DIAL TONE JOB

ESTABLISHING THE DIALING CONNECTION

NO. 5 CROSSBAR OFFICES

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FIGURES PAGE

1. GENERAL

1.01 This text outline is one of a group that describes the detailed circuit operation for the various types of calls and is associated with wire spring relay type circuits of No. 5 crossbar offices.

1.02 The basic equipment element used in the No. 5 crossbar office, is the crossbar switch (Fig. 1), from which the system receives its name. Section 971.505.01 contains the general description of the switch. For a more detailed study of the selection elements of the crossbar switch, refer to Figs. 2 and 3.

1.03 A telephone customer by lifting the receiver requests service. During normal traffic a number of other customers are also making requests. The No. 5 crossbar common control equipment (marker) must determine the origin of these requests. In so doing, it also determines which line will be served first. The equipment must then prepare itself to accept the customer's instructions, that is, the dialed digits of the called number. To do this, apparatus capable of interpreting and storing these digits (originating register) must be attached to the calling line. The marker tests this connection and then the originating register transmits dial tone to the calling customer. This entire operation is called Establishing the Dialing Connection and is shown on SC 701-1. After this connection is established, the customer can dial the desired number.

1.04 In the following description all FS references are associated with SD-26001-01 unless otherwise noted.

1.05 The major functions for establishing the dialing connection are summarized in Table A. Associated with these functions are the key relays, trouble recorder card punch indications, and pertinent information useful in following the progress of the call. The table is also an aid in localizing the area in which circuit troubles may be found. By giving a cross reference to the operational sketches, functional schematics and the sequence charts the table is useful when analyzing trouble recorder cards.

2. LINE RELAY OPERATION (OS 701-1, FS1, 101, 102, SD-26030)

2.01 Each line has an L- (line) relay which is located on the line link frame and each relay is associated with a vertical on a line switch. A variety of basic and supplementary frame sizes are available so that the number of lines (L relays) may be from 190 to 590 in 50 line increments, the remaining ten line switch verticals being used for no-test purposes.

2.02 Several of the sizes employ split frames, an arrangement not used on the replaced "U" type equipments. Split frames accommodate line switches associated with two adjacent line link frames. On the split supplementary frames the lower five switches are associated with the frame to the left and the upper five switches are associated with the frame to the right. On the 190 line basic frame the lower five switches are associated with that frame and the upper five switches are associated with a basic frame having only combined line and junctor switches.

3. THE LINE LINK FRAME (FS 101, 102, SD-26030)

3.01 For purposes of calling line identification, the line link frame is divided into horizontal groups, vertical groups, and vertical files.

3.02 On nonsplit frames a horizontal group consists of all the lines on all the switches of the same number, and are the switches whose horizontals are multiplied. Switches number from 0 to 9 from the bottom of the frame up. On split frames, the horizontals on each switch are also split so that half of the verticals are in one horizontal group and the other half in another. Here the left half of each group of five switches are numbered 0-4 and the right half 5-9.

3.03 Also on nonsplit frames a vertical file consists of ten verticals, one in each of the ten horizontal groups and in the same position on each switch. Five successive vertical files comprise a vertical group except in vertical group 2 where the first file is used for no-test purposes. Vertical groups are numbered 0-11. On split frames a vertical file consists of five verticals on the left half of the upper or lower five switches, that is in horizontal groups 0-4 and five verticals in corresponding positions on the right half of the upper or lower five switches, that is in horizontal 5-9. Vertical groups on the split frames follow the same pattern, the five 10 vertical switches having one vertical group and the 20 vertical switches having two vertical groups.

4. VERTICAL GROUP START RELAY OPERATION (OS 701, FS1-SD-26029, FS2-SD-26030)

4.01 The L- relays connected to one line group have contacts multipled together and connected to a 536-ohm resistor. The resistors for all of the line groups in the vertical group connect to the VGS- (vertical group start) relay. Hence, any L- relay in the vertical group operates the VGS- relay (one VGS- per vertical group). A line group consists of five verticals, line hold magnets and associated equipment common to one vertical group and one horizontal group. These line groups are numbered 0-11 according to the vertical group in which they appear and the line relays and associated hold magnets in each line group are numbered 0-4.

4.02 In each connector the marker start relay circuit for each marker is brought out to an MS- terminal so that any marker may be connected as first choice. There are two start circuits in each connector which are brought through the connector control and thence to MSA and MSB terminals. These terminals are cross-connected to the MS- terminals of different markers giving each connector two choices. The VGS- relay connects battery through resistances "STA" and "STB" to the two marker connector start circuits. One or the other of these start circuits is closed through depending on whether relay Z in the connector control circuit is operated or normal, the position of the Z being changed on alternate calls. Assuming Z normal, VGS- connects battery through resistance STA, through control relays TC, Z, TRS, TRL, and TR relays to the MSA terminal. This terminal is cross-connected to an MS- terminal and determines which marker is preferred. This circuit is known as the "A" start circuit and is sometimes referred to simply as STA. A "B" start circuit or STB is similarly closed when Z is operated from battery through the STB resistance,

through control relays TC, Z, TRS, TRL and TR relays to the MSB terminal. This terminal is also cross-connected to an MS- terminal and determines which marker is preferred by the "B" start circuit. Only one of these leads is required on a connector usage. The connector control determines which start lead is to be used on a call, using the leads alternately, or in case of delay or trouble, shifting to the alternate choice. By this means a connector is always sure of being connected to a marker and the use of markers can be spread among the connectors to obtain a reasonably equal distribution of load.

5. THE LINE LINK MARKER CONNECTOR

5.01 The line link marker connector connects the leads necessary for a dial tone connection from a line link frame to a marker. Each line, line link and marker connector control circuit is provided with a line link marker connector circuit and a preference control circuit per marker. The line link marker connector circuit is equipped with one set of multicontact relays per marker. The number of leads to be connected by this circuit requires the use of two 30 contact wire-spring multicontact relays. The multicontact connector relay that is common to the line link frame requesting service and to the chosen marker is operated on marker seizure and is controlled by the preference control circuit.

5.02 There is an MS relay per marker per connector and when this relay operates, in response to a bid by a line link circuit for a marker it causes the connector relays to operate which will close all the necessary leads between the marker and line link frame.

5.03 The cabling of the leads connected by these relays is shown in Fig. 4. The leads are cabled from the line link frame to a terminal strip on the marker connector frame. Then they are multipled with bare wire horizontal strapping (protected by plastic guards) to the armatures of the MA and MB connector relays serving the line link frame. The contacts of these relays are cable-multipled to the relays - in other connectors - common to each marker, and then to the markers.

6. RELAY CHAIN CIRCUITS IN THE MARKER CONNECTORS (OS 701-1, FS2-SD-26029, FS28)

6.01 In each marker connector there is a preference control circuit consisting of a marker start relay MS and marker busy relay CB for each marker. It is the purpose of these relays to give each connector access to the first idle marker in the group depending on the point of connector access and to make that marker busy to all other connectors; to operate connector relays which will close all the necessary leads between the marker and the circuit requiring service; and by means of cross-connections in the markers to vary the order of preference of connectors for markers. Two relay chain circuits are used to choose a marker:

(a) A CB- (marker busy) relay chain circuit per connector with one relay per marker in the group of markers serving the connectors. This chain determines which marker is used.

(b) An MS- (marker start) relay chain circuit per marker in the group serving the marker connectors, with one relay per connector. This circuit determines which connector seizes the marker.

6.02 A connector's preference is determined by its position in the MS- relay chain. The connector whose MS- relays are cross-connected directly to the MAK-ST and MCK-ST punchings in the markers has the highest preference. These connections give the marker connector first access to the operating grounds for its connector relays.

6.03 In dial tone markers, only line link frames are competing through MS- relay chains for markers. However, in completing markers, originating and incoming registers are competing for markers through the same MS- relay chains. The preference arrangement for marker connectors when used with completing markers gives highest preference to the originating register marker connectors.

6.04 An MS- cross-connection punching is provided per CB- relay. Punchings MSA and MSB for each connector are cross-connected to two of these MS- punchings. A marker associated with an MS- punching connected to an MSA or MSB punching is a first choice marker for the line link frame from which the start lead originates. Since there are two start leads, each frame has two first choice markers. The start lead that is connected through the marker connector control circuit determines which of these two markers is the first choice marker on a particular usage. The arrangement of the cross connection is such that each marker is first choice for about the same number of line link frames.

6.05 The particular start lead that is connected through the marker connector control circuit applies resistance battery to the punching to which it is connected. If the marker associated with this punching is busy serving another connector, relay CB- is operated. Resistance battery is then passed to the next CB- relay in the chain. Assume that the resistance battery is finally connected to a released CB- relay associated with an idle marker. This battery then operates and locks relay MS- (in preference control circuit) associated with the idle marker.

6.06 The operation of relay MS- operates relays MA and MB (line link marker connector), thereby seizing the marker. The operation of relay MA shunts relay CB- in the seizing preference control circuit associated with the seized marker. Relay MA operates relays MCB- (marker connector busy) in the marker. These relays apply ground to all of the CB- relays associated with the marker and operate all but the shunted one in the seizing connector. Relay MS- in operating also releases the marker connector check relays, MAK, MCK, and MSK in the marker. The release of any one of these relays operates relay, TM, which starts marker timing. Marker timing is described in CD-26001-01.

6.07 The connector is prevented from reverting to a more preferred marker by locking operated those CB- relays in the connector corresponding to busy markers at the time a seizure is attempted. The locking ground is provided immediately by relay TM (timing), and later by relay MA (marker connector.

It is connected in such a way that at least one CB- relay must be normal to enable the ground to lock those that are operated. This is necessary to prevent a call from blocking itself if a temporary all-markers-busy condition is encountered.

6.08 There is a time interval between the operation of relay MS- in the seizing preference control circuit and the operation of relays CB- in all of the other preference control circuits. During this interval other connectors may also operate MS- relays associated with the same marker. These MS- relays, however, would be in less preferred connectors than the first connector to succeed in operating its MS- relay. Because of the arrangement of the chain circuits controlling the operation of the MA and MB relays, the highest preference connector, with relay MS- operated, always succeeds in seizing the marker. The subsequent operation of CB- relays in the other connectors transfers their start leads to other markers, releasing their MS- relays associated with this matter.

6.09 On an attempt by two connectors to seize the same marker, the one with a faster operating MS- relay always succeeds. In order to prevent a particular connector from being served repeatedly while others are forced to wait, a system of traffic control is provided. Traffic control is described in CD-26029-01.

7. W AND Z RELAY COMBINATION FOR TRANSFERRING START LEADS (OS 701, FS4, SD-26029)

7.01 If only one start lead was provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. To prevent this, and also to reduce the possibility of circuit failure, two start leads are provided in each marker connector. By alternating the use of these start leads, two markers serve alternately as first choice markers, thereby providing more even wear on the marker connector relays. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

7.02 In the following description, assume that relay TRS (transfer start) is normal. The functions of relay TRS are discussed in CD-26030-01.

7.03 The W and Z relay combination operates as follows:

(a) First Connector Usage

(1) Marker Seizure - Assume that relays MA, MB, W, and Z are normal. Lead STA has continuity through relay Z, and lead STB is open. A marker is seized by the operation of relay MS- via the MSA MS cross connection. Relay MS- causes the operation of relays MA and MB. Relay MA operates relay MK which in turn operates relay W, which locks. At this time, ground is also applied to both sides of the Z relay to prevent its operation.

(2) Connector Release - The marker releases the connector by opening the battery path of relay MS-. Relay MS- causes the release of relays MA and MB. Relay MA releases relay MK which removes the ground that shunts relay Z. Relay Z operates from the locking ground of relay W, which remains operated. The operation of relay Z opens lead STA and closes STB, making it available for the next usage.

(b) Second Connector Usage

(1) Marker Seizure - Relays MA and MB are normal and relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB-MS cross connection. Relay MS- causes relays MA and MB to operate. The operation of relay MK, this time, shunts relay W, releasing it. Relay Z remains operated because relay W in releasing transfers the operating ground of relay Z from the locking ground of relay W to the ground furnished by relay MK.

(2) Connector Release - The marker again releases the connector by opening the battery path of relay MS-. The release of relay MK removes the Z relay holding ground, allowing it to release. Relay W remains released. The release of relay Z opens lead STB and closes lead STA making it available for the next usage.

(c) Subsequent Usages - The action described in (a) and (b) above continues.

8. MARKER CONTROL, CLASS, CHECK, AND ROUTE RELAY OPERATION (FS23-26)

8.01 Line link marker connector relays MA and MB, in addition to connecting a number of leads from the line link frame to the marker, also apply ground to various marker leads. Ground on one of these, the CKG (connector check ground) lead causes the operation of a number of marker relays. They in turn provide the batteries, grounds, and interconnections necessary for the marker to function.

8.02 Relay MS- may operate relay D (dial line frame), MF (multifrequency line frame), or MLF (mixed line frame) via the LF- to LFD, LF- to FLMF, or LF- to LFM cross connection. Relay D or MF indicates which type of originating register is required by all lines on the line link frame. Relay MLF indicates that some of the lines on the frame require one type of originating register and the rest require another. For the latter, relay D or MF is operated after vertical group identification via the VGR- to VGD or VGR- to VGMF cross connection.

8.03 At the present time No. 5 crossbar offices are equipped only with dial pulsing originating registers; hence the LF- to LFD cross connection is the only one used. Therefore, relay MS- in the line link marker connector always operates relay D. If in the future other types of originating registers are added, the other arrangements will be used.

8.04 Relay D starts the operations necessary for the identification of the calling line and for the selection of an available originating register.

9. CALLING LINE IDENTIFICATION AND SELECTION

A. General

9.01 Calling line identification and selection is made by the marker. It controls the connection of an originating register to a particular customer out of a number who may have originated calls at about the same time.

9.02 Calling line identification takes place in five steps:

(1) Line link frame identification

(2) Vertical group identification and selection

(3) Horizontal group identification and selection

(4) Vertical file identification and selection

(5) Class-of-service identification

B. Line Link Frame Identification (FS10)

9.03 A line link frame is permanently connected to its line link marker connector. Three leads out of nine are grounded in the line link marker connector when relay MA operates. This serves to identify the line link frame number to the marker. The frame number may vary from 00 to 39. One-out-of-four leads identifies the first digit and two-out-of-five leads identity the second digit. Relays FT $\frac{1}{4}$ (frame tens) and FU $\frac{2}{5}$ (frame units) in the marker operate, through contacts of relay GTL1, in response to these grounds. These relays operate one FTB- (frame tens-line link) and one FUT- (frame units test) relay. Relays FTB- and FUT- are used later in selecting a connecting path from the register to the calling line.

C. Two-out-of-five Transfer Circuit (FS6-13)

9.04 The two-out-of-five operation of the FU $\frac{2}{5}$ relays, previously mentioned, is an example of representing ten values with five relays. There are exactly ten combinations of two-out-of-five relays, or just enough to represent the ten values of a decimal digit. Instead of using arbitrary pairs of relays to represent the ten values, the five relays are designated 0, 1, 2, 4, 7, and a digit is represented by operating the two relays whose designations add up to its value. Thus digit one is represented by operating relays designated 0 and 1; digit 2 is represented by operating relays designated 0 and 2; and so forth. There is a single exception to this additive arrangement: digit 0 is represented by operating relays designated 4 and 7. This two-out-of-five additive code is useful for two reasons. First, only five relays are required to represent any one-of-ten values; and second, its pattern of two and only two elements out of five permits a check for correctness. This pattern is used in the registration check. The units digit (FU $\frac{2}{5}$) of the line link frame number is part of this check.

9.05 By the addition of one relay, a two-out-of-six additive code may be arranged to represent a maximum of 15 values. The sixth relay is designated 10. Digits 0 to 9 are represented by the same additive process as for two out of five, and digits 10 to 14 are represented by adding the designation 10 to designations 0, 1, 2, 7, and 4, in this order. Note that here again the process is additive with one exception; digit 13 is represented by operating relays designated 10 and 7. This two-out-of-six combination, limited to represent digits 0 to 11, is used for vertical group number registration.

D. Gating Control Circuit (FS6-7-8, 26)

9.06 The gating circuit, by its operation and release, controls the time during which one circuit can accept information from another. The gating circuit permits the marker to determine the particular vertical and horizontal groups and vertical files requesting service. Relay D operates the VGG- (vertical group gate) relay, the HGG (horizontal group gate) relay and the VFG (vertical file gate) relay in the marker. These relays connect test leads from the line link frame to test relays in the marker. As described later for the various parts of line identification, relays VGG-, HGG, and VFG in releasing disconnect the test leads after the marker test relays operate. This excludes later service requests and at the same time allows the marker to select one vertical group, one horizontal group, or one vertical file for service.

9.07 Before the marker can begin line identification, relay GK (gate check) must operate. This verifies that the line link marker connector is still attached and that relays VGG-, HGG, and VFG have operated.

E. Junctor Sequence Walking Circuit (FS15)

9.08 The marker provides a walking circuit for equalizing preference for various marker selections and to safeguard service by shifting the entrance point of preference circuits. Circuit functions using the walking circuit are:

(a) Vertical groups (FS6)

(b) Horizontal groups (FS7)

(c) Vertical files (FS8)

(d) Trunks (FS4 and 5)

(e) Junctor Group and pattern (FS16-18)

9.09 The sequence circuit is arranged to advance one step each time the marker releases from a call. Assume that the marker is idle with one of its even numbered JSQ- and JLO relay operated. When the marker is seized the operation of relay LLC2 operates relay JSO. This provides a path to operate the next odd numbered JSQ- relay when relay LLC2 releases at the end of the call. The odd numbered JSQ- relay operates relay JLE, releasing the even numbered JSQ- relay which in turn releases relays JLO and JSO. Relay JSQ- (odd) and relay JLE are now operated and the same process occurs in operating an even numbered JSQ- relay on the next marker release.

9.10 Relays JSQ0-5 provide a six step sequence control circuit. A twelve step circuit can be obtained with relays SQ0 and SQ1 in either an operated or released condition. When these relays are released, relay JSQ0 operates relay SQ0 which locks to the released JSQ0 relay. Relay JSQ2 operates relay SQ1 which locks to the released JSQ2 relay, thus providing six steps. Relays SQ0 and SQ1 operated, provide the other six steps. In this case relay JSQ0 releases relay SQ0 and relay JSQ2 releases relay SQ1.

9.11 Slow release relay SQA is a check to see that the circuit advances properly. Failure of relays JS0, JSE, JL0 and JLE to operate will operate relay SQA. Relay SQA also operates relay JSQ0 to start the sequence circuit when battery is first applied.

F. Vertical Group Identification and Selection (FS6-26)

9.12 Relay MA extends a maximum of twelve VGT- (vertical group test) leads from the VGS- relays in the line link frame to the marker. For a marker seizure by the line link frame at least one VGS- relay must be operated. Hence, one or more VGT- leads are grounded. These leads pass through the contacts of the VGG- relays to relays VGT- (vertical group test). A VGT- relay operates for each operated VGS- relay in the line link frame. The operation of one or more VGT- relays operates relay VGR (vertical group release). Relay VGR operates relay VTK (vertical group test check).

9.13 The operation of relay VTK connects relay OC1 (originating call - start lead A or B) in series with relay MS-. This places the marker connector under control of the marker. Relay OC1 operates relay OC (originating call).

9.14 Relay VTK operated also releases relays VGG-, thus releasing all but one of the operated VGT- relays. Relay VTK1 (vertical group test check) operates and verifies that relays VGG- and all but one of the VGT- relays have released. This one VGT- relay remaining operated is held under control of one of the operated JSQ- (sequence) relays. The holding circuit is from ground on contacts of relay D to relay VGT2 and then through an operated JSQ- relay to the contact chain on the other VGT- relays. On each marker usage the ground is applied at a different point in the contact chain. The first operated VGT- relay in the chain is thereby locked and opens the ground to any others, allowing their release when VGG- releases. The connection of the VGT2 relay is made independent of the sequence relays, because it is to this vertical group that police, fire, and other emergency lines are connected.

G. Horizontal Group Identification and Selection (FS7) (FS106-SD-26030)

9.15 The VGT- relay that remains operated as a result of vertical group identification operates a corresponding VGA- (vertical group auxiliary) relay on the line link frame. This relay extends ten test leads (HGT0-9) from contacts of the line relays (L0-L4) in the selected vertical group to the marker. An operated line relay or relays in any line group in the vertical

group apply direct ground to the corresponding test lead. Because of the multiple arrangement for operating relay VGS- (refer to Section 4), those test leads for line groups in which all of the line relays are released will have ground from the operated line relays in other line groups connected to them through two 536-ohm resistors in series. In the marker, the ten test leads terminate on HGT- (horizontal group test) relays which operate only in response to the direct grounds. One or more operated HGT- relays operate relay HGR (horizontal group release). Relay HGR in turn operates relay HTK (horizontal test check) which releases relay HGG. Just as for vertical group identification, the release of relay HGG releases all but the one HGT- relay that is locked under control of the JSQ- relays.

9.16 The successful release of all but one HGT- relay and of relay HGG is checked by the operation of relay HTK1 (horizontal group test check auxiliary).

H. Vertical File Identification and Selection (FS8) (FS106-SD-26030)

9.17 As a result of vertical and horizontal group identification, the marker has determined the line group containing the calling line. The marker must now identify the vertical file to determine which of these five lines is the calling line.

9.18 The selected VGT- and HGT- relays operate relays VGB- (vertical group auxiliary) and HG(A, B)- (horizontal group), respectively, on the line link frame when it is seized. The operation of relay HG(A, B)- is checked by the operation of relay HGK (horizontal group check) in the marker. The combination of one VGB- and one HG(A, B)- relay, operated in the line link frame, operates relay LG- (line group connector) corresponding to the line group common to the selected vertical and horizontal groups. This extends a group of five leads (VFT-) from the contacts of the line relays in the group through contacts of relays VFG in the marker to the VFT- (vertical file test) relays. The operation is the same as for vertical and horizontal group identification. The operation of one or more VFT- relays operates relay FR (vertical file release). This releases relay VFG. All but one VFT- relay are thereby released, and FTK1 (vertical file test check) operates to indicate that VFG is released and only one VFT- is operated.

I. Marker Supervision During Line Identification and Selection (FS23)

9.19 While line identification is in progress, the marker maintains constant supervision over its selections, namely, the vertical group, horizontal group, and vertical file. Withdrawal of demands for dial tone during these selections will result in marker release.

9.20 On any stage of line identification, the release of relays VGG1, VGG2, HGG, or VFG releases all but one VGT-, HGT-, or VFT- relay. The test check relays VTK and VTK1, HTK and HTK1, and FTK1 are thereby operated. Relay VGR, HGR, or FR is held by the ground on the line link frame that originally operated the selected test relay. If at any stage of line identification this ground is removed (abandoned call), the VGR, HGR, or FR relay releases. This condition, together with the operated test check relays, operates relays DIS1 and DIS2 (marker disconnect), causing the marker to disconnect.

J. Class-of-service Identification (OS 705-1, (FS6-12)

9.21 To properly charge the calling subscriber for the call, it is necessary to identify the class of service. This information is required so that subscribers being served under different charging plans may be correctly charged. To accomplish this, as many as sixty classes of service can be provided.

9.22 With the exception of the no-test vertical file, all the vertical files on the line link frame are available for line assignment and may be assigned to any of sixty classes of service. They may be grouped on the line link frame in any manner subject to two limitations.

(a) All lines located in the same vertical file within the same vertical group must have the same class of service.

(b) The assignment of a class of service number for a particular class of service must be the same for both the A and B groups.

9.23 On the line link frame there is a V-punching for each vertical file, and a CS- punching for each class of service. The V- punchings are cross-connected to the appropriate CS- punchings in accordance with the class of service.

9.24 When an office requires more than thirty class of service indications they are divided into two groups of thirty classes on each line link frame, group A and group B. On the line link frame there is a VG- punching for each vertical group, a CA punching and a CB punching. The CA and CB punchings are connected in series to the CGA and CGB relays respectively in the marker through the line link connector circuit. When the lines in a particular vertical group belong to the first group of 30 classes or group A the VG- punching is cross-connected to the CA punching, this causes the VGB- relay in line link and marker connector control circuit and the CGA relay in the marker to operate in series. When the lines in a particular vertical group belong to the second group of 30 classes or group B the VG- punching is cross-connected to the CB punching, this causes the VGA relay in the line link and marker connector control circuit and the CGB relay in the marker to operate in series. The operation of relay FTK1, together with an operated VGB- relay for the vertical group, and an operated VFT- relay for the vertical file, operates the marker CS- relay that corresponds to the class of service of the selected vertical file.

10. TRUNK LINK FRAME SELECTION, PREFERENCE, AND SEIZURE (FS1-2-3-26, OS 702-1)

A. General

10.01 When the marker is directed to establish a dialing connection, it tests for an idle trunk link frame that has access to one or more idle originating registers. An idle trunk link frame is one to which another marker is not connected at this time, although many of the trunks and registers which

have appearances on this frame may be busy serving other calls. When an idle trunk link frame is found, the marker operates the set of trunk link connector relays common to itself and the frame, thereby seizing it. A typical multiple arrangement of the trunk link connector frames is shown in Fig. 5.

B. Testing for an Idle Trunk Link Frame (FS1, OS 702-1)

10.02 Relay D or MF operates relays BC0 and BC10 which are the busy cut-in relays. Relay BC0 extends the windings of the frame busy FB0 to 9 relays and BC10 extends the windings of the frame busy FB10 to 19 relays to their associated trunk link connector over the FB10-19 leads. If the trunk link connector is busy the corresponding test lead is grounded and the associated FB- relay will be operated. Idle trunk link frames are indicated by normal FB- relays.

C. Testing for an Idle Originating Register (FS1-2-26, OS 702-1)

10.03 Relay D operates the FCD0 and FCD10 (frame connector) relays and the MF operates the FCM0 and FCM10 (frame connector) relays associated with originating register test leads. When the FCD0 and FCD10 or FMC0 and FMC10 relays operate they extend test leads (one per trunk link frame) from the marker to the trunk link frames. These leads are cross-connected in the frame to test leads from all of the originating registers having appearances on the frame. If at least one register is idle the test lead is grounded, thereby operating the corresponding FTC- (frame test common) relay in the marker. If no registers are idle, the lead is not grounded and the corresponding FTC- relay remains released. Relay FTCK (frame test check) operates to indicate that one or more FTC- relays are operated.

D. Trunk Link Frame Preference

10.04 Since it is undesirable for the same trunk link frame to be first choice for the same marker on each usage, a rotating preference system is used. On the previous marker usage, one of the FM0-4 (frame memory) and FMG- (Frame Memory group) relays that correspond to the trunk link frame used were operated and held until this marker usage. If none were operated, such as after initial application of power, the FM0 and FMG0 would operate when power was applied. The FM0 operates through a chain of break contacts on the other FM relays and released RYC relay. The FMG0 operates through break contact of FMG5 and released RYC relay.

10.05 On this usage, the operated D or MF relay together with the held FM- and FMG- relays operate the FMK (frame memory check) relay, this in turn will operate the FMG (frame memory guard) relay. Relays FMK and FMG indicate that an FM- and an FMG- relay is operated.

10.06 The operating ground for relay FS- (frame selection) is supplied through the operated FTC- relay corresponding to a trunk link frame with an idle originating register and the contacts of the operated FM- and FMG- relays associated with the previous trunk link frame usage. If relay FTC- is released, indicating no idle registers, the ground is passed to the next FTC- relay.

If relay FTC- is operated, indicating idle registers, but relay FB- is operated, indicating a busy frame, the ground is still passed to the next FTC- relay. If the FTC- relay is operated and the FB- relay that corresponds to the same trunk link frame is released, the ground is then applied to the FS- relay, operating it.

E. Trunk Link Frame Seizure (FS2-3-4, SD-26039)(FS1, SD-26033)(FS1-3)(OS 702-1)

10.07 Each trunk link frame has a trunk link connector and a preference control and make busy circuit associated with it. The marker preference relays are contained in the preference control circuit and the marker connector relays in the trunk link connector circuit.

10.08 In each preference control circuit there is one MP- (marker preference) relay associated with each marker. The operation of the FS- relay extends battery over the ST- lead to the MP- relay which operates if no other marker closer to ground in the chain attempts to operate its MP- relay. The MP- relay locks to ground on its own contacts.

10.09 The operation of the MP- relay causes the operation of the M relay in the trunk link connector circuit under control of a chain circuit through normal MP- relays in lower preference circuits unless it is the lowest preference circuit. Relay M operates the MA1,2, MB1,2, MC1,2, and MD1,2 relays in the trunk link connector. TFK1 and TFK2 (trunk frame check) operate to indicate the seizure of the trunk link frame.

F. Recycle of Frame Memory Preference (OS 702-1, FS1-2

10.10 After the trunk link frame has been seized it will be necessary for the marker to reset the frame memory relays. The operation of relay TFK1 removes the locking ground from relays FM- and FMG- held from the previous usage, thereby allowing them to release. The release of relays FM- and FMG- release relay FMK which releases relay FMG. The release of relay FMG, together with the operated relay FS- on this usage, operates the FM- relay that corresponds to the trunk link frame being used. Relay FMK reoperates. Because relay TFK1 is operated, relay FML (frame memory lock) operates and relay FMG remains nonoperated. The operation of relay FML releases relays BC0 and BC10, opening the trunk link frame test leads and releasing the operated FB- relays.

Note: On incoming and pulse conversion calls the frame memory is not recycled. This is because the seized trunk link frame on these calls is predetermined by the trunk location instead of being selected by the marker.

11. LINE LINK FRAME SEIZURE (OS 703-1) (FS1-SD-26031) (FS11)(FS2-4-SD-26039)

11.01 Each line link frame has a marker connector control circuit, a marker connector circuit, a line link connector circuit and a preference control and make busy circuit associated with it. The preference control circuit is used by the marker to gain access to the line link frame and its purpose is to permit only one marker to have access to a particular frame at a time.

11.02 Following trunk link frame and connector seizure, the marker seizes the line link frame (which has identified itself through its marker connector) in competition with other markers which may be connecting or waiting to connect calls to the line link frame through the preference control circuit.

11.03 The operation of the marker TFK1 relay indicating trunk link frame seizure, connects battery to the LFS lead through the associated line link marker connector circuit, the start lead ST- to the preference control circuit. This start lead, together with start leads from all other markers, connects to the MP- (marker preference) relays arranged in a lockout chain circuit.

11.04 The first MP- relay to operate opens the ground path for more preferred MP- relays, and at the same time operates its own line link connector relay MA1. The break-make chain on the MP relays prevents the operation of more than one MA1 relay at one time. The MA1 relay operates relay LFK (line frame check) to indicate the seizure of the frame.

11.05 During this time, less preferred markers are able to operate their MP- relays in the chain. These markers are later served in preference order as previously served markers release.

11.06 This permits vertical file identification to proceed (described in Section 9, H).

12. ORIGINATING REGISTER SELECTION (OS 704-1)(FS4, FS5)(FS14, SD-26040)

A. Trunk Blocks and Trunk Groups

12.01 The trunk link frame has 160 outlets to which trunks and originating registers may be assigned. The trunks that have their connection to the marker predetermined are assigned to 40 of these outlets. For example, an incoming trunk from another office, when used on a call, is identified to the marker; and the marker must connect to this particular trunk to assist the call. The remaining outlets (120) are assigned to originating registers and those trunks which the marker may select. For example, the marker may use any idle outgoing trunk of the proper type (AMA, flat rate, coin, etc.) that connects to the desired completing office. By the same token, any idle originating register is suitable to complete a dialing connection.

12.02 These 120 outlets or appearances are assigned to trunk blocks (TBO-5) which consist of twenty trunks and/or registers. All of the originating registers (10 maximum) appearing on one trunk link frame are in one trunk block. In addition to the originating registers, one or more types of trunks may be assigned to this same trunk block. In order to differentiate these from each other, and from the registers, a further subdivision of twenty test groups (TGO-19) is provided. Originating registers and each trunk of a group, within one trunk block, are assigned to different test groups; therefore, the selection of one trunk block and one test group differently selects the originating register or desired trunk.

12.03 The trunks connect to the horizontals or levels on the trunk switches. There are two trunk appearances per level for levels 2 to 9 on the 10 trunk switches. The two appearances per level are obtained by using a 6-wire switch and operating a T0 or T1 select magnet (Position 0 or 1 respectively) in addition to the T select magnet associated with the level on which the trunk appears. The T0 or T1 select magnet controls crosspoints which connect the link to one or the other of two vertical multiples each consisting of tip, ring and sleeve. The trunk select magnet T- controls crosspoints which connect two horizontal tip, ring and sleeve multiples (corresponding to two trunk appearances) to the two vertical multiples but, as was just explained, only one vertical multiple is connected to a link. In this manner we have effectively obtained 16 trunk appearances per switch. Appearances connected by a T0 select magnet are called A appearances and those by a T1 select magnet, B appearances. Associated with each A appearance is an FA relay and with each B appearance an FB relay. These relays are effectively trunk connector relays and are operated by the F relay in the trunk. Intraoffice trunks require two appearances on the same trunk link frame and on the same level but on different switches. The calling end is on an A appearance and the called end is on a B appearance. The B appearance is on a switch one higher in number than the one containing the A appearance. Incoming trunks and other trunks requiring ringing are on B appearances. Registers, outgoing trunks and other trunks handling outgoing calls may be on either A or B appearances.

12.04 Economies were made for the dial tone marker circuit by assigning all registers to trunk block 0 with trunk group 0 for dial pulse originating registers and trunk group 1 for multifrequency originating registers. Also, only the A appearance of the trunk switch are used for originating registers. With these restrictions all originating registers are assigned to level 2, A appearance on the trunk switches, while the trunk switch number, 0-9, are associated with the BT0-9 leads.

B. Selection of Register

12.05 Before selecting the trunk link frame the marker has determined that one or more originating registers are available for use. Now it is necessary to determine which are idle.

12.06 Following seizure of the trunk link frame, the marker determines which originating registers on that frame are idle, and then selects an idle one.

12.07 Battery from the marker operates relay TBO (trunk block) in the trunk link circuit when the connector cut through relays operate. The operation of relay TBO is checked by relay TBK (trunk block check) in the marker.

12.08 Relays TSE1,2 are operated by relay TLC. Ground on the BT0-9 leads, when the connector cut through and TBO relays in the trunk link circuits operate, will operate one or more TT0-4 relays if relay TSE2 is operated. Since relays TT0-4 are double wound, their operation calls for an odd and even preference lockout circuit to identify which BT lead is grounded.

12.09 The operation of relays TSE1, TBK, MAK 1, and one JSQO-5 and TTO-4 relay operates one TSO-4 (trunk select) relay. Relay TS- locks to relay TLC and releases relays TSE1,2 which release all operated TTO-4 relays. The JSQO-5 relays are used for even distribution and their operation is described in Section 9E.

12.10 The released TSE1 relay and operated TSO-4 relay extends the BT lead to the OTS and ETS (odd and even trunk selection) relays. If either an even or odd BT lead is grounded, it operates its corresponding trunk selection relay. If both an even and odd BT lead is grounded, relay SQ1 (sequence) determines the selection of the proper trunk selection relay.

12.11 Relays ETS and OTS have 10-ohm windings to operate them and 200-ohm windings to release them. When both windings are energized the 200-ohm winding holds the relay released. A released SQ1 relay thus operates relay ETS and disables relay OTS. Relay OTS operates and ETS releases when relay SQ1 is operated.

12.12 Relay F in the originating register would not operate in series with the high resistance TTO-4 relays. Relays ETS or OTS are lower in resistance than relays TTO-4 and since they are now in series with relay F they allow it to operate. Relay F operates relays F1A and F1B in the register. The group of leads over which the marker passes calling line identification to the register are thereby connected to the trunk link frame.

13. CHANNEL SELECTION

A. General

13.01 After calling line identification and originating register seizure the marker selects an idle channel (path connecting a line to a register). A channel consists of a line link, a junctor, and a trunk link. Line identification fixes the line link frame termination of the channel, and the originating register location fixes the trunk link frame termination.

13.02 There are at least half as many trunk link frames as line link frames. Each line link frame terminates 100 junctors and each trunk link frame terminates 200 junctors. Depending on office size, there are ten to fifty junctors common to a line link and a trunk link frame. They are divided into subgroups; the first containing ten and the others ten or few junctors. For offices with more than twenty line link frames, extension trunk link frames are provided. They allow a pair of trunk link frames to share a group of junctors, thereby maintaining at least ten junctors available for connections to each line link frame.

13.03 In selecting a channel, the marker tests:

(a) the ten line links on the line switch connecting to the calling line

(b) a subgroup of junctors to the trunk link frame connecting to the register

(c) the ten trunk links from these junctors to the trunk switch connecting to the register

By testing the ten channels formed by these elements, the marker selects an idle channel for the connection.

13.04 If no channel is found, the marker steps the junctor subgroup selection and again makes channel test. If this fails or if there is only one subgroup, another register is seized and channel selection is again attempted (marker recycle).

13.05 Selecting or marking the entire connecting path is unique to crossbar systems. It distinguishes them from hunting systems in which idle elements of the connecting path are tested and seized in succession as the connection progresses from a calling line to a trunk.

B. Junctor Subgroup Selection (OS 706-1, OS 707-1)(FS14, FS15, FS16, FS18, FS19, FS21)

13.06 The junctor subgroup to be tested depends on the frames to be connected, the junctor distribution, and the junctor sequence circuit setting.

13.07 As stated in 13.02, the number of junctors in a junctor group (particular trunk link to particular line link frame) may vary from a maximum of fifty junctors to a minimum of ten junctors. When the number of junctors in a junctor group is in excess of ten, the junctor group is divided into subgroups. Since a subgroup may contain from one to ten junctors, the number of junctor subgroups may vary from a maximum of five to a minimum of one.

13.08 The STP1 (stepping) relay and the JSQ0-5 (junctor sequence) relays control junctor subgroup selection for the first step. When more than one subgroup is provided, the second step in subgroup selection is controlled by the STP2 relay and the JSQ0-5 relays. The first selected subgroup always contains a full complement of ten junctors. The second selected subgroup may contain from one to ten junctors.

13.09 When the marker selects a subgroup which contains the full complement of ten junctors, the PNR (pattern normal) relay is operated. However, when the selected junctor subgroup consists of less than a full group of ten junctors one of the junctor pattern tens digit number PA, PB or PC relays and one of junctor pattern units digit P0-9 relays will be operated to identify the junctor subgroup pattern and to identify the junctors within the junctor subgroup which are available.

13.10 The number of junctors within a junctor subgroup will vary from a maximum of ten junctors to a minimum of one junctor depending upon the office size and the selected junctor subgroups. The marker is equipped to simultaneously test ten separate channels therefore the marker must determine those channels which are incomplete because of nonexistent associated junctors within the selected junctor subgroup. The marker must then consider these incomplete channels unavailable so that the marker will not select one of these incomplete channels for service.

13.11 As outlined in 13.03, the marker tests the line links, trunk links, and junctors to select an idle channel. The test leads for 20 junctors, which are associated with a particular horizontal level on the trunk link frame junctor switches, are under control of a junctor connector relay JC0-19. Of the twenty junctors, ten are connected to the left half and ten to the right half of the switches. The left half is controlled by relay L (left) and the right half by relay R (right). In single frame or paired frame offices the JC0-9 relays control horizontal levels 0 through 9 on the regular junctor switches. In paired frame offices, the JC10-19 relays control horizontal levels 0 through 9 on the extension junctor switches. When there are extension frames, relays EL (extension left) and ER (extension right) are also provided.

13.12 Each junctor in the subgroup has a J-test lead. By operating one JC- relay and either the L or R relay, the marker connects these leads to the CHT0-9 (channel test) relays.

13.13 Relay R operates when relay JG0 or JG3 and an odd-numbered FUT- relay are operated, or when relay JG1, 2, or 4, and an even-numbered FUT- relay are operated. Relay L operates from JG0 or JG3 and an even FUT- or JG1, 2, or 4 and an odd FUT- relay.

C. Selection of the Group of Line Links (FS19)

13.14 The operation of relay HG(A,B)- in the line, line link, and marker connector control circuit, as a result of horizontal group identification, connects the sleeves of the ten line links on the calling line switch to the windings of the CHT0-9 relays in the marker. This operates the CHT0-9 relays that correspond to busy line links.

D. Selection of the Group of Trunk Links (FS1, SD-26032-01)(FS19)

13.15 The operated F relay in the originating register operates one of the FA02-FA92 (A appearance trunk connector) relays in the trunk link circuit. This operated FA02-FA92 relay operates the LV2 (level 2) relay. Battery from the marker on the ALC lead operates the LC- (link connector) relay in the trunk link circuit. The operated LC- relay, together with the L or R relay, extends the ten trunk links to be tested to the CHT0-9 relays in the marker; an operated CHT0-9 relay in this case indicates a busy trunk link.

E. Test Check (0S 708-1, FS21)

13.16 Before the marker proceeds with channel selection it first determines whether the necessary preliminary functions were performed. These functions are checked by the operation of relay TK (test check).

13.17 The following relays must be operated for this check to be successful:

Relay	Functional Meaning	Indication
FAK	(frame A appearance check)	Relay LV2 and an FA02-92 relay are operated

Relay	Functional Meaning	Indication
RK or LK	(right- or left-half frame check)	Relay R or L is operated
HGK	(Horizontal group check)	Line link sleeves are closed through to the marker
LCK	(trunk link connector check)	Trunk link sleeves are closed through to the marker
JCK	(junctor connector check)	Junctor sleeves are closed through to the marker
TCHK	(test channel check)	One or more TCH- relays are operated

F. Channel Test and Selection (OS 706-1, 707-1, 708-1, FS19)

13.18 The channel test CHTO-9 relays are provided to test the sleeve leads associated with the selected group of junctors for a busy indication. Ground on any of the three leads associated with a particular CHT- relay indicates a busy channel and will operate the relay. The CHTO-9 relays will simultaneously test these three leads (line link, trunk link and junctors) to determine if the associated channel is busy. Therefore the operation of a CHT- relay indicates that at least one of the three linkages that make up the channel are busy. The operation of the CHT- relay prevents the marker from selecting that channel for this call.

13.19 The windings of the CHTO-9 relays are connected to the sleeve circuit through the associated LO-9, JO-9, and TO-9 diodes, LO-9, JO-9, and TO-9 resistances through the back contacts of the CHO-9 relays and to the respective LLO-9, JO-9 and LHO-9 leads.

13.20 The diodes are used to prevent the high negative surges produced by the release of hold magnets, which had been associated with busy linkages, from reaching the winding of the CHTO-9 relays. A voltage divider effect is provided by the LO-9, JO-9, and TO-9 resistances. The LO-9, JO-9, and TO-9 capacitors reduce the transient voltages.

13.21 When the marker is normal a standing cross test is made on these leads by the XCH relay. During this period the negative side of the windings of the CHTO-9 relays is connected to the XCH relay. When the marker is off-normal the STX relay shifts the windings to battery potential.

13.22 It is necessary to delay the action of the channel selection CH- relay until all the CHT- relays have had sufficient time in which to operate. This delay function is performed by the operate times of the TK and DTK which operates from the TK when the marker has possession of both the line link marker connector and the line, line link and marker connector control circuits.

After this delay one preferred channel selection relay, associated with a released CHT- relay, will be operated. This selects the connecting path associated with an idle line link, trunk link and junctor. The operated CH- relay operates relay CHA to indicate that a channel has been selected.

G. Junctor Distribution (OS 707-1, FS14, FS15, FS16)

13.23 Office size determines junctor distribution. When junctor distribution is uniform for all frames, the operation of relay TLC (trunk link control) operates one of the 2TLF-10TLF relays via the SZD to SZ- cross connection. Relay TLC also operates relay STF (single-trunk link frame) or relay PR (paired-trunk link frame) via the SPF to SF or SPF to PR cross connection. The 2TLF-10TLF relay indicates how many trunk link frames or pairs of frames are in the office, therefore, the junctor distribution is indicated. The STF or PR relay indicates single frames or pairs of frames. In addition to these relays, auxiliary indication of office size is given by relays 20F (maximum of 20 line link frames); 40F (21 to 40 line link frames); 7Q (7 quad) for 7 trunk frames or pairs of frames; or RQ (regular quad) for 6, 8 or 9 trunk link frames or pairs.

13.24 During changes in office size, the trunk link frames are arranged for different junctor distribution. As the work progresses some trunk link frames will have junctor distributions corresponding to the new office size, some to an intermediate size, and some to the original size. For example: suppose that the 10 line link - 5 trunk link frame office is to be expanded to the 12 - 6 office. In the 5-trunk link frame size the junctor groups contain twenty junctors, ten in each subgroup. The change in distribution resulting from the addition requires the removal of some of the junctors from the second subgroup to form new junctor groups to the added line link frames. During this work the subgroup is unusable. To prevent the selection of this subgroup, the trunk link frame is temporarily arranged to indicate to the marker that it has the same junctor distribution as a trunk link frame in an office with ten trunk link frames; namely, only one subgroup of ten junctors. After completion of work on this frame, it is then arranged to indicate its new distribution - for an office with six trunk link frames.

13.25 For an office being expanded from 5 to 6-10 trunk link frames, relay 10TLF is used as an intermediate office-size relay; for expansion from 3 to 4 or 5 frames, relay 5TLF is used; and for expansion from 2 to 3 frames, relay 2TLF-3TLF is used. It should be noted that the 2TLF-3TLF relay is used only as an intermediate office-size relay.

13.26 During transition, the 2TLF-10TLF relays are operated via cross connections SZA, SZB, and SZC to SZ- in the marker and G to SZA, SZB, and SZC in the individual trunk link frames; punching SZD is not used during this period. When the transition involves adding extension trunk link frames to pair the frames, the G to SF or G to PR cross connection in the trunk link frame permits the operation of relays STF or PR in the marker until the changeover is complete.

14. FORWARDING CALLING LINE IDENTIFICATION AND CHANNEL NUMBER TO THE ORIGINATING REGISTER (FS8-13)(FS2-8-9-14, SD-26040)

14.01 When the originating register is seized, relay F operates, in turn operating the F1A and F1B (frame auxiliary) relays. After vertical file identification, relay FTK1 operates. Relays F1A, F1B, and FTK1 operate the GTL3, (ground transmitting leads auxiliary) relay. This permits the marker to operate relays in the register to record the calling line information and channel number. This information is used by the marker which is seized after dialing is completed.

14.02 The following table shows the register relays operated and the information passed.

Register Relays Operated	Information Passed
FT-	line link frame tens
FU $\frac{2}{5}$	line link frame units
VG $\frac{2}{5}$ or $\frac{2}{6}$	vertical group number
HG $\frac{2}{5}$	horizontal group number
VF-	vertical file number
CT-	class tens
CU $\frac{2}{5}$	class units
MAN (manual) 2P (2 party) CN (coin)	auxiliary class information
LL $\frac{2}{5}$	line link number (corresponds to channel number)

14.03 The RK1 and RK2 (registration check) relays in the marker operate to indicate that all of the marker registration relays have operated. To verify that the register is attached and that it can lock in the information passed, the RK3 (registration check) operates. This releases the GTL1, GTL2, and GTL3 relays (ground test relays). The grounds which operated the register and marker registration relays are thereby removed. These relays must be held operated by the originating register ON (off-normal) relay in order to maintain the registion. The release of any operated registration relay in the marker indicates that the corresponding register relay failed to operate or to lock operated.

15. SELECT AND HOLD MAGNET OPERATION (FS20, FS22)

15.01 Relay FAK operates trunk switch select magnets T2 and A through contacts of relays FA02-FA92 and LC-. Relay CH- corresponding to the selected channel operates select magnets J- on the trunk link frame, and L- and LJ- on the line link frame.

15.02 The operation of relay CHA at the end-of-channel selection starts the timed operation of the HMT (hold magnet timing) relay. This delayed operation is necessary to insure that the select magnets are operated and that any hold magnets for this channel are released from previous connections.

15.03 Relay HMT operates relay HMT1 (hold magnet timing auxiliary) which operates relay HMS1 (hold magnet start).

15.04 Since the operation of the hold magnets for light and heavy traffic is different, it is described separately.

Hold Magnet Operation - Light Traffic (OS 709, 710, FS19, FS20, FS24, SC 701-1)

15.05 During light traffic conditions, relay HMS1 extends battery from the line link frame junctor hold magnet J-, through the trunk link frame, and into the marker over the JO-9 leads. These leads are extended to the primary winding of the JXP (junctor crosspoint) relay. Hold magnets J- and T- on the trunk link frame are also operated by relay HMS1 over the LHO-9 leads.

15.06 Relays LLTA, SLA, and JXP1 operate to show that these hold magnets have operated. The operation of these relays, with relay, HTR released and relay RK3 operated, operates relay LTR. Relay LTR is slow in operating to allow for completion of the false cross and ground test. If relay FCG (false cross and ground) remains released, relay LTR will operate relay LTRA which operates relay GLH. The operation of relays GLH and LTRA removes relay FCG from the tip and ring conductors. Relay, LTRA also operates the line link frame line switch hold magnet.

Hold Magnet Operation - Heavy Traffic (OS 709-1, FS20, SC 701-1)

15.07 Relay HTR operates during heavy traffic and operates relay DVO, this indicates that the hold magnets should be operated by dual voltage.

15.08 During the hold magnet timing interval the +130 volt battery will charge either one 4.32 MF or two 4.32 MF capacitors to +130 volts. When a hold magnet is to be operated, the +130 volts on the capacitor is extended from the marker to the winding of the hold magnet. The +130 volt charge on the capacitor will then be discharged through the hold magnet. The capacitor discharge current will operate the hold magnet more quickly. When the voltage across the capacitor drops to about -.5 volts the diode will become conducting and will supply the steady current flow to hold the hold magnet operated.

15.09 To decrease the time of operation of the crossbar switch hold magnets and of the marker holding time the hold magnets may be operated by the use of a momentarily applied dual voltage of 178 volts (130 + 48) instead of the usual 48 volts. In this case, when a hold magnet is to be operated, the marker will apply momentarily a voltage of +130 volts to the hold magnet winding. Since the other end of the hold magnet winding connects to -48 volts, this will give a total operating voltage of 178 volts which will operate the hold magnet in about one-third of the time required for 48-volt operation.

15.10 One side of the LH, JH, and TH capacitors are connected to ground through either the LXP or JXP relay or TXP lamp. When the CHA relay operates with the DVO relay operated, the +130 volt battery will charge the other side of the capacitors to +130 volts. The operation of the HMT1 relay will remove this charging circuit. While the capacitors are charging the LH, JH and TH diodes will have no effect. The false cross and ground test is eliminated during heavy traffic to reduce marker holding time.

16. CONTINUITY TEST (FS20-24, SC 701-1)

16.01 The continuity test is made from the marker, through the switching elements, to the calling line. It has two functions: first, to determine whether the connection is complete; and second, to determine when the last crosspoint (line switch) has closed. This latter function brings about a reduction in marker holding time. If it were not for this test, marker release would always have to be delayed for an interval equal to the slowest possible operating time of the crosspoints.

16.02 Basically, the test consists of connecting a grounded source of alternating voltage in series with a capacitor to one side of the line, and ground to the other side. The start gap of a cold-cathode tube is bridged across the capacitor. If the connecting path is continuous, the major portion of the applied voltage appears across the capacitor. This causes the tube to conduct, thereby indicating a successful test. If the path is open, a small amount of line capacitance completes the circuit, but the voltage across the tube gap is insufficient for conduction.

16.03 The operation of relay GLH, with relay RCTA (reverse continuity test) operated, connects ground to the tip lead and the applied voltage to the ring lead. The closure of the line switch hold magnet completes the path through the customer's telephone set (off-hook condition) or ringer (abandoned call). The voltage across capacitor CON2 builds up to the firing potential of tube CON, causing it to conduct. Current flow in the anode path operates relay CON (continuity test). This relay operates relay CON1, which locks and indicates that the continuity test has been successfully completed. A contact on relay CON1 grounds the start anode on tube CON allowing it to function as a cathode, thereby splitting the required anode current between it and the original cathode. This is a factor in prolonging the life of the tube. Relay GT1 (ground test) operates from relay CON1. Relay GT1 opens the anode path, making the tube nonconducting and releasing relay CON.

16.04 The closure of the line switch crosspoint releases relay LXP by placing the sleeve holding ground on its primary winding, thereby shunting it down. Relay LXP1 operates relay RCTB (reverse continuity test auxiliary). Relay RCTB opens the operating path of the slow-release relay RCTA. If the continuity test is successful before RCTA releases, relay CON1 releases RCTB, reclosing the operating path of RCTA. The alternate operation and release of relay RCTA switches the alternating voltage to either the tip or ring lead.

16.05 As previously described, the continuity test can be successful through the closed switchhook path or, if the call is abandoned, through the telephone ringer. When a call is abandoned by the tip party on the 2-party line that has no ring party installed, the release of relay RCTB causes the continuity test to be successful through the tip ringer to ground. The continuity test must be successful on an abandoned call; otherwise, abandoned would cause continuity test failure and a consequent trouble record.

17. DOUBLE CONNECTION TEST (OS 710-1, FS20-23)

17.10 Double connection test is made to insure that the only ground holding the magnets connected to the channel sleeve is being provided by the marker making this connection. The operation of relay LXP1 and JXP1 transfers the holding ground for the sleeve circuit to the DCT (double connection test) relay. The holding ground is now provided through the DCT relay primary winding. The operation of relay DCT operates relay DCT1, which locks, and thereby records a successful double connection test. If there is another ground present on the sleeve, the DCT primary winding is short-circuited and the relay fails to operate.

18. TRANSFER OF SUPERVISION TO THE ORIGINATING REGISTER (FS1-2, SD-26032) (FS1-9, SD-26040)(FS1-4-9-11-12-19-20)

18.01 The operation of relay DCT1 removes the operating ground from the F relay in the selected register. Relay F releases, and releases the one operated FA02-FA92 relay in the trunk link circuit. The release of the one operated FA02-FA92 relay transfers the channel sleeve lead to a 10-ohm ground in the originating register. The release of the one operated FA02-FA92 relay also releases relay SL, and the 10-ohm register ground short-circuits the DCT primary winding releasing the relay. Relay DCT verifies that the selected channel is connected to the calling line.

18.02 The release of the one operated FA02-FA92 relay operates the L (line) relay in the originating register. Its path of operation extends through the TN coil, over the loop and back through the TN coil to ground. Relay L operates the SR (slow-release) relay which operates relay ON1. Relay ON1 closes the tone path to the tertiary winding of the TN coil, causing dial tone to be transmitted to the customer. However, when manual service is provided for the calling line, dial tone is unnecessary. Therefore, the operated MAN relay in the register opens the dial tone supply lead.

18.03 When the calling line is 2-party message-rate class or 2-party flat-rate class in offices arranged for AMA, the transmission of dial tone to the customer is delayed until the originating register determines which party on the line is originating the call. When the calling line identification is transferred to the register, relay 2P in the originating register operates and locks.

18.04 For lines having low-impedance ground (approximately 1000-ohm ground on tip party station), relay 2P operates relay TPA which connects relay TP (tip party) to the tip and ring of the calling line. If the line is grounded, indicating a tip party, relay TP operates and in turn operates relay TP1 which locks.

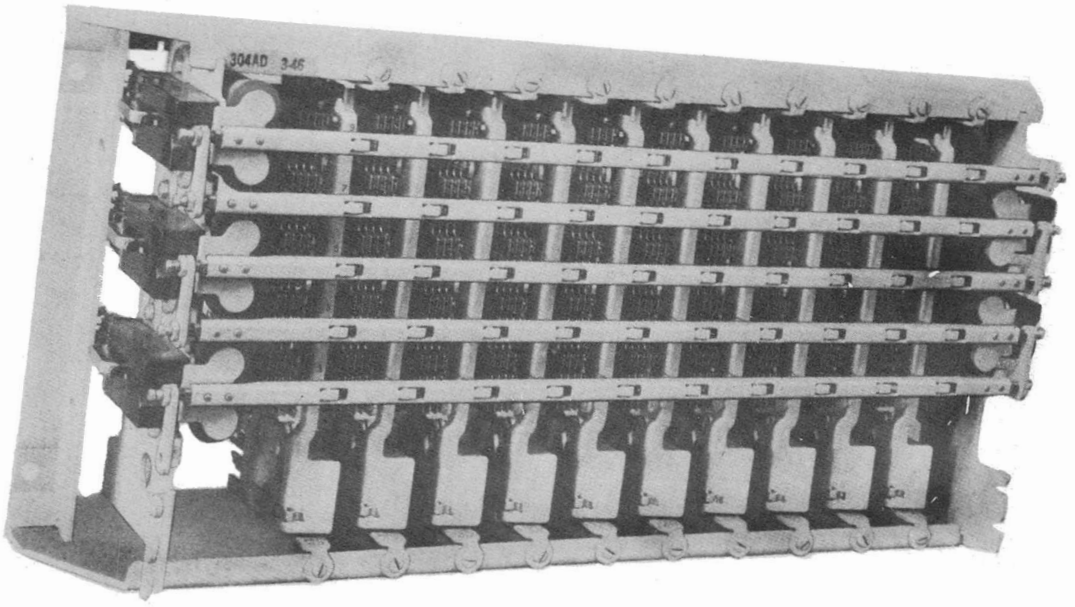
18.05 When the F relay releases after the dial tone connection is set up, ground is removed from the TPT3 resistor. Capacitor TPT starts charging. After about 0.3 second the voltage across the capacitor is high enough to cause the TPT tube to conduct. Relay TPT (2-party test timer) operates and unlocks relay TPA. Relay TPA removes relay TP from the tip and ring and places relay L across the line. Relay L operates from the closed loop and causes dial tone to be transmitted to the customer as described in 18.02.

18.06 For lines having high-impedance ground (approximately 3640 ohms for a tip party station), relay 2P operates relays TPA and TPD. Relay TPD operates relay TPT. Relay TPA connects the tip and ring leads of the calling line to relay TP which operates if the line is grounded. However, relay TP is fast operating and may operate on line surges. To prevent false party identification, ground is removed from the TP armature pending the slow release of relay TPD, when relay F releases. If relay TP remains operated when TPD releases, relay TP1 operates to indicate a tip party.

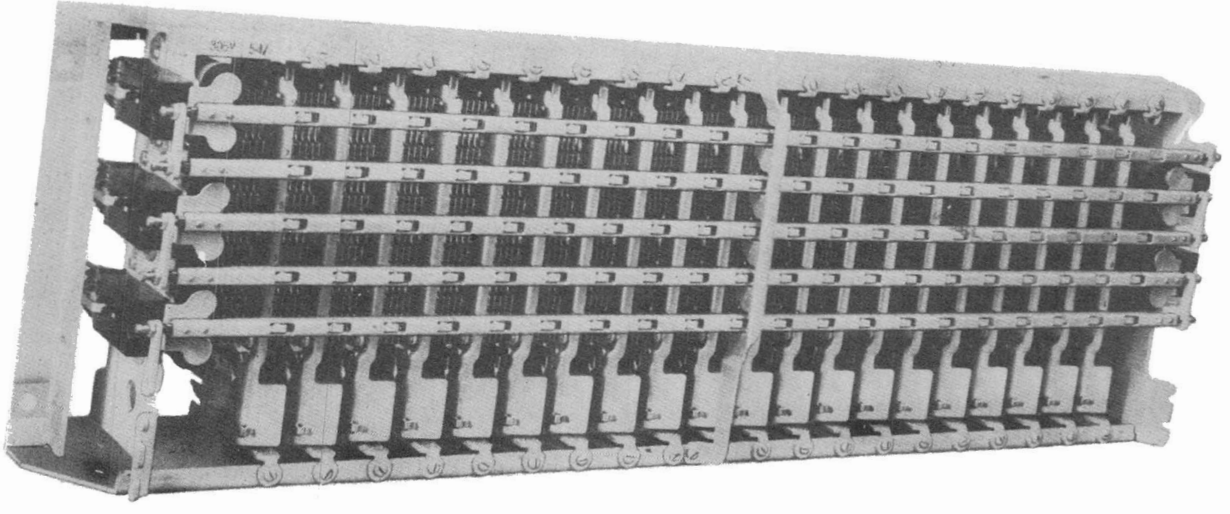
18.07 The release of relay TPD starts the timed release of relay TPT, which unlocks relay TPA. The release of relay TPA removes TP from the tip and ring leads and places relay L across the line. Dial tone is transmitted as described in 18.02.

19. MARKER RELEASE (FS23-26)

19.01 The release of relay DCT operates the DIS1 and DIS2 (marker disconnect) relays. Relay DIS1 releases relays LLC1 and LLC2. Relays DIS1 and DIS2 operating cause the release of the marker check and control relays. They also release the MS- relay which controls the release of the marker connector. The marker is then available for a new seizure.



10—VERTICAL UNIT 100—POINT CROSSBAR SWITCH



20—VERTICAL UNIT 200—POINT CROSSBAR SWITCH

FIG. 1—TEN-VERTICLE UNIT 100-POINT CROSSBAR SWITCH AND A TWENTY—VERTICAL UNIT 200—POINT CROSSBAR SWITCH

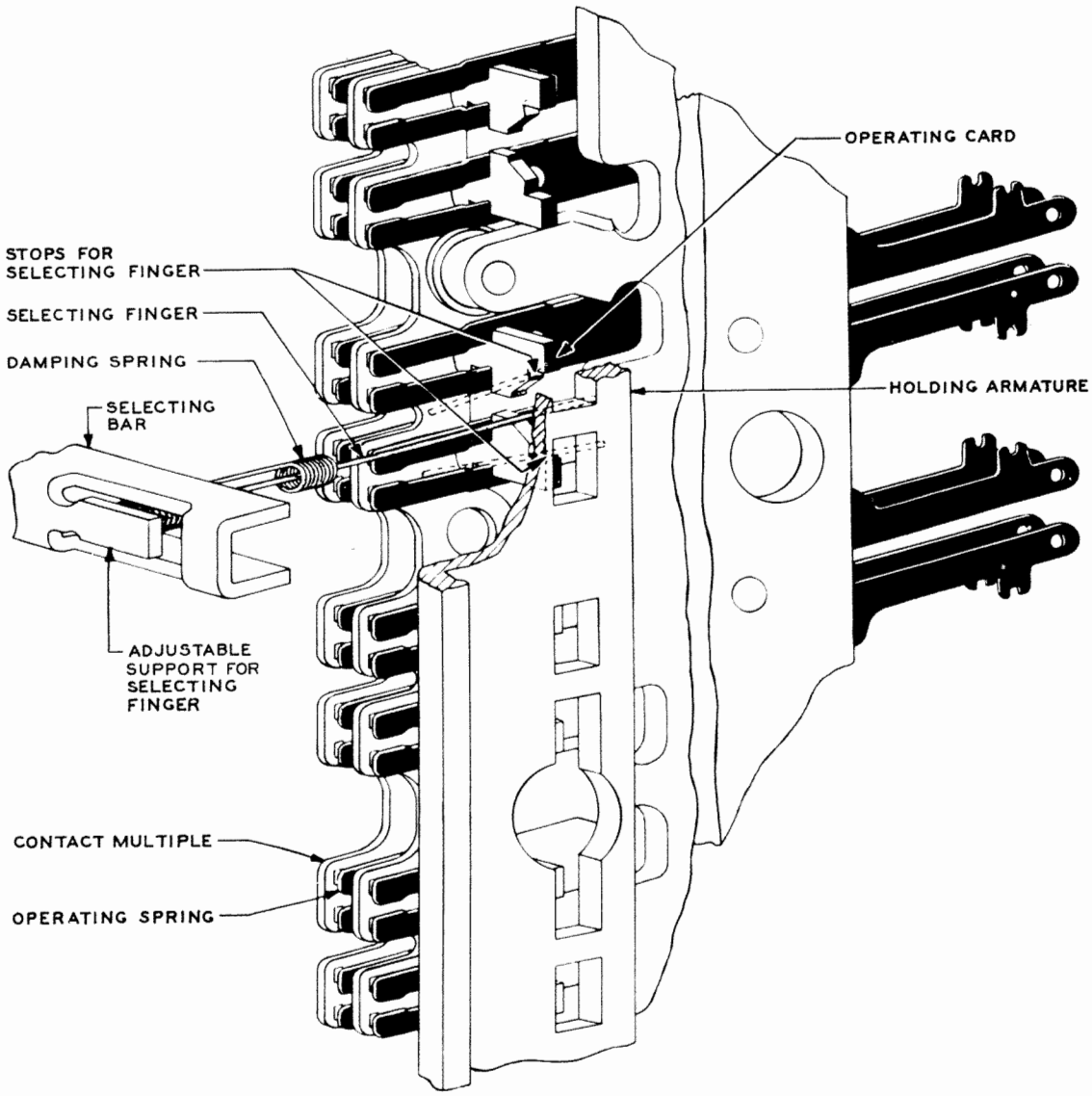
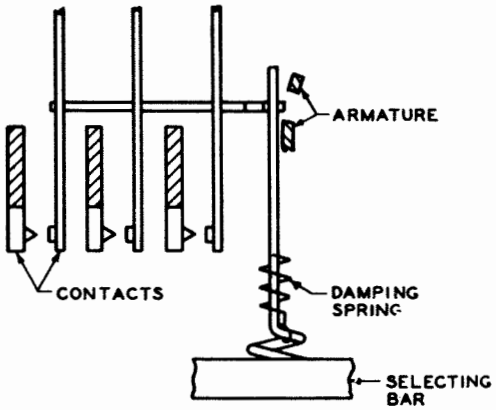
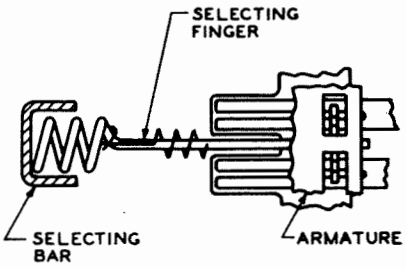
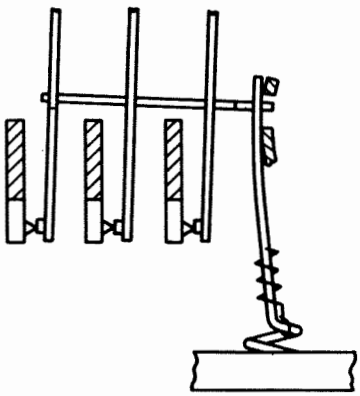


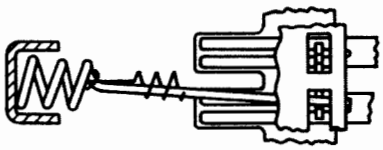
FIG. 2 — PARTIAL PERSPECTIVE VIEW OF THE SELECTION ELEMENTS OF A CROSSBAR SWITCH



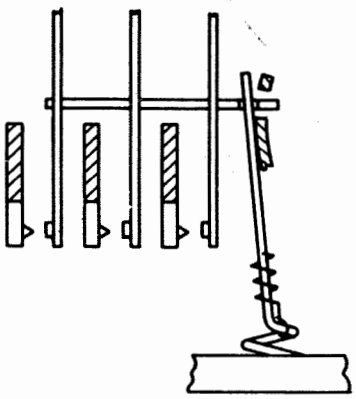


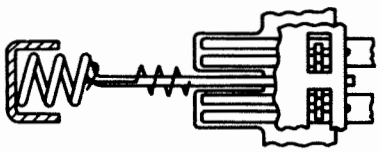
HOLD AND SELECT MAGNETS NORMAL





HOLD AND SELECT MAGNETS OPERATED
(LOWER CROSS POINT OF A PAIR OPERATED)





HOLD MAGNET OPERATED, SELECT MAGNET NORMAL
(LOWER CROSS POINT NORMAL, ARMATURE OPERATED)

CROSSBAR SWITCH
SELECTING MECHANISM

FIG. 3 — CROSSBAR SWITCH SELECTING MECHANISM

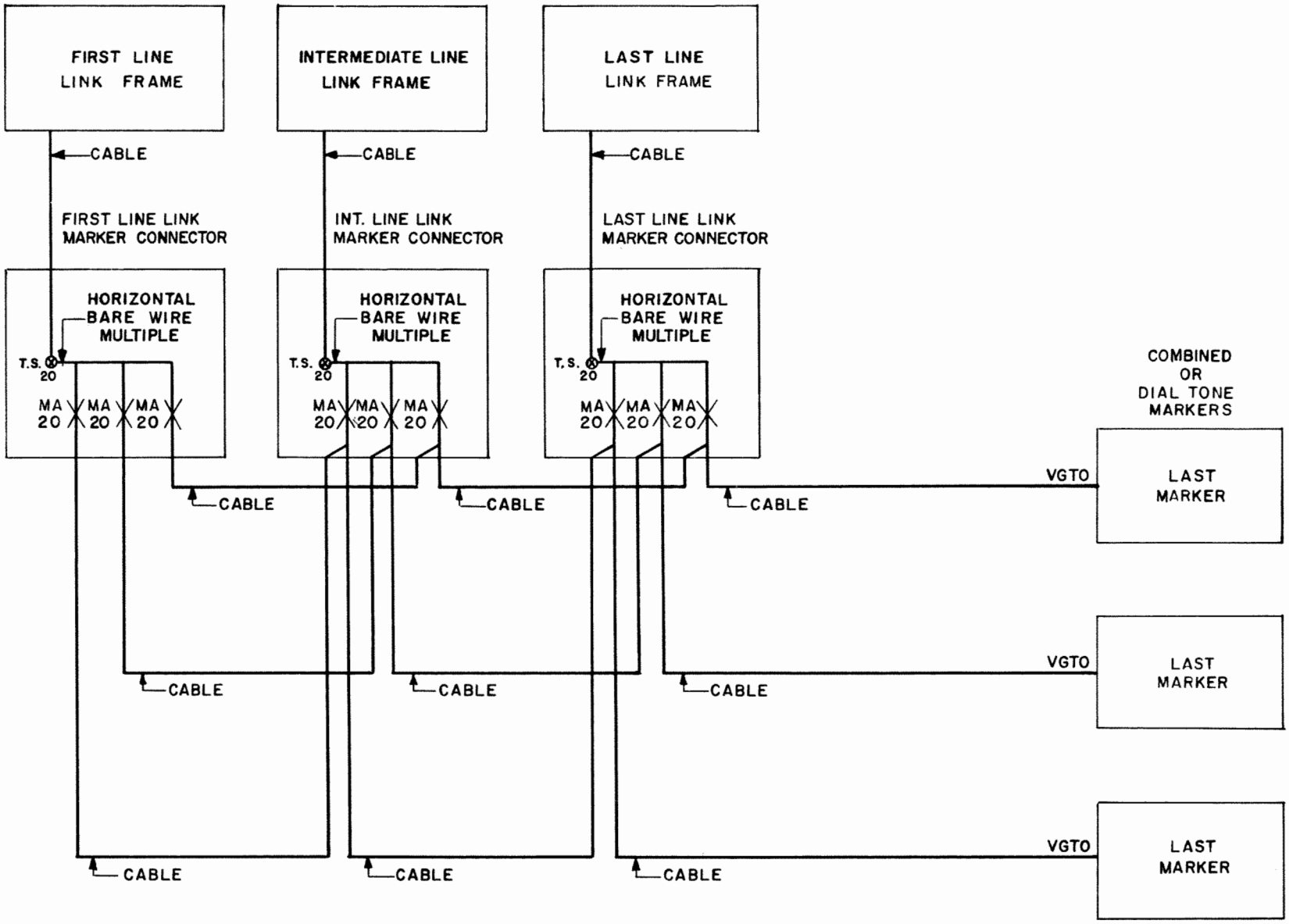


FIG. 4 — WIRING OF A TYPICAL LEAD (VGTO) THROUGH THE LINE LINK MARKER CONNECTORS

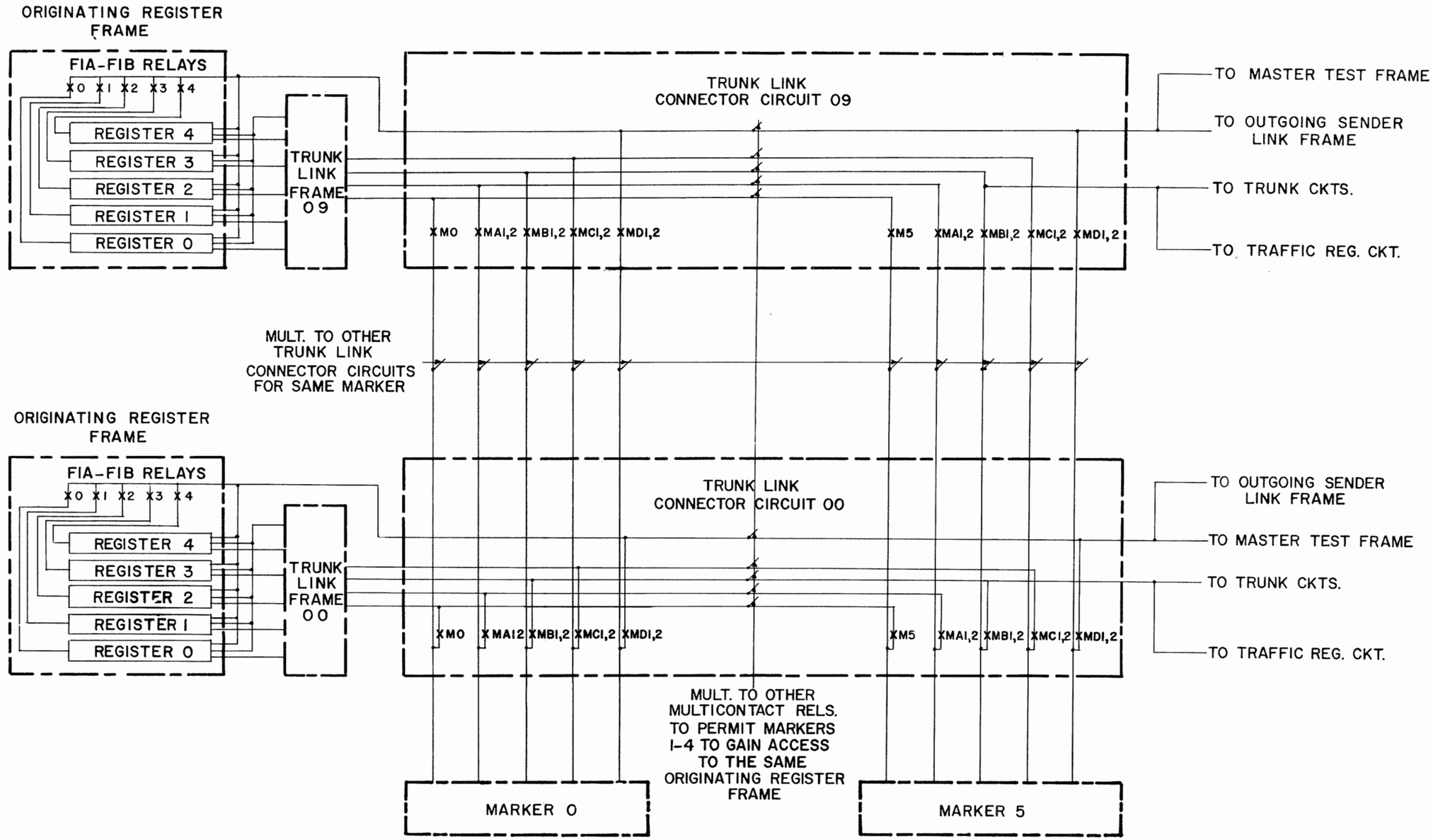


FIG.5—TYPICAL MULTIPLE ARRANGEMENT OF THE TRUNK LINE CONNECTOR CIRCUITS

TABLE A

ESTABLISHING THE DIALING CONNECTION - MAJOR FUNCTIONS

FUNCTION	KEY RELAYS OPER.	KEY RELAYS REL.	LOC.	OS	FS & SD	PUNCH INDICATION PROG.	PUNCH INDICATION IDENT.	TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD. ▼	SC 701-1 LINE COORD. ▲	REMARKS
Receiver Off Hook	L- VGS-		LL LL	701-1 701-1	FS1, 26030 FS2, 26030						
					FS25, 26001	HTR		S7 42	1AC1	-	Hvy Traff
Marker Selection and Seizure	MS- MA- MB-		PCLLMC LLMC LLMC	701-1 701-1 701-1	FS2, 26029 FS26,26001 FS28,26001 FS1, 26022 FS1, 26022	TM	D	S7 1 S8 30	1N3 1B4	2H11 2N12	
Vert Grp Ident and Selection	VGT-	VGG-	M		FS6, 26001		VGT-	S3 30-41	1F5	2C12 1E9	Pref. Nonpref.
					FS26,26001 FS11,26001	TRK DTK		S4 14 S8 55	1AG4 1U3	2K12	
Trunk Link Frame Selection	BC0 BC10 FS-	FB-	M M M	 702-1 702-1	FS1, 26001 FS1, 26001 FS2, 26001 FS2-3,26001	 FCK 	 FS-	 S8 39 S1 30-49	 1L4 1L6	 1K10 2X13	
Marker Route Selection				704-1	FS4, 26001 FS26,26001		TB0 TG0	S1 50-55 R8 30-49	- 1N3	- 2H11	
					FS23,26001 FS27,26001	CKG SNK		S8 31 S8 59	1J5 1N5	2P11 2AB11	
Test for Idle Orig Reg	FTC-		M	702-1	FS1,2,26001	FTCK		S8 40	1J5	2Y13	
Junctor Pattern Selection	PNR/PA P- JG-		M M M	706-1 706-1 706-1 706-1 704-1	FS16,26001 FS18,26001 FS14,26001 FS16,26001 FS5, 26001 FS13,26001	 TSE GTL	SF/PR PNR/PA P- JG-	S1 56,57 R6 46,47 R6 50-59 R6 40-44 S8 45 S8 33	1Z5 1AD7 1AB10 1W8 1R6 1AA5	2X11 2AD12 2AU10 2AQ11 1T14 1K32	

TABLE A (Contd)

FUNCTION	KEY RELAYS		LOC.	OS	FS & SD	PUNCH INDICATION		TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD.		REMARKS
	OPER.	REL.				PROG.	IDENT.		▼	▲	
Trunk Link Frame Seizure	MP- TFK1,2		PCTLC M	702-1	FS2-4,26039 FS3, 26001	CK		S8 41	1P8	2X12	
				710-1	FS16,26001 FS20,26001	TCHK LXP1		S8 48 S8 36	1AD9 2AA3 3Y8 3AA13	2AF12 2AS11 3X10 2AS11	Hvy Traff Lgt Traff Reoperates
				701-1 701-1	FS2, 26022-01 FS2, 26022-01		FR- CN-	S6 0-9 S6 10-13	1AJ4 1AJ4	2J12 2J12	
Line Link Frame Ident	FUT- FTB-		M M		FS10,26001 FS10,26001 FS10,26001 FS10,26001		FT- FU- FUT-	R1 0-3 R1 4-8 S4 34-43	1AA6 1AB6 1AB7	2M12 2M12 2AZ9	
				704-1 702-1	FS6, 26001 FS4, 26001 FS3, 26001	VTK1 TBK MAK1		S7 31 S8 44 S8 43	1E10 1Q10 1S10	2B13 2D11 2T12	
Junctor Cut-in	JG-		M	707-1-2	FS16,26001 FS17,26001		JC-	R6 30-39	1X9	2AN10	
Hor Grp Ident and Selection	HGT-	HGG	M		FS7, 26001		HGT-	S3 45-54	1D12	2E12 1E16	Pref. Nonpref.
Line Link Frame Seizure	MP- LFK		PCLLC M	703-1	FS2-4,26039 FS11,2600[illegible]	LFK		S7 35	1G11	2AL13	
Orig. Reg Selection and Seizure	TS- F T-Sel	TSE1	M OR TL M	704-1	FS4,5,2604[illegible] FS11,26040 FS2, 26032 FS5, 26001		TS-	S0 30-39	1S12 1S16	2Z11 2AJ7	Even Odd
Recycle of Frame Memory	FM- (Present Usage)	FM- (Previous Usage) FMG	M M M	702-1	FS2, 26001 FS2, 26001 FS2, 26001	FML		S8 42	1M14	2W13	
				707-2 707-1-2 708-1	FS16,26001 FS17,26001 FS21,26001 FS7, 26001	EF/RF LK/RK JCK HTK1		S1 58,59 S8 49,50 S8 47 S7 32	1X9 1V11 1Y12 1C18	2AP12 2AZ11 2AR11 2E13	

TABLE A (Contd)

FUNCTION	KEY RELAYS OPER.	KEY RELAYS REL.	LOC.	OS	FS & SD	PUNCH INDICATION PROG.	PUNCH INDICATION IDENT.	TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD. ▼	SC 701-1 LINE COORD. ▲	REMARKS
Selection of Group of Trunk Links	LV- LC-	CHT-	TL TL M	710-1 710-1	FS1, 26032 FS1, 26032 FS19,26001		LV- LC-	R8 52-59 S0 50-59	1Q17 1T17	2L8 2D8	
				710-1 710-1	FS22,26001 FS19,26001	LCK	FAK	R8 50 S8 46	1Q18 1T18	2H8 2D9	
Selection of Group of Line Links	HG-	CHT- M	LL		FS2, 26030 FS7, 26001 FS19,26001	HGK		S7 36	1D19	2AK12	
Marker Test Check	TK		M	708-1	FS21,26001	TK		S8 51	1Z20	2AE12	
					FS11,26001	DTK		S8 55	1Z21	2AR7	
Vert File Ident and Selection	VGB- LG- VFT-	VFG	LL LL M M	705-1	FS2, 26030 FS2, 26030 FS8, 26001 FS8, 26001		VFT-	S3 55-59	1D21	2D12 1E24	Pref. Nonpref.
Channel Test and Selection	CHT- CH- CHA		M M M	708-1	FS19,26001 FS21,26001 FS21,26001		CH-	R7 50-59	1Z22	2AG11	
					FS8, 26001	FTK1		S7 33	1D25	2D13	
Select Magnet Operation	J- L- LJ-		TL LL LL		FS2, 26032 FS1, 26030 FS1, 26030						
Class-of-Service Ident	CS-		M	705-1 705-1 705-1	FS12,26001 FS12,26001 FS12,26001		CS- CT- CU-	S2 30-59 R1 25-27 R0 25-29	1E26 1E27 1H27	2AH11 2AL7 2U12	
Forwarding Calling Line Ident and Channel Number to Orig Reg	VG- HG- HG- VF		OR OR OR		FS9, 26001 FS14,26040 FS9, 26001 FS14,26040 FS9, 26001 FS14,26040		VG'- HG'- VF'-	R0 9-14 R0 15-19 R0 15-19 R0 20-24	1V27 1S27 1Y27	2U12 2U12 2U12	

TABLE A (Contd)

FUNCTION	KEY RELAYS OPER.	KEY RELAYS REL.	LOC.	OS	FS & SD	PUNCH INDICATION PROG.	PUNCH INDICATION IDENT.	TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD. ▼	SC 701-1 LINE COORD. ▲	REMARKS
	MAN/2P		OR		FS2-9,26040 FS12,26001		MAN/2P	S3 6,7	1B28	2AG7	
	CN		OR		FS8, 26040 FS12,26001		CN	R4 31	1B28	2AF7	
	LL-		OR		FS14,26040 FS9, 26001		LL-	S4 25-29	1P27	2U12	
	FT-		OR		FS14,26040 FS10,26001		FT'-	R0 0-3	1X28	2U12	
	FU-		OR		FS14,26040 FS10,26001		FU'-	R0 4-8	1AA28	2U12	
					FS13,26001	RK1,2		S8 56,57	1M31	2AL9	
					FS13,26001	RK3		S8 58	1L31	2R11	
		GTL1,2,3	M		FS13,26001						
Hold Magnet Operation	HMT		M		FS20,26001						
	HMS1		M	710-1	FS20,26001	HMS1		S7 39	2AF0	2AE11	Hvy Traff
	J-,L-		LL		FS1, 26030				3AA4	2AE11	Lgt Traff
	J-,T-		TL		FS2, 26032						
				710-1	FS20,26001	GLH		S7 43	3AA9	2AC12	Lgt Traff
				710-1	FS20,26001	SL		S7 40	1AE7	1AG25	
								S7 40	2AN4	2AU13	Hvy Traff (Reoperates)
				710-1	FS20,26001	LTR		S7 41	3AA8	2AC11	Lgt Traff (Reoperates)
				710-1	FS20,26001	CHE		S8 35	2AF4	2AT12	Hvy Traff
									3Z8	2AT12	Lgt Traff
Continuity Test	CON (tube)		M		FS24,26001						
	CON		M		FS24,26001	CON		S7 44	3W13	3X17	
	CON1		M		FS24,26001				3W21	3X24	
	GT1		M	710-1	FS20,26001	GT2		S7 45	2AK4	2AN12	
					FS23,26001	DCT		S7 46	2AD4	2W8	
Double Connection Test	DCT		M		FS20,26001						
	DCT1		M		FS23,26001	DCT1		S7 47	2AG5	2E14	
Supervision Transferred to Orig Reg		DCT	M		FS20,26001						
		F	OR		FS11,26040						

TABLE A (Contd)

FUNCTION	KEY RELAYS		LOC.	OS	FS & SD	PUNCH INDICATION		TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD.		REMARKS
	OPER.	REL.				PROG.	IDENT.		▼	▲	
Marker Release	DIS1	LLC1,2	M M		FS11,26001 FS23,26001 FS26,26001	DIS1 MRL		S7 54 S7 55	2Y9 2AD10	2K12 2J13	
		MP- MP- MS-	PCTLC PCLLC PCLLMC		FS2-4,26039 FS2-4,26039 FS2, 26029						
Dial Tone Connected to Line	SR		OR		FS1, 26040						