four-wire switching network.

The frame is a single bay frame which contains fields of cross-connection terminal strips and surface wired units of general purpose relays.

2. Four-Wire Originating Register

The basic function of the four-wire originating register is the same as the two-wire originating register. The four-wire originating register, in addition, can be arranged to signal the marker and to perform additional tasks when the call requires camp-on or preemption treatment. Like the two-wire originating register, the four-wire originating register can accept either dial pulses from a rotary dial set or TOUCH-TONE pulses from a TOUCH-TONE set.

The four-wire originating register consists of surface wired units of general purpose relays.

The four-wire originating register frame contains a maximum of eight originating registers and associated multicontact relay assemblies for assigning each register to one of a possible three originating register marker connectors.

3. Four-Wire Incoming Register

The basic function of the four-wire incoming register is the same as the function of the two-wire incoming register. The four-wire incoming

register, in addition, can be arranged to signal the marker and to perform additional tasks when an incoming call requires camp-on or preemption treatment.

Only four-wire incoming registers arranged to accept multifrequency pulses are available.

The four-wire incoming register consists of surface wired units of general purpose relays.

4. Auxiliary Originating Register - Incoming Register Marker Connector

The function of the auxiliary originating register - incoming register marker connector frame is to provide connections between the completing markers and the four-wire originating and four-wire incoming registers in addition to those provided by the basic originating register and incoming register marker connector frames. This frame is a single bay frame which contains multicontact relay assemblies.

5. Four-Wire Outgoing Sender

The basic function of the four-wire outgoing sender is the same as the function of the two-wire outgoing sender. The four-wire outgoing senders, however, can handle calls which originate in the four-wire switching network and complete to a two-wire network, in the same marker group, in addition to calls which both originate and complete in the four-wire network. Calls which complete to the two-wire network in the same marker group may either complete to a local customer or may be switched through the two-wire network on a tandem basis.

Only a four-wire outgoing multifrequency sender is used for basic operation in the four-wire switching network.

The four-wire outgoing sender consists of surface wired units of general purpose relays.

6. Register Priority Links

The function of the register priority link frame is to give four-wire originating and incoming registers access to the group busy leads of the various four-wire trunk groups when a call requires camp-on treatment. The registers monitor the appropriate trunk groups and signal the completing marker, when a trunk becomes idle, to make another attempt to establish a transmission path.

F. FOUR-WIRE MAINTENANCE AND TEST FACILITIES

The same facilities which are used in the two-wire switching network are used in the four-wire switching network. However, four-wire register and senders are tested only with the manual test set facilities. The variations which are required to permit operation with the four-wire switching network are covered in the individual equipment specifications.

G. ADDITIONAL CUSTOMER SERVICE - FOUR-WIRE DIRECT-INWARD-DIALING

Four-wire direct-inward-dialing (DID) enables a four-wire marker group to provide direct-inward-dialing to a step-by-step PBX extension and permits direct outward dialing from a PBX extension to the four-wire marker group, also shown in Figure 3-22.

The PBX in addition to being arranged for DID, must also be arranged to convert the two pairs of wires in the normal four-wire transmission path to the single pair available at the PBX.

The capacity of a marker group arranged for four-wire direct-inward-dialing is the same as the capacity of a marker group arranged for four-wire switching without direct-inward-dialing.

H. METHOD OF OPERATION

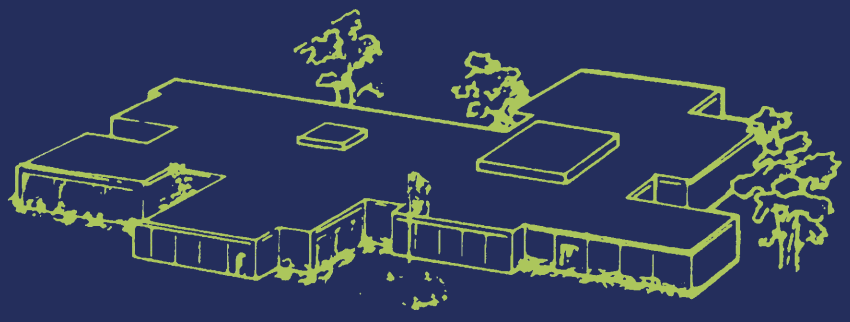
The transmission path for a call which completes directly to a PBX extension is through a four-wire line link frame appearance of a four-wire two-way intertoll trunk and the four-wire trunk link frame appearance of a four-wire two-way trunk to a PBX.

If the call to a PBX is originated by a customer whose line terminates on a four-wire line link frame in the same marker group, the transmission path is between the four-wire line link frame appearance of the line and the four-wire trunk link frame appearance of the four-wire two-way trunk to a PBX.

The four-wire two-way trunk to a PBX has both a four-wire line link frame and a four-wire trunk link frame appearance. The four-wire line link frame appearance enables the PBX extension to originate calls to the four-wire marker group and the four-wire trunk link frame appearance enables a call from a four-wire marker group to be direct-inward-dialed to the PBX extension.

The transmission path for calls which are originated by a customer line in the four-wire marker group is established the same as the path for outgoing calls. The path for calls which originate in a connecting marker group is established the same as the path for other calls which are switched through the four-wire marker group on a toll switching basis.

For this transmission path, however, the completing marker selects a four-wire outgoing dial pulse sender instead of a four-wire outgoing multifrequency sender to match the pulsing requirements of the PBX.



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