NO. 5 CROSSBAR SYSTEM
GENERAL DESCRIPTIVE INFORMATION

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

TABLES

CONTENTS PAGE

FIGURES

CONTENTS PAGE

1. GENERAL

1.01 This section describes in general terms the No. 5 Crossbar System and its equipment components.

1.02 The principal features of the No. 5 Crossbar System are as follows:

(a) ***Flexibility:*** The flexibility of the No. 5 Crossbar System allows it to be used economically in comparatively small offices as well as large offices. It can handle the basic types of calls, can serve as a tandem or toll switching center, and can be arranged to serve as a local automatic message accounting (LAMA) office or to serve other offices as a centralized automatic message accounting (CAMA) office.

(b) ***Common Control:*** The switching of traffic in an office is controlled by certain units of equipment which are common to all switching frames. This arrangement allows a few switching circuits to set up the call, leaving the common circuits available to control the switching of other calls. These control circuits are equipped with self-checking and service safeguarding features.

(c) ***Methods of Charging:*** Automatic message accounting (AMA) is especially well suited for operation with a No. 5 crossbar office. This method makes a permanent record of charge data on paper or magnetic tape and requires very little manual operation. No. 5 crossbar offices are arranged for LAMA or CAMA with operator or automatic identification of the calling customer. Message register and coin service, including coin zone dialing, can also be provided by the No. 5 crossbar offices.

(d) ***Dialing Capacity and Classes of Service:*** No. 5 crossbar offices are designed to use the nationwide numbering plan (area and office codes), which provides for customer dialing of station calls, special toll calls, reservations for future use of special 2-digit codes, and dialing procedures for reaching local and toll information and other special services. One hundred classes of service are provided; these include coin and

noncoin, flat rate and message rate, and individual and party lines. (See Part 7, Glossary.)

(e) ***Tandem and Toll Considerations:*** Tandem and toll center switching features can be provided in a No. 5 crossbar office. Such an office serves as a tandem office and toll center as well as a local office.

(f) ***Pulsing Considerations:*** This system can operate with present dial systems with their particular types of pulsing which consist of dial, revertive, panel call indicator, or multifrequency. However, multifrequency pulsing is generally more efficient than other types of pulsing and is used by the No. 5 crossbar office whenever practicable. Table A lists the types of pulsing for various combinations of No. 5 crossbar and connecting offices.

(g) ***Maintenance:*** The No. 5 Crossbar System contains a number of self-checking features. The marker (a unit of common control equipment) has access to most of the circuits in an office and it is able to determine the performance of the different circuits. When a trouble is encountered in an office equipped with a master test frame, the marker will cause the trouble recorder to make a permanent record on punched cards. If the office is equipped with an office test frame, the marker will cause the trouble indicator connector circuit to indicate the trouble on lighted lamps. The punched cards or lighted lamps can be used by the maintenance force as an aid to locate the trouble.

2. SWITCHING PRINCIPLES

GENERAL

2.01 Part 2 describes how the No. 5 crossbar office provides telephone service to the customers. The switching principles are described in terms of the switching frames.

2.02 The basic element in any crossbar system is the crossbar switch. Talking connections through switching frames are made by these crossbar switches.

2.03 The crossbar switch is essentially a relay mechanism consisting of 10 horizontal paths and 10 or 20 vertical paths, depending on the size of the switch unit. Any horizontal path can be connected to any vertical path by means of contacts controlled by the operation of relay magnets. The points of connection are known as crosspoints. The switch with 10 vertical paths has 100 crosspoints and is called a 100-point switch; the switch with 20 vertical paths has 200 crosspoints and is called a 200-point switch. A partial perspective view of a crossbar switch is shown in Figure 1.

2.04 ***Horizontal Paths:*** There are five horizontal selecting bars mounted across the face of each switch. Each selecting bar has flexible selecting fingers attached to it, one finger for each vertical path. The bars are rotated slightly by the operation of a selecting magnet to cause the selecting fingers to go either up or down.

2.05 ***Vertical Paths:*** Ten or 20 vertical units are mounted on the switch and each unit forms one vertical path. Each unit operates under control of a holding magnet and has ten groups of contacts (one for each horizontal path).

2.06 Each group of contacts may consist of three to six pairs of contact springs. A switch is classified according to the number of crosspoints and pairs of springs, for example, a 200-point, 3-wire crossbar switch.

2.07 ***Operation of the Crossbar Switch:*** The selecting fingers, in the released position, lie horizontally between two groups of contacts (Fig. 2). When a selecting magnet operates, the associated selecting bar is rotated and the selecting fingers lie in front of a group of contacts of each vertical unit.

2.08 The holding magnet of the vertical path to be connected to this horizontal path then operates its holding bar. Using the selecting finger as a wedge, the holding bar causes the group of contacts in front of the selecting finger to operate, thus connecting the horizontal and vertical paths. Both selecting and holding magnets must be operated in order to close a crosspoint. The other groups of contacts on this vertical unit do not operate since there is no selecting finger between the contacts and the holding bar.

2.09 After the operation of the holding magnet, the selecting magnet is released thereby returning the horizontal bar and the selecting fingers to normal, except those actively held by operated holding magnets. The flexible finger used

to establish a connection remains wedged against the contacts by the holding bar, thus keeping the contacts closed. When the holding magnet releases, the connection is released and the selecting finger returns to normal. The selecting finger tends to oscillate when released and could cause a false connection if a holding magnet operated while the finger was oscillating. Damping cones are provided on the holding magnet armature to act in conjunction with the damping springs to minimize these oscillations.

MAJOR SWITCHING FRAMES

2.10 All No. 5 crossbar office connections in the talking paths are established through line link switching frames and trunk link switching frames. Lines are connected to the switches on the line link frames, and trunks and register circuits are connected to the switches on the trunk link frames. These frames interconnect over junctors that are attached to junctor switches on the line link and trunk link frames. These switching operations are controlled by the common control equipment which includes markers and associated connectors.

2.11 Figure 3 is a simplified diagram showing the relationship of the switching frames and common control equipment.

A. Line Link Frames

2.12 The crossbar switches on the line link frame (Fig. 4) are divided functionally into line switches and junctor switches. Customer lines, auxiliary line circuits, and some trunk circuits are connected to the line switches and junctor circuits are connected to the junctor switches. Line links are provided for interconnecting the line and junctor switches.

Line Switches

2.13 The basic line link frame is available in two sizes: 190 lines and 290 lines. The 290-line frame most commonly used is a 2-bay frame with each bay mounting ten 200-point crossbar switches. One and one-half switches on each level are used as line switches. Each vertical on a line switch is used for a customer line, an auxiliary line, a tandem trunk, an intercept line, line link pulsing, or a toll trunk, except one which is used for no-test access to the remaining 29. One advantage of using a vertical for a customer line is that the off-normal springs of the holding magnet can be used as a cutoff relay. The half switches not used as line switches are used as junctor switches, thus providing ten verticals for terminating the junctors on each level. The line relays, one for each customer line, are mounted at the top of the line link frame.

2.14 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 line link to one horizontal on each of the ten junctor switches. This system of line links permits each line on a line link frame to reach any one of the 100 junctors serving that frame (Fig. 5).

2.15 Any particular line link can be readily traced because the line switch horizontal number of each line link is the same as the junctor switch number and the junctor switch horizontal number of each line link is the same as the line switch number.

Capacity of Line Link Frames

2.16 Since each basic line switch is made up of one and one-half 200-point crossbar switches, the basic line link frame has a capacity of 300 line switch verticals (30 on each level) and 100 line links. However, the actual number of customer lines, auxiliary lines, or trunks on this frame is 290 because ten line switch verticals (one on each level) are required for no-test operation, such as obtaining access to busy lines from the local test desk or verification of busy lines by DSA operators.

2.17 Greater line capacity can be obtained by supplementary bays of switches. The number of lines served by 100 line links can be determined by the average incoming plus outgoing usage (calling rate times holding time) of the lines. To accommodate varying requirements, provision is made for adding supplementary bays to the basic 290-line frame to serve from 340 to 590 lines in steps of 50, 100, or 200 lines.

2.18 A feature of this line link is that the same frame can serve various classes of service. For example, coin, flat-rate, and message-rate customers can have their lines terminating on the same frame. A maximum of 30 classes of service or 60 classes of service (two groups of 30 classes)

can be served in flat-spring-relay type installations and 100 classes of service in wire-spring-relay type installations.

B. Junctors

2.19 Each line link frame has 100 junctor terminations which are used to connect to all trunk link frames in the office. Since each trunk link frame has 200 junctor terminals for connecting to all line link frames, the ratio of line link frames to trunk link frames in an office is generally 2:1. There are no half frames. (In an office with 13 line link frames, there are usually 7 trunk link frames.) However, conditions peculiar to a particular office may cause some variation in this ratio.

2.20 The 100 junctors from each line link frame are divided into approximately equal groups, with one group from each line link frame going to each trunk link frame. The number of junctors in a group depends on the number of trunk link frames in the office. The number of junctors per group is determined by dividing the 100 junctors by the number of trunk link frames. However, there is a limiting factor—for efficient service, no group can contain less than ten junctors.

2.21 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 8 trunk link frames and 16 line link frames, each junctor group contains either 12 or 13 junctors. Figure 6 illustrates the junctor distribution for 2 trunk link frames and 4 line link frames.

2.22 In an office with 11 to 20 trunk link frames, each junctor is multipled to 2 trunk link frames in order to have at least 10 junctors per group. For example, in an office with 20 trunk link frames and 40 line link frames, each junctor group contains 10 junctors. Figure 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.

2.23 In offices with 21 to 30 trunk link frames, each junctor is multipled to 3 trunk link frames. In an office with 60 line link frames, each junctor group contains 10 junctors. Figure 8 illustrates the junctor distribution for 30 trunk link frames and 60 line link frames.

C. Paired Line Link Frames

2.24 Arrangements have been made for paired line link frame operation in No. 5 crossbar offices. This arrangement permits a pair of line link frames to make joint use of their junctors, and as a result, increases the load carrying capacity by approximately 20 percent. Paired line link frame operation can be used only in offices which have a 20:10 ratio of line link to trunk link frames or a larger number of trunk link frames that are paired or tripled so that there are always ten trunk link frame pairs or triples. These pairs or triples do not have to be fully equipped, but if they are not, the efficiency of the arrangement is reduced.

D. Trunk Link Frames

2.25 The trunk link frame is made up of trunk switches, junctor switches, and various miscellaneous circuits. Trunks and originating registers are connected to the trunk switches (Fig. 9). The junctors from the line link frame are connected to the junctor switches. The trunk and junctor switches are interconnected by trunk links which are similar to line links. The trunk links connect the junctor switch verticals to the trunk switch verticals; line links connect line switch horizontal to junctor switch horizontal.

E. Trunk Links and Junctors

2.26 The system of trunk links that permits any outlet or trunk on a trunk link frame to be connected to any one of 200 junctors serving that frame is similar in principle to that used on line link frames. There are 200 trunk links, which is the same as the number of junctors. The junctors are connected to the horizontals of the junctor switches and the trunks to the horizontals of the trunk switches. In order to terminate 20 junctors on the horizontals of one 200-point switch, it is necessary to split the horizontal multiple into left and right half switches. The two half switches thus formed are treated separately. The numbering of the verticals in each half is similar, but they are identified as left and right. Although the trunk switches are not physically split, the numbering of verticals is also on a left and right basis.

2.27 The trunk link distribution is similar to that provided for line link distribution. The vertical number at one end of a link is always the

same as the switch number at the other end of the link. In addition, a vertical on the left half of a switch is always connected to a vertical on the left half of the switch at the other end of the link, and a vertical on the right half of a switch is always connected to a vertical on the right half of the switch at the other end of the link. (See Fig. 10.)

Extension Trunk Link Frame

2.28 When 11 to 20 trunk link frames are involved, each junctor is multipled to 2 trunk link frames in order that each junctor group contains a minimum of 10 junctors. This requirement reduces the junctor capacity of the basic trunk link frames by 50 percent, and it is necessary to provide additional junctor switches for each trunk link frame. These additional switches are mounted on the extension trunk link frame which, if equipped initially, is placed adjacent to the junctor switch bay of the trunk link frame. The extension frame consists of a framework with ten 200-point, 3-wire switches, the same as the junctor switches on the trunk link frame. These switches have a capacity for 200 junctors and with the 200 junctors on the trunk link frame provide a total of 400 junctors for the combination.

2.29 For those offices with more than 40 line link frames or 20 trunk link frames, a second extension trunk link frame is required to provide additional junctors. The junctor switches of one trunk link frame plus those on two extension frames provide terminations for 600 junctors.

F. Trunk Switches

2.30 The ten trunk switches on the trunk link frame are 6-wire switches. They furnish locations for 160 trunks. Each switch has appearances for 16 trunks on 8 levels on horizontals (Fig. 11). On levels 2 through 9, the 6-wire switches of each level terminate on two 3-wire trunks.

2.31 The trunk link is wired to the first three nonmultiple terminals of level 1 and the last three nonmultiple terminals of level 0. Each operation of the trunk switch requires two selecting magnet operations. Either 0 or 1 selecting magnet must be operated to direct the trunk link to the proper 3-wire connection of the vertical, and the selecting magnet associated with one level of levels 2 through 9 where the trunk appears must be operated. The levels 0 and 1 are directing levels. The eight appearances on each switch that are selected by horizontal 0 are called A appearances and those selected by horizontal 1 are called B appearances.

G. Channels

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

2.33 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 frames, the junctor switch number being the same on both ends for each junctor. There are ten line links serving each customer line on the line link frame distributed over the ten junctor switches.

2.34 There are 20 trunk links serving each trunk on the trunk link frame distributed over the 10 junctor switches. Thus, when a line and a trunk for an office consisting of 20 line link and 10 trunk link frames are considered, 10 channels are available for a connection. These channels are numbered according to the junctor switches on which they terminate (A of Fig. 12). An idle channel is selected by testing the 10 channels at the same time. For office sizes smaller than the above, there are more than 10 channels available. For example, in a 10-line link and 5-trunk frame office, 20 channels are provided (B of Fig. 12). Additional tests are required if an idle channel is not found when the first 10 channels are tested.

2.35 The channel number also corresponds to the number of the line switch horizontal on the line link frame, as well as the number of the trunk switch vertical on the trunk link frame.

3. EQUIPMENT ELEMENTS

3.01 The functions and physical appearance of the main equipment elements in a No. 5 crossbar office are briefly described in this part.

LINE LINK FRAMES

3.02 Line link frames contain customer line appearances. All calls to or from a customer are connected through the line link frame. These frames also contain access leads for tandem trunks, toll trunks, line link pulsing trunks, intercept trunks, and test lines.

3.03 Standard line link frames are 2-bay frames providing termination for 290 lines. In addition to the 2-bay frames, there are single-bay supplementary line switch bays containing terminations for 50 lines. When paired line link frame operation is provided, an auxiliary line link frame which mounts ten 200-point crossbar switches must be provided for each pair of line link frames.

TRUNK LINK FRAMES

3.04 Trunk link frames are 2-bay frames which provide terminations for originating registers and trunks on switching frames.

EXTENSION TRUNK LINK FRAMES

3.05 Extension trunk link frames are single-bay junctor switch frames. Extension frames are required in offices equipped with more than 20 line link frames or 10 trunk link frames. The extensions will be provided as follows:

(a) One per trunk link frame for offices with more than 20 line link or 10 trunk link frames

(b) Two per trunk link frame for offices with more than 40 line link or 20 trunk link frames.

When extension and second extension trunk link frames are added, the verticals are multipled so that each trunk has three junctor appearances.

JUNCTOR GROUPING FRAME

3.06 The junctor grouping frame is a single-bay frame containing terminal strips, fanning rings, and rings for jumpers. The junctor grouping frame provides means for terminating the junctors of the line link frames and trunk link frames and for cross-connecting these terminations for equal access to all trunk link frames and all line link frames. One basic junctor grouping frame is provided for each 20 line link frames. Supplementary junctor grouping frames are provided when trunk link frames are paired or tripled and the basic junctor grouping frames are not adjacent.

MARKERS

3.07 Markers perform the major portion of the switching control in an office. Marker action is required on all customer service requests. Markers have access to routing information, customer class-of-service treatment, and other information required to establish transmission paths.

3.08 The quantity of markers in an office depends on the amount of calling traffic handled by the office. A marker group, comprised of markers and their associated equipment units, can serve a maximum of 40,000 customer numbers and 4000 trunk numbers.

3.09 There are three types of markers: combined, dial tone, and completing. The combined marker performs both the dial tone and completing marker functions.

A. Dial Tone Marker

3.10 The principal functions of the dial tone marker are to respond to customer demands for dial tone by establishing a connection between the calling line and an originating register and transferring the calling line location and customer class-of-service information to the originating register.

3.11 The equipment for the dial tone marker is mounted on a single-bay frame.

3.12 A supplementary dial tone marker frame is used as a supplement to the dial tone marker frames when 60 line link frames and 30 trunk link frames are provided in a wire-spring-relay type marker group.

B. Completing Marker

3.13 The completing marker consists of several frames that function together to select and establish a connection between the switching frames for calls originating in, completing to, or switching through the No. 5 crossbar office. The principal functions of the completing marker are as follows:

(a) To determine the proper route for the call from the called number received and the

class of service of the calling customer by use of wire cross-connections placed in the marker.

(b) To connect the calling customer to a trunk or, in the case of incoming or tandem service requests, to connect a trunk to a trunk or a trunk to a customer.

(c) To select an outgoing sender of the proper type when the calling digits indicate a sender is required. The marker then functions to pass digit and trunk information to the sender to be used in transmitting directing information to connecting office equipment.

(d) To determine from area or office code digits if AMA action is required and to transmit information needed for billing purposes to AMA recording equipment.

(e) To connect to the correct number group frame to determine the exact line link location and ringing code of a called number or trunk number.

(f) To recognize circuit busy, channel busy, line busy, vacant numbers, line intercept numbers, trouble conditions, and to control hunting operations in PBX groups.

(g) To provide a start signal to the trouble recorder when abnormally delayed operation or trouble conditions are encountered in order to initiate a permanent card record of the trouble. This card can be used by maintenance personnel to locate and clear the trouble.

C. Marker Special Features

3.14 Two completing markers, 0 and 1, are equipped with special features for handling some test calls. These calls are set up by operators, local test desk personnel, or maintenance personnel or are automatically controlled by timing devices and consist of the following types:

(a) Busy verification originated by a DSA operator or no-test calls originated by test desk personnel

(b) Line insulation test cycles originated locally by maintenance personnel or remotely by test desk personnel

(c) Special hunt calls originated at the local test desk

(d) Line verification tests performed by frame personnel.

3.15 Normal ground and continuity line tests performed on marker calls are canceled during the preceding special tests.

D. Marker Description

3.16 The basic completing marker frames in a No. 5 crossbar office consist of the common equipment frame, the translator and code treatment frame, and the route relay frame.

(a) ***Common Equipment Frame:*** This frame is designated COM EQPT and contains general purpose relays, connection fields, and memory relays to store customer identification information for routing and billing of service requests.

(b) ***Translator and Code Treatment Frame:*** This frame is designated T&CT and functions to translate and route called office codes, screen customers or trunk class of service, and transfer the called numbers to the number group frame.

(c) ***Route Relay Frame:*** This frame is designated RR and provides for route information to a connecting office. It contains provisions for 100 route relays on 4 completing markers.

3.17 Supplementary features are available in no. 5 crossbar offices, and when these features are provided, the following frames are required.

(a) ***Code Conversion Frame:*** This frame is designated CC and enables an office code to be converted to a 2- or 3-digit arbitrary code for routing through offices such as step-by-step tandem or toll centers.

(b) ***PBX Allotter Frame:*** This frame is designated PBX ALLR and serves up to four markers. Lines to large PBXs may be allotted to two or more number groups.

(c) ***Supplementary Service Treatment Frame and Auxiliary Service Treatment Frame:*** These frames are designated SST and AST, respectively. The function of each frame is to increase the number of service treatment relays

from 60 (a basic complement) to 120 with the addition of the supplementary frame or 180 with the addition of the supplementary and auxiliary service treatment frames.

(d) ***Originating Line Identifier Unit:*** This unit is provided in small No. 5 crossbar package offices, where installation of dial tone markers is not economical. The function of the unit is to serve customer requests for dial tone and to identify and transmit the customer location to the completing marker.

ORIGINATING REGISTERS

3.18 The functions of the originating register are to:

(a) Transmit dial tone to the customer

(b) Receive and store the digits of the called number

(c) Allow preliminary translation of the initial office code dialed by the pretranslator

(d) Transfer customer location and called number information to the marker after dialing has been completed

(e) Make 2-party tests to recognize the originating customer for AMA billing information

(f) Perform customer loop tests designed to detect trouble conditions

(g) Accept dial pulses or TOUCH-TONE® frequencies.

Originating register circuits appear on the trunk link frame and connections are established to these circuits by either the dial tone marker or originating line identifier unit.

3.19 The originating register frame is a double-bay frame which can be equipped with eight originating registers. The bay is also equipped with register multicontact relays associated with the marker multicontact relays located on the originating register line memory frame. This 2-bay frame is designated OR.

ORIGINATING REGISTER LINE MEMORY FRAME

3.20 The function of the originating register line memory frame is to register the calling customer line link frame location and class of service and to store this information until required by the completing marker. This frame is a single-bay frame containing multicontact relays and reed-type relays.

PRETRANSLATORS

3.21 The function of the pretranslator is to determine from the second or third digit received by the originating register the number of additional digits that should be received by the register before it attempts to seize a marker. This feature can be applied to all present combinations of office codes or numbering area codes.

3.22 The pretranslator frame is a single-bay frame with space for two pretranslators and two pretranslator connectors which serve up to 144 originating registers. If another frame is necessary, it is provided for one pretranslator and its connector. Two pretranslators are adequate for most marker groups. The arrangements provide for one pretranslator group to serve two marker groups when desired.

FOREIGN AREA TRANSLATORS

3.23 The foreign area translator operates in conjunction with completing markers to permit routing calls to other numbering plan areas if more than one trunk route is available to the numbering area. Arrangements of two frames with three areas each are provided for 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.

NUMBER GROUPS

3.24 The number group translates customer directory numbers and certain trunk numbers into line equipment location. The line equipment location identifies the line link frame location. The number group also supplies the proper ringing combination and other information concerning the number, such as whether or not it is in a terminal hunting group.

3.25 A number group frame serves 1000 consecutive directory numbers. The total amount of directory numbers, in multiples of 1000, to be equipped determines how many number group frames are required. A maximum of 40 number group frames can be associated with one marker group.

OUTGOING SENDERS

3.26 An outgoing sender is used on all calls requiring pulsing to the connecting office. The completing marker transfers the required digits of the called number to the sender connected to an outgoing trunk. The function of the sender is to pulse the digits of the called number to the connecting office. The type of pulses required at the connecting office (step-by-step, panel, manual, ESS, or crossbar) determines the type of sender used to transmit the called number. Therefore, five different types of outgoing senders are provided in a No. 5 crossbar office as follows:

(a) Dial pulse (DP)

(b) Multifrequency (MF)

(c) Revertive pulse (RP)

(d) Panel call indicator (PCI)

(e) Frequency shift pulsing (FSP).

3.27 The outgoing sender frame mounts four senders of one type.

3.28 The MF sender requires an ac supply of six different frequencies. These are used in combinations (2-out-of-6) for each digit (0 through 9) and the start and end signals. One ac supply of each frequency may be provided for all senders, or each wire-spring-relay type sender may contain the ac supply of each frequency in the form of transistorized oscillators.

3.29 The wire-spring-relay type MF sender circuit can also be equipped for ANI operation. For ANI operation, the MF sender functions to:

(a) Outpulse the called number

(b) Connect to an ANI transverter through an ANI transverter connector and transfer the calling line equipment number to the transverter

(c) Receive from the transverter the associated directory number

(d) Outpulse directory number of the calling customer.

OUTGOING SENDER LINKS

3.30 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.

3.31 One sender link frame, designated OSL, mounts ten 200-point crossbar switches. Any or all of the types of outgoing senders (MF, DP, RP, PCI, FSP) and intermarker group senders may have appearances on one sender link frame.

INCOMING REGISTERS

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

(a) Dial pulse (DP).

(b) Multifrequency (MF).

(c) Revertive pulse (RP). (There are two types of revertive incoming registers.)

(1) The local revertive incoming register receives only the four numericals from the originating panel or crossbar office. This register can recognize the "high five" or "low five" incoming group selection to discriminate between the two terminating offices in the marker group.

(2) The tandem revertive pulse incoming register receives from the originating panel or crossbar equipment the office brush and group selectors in addition to the four numericals. The office brush and group selectors are translated into an office code from which the marker determines the routing of the call.

(d) Frequency shift pulsing (FSP).

3.33 The wire-spring-relay type registers mounted on the same frame must be of the same

type. Each MF incoming register has an associated MF receiving unit. These receiving units receive, amplify, and convert the MF pulses to dc pulses which operate the register relays in the associated MF incoming register. These receiving units are mounted on miscellaneous relay racks for flat-spring-relay type registers. These receiving units are mounted on the incoming register frame as part of the associated register for wire-spring-relay type registers.

INCOMING REGISTER LINKS

3.34 The incoming register links connect incoming trunks to incoming registers. Information from incoming trunks to incoming registers is transmitted through these links.

3.35 Wire-spring-relay type incoming register link frames are designated IRL. The eight crossbar switches on this frame provide 160 nonbylink trunks with access to a maximum of ten incoming registers. One, two, or three frames may be used together as one link group with MF, DP, or RP (without bylink) registers. A separate incoming register link group is required for each incoming register with the same type of pulsing. A wire-spring-relay type bylink frame may be equipped with six crossbar switches with provisions for a maximum of 120 trunks and one DP register group per frame.

INTERMARKER GROUP SENDERS

3.36 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 calling the marker and as an incoming register for the called marker.

3.37 If AMA billing is not provided, six senders can be mounted on the single-bay frame which is designated IMGS. If AMA billing is provided, four senders may be mounted on one frame.

CONNECTORS

3.38 A connector is a relay-type switching device for interconnecting two equipment units by a relatively large number of leads.

3.39 A specific method is used to designate connector titles. If a particular type of equipment originates action toward a marker, the connector title includes both the originating and the terminating equipment. For example, the line link marker connector action is originated by the line link frame and terminates in the marker. The originating circuit must be mentioned because many circuits can originate action toward a marker.

3.40 When a marker originates action toward another type of equipment, the connector is named according to where the connector action terminates but does not contain the word marker in the title. Table B lists the principal connectors in a No. 5 crossbar office.

3.41 Connector frames vary in their marker capacity and connector equipment capacity. When the number of markers or connectors exceeds these frame capacities, additional connector frames must be used. These frames are designated supplementary or auxiliary connector frames and an example is the supplementary trunk link connector frame used in offices equipped with or planned for 12 completing and dial tone markers.

3.42 In general, the wire-spring-relay type connector frame capacity is greater than that of its flat-spring-relay type counterpart. This is because the connector control and preference equipment is mounted on separate frames. The equipment mounted on a control frame must be of the same type. For example, the trunk link connector control frame accommodates the equipment for trunk link connectors, and likewise, the number group connector control frame accommodates the equipment for number group connectors. The capacities of the control frames vary according to the type connectors they serve.

3.43 The major connectors now used have been grouped on three basic combined frames for small office installations. These combined frames are as follows:

(a) Line link and trunk link connectors

(b) Number group and outsender connectors

(c) Originating register, incoming register, and line link marker connectors.

The associated control and preference equipment is mounted on the same frames with its respective connectors.

TRUNKS

3.44 Trunks have their switch frame appearances on trunk link frames and carry calls from one office to another and from customer to customer within the office. Various types of trunks are provided to serve the various types of traffic in an office.

3.45 Trunks are mounted on relay rack frames. Those trunks which require ringing, such as intraoffice, incoming, and revertive ringing trunks, usually have ringing selection switches on the same relay rack. Ten trunks can appear on each ringing switch.

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

(a) ***Intraoffice trunks*** handle traffic between customers served by the same marker group. 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.

(b) ***Outgoing interlocal trunks*** are used to transmit calls going 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.

(c) ***Incoming interlocal trunks*** carry the traffic incoming to a No. 5 crossbar office. There are two general types of these trunks, nontandem and tandem. The nontandem-type trunks carry only the calls completing to customers in the office and have only one appearance in the office, 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 crossbar office functions as a tandem switching point. Tandem trunks have two frame appearances 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.

(d) ***Two-way interlocal trunks*** are provided on small trunk groups when it is not economical to use one-way trunk groups. The trunks are arranged for bylink operation with either loop or CS (E and M lead) signaling.

(e) ***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:

(1) Customer-to-customer

(2) Customer-to-trunk

(3) Trunk-to-customer.

(f) ***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.

(g) ***Tone trunks*** are used to give line-busy on intraoffice calls, overflow (paths-busy), partial dial, and vacant code tones. Again there may be coin and noncoin groups of these trunks.

(h) ***Common overflow trunks*** are provided as a final route when all permanent signal holding or noncoin combination tone trunks are busy. This trunk returns a line-busy signal to the calling party.

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

(1) ***One-Way Incoming Trunks:*** These have three frame appearances in an office: two line link frame appearances for calls switched through the No. 5 crossbar office as a toll center and one trunk link frame appearance for calls terminated in the toll center.

(2) ***One-Way Outgoing Trunks:*** These have one trunk link frame appearance for calls outgoing from the No. 5 crossbar office as a toll center and one jack appearance at the

toll switchboard for operator-handled outgoing calls.

(3) ***Two-Way Trunks:*** These have all of the appearances mentioned above. Since interlocal and intertoll trunks employ different supervision and impedance characteristics, one type may not be switched directly to the other type without conversion arrangements.

(j) ***Line link pulsing line circuits*** are used to complete calls from the No. 5 crossbar office, functioning as a regular or centrex office, directly to PBX extensions. This is accomplished by providing a location for a line link pulsing sender link so that a DP sender can outpulse to the PBX switches. These line circuits have a line link frame appearance.

(k) ***Junctor circuits*** are accessory circuits which can be attached by switching to trunks to provide additional features which these trunks do not have. Their functions are as follows:

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

(2) ***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.

(3) ***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 coin service.

(4) ***Coin Zone Junctor:*** In addition to 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.

(5) ***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.

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

(7) ***Off-Net Access Junctor:*** This circuit provides common control switching arrangement (CCSA) customers with local off-net access to complete calls to customers in the Bell System network.

COIN SUPERVISORY CIRCUITS

3.47 Coin supervisory circuits handle all coin operations except those handled by the originating register. In operation, one of these circuits, which are in a common group and are mounted on relay racks, is connected to a trunk that is serving a coin call. The function of this circuit is 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.

3.48 On 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 an operator to come in on the connection.

COIN SUPERVISORY LINKS

3.49 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. Because the holding time of coin supervisory circuits with coin trunks is very short, a group of 10 coin supervisory circuits can serve as many as 480 trunks.

COIN ZONE TRUNK CONCENTRATOR

3.50 When the coin zone operator is located in a remote building, this concentrator may be used to provide for a more economical trunking plan between buildings. The concentrator uses 200-point crossbar-type switches, with the interbuilding trunks appearing on the horizontals and the trunks to be concentrated appearing on the verticals. The concentrator handles a maximum of 30 outgoing trunks to the switchboards.

MESSAGE REGISTER FRAMES

3.51 Calls involving one message unit may be recorded by AMA equipment or on message registers. If used, message registers are mounted on message register frames.

3.52 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.

3.53 Five hundred message registers and 500 associated vacuum tubes are mounted on a message register frame. Where 100 or less message registers are required, a small mounting is available.

FOREIGN AREA TRANSLATORS

3.54 A foreign area translator frame and associated connectors contain circuits which operate in conjunction with the completing markers to permit routing calls to other numbering plan areas if more than one trunk route is available to the numbering area. Arrangements of two frames which can route to three areas each are provided for 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.

ANI TRANSVERTERS

3.55 ANI operation requires that the calling customer directory number be transmitted to the CAMA office. The ANI transverter assists the modified MF sender to meet this requirement. The functions of the ANI transverter are as follows:

(a) To register the calling line equipment number as transferred to it by the outgoing sender

(b) To connect to a translator to have this number converted into the corresponding directory number

(c) To transfer the directory number to the outgoing sender.

3.56 The basic difference between the ANI transverter and the CAMA and LAMA transverters is that this transverter is used for converting line equipment numbers to directory numbers. This circuit does not control the perforation of the AMA tape, as do the other transverters.

ANI TRANSLATORS

3.57 The translators used for ANI operation are the same as those used for LAMA operation. Each translator frame accommodates the equipment for translating 2000 line equipment numbers. As with LAMA, each 2-party line to be served by ANI must have appearances in two translator frames, one appearance for the tip station and one appearance for the ring station.

4. METHOD OF OPERATION

GENERAL

4.01 This part describes, without detailed reference to circuit operations, how the various types of calls in a No. 5 crossbar office are handled. Also described is the operation of a No. 5 crossbar office when it is associated with combined toll and DSA switchboards, when it is associated with certain special features [common control switch arrangement (CCSA), centrex, line link pulsing (LLP), etc], when it has tandem or toll switching features, when it has foreign area translation, and when it is arranged for coin zone dialing.

4.02 The calls in a No. 5 crossbar office are of four general types: intraoffice, reverting, outgoing, and incoming. A dialing connection is established in the office for the first three types of calls as shown in Figure 13.

4.03 An intraoffice call is a call between customers with different customer lines and are served by the same office. The talking connection in the office consists of two channels established between the customer lines through an intraoffice trunk as shown in Figure 14.

4.04 A reverting call is a call between two customers served by the same customer line (party line service). The talking connection consists of the customer line and a reverting trunk as shown in Figure 15.

4.05 A customer who makes an outgoing call to another office is connected through a channel to an outgoing trunk as shown in Figure 16.

4.06 An incoming call to a No. 5 crossbar office is connected to the called customer by means of a channel between the incoming trunk and the called number as shown in Figure 17.

NONCOIN CALLS EXCLUDING MESSAGE CHARGING

A. Dial Tone Connection

4.07 A dialing connection is established between the calling station and an originating register in the central office after the calling customer lifts the receiver from the switch hook. Dial tone, which is the signal to start dialing, is returned to the calling customer from the originating register.

B. Establishing Dialing Connection

4.08 When a customer takes the receiver from the switch hook, the line relay on the line link frame is operated to inform the line link marker connector that a dial tone marker is required. The line link marker connector selects an idle dial tone marker, then transmits to this marker the location of the calling line. The only time the line link marker connector seizes a marker is when a dialing connection is to be established. (See Fig. 18, connection 1.)

4.09 In order to establish a dialing connection between the customer line and an idle originating register, the marker must determine the following:

(a) The class of service and equipment location of the calling line

(b) The trunk link frame location of an idle originating register

(c) That a channel between the line and the register can be obtained.

The calling line class of service and equipment location will be stored in the originating register by the marker for subsequent use on marker intraoffice or outgoing trunk jobs.

4.10 The equipment location of the calling line is identified in terms of the line link frame number, vertical group, horizontal group, and vertical file numbers.

4.11 A vertical group of customer lines is 5 verticals wide and 10 switches high for a total of 50 lines. Thus, the number of vertical groups in a line link frame will vary from 4 for a 190-line frame to 12 for a 590-line frame. A horizontal group is one switch high and extends across all the vertical groups on a frame. There are always 10 horizontal groups on a frame. A vertical file is one vertical wide and 10 switches high for a total of 10 lines. The number of vertical files on a frame depends on the number of lines on that frame. The division of the frame into vertical groups, horizontal groups, and vertical files is illustrated in Figures 19 and 20.

4.12 The number of the line link frame, vertical group, and horizontal group in which the line appears is transmitted to the marker via the line link marker connector. Therefore, at this point, the calling line location is identified as one of a group of five lines. The other information required by the marker to completely identify the line location within the frame is the vertical file number. This is obtained from the line link frame through the line link connector associated with the frame.

4.13 While the marker is recording the line location information (except the vertical file number), an idle originating register is selected in the same manner as an idle trunk. Originating registers are distributed as equally as possible over all trunk link frames. The marker is notified, by means of test leads from each trunk link frame, which frames have an idle register and are not being held busy by other markers. In a preference sequence, an idle frame having an idle register is selected and the marker connects to that frame through a trunk link connector. (See Fig. 18, connection 2.) The marker selects an idle register on that frame in a preference sequence.

4.14 After a trunk link frame has been selected, additional leads are connected between the marker and line link frame via the line link connector. Each line link frame has a line link connector which provides the leads for vertical file identification and other leads which the line link marker connector does not have for completing connections to the frame (connection 3). The vertical file number is transmitted to the marker which

now has all the data for locating the position of the line on the line link frame.

4.15 Identification of the class of service of the calling line is passed to the marker from the line link frame via the line link connector after the vertical file number has been recorded. Normally, all lines on the same vertical file have the same class of service. If necessary, an arrangement is available to permit customers having different classes of service to be assigned to the same vertical file. Offices may be equipped for as many as 100 classes of service per marker group. In an office arranged for more than 30 classes of service, the recommended allocation of these classes of service is 00 through 29 for all noncentrex services and 30 through 99 for centrex customer groups. Unused numbers in the 30 through 99 series may be used for noncentrex service, if required. The marker transmits the equipment location and class of service of the calling line to the originating register where this information is stored.

4.16 The marker now must select an idle channel between the customer line and the originating register. A channel consists of a line link, junctor, and trunk link. Channels are arranged in groups of ten so that the marker can check ten channels at one time. If the number of channels in an office is not divisible by ten, one group will have nine or fewer channels in it. When the marker finds an idle channel, it operates the selecting and holding magnets required to close through the channel. The marker then indicates to the originating register the identity of the line link used in the channel, and the register stores this information for later use.

4.17 Before the marker transfers control of the channel to the originating register, it checks the connection for continuity (connection 4). The marker then releases the associated connectors and itself. The register now furnishes dial tone to the customer and is ready to receive the digits.

4.18 Normally it takes less than 1/2 second to establish the dialing connection and return dial tone to the calling customer.

4.19 The digits which the customer dials are registered in the originating register. The originating register seizes a marker and transmits the registered digits to it.

C. Pretranslation

4.20 Pretranslation is the process of determining from the first, second, or third digit how many digits the register expects to receive on a particular call. It is called pretranslation because it takes place before marker translation and is required when the total number of digits within the range of customer dialing varies.

4.21 Where the volume of calls is small and the numbering plan is not complex, pretranslation can take place in the originating register. The register can be arranged to determine from the first and second digits the number of digits it should receive.

4.22 For more complex numbering plans, a separate pretranslator circuit is provided. This circuit is called in by the pretranslator connector when the second or third digit has been set in the originating register. The pretranslator determines from these digits how many should be dialed before it calls in a marker.

4.23 On calls to stations where a party letter is part of the directory number, the register must 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.

D. Intraoffice Calls

4.24 When the calling customer removes the receiver from the switch hook, the dialing connection is established as shown in Fig. 18. After the number is dialed, the originating register engages a marker through an originating register marker connector. (See Fig. 21, connection 1.) The register then transmits the line equipment location of the calling line and the digits of the called number to the marker. The marker translates the office code and determines that the called number is assigned to the same marker group as the calling line.

4.25 The marker then proceeds to perform an intraoffice trunk job which consists of two parts, the establishment of a terminating and an originating connection. The terminating connection is set up between the called line and the B appearance of the intraoffice trunk; the originating

connection is set up between the calling line and the A appearance of the intraoffice trunk.

E. Establishing Terminating Connection

4.26 The terminating connection is established first, so that if the called line is busy, the marker can immediately connect the calling line to a tone trunk and thus save holding time on equipment. Before the terminating connection can be set up, the marker must obtain the following information from the number group:

(a) The equipment location of the called number

(b) The setting of the ringing selection switch

(c) If terminal hunting is necessary.

Nonterminal Hunting

4.27 The marker gains access to the number group connector. (See Fig. 21, connection 3.) The proper number group frame is selected from the dialed thousands digit, and the hundreds, tens, and units digits of the called number are transmitted to it. The number group frame translates these digits into an equipment location in terms of line link frame, vertical group, horizontal group, and vertical file numbers and transmits this information to the marker. The number group also informs the marker the correct setting of the ringing selection switch for ringing the called number. The ringing codes appear on the horizontals of the ringing selection switch, and the trunks appear on the verticals. The marker operates the selecting and holding magnets, respectively, to connect individual or party line ringing to the trunk.

4.28 While the marker is obtaining this information from the number group, it is also selecting an intraoffice trunk on an idle trunk link frame (connection 2). Through the line link connector, the marker gains access to the line link frame on which the called customer line is located (connection 4). If it is not busy, the terminating channel is set up between the B appearance of the intraoffice trunk on the trunk link frame and the called line (connection 5).

4.29 If there is no idle channel available, the marker recycles by releasing the intraoffice trunk it was holding and selecting another one (usually on another frame). If there is no idle channel on this recycle, the marker reroutes the call to a tone trunk.

Terminal Hunting

4.30 A customer who has more than one terminating line is assigned one directory number per line, with usually only the lowest number listed in the directory. These lines form a terminal hunting group and are usually numbered consecutively. If the listed number is called and is busy, the marker tests the next higher number in the group and completes the call to the lowest idle number. The marker hunts in the same manner if one of the intermediate numbers is called and is busy.

4.31 Each number group is divided into ten hundreds blocks, each containing ten blocks of ten numbers. One hunting group can spread over more than one hundreds block or more than one tens block. Two or more hunting groups, other than blank number or intercept trunks, may appear in any tens block. Nonhunting terminals may appear in the same tens block with hunting groups, except when the block select method or the allotted PBX hunting group feature is used. Where there are more than 10 but less than 100 trunks, the block select method can be used. Using this method, the marker hunts first through the lines located in the directory number tens block and finding them all busy, selects the lowest block containing an idle line without testing the intermediate blocks containing all busy lines. The allotted PBX hunting group feature can also be used. With this feature, the line numbers of a hunting group may be assigned in more than one number group (eight number groups maximum). The marker recognizes the thousands, hundreds, and tens digit before connecting to any number group, and steers the call to a tens block on a preferred number group containing idle lines to the PBX. Because the marker does not look at the units digit initially, the tens block containing the listed directory must not contain numbers of any other customer. The latter two plans require an auxiliary relay per PBX trunk.

F. Establishing Originating Connection

4.32 After the terminating channel is established, the marker proceeds to set up an originating channel between the calling line link frame and the A appearance of the intraoffice trunk on the

trunk link frame over an idle channel (Fig. 21, connection 7). The marker seizes the line link frame of the calling customer (connection 6). Before it releases the dialing connection, the marker determines if there is an idle channel between the calling customer and the A appearance of the intraoffice trunk. If there is an idle channel, the dialing connection is released immediately, enabling the marker to use the dialing connection line link as part of the originating connection, if necessary. However, if there is no idle channel available, the marker recycles. In the event no idle channel is found on the recycle, overflow tone is returned from the originating register through the dialing connection.

4.33 After the marker sets up the ringing selection switch in the terminating connection in accordance with the information obtained from the number group, it releases itself and the originating register from the intraoffice connection. The dialing connection is disengaged and the customers are interconnected. The trunk now controls the ringing and supervision of the call. The ringing is tripped when the called party answers and the ringing selection switch releases. When the call is finished, the originating and terminating connections are released and the intraoffice trunk is released.

Timed-Release Feature

4.34 A timed-release feature is provided in order to prevent the calling party from holding the called line out of service indefinitely by failing to hang up the receiver. In this case, the timed-release feature disconnects the calling line 13 to 35 seconds after the called customer hangs up. If the calling customer disconnects first and the called customer fails to disconnect, the timed-release feature disconnects the called party after 13 to 35 seconds.

G. Interoffice Calls—Outgoing

4.35 Outgoing calls are established to customers in a connecting office or to operators (toll, assistance, and service code calls). Calls to connecting offices require the services of an outgoing sender but assistance calls and service code calls usually do not.

Establishing Outgoing Trunk Connection

4.36 When the customer has dialed the called number, the originating register engages a marker via an originating register marker connector. (See Fig. 22, connection 1.) The register transmits the following information to the marker: the equipment location and class of service of calling customer, the number of the line link frame used in the dialing connection, and the called number.

4.37 From the office code, the marker determines the following:

(a) That the call is to be completed to a connecting office and requires a marker outgoing trunk job

(b) Type of pulsing the office requires (multifrequency, dial, revertive, or panel call indicator).

By means of the outgoing sender connector, the marker gains access to an outgoing sender that generates the type of pulses the connecting office requires (connection 2).

4.38 When the outgoing sender connector is engaged, the marker, by means of the trunk link connector, gains access to an idle outgoing trunk on an idle trunk link frame (connection 3). The sender is connected to the marker through the outgoing sender connector and receives the called number from the marker. The marker also sets up a connection between the outgoing trunk and the outgoing sender through the sender link.

4.39 As soon as the trunk link frame is seized, the marker connects to the line link frame of the calling customer (connection 4) and establishes a channel between the customer and the outgoing trunk (connection 5). The dialing connection is released if the marker finds an idle channel. The line link used in the dialing connection may be reused in the outgoing connection. If there is no idle channel available, the marker recycles the call by releasing the outgoing trunk it was holding and selects another one. If there is no idle channel on the recycle, the marker reroutes the call to a tone trunk on a trunk link frame.

4.40 The outgoing sender then makes a trunk test. If the trunk test fails, overflow tone is returned to the customer from the trunk. As

in an intraoffice call, the marker releases upon completion of its functions. The sender transmits the called number to the connecting office, then disconnects itself and the sender link. The outgoing trunk maintains supervision of the call.

(a) The DP and MF outgoing senders are arranged (optionally) to prefix up to three arbitrary digits when the call is routed through a distant tandem point which uses the prefix digits in completing the connection to the office of destination. These senders are also arranged to delete some of the digits dialed by the customer.

H. Interoffice Calls—Incoming

4.41 An incoming call is the continuation and completion in a called office of an outgoing call from a connecting office. In the called office, the trunk from the originating office is an incoming trunk. The incoming connection consists of a channel between an incoming trunk and the called customer.

Establishing Incoming Trunk Connection

4.42 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. (See Fig. 23, connection 1.) Separate groups of incoming registers are provided for each type of pulsing that the office is equipped to receive (multifrequency, dial, frequency shift, or revertive pulsing).

4.43 After the trunk is seized in the called office, the incoming register is connected to the incoming trunk and receives the numericals of the called number. (In this example, it is assumed that the trunk is used for completing calls to only one of several offices which may be served by a marker group.) The register records the number of the trunk link frame on which the incoming trunk appears in order that the marker will later be able to reach that incoming trunk. After the numericals of the called number have been registered, the register gains access to a marker through an incoming register marker connector (connection 2) and transmits the called digits and the trunk link frame number to it.

4.44 The marker first seizes the trunk link frame (connection 3), then selects the proper number group frame from the called number thousands digit (connection 4). The number group translates the called hundreds, tens, and units digits. As soon as the marker determines the called line location from the number group, it seizes the proper line link frame and performs the line-busy test on the called line (connection 5).

4.45 If the called line is idle, the marker sets up a channel between the trunk and the called line (connection 6). Utilizing the ringing code information it has obtained from the number group, the marker sets the ringing selection switch. If the marker cannot find an idle channel, it sets the ringing selection switch to return a reorder signal and releases itself from the connection.

4.46 As soon as the marker has finished these functions, it disconnects the incoming register, the register link, and itself from the connection. The trunk now controls the ringing and further supervision of the call. The ringing selection switch vertical releases when the called party answers or the call is abandoned.

4.47 If the called line is busy, the marker sets up a busy signal on the ringing selection switch. The marker then releases the incoming register, the register link, and itself from the connection.

I. Reverting Calls

4.48 A reverting call takes place between customers who share the same party line. The talking connection is set up between the customer line and a reverting trunk when the class of service of the calling customer line is flat rate and when reverting trunks are provided in the office.

4.49 When the class of service of the calling customer line is flat rate and reverting trunks are not provided in the office, it is necessary to connect the calling customer to an operator over an outgoing trunk to the toll and DSA switchboard. The operator obtains the called customer and supervises the connection.

4.50 When the class of service of the calling customer is message rate, it is always necessary to connect the calling customer to an operator. The operator, in addition to obtaining the called customer and supervising the call, makes the necessary charge. This operation is employed because reverting call trunks are not arranged to provide automatic message charging.

Establishing Reverting Trunk Connection

4.51 The calling customer receives dial tone and dials in the usual manner. The originating register transmits the calling customer line location and class of service and also the called number to the marker which recognizes that number as belonging to the same office. (See Fig. 24, connection 1.) The marker then proceeds to seize both the proper number group and an intraoffice trunk (connections 2 and 3). Up to the point that the marker checks the number group for the called line location, a reverting call is handled in the same manner as an intraoffice call. However, as soon as the marker determines from the number group that the called line location is the same as that of the calling line, it releases the intraoffice trunk.

4.52 The marker then seizes a trunk link frame on which an idle reverting trunk appears (connection 4) and sets up a channel between the customer line and that trunk (connections 5 and 6). After the marker sets up the proper ringing codes in the reverting trunk, it releases from the connection. The reverting trunk is now left in control of the call.

4.53 The following are two types of reverting trunks:

(a) Trunks used for 2-party selective, 4-party semiselective, and 10-party divided code ringing

(b) Trunks used for 2-party selective, 4-party full selective, and 8-party semiselective ringing.

Depending on office requirements, one or both types of reverting trunks may be used.

Reverting Trunks for 2-Party Selective Lines

4.54 In the case of one customer calling the second customer on a 2-party line, the trunk returns a busy signal to the calling customer who hangs up. The trunk then applies regular ringing to the called party and reverting ringing signal (1/2 second on, 2-1/2 seconds off) to the calling customer. When the called customer answers, the ringing is tripped, which notifies the calling party to lift the receiver and start talking.

Reverting Trunks for 4-Party Semiselective and 10-Party Divided Ringing Lines

4.55 The method of operation on these lines is the same as that used on 2-party lines, except that the trunk rings all parties on one side of the line. Since each customer on the same side of the line has a separate ringing code, only one of the parties will answer.

Reverting Trunks for 2-Party Selective, 4-Party Full-Selective, and 8-Party Semiselective Lines

4.56 When a customer on a 4-party full selective or an 8-party semiselective line wishes to call another party on the same line, the customer dials the called number. The originating register engages a marker which connects to a reverting trunk in the same manner just described and sets the ringing switch for the called station. The trunk then supplies a steady high tone to the calling customer; this tone notifies the customer to dial an additional digit which is associated with his station for use on reverting calls. From this digit, the trunk selects the individual ringing position for the calling station. After the extra digit is dialed, the trunk supplies busy signal to the calling station. The calling customer hangs up, and the trunk proceeds to alternately ring the called and calling station.

4.57 When the called station answers, the ringing is tripped. This notifies the calling customer to remove the receiver and start talking. When both parties hang up, the equipment returns to normal.

J. Assistance and Service Code Calls

4.58 Calls for which a customer dials zero or a service code are completed over channels between the calling customer and an appropriate outgoing trunk. (See Fig. 25.) When there are direct trunks to the operator positions, no outpulsing is necessary, and therefore, outgoing senders are not required in the connection. However, service code calls excluding zero operator calls may sometimes be handled through a centralized point, and in that case, an outgoing sender is required to outpulse the dialed digits.

4.59 Pretranslation is not necessary because the originating register is equipped to recognize the zero and service codes directly.

Zero Operator Calls

4.60 When the originating register records the single 0 without waiting for any additional digits, it engages a marker (connection 1). The marker establishes a channel between the calling line and an outgoing trunk to an operator and releases (connections 2, 3, and 4). The customer hears an audible ringing signal until the operator answers. After the operator has connected to the trunk, the circuit is so arranged that if the customer hangs up, the operator can hold the connection. This prevents any accidental manipulation of the switch hook from destroying the connection.

Service Code Calls

4.61 For service code calls (business office, repair service, etc), the originating register receives the service code digits, engages a marker, and transmits the digits to the marker. The marker then sets up a channel between the calling customer and an outgoing trunk to the proper operator or desk and releases. The customer hears an audible ringing signal until the operator answers. When the customer hangs up, the connection is released.

K. Manual Calls

4.62 A dial office may also serve some customers who require the assistance of an operator on all originating calls.

4.63 When a customer with manual class of service lifts the receiver from the switch hook, the line link marker connector engages a marker. At the same time that it is receiving the line link frame location and the class of service of the calling line from the connector, the marker selects an idle originating register as though the call were from a dial station. The marker transmits this information to the register and releases. No dial tone is returned to the customer because the register recognizes the class of service of the calling line as manual. The originating register then seizes a marker and indicates that a connection to an operator is required. The marker establishes a channel between the calling customer and an outgoing trunk to a DSA operator. The operator then completes the call at the request of the customer.

L. Direct Distance Dialing

4.64 The No. 5 crossbar office is designed so that the customers may dial into all the numbering plan areas in use in the United States and Canada. The calling customer dials the 3-digit numbering plan area code of the called customer, then the 7-digit directory number. Depending on local options, the calling customer may dial a 0 or 1 access digit before dialing the 3-digit numbering plan area code and the 7-digit directory number. The 0 is used for calls which require assistance, such as person-to-person. The 1 is used as a toll access digit to prevent incorrectly dialed calls from completing to toll points. The marker, in translating the area code, establishes the connection to a trunk directly to the switching center in the area dialed or to an intermediate toll switching point which will select a route to the area dialed. Where more than one route is available from the No. 5 crossbar office to a particular area, the marker determines from its foreign area translator which route to use to the particular office. The marker has the ability to recognize certain unauthorized code combinations dialed by customers. On these incorrectly dialed calls, a 0 or 1 in the D or E digit will cause the marker to prevent the call from completing and will route the call to a tone trunk.

M. Various Call Conditions

Permanent Signal

4.65 A permanent signal may result from faulty handling of the station equipment or from trouble conditions in the telephone plant.

4.66 After dial tone has been sent to the calling line, the originating register waits for dialing to start.

4.67 The register allows 20 to 37 seconds, under normal traffic conditions, for the receipt of the first digit. If it does not receive the first digit in time, the register refers the call to a marker as a permanent signal. The marker then connects the calling line to a permanent signal trunk. Before releasing, the marker indicates to the trunk whether the calling line is coin, PBX, or a noncoin, non-PBX class.

4.68 The signal first appears before an operator. The operator challenges on the trunk and,

if no answer is received, takes the necessary action as covered by local instructions.

Partial Dial

4.69 Having recorded the first digit, the register waits 20 to 37 seconds under normal traffic conditions for each succeeding digit.

4.70 If the customer fails to dial a digit within this specified time interval, the register refers the call to a marker as a partial dial. The marker may handle the situation in one of two ways: it may connect the calling line to a tone trunk or connect the calling line to an outgoing trunk which terminates before an announcement or an operator. The method that is used depends on the procedure followed in the individual office.

Local Overload Announcement

4.71 During periods of severe weather, widespread commercial power failure, or other emergencies, abnormal load conditions may be placed on the No. 5 crossbar office. The local overload announcement feature can be provided to prevent long dial tone delays which would result from an all-registers-busy condition during these periods of heavy emergency traffic. The feature can be activated manually so that customer call attempts will be routed to an announcement when an all-registers-busy condition exists. The announcement will inform the customer of the overload condition, and as a result, prevent his repeated attempts for service so that the overload condition will be reduced.

4.72 Some customers are not routed to the local overload announcement, thus allowing them to wait for dial tone. This arrangement is provided for lines such as data customers, coin lines, police, fire, etc.

4.73 Package No. 5 crossbar offices equipped with an originating line identifier (OLI) and/or an office test frame will not have the local overload announcement feature since they are limited in size.

Dialing Before Receipt of Dial Tone

4.74 If a customer starts dialing before receiving dial tone, one of the following situations will occur:

(a) The first digit may be distorted so that the originating register will record an incorrect code.

(b) The register will record an insufficient number of digits.

4.75 If the code which the register records is a working one, the calling customer may get a wrong number. However, if the digits recorded by the originating register constitute a vacant code (a code not in current use), the calling party will be connected either to an operator or to a tone or announcement trunk.

4.76 If pretranslation is not provided, the originating register does not recognize the vacant code; therefore, it waits for the full directory number or partial dial timeout before it engages a marker. The marker then recognizes the vacant code and routes the call to an operator or to a tone or announcement trunk.

Intercepting

4.77 A call is intercepted if it is made to any of the following:

(a) Temporarily disconnected number

(b) Changed number

(c) Out of order number and arrangements have been made to intercept incoming calls

(d) Permanently disconnected number

(e) Unassigned number

(f) Blank number

(g) Vacant code

(h) Denied code.

4.78 When a number which is on intercept for (a), (b), or (c) is called, the calling party is routed to an intercept operator over an intercept

trunk. Each intercept trunk has a line link appearance and is assigned a number in a terminal hunting group. Therefore, on an intraoffice or incoming call, when the marker seizes the number group and finds that the called number is on intercept, the marker goes to an intercept trunk (which may be on the same or a different frame) and obtains the line location of an intercept trunk. Through a line link connector, the marker seizes the line link frame on which the trunk appears and establishes a channel between the calling line and the intercept trunk. The other appearance of this trunk is before an intercept operator.

4.79 Blank numbers, permanent disconnects, and unassigned numbers are also treated in this manner, except that a recorded announcement may be connected to the end of the trunk. Unassigned numbers are numbers in an office which are not currently assigned to customers; blank numbers are numbers which do not exist in the office.

4.80 For example, in an office which is equipped to serve 5000 directory numbers, there are some numbers within the 5000 which are not allotted to customers. When such numbers are dialed, the marker, after learning from the number group that the number is on intercept, connects the calling customer to an intercept operator or a recorded announcement.

4.81 Using the same office as an example, a customer dials a number above 5000, which is called a blank thousands number. When such a number is dialed, the marker recognizes it immediately and connects the calling customer to an intercept operator or recorded announcement.

4.82 Vacant codes and denied codes may be routed to either machine announcements or operators over trunks appearing on the trunk link frame. The routing for each of these conditions is determined by cross-connections in the completing marker.

MESSAGE CHARGING ON COIN AND NONCOIN CALLS

A. Prepayment Coin Service

4.83 There are two types of prepayment coin service: coin first (the most common) and dial tone first. With coin first service, a coin must be deposited before dial tone is returned to the calling party. With dial tone first service, dial tone is returned when the receiver is removed from the switch hook; a check for coin deposit is made after dialing is completed. Only coin first ground-start service, which is required for 10-cent coin operation, is described.

4.84 With ground-start operation, the customer is connected to an originating register after a coin is deposited. When dialing is completed, the originating register engages a marker and transmits the usual information to it, including the coin class of service of the calling party. The marker then establishes a connection between the calling party and a trunk arranged for coin operation.

4.85 The answer of the called customer sets the charge condition in the trunk. If the office has no provision for overtime charging, the collection of the coin is made when the calling customer disconnects at the end of the call. For example, when the called customer takes the receiver off-hook, the battery and ground on the trunk pair is reversed. When the receiver off-hook situation continues for the charge delay interval of 2 to 5 seconds, the charge condition, which determines that the calling party will be charged for the call, is set in the trunk. This charge delay is used to prevent an intermittent short creating a false charge condition.

4.86 On an intraoffice call, the 2- to 5-second charge delay is the same, but the charge condition is set locally in the trunk.

4.87 When the calling party disconnects, the trunk used in the talking channel associates itself with a coin supervisory circuit through a coin supervisory link. (See Fig. 26.) The coin supervisory circuit then tests for and collects the coin if the charge condition has been set; if it has not, the coin is returned.

4.88 After coin collect or return is made, the coin supervisory circuit again tests for the presence of coin ground. If the coin ground is found, indicating that the coin is still in the box, the circuit signals a stuck-coin condition to an operator. From the signal, the operator knows whether the coin should be collected or returned and tries to dispose of the coin. If this is unsuccessful, the line is considered out of order because of the stuck-coin condition and is referred to the maintenance department.

4.89 When the circuits are arranged for coin overtime, an additional charge is made for each overtime period beyond the initial timing period. The trunks are equipped with interval timers and collect the coin 1/2 minute before the end of initial charging period. At this time, a tone is put on the connection for 1/2 second to remind the calling party that another coin must be deposited if the conversation is to continue beyond the next 1/2 minute without interruption. At the end of the initial period, if the connection has not been released, the coin supervisory circuit is again connected to the trunk to test whether a coin has been deposited. If a coin has been deposited, the coin control circuit releases itself from the connection and the conversation continues uninterrupted. If a coin has not been deposited, an operator is signaled to interrupt the conversation and to request the additional coin. The coins deposited for overtime service are collected 1/2 minute before the end of the overtime charge interval. If another coin is collected and the connection is released before the full charge interval has elapsed, this coin is returned by the coin supervisory circuit.

4.90 On 0+ and 211 calls, the trunk may be arranged to retain or return the initial deposit when the operator answers. If the customer hangs up before the operator answers, the initial deposit is returned.

4.91 On service codes and all other calls, except as mentioned, the trunks use coin supervisory circuits to dispose of the coins.

B. Coin Junctor

4.92 Separate groups of trunks may or may not be provided for handling outgoing interoffice calls dialed from coin lines. With the coin junctor arrangement, outgoing trunks that handle coin and noncoin traffic do not need coin features.

4.93 The coin junctor is composed of two trunk circuits. One is an outgoing trunk arranged for coin service and the second is an incoming trunk arranged with tandem or toll features. The junctor therefore has two frame appearances: one on a trunk link frame and the second on a line link frame.

4.94 With coin junctor operation, the calling customer is connected to an outgoing trunk the same as a regular outgoing call. (See Fig. 27, connections 1 through 5.) The marker instructs the outsender to outpulse the called directory number and releases. The call proceeds in the same manner as an incoming tandem or toll call. The called number and trunk number are placed in the incoming register (connection 6). The register seizes a marker through a connector and transmits the called number and trunk number to the marker (connection 7). The marker seizes a number group (connection 8), and from the trunk number, determines the line link frame location of the incoming trunk. The marker then proceeds to establish a connection between this location and an outgoing trunk (connections 9 through 12). It is not necessary for the outgoing trunk to be equipped for coin service, since the junctor is equipped for it.

Coin Zone Dialing

4.95 Coin zone dialing is a form of prepayment coin service; however, it differs from the coin service described. Coin zone dialing, in addition to providing for local calls, also has provision for coin customer dialing outside of the local area or for multiunit initial charge calls. A second difference is that local calls may be fully automatic, whereas the coin zone dialed calls require the use of an operator to verify that the customer makes the proper deposit for the initial period and later, if the call extends into an overtime period, to time and collect for the overtime.

4.96 Upon completion of dialing by the coin customer, the completing marker is seized by the originating register and functions to connect the customer to an outgoing coin zone trunk. This trunk has an appearance before a coin operator (either locally or remotely located from the No. 5 crossbar office), and informs the operator of the required initial charge for the call by lighting one of eight initial charge lamps associated with that group of outgoing trunks. The operator requests the customer to deposit the initial deposit. When the operator has verified that the proper deposit has been made, the call is completed. The initial deposit is collected automatically if the call terminates before the end of the initial charge period. If the call progresses beyond this period, the coin zone trunk again calls in an operator by flashing the proper overtime charge lamp. From this point on, the coins are collected manually by the operator as the call is timed until it is completed.

C. AMA Service

4.97 AMA equipment may be used to record charging information for calls to any point within the range of the switching facilities available to the customer and may include local message rate calls, multiunit calls, and toll calls. The equipment takes the place of message registers and zone registration equipment. The AMA equipment may be located in the marker group to provide for LAMA or at some tandem switching point to provide for CAMA. In either case, when a noncoin customer dials an office code or a numbering plan area code that involves a message or toll charge, the call is connected to an outgoing trunk to the distant point. While this connection is being established, the following information is being recorded on the punched tape or magnetic tape by the AMA equipment in the No. 5 crossbar local or tandem switching office (initial entry).

(a) Calling number

(b) Called number (when applicable)

(c) Numbering plan area code (when applicable)

(d) Message billing index

(e) Other miscellaneous details to identify the call.

4.98 When the called party answers and the conversation terminates, separate entries are made on the tape. Included in each entry is the time of day and information to identify the call involved. These are answer and disconnect entries.

4.99 Each time an item of charge data on a given call is entered on the tape, the identity of the transmission circuit engaged on the call is entered. With this arrangement, the entries on a given call (initial, answer, and disconnect) can be made as the call progresses with entries from other calls interspersed.

4.100 The punched tapes or magnetic tapes are processed through the accounting center, and the customer calls are tabulated and arranged in chronological order.

D. ANI for CAMA Service

4.101 Automatic number identification (ANI) provides for identifying a calling customer number and for transmitting this number to the CAMA office for the CAMA record of the call. ANI, however, is limited to calls originated by PBX, individual, and 2-party customers. Calls from 4-party and rural lines require that the CAMA operator identify the calling customer.

4.102 After the calling customer has completed dialing, the originating register transfers the calling customer class of service, line location, and called number to the completing marker.

4.103 The marker determines from the called office code that the call is to be routed through a CAMA point. It determines from the class of service of the calling customer that the calling customer is to be CAMA operator identified (OI) or automatically identified (AI) by the ANI equipment. As a result, the marker will select a trunk to the CAMA point and attach an MF outgoing sender to that trunk.

4.104 After the marker has selected an idle sender and is connected through the outgoing sender connector, the following information is passed to the sender:

(a) Class of call, automatically identified (AI), operator identified (OI), or identification failure (IF)

(b) Called number

(c) Calling line equipment number

(d) Party identity (tip or ring)

(e) Other miscellaneous information to enable the sender to complete its functions.

4.105 The marker will establish a connection between the trunk and sender and a channel between the calling customer and the trunk to the CAMA point. Having completed its functions, the marker releases from the connection.

4.106 The sender then makes trunk test. If the test fails, overflow tone will be returned to the customer from the trunk. If the test is satisfactory, the sender will outpulse the called

number. After the called number is outpulsed, the sender signals the ANI transverter connector for a connection to an ANI transverter. The sender transfers to the transverter the calling line equipment number. The transverter uses this information to connect to the proper ANI translator to determine the associated directory number.

4.107 The AMA translator circuit translates the customer line equipment number into a 5- or 6-digit directory number. This directory number, consisting of one or two office digits and four numericals, is transferred to the transverter. Cross-connections within the transverter expand the office digit or digits into the corresponding PBX code. The transverter records this information, releases the translator, and transfers the directory number to the sender.

4.108 When the equipment in the distant office is ready to receive the calling number, it indicates this by transmitting an off-hook signal. The outgoing sender recognizes this as a start signal and outpulses the calling directory number prefixed by an information digit.

4.109 The information digit is used to inform the distant CAMA equipment of the type of call being handled. Translation of this information digit by the CAMA sender is as follows:

DIGIT	TRANSLATION
0	AI—Service nonobserved
1	OI—Service nonobserved
2	IF—Service observed
3	AI—Service observed
4	OI—Service observed
5	IF—Service observed

OPERATION OF NO. 5 CROSSBAR OFFICE WITH COMBINED TOLL AND DSA SWITCHBOARD

4.110 The switchboard considered for this discussion is a combined toll and DSA switchboard located in the same building with the No. 5 crossbar office. The terms "combined toll and DSA switchboard" and "switchboard" and the terms "combined toll and DSA operator" and "operator" are synonymous, respectively.

4.111 The difference between having the switchboard in the same building as the No. 5 crossbar office or in another building is the type of trunks used. The method of operation is the same for both arrangements.

4.112 The types of calls which may be handled by switchboard operators are shown in Figure 28. Some service code calls are answered by an information operator, repair clerk, etc, instead of the toll and DSA operator. Permanent signal, partial dial, and vacant code calls may appear at the switchboard according to the practice in individual offices.

4.113 Each incoming trunk to the switchboard has a lamp appearance before an operator which indicates that a call should be answered and appropriate action taken. This operator has access to various types of outgoing trunks for calls extended from the switchboard.

4.114 When traffic is heavy, direct or tandem trunks are provided between the switchboard and some connecting offices. The operator can key or dial the called number directly into these outgoing trunks to reach the connecting office without going through the No. 5 crossbar office.

4.115 There are also operator junctors and trunks arranged for pulse conversion outgoing from the switchboard. The operator can handle operator assistance completing traffic by means of these circuits.

A. Assistance and Long Distance Calls

4.116 A dial customer who desires the service of an operator to make a long distance call or to complete a local call, dials the long distance code or 0 and is routed to a combined toll and DSA operator. Some of the duties of an operator are as follows:

(a) To complete calls for customers who require assistance to complete coin or person-to-person calls or calls requiring a ticket

(b) To check complaints about called numbers which are continuously busy or unanswered.

B. Calls From Switchboard Completed to No. 5 Crossbar Customer

4.117 The operator can complete calls to customers in the No. 5 crossbar office over toll switching trunks. These trunks have two appearances, one at the switchboard and the other on a trunk link frame. (See Fig. 29.)

4.118 The operator plugs into a toll switching trunk (connection 1). The trunk is connected to an incoming register through an incoming register link (connection 2). The operator keys the four numericals. (A directing digit is prefixed if the trunk serves more than one office code.) The call then proceeds in the same manner as a regular incoming call (connections 3 through 7).

C. Calls From Switchboard to Connecting Office

4.119 By means of an operator junctor or operator toll junctor, an operator located in the same building as the No. 5 crossbar office can gain access to the outgoing trunks in that office.

4.120 Operator junctors and operator toll junctors are trunks that have appearances at the toll and DSA switchboard, on a line link frame, and on a trunk link frame in a No. 5 crossbar office. (The trunk link location is used for returning overflow signal.) DSA or toll operators use these junctors to gain access to the outgoing trunks in the office to switch a call to a connecting office. Since the operator junctor is a type of tandem trunk, the No. 5 crossbar office must be equipped for tandem operation and since the operator toll junctor is a type of intertoll trunk, the No. 5 crossbar office must be equipped for toll switching.

4.121 In Figure 30, a calling customer reaches a DSA operator and gives the operator the called number. From this number, the operator determines the route for the call and plugs into an operator junctor. The operator keys the called number into the junctor (connection 1) when the junctor has been connected to an incoming register through an incoming register link (connection 2). After the called number, the trunk number, and the trunk link location of the operator are set in the incoming register, the register seizes a marker and transfers this information to the marker via an incoming register marker connector (connection 3). Directed by the trunk number, the marker obtains the line link frame location of the trunk from the number group (connection 4).

4.122 The marker seizes and transmits the called number to an outgoing sender through an outgoing sender connector (connection 5). By means of a trunk link connector, the marker seizes an idle trunk link frame with an idle outgoing trunk on that frame (connection 6), then connects the outgoing sender to the outgoing trunk through the sender link. Through a line link connector, the marker seizes the line link frame on which the junctor appears (connection 7). At this point, the marker sets up a channel between the junctor and the outgoing trunk. The sender transmits the required digits to the connecting office through the sender link and the outgoing trunk, releases, and then releases the sender link. The marker releases upon completion of its functions, and the DSA or toll operator has supervision of the call (connection 8).

D. Pulse Conversion Outgoing Calls

4.123 A combined DSA and toll switchboard located in the same building as the No. 5 crossbar office which it serves may have, if traffic warrants it, direct trunks to a connecting office which receives only dial or revertive pulsing. These trunks are provided for calls that require the assistance of an operator. By means of a process known as pulse conversion, the operator can complete a call from the No. 5 crossbar office to such a connecting office.

4.124 Pulse conversion is the action of converting MF pulsing, received from a switchboard position, to the type of pulsing required by the office to which the call is completed. This type of pulse conversion requires that these pulses be converted to either dial or revertive pulses, whichever are required by the connecting office. This method of completing calls to a connecting office from a DSA switchboard is economical and efficient for three reasons:

(a) No junctors are used in the connection.

(b) The operator keys the numericals of the called number into the trunk when completing to a local office. (Directing digits are prefixed if the trunk serves more than one office code.)

(c) The switchboard sender for converting pulses to the proper type is eliminated.

4.125 A pulse conversion trunk first operates as an incoming trunk by seizing an MF incoming register and passing pulses to it. Later, it acts as an outgoing trunk by connecting to a dial or revertive pulse outgoing sender and transmitting the required type of pulses to the called office.

4.126 The calling customer reaches the DSA operator in the usual manner and gives the operator the called number. From this information, the operator plugs into a trunk arranged for pulse conversion outgoing to the called office. (See Fig. 31, connection 1.) Through an incoming register link, the trunk is connected to an MF incoming register (connection 2) and transmits the trunk class mark indication to it. The operator then keys the number after receiving a start dialing signal.

4.127 The incoming register seizes and transmits the trunk class and called number information to a marker through an incoming register marker connector (connection 3). From the trunk class mark, the marker determines that this is a pulse conversion job and seizes and transmits the called numerials to the proper sender through an outgoing sender connector (connection 4). The marker causes the outgoing sender (connection 5) to be connected through a sender link to the trunk, and after the sender makes a trunk test, it outpulses the digits to the connecting office. The talking connection is established over the trunk (connection 6). The crossbar control equipment is released and the operator supervises the call.

NO. 5 CROSSBAR OFFICE WITH TANDEM SWITCHING FEATURES

4.128 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 connections. This type of operation is known as tandem switching.

4.129 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 appearances in the No. 5 crossbar office with tandem switching features. The trunk link frame appearance 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 appearance is used.

A. Establishing a Tandem Connection to a Connecting Office Through a No. 5 Crossbar Office

4.130 A calling customer served by office X (Fig. 32) originates a call to a customer served by office Z. In this case, there are no direct trunks connecting offices X and Z, and the call is routed from office X over a tandem trunk to a No. 5 crossbar office Y, which has completing trunks to office Z. These completing trunks can be used for handling calls from several offices.

4.131 In a No. 5 crossbar office, a tandem trunk incoming from another office is connected to an incoming register through an incoming register link (connection 1). The following information is then transferred to the incoming register: the called directory number, the trunk link frame number (not used on tandem calls), the trunk number, and the class mark of the incoming tandem trunk. The trunk number is an arbitrary 3-digit number (000 through 999) assigned to each trunk for the purpose of obtaining the line link equipment location of the trunk. These trunk numbers appear either in a separate trunk number group frame or in a customer number group frame. The requirements of each individual office determine which arrangement is used. If there are too many trunk numbers to be handled by the customer number group, a separate trunk number group frame is provided. The called number may consist of five, six, seven, or eight digits: a single-digit office code and four numericals, a single-digit directing code and four numericals, a 2-digit office code and four numericals, a 3-digit office code and four numericals, or a 3-digit office code with four numericals and a party letter. If the pulses are transmitted on a revertive pulse basis, the office code is designated by office brush and office group pulses which are always sent. They are translated by the incoming register into a 2- or 3-digit office code as required for presentation to the marker. The register also determines from its translator the number of

selections it may expect and whether the code received is a working or vacant code. This register will handle calls terminated in the local office as well as those terminating in a distant office.

4.132 The incoming register seizes a marker and transmits the information in the register to the marker through an incoming register marker connector (connection 2). From the called office code, the marker determines that a tandem job is necessary because the call is to be switched through to a connecting office. The marker seizes an outgoing sender through an outgoing sender connector (connection 3), proceeds to engage an outgoing trunk on an idle trunk link frame (connection 4), and connects the outgoing sender and the outgoing trunk by means of the sender link. At the same time, from the trunk number the marker seizes the proper number group frame through a number group connector and obtains the line link frame location of the tandem trunk (connection 5). The marker then seizes the line link frame on which the incoming tandem trunk appears via a line link connector (connection 6).

4.133 A channel is established between the incoming tandem trunk and the outgoing trunk by the marker (connection 7). The marker then releases the incoming register and itself from the connection, and the incoming tandem trunk is left in control of the supervision of the call.

4.134 A feature known as tandem screening is available to permit denial of service from specific incoming trunk groups to selected office codes available to other customers. For example, with this feature, customers in noncommon control offices, such as step-by-step, can be given unlimited access to the No. 5 crossbar office and be denied service by the No. 5 crossbar office to those office codes not allowed on a free basis by their tariff. The incoming trunks used for this purpose are given tandem class-of-service treatment.

B. Establishing a Terminating Connection in a No. 5 Crossbar Office Via an Incoming Tandem Trunk

4.135 A call coming over an incoming tandem trunk and terminating in the No. 5 crossbar office is treated in the same manner as a call coming in on a nontandem trunk.

4.136 In Fig. 32, the incoming tandem trunk connects to an incoming register through an incoming register link (connection 1) and transmits the called number and the trunk link frame number to the register. (This called number ranges only from five to seven digits because there are no party letters in a No. 5 crossbar office.)

4.137 The register seizes and transmits the information to a marker by means of an incoming register marker connector (connection 2). The marker seizes the trunk link frame (connection 4) and the number group (connection 5). From the number group, the marker determines the line link location of the called number and seizes the proper line link frame (connection 6). The marker establishes a channel between the incoming tandem trunk and the called line (connection 8). The marker then sets the proper ringing in the ringing selection switch, releases its associated linkage and itself, and leaves the incoming tandem trunk in control of the call.

4.138 A screening feature is also provided on dial pulse incoming nontandem trunks whereby either six or seven digits can be received. This feature is useful when it is not desired to absorb the excess digits in the originating office, such as step-by-step. Under this condition, the marker is given both the incoming class mark, indicating that this particular trunk is capable of being used in tandem connections, and a signal indicating the proper 6- or 7-digit translator to be used. Then, if the marker receives a code not usable over this trunk, it sets up reorder. This feature is applicable whether or not other trunks in the office, or in the same register link, are equipped for tandem operation. The registers must be equipped to record the total number of digits.

NO. 5 CROSSBAR OFFICE WITH TOLL CENTER SWITCHING FEATURES

4.139 A local No. 5 crossbar office may be arranged to serve as a toll center for surrounding offices and handles the following types of traffic:

(a) Regular local traffic

(b) Toll calls originated by local customer or terminated to local customers

(c) Toll calls switched through the No. 5 crossbar office (calls which originate or terminate in other offices)

(d) TX calls to TX operators on the toll switchboard serving the No. 5 crossbar office.

4.140 Traffic between toll offices is carried over intertoll trunks. The three general types of intertoll trunks are one-way outgoing, one-way incoming, and 2-way. These trunks have the following frame appearance in a No. 5 crossbar office:

(a) ***One-Way Outgoing Trunk:*** Trunk link frame.

(b) ***One-Way Incoming Trunk:*** Two on line link frame and one on trunk link frame. The line link appearances are used on switched-through calls. The trunk link frame appearance is used on incoming calls terminating in the No. 5 crossbar office.

(c) ***Two-Way Trunk:*** Two on line link frame and one on trunk link frame. The line link frame appearances are used on switched-through calls. The trunk link frame appearance is used for calls outgoing from the No. 5 crossbar office or for incoming calls terminating in the No. 5 crossbar office.

4.141 The two line link frame appearances for trunks are provided in order to increase the number of channels between the intertoll trunks and the trunks to connecting offices and thus reduce the number of reorders. In addition to the two line link frame appearances, the one-way outgoing and 2-way intertoll trunks usually have outgoing appearances in a toll switchboard located in the same building.

A. Establishing a Connection for a Toll Call to a Connecting Office Through a No. 5 Crossbar Office

4.142 A calling customer served by a local office X (Fig. 33) originates a toll call to a customer served by office Z. The customer dials 0 or 211 and is connected by the originating office to a long distance trunk appearing at a toll switchboard in office Y (connection 1).

4.143 The toll operator receives the request of the customer and plugs into a toll switching trunk or an intertoll switching trunk (connection 2). The toll switching trunk is used for direct access to office Z if the switchboard has the correct type of outpulsing to work into that office (connection 3). The intertoll trunk is used if the call is routed through an intermediate point before reaching office Z due to traffic considerations or if the call must be routed through an intermediate point due to an incorrect type of outpulsing to work directly into office Z (connection 4).

4.144 After selecting the proper trunk (connection 3 or 4) the intermediate or terminating office returns a start-pulsing signal to the toll operator. The operator then keys the called number to the intermediate or terminating office.

4.145 Calls to TX operators are established in a similar manner. In Fig. 33, the TX operator is shown on one of the terminating points. The toll switchboard operator keys the appropriate TX code or connects to the appropriate toll switching trunk and the call is established without outpulsing to the TX operator.

4.146 Calls dialed direct by the customer are completed the same way as those described for a No. 5 crossbar office with tandem features.

4.147 A feature known as toll screening is available to permit denial of service to certain incoming trunk groups to select office or area codes available to other incoming trunk groups. This screening may be used in much the same way as tandem screening.

B. Establishing a Connection for a Toll Call Terminating in a No. 5 Crossbar Office

4.148 In Fig. 33, a calling customer served by local office X originates a toll call to a customer served by a No. 5 crossbar office Y. This call arrives at office Y on a 0 or 211 trunk (connection 1) or on incoming intertoll trunk (connection 1A). When the call uses a 0 or 211 trunk, the toll operator listens to the customer request and connects to an appropriate toll switching trunk (connection 2). This trunk is connected to an incoming register through an incoming register link (connection 3A). The operator keys the called number into the register and the number of the trunk link frame on which the toll trunk appears is also registered in the incoming register. The register seizes and transmits the information to a marker by means of an incoming register marker connector (connection 4A). The marker seizes the

proper trunk link frame (connection 5) and the number group frame (connection 6).

4.149 From the number group, the marker obtains the line equipment location of the called number and connects to the proper line link frame (connection 7). The marker then establishes a channel between the toll switching trunk and the called customer. After setting the proper ringing in the ringing selection switch, the marker linkage and marker release, leaving the switchboard in control of the call.

4.150 If an idle channel is not available between the trunk link frame and the line link frame, the marker sets the toll trunk to return reorder to the toll operator.

4.151 If the toll call is dialed directly by the customer in office X (connection 1A), the call is handled in the same manner as the tandem call except an intertoll trunk is used and no operator is required.

MULTIOFFICE OPERATION

4.152 A No. 5 crossbar marker group can be arranged to handle a maximum of 40,000 numbers (directory and trunk). When an office is equipped for more than 10,000 numbers, at least one office code must be assigned for each number series (0000 through 9999). A particular marker group may have as many as six number series. The major reasons for using additional office codes in a marker group are as follows:

(a) To obtain discrimination between the number subdivisions for rate purposes

(b) To have ample line numbers for the lines required to load the marker group.

4.153 More than one office code may be needed whenever the customers served by one marker group are located in more than one subdivision with different tariffs. Assignment of a distinct office code to the customers in each subdivision enables the equipment to provide distinctive charging and routing treatments. In this situation, incoming calls from distant wire centers are given a different charge treatment to the several offices in the marker group. This feature prevents completion of calls on which distant customers dial the office code of the lowest charge in the No. 5 marker group, followed by the numericals of the line desired. When such a dialing condition occurs, the call is routed to an intercepting operator or a machine announcement.

4.154 Where one No. 5 crossbar marker group installation replaces more than one central office, the names or numbers associated with these offices may be retained to eliminate wholesale number changes. The No. 5 crossbar equipment cannot handle directory numbers with party letters.

4.155 Early marker groups equipped for a maximum of 20,000 numbers (directory and trunk) can accommodate three office codes in each number series (0000 through 9999) as follows:

OFFICE A	OFFICE B
Physical office A	Physical office B
Theoretical office A	Theoretical office B
Extra-theoretical office A	Extra-theoretical office B

This is known as physical-theoretical office operation.

4.156 Marker groups equipped for a maximum of 40,000 directory and trunk numbers are arranged for six number series as follows:

NO. SERIES GROUP A	NO. SERIES GROUP B
0	1
2	3
4	5

This is known as number-series operation.

4.157 In assigning blocks of numbers to a particular office code, the same principles apply to both physical-theoretical office operation and to number-series operation.

4.158 When discrimination is used, the customer numbers associated with a particular office code are assigned in increments of 100 numbers and in any ratio desired. The blocks assigned to any one of these subdivisions need not be consecutive. There is a restriction that an increment of 100 numbers cannot contain numbers of two or more subdivisions.

4.159 Usually, where discrimination is used, one or more blocks of 100 numbers are arranged for nondiscrimination. These are called common numbers and are assigned to official lines, business office lines, test lines, etc.

4.160 When discrimination is not used, any of the hundreds blocks may be arranged to complete the connection when the numericals are preceded by any one of the several office codes in the group of 10,000 numbers associated with a physical-theorectical office A or B, or with any one of the six number series.

A. Intermarker Group Operation

4.161 Intermarker group operation is an efficient method of handling the traffic between No. 5 crossbar marker groups located in the same building. The three types of intermarker group trunks for carrying this traffic are as follows:

(a) Customer-to-customer

(b) Customer-to-trunk

(c) Trunk-to-customer.

4.162 These trunks have appearances in both marker groups. Customer-to-customer and trunk-to-customer trunks have trunk link appearances in each marker group. Customer-to-trunk trunk has a trunk link frame appearance in the nontandem marker group and line link frame and trunk link frame appearance in the tandem marker group. This method is more efficient and economical than handling such traffic as regular interoffice traffic because the traffic between these marker groups is carried over intermarker group trunks and senders, using customer-to-customer type trunks. This avoids using the conventional outgoing senders, incoming registers, and interoffice trunks.

4.163 The intermarker group sender serves both as an incoming register and as an outgoing sender. It acts as an outgoing sender when connected to a calling marker and as an incoming register when connected to a called marker.

Method of Operation

4.164 The traffic between the two marker groups is of the following three types.

Customer-to-Customer

4.165 For calls that originate in marker group 0 and terminate in marker group 1, and vice versa, the trunks used are called customer-to-customer type. These calls are routed over an intermarker group trunk which requires the use of an intermarker group sender. From the called code, the marker in the originating office determines that an intermarker group connection is necessary and proceeds to set up a connection to an intermarker group trunk. (See Fig. 34, connections 1, 2, and 4.) The marker also connects to an intermarker group sender and transmits the called directory number to it (connection 3). The calling marker interconnects the trunk and sender via a sender link (connection 5) and releases.

4.166 Now the intermarker group sender acts as an incoming register and connects to a marker in the called office via an incoming register marker connector (connection 6). The sender transmits the called number and the trunk link frame number of the intermarker group trunk in marker group 1 to the called marker and releases. The marker, using this information, proceeds to set up a regular incoming call connection to the called customer (connections 7, 8, 9, and 10).

Customer-to-Trunk

4.167 For calls that originate in marker group 0 and require the use of marker group 1 as a tandem office to a connecting office, the trunks used are called customer-to-trunk type. When no direct trunks are provided from marker group 0 to the desired destination, or when the direct trunks are all busy and an alternate route is to be used, a call from marker group 0 to a connecting office is tandemed through marker group 1 in order to obtain an outgoing trunk.

4.168 Figure 35 shows a call to a connecting office from a customer in marker group 0. After receiving the called number, the marker recognizes that the required trunk is a customer-to-trunk type. This trunk has trunk link and line link frame appearances in marker group 1. The marker sets up a connection to the proper trunk (connections 1, 2, and 4), seizes an intermarker group sender (connection 3), and connects them to each other through a sender link (connection 5). The marker transmits the called number to the sender and releases.

4.169 Since the line link appearance of this trunk in marker group 1 is used on the call, the trunk number (000 through 999) is obtained and stored in the sender. The sender then passes this trunk number to the called marker through the incoming register marker connector (connection 6). The trunk also passes the trunk frame number to the sender, which in turn passes it to the called marker.

4.170 The marker goes to the number group, and from the trunk number, obtains the line link frame location of the trunk (connection 7). The marker seizes both the line link frame on which the trunk appears (connection 8) and an idle trunk link frame which has an outgoing trunk (connection 9), then sets up a channel between the frames (connection 11). At the same time, the marker selects an outgoing sender (connection 10). The marker passes the called number to the sender, connects the sender and the outgoing trunk through the sender link (connection 12), and releases. The call proceeds as a regular outgoing call.

4.171 If the marker cannot obtain an idle outgoing trunk, it seizes the trunk link frame appearance of the intermarker group trunks (from the trunk link frame number) and sets the trunk to return overflow signal to the calling office.

Trunk-to-Customer

4.172 Calls that originate in connecting offices and require the use of marker group 1 as a tandem or toll center switching point for reaching customers in marker group 0 have to be tandemed through on an intermarker group basis. The incoming trunks, which are regular incoming tandem equipment, have two appearances in marker group 1, one on the line link frame and one on the trunk link frame. Just as for regular tandem calls, the line link appearance is used for calls going through the office, and the trunk link appearance for calls terminating in the office.

4.173 As shown in Figure 36, the call starts out as a regular incoming call, going through the incoming register to the marker (connection 1). Through this linkage, the following information is transmitted to the marker: the called directory number, the trunk number (000 through 999), and the number of the trunk link frame on which the trunk appears.

4.174 From the called office code, the marker recognizes that this call is to be tandemed through to marker group 0. First the marker selects a trunk link frame (connection 2) with an idle intermarker group trunk (trunk-to-customer), and then seizes an intermarker group sender (connection 3). From the number group (connection 4) and by means of the trunk number, the marker obtains and seizes (connection 5) the line link frame appearance of the incoming trunk. The marker then connects the intermarker group trunk and the intermarker group sender using a sender link (connection 6). The marker transmits the called directory number and the trunk link frame number to the sender, establishes a channel between the incoming trunk and the intermarker group trunk (connection 7), and releases.

4.175 The intermarker group sender seizes a marker in marker group 0 and via a connector, passes the called number and trunk link frame number (connection 8) before releasing. The marker seizes the trunk link frame on which the trunk appears (connection 9) from the number group (connection 10) and determines from the called number the line link location of the called line. After seizing this appearance, the marker sets up a channel between the intermarker group trunk and the called customer (connection 12). The call proceeds from the incoming trunk through the intermarker group trunk to the called customer.

DIRECT AND ALTERNATE ROUTE ARRANGEMENTS IN NO. 5 CROSSBAR SYSTEM

A. Direct Routes

4.176 In a small or moderate sized exchange area, each central office may have direct trunks to all other central offices in that area. The trunks are usually provided on a one-way basis, with traffic in each direction handled over a separate group of trunks. Such an arrangement permits the interconnection of any two customers in the exchange area.

4.177 When setting up an interoffice call, the marker determines whether a trunk link frame has idle trunks before seizing the frame. After a frame has been seized, the marker can test a maximum of 20 trunks at a time on the frame. Since each frame is limited to a maximum of 20 trunks per route, the total number of trunks per route in the marker group is limited to 20

times the number of trunk link frames. For example, if office X has 5 trunk link frames, the marker can determine if any of 100 trunks to office Y are idle by the single trunk link frame test.

4.178 In the above example, if the 100 trunks of office X (5 trunk link frames) are not adequate to handle the amount of traffic to office Y, then more than 100 (but not more than 200) trunks are provided. The trunks are divided into two subgroups, 100 trunks maximum per subgroup. These subgroups are spread over the 5 trunk link frames, a maximum of 20 trunks of each subgroup on a frame.

4.179 Note that the subgroup in such an office cannot be more than 100 trunks because the marker is limited to testing 20 trunks after the frame has been seized. To use both subgroups effectively, the marker allots calls into each subgroup. This is done by testing one subgroup on one call to office Y and the other subgroup on an alternate call. If the marker tests for idle frames with idle trunks in one subgroup but finds no trunks available, it tests the second subgroup in an effort to complete the call successfully before routing it to overflow.

B. Alternate Routes

4.180 The alternate route principle is a combination of direct and tandem routing. Direct trunk groups are supplied from office X to office Y, but these groups will not carry all of the traffic during heavy loads. Office X will always attempt to route calls over the direct group to office Y first, and therefore, the high load on that group keeps it working efficiently. When all of the trunks of the direct group are in use and another call is originated to the same destination, the marker in office X will attempt to complete the call over the direct group, but in this case, will find all trunks busy. The marker then attempts to complete the call over the alternate (tandem) route as a tandem call.

4.181 In large exchange areas where trunking becomes more involved, more than one alternate route may be available for a call. For example, office X can reach office Y over the direct route trunks and also through tandem offices 1 and 2.

4.182 The marker in office X routes calls for office Y over the direct route trunks as long as any of them are idle. Additional calls are then routed to office Y through tandem office 1. The route through tandem office 1 is called the first alternate route. If both the direct route and the first alternate route trunks all test busy, the markers in office X attempt to route additional calls for office Y through tandem office 2 (second alternate route).

4.183 The No. 5 Crossbar System can handle three alternate routes in addition to the direct route. If a call cannot be completed over any of these routes, overflow tone is returned to the calling customer.

FOREIGN AREA TRANSLATION

4.184 When an incoming register, originating register, or intermarker group sender has received all the dialed digits from an operator or customer, it will engage a combined or completing marker through its associated marker connector. From the register or sender, the marker receives the dialed digits, class of call, and the trunk number or equipment location of the calling line. The marker examines this information and determines whether or not the call requires foreign area translation for completion.

4.185 On a call requiring foreign area translation, the completing marker is momentarily associated with the translator through a foreign area translator connector. A timing circuit in the marker is started to ensure that the marker is released if there is a failure in the translator or connector seizure circuits. If the preferred translator is busy, a transfer arrangement in the connector will enable it to seize the idle alternate translator. (A minimum of two and a maximum of six translators are provided.)

4.186 When two pairs of foreign area translators are provided, a maximum of 200 area-route indications can be provided, 100 for each pair of translators. On a given call, one of the area-route indications is passed to the marker. When the area-route indication is passed through the connector, the translator is released. With this information, the marker is able to connect the call to the proper outgoing trunk, complete its functions, and release from the connection. When the marker releases, the connector is released.

SELECTION PREFERENCE

A. Selection Preference for Vertical Groups, Horizontal Groups, and Vertical Files

4.187 To distribute service among the lines on a line link frame, a circuit arrangement is provided which rotates the order of the marker preference for serving calling lines, one step for each call or connection. The preference chain is fixed, but the point of entry is different each time.

4.188 When a line link frame is seized to set up a dial tone connection, the marker follows a fixed selection preference for serving vertical groups, horizontal groups, and vertical files. The only exception to this chain of preference is vertical group 02, which is always served first. Coin, police, fire, and emergency lines appear on this vertical group. The selection preference feature solves the problem of giving an equal grade of service to all lines when simultaneous demands for dial tone occur. The marker serves one call at a time in accordance with the selection preference sequence, and any other call has to wait its turn.

4.189 When a marker serves a dial tone job on a line link frame, it immediately looks at vertical group 02. If there is a call on one of the lines in that group, the marker serves it; if not, the marker attempts to serve calls in other vertical groups. The marker proceeds to do this by identifying which vertical groups have lines waiting service. Of those groups, a preference circuit will decide which one is to be served on this marker use. Similarly, the horizontal groups and vertical files will be examined, and the same preference circuit will select one of each in order to identify the line to be served on this marker use.

4.190 The preference circuit is advanced after each marker use.

B. Selection Preference for Originating Registers and Trunks

4.191 When selecting an originating register or a trunk circuit, the marker seizes a trunk link frame on which there is at least one idle circuit. If there are several idle circuits on the frame, the marker must select one for service. In order to distribute the traffic uniformly, a method of rotating the selection preference is used. The preference circuit is the same one used for selecting vertical groups, horizontal groups, and vertical files. Originating registers associated with a trunk link frame are grouped on one trunk block relay, trunk block 0. The maximum number of originating registers per trunk link frame is ten, the maximum number of trunks is 160.

4.192 The marker selects the trunk link frames in numerical order. However, the marker does not have a means of rotating the selection of frames. A frame memory circuit records the number of the frame used on the last marker usage. On the next marker use, the marker will select a higher numbered frame.

CODE CONVERSION

4.193 When calls from a No. 5 crossbar office are routed through an intermediate step-by-step office, it may be necessary to outpulse from the No. 5 crossbar office to the intermediate office digits which do not correspond to those dialed by a customer or operator. This conversion of codes is required where the trunking arrangements of the step-by-step selectors are on an arbitrary code basis.

4.194 Dial pulse and multifrequency outgoing senders are arranged (optionally) for a maximum of three arbitrary digits, from which full flexibility in single-digit, 2-digit, and 3-digit arbitrary codes can be obtained. The arbitrary codes can be substituted for the directory codes (code conversion) or they can be prefixed ahead of directory codes.

CALLS INVOLVING EQUIPMENT IRREGULARITIES

A. Stuck Originating Registers

4.195 An originating register may be stuck in such a way that after dialing is completed, it cannot obtain a marker. In this case, the register times out and releases itself and the dialing connection after 20 to 37 seconds. The originating customer is then given another dial tone connection. During periods of heavy traffic, the timeout period may be reduced to 10 to 18 seconds, depending on whether or not any digits are dialed.

4.196 If the originating register is stuck in such a way that it cannot register any of the

dialed digits, the call is treated as a permanent signal.

4.197 If the originating register is stuck in such a way that it registers part of the dialed digits, the call is treated as a partial dial.

B. Stuck Outgoing Senders

4.198 An outgoing sender which is being used in an outgoing connection may not be able to outpulse or complete pulsing because of an equipment irregularity. In this case, a DP or RP sender times out after 19 to 37 seconds on non-AMA calls, 7 to 13 seconds on AMA calls; an MF sender times out after 13 to 24 seconds on non-AMA calls, 7 to 13 seconds on AMA calls; an FSP sender times out after 12 to 24 seconds on non-AMA calls, 7 to 12 seconds on AMA calls. After timing out, the sender sets the outgoing trunk to give a reorder signal to the calling customer and releases itself from the connection.

4.199 The timing features of the PCI sender also depend on the type of call involved. On AMA calls, it allows 7 to 13 seconds for the initial entry. When handling calls to switchboards, it allows 19 to 37 seconds while awaiting assignment by an operator. After timeout, the sender sets the outgoing trunk to give a reorder signal to the calling customer and releases from the connection.

4.200 An outgoing sender may not be able to outpulse because of a shortage of incoming registers or senders in the connecting office. To prevent overloads in connecting offices from affecting the equipment in the No. 5 crossbar office, all senders are provided with an intersender timing feature. This feature allows for a delay of 4 to 8 seconds for the receipt of the start-dial signal. If the signal is not received by this time, the sender records this fact and continues to time. However, if a completing marker discovers that all senders in a desired group are busy, it will initiate a sender group-release signal to release all senders whose intersender timers have timed out. Before releasing, these senders will set their associated trunks to return a reorder signal.

4.201 If the trunk test which the sender performs fails, the sender times out to release after first setting the outgoing trunk to return reorder signal.

C. Stuck Incoming Registers

4.202 An equipment irregularity may prevent an incoming register from calling in a marker or from transmitting all of the necessary information to a completing marker after the register has seized the marker. In the first case and under normal conditions, a DP, RP, MF, or FSP register times out after 19 to 37 seconds and the register releases from the incoming trunk. In the second case, the marker, having been seized and lacking receipt of the call information, will time for 0.45 to 0.61 or 2.6 to 4.3 seconds, depending on which information is missing, and then signal the incoming register to make a second attempt. If this attempt fails, the second marker signals the incoming register to release and, if conditions permit, sets the incoming trunk to return a reorder signal to the originating end.

4.203 The timeout period for the DP incoming register is reduced to 4 to 8 seconds during heavy traffic; the timeout period for MF and FSP registers remains the same.

4.204 A stuck revertive pulse incoming register does not go to the marker, but signals the outgoing sender in the originating office to set up the reorder signal in the trunk. This register has the same timeout periods as the DP register.

D. Marker Irregularities

4.205 If for any reason, while handling a call, a dial tone marker encounters a trouble condition, it signals its associated marker connector to select another marker. If the second marker encounters trouble, the process is repeated. In this way, as long as there is an off-hook condition on the calling customer line, the line link marker connector continues to select a marker until the customer hangs up or the call is completed.

4.206 Before it releases, each marker which encounters trouble causes the trouble recorder to make a trouble record.

NO. 5 CROSSBAR SPECIAL FEATURES

A. Centrex Service

4.207 The addition of centrex service to the No. 5 crossbar office provides the means for PBX extensions to be switched directly by central

office common control equipment. All extensions terminate on the central office line equipment, eliminating the need for switching equipment at the customer location.

4.208 Centrex service effectively provides the equivalent of individual line service for each PBX extension. All incoming calls can be dialed directly to the extensions (DID). Automatic identification of outward dialed calls by centrex stations can be provided for automatic billing if the customer desires. A station within a centrex group can dial another station within that group on a 4- or 5-digit basis. Centrex can also provide attendant or dial transfer of calls, don't answer transfer, and busy line transfer.

4.209 No. 5 crossbar wire-spring-relay type offices can serve a maximum of 100 PBX customer groups or a lesser number of PBX customer groups combined with regular customers. For a more complete description of No. 5 crossbar centrex, refer to the general descriptive section for No. 5 crossbar centrex service.

B. Line Link Pulsing (LLP)

4.210 In some cases, it is not practical to serve all PBX extensions with central office switching equipment, and as a result, PBX switching equipment outside the central office is used. Line link pulsing provides a means for giving these customers direct-in-dialing (DID). Line link pulsing, as the name implies, allows outward pulsing from the line link frame without requiring a tandem switching function.

4.211 A main PBX location and one or more secondary locations can be served over a common PBX trunk group (Fig. 37, connection 1). When calls are directed to PBX extensions, a sender associated with the LLP circuit transmits the digits of the called extension to select that extension using PBX switching equipment. If the extension is served by a secondary PBX, the called number will be preceded by a directing digit which will be used by the main PBX to select a tie trunk to the secondary PBX and then the called number will select the extension within the secondary PBX.

4.212 In another LLP arrangement, extensions in the main PBX can be served directly by the No. 5 crossbar office (connection 2) and the extensions in a secondary PBX served by LLP (connection 1). With this arrangement, only the called extension number needs to be outpulsed since the PBX trunk used is incoming directly to the secondary PBX switching equipment.

4.213 Calls to PBX consoles may be handled directly by the No. 5 crossbar office (connection 3) or over the same trunk group which handles PBX extensions (connection 1). When connection 1 is used, the sender outpulses a single digit (usually 0) which is determined by the marker. This extends the call through the incoming switch at the PBX to the attendant console.

4.214 Provision has been made to route line link pulsing calls directed to unassigned, unequipped, changed, disconnected, or temporarily out of service directory numbers to an automatic intercept center (AIC) when the No. 5 crossbar office is arranged for automatic intercept service.

4.215 When the marker attempts to complete an intercept call, a number group cross-connection provides a blank or unassigned indication to the marker if the called number has been changed or disconnected. These indications cause the marker to generate the appropriate information digit plus the line number for the group of intercept lines.

4.216 The marker seizes the number group a second time for the equipment location of the intercept lines. Upon finding an idle intercept line with an idle sender, the marker connects the incoming trunk circuit to the intercept line circuit, transfers the called number and the information digit to the associated MF sender, and releases.

4.217 The information digit and the called number are pulsed to the AIC which connects an appropriate recorded announcement based on the information digit or routes the call to an operator.

C. Common Control Switching Arrangements (CCSA)

4.218 CCSA, also referred to as switched services networks, provides for the interconnection of several customer PBX locations by means of private line facilities or telepak voice channels. Switching is on a shared basis, using 2-wire or 4-wire No. 5 crossbar offices as switching centers. These networks are intended primarily for use by large industrial customers and government agencies who have extensive requirements for voice, telegraph, and data communications between a number of

geographical locations. Each customer network has its own private or dedicated access lines and network trunks and will share No. 5 crossbar switching centers with a maximum of four other private networks as well as regular No. 5 crossbar switching functions.

4.219 The services provided by CCSA will depend on the individual customer requirements. Some of the principal services are as follows:

(a) Uniform numbering plan—allows any station within a customer network to reach any other station by dialing a 7-digit telephone number or an access digit plus a 7-digit telephone number.

(b) Network indialing (NID)—allows dialing from outside the private network directly to stations served by the network.

(c) Network outdialing (NOD)—allows stations served by the network to dial directly to the DDD network or telephones not served by the network on a 7- or 10-digit basis.

(d) Dial or attendant controlled transfer of NID calls at centrex locations which are served by offices arranged for 100 classes of service.

(e) A maximum of 20 percent AMA traffic sampling of network usage. The information derived from this sampling can also be used for cost analysis by the customer.

(f) Optional universal service under attendant or direct station control—allows stations served by CCSA access to the DDD network on a station basis or under control of an attendant, depending on the arrangement the customer desires.

(g) Service observing arrangements.

(h) Traffic usage recording arrangements.

D. Direct Access Dialing From No. 5 Crossbar System to No. 101 Electronic Switching System

4.220 Arrangements have been provided in No. 101 ESS for direct access dialing from No. 5 crossbar offices. This direct access arrangement eliminates the need for line link pulsing from the No. 5 crossbar office.

4.221 When a call is established from a customer served by a No. 5 crossbar office to a customer served by a No. 101 ESS office, the marker in the No. 5 crossbar office connects to the No. 101 ESS office as it would to a number group circuit and passes a 4-digit called number. The No. 101 ESS office translates the four digits to determine the called customer and trunk to be used and passes the line link frame appearance of this trunk to the marker. The marker proceeds to connect the call to the trunk identified.

4.222 The No. 101 ESS times for seizure on the trunk and when a seizure signal is received the call is cut through to audible ringing or busy tone. When the called customer answers, the No. 101 ESS returns answer supervision to the No. 5 crossbar office and establishes a talking connection to the called customer.

E. Range Extension and Unigauge

4.223 Outside plant cabling is being converted to a uniform gauge. Customer loops which do not exceed 30,000 feet in length are using 26-gauge cable. As a result, this cable contains approximately half the copper which was required for the 22-gauge cable previously used and provides a considerable savings in copper cost.

4.224 The use of smaller gauge wire increases the customer loop resistance and results in greater losses in the customer loop. To compensate for these greater losses, it is necessary to increase voltage levels for signaling and talking purposes and provide amplification for voice frequencies.

4.225 To provide an economical arrangement for serving customers with high loop resistance, a circuit called a range extender has been added. As shown in Figure 38, the range extender is inserted in the line link frame between the line link primary and the line link secondary. Physically, this equipment is mounted externally to the line link frame and connected by cabling.

4.226 In addition to the range extender, higher battery voltage is used and circuits are modified to apply the higher battery for customer long loops.

5. EQUIPMENT ARRANGEMENTS

5.01 The line link and trunk link frame line-ups are usually placed close together to reduce the length of the cabling between these frames and a junctor grouping frame which is common to both. For the same reason, the trunk link connectors are next to each trunk link frame. The testing and maintenance frames are located in a central spot for easy access.

5.02 The basic framework is the same throughout the No. 5 crossbar office. The frames are 11-1/2 feet high and 10-1/2 inches deep and their widths vary from 20-1/2 to 45 inches. Generally, they are arranged with the apparatus sides of two frames facing each other, with a 2-foot 6-inch aisle between them. The wiring aisles between the backs of the frames are approximately 23 inches wide.

5.03 Since the contacts of wire-spring-type relays are protected from dust by a cover and equipment using these relays is wired with fire-resistant wire, front and rear frame covers are not furnished on frames where such equipment is mounted. Frames on which flat-spring-type relay equipment is mounted are furnished with enclosures. There are metal covers for some equipment units and transparent plastic covers for others. When the equipment units are enclosed with front covers, front horizontal baffles are provided to prevent the distribution of dust and the spread of fire. Rear baffles are provided with rear covers.

5.04 An end guard, which is a metal panel, is on the side of the frame at the end of a frame line-up. The aisle pilot lamps for the alarm systems are mounted on these end guards at the main aisle end of the line-up. There is also space for mounting the frame distributing fuses at the top end of the guard panel.

5.05 The front of each frame is stamped with the frame name and number. In addition, each line-up has designation cards to identify each frame and its position in the line-up.

5.06 In order to trace the interconnections between the circuits mounted on these frames, designation cards which contain this information are provided for various frames.

6. MAINTENANCE FEATURES

GENERAL

6.01 The basic provisions for maintenance of No. 5 crossbar offices consist of the following:

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

(b) Arrangements for providing notice of, and information about, failures occurring on service and test calls

(c) Means for removing equipment from service.

In addition, testing equipment is provided for use in the maintenance of the customer line plant and of trunks terminating in other buildings.

6.02 The majority of the equipment required for the maintenance features is mounted on bays which collectively are called the master test frame. The remaining apparatus is mounted on other equipment bays or frames, or in portable test boxes.

6.03 For small and medium sized offices, an office test frame is used rather than a master test frame. This test frame and its associated trouble indicators is intended for use with 580-, 980-, and 1960-line offices. The office test frame does not have a trouble recorder associated with it. It uses lamps to indicate trouble and test conditions.

6.04 The master test frame bays are required in larger offices. They are located in the maintenance center, since most of the apparatus required for operating and administering the testing and the other maintenance features associated with the master test frame are mounted on these frames. This apparatus includes a recording device which automatically provides, in the form of punched cards, information concerning both failures on service calls and the results of certain test calls.

6.05 A basic 2-bay connector frame is provided as part of the master test frame in every office for the purpose of connecting to a maximum of eight completing markers. An auxiliary bay is provided for each marker group equipped for AMA. A separate connector bay is provided for connecting to dial tone markers. These connector bays are

placed in some convenient location, but not necessarily in or close to the maintenance center.

6.06 From one to four additional frames may be required, depending on the type of testing equipment desired for the senders and registers and on the type of senders and registers to be tested. These bays are also located in some convenient location on the maintenance center floor.

6.07 The following choice of testing equipment for the senders and registers is available.

(a) Permanently located apparatus arranged to provide extensive tests of the circuits. This equipment will automatically produce or select digits, using pulses which are precise in speed (ratio of open to closed intervals), and it includes registering devices for receiving the output of senders.

(b) Test set type testing equipment employs portable test sets which perform marginal tests only. It is used where a small expense in test apparatus is desired and requires that digit and selection pulses be produced by manually operating a dial or keys. Some auxiliary apparatus is required and is located on the master test frame. With such an arrangement, a pulse generator, capable of producing pulses which are accurate in speed and length of pulse and which can be varied over a considerable range, will be required for occasional conditioning purposes. Such a generator is available in portable form.

6.08 The choice of testing arrangements can be made for each type of sender or incoming register, except for tandem revertive incoming registers. For these registers, only the test set type of testing equipment is available. It should be noted that although a No. 5 crossbar office may be furnished with both testing facilities (the automatic monitor, register and sender test circuit and the test set type facilities), both cannot be used for testing the same type of registers or senders. Each testing facility requires a different circuit arrangement in the type of register or sender to be tested. This prohibits the use of both facilities for testing the same type of registers or senders.

6.09 The more complete type of testing equipment is a dual-purpose arrangement which permits its use as a means for automatically monitoring on the senders and registers while they are being used on service calls. Failures indicated during this monitoring process cause the trouble recorder to make a record of the conditions and of the circuit units used on the call.

6.10 In addition to the trouble recorder, the following apparatus is mounted on the four basic bays located at the maintenance center.

(a) Keys, lamps, and other apparatus for directing test calls to the circuit or combination of circuits to be tested, for controlling the actual testing functions and indicating the progress of the test call, and for monitoring on senders and registers. Certain testing functions are also included in the control circuit.

(b) The apparatus required for making tests of trunk circuits.

(c) Lamps for indicating certain trouble conditions which do not cause an automatic record to be made and other lamps which indicate the duration of use of certain of the circuits.

(d) Lamps and jacks associated with permanent signal holding trunks, common overflow trunks, and plugging-up lines.

(e) Jacks for taking units of the common control equipment out of service.

(f) Test and make-busy jacks for outgoing trunks.

(g) A voltmeter circuit for use in testing customer lines and outgoing trunk circuits.

(h) Communication trunks, including a telephone circuit and a dial.

(i) Plant peg count registers.

6.11 Some of the other testing equipment used in No. 5 crossbar offices is as follows:

(a) A manually operated outgoing trunk test frame for use where there are a large number of outgoing trunks.

(b) A 17-type toll testboard for use in maintaining intertoll trunks. For smaller installations, a 4-type toll test unit or the 18-type toll testboard may be used in maintaining intertoll trunks.

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

(d) Test lines for making 1000-Hz one-way transmission tests of local and intertoll trunks.

(e) Test lines for making loss and noise transmission tests of local and intertoll trunks.

(f) A test line for making a balance test of intertoll trunk circuits.

(g) A test circuit for checking foreign area translator code cross-connections.

(h) A test circuit for checking the cross-connections in the number group frames and AMA translator frames.

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

(j) Several portable test sets.

(k) Testing arrangements required for use in the maintenance of customer lines consisting of the following:

(1) An automatic line insulation test circuit

(2) Station ringer test arrangements

(3) Test and no-test trunks, which can be used to reach customer lines from the local test desk

(4) Trunks to local test desk

(5) A circuit under control of test desk for providing access to permanent signal holding trunks and plugging-up lines.

6.12 An alarm system giving audible and visual signals is provided. It is used to advise the central office personnel of trouble conditions and to assist in locating these troubles. Location is accomplished by a pilot lamp indicating the floor involved and pilot lamps at main aisles, cross aisles, and the aisle in which the trouble is located. Individual lamps are provided on equipment frames or master test frame as needed. Arrangements are available for transferring alarm indications to some other point in the same or another building when the office is to be unattended.

6.13 Except for the test set type testing arrangements, the uses and operation of the various features of the master test frame are described in the master test frame description. Features of the office test frame are covered in the office test frame description.

6.14 General description of test set type testing arrangements, testing equipment for message registers, and arrangements for testing of customer station ringers and general central office alarm circuits are given in the following paragraphs.

TEST SET TYPE TESTING ARRANGEMENTS FOR REGISTERS AND SENDERS

6.15 A portable test set is provided for use in testing both originating and incoming registers in offices with a master test frame. This test set is provided with two standard dials, one in the 8- to 11-pps (pulse per second) range and one in the 16- to 19-pps range. A keyset is also provided for use in testing MF incoming registers. The dials are used for testing both originating and dial pulse incoming registers. Some additional control keys and lamps are also provided.

6.16 Access to originating registers is obtained by the master test frame in the same manner as when the more complete test equipment is provided. The portable test set is then connected to the registers by way of the master test frame. The dials on the test set are used to send the test code and number into the register. The results of the test are shown on a trouble recorder card.

6.17 Access to incoming registers is obtained by way of a control circuit provided when the portable test set is to be used. This control circuit is mounted on the master test frame. The test set is connected to the control circuit and some auxiliary apparatus, to a source of multifrequency for use when testing MF registers, and to a source of battery and ground. When testing revertive pulse incoming registers, the keyset is used to control the number of revertive pulses expected for each selection. The results of the tests are shown on a trouble recorder card.

6.18 A separate portable test set is provided for testing outgoing senders, and a separate auxiliary relay circuit is required for each type of outgoing sender, DP, MF, RP, PCI, and FSP. Access to the sender is obtained by way of the master test frame.

6.19 Test connections are made in the same manner as described for registers, except two patching cords are used for this test set.

6.20 The test set is provided with lamps which light when DP, MF, FSP, or PCI pulses are transmitted by the sender. In the case of revertive pulse senders, the pulses are transmitted by the auxiliary relay circuit, and the lamps record the number of pulses required to cause the sender to open its fundamental circuit on each selection. In the case of MF senders, the pulses are transmitted by the sender into an MF receiver, from which the test set gets its information. This receiver can be one which is normally associated with an MF incoming register or a receiver provided for testing purposes.

6.21 The portable test sets can be used at the master test frame or, by means of a tie line arrangement, at the location of the circuit being tested.

ELECTRONIC PULSE GENERATOR

6.22 The electronic pulse generator is a portable device arranged so that pulses (opening and closing of a circuit path) at any desired speed and ratio of closed to open periods over a reasonably large range can be obtained. The purpose of this generator is to provide the means for making an occasional marginal test of senders and registers without necessitating the provision of pulse generating equipment (used to make these tests) in the master test frame in every office.

ARRANGEMENT FOR TESTING CUSTOMER STATION RINGERS

6.23 A station ringer test circuit is reached by dialing a special code and replacing the receiver on-hook. The ringing is stopped by again taking the receiver off-hook.

6.24 For the No. 5 Crossbar System, a special code is dialed, followed by the number assigned to the station under test. The code causes a connection to be established between the line and a ringer test circuit.

6.25 The number which is dialed causes the marker to set the ringing selection switch associated with the selected circuit for the kind of ringing which the station should receive.

CENTRAL OFFICE ALARM SYSTEM

6.26 The central office alarm system provides audible and visual signals to notify the maintenance force of trouble conditions and the location of the equipment in trouble.

6.27 Each aisle is equipped with a red aisle pilot lamp for indicating major alarms involving that aisle and with a green aisle pilot lamp for indicating minor alarms.

6.28 The same general arrangement of cross-aisle, main-aisle, and other floor and exit pilots, are provided. Similarly, an individual lamp indicating the equipment causing the alarm is provided.

6.29 The audible signals are those which have been standard for other systems, as follows:

(a) Tone bar for major alarms

(b) Customer sets for minor alarms

(c) Customer set for alarm battery fuse alarms

(d) Loud ringing bell for indicating power failures affecting a portion of the office.

AUTOMATIC LINE INSULATION TEST EQUIPMENT

6.30 The primary function of this equipment is to automatically scan customer lines for defects which show up as low insulation resistance. A secondary function (optional) is used for making some traffic measurements. In regard to the latter, it is arranged to automatically scan line links and trunk links at regular intervals and to record the number of links found busy.

6.31 When used for testing customer line insulation, about 12,000 lines per hour are tested and the trouble recorder records the line link equipment number of the lines failing to meet the test conditions or transmits the data to a teletypewriter page printer at the local test center.

LINE VERIFICATION FRAME

6.32 This circuit is used to verify the cross-connections associated with line numbers in the number group frame, class-of-service cross-connections in the line link frame, and the cross-connections associated with line numbers in the LAMA and ANI translators. These tests may be made independently or performed in combination. When combined into one test, the number group and line link frame cross-connections are checked and then the associated cross-connections in the translator. Lamps light to indicate verification or mismatches.

6.33 The line verification frame is a single-bay frame and may be used in common by two marker groups. The use of this circuit allows the master test frame to be employed for clearing troubles.

AUTOMATIC PROGRESSION TRUNK TEST FRAME

6.34 With the automatic progression trunk test frame the following trunks may be tested automatically or manually.

- Outgoing intertoll
- Outgoing interoffice
- Intraoffice
- Customer-to-customer intermarker group
- Customer-to-trunk intermarker group
- Line link pulsing
- Centrex
- Data.

These tests may be transmission tests or operational tests. In addition, CAMA incoming trunks, CAMA intermarker group trunks, CAMA junctors, and outgoing junctors may be tested operationally on a manual or automatic basis. When these tests are done automatically, the test frame is under control of a tape fed into teletypewriter equipment. This tape is prepunched to identify the trunks to be tested and the tests to be made. The results of the tests are displayed at the test frame by progress lamps and/or printed on teletypewriter page copy. Any test failure, when the frame is used for automatic testing, will cause the frame to stop its tests and sound an alarm or produce a teletypewriter page printout to indicate the trouble.

7. GLOSSARY

7.01 The following is a glossary defining terms used throughout this section.

A and B Appearances for Trunks on Trunk Link Frame These are the two possible trunk switching connections on a trunk link frame. Trunks are assigned to these appearances according to the traffic engineering practices of an office. Originating registers are always assigned to the A appearances.

Alternate Routing A method of advancing a call at any point by diverting it to a trunk group other than the first choice group when the first choice group is busy. Arrangements for three alternate routes are provided.

Assistance Call A call which the customer could or could not dial directly, but on which he dials zero to contact the operator for assistance.

Automatic Message Accounting System or AMA System An equipment arrangement for recording and processing on continuous paper tapes or magnetic tape the data required for computing telephone charges on customer-dialed calls and on calls handled by operators where provision is made for treating these calls in a similar manner. The system may include provision for compiling all charges and credits which affect the customer bill and the automatic printing of the bill.

Automatic Monitor A unit of equipment which attaches itself to registers and senders on a progressive basis. It records the signaling input without distortion and compares this with the output. The unit causes the trouble recorder to record any incorrect operation and may be used under manual control for testing senders and registers.

Blank Number A number outside the assigned capacity for a particular office.

Call Versus Job The word call is used only if the function is inclusive of all equipment. (See **Job.**)

Central Office Code A code consisting of the one, two, or three digits or letters which appear in front of the numericals of a directory number. The

central office code identifies a particular office within an exchange area.

Channel A combination of a line link, a junctor, and a trunk link which, by crosspoint closures, forms a path to connect a line with a trunk or a trunk with a trunk.

Channel Number A composite number identifying the line switch horizontal number of the line link, the trunk switch vertical number of the trunk link, and the junctor switch number in a channel.

Charge-Delay Interval An extended interval of time (2 to 5 seconds), maintained in the control of message charging, to ensure against possibilities of false charging due to transients or other conditions of short duration.

Class of Service The commercial term applying to the subgrouping of customers for the sake of rate distinctions. This subgrouping may, for example, distinguish between individual and party, between business, residence, and coin, between flat rate and message rate, and between restricted and extended scope. In equipment and traffic engineering, it is used to refer to the subgrouping of lines for originating service for the sake of equipment operation distinction, whether or not rate distinctions are involved. For example, in dial operation, lines may be subdivided into PBX and non-PBX classes to permit proper use of the howler on permanent signal conditions.

CLR Operator A toll operator who performs the following duties:

(a) Answering the call when the customer dials the long distance code 211

(b) Writing the toll ticket, using the information furnished by the customer

(c) Making attempts to reach the called party while holding the calling party

(d) Timing the call if connection is established

(e) Passing the ticket to the designated TX operator if the initial attempts fail and the operator dismisses the customer.

Code Conversion Converting a directory or toll directing code into an arbitrary code for controlling the selection of a trunk route at a distant switching point.

Code Point A terminal punching located in a cross-connection field in the marker and energized by registration of a 1-, 2-, or 3-digit code.

Code Ringing Party line ringing wherein the number of rings, their duration, or both, indicate which customer is being called.

Coin Service A public, semipublic, or customer class of service which has a coin collecting device as part of the station equipment.

Coin Supervisory Link A switching arrangement for connecting originating dial equipment to coin supervisory circuits.

Coin Test A test made by either the originating register or coin supervisory circuit to establish the presence of a coin in the trap of a coin station subset.

Combined Toll and Dial System A Switchboard or Toll and DSA Switchboard A local dial office switchboard which handles toll assistance calls, intercepted calls, and calls from miscellaneous lines and trunks.

Common Control Equipment All switching equipment exclusive of line link frames and trunk link frames.

Connector A relay-type switching device for interconnecting two equipment elements over a relatively large number of leads.

Dial Pulsing (DP) A system of dc pulsing in which the digits are transmitted by the interruption of the dc circuit a number of times, one of ten interruptions corresponding to the digits 1 through 0 on the dial.

Dial System B (DSB) Switchboard A switchboard of a dial system for completing incoming calls received from operators over straightforward or call circuit trunks.

Dial Tone A tone used in dial telephone systems to indicate that the equipment is ready for the dialing operation.

Directing Code Digits, such as 11, 0X, and X1X, dialed ahead of the directory number of the called

station. These will enable a customer or operator to dial a number in an area out of the basic numbering plan area of the customer or operator.

Directory Number The full complement of digits required to designate a customer in the directory. In a 5-, 6-, or 7-digit exchange area, the directory number consists of the office code followed by four numericals. In some areas, a station letter to control selected ringing follows the four numericals and is considered part of the number.

Divided Ringing A method of obtaining partial ringing selectivity by connecting one-half of the ringers from one side of the line to ground and the other half from the other side of the line to ground. This term is not ordinarily applied to selective and semiselective ringing systems.

Exchange A unit of a telephone company used for the administration of service in a specified area which usually encompasses a city, town, or village and its suburbs. It consists of one or more central offices together with the associated plant used in furnishing communication service in that area. Ordinarily an individual local tariff is filed for each exchange.

Exchange Area The territory included within the boundaries of an exchange.

Extheo Contraction of the words extra and theoretical. (See **Theoretical Number.**)

Flat Rate Service A customer classification of local service in connection with which a stipulated monthly charge is made covering all message use to stations within a specified area.

Foreign Area Translator An equipment frame and associated circuits common to a marker group used in conjunction with the markers for translating the office codes of a foreign area for routing purposes when there is more than one trunk route available for entry into the foreign area.

Free Code Call A call which the terminating equipment recognizes from the code dialed as one to be handled on a free-service basis.

Frequency Shift Pulsing (FSP) A method of pulsing in which the 0 through 9 digits and the start and end signals are represented by a frequency shifted above or below a reference frequency to represent these digits in a 2-out-of-6 code.

Home Area The numbering plan area in which a calling customer is located.

Horizontal Group All of the lines served by the same ten line links.

Incoming Register The register which receives the pulsing (dial, multifrequency, or revertive) from the incoming trunk and transmits it to the marker through an incoming register marker connector.

Incoming Register Link A switching arrangement for connecting incoming trunks to incoming registers.

Incoming Trunk A trunk incoming to a local central office switching unit for use in terminating calls on the customer lines of the unit. Also, a trunk incoming to a local toll, tandem, or PBX switchboard or switching unit.

Interoffice Trunk A trunk between two switching units regardless of type. This term is confined largely to trunks between local offices in the same exchange area.

Intertoll Office Trunk or Intertoll Trunk A trunk between toll switchboards or toll switching systems in different offices.

> *Note:* Where combined toll and local switchboards are involved, the trunks are classed as intertoll or interlocal, depending on whether the switchboards in question are performing toll switchboard or local switchboard functions in handling the traffic over these trunks.

Intraoffice Trunk A trunk between two points in the same central office or switching unit.

Intermarker Group Trunk A trunk between two marker groups located in the same building. There are three types of these trunks:

(a) Customer-to-customer

(b) Customer-to-trunk

(c) Trunk-to-customer.

Inward and Through Toll Position An inward and through toll position is used primarily to receive calls over intertoll trunks and to establish inward connections to local customers or extend through connections to other intertoll trunks. In certain cases, the inward function and the through function may be performed at separate positions.

Job A specific function attributed to the marker. (See **Marker Job.**)

Junctor A circuit extending between frames of a switching unit and terminating in a switching device on each frame.

Junctor Group The junctors which extend from a particular line link frame to a trunk link frame. The size of the junctor group depends on the number of trunk link frames or pairs of trunk link frames.

Junctor Grouping Frame A frame which functions to facilitate the distribution of the 100 junctors from each line link frame to all of the trunk link frames so that each line link frame will have equal access to all trunk link frames.

Line Link A switching arrangement for connecting customer lines to junctors on originating calls and junctors to customer lines or trunks on terminating or through calls.

Line Link Frame A frame containing line links with associated equipment and customer line relays.

Local Central Office or Local Office A switching unit in a telephone system serving primarily as a place of termination for customer lines. It has a maximum of 10,000 numbers. Services can be provided on both a physical and theoretical office basis. This arrangement is considered as one local central office.

Local Service Area The area within which are located the stations which a customer may call at local rates in accordance with the provision of the local tariff.

Main Distributing Frame (MDF) A frame for terminating the permanent inside and outside wires in a central office and for effecting flexible connections between them. It generally carries the central office protective devices and functions as a test point between line and office.

Marker Equipment which establishes communication paths between calling customers and trunks, between trunks and called customers, and between trunks.

Marker, Combined A marker which performs all marker operations in the office.

Marker, Completing A marker which performs all marker operations except the dial tone job.

Marker, Dial Tone A marker which performs marker dial tone job only.

Marker Group 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.

Marker Job The single marker usage (from seizure to release) involved in completing any one of its designated functions. Marker jobs are indicated accordingly as follows:

(a) Dial tone job

(b) Intraoffice trunk job

(c) Outgoing trunk job

(d) Incoming trunk job

(e) Reverting trunk job

(f) Toll trunk job

(g) Tandem trunk job.

Master Test Frame A unit of equipment which provides for the testing of the equipment units of a marker group.

Master Test Frame Connector A connector by which markers and other equipment obtain access to the master test frame.

Message Rate Service A customer classification of local service which is measured in terms of messages or message units for the purpose of charging for the service.

Message Register A counting device which records message units on originating traffic for calls to points within the one message unit charge area. In the No. 5 Crossbar System, message registers can be used only in connection with individual and 2-party message rate classes of service.

Message Unit The unit of measurement for charging for message use by the translation into equivalent message units of ticket or AMA charges for calls within a specified area.

Multifrequency (MF) Pulsing A method of pulsing in which the identity of the ten digits (0 through 9) and the start and end signals are each determined by combinations of two of six frequencies. The two frequencies for each digit, or signal, are transmitted simultaneously over the trunk.

No-Hunt Call A call made from the outgoing trunk test frame or the message register rack which will not hunt in a terminal hunting group. If the line associated with the dialed number is busy, busy signal is returned.

Nondiscriminating Number A number associated with two office codes. Such a number is reached regardless of which of the two codes is dialed.

No-Test Call A call from an operator or a test desk which will connect to the dialed customer line regardless of whether or not it is busy. If the line is idle, the connection is established through a regular channel, and if the line is busy, the connection is established through the no-test connector and a no-test vertical on the line link frame.

No-Test File The ten vertical units which are used for no-test operation and are located one above another on a line switch bay of the basic line link frame.

No-Test Vertical Vertical file 0 in vertical group 02 of each line link frame contains ten no-test verticals. These no-test verticals are used when a connection is established between a busy line and a no-test trunk through the no-test connector. No-test verticals 0 through 4 are multipled, and also no-test verticals 5 through 9, so that only two no-test calls may be simultaneously established through the no-test connector between no-test trunks and busy lines of one line link frame.

Number or Numericals The digits which identify a customer in a central office. A letter suffix, a requirement in some offices, is considered part of the numericals.

Numbering Plan The arrangement of digits as listed in local area directories. For example, a directory number with three code digits and four numericals is in a 7-digit numbering plan.

Numbering Plan Area The United States and Canada are divided into numbering plan areas. In general, the subdivisions follow state and province boundaries. However, where there is a high telephone density, a state or province may have two or more areas within its geographical boundary. Each numbering plan area is assigned a national code in the X0X and X1X code series. Within a numbering plan area, there can be no local office code conflicts.

Number Series Ten thousand or less nonconflicting numbers between 0000 and 9999. They may be associated with one, two, or three office code groups.

Number Series Group Thirty thousand or less numbers that are associated with three or less office code groups. There is a maximum of two number series groups, designated group A and group B, each consisting of a maximum of three number series with a maximum of three office code groups. Number series groups A and B have the same significance as offices A and B (in past terminology) when each number series group consists of a single number series.

Number Group (NG) Frame A frame containing 1000 consecutive numbers that can be associated with one, two, or three office code groups. A maximum of 40 number groups are associated with one marker group.

Office A—Office B The terms which refer to each of the two number series groups in a marker group.

Office Code Group One or more local office codes associated with 10,000 or less directory numbers, given the same rate or number treatment (office code or codes grouped together to operate the same local completion relay in the marker).

Office Selector Tandem A group of distant office selectors controlled from the originating office or from a sender tandem.

Office Test Frame A unit of equipment units in smaller No. 5 crossbar offices not equipped with a master test frame.

Operator—Completing Trunk A trunk at the DSA switchboard over which the operator can complete assistance calls either to a customer served by the office in the building or to an outgoing trunk from that office.

Originating Register A register connected to a customer line via line and trunk links for giving dial tone and for recording the customer-dialed or keyed pulses.

Originating Stage That portion of the switching process involved in extending the connection from the selected intraoffice trunk to the originating line. The originating stage is a subdivision of the marker intraoffice trunk job.

Outgoing Trunk A trunk used for calls terminated outside a switching unit.

Outward Toll Position An outward toll position is arranged to complete, time, and ticket toll calls received from customers. These positions may also handle DSA traffic.

Overflow Tone A tone returned to the calling customer to indicate the call could not be completed because the marker was unable to find an idle channel, outgoing sender, or trunk to use in the connection. Overflow tone is usually interrupted 120 times per minute.

Panel Call Indicator (PCI) Pulsing A system of dc pulsing in which each digit is transmitted as a series of four marginal and polarized impulses.

Partial Dial or Partial Digits A failure of the originating register to receive sufficient digits to complete the call. It may result from a customer dialing before dial tone or failing to dial or key sufficient digits after receiving dial tone.

Party Line A customer line arranged to serve more than one main station. Provision is made for discriminatory ringing with respect to the parties on that line.

Permanent Signal The condition caused by the operation of a line relay followed by no dialing or keying. After a measured interval, the customer line is connected to a permanent signal trunk in order to conserve register usage and to ensure proper maintenance action in case of trouble on the line.

Physical Number An arbitrary designation for the numbers associated with only one of three office codes using the same number series. The numbers associated with the other office code only are designated as theoretical or extheo numbers.

Physical-Theoretical Discriminating Feature The feature which indicates to the marker whether the physical or the theoretical office is wanted and whether the number is a physical or a theoretical number.

Pretranslation This operation takes place after a fixed number of digits (usually the office code) has been recorded to determine how many additional digits, if any, are required for the complete translation of the directory number. This feature is designed to reduce time delay in transmitting the call from the register to the marker where the total number of digits which can be dialed or keyed is variable.

Pulse Conversion The operation of changing, when necessary, the type of pulsing between connecting offices in order to meet their particular transmission requirements.

Pulsing The act of transmitting digit information over a circuit to a switching unit for the purpose of reaching a called customer or operator. The various kinds of pulsing used in the No. 5 crossbar office with interconnecting offices include the following:

(a) Dial (DP)

(b) Multifirequency (MF)

(c) Panel call indicator (PCI)

(d) Revertive (RP)

(e) Frequency Shift Pulsing (FSP).

Rate or Number Discrimination Discrimination is a means of differentiating, where necessary, between numbers in different code groups but within the

same number series group. Numbers in two different number series groups are differentiated by a number series group A or B indication. Where required, rate discrimination is provided for giving separate rate treatment to the three or less office code groups within a number series group. Where rate discrimination is not provided, it may be necessary to provide number discrimination to identify the particular number series so that a connection to the correct number group can be made. For example, if no rate discrimination is necessary for two office code groups that are associated with different number series, number discrimination must be provided.

Recycle The action which releases the initially selected trunk, and permits an attempt to establish the connection to another trunk of the same route but using a different group of junctors and trunk links.

Reverting Call A customer-dialed call between two customers served by the same customer line.

Revertive Pulsing (RP) A system of DC pulsing in which intelligence is transmitted in the following manner:

(a) The near end presets itself in a condition representing the number of pulses required and in a condition to count the pulses received from the far end.

(b) The terminating end transmits a series of pulses by momentarily grounding out its battery supply until the originating end breaks the dc path to indicate that the required number of pulses has been counted.

Reverting Call Trunk A trunk used to set up a talking channel for a reverting call.

Selective Ringing A party line ringing system where the bell of the desired party only is rung. The No. 5 crossbar office is designed to utilize individual 2- and 4-party full-selective ringing.

Semiselective Ringing A party-line ringing system where the station bells of two parties are rung simultaneously, differentiation being made by a single-ring, 2-ring code. The No. 5 crossbar office is designed to utilize 4- and 8-party semiselective ringing.

Sender A unit of equipment in the dial switching system which receives digits from the marker and transmits them as pulses to a distant office.

Sender Link A switching arrangement for connecting outgoing senders and trunks.

Service Code Call A customer call to a service desk, such as repair, test desk, or long distance, which is identified by the code dialed (usually an X11 code).

Special Hunt Test Call A call made from the test desk to a customer line for the purpose of making voltmeter and other tests on the line. Special test calls use a special marker, and certain tests which are made on regular calls are omitted.

Tandem Central Office or Tandem Office A central office used primarily as an intermediate switching point for traffic between other central offices. Unless qualified by a prefix or other explanation, this term is restricted by usage to an office used primarily for the interconnection of local central offices.

Tandem Screening A circuit feature of combined and completing markers whereby calls incoming to a No. 5 crossbar office, serving as a tandem office, from customers in a step-by-step office, can be screened for rate purposes. The code of the called office received in the marker must be one within the rate area of the calling customer in order for the call to proceed through the tandem office; otherwise, the call is denied completion.

Tandem Trunk A trunk incoming to a tandem office, tandem switchboard, or tandem position from a local office or switchboard.

Terminal Hunting The function performed by the switching equipment in a dial office in searching for an idle line in a PBX or other terminal hunting group.

Terminating Stage The switching process involved in extending the connection from the selected intraoffice trunk to the terminating line. The terminating stage is a subdivision of the marker intraoffice trunk job.

Theoretical Number An arbitrary designation for the numbers associated with only one of three office codes using the same number series. The

numbers associated with the other office codes only are designated as physical or extheo numbers.

Toll Call Any call for a destination outside of the local service area of the calling station.

Tone Trunk A trunk which supplies tone to the calling customer. The marker attempts to route a customer to a tone trunk for conditions of overflow, partial dial, vacant code, or line busy on an intraoffice call.

Trunk Link A switching arrangement for connecting originating registers and trunks to junctors.

TX Call A call which terminates at a TX operator position.

TX Operator An outward toll operator or team of operators who performs three specialized jobs.

(a) Initiating subsequent attempts on toll calls which are delays for the following reasons:

(1) The called party does not answer.

(2) The called line is busy.

(3) An all-circuits-busy condition was encountered on the initial attempts by the CLR operator.

(4) The specific person was not available on a person-to-person call.

In the last case, the CLR operator "leaves word" for the called person to call the TX operator in the originating city.

(b) Completing the call when the specific person in the distant city reports back on a "leave word" call.

(c) Keeping a file of uncompleted and delayed toll tickets to specific locations and answering inquiries concerning the status of completion.

TX Trunk A trunk that has its terminating end in front of a TX operator.

Unassigned Number A number within the assigned capacity for a particular office, but unassigned to a customer.

Vacant Code or Vacant Code Point A code point which is unassigned. If a call is directed to a vacant code point, it is routed to an operator or vacant code trunk.

Vertical File The ten vertical units of a crossbar switch, located one above another on a line link frame.

Vertical Group The five vertical files making up the left or right half of a column of lines.

Note: One of the vertical groups of each line link frame contains the no-test file. Consequently, this vertical group has only 40 instead of 50 lines.

TABLE A

TYPES OF PULSING

PULSING FROM NO. 5 CROSSBAR OFFICE	INTERCONNECTING OFFICE	PULSING TO NO. 5 CROSSBAR OFFICE
Multifrequency (MF) Dial (DP) Revertive (RP) Frequency Shift (FSP)	No. 5 Crossbar	Multifrequency (MF) Dial (DP) Revertive (RP) Frequency Shift (FSP)
Multifrequency (MF) Revertive (RP) Dial (DP)	No. 1 Crossbar	Multifrequency (MF) Revertive (RP) (Predominant)
Revertive (RP)	Panel	Multifrequency (MF) Revertive (RP) (Predominant)
Dial (DP)	Step-by-Step	Dial (DP)
Panel Call Indicator (PCI) Straightforward (Nonpulsing) Step-by-Step Call Indicator (DP)	Manual	Multifrequency (MF) Dial (DP) Straightforward (via DSB Switchboard)
Panel Call Indicator (PCI)	Panel Sender Tandem	Revertive (RP) Dial (DP)
Multifrequency (MF) Dial (DP) Revertive (RP)	Crossbar Tandem	Multifrequency (MF) Dial (DP) Revertive (RP)
Multifrequency (MF) Dial (DP)	No. 4-Type Toll (Crossbar)	Multifrequency (MF) Dial (DP) Revertive (RP)
No Provision	Panel Distant Office Tandem (2-Wire Office)	Revertive (RP)
Multifrequency (MF)	Electronic Switching	Multifrequency (MF)

TABLE B

CONNECTORS

CONNECTOR	CONNECTS FROM	CONNECTS TO
Line Link Marker Connector	Line Link Frame	Dial Tone Marker
Originating Register Marker Connector	Originating Register	Completing Marker
Incoming Register Marker Connector	Incoming Register	Completing Marker
Transfer Line Link Marker Connector	Transfer Line Link Frame	Dial Tone Marker
Transfer Register Marker Connector	Transfer Register	Completing Marker
Line Link Connector	Dial Tone or Completing Marker	Line Link Frame
Trunk Link Connector	Dial Tone or Completing Marker	Trunk Link Frame
Transfer Line Link Connector	Dial Tone Marker	Transfer Line Link Frame
Transfer Trunk Link Connector	Dial Tone Marker	Transfer Trunk Link Frame
Outgoing Sender Connector	Completing Marker	Outgoing Sender
Number Group Connector	Completing Marker	Number Group
Foreign Area Translator Connector	Completing Marker	Foreign Area Translator
Direct Access Pretranslator Connector	Completing Marker	Direct Access Pretranslator
ANI Transverter Connector	Outgoing Sender	ANI Transverter
Pretranslator Connector	Originating Register	Pretranslator
Transfer Register Identifier Connector	Line Identifier	Transfer Register

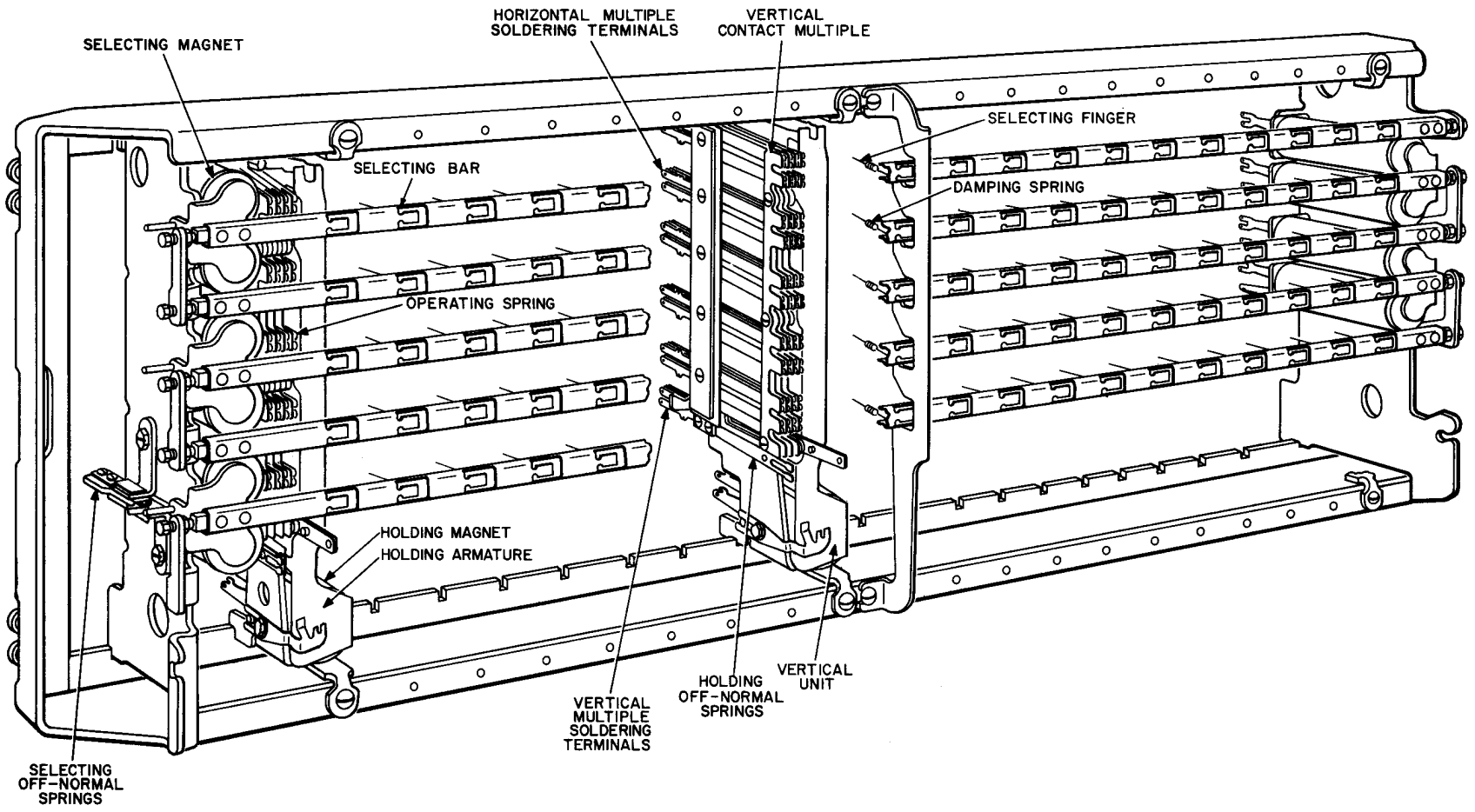


Fig. 1—200-Point Crossbar Switch for 20 Vertical Units

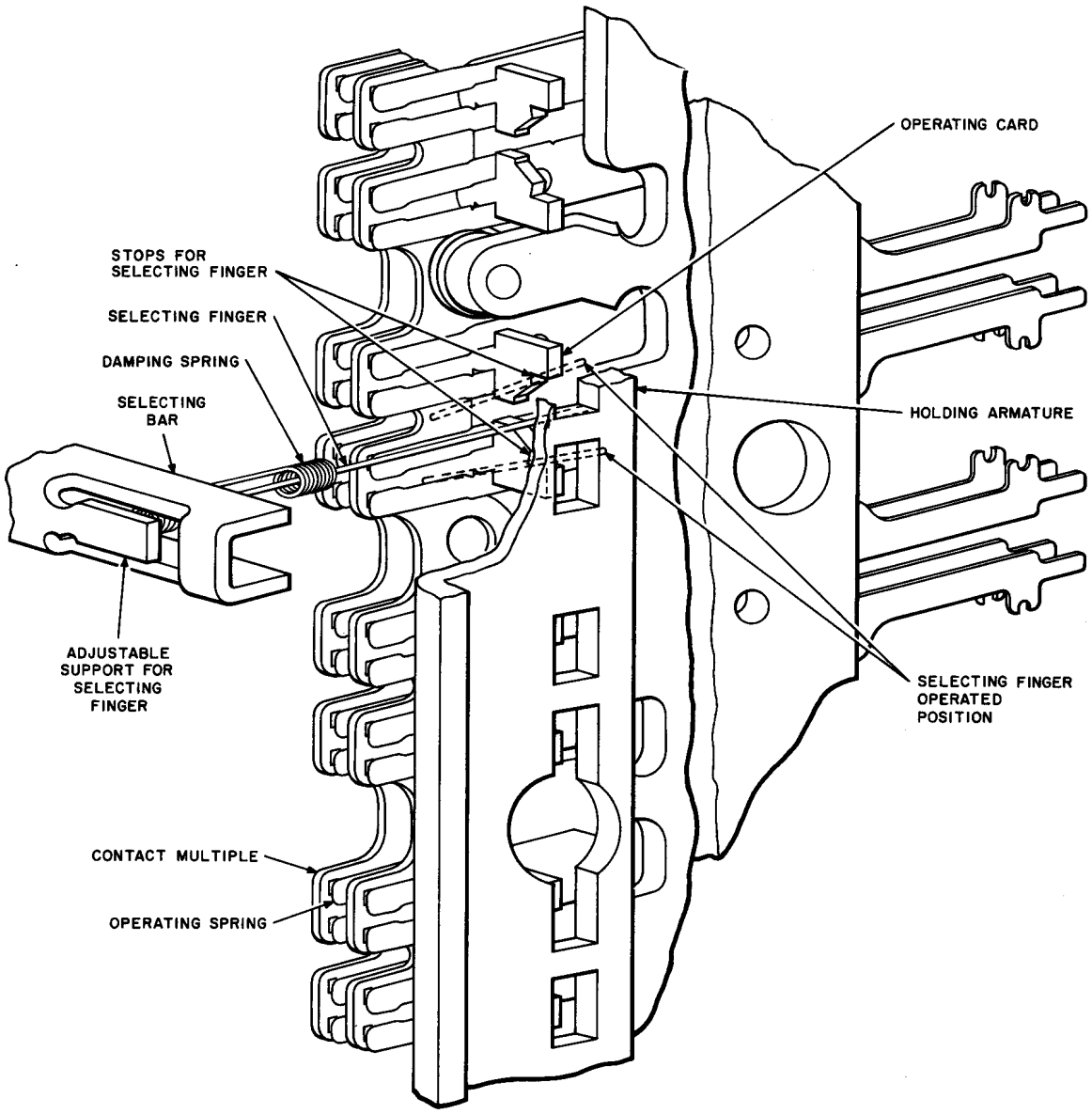


Fig. 2—Selection Elements of a Crossbar Switch

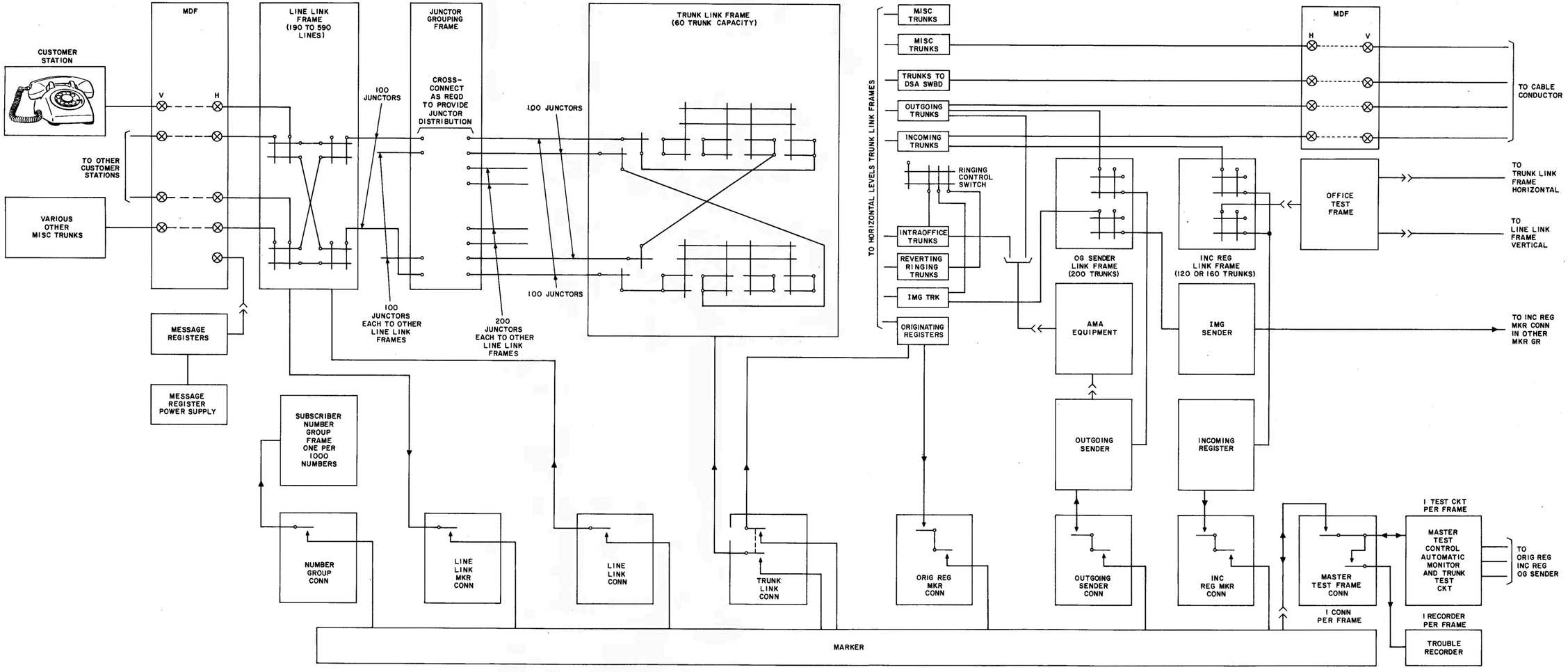


Fig. 3—No. 5 Crossbar System—Block Diagram

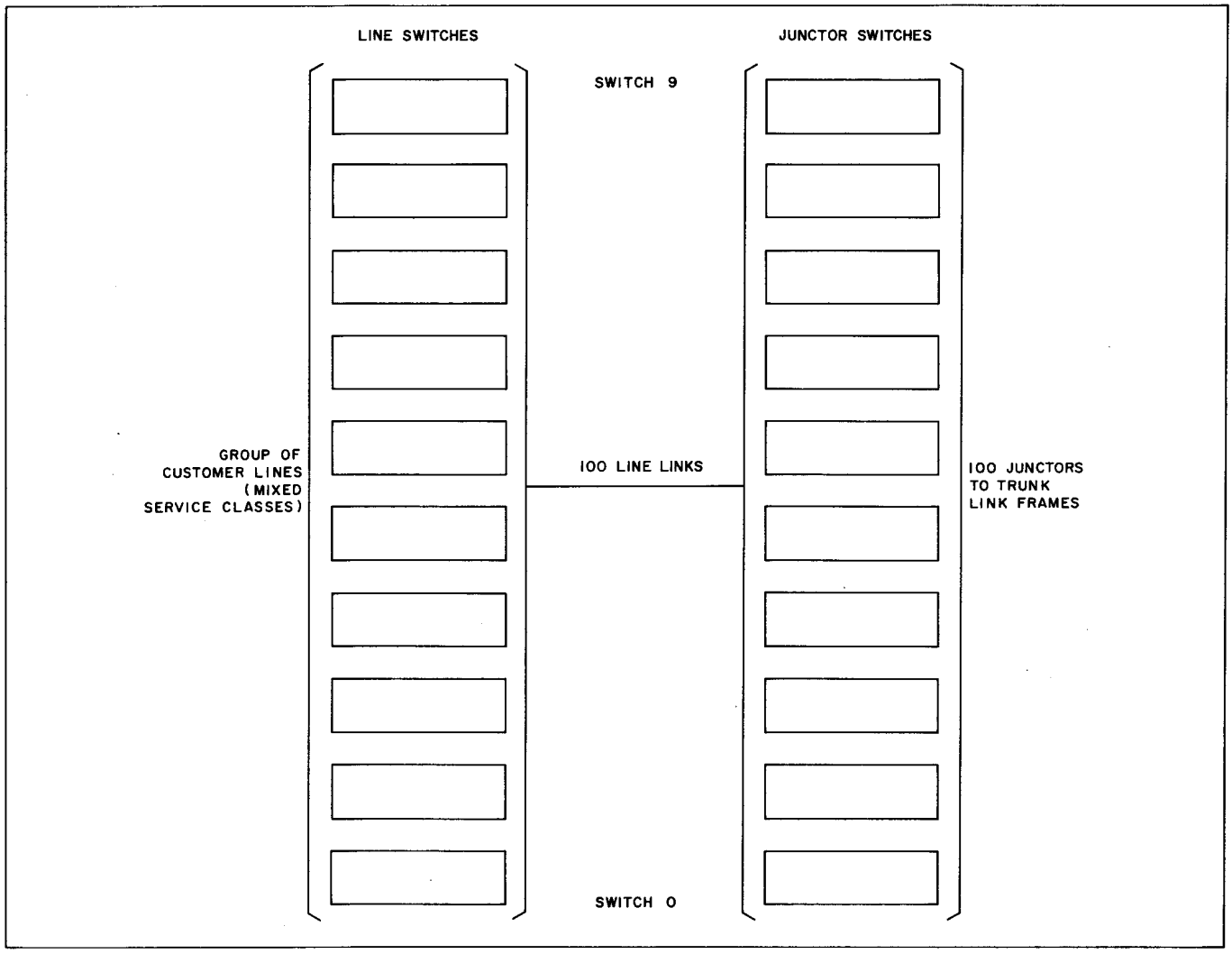


Fig. 4—Line Link Frame

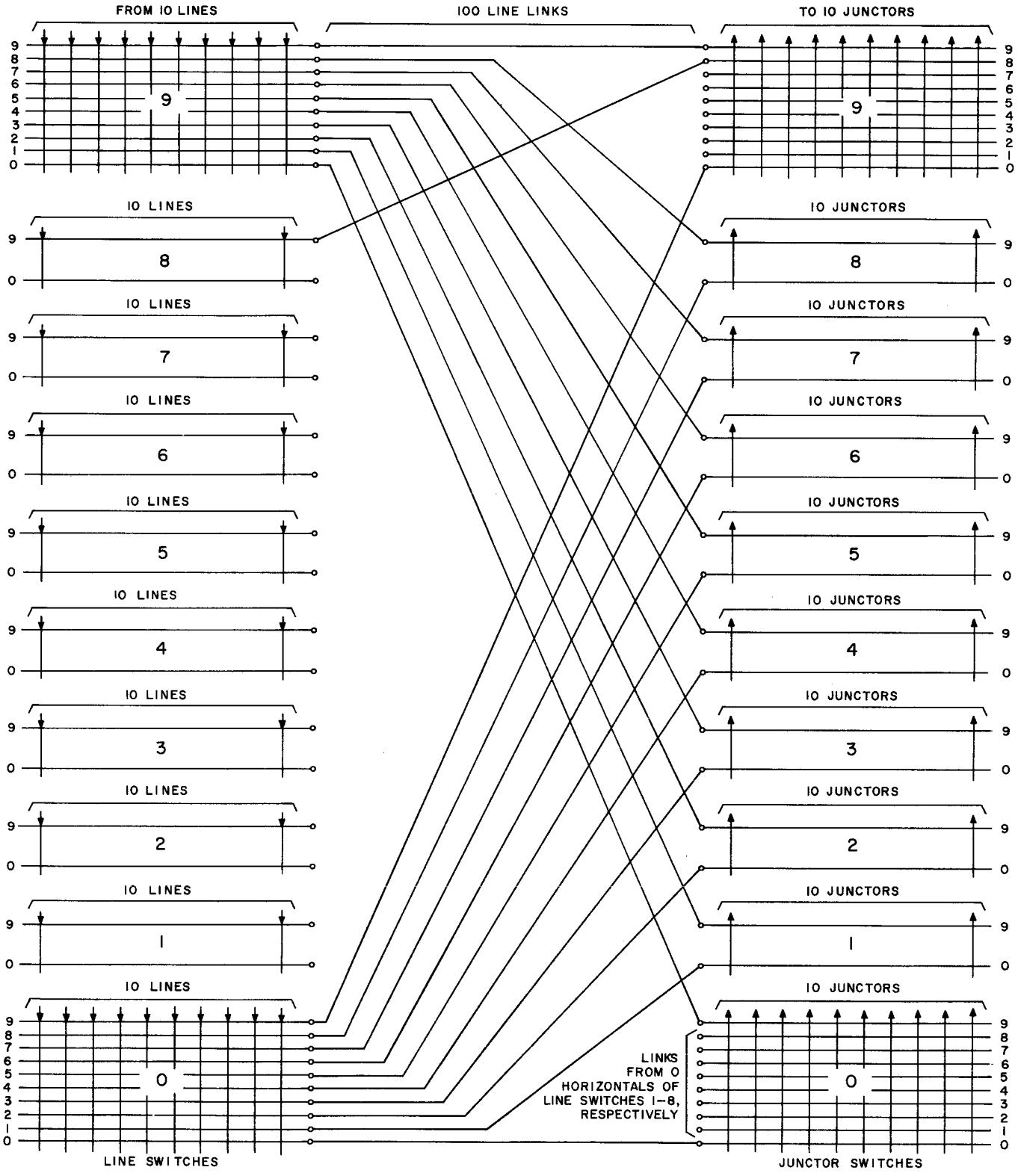


Fig. 5—Line Link Distribution

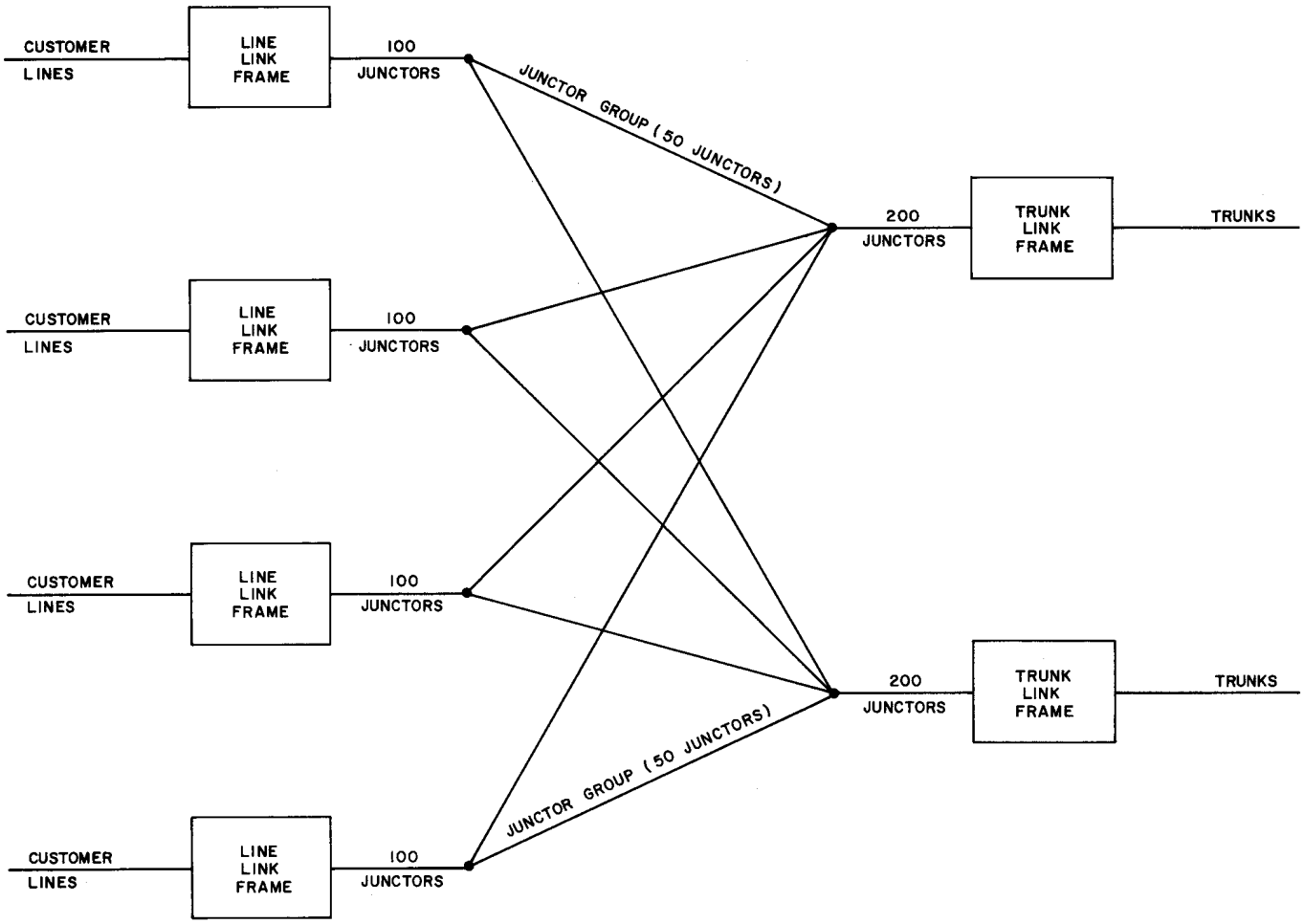


Fig. 6—Junctor Distribution—Four Line Link and Two Trunk Link Frames

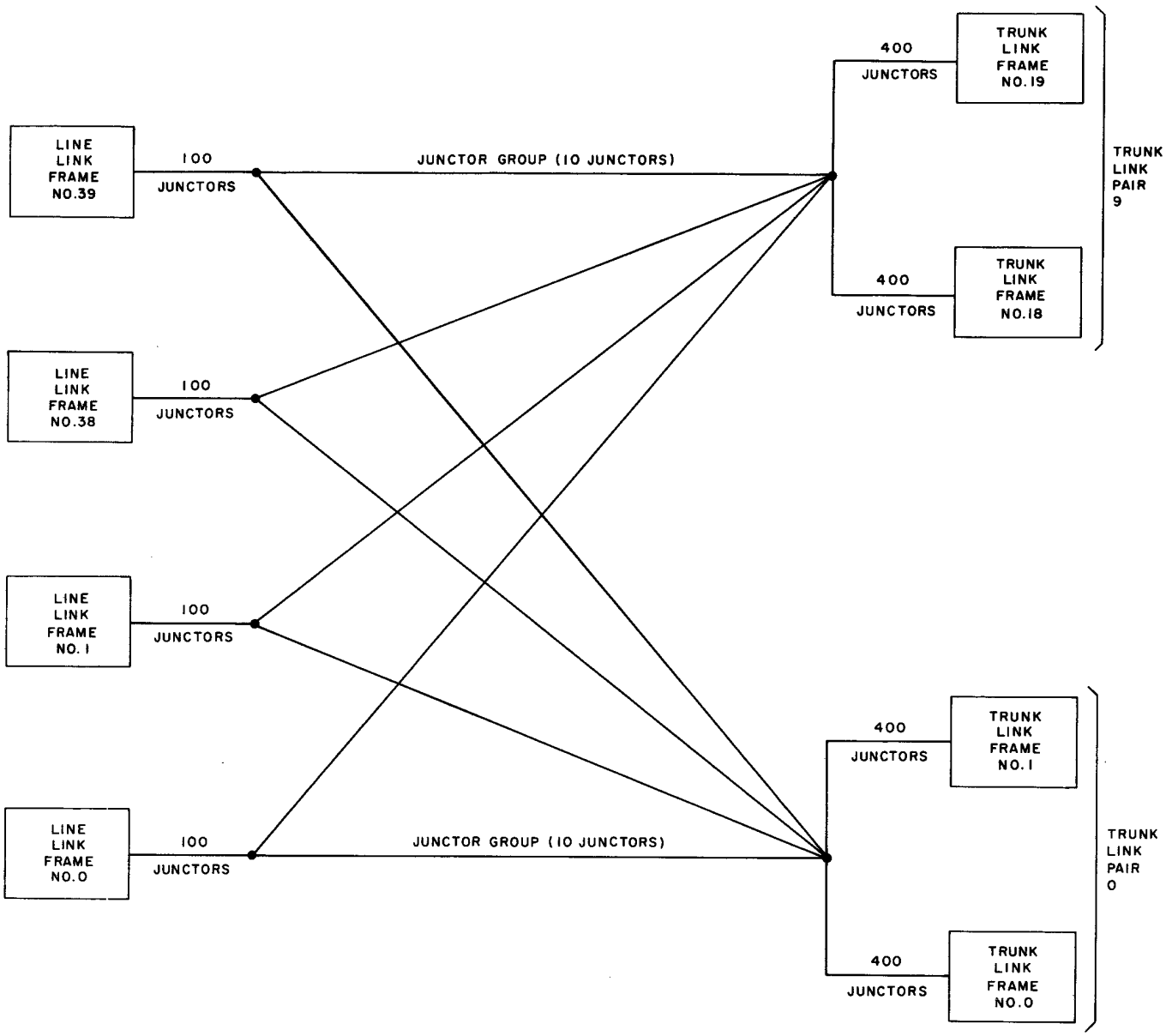


Fig. 7—Pairing of Trunk Link Frames—40 Line Link and 20 Trunk Link Frames

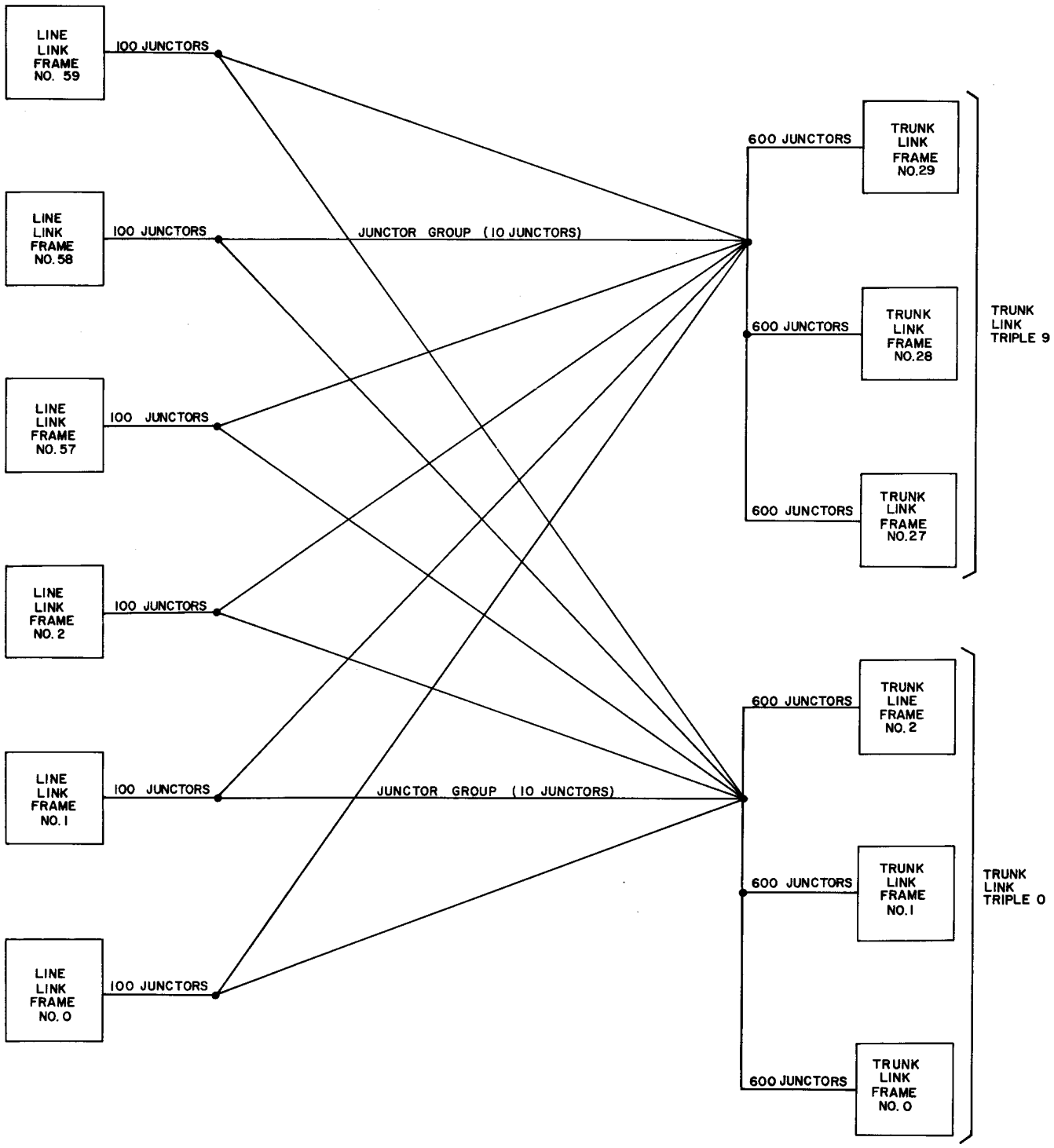


Fig. 8—Tripling of Trunk Link Frames—60 Line Link and 30 Trunk Link Frames

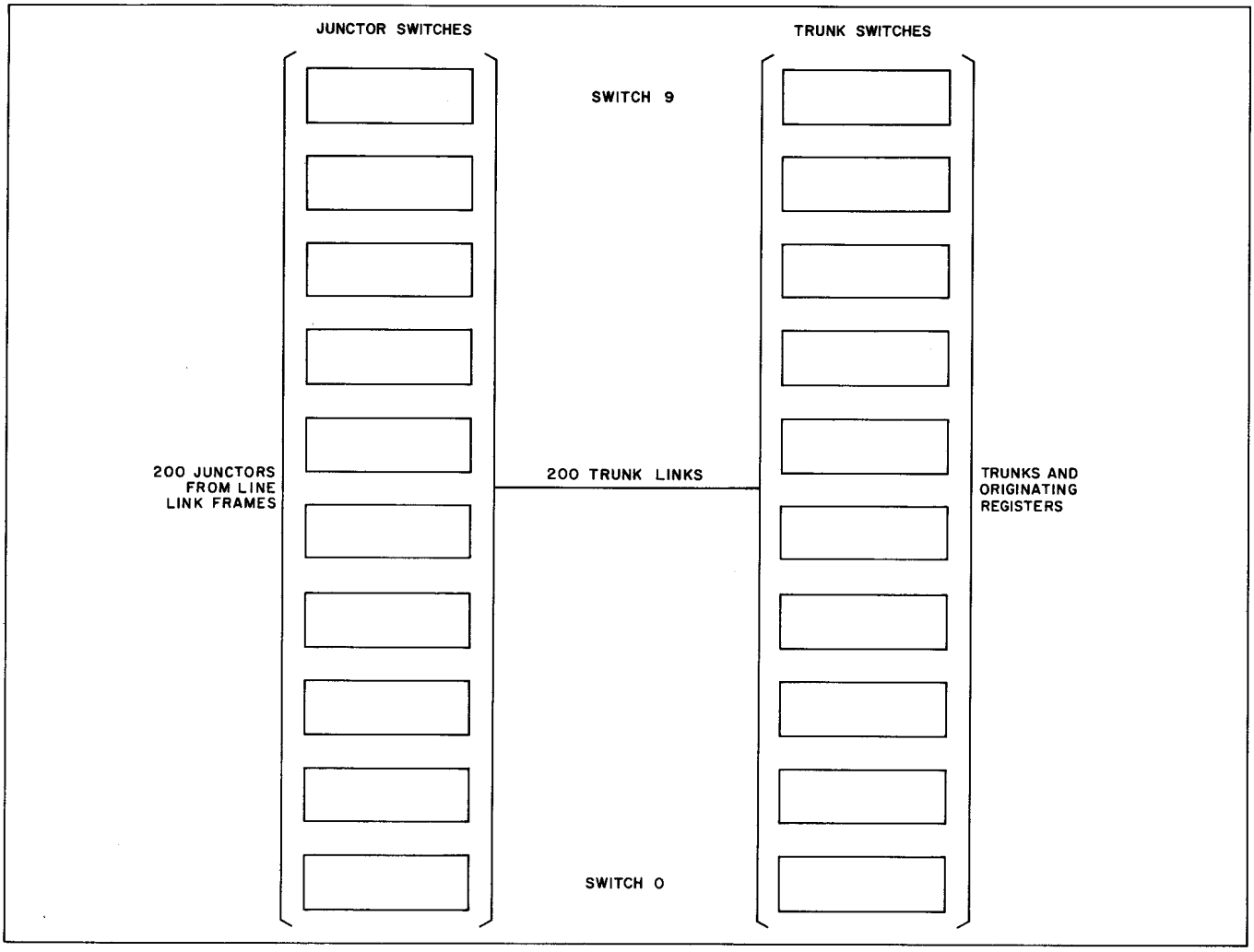


Fig. 9—Trunk Link Frame

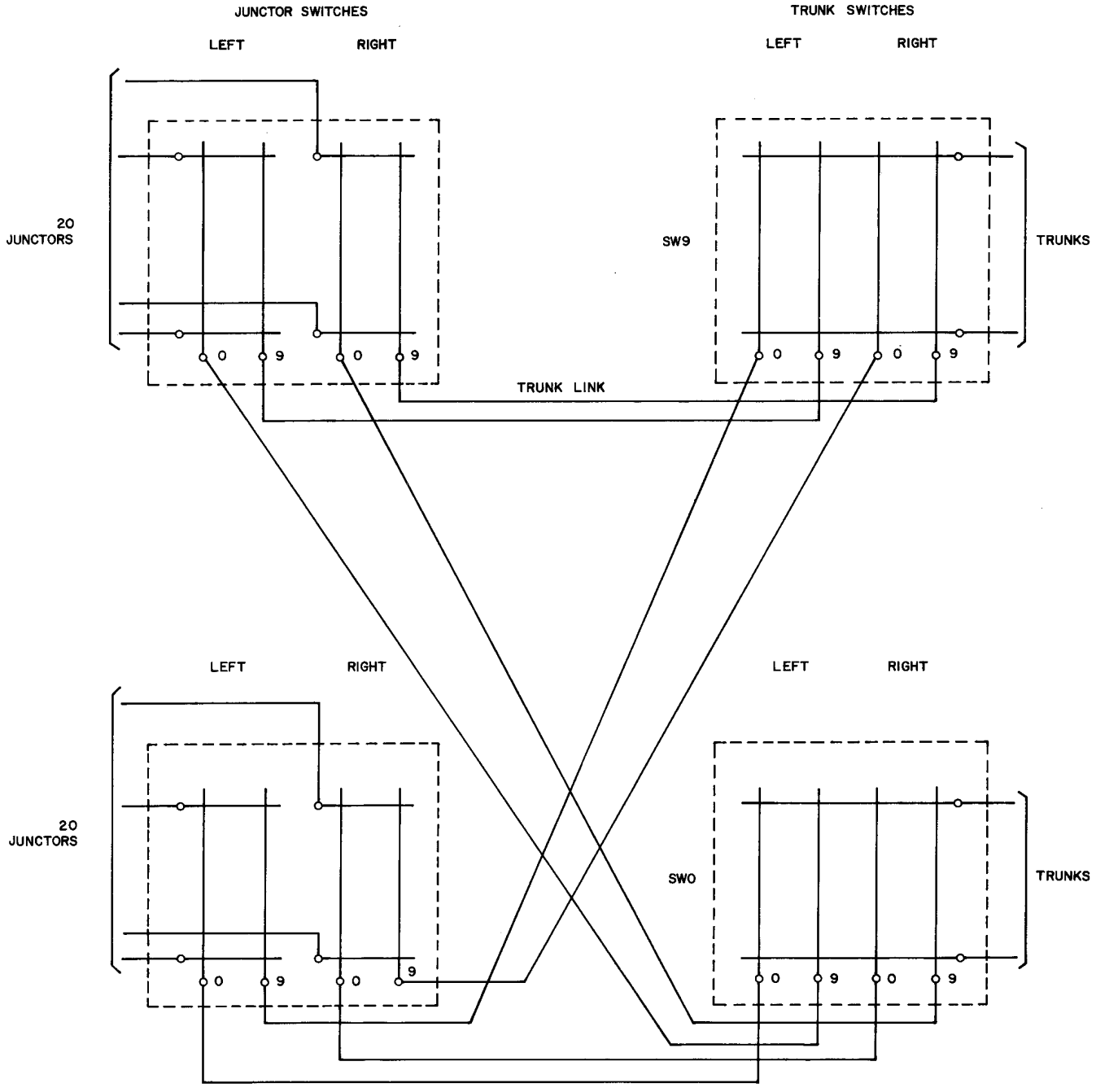


Fig. 10—Trunk Link Distribution

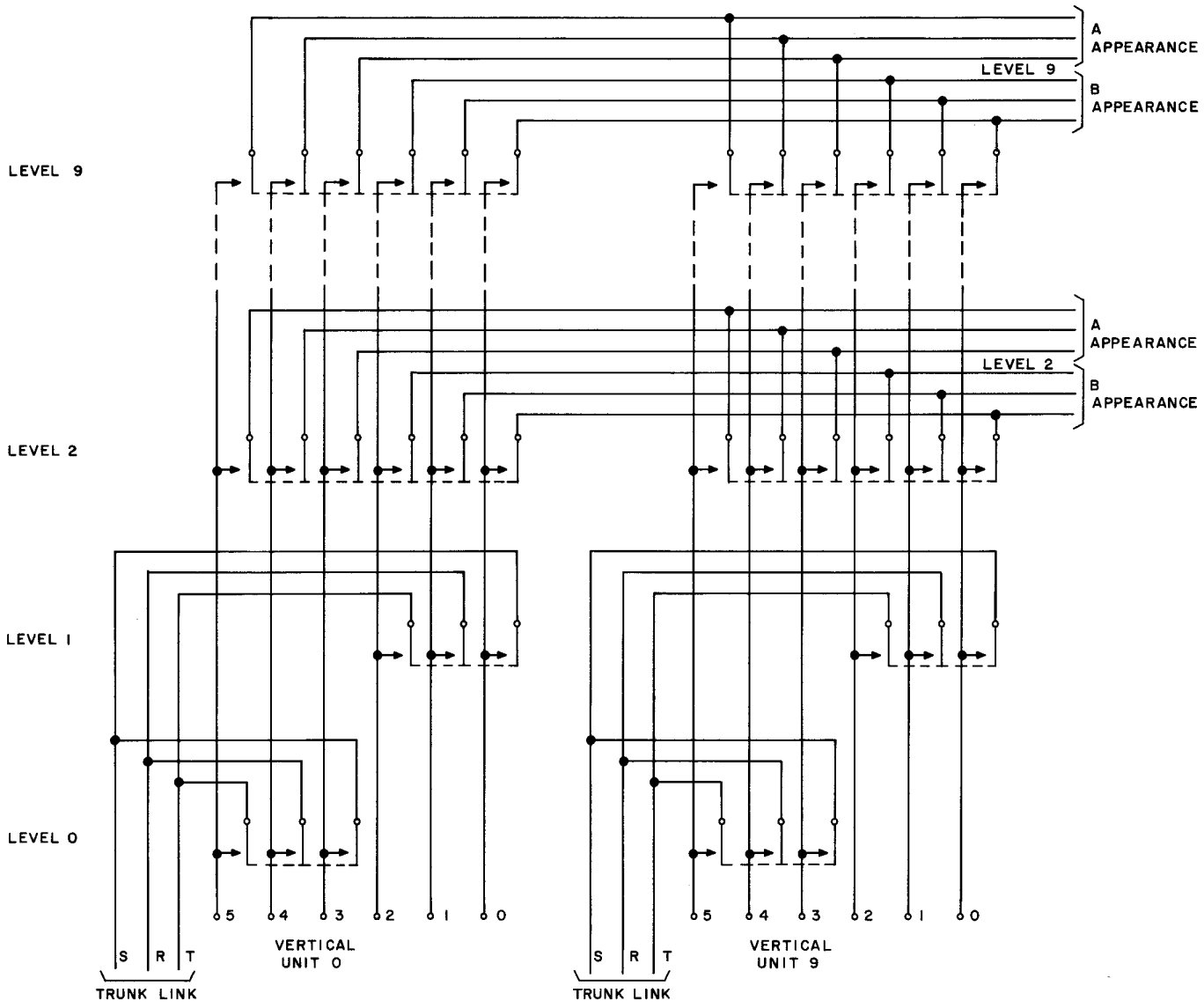


Fig. 11—Switch Arranged for 16 Trunk Appearances on Trunk Link Frame

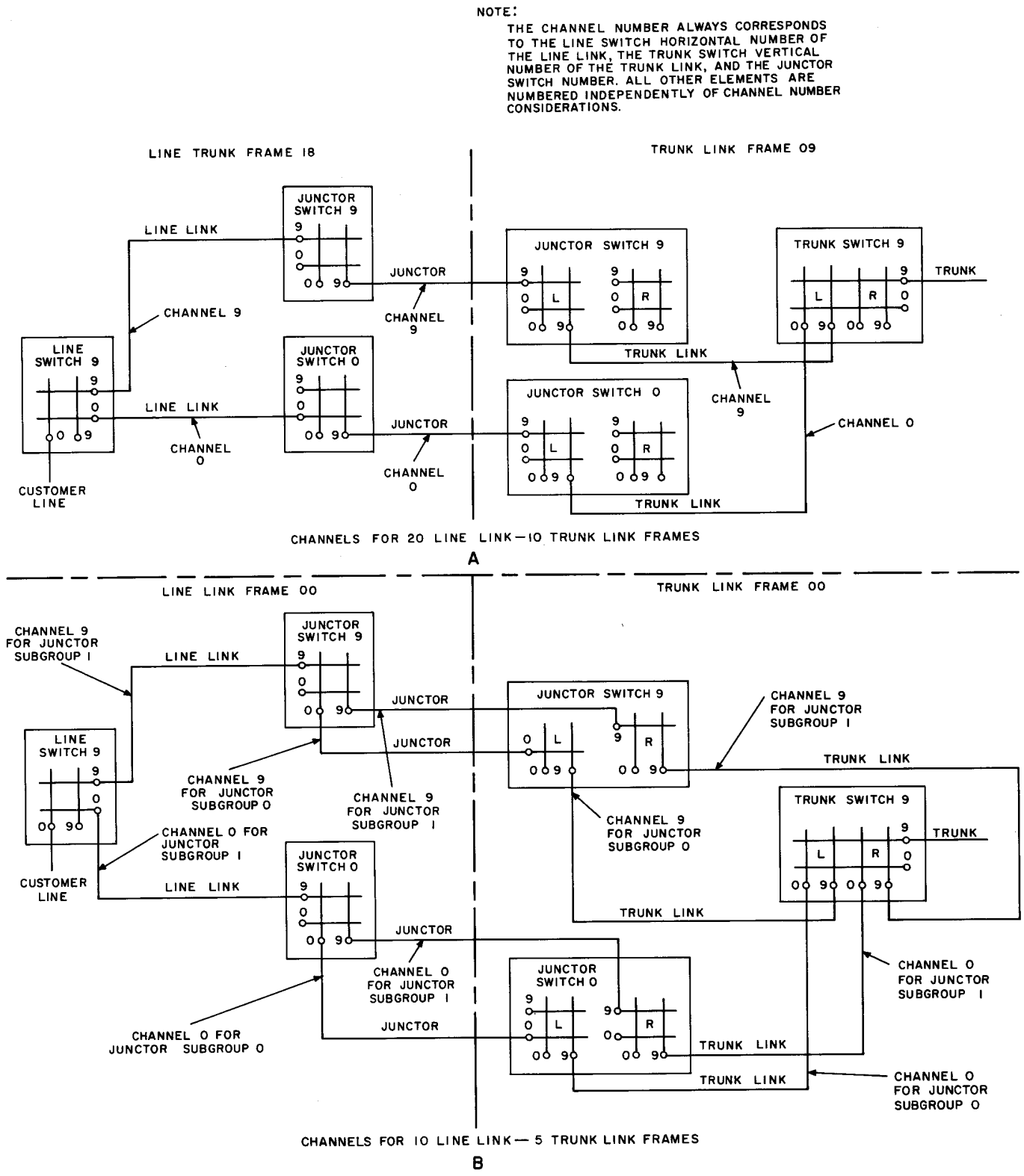


Fig. 12—Channel Distribution—Line Link to Trunk Link Frames

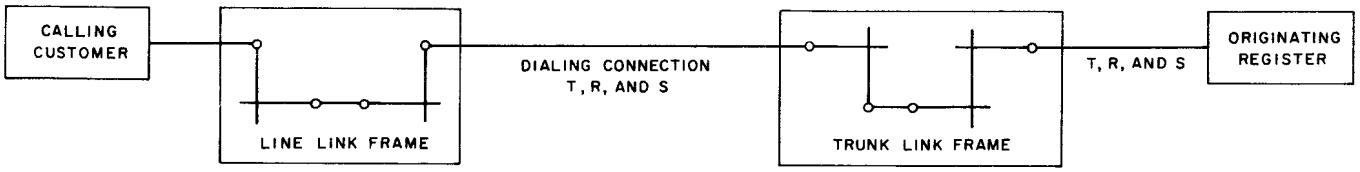


Fig. 13—Dialing Connection

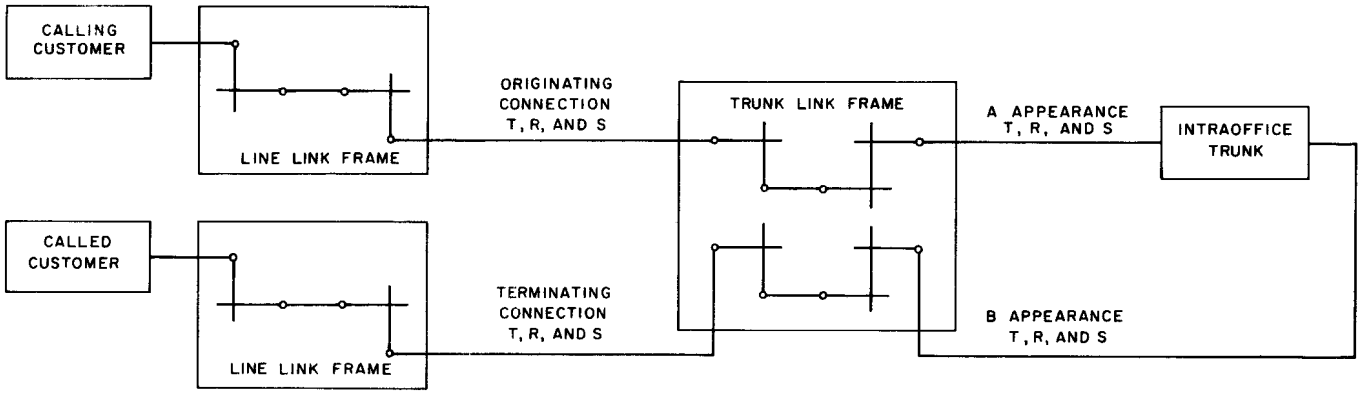


Fig. 14—Intraoffice Trunk Connection

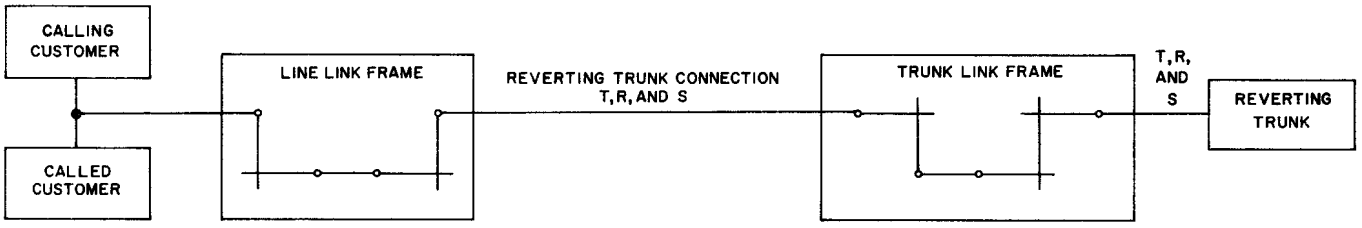


Fig. 15—Reverting Trunk Connection

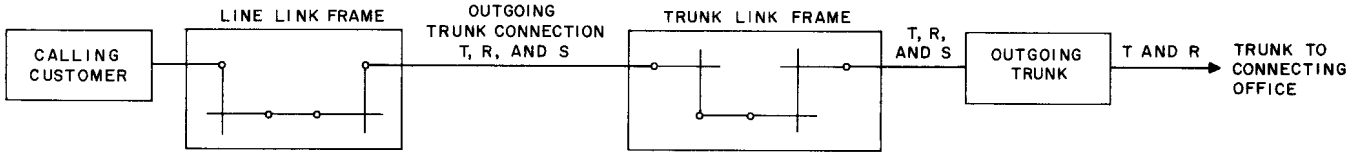


Fig. 16—Outgoing Trunk Connection

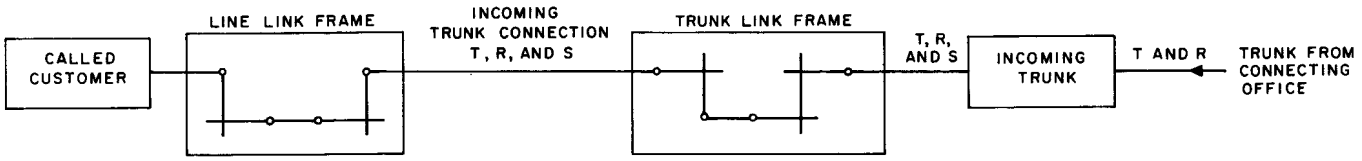


Fig. 17—Incoming Trunk Connection

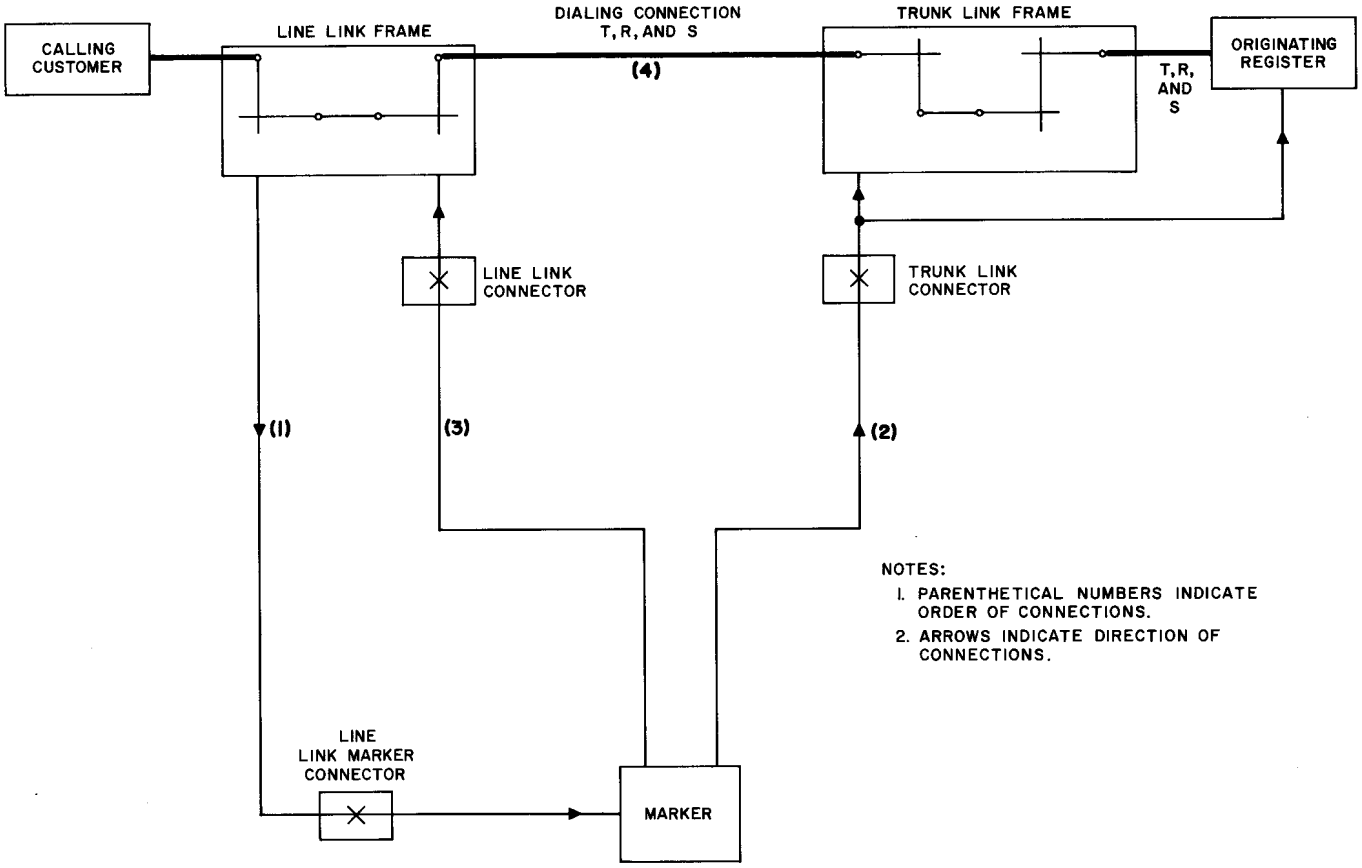


Fig. 18—Establishing Dialing Connection

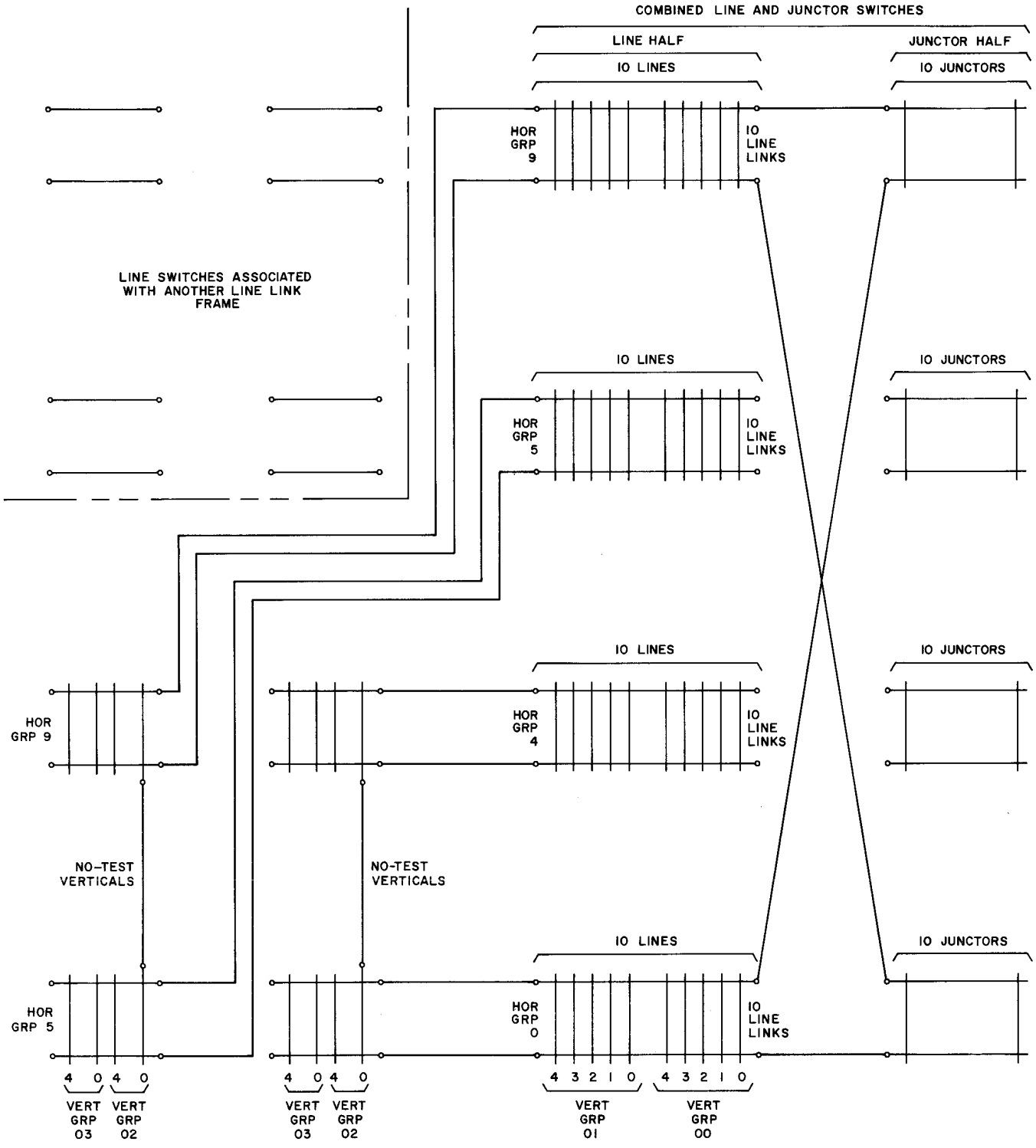


Fig. 19—Basic Line Line Frame—Split Frame—190 Lines—Schematic—Wiring Side

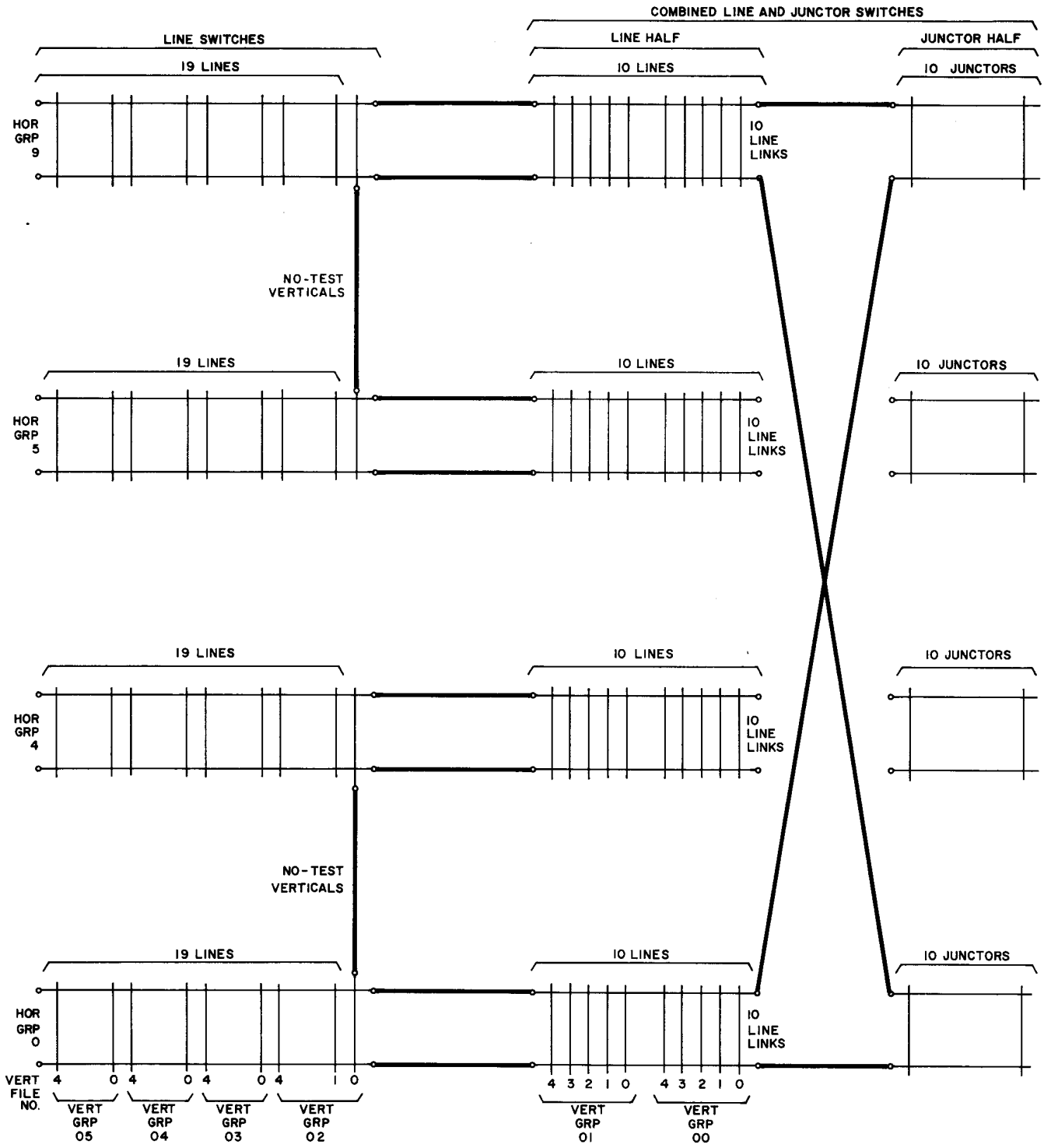


Fig. 20—Basic Line Link Frame—Nonsplit Frame—290 Lines—Schematic—Wiring Side

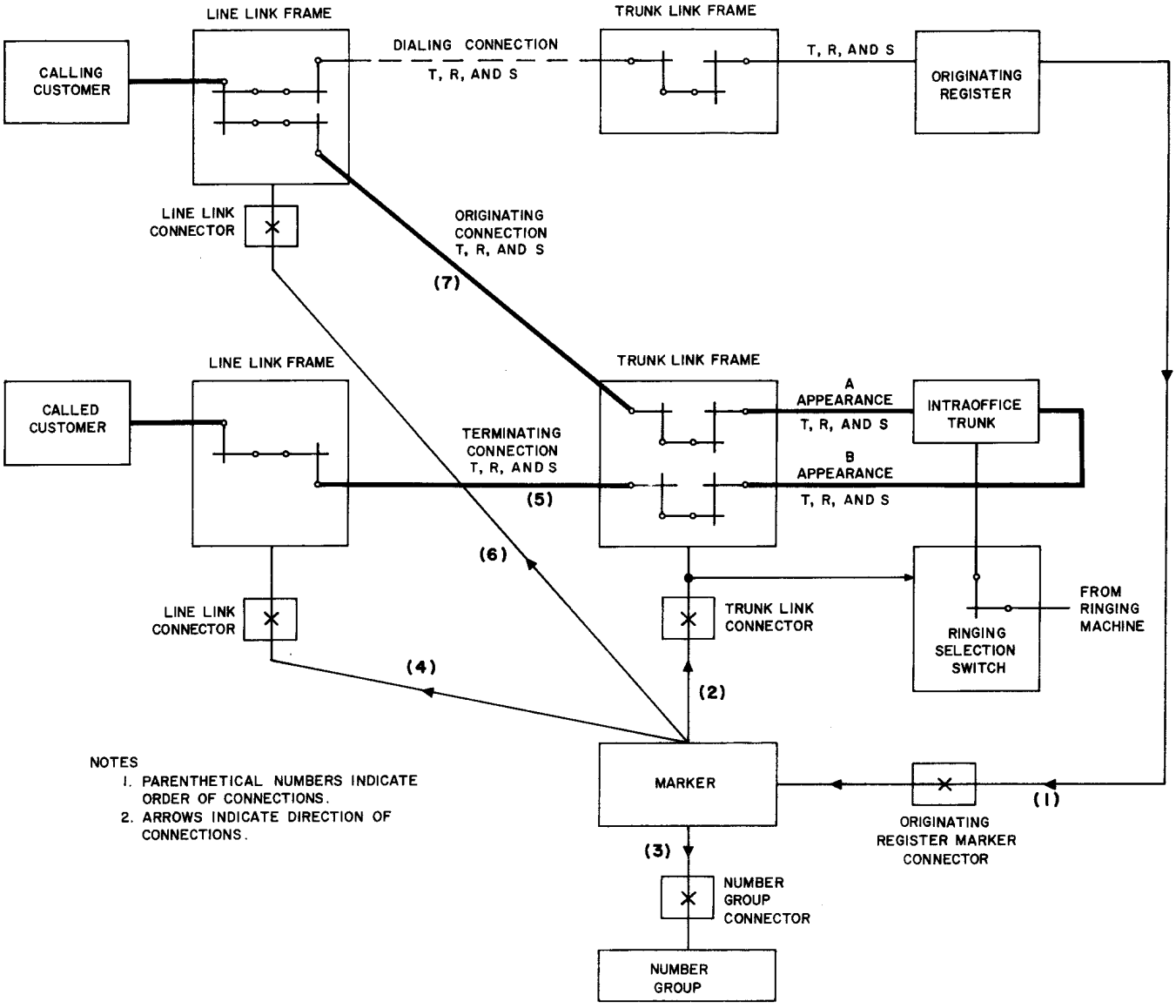


Fig. 21—Establishing Intraoffice Trunk Connection

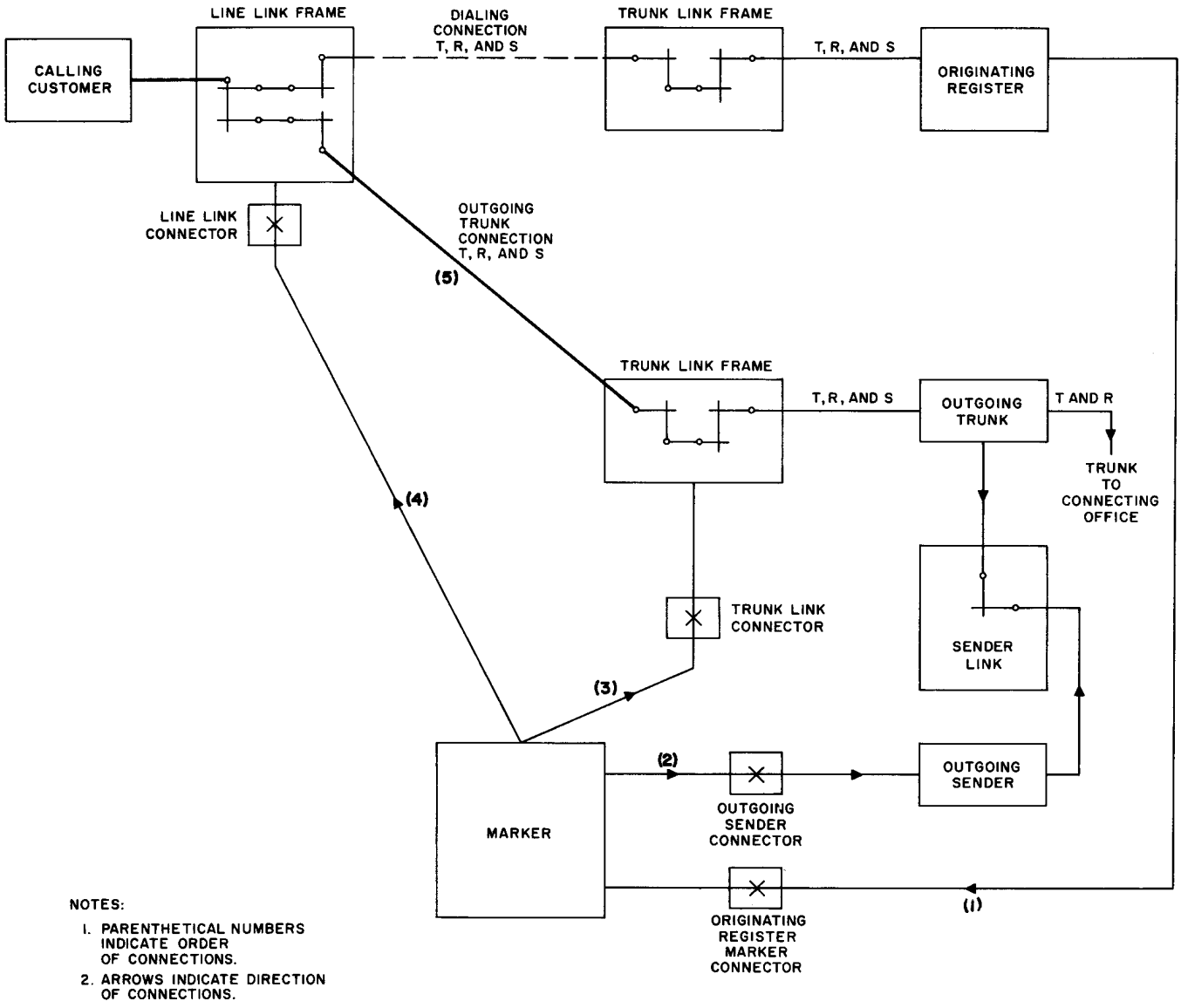


Fig. 22—Establishing Outgoing Trunk Connection

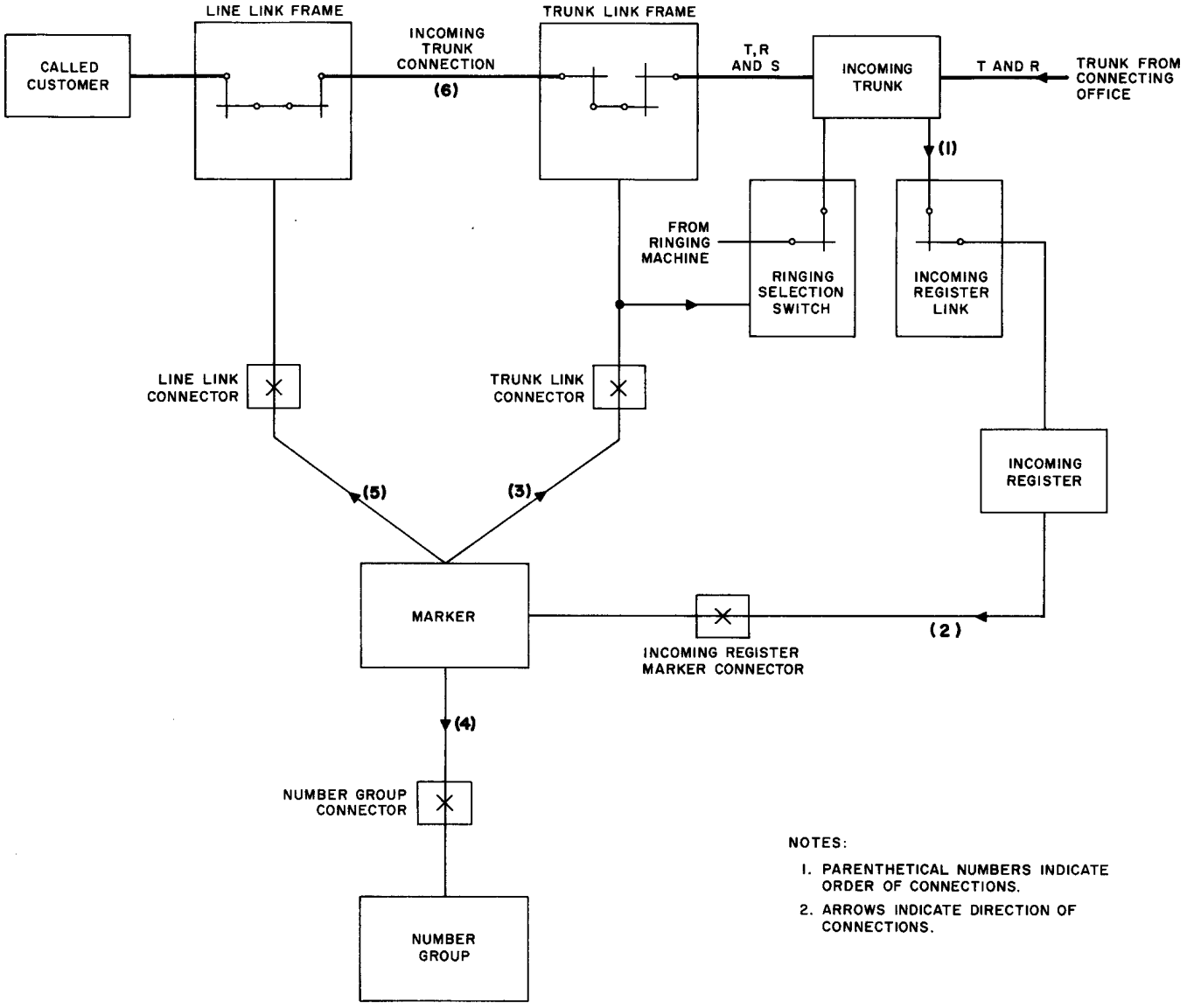


Fig. 23—Establishing Incoming Trunk Connection

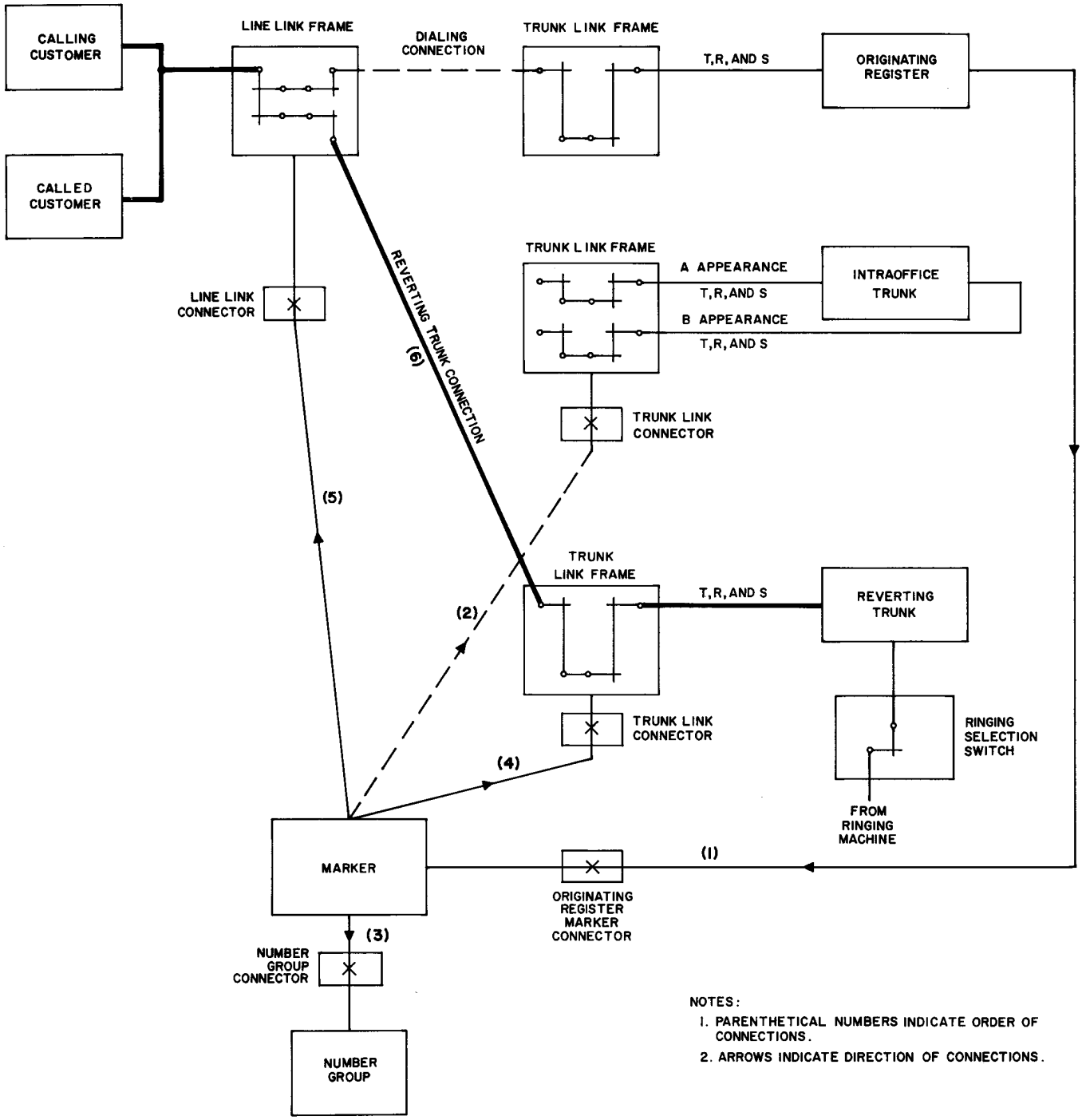


Fig. 24—Establishing Reverting Trunk Connection

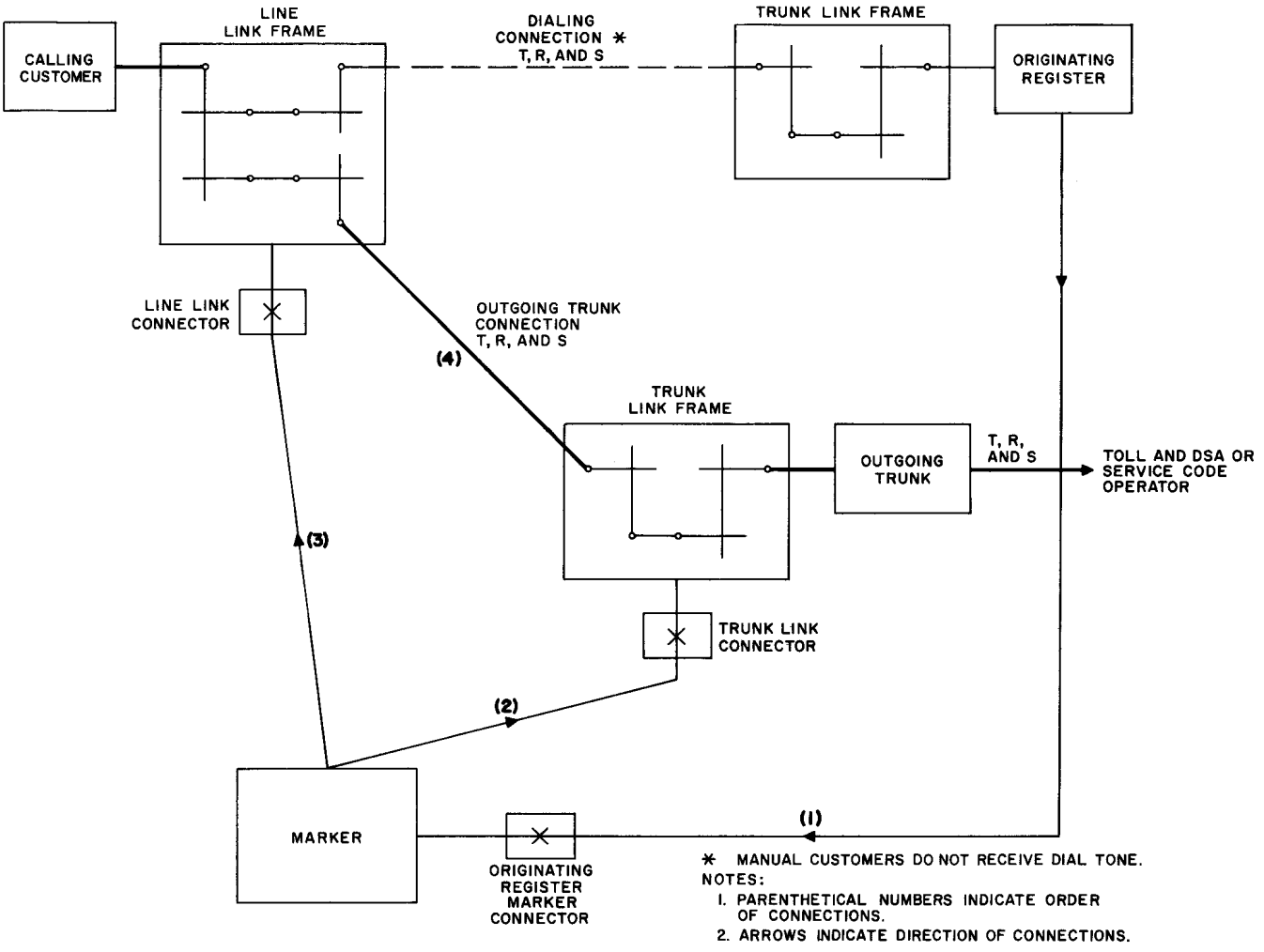


Fig. 25—Establishing Toll and DSA Operator Service Code or Manual Trunk Connection

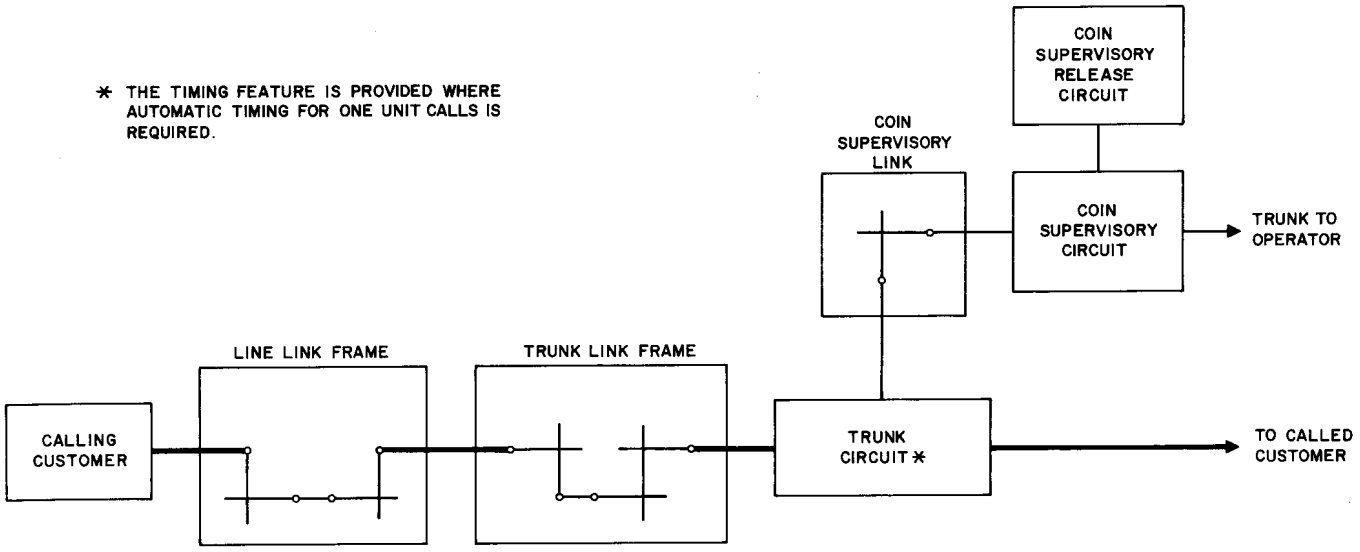


Fig. 26—Association of Coin Trunk and Coin Supervisory Link

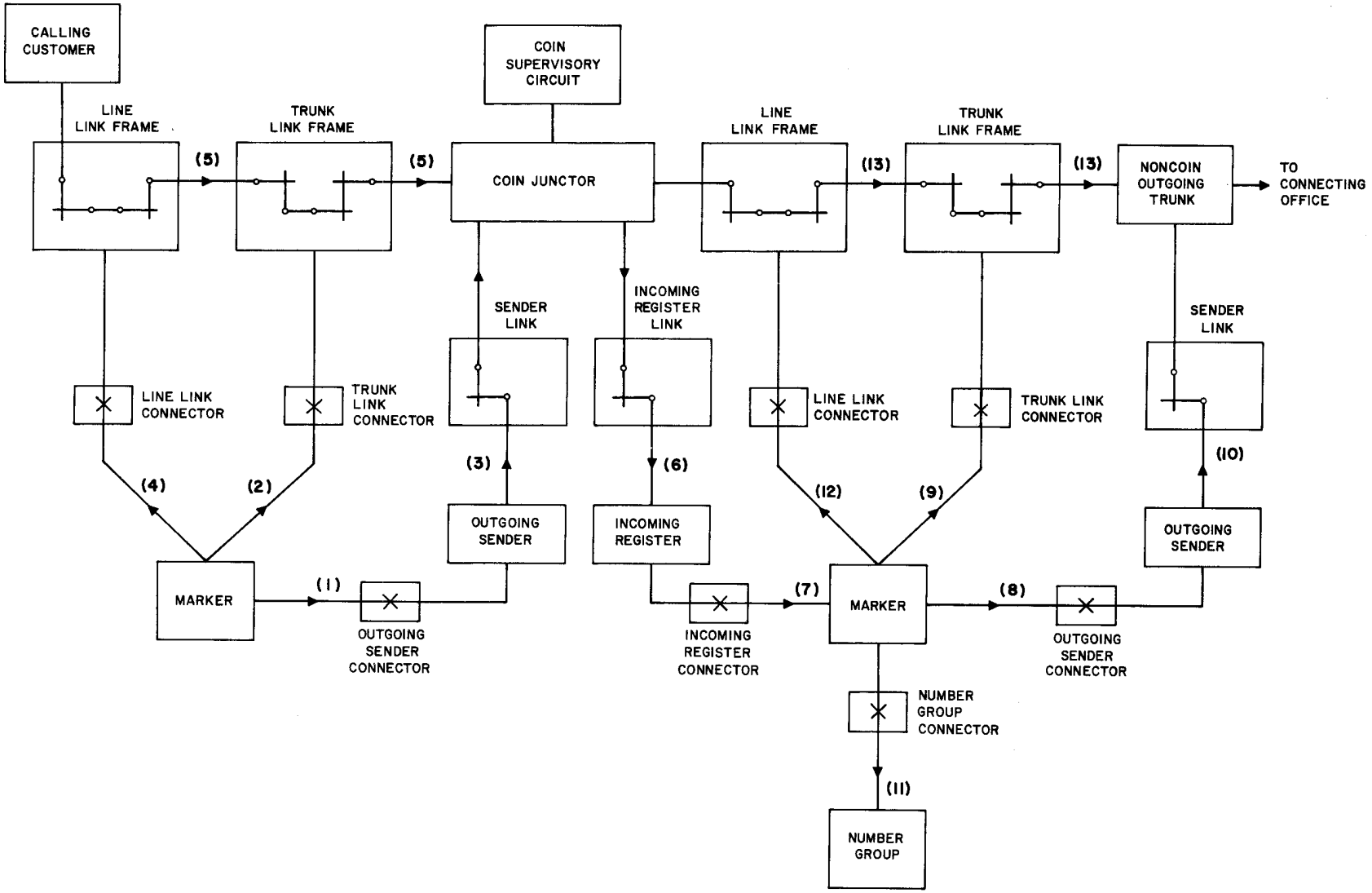


Fig. 27—Coin Junctor Operation

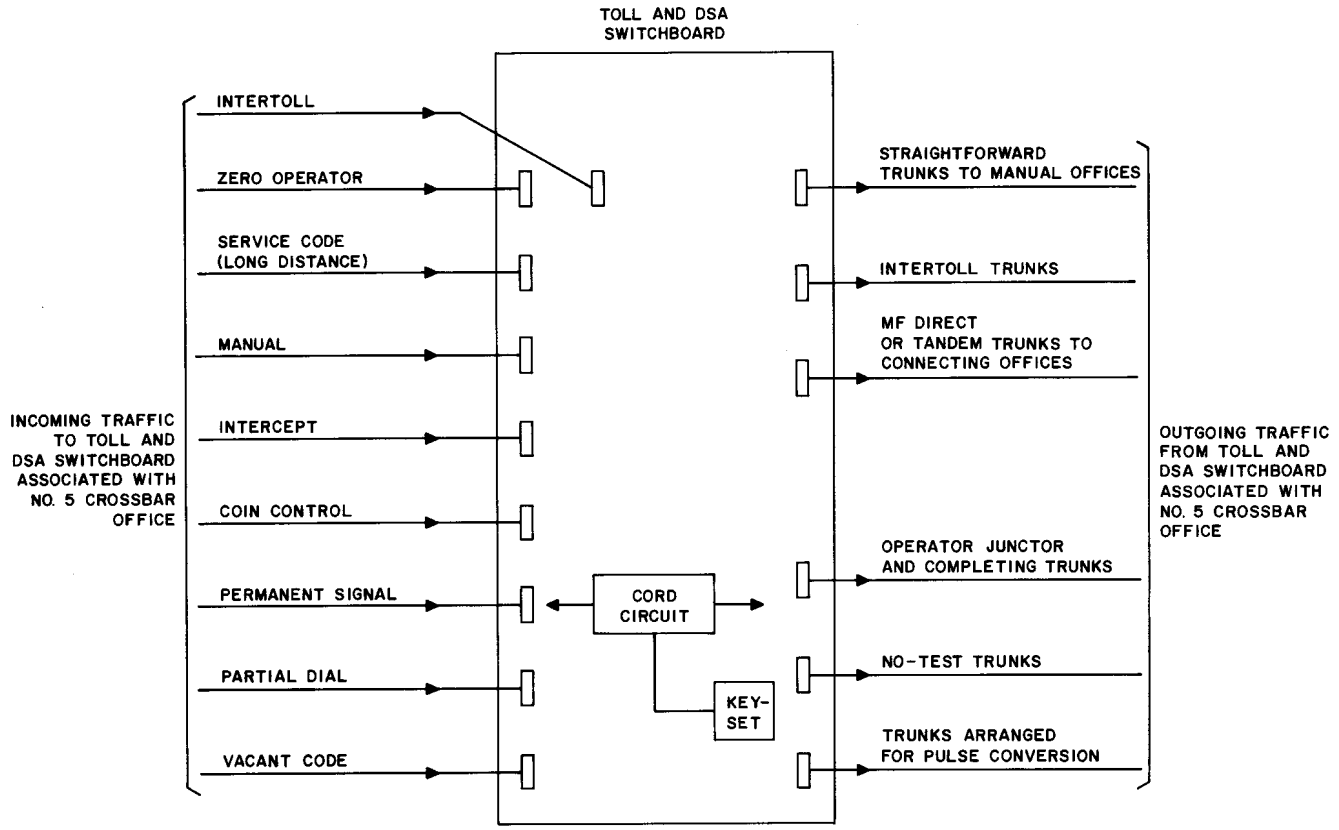


Fig. 28—Traffic at Toll and DSA Switchboard Associated With No. 5 Crossbar Office

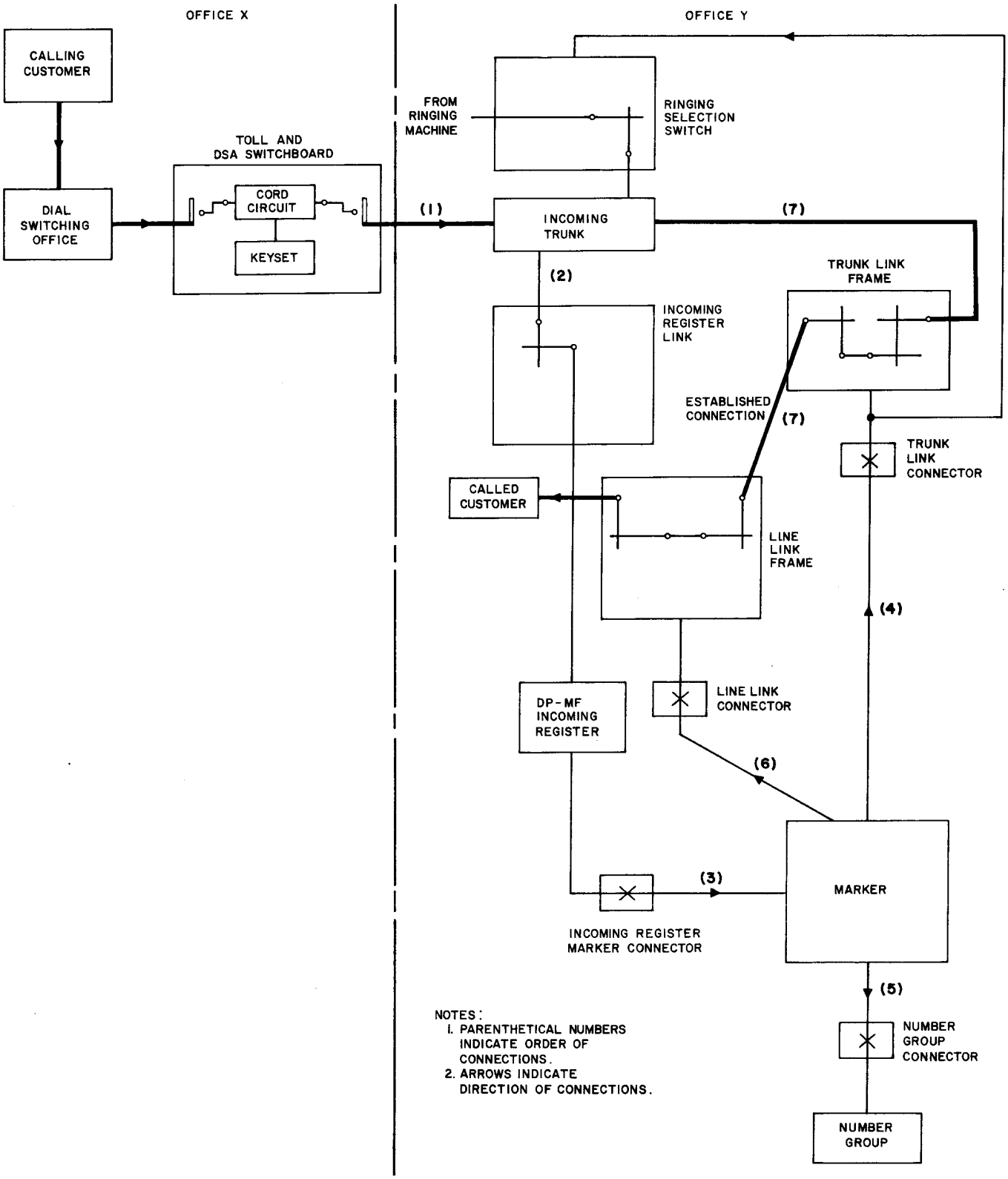


Fig. 29—Call From Toll and DSA Switchboard Completed to No. 5 Crossbar Customer

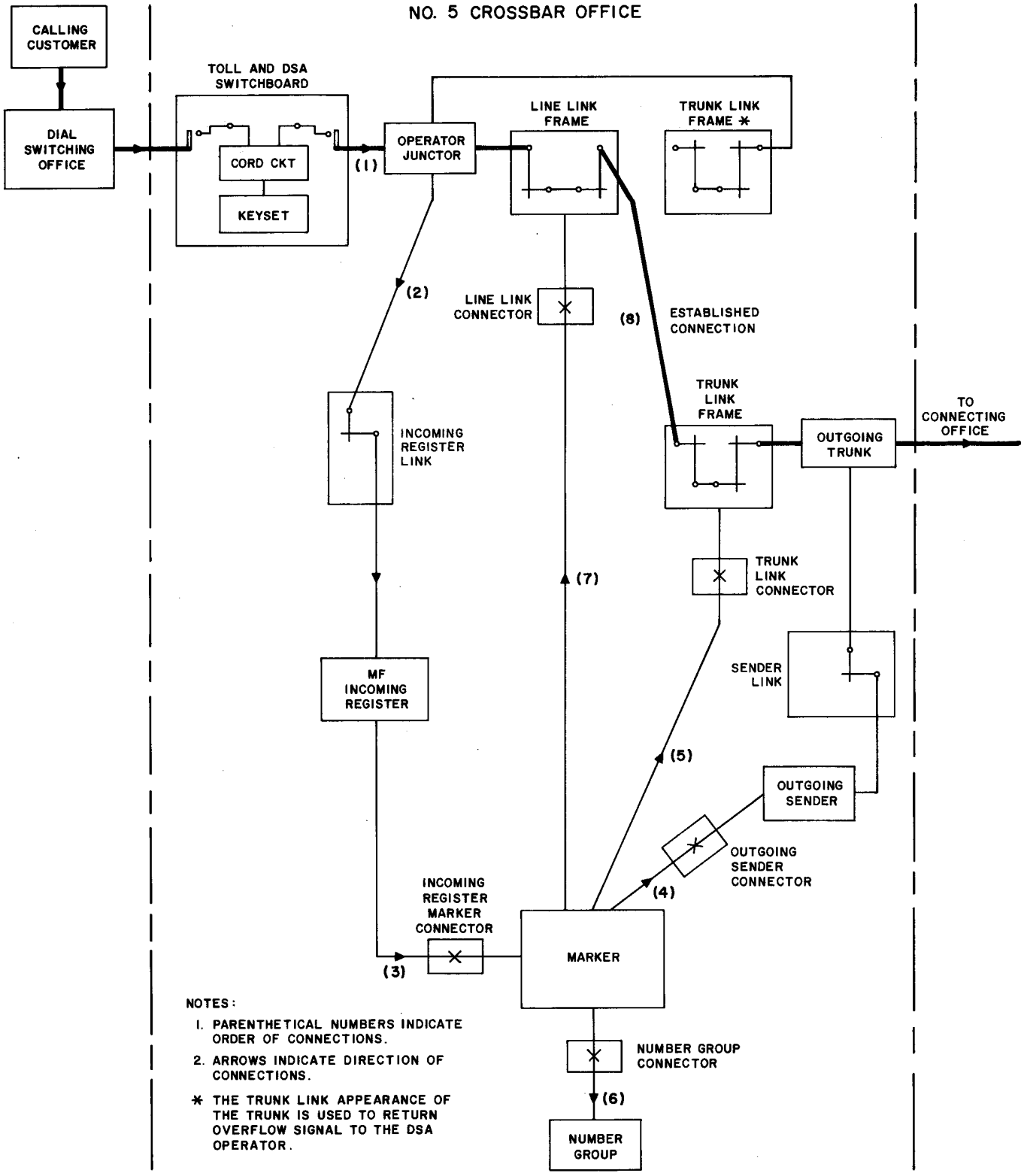


Fig. 30—Call From Toll and DSA Switchboard Associated With No. 5 Crossbar Office to Connecting Office

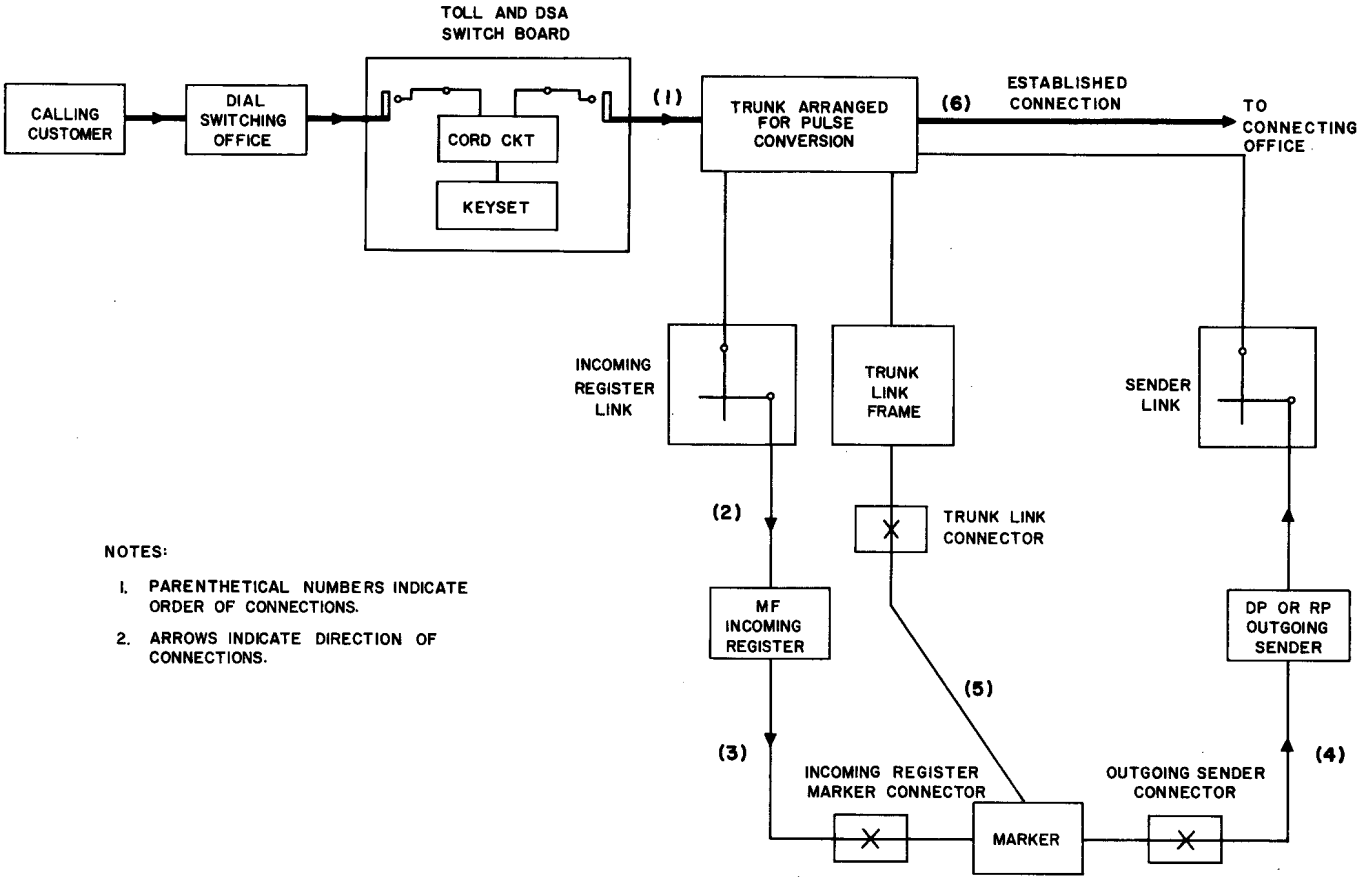
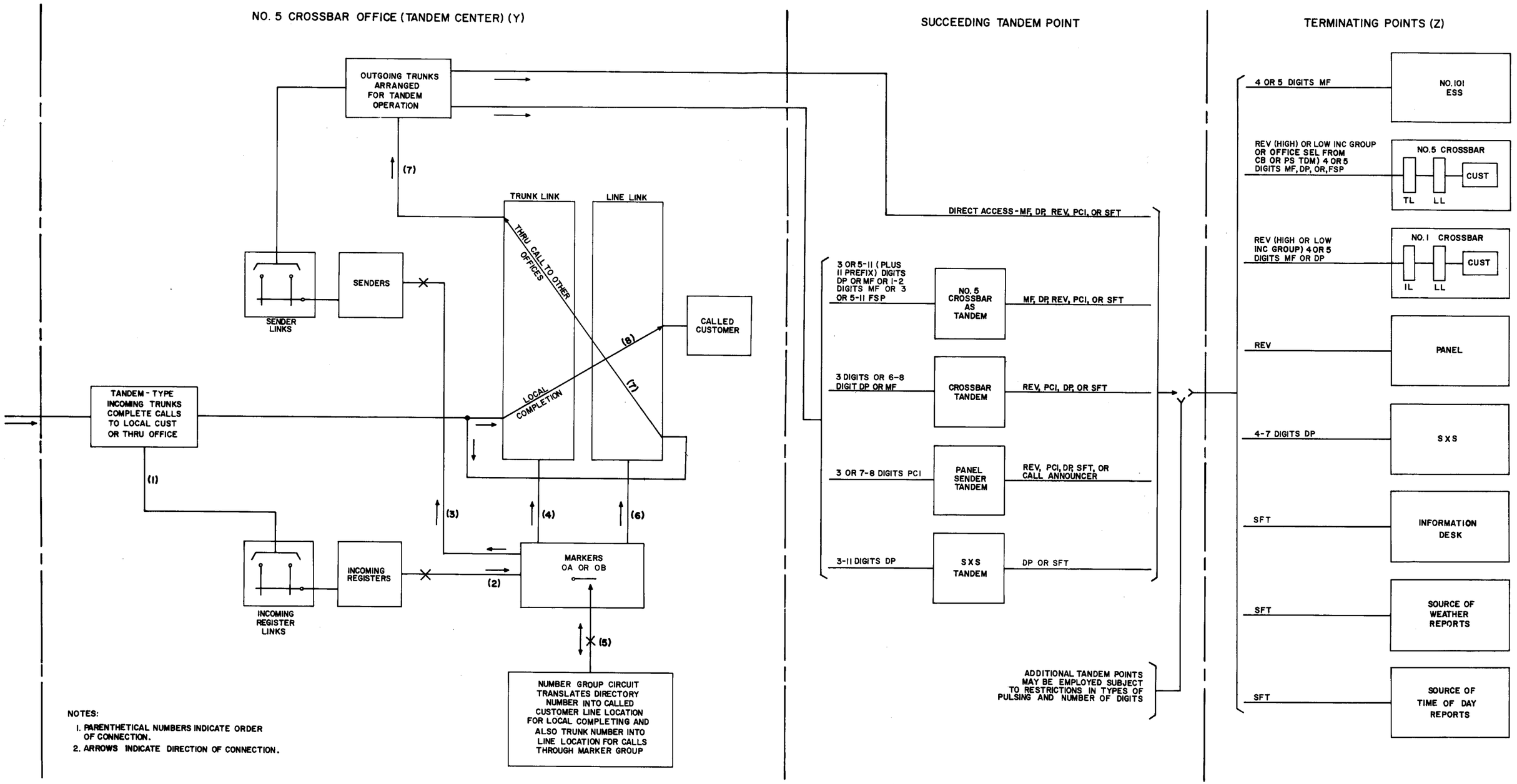


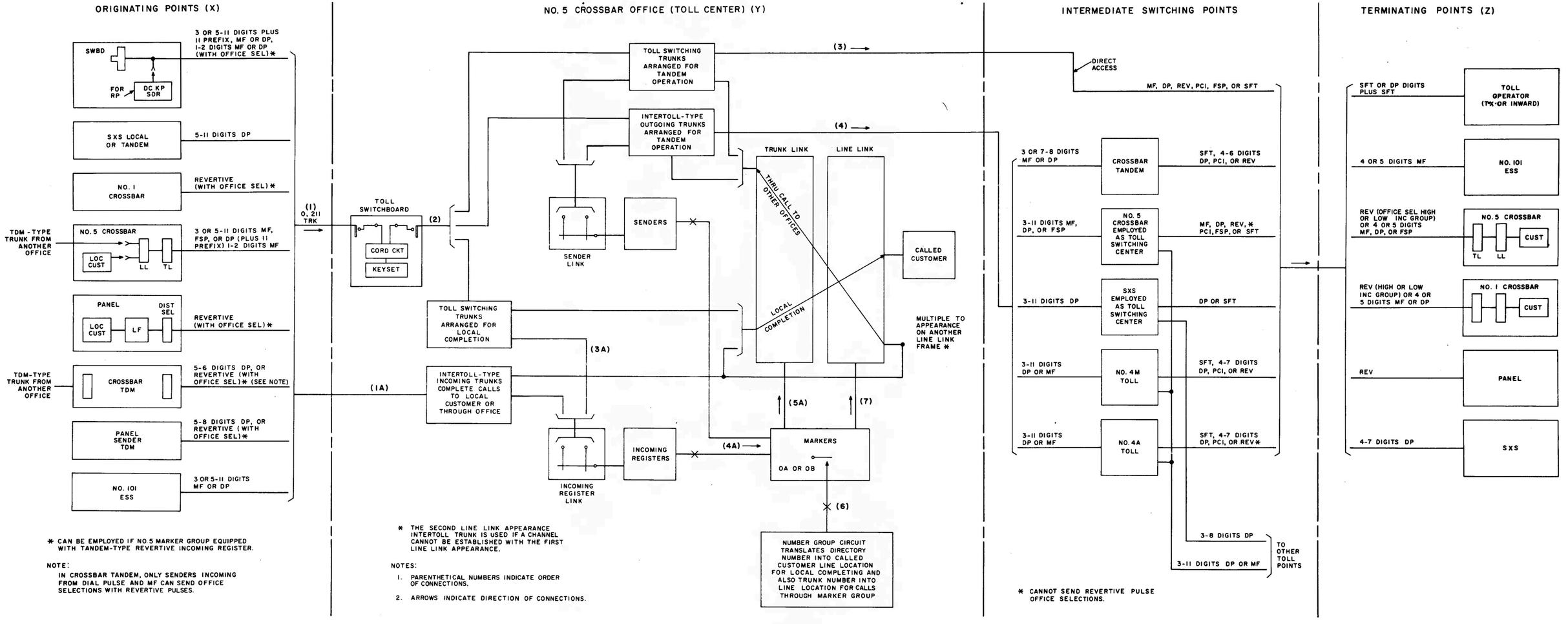
Fig. 31—Outgoing Call From Toll and DSA Switchboard—Pulse Conversion



NOTES:

1. PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTION.
2. ARROWS INDICATE DIRECTION OF CONNECTION.

Fig. 32—Tandem Center Switching Combined With Local Completion to Customers in the Same Marker Group



* CAN BE EMPLOYED IF NO.5 MARKER GROUP EQUIPPED WITH TANDEM-TYPE REVERTIVE INCOMING REGISTER.

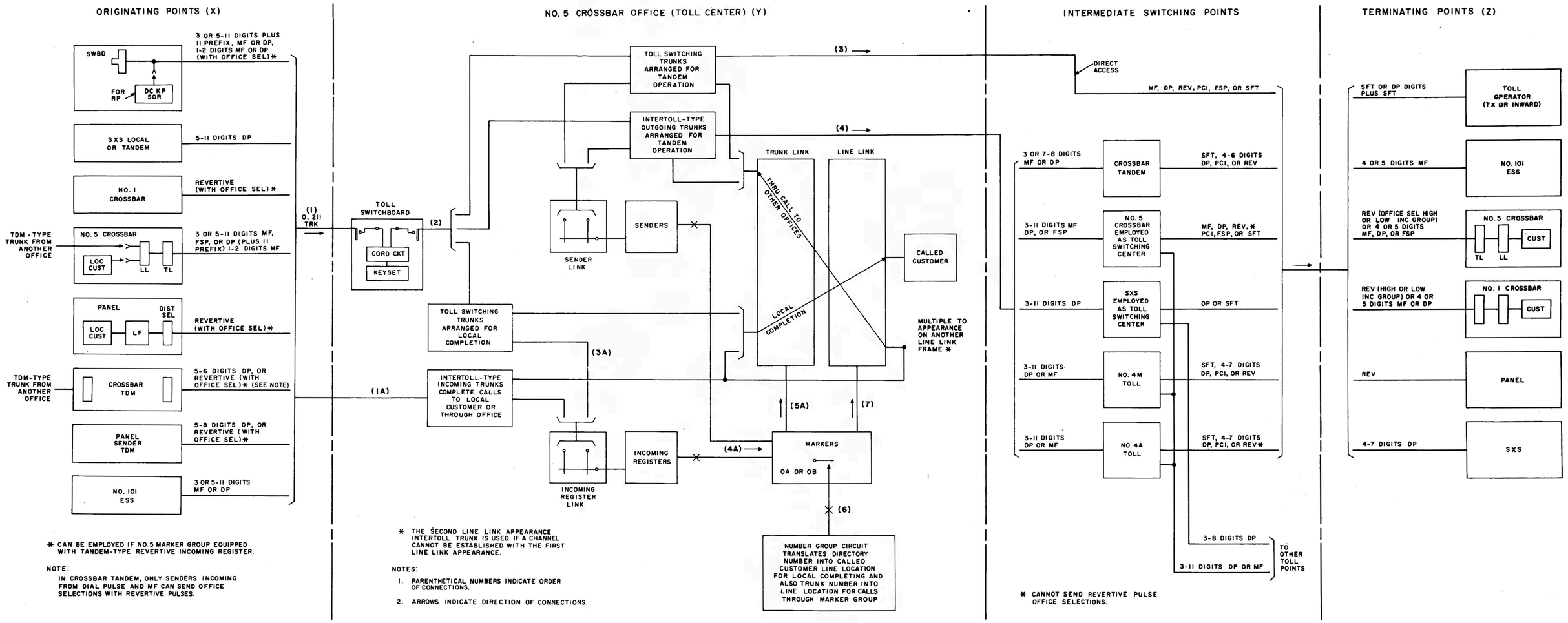
NOTE:
IN CROSSBAR TANDEM, ONLY SENDERS INCOMING FROM DIAL PULSE AND MF CAN SEND OFFICE SELECTIONS WITH REVERTIVE PULSES.

* THE SECOND LINE LINK APPEARANCE INTERTOLL TRUNK IS USED IF A CHANNEL CANNOT BE ESTABLISHED WITH THE FIRST LINE LINK APPEARANCE.

NOTES:
1. PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTIONS.
2. ARROWS INDICATE DIRECTION OF CONNECTIONS.

* CANNOT SEND REVERTIVE PULSE OFFICE SELECTIONS.

Fig. 33—Toll Center Switching Combined With Completion to Customers in the Same Marker Group (Sheet 1 of 2)



* CAN BE EMPLOYED IF NO.5 MARKER GROUP EQUIPPED WITH TANDEM-TYPE REVERTIVE INCOMING REGISTER.

NOTE:
IN CROSSBAR TANDEM, ONLY SENDERS INCOMING FROM DIAL PULSE AND MF CAN SEND OFFICE SELECTIONS WITH REVERTIVE PULSES.

* THE SECOND LINE LINK APPEARANCE INTERTOLL TRUNK IS USED IF A CHANNEL CANNOT BE ESTABLISHED WITH THE FIRST LINE LINK APPEARANCE.

NOTES:
1. PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTIONS.
2. ARROWS INDICATE DIRECTION OF CONNECTIONS.

* CANNOT SEND REVERTIVE PULSE OFFICE SELECTIONS.

Fig. 33—Toll Center Switching Combined With Completion to Customers in the Same Marker Group (Sheet 2 of 2)

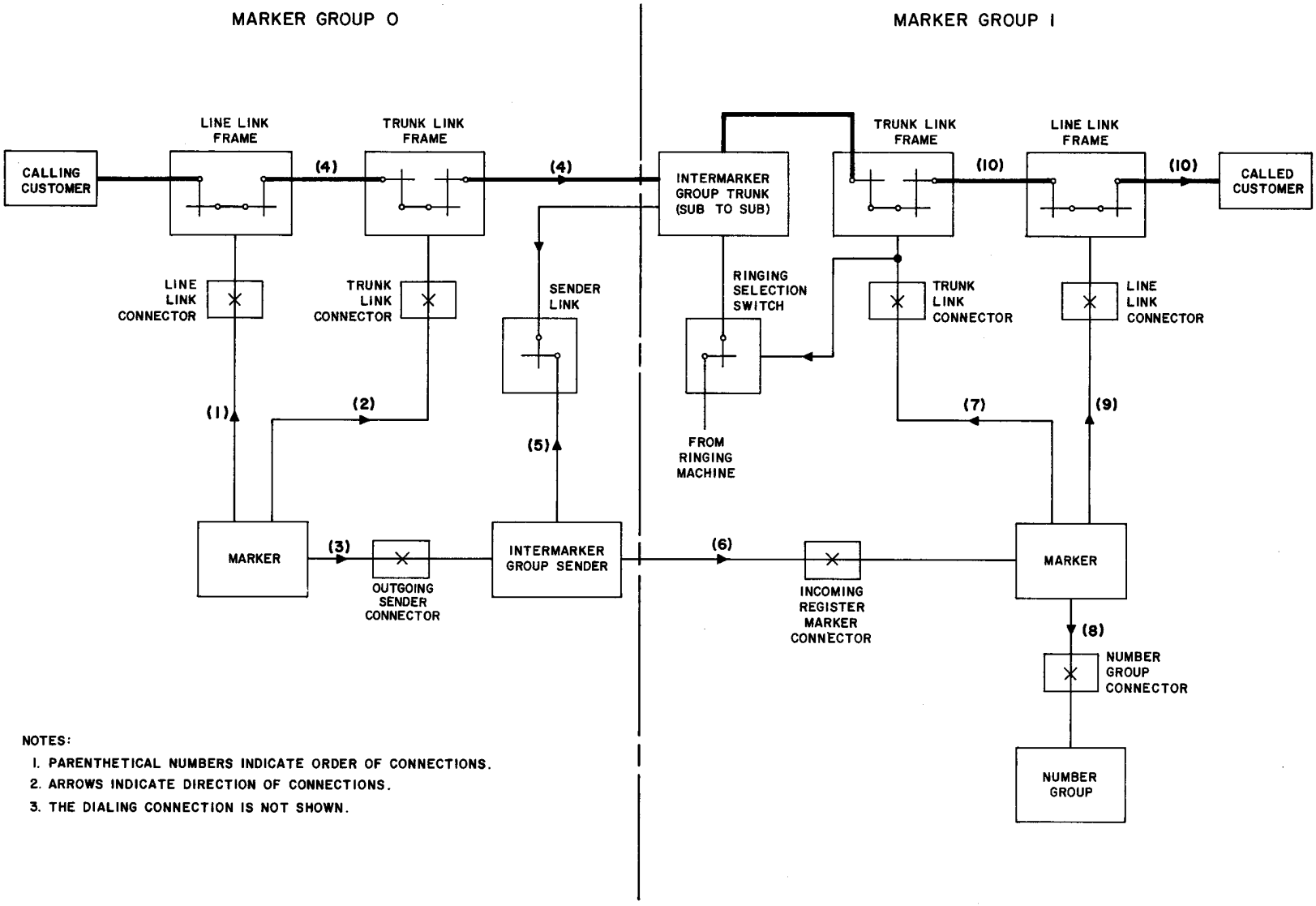


Fig. 34—Intermarker Group Trunk Connection—Customer-to-Customer

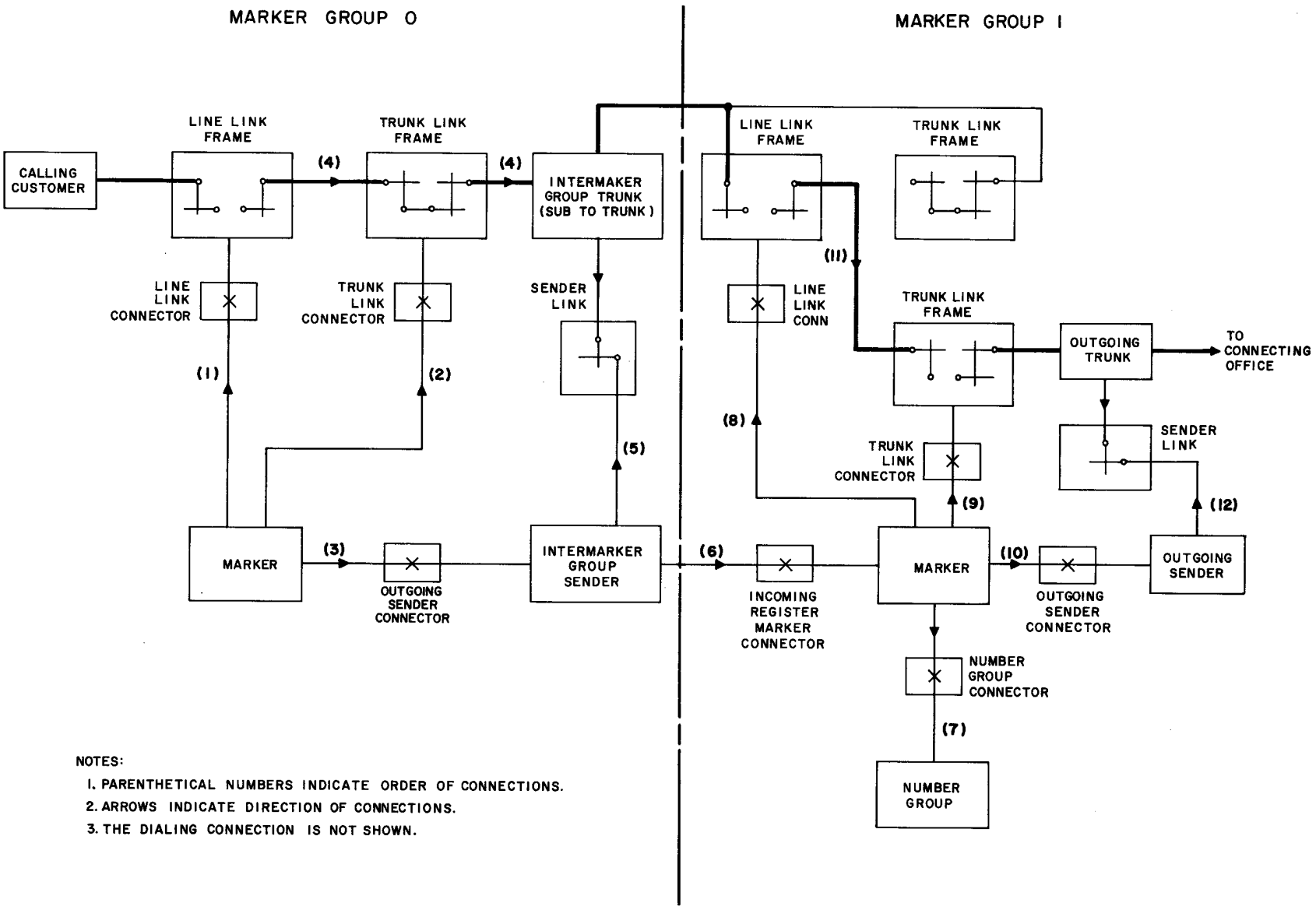
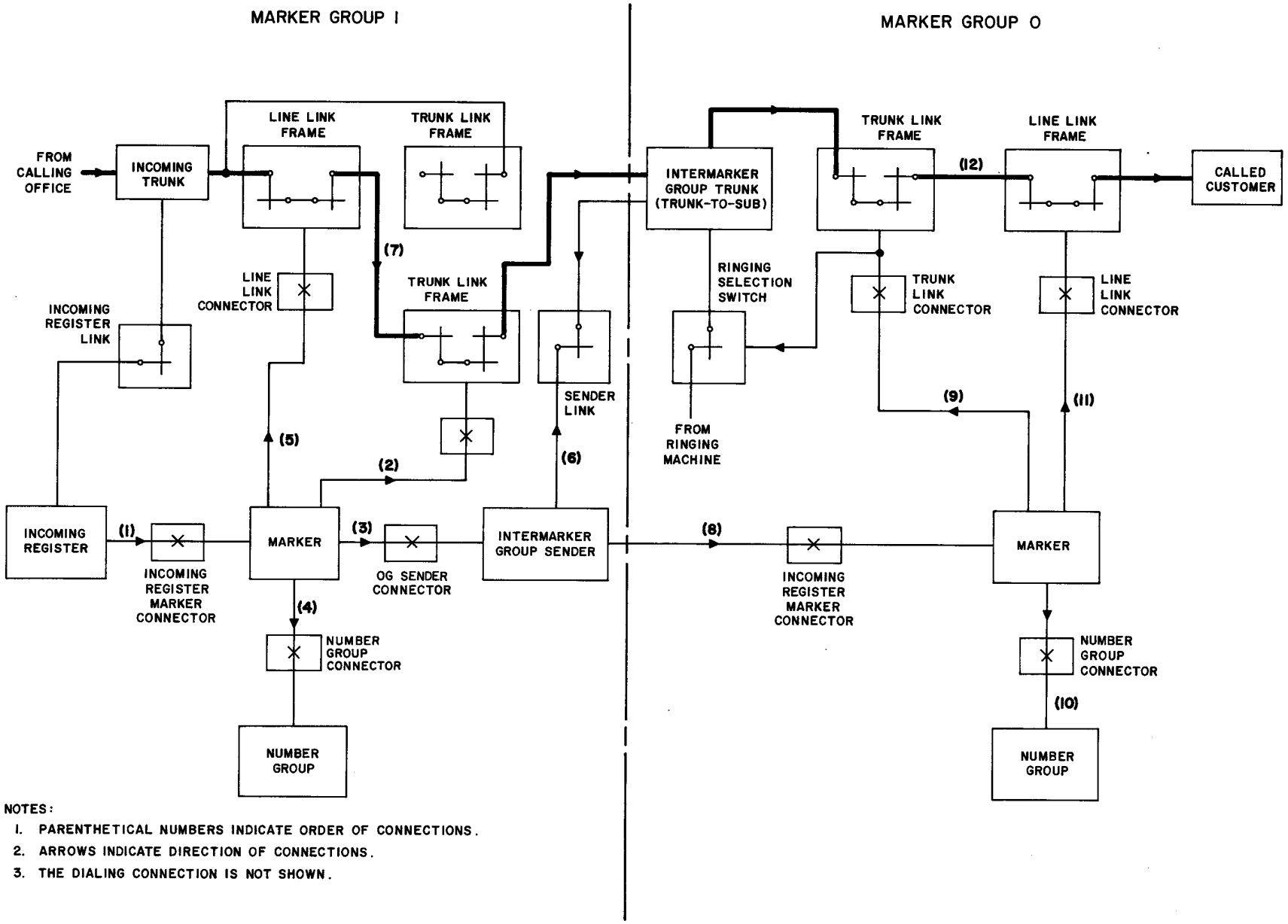


Fig. 35—Intermarker Group Trunk Connection—Customer-to-Trunk



NOTES:

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

Fig. 36—Intermarker Group Trunk Connection—Trunk-to-Customer

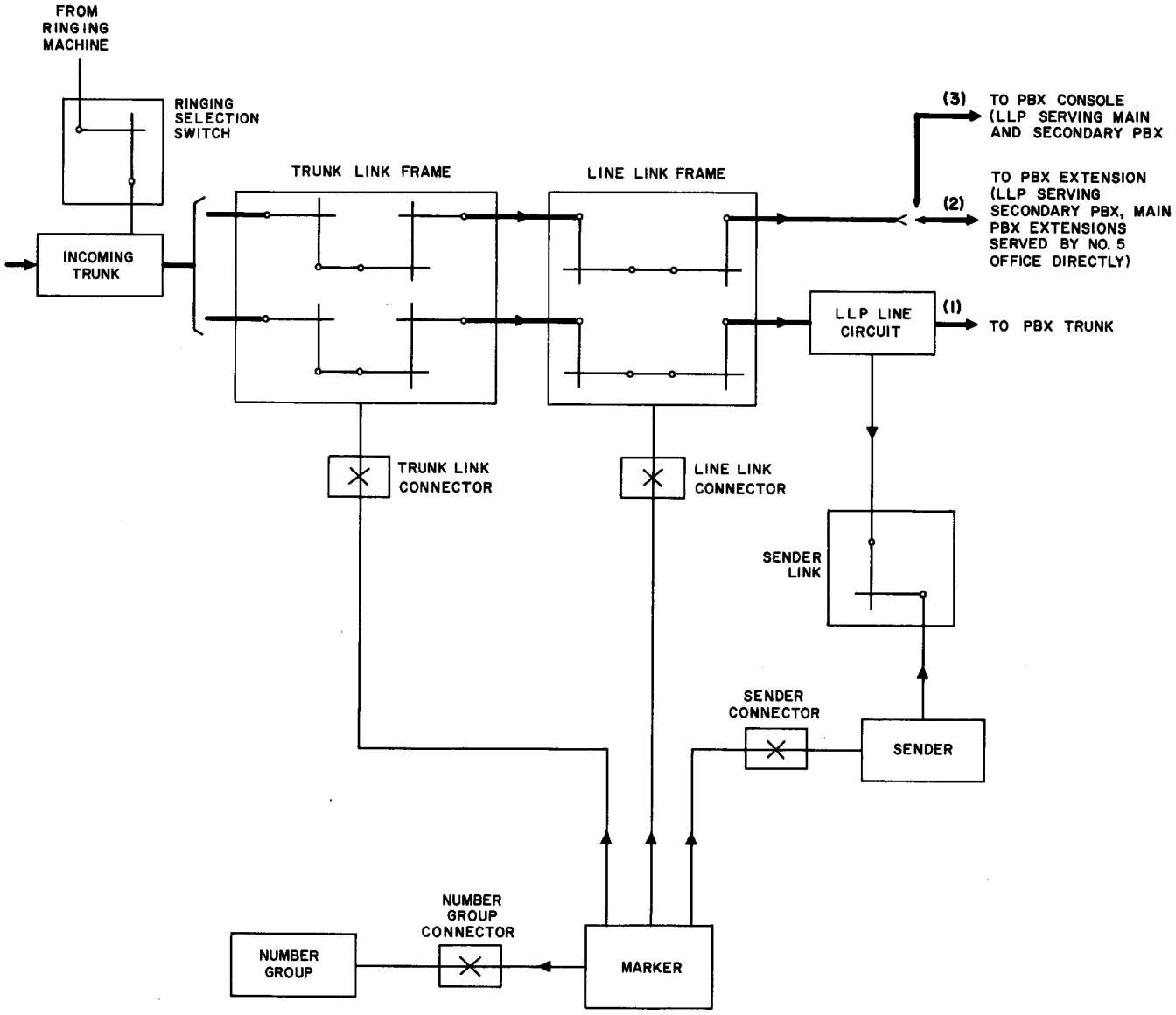


Fig. 37—No. 5 Crossbar Office With Line Link Pulsing Features

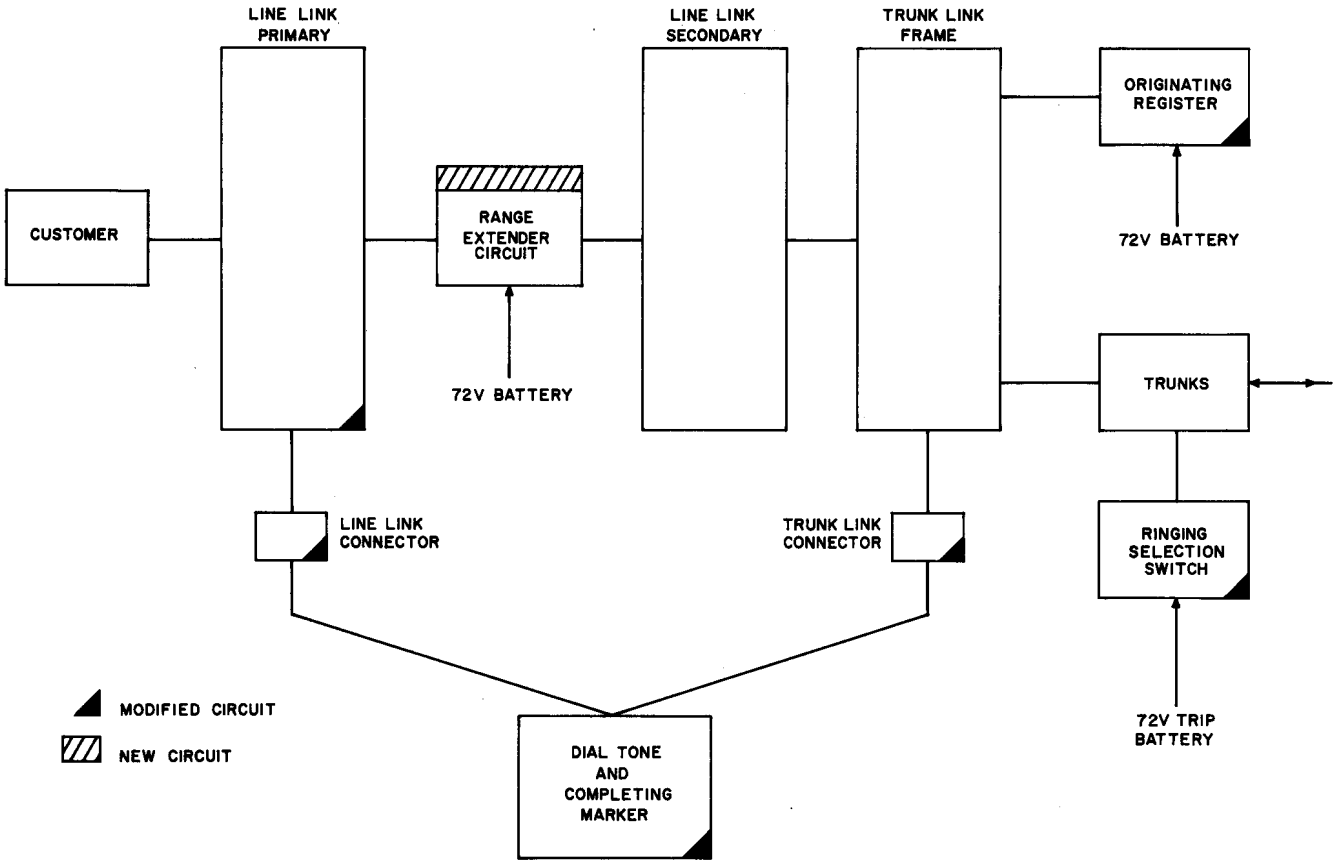


Fig. 38—Range Extender for Unigauge Cabling Arrangement