No. 5 CROSSBAR SYSTEM CIRCUIT DESCRIPTION SCD-10-01

Bell Laboratories

300-160

SECTION A, PART 0

CONTENTS

Section A, Part 0 provides an index of the SCD by section and part. Each section is indicated by a letter. The digit immediately following the letter indicates the part of the section. A detailed index is provided at the beginning of each part of each section.

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SECTION A, PART 1

OBJECTIVES, SCOPE, AND GENERAL

DESCRIPTION OF SFD-10-01 AND SCD-10-01

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A1 OBJECTIVES, SCOPE AND GENERAL DESCRIPTION OF SFD-10-01

A1-1 OBJECTIVES

A major objective of SFD-10-01 is to portray, in simple form, the system service functions of the basic No. 5 Crossbar office (wire spring marker group) which provides POTS (Plain Old Telephone Service). A further objective is to correlate service functions with the maintenance facilities which have been provided to aid in detecting, analyzing, locating, and clearing trouble conditions. The same objectives apply to SCD-10-01 which provides a written description of SFD-10-01.

A1-2 SCOPE

This issue of the SFD-10-01 will include four sections:

A. INDEX

B. ESTABLISHING DIALING CONNECTION

C. ESTABLISHING OUTGOING TRUNK CONNECTION

D. ESTABLISHING INCOMING TRUNK CONNECTION

Additional sections planned include:

E. ESTABLISHING INTRAOFFICE TRUNK CONNECTION

F. ESTABLISHING INTERMARKER GROUP TRUNK CONNECTION

G. ESTABLISHING TANDEM TRUNK CONNECTION

H. PULSE CONVERSION

J. MAINTENANCE

A1-3 GENERAL DESCRIPTION OF SFD-10-01

SFD-10-01 is divided into a number of sections, each of which, except for Section A describes a specific job performed by No. 5 Crossbar. Each section is divided into parts which describe the major steps or operations through which the system proceeds to perform the job.

A1-3.1 A SECTION OF SFD-10-01

The A section of SFD-10-01 provides the indexes to:

A0 PAGE INDEX

A1 GENERAL DESCRIPTION, INFORMATION NOTES, AND ABBREVIATIONS

A2 TROUBLE ANALYSIS FLOW CHARTS

A3 APPARATUS INDEX

A4 LEAD INDEX

The A section is self explanatory except for A2, "TROUBLE ANALYSIS FLOW CHARTS".

A1-3.1.1 Trouble Analysis Flow Charts

The trouble analysis flow charts are an aid in determining from a relatively few punches on the trouble record card where to proceed in the SFD to analyze the trouble. Since there are three different types of trouble cards in general use in the field, three different flowcharts are provided along with facing drawings of the associated trouble record cards. The flowchart is colored to correspond to similarly colored designations on the trouble record card on the facing sheet.

A1-3.1.1.1 Using the Trouble Analysis Flow Charts

The use of trouble analysis flowcharts, presents a logical means for analyzing trouble record cards. It is probable that after the user has followed this approach a few times the flowcharts will be bypassed and numerous shortcuts will be developed. Nevertheless, what is presented is the thought process which the user must go through, even though much of it will eventually be absorbed subconsciously. Once a sound basic understanding of trouble card analysis is established, speed and accuracy in analysis will follow.

Assume that an E4393 double-sided 1/X trouble record card is to be analyzed. (Refer to description of symbols (SFD-A103).

Start at A0 on SFD-A204 with instruction block marked "Observe Front of Card," follow line to right to the decision box with the designation TI in it. Each decision box has two outputs marked Y (YES) and N (NO). The location of the TI designation on the card (S8-00) is included in the decision box which asks the question "Is the TI designation punched?" If the answer is YES, follow the output marked Y.

If the answer is NO, follow the output marked N. Thus, if the TI designation is punched, the next decision to be made is whether to read the front or back of the card. Since the back of this card* deals only with AMA circuits which are not covered in this book, assume the TURN OVER designation is not punched.

Since it was assumed that the TI designation was punched and since this indicates a service call rather than a test call, none of the test call indications in the blue decision box should be perforated. If LVM† is punched, and MLV is not, it indicates that this is a calling line identification card. Such cards are produced on all calls to lines which have been bothered by nuisance calls and have requested special treatment to help determine the origin of the nuisance calls.

If the LVM designation is not punched but the PRT designation is punched, this is a pretranslator trouble record. The box below the PRT decision box directs the reader to B602 which is a sequence chart for the pre-translator used for determining the point of failure. Its use is described in SCD-B6-17.

If the PRT designation is not punched but MKR is punched, this is either a dial tone or a completing marker failure. For this type of card,‡ reference to the next decision box must be made. It must be known for the particular office which marker numbers are for DTMs and which are for CMs. Assume that the DR-, DRT- designations punched are for a DTM. The reader is directed to SFD-B002/CO which is another flowchart for analysis of dial tone marker trouble record cards. Its use is described in SCD-BO.

If the DR-, DRT- designations are for a CM, the reader should proceed down the column of red decision boxes which indicate the class of completing marker call. The class of call designation punched directs the reader to one or more subclasses of call. The subclass of call directs the reader to a flowchart similar to SFD-B002 for each subclass.

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* When using the 2/X card E5488, the "TURN OVER" designations will be punched for pretranslation trouble records which appear on the back of the card. Pretranslators are covered in this issue.

† LVM on a test call with MLV punched means "Line Verification Match."

‡ Only the double-sided 2/X card indicates directly (using a DTM and a CM designation) whether a dial tone or a completing marker produced the card.

SECTION B, PART 0

DIAL TONE TROUBLE CARD ANALYSIS

Index

BO DIAL TONE TROUBLE CARD ANALYSIS*

The trouble analysis flowcharts in the A2 Section of the SFD direct the reader to one of the rounded boxes† at the left of SFD-B002 for dial tone marker trouble record cards.

BO-1 CROSS DETECTION: SEQUENCE FAILURE

For either of the double-sided trouble record cards, there is an MXT designation which is punched if there is a cross detected (X-) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single-sided trouble card, there is no MXT punch and it is necessary to scan all of the X- designation and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y(YES) if the designation is punched or the statement is true or N(No) if the designation is not punched or the statement is not true. If there is no MXT, cross or sequence failure, the procedure beyond this point is the same for all trouble record cards.

BO-2 WORK TIME OUT

Assume that there was no cross or sequence failure and that the WT designation is punched as an indication of a work time out. If FCG is punched, this is an indication of a cross in the network, which might be anywhere along the path used on the particular call. If there are other FCG cards, several of which indicate use of the same portion of a path such as the same junctor or the same link or a trunk link frame, the probable location of the cross is narrowed.

If the FCG designation is not punched, it is necessary to determine at what point progress in the DTM stopped to cause the work time out. Four key progress points are shown in decision boxes. Analysis should start at the first key progress point which is missing.

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* Trouble card analysis is covered at the beginning of each section as a convenience for use in the central office.

† Symbols used in flowcharts are described on SFD-A101.

Assume that the TK designation is not punched. A typical procedure for analysis starting at a missing TK punch will be described. This same general procedure may be adopted starting at HMS1, DCT1, or DIS1 if any of them is the first missing key progress point.

The reader is directed to go to SFD-B003 as described in SCD-BO-2.1.1 and to work up from the first missing key progress designation which in this case is TK. Key progress designations are shown in large heavy letters and are underlined for easy locating.

BO-2.1 TROUBLE ANALYSIS SEQUENCE CHARTS

Sequence charts generally used show a sequence of relay operations with superimposed indications showing trouble record designations which would be present if a record were taken at that point in the sequence.

Trouble analysis sequence charts leave out all of the regular sequence chart except the sequence of the trouble record designations (SFD-A101). A designation with no symbol indicates the point in the sequence at which that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

BO-2.1.1 Use of Trouble Analysis Sequence Chart (SFD-B003)

It was assumed in SCD-BO-2 that the TK key progress point was missing on a trouble card having a WT punch. Start at TK designation on SFD-B003 and work up to the first missing progress designation* required to advance to TK. Assume that HGK, LCK, RK/LK, JCK, and TCHK are all punched, but FAK is not. Proceed up from FAK. Assume that LV2 is not punched and TSE is not punched. TSE should not be punched, but LV2 should. This is the point where DTM marker progress stopped. The LV2 designation is within the block which refers to sequence chart SFD-B004. Proceed to SFD-B004 as described in SCD-BO-2.2.1.

BO-2.2 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts except as noted SFD-A103.

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* In some instances, there may be a designation punched such as TSE which occurs early in the call but provides a progress indication by not being punched later in the call.

BO-2.2.1 Use of Sequence Chart (SFD-B004-B006)

It was assumed in SCD-BO-2.1.1 that the LV2, FAK, and TK designations had not been punched but that the LCK was punched and the analysis was that DTM marker progress stopped awaiting the action that would punch the LV2 designation.

The sequence chart SFD-B004 aids in locating the probable cause of the failure. It should be noted from the symbol at the LV2 relay that the LV2 designation is punched from the same source that operates the LV2 relay. Use the relay index to locate the page, for the LV2 and the LC- relay winding of the TL. Both appear on SFD-B421. Since the LC- relay must have operated to cause an LCK punch, the FA- relay, which is required to operate both LC- and LV2, must have operated.

The probable trouble appears then to be in the path that operates the LV2 relay. Before accepting this conclusion, however, consider the following and arrive at a logical answer:

(1) With these assumptions, could the trouble be an open winding on the LV2 relay?

(2) Could TRA relay have failed to operate when a trouble record was taken?

(3) Could an open contact on the TRA relay or an open LV2 lead to the MTFC be the trouble?

(4) Could the trouble be an open contact on the FA2 relay?

Logical answers are:

(1) Unlikely unless there are two troubles. An open winding would not prevent punching the LV2 designation.

(2) No. If TRA relay had failed to operate, there would be no LC- punch.

(3) Unlikely unless there are two troubles. An open LV2 lead to the MTFC would not have stopped the DTM progress and there would not have been a record.

(4) Yes. This is a possible cause and quite probable.

BO-3 SDT OR LDT FRAME SEIZURE TIME OUT

If the WT designation is not punched but the SDT or LDT is punched, the DTM is delayed an escessive time while waiting to seize either a line link or a trunk link frame. Normally the SDT (short delay) timer will time out rather than the LDT (long delay) timer. However, if any marker is connected to the trouble recorder or is handling a test call, only the LDT timer is used to allow a longer interval for frame seizure. This is necessary because a marker on test or taking a trouble record holds the frames to which it is connected for the duration of the test call or trouble record. This may delay any other marker which is waiting for the frames being held.

BO-3.1 DELAY IN SEIZING A LINE LINK FRAME

Since the LFK relay causes the SDT and LDT timers to recycle, if there is an LFK punch along with either an SDT or LDT punch, the timers should recycle. However, it is possible that if the LFK should come up just as the timer timed out, the time out SDT or LDT conditions would lock in and the LFK punch could appear along with the SDT or LDT punch.

If LFK is not punched but MAK1 is, this is an indication that the TLC has been seized and has operated its relays (MAK1) but that the line link frame has not been seized (no LFK).

BO-3.2 DELAY IN SEIZING A TRUNK LINK FRAME

If MAK1 is not punched, the interpretation of the CK punch is dependent on whether or not ZL option is provided in the DTM. This option is shown as STD (Standard) option in the operate path of the TFK1 relay (SFD-B204).

If STD option is not provided, absence of the CK punch after an SDT or LDT time out indicates a delay in seizing a TL.

If STD option is provided, the operation of the SDT or LDT relay caused by an SDT or LDT time out operates the TFK1 relay and grounds the CK lead (SFD-B204), so that there will always be a CK punch after an SDT or LDT time out. In this case, the absence of an MAK1 punch with a CK punch indicates a delay in seizing a TL.

BO-4 TRANSFER START

If none of the designations WT, SDT, or LDT are punched and TRS is punched, the record indicates that the LL could not connect to a DTM within the transfer start timing interval and had to transfer its start leads.

SECTION B, PART 1

DIAL TONE MARKER INPUT

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B. ESTABLISHING DIALING CONNECTION

When a customer served by a No. 5 Crossbar office removes the receiver, a dial tone will normally be heard concurrently with the receiver reaching the ear. Section B, SFD-10-01 illustrates the steps through which this is accomplished.

Each line in a No. 5 Crossbar office is associated with a line relay which operates when the customer lifts the telephone receiver. The operation of the L relay starts a circuit action which causes the system to establish a connection from the tip and ring of the line through the switching network to an originating register. The originating register provides dial tone to the tip and ring as a signal for the customer to start dialing, then registers the dialed or keyed digits. The sequence of operations in establishing this connection is shown on a sequence chart SFD-B004 through B006. A functional description of these steps follows.

(B1) In establishing a dial tone connection, a line link frame connects to a dial tone marker via an associated line link marker connector. The LLMC closes through most of those leads required exclusively for the dial tone connection.

(B2) When a DTM has been seized and has received input information through the LLMC, it proceeds to select a trunk link frame having idle originating registers of the correct type. It then proceeds to select and connect to an OR.

(B3) After the DTM has seized a TL, it bids for access to the line link originating the call via the associated line link connector. The LLC primarily closes through leads which are required for completing marker functions as well as for DTM functions.

(B4) When the dial tone marker has identified the calling line location and has selected an originating register, it proceeds to establish a connection through the switching network from the line to the originating register. It also transmits line location and other information to the originating register.

(B5) Upon completion of the double connection check on heavy traffic or upon completion of both the double connection check and the continuity test on light traffic, the DCT1 relay operates. This starts the release of the marker and cuts dial tone through from the originating register to the calling line.

(B6) From the A, B, and C dialed digits, it is possible, in most cases, to determine the total number of digits required to be dialed. The OR needs this information so that it can request connection to a completing marker as soon as the required number of digits have been dialed. Determination of this information from the A, B, and C digits is called pretranslation. Pretranslation may be performed within the OR or by pretranslator circuits common to all originating registers.

B1 DIAL TONE MARKER INPUT

B1-1 MARKER SEIZURE

Upon operation of an L relay on a line link frame (SFD-B102) the vertical group start relay (VGS-) of the associated vertical group is operated. This applies a resistance start battery to activate a marker start MSA lead or a marker start MSB lead to start seizure of a dial tone marker. As will be seen later, the Z relay is operated and released on alternate calls so that the MSA and MSB start leads are alternately activated on successive calls. Each line link frame is given preference to one dial tone marker for an MSA start and to another for an MSB start by cross connecting MSA and MSB punchings on SFD-B102 to appropriate MS- punchings on SFD-B103.

B1-2 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-B103)

Three chain circuits are used in selecting a dial tone marker and closing the connector relays between the line link frame and the marker selected. The description of these chains which follows is typical of chains in other types of connectors which will be encountered later.

B1-2.1 CB- (MARKER CONNECTOR BUSY) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

B1-2.2 MS- (MARKER START OR PREFERENCE) RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS- relay operation is straightforward. A start signal from a line link frame operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more line link frames may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last line link frames (SFD-B102, B103) initiate simultaneous marker requests. Also assume that both start leads are connected to MSO (that is both prefer marker 0). The MSO relay associated with each of the two line link frames will operate through the MSK cross-connection to ground in the marker. An early make contact on the MSO relay for the first line link frame will provide locking ground for that MSO relay before the break contact on the MSO relay for the last line link frame opens the MSK ground. Thus both relays will operate and lock.

If, however, the last line link frame initiated a request for a marker slightly ahead of the first line link frame, the MSO relay for the first frame could not operate. On the other hand, if the first line link frame initiated a marker request first, a subsequent request by the last line link frame could operate the MSO relay for that frame.

B1-2.3 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain initiates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MSO relay in a reverse direction to the preference MSK chain. Contacts on the MSO relay for the first line link frame are therefore enabled to operate connector relays MA and MB whether or not any other MSO relay is operated.

Upon operation of the line link marker connector relays MA- and MB-, the MCB- relays of the selected marker are operated over the MB lead. (SFD-B110). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-B103). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MSO relay is not released when the associated CBO relay operates.

If two or more MSO relays had operated for different line link frames, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other marker was available, no new MS- relay would operate until some marker became available, at which time one or more MS- relays for that marker would operate. This would continue until all line link frames had been served.

During periods of heavy traffic when all DTMs become busy, a traffic control circuit gates requests by line link frames for DTMs as described in a subsequent section so that all line link frames requesting service are served once before any line link is served a second time.

Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-B103). The release of any one of these relays operates relay TM (SFD-B110), which starts marker timing.

B1-3 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-B102)

If only one start lead is provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that line link frame might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, 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 connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

In the following description, assume that relay TRS (transfer start) is normal.

The W and Z relay combination (SFD-B102) operates as follows:

(a) FIRST CONNECTOR USAGE

(1) Marker seizure - Assume that relays MA- and MB- of the line link marker connector and W and Z of the line link frame are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS- cross-connection. Relay MS- causes the operation of relays MA- and MB-. Relay MA- operates relay MK in the line link frame circuit (SFD-B106), 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 - When the connector releases, release of the MA- relay releases relay MK which removes the ground which provided the shunt circuit preventing relay Z from operating. Relay Z operates from the locking ground of relay W which remains operated. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

(1) Marker Seizure - At this time relays MA- and MB- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the 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 release of relay MK when the connector releases 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 connector usage. For subsequent usages the actions described above repeat.

B1-4 LINE LINK FRAME TIMING

There are three timers in the link link frame which are normally started whenever a line requests service.

B1-4.1 TRANSFER START TIMER (SFD-B106)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the LLMC to connect to a DTM (unless all DTMs are busy). If the connection is not established in this time, the line link transfers the start leads and gives a TRS signal to the DTM to cause a trouble record to be taken showing that there was a transfer start condition.

The operation of a VGS- relay operates the DT and TM relays (SFD-B106). The TM relay operates the TM1 and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will normally be grounded unless all DTMs are busy, in which case operation of the IM relay is delayed until a DTM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the DTM has recognized ground on at least one VGT- lead by operation of a VGT- relay which in turn operates the VGR relay (SFD-B108). The VGR relay operates VTK (SFD-B106) which closes through the OC1 and OC2 leads (SFD-B104) to operate the OC1 relay which operates the OC relay. The OC relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the LL. The operated TC and TC1 relays in the LL open the start leads to give the DTM control of the connection and also releases the IM relay (SFD-B106) which stops and recycles the TRS timer.

If a marker is not seized in approximately one second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-B104), releases the TM relay, and holds the TM1 relay operated (SFD-B106). The TM relay is released to open the signal leads CWA and TCA to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-B106). The TM1 relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TM1 relay. When a marker is obtained over the new start lead, the TM1 relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the LL which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

B1-4.2 OVERALL TIMER

An overall timing circuit is provided which sounds the major alarm if a line link calling for a marker has not been connected to one within 4.8 to 10 seconds. It functions as follows: Upon the start of a call, operation of a VGS- relay operates the TM relay at the same time that battery is connected to the start leads for marker seizure. The TM relay operates the TM1 relay which starts the overall TM timer (SFD-B106).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay from the operated marker multicontact connector relays in line link marker connector circuit. The MK relay releases the TM and TM1 relays. During the releasing time of the TM and TM1 relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TM1 relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not break down. However, should the marker exceed this time because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the LLMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in-use indication for the LLMC. When it remains steadily lighted, it serves as an LLMC alarm indication.

The MK relay releases at the end of the call, upon release of the line link marker connector circuit multicontact relays, and discharges the A capacitor to recycle the TM timer for the next call.

B1-4.3 CALLS WAITING TIMING

When a VGS- relay operates on the LL, it operates the DT relay (SFD-B106) which starts the calls waiting timer which has a timing interval of 5.4 to 8.0 seconds. If calls are initiated on a LL at a faster rate than they can be handled so that VGS- relays on an overlap basis supply ground to the D relay (the D relay does not release within the calls waiting timing interval), the CWT relay operates.

The sole purpose of the calls waiting timer is to light a G lamp at the line overload panel for each LL as an indication when calls are waiting an excessive time to be handled by that LL (SFD-B112).

B1-5 DETERMINATION OF REGISTER GROUP

The marker may be equipped to handle one, two, or up to six register groups. The "register group" relays (D, MF, RO-3) actually are associated with different routes, which may contain different types of registers or may contain trunks, such as announcement trunks.

Operation of the MS- relay of the LLMC preference control extends ground to the MC- lead associated with the particular LL and to the associated 2LF- cross-connection terminal in the selected marker (SFD-B104,B105). Cross-connections from these terminals determine the register group.

B1-5.1 MARKER EQUIPPED FOR ONE REGISTER GROUP (SFD-B105)

When the marker is equipped for only one register group, the 2LF- terminals are cross-connected to the LFD terminal to operate the D register group relay.

B1-5.2 MARKER EQUIPPED FOR TWO REGISTER GROUPS (SFD-B105)

If all of the lines on a LL require connection to the same type of register, the corresponding 2LF- terminal is cross-connected directly to the LFD or LFMF terminal to operate the D or MF relay (SFD-B105).

If some lines on a LL require one kind of register and other lines on the same LL require a different kind of register, the corresponding 2LF- terminal is cross-connected to the LFM terminal. Ground on the LFM terminal operates the MLF relay.

Operation of the MLF relay indicates that the LL requiring service is a mixed line frame. When the LL is a mixed frame, the D or MF and associated relays operate after the vertical group is selected with the MLF relay operated. For a mixed frame, the vertical group which is selected will identify the type of register required by the customer.

B1-5.3 MARKER EQUIPPED FOR UP TO SIX REGISTER GROUPS (SFD-B105)

If all of the lines on a LL require connection to the same type of register, the corresponding 2LF- terminal is cross-connected directly to the LFD, LFMF, or LFR- terminal to operate the D, MF or R- relay.

B1-5.4 REGISTER GROUP SELECTION

Three typical cross-connections are shown on SFD-B105 for different types of control of register group selections.

The heavy dashed cross-connections are for line link frames on which all lines use the same type of originating register. Ground on the 2LF lead for one line link frame directly operates the MF relay to direct the selection of a TOUCH-TONE® type originating register. Another line link frame directly operates the D relay to direct the selection of a dial pulse originating register. A third line link frame directly operates the RO relay. This route relay could be assigned to a second group of TOUCH-TONE or dial pulse originating registers. This third illustration would be only for offices having more than two originating register groups (option B provided).

The lightweight long dashed cross-connections are for line link frames on which some lines require dial pulse registers and some require TOUCH-TONE registers, and only two register groups are provided for the office (option A.) Lines requiring TOUCH-TONE originating registers are shown as assigned to vertical group 0-7 while lines requiring dial pulse lines are shown as assigned to vertical group 8. Later in the progress of setting up the connection, if the call had originated in any of the vertical groups 0-7, operation of a relay VGT0-7 would cause the MF relay to operate. However, if the call had originated in vertical group 8, the VGT8 relay operating would operate the D relay.

The lightweight short dashed line cross-connections are only for offices having more than two originating register groups (B option provided). Ground via the 2LF- punching directly operates the VP1 relay. Later in the progress of setting up the connection, if the VGT8 or VGT9 relay operates, the R1 route relay operates. If the VGT10 or VGT11 relay operates, the R2 route relay operates.

A marker will not normally be equipped for more than two register groups. (See Note 400, Parts 2 and 3 of SD-26000-01 for more detailed cross-connection data.)

B1-5.5 FCD-, FCM-, AND FCR- RELAYS

The operation of the D, MF, or R- relay operates the corresponding FCD-, FCM-, or FCR- relays (SFD-B105). Operation of a VP- or an R- relay causes the MLF relay to operate. Operation of the above relays initiates the operations necessary for the identification of the calling line and for the selection of an originating register.

B1-5.6 OPERATION OF THE CKG1,2, GC, GCA, GTL1,2, LLC1,2, ONX, RCY, TLC, AND BX RELAYS

To provide a large number of off-normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; GTL1,2; LLC1,2; RYC; and TLC relays will be operated.

The operation of the LLMC MA- relay will extend ground to the CKG lead and will operate the CKG1,2 relays in the marker (SFD-B104). The CKG1,2 relays provide off-normal grounds.

The operation of the CKG1 relay will operate the GTL1 relay, which in turn will operate the GTL2 relay (SFD-B428). The GTL1 and GTL2 relays provide means for transmitting ground supply for the operation of the customer line identification and class-of-service memory relays in the originating register. The GTL1 relay also provides means to connect the frame number identification relays to the LLMC (SFD-B107).

The CKG1 relay in operating will operate the BX relay (SFD-B207) and ONX relay (SFD-B425). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the D, MF, MLF, or CKG1 relay will operate the TLC relay (SFD-B204). (MLF may be operated by an R- or VP- relay.) The TLC relay provides battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The RYC relay will be operated when the D, MF, or MLF relay operates (SFD-B204). The RYC relay provides some off-normal grounds and is used for recycle control.

The operation of the RYC relay will operate the LLC1,2 relays (SFD-B205). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-B415).

The standing cross test STX relay will be operated when the marker goes off-normal to remove the standing cross tests (SFD-B207). During the time the marker is idle and the STX relay is normal, some miscellaneous tests are made to check that there are no false grounds or crosses within the connectors, by testing some of the leads to the connectors.

B1-5.7 CONTROL OF REGISTER GROUP SELECTION FROM MTC

Keys are provided on the older test frames to control register group selection. Newer frames provide an RG switch. The keys or switches function as shown in Table A.

TABLE A

KEY OPERATED	SWITCH POSITION	LEAD GROUNDED	ROUTE REL	TG*	OTHER DTM RELS	NOTES
All Normal	DP	D	D	0		Simulated 2LF- to LFD, LFMF or LFR- X CONN where all lines on a LL require same register group
MF	MF	MF	MF	1		
RT0	RT0	RT0	R0	2		
RT1	RT1	RT1	R1	3		
RT2	RT2	RT2	R2	4		
RT3	RT3	RT3	R3	5		
MLF	MLF	MLF	D/MF See note to the right.	0/1 See note to the right.		Used for 2 register groups where REG GRP is determined by VERT GRP. Used to verify VGR- to VGD or VGMF X-CONN.
MLF, RT0	VP0	MLF, RT0	D/MF/		VPT, VP0	Used for more than 2 REG GRPS where REG GRP is determined by VERT. GRP. Used to verify VGP- to LFD, LFMF, or LFR- X-CONN
MLF, RT1	VP1	MLF, RT1	R0-3	0-5	VPT, VP1	
MLF, RT2	VP2	MLF, RT2	See note to the right.	See note to the right.	VPT, VP2	

* To verify which register group DTM selected, REC key should be operated to force a trouble card, The TG- punch corresponds to register group selected and a D or MF punch should accompany TG0 or TG1, respectively.

B1-6 IDENTIFICATION OF THE CALLING LINE

The equipment location identification of the calling line is needed to connect an originating register to the calling line. The identification of the calling line must be transmitted to the originating register where it is stored for further use on the call back connection by a completing marker. The calling line identification is also necessary to determine the type of register to be connected to the customer, and the class of service required. The steps followed in the identification of the calling line are shown as part of the sequence chart (SFD-B004).

To properly identify the calling line, information is required which will identify the line link frame on which the calline line appears and the location of the calling line on that line link frame.

Each line link frame consists of bays of ten crossbar switches mounted one above another.* Each customer line is associated with a hold magnet on a crossbar switch. Therefore, the identification of a particular hold magnet on a particular switch will identify the calling line. This identification is accomplished by dividing the line switches into the following groupings.

(a) Horizontal Groups - The switches on each bay in the line link frame are numbered 0-9 from the bottom switch to the top switch. Switches of the same number on all bays of the line link frame comprise a horizontal group and are served by the same ten line links.

(b) Vertical Groups - The hold magnets on each crossbar switch are divided into groups of five adjacent hold magnets, designated line groups. The ten line groups located in the same position in each horizontal group are designated as a vertical group. Therefore, a vertical group consists of 50 customer lines associated with the same five adjacent hold magnets in each horizontal group. A minimum of four and a maximum of 12 vertical groups,† numbered 0-11, can be equipped.

(c) Vertical Files - The ten hold magnets in the same position in each vertical group are designated as a vertical file. There are five vertical files, numbered 0-4 in each vertical group.

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* Some supplemented line link frame bays have split switches and are not arranged 10 switches one above the other. This type of frame has not been shown in the SFD.

† Initially a maximum of 14 vertical groups were provided. Older MTCs have 0-13VG keys as shown on SFD-B107.

Identification of the calling line can therefore be made in terms of line link frame number, horizontal group number, vertical group number, and vertical file number.

SFD-B107 is a simplified diagram showing line location, input to the DTM from the LL and LLMC as used on service calls and from the MTC for use on test calls.

B1-6.1 LINE LINK FRAME IDENTIFICATION

The line link frame identification of the calling line will be acquired by obtaining the line link frame tens digit number and the frame units digit number.

The line link marker connector will extend ground to the marker on two of the FU0-7 leads and optionally on one or two of the FT0-3 leads to identify in the marker the particular LLMC involved in this connection. Each line link marker connector is associated with one line link frame, therefore the identity of the LL is also known.

B1-6.1.1 Operation of the FT0-3 Relays (SFD-B107)

There are four frame tens (FT0-3) identification relays in the marker. The FT0-3 relays are associated with the FT0-3 frame tens digit identification test leads from the LLMC. The line link frame tens digit number will be identified upon operation of two, or optionally one, of the FT03 relays. Each LLMC will place ground potential on a particular test lead or leads when GTL1 is operated to correctly identify the tens digit number of the LL with which it is associated.

If the one ground option is provided, leads FT0-3 indicate directly tens digit 0 to 3. If the two ground (or 2/4 option) is provided, the Table B is used in interpreting the code.

TABLE B

Tens Digit	Leads Grounded
0	0, 3
1	0, 1
2	0, 2
3	1, 2
4	1, 3
5	2, 3

Note that adding the designations of the leads grounded gives the tens digit except for digit 0.

Auxiliary relays operated from the FT- relays are shown on SFD-B114.

B1-6.1.2 Operation of the FU0-7 Relays (SFD-B107)

There are five frame units (FU0,1,2,4,7) identification relays in the marker. Two leads out of five FU0-7 leads will be grounded by the LLMC. This will operate the two associated FU0-7 relays in the marker to identify the line link frame units digit in 2/5 code according to Table C when the GTL1 relay operates.

TABLE C

Units Digit	Leads Grounded
0	4, 7
1	0, 1
2	0, 2
3	1, 2
4	0, 4
5	1, 4
6	2, 4
7	0, 7
8	1, 7
9	2, 7

Note that adding the designations of the leads grounded gives the units digit except for digit 0.

Auxiliary relays operated from FU- relays are shown on SFD-B114.

B1-6.2 VERTICAL GROUP IDENTIFICATION

The marker in determining the identification of the calling line on the selected LL will first identify the vertical group, then identify the horizontal group, and finally, the vertical file of the calling line.

When a customer removes the receiver from the switchhook to originate a call, the customer line relay and a vertical group start relay are operated on the LL. On each LL there is one vertical group start relay associated with each vertical group of line terminations. Any customer within a vertical group desiring a dial tone connection will initiate the operation of the associated vertical group relay.

After the marker has been connected to the LL of the calling customer through the LLMC, the marker will test the VGT0-11 leads to the LLMC to determine which vertical group start relay has operated on the LL as an indication of the vertical group in which the calling customer is located. If there are calling customers waiting for a dial tone connection in more than one vertical group on the line link frame to which the marker is connected, the marker will select one vertical group for service and exclude all other vertical groups. When the marker has determined the vertical group identification, the calling line identification is known to be within the 50 customer lines composing that vertical group.

B1-6.2.1 Operation of the VGG1 and VGG2 Relays (SFD-B108)

To initiate vertical group identification the vertical group gating relays VGG1,2 will be operated to connect the vertical group test relays to the LLMC, to identify the vertical group that is requesting service. The operation of the D, MF, or MLF relay will operate the VGG1,2 relays.

B1-6.2.2 Operation of the GK Relay (SFD-B108)

To check that the line identification gating relays, the vertical group gating relays VGG1,2, and the vertical file gating relay VFG have operated properly, the gating check GK relay will be operated.

B1-6.2.3 Operation of the VGT0-11 Relays (SFD-B108)

When a customer removes the receiver from the switchhook to originate a call, the customer line relay will operate a vertical group start VGS-relay on the LL. On each LL there is one vertical group start relay associated with each vertical group of 50 customer lines and the operation of any line relay within a vertical group will operate the associated vertical group start relay. The operation of a vertical group start relay will ground one VGT0-11 lead to the marker.

The marker provides facilities for testing either 8 or 12 vertical groups. However, 12 vertical groups are the maximum number that any LL can have. The number of vertical groups on the LL is optional up to the allowable maximum of 12.

Ground potential on one or more of the VGT0-11 leads will operate the associated group test relay VGT0-11 in the marker with the VGG1,2 relays operated. The operated VFT0-11 relay or relays will identify the vertical groups of the customer or customers requesting service.

B1-6.2.4 Operation of the VGR and VTK Relays (SFD-B108, B106)

The vertical group release relay VGR is operated as an indication that one or more VGT0-11 relays have operated (SFD-B108). The VGR relay serves to disconnect the marker if the call is abandoned by the customer during line identification.

The VGR relay in operating operates the vertical group test check relay VTK (SFD-B106). One of the purposes of the VTK relay is to allow sufficient time between the interval when the first VGT0-11 relay operates and when the last VGT0-11 relay operates. Since all VGT0-11 relays may not operate in the same time interval (slower operating relays), the operation of the VGR and VTK relays allows for this stagger time before the VGG1,2 relays are released and the paths to the vertical group test leads are opened. The VTK relay also gives an indication of false starts where the VGT-, VGR, VTK, and VTK1 relays operated and when the VGR relay released due to a customer replacing the receiver on the switchhook. The VTK and VTK1 relays operated with the VGR relay released indicates a false start or an abandoned call which will operate the DIS1,2 relays to release the marker (SFD-B502).

B1-6.2.5 Release of the VGG1,2 Relays (SFD-B108)

After an indication has been received that one or more vertical groups of calling customers have been identified, the vertical group gating VGG1,2 relays will be released. This excludes the future operation of a nonoperated VGT0-11 relay. The VGG1,2 relays are released when the VTK relay operates (SFD-B108).

B1-6.2.6 Release of the Nonpreferred VGT0-11 Relays (SFD-B108)

Operation of two or more VGT0-11 relays indicates that customers in more than one vertical group desire a dial tone connection. Since only one customer can be connected to an originating register at a time, it is necessary to prefer one of the customers requesting dial tone and to exclude all others. Therefore, the preferred VGT0-11 relay will be locked operated and all other operated VGT0-11 relays will be released. The VGT- relay remaining operated will allow calling customers within this vertical group to be selected for service.

The method of preferring one of the operated VGT0-11 relays and releasing the others is accomplished by using the junctor sequence circuit. It should be noted that regardless of the setting of the junctor sequence circuit vertical group two (VGT2) will always have first preference on a first trial call. However, on second trial calls the selection of the preferred VGT0-11 relay is only determined by the setting of the junctor sequence circuit. The selection preference of any VGT0-11 relay will vary with each connection set up by the marker as the junctor sequence circuit is advanced with each DTM usage. The operation of a particular junctor sequence JSQ0-5 relay will prefer one of the operated VGT0-11 relays and will lock up this selected relay. Upon the release of the vertical group gate relays VGG1,2, the preferred VGT0-11 relay will be locked operated through one of the junctor sequence contacts and all other VGT0-11 relays will be released. The detailed operation of the junctor sequence control is described in SCD-B4-1.1.

B1-6.2.7 Operation of the VTK1 Relay

The vertical group test check relay VTK1 is operated when all the nonpreferred VGT0-11 relays have released, and with the preferred VGT- relay operated (SFD-B107). The operation of the VTK1 relay indicates that one and only one of the VGT0-11 relays is operated and the VGG1,2 relays have released. The VGR remains connected to the VGT- lead to monitor for abandoned calls.

B1-6.2.8 Operation of the VGA- and VGB- Relays on the LL (SFD-B107, B304)

The VGA- relay of the LL operates in parallel with VTK1 relay of the DTM when all nonpreferred VGT- relays have released with the preferred VGT- relay operated.

The operation of the VGA- relay on the LL initiates the selection of a horizontal group by extending the ten horizontal group test leads within the selected vertical group to the marker.

The vertical group VGB- relay on the LL operates after the vertical group has been selected and the vertical group test check VTK1 relay has been operated. However, the VGB- relay will only be operated after the line link connector has been seized and the connector cut-through relays operated (SFD-B304).

The operation of the VGB- relay on the LL assists the DTM in identifying the line group of the calling customer after the horizontal group has been selected. The operation of the VGB- relay also assists the DTM in determining the class of service of the calling customer after the vertical file has been identified.

B1-6.3 HORIZONTAL GROUP IDENTIFICATION

After the DTM has identified the vertical group, it operates the VGA- relay on the LL to extend to the DTM ten horizontal group identification test leads from the 50 line relays on the LL associated with the selected vertical group. The operation of any one of the five line relays within a horizontal group and within the selected vertical group places ground on the associated horizontal group identification test lead.

The DTM test for ground on the ten horizontal group identification test leads and determines in which horizontal group of the selected vertical group the calling customer line is located. If there are calling customers waiting for a dial tone connection in more than one horizontal group of the selected vertical group, the DTM selects one horizontal group for service and excludes all other horizontal groups. After the DTM has determined the vertical group and the horizontal group identification, the calling line identification is known to be within the five customer lines, composing the line group within the selected vertical group and horizontal group.

B1-6.3.1 Operation of the HGG Relay (SFD-B109)

The operation of the horizontal group gating relay HGG connects the horizontal group test relays to the horizontal group test leads from the LLMC to identify the horizontal group of the calling customer on the LL. When the D, MF, or MLF relays operate, the HGG relay operates.

B1-6.3.2 Operation of the HGT0-9 Relays (SFD-B109)

After the vertical group has been selected, it is necessary to determine which horizontal group within the selected vertical group should be served. The operation of one or more horizontal group test HGT0-9 relays indicates which horizontal group within the selected vertical groups have customers desiring dial tone connection.

The operation of any customer line relay in a horizontal group and within the selected vertical group with the associated VGA- relay operated grounds the associated horizontal group test lead HGT0-9 on the LL. Ground extended to the DTM over the horizontal group test leads HGT0-9 from the LL operates the associated HGT0-9 relays in the marker with the HGG relay operated. Thus, the horizontal group of customers within the selected vertical group is identified by the operation of the HGT0-9 relays.

B1-6.3.3 Operation of the HGR and HTK Relays

The horizontal group release relay HGR is operated as an indication that one or more HGT0-9 relays have operated. The HGR relay also monitors for a customer disconnect within the selected horizontal and selected vertical groups.

The HGR relay in operating operates the horizontal group test check relay HTK. One of the purposes of the HTK relay is to allow sufficient time between the interval when the first HGT0-9 relay operates and when the last HGT0-9 relay operates. Since all HGT0-9 relays may not operate in the same interval of time, the operation of the HGR and HTK relay allows for this stagger time before the HGG relay is released and the paths to the horizontal group test leads are opened. The HTK relay also gives an indication of false starts, where the HGT-, HGR, HTK, and HTK1 relays operated and when the HGR relay is released due to the customer replacing the receiver on the switchhook. The HTK and HTK1 relays operated with the HGR relay released indicates a false start or an abandoned call. The DIS1,2 relays will then be operated to release the marker (SFD-B502).

B1-6.3.4 Release of the Nonpreferred HGT0-9 Relays (FS7)

Operation of two or more HGT0-9 relays indicates that customers in more than one horizontal group desire a dial tone connection. Since only one customer can be connected to an originating register at a time, it is necessary to prefer one of the customers requesting dial tone and to exclude all others. Therefore, the preferred HGT0-9 relay is locked operated and all other operated HGT0-9 relays are released. The HGT-relay remaining operated allows the calling customers within this horizontal group and the selected vertical group to be selected for service.

The method used to prefer one of the operated HGT0-9 relays and to release all other HGT0-9 relays is similar to the method used in preferring one of the VGT0-11 relays for service as described in SCD-B1-6.2.6 except no horizontal group has a continuous first choice preference as VGT2.

B1-6.3.5 Operation of the HTK1 Relay (SFD-B107)

The horizontal group test check HTK1 relay is operated when all the nonpreferred HGT0-9 relays have released with the preferred HGT- relay operated. The operation of the HTK1 relay indicates that one and only one of the HGT0-9 relays is operated and the HGG relay has released.

B1-6.4 VERTICAL FILE IDENTIFICATION

Vertical group and horizontal group identification is made from information received by the DTM via the LLMC. Vertical file identification cannot proceed until the DTM has seized a trunk link frame with an idle OR and has connected to the LL via the line link connector (LLC). Selection and seizure of a TL is described in SCD-B3. The seizure and connection to a LL via the LLC is described in SCD-B4. To complete the description of line identification, it is assumed that these functions have been completed during vertical group and horizontal group identification. If the connection to the LL via the LLC has not been completed, vertical file identification is delayed.

After the DTM has identified the vertical group and horizontal group and has connected to the LL via the LLC, it operates relays in the LL to extend the five vertical file identification test leads VFT0-4 from the five line relays of the selected line group (SFD-B107). Each vertical file identification lead connects to a contact on one line relay in the selected line group. The operation of one or more line relays in the line group will have placed ground on the associated VFT- leads.

The DTM tests for ground on the VFT0-4 leads and determines in which vertical files of the selected line group the calling customer line is located. If there are calling customers waiting for a dial tone connection in more than one vertical file of the selected line group, the DTM selects one vertical file for service and excludes all other vertical files. After the DTM has determined the vertical group, the horizontal group, and vertical file identification, the calling line identification is complete.

B1-6.4.1 Operation of the VFG Relay (FS8) (SFD-B109)

The vertical file gating relay VFG, when operated connects the vertical file test leads VFT0-4 from the LL to the vertical file test VFT0-4 relays to identify which vertical file or files are requesting service. The operation of the D, MF, or MLF relay operates the VFG relay.

B1-6.4.2 Operation of the Horizontal Group Relays HGA-, HGB- on the LL (SFD-B107)

The HTK1 relay of the DTM and the horizontal group relays HGA-, HGB- on the LL operate when all nonpreferred HGT0-9 relays have released with the preferred HGT- relay and connector cut-through relays operated. The operation of the HGA-, HGB- relays on the LL with the VGB- relay on the LL operated narrows the selection to five lines.

B1-6.4.3 Operation of the HGK Relay (SFD-B107)

As a check that HGA-, HGB- relays on the LL have operated, the HGK relay operates.

B1-6.4.4 Operation of the Line Group LG- Relay on the LL (SFD-B107)

On the LL there is one LG- (line group) relay associated with the five customer lines that have been selected by the operation of the vertical group and horizontal group relays. The group of five customer lines is called a line group. There are ten LG- relays per vertical group. Therefore, if the line link frame has 12 vertical groups there will be 120 LG- relays on that LL (one line group relay for each five customer lines). By identifying the vertical group of the calling customer the identity of the customer line group is known to be within the ten line groups associated with the selected vertical group. By identifying the horizontal group within the selected vertical group of the calling customer line the complete identity of the calling customer line group is known.

The operation of the line group relay extends five vertical file test leads VFT0-4 to the LL to determine the vertical file numbers of the customers desiring service.

After the horizontal group check (HGK) relay has operated, battery potential is extended to the LL on the BS lead to operate the LG-relay.

B1-6.4.5 Operation of the VFT0-4 Relays (SFD-B107), B109)

When a customer removes the receiver from the switchhook to originate a call, the customer line relay operates. The operation of any customer line relay in a vertical file and within the selected vertical group and selected horizontal group grounds the associated vertical file identification test lead VFT0-4 from the LL.

B1-6.4.6 Operation of the FR Relay (SFD-B109)

The vertical file release (FR) relay is operated as an indication that one or more VFT0-4 relays have operated. The FR relay also monitors for a customer disconnect within the selected vertical file, horizontal group, and vertical group in a manner similar to the description for the HGR relay (SCD-B1-6.3.3).

B1-6.4.7 Release of the VFG Relay (SFD-B109)

After the FR relay operates as an indication that one or more vertical files of calling customers have been identified, the vertical file gating relay (VFG) releases to exclude the future operation of a non-operated VFT0-4 relay on this call.

B1-6.4.8 Release of the Nonpreferred VFT0-4 Relays (SFD-B109)

If two or more VFT0-4 relays have operated indicating that customers in more than one vertical file desire a dial tone connection, the one VFT0-4 relay among the operated VFT0-4 relays with the higher selection preference will be locked operated and all other VFT0-4 relays will be released. The VFT- relay remaining operated selects the calling customer within this vertical file for service.

The method used to prefer one of the operated VGT0-4 relays and to release all other operated VGT0-4 relays is accomplished in a manner similar to the method used in preferring one of the HGT0-9 relays as described in SCD-B1-6.3.5.

B1-6.4.9 Operation of the FTK1 Rèlay (SFD-B107)

The vertical file test check relay FTK1 is operated when all nonpreferred VFT0-4 relays have released with the preferred VFT- relay operated. The operation of the FTK1 relay indicates that one and only one of the VFT0-4 relays is operated and the VFG relay has released.

B1-6.4.10 Junctor Sequence Walking Circuit

The DTM 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 for line identification are:

(a) Vertical Group Selection (SCD-B1-6.2.6)

(b) Horizontal Group Selection (SCD-B1-6.3.5)

(c) Vertical File Selection (SCD-B1-6.4.8)

Operation of the junctor walking circuit is described in SCD-B4-1.1.

B1-7 MARKER SUPERVISION DURING LINE IDENTIFICATION AND SELECTION

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

In 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 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 DIS1/2 (marker disconnect) (refer to SFD-10-01-B502) causing the marker to disconnect without a trouble record (normal release).

B1-8 MASTER TEST CONTROL - DT AND OR CLASS OF TEST - SIMULATION OF PORTIONS OF LINE LINK FRAME, LINE LINK MARKER CONNECTOR, AND PREFERENCE CONTROL

The DT class of test is used for testing dial tone markers and the various other circuits which the markers control.

The OR class of test establishes a connection through the network from a test line to an originating register which is then tested by the automatic monitor register and sender test circuit. (AMRST).

The information required to prime the marker is similar for both classes of test calls. The master test control (MTC) simulates portions of a line link frame, line link marker connector, and preference control. It gains access to the marker via the master test frame connector (MTFC). Inputs to the DTM from the MTC are held open in the MTC by contacts on isolating relays (generally designated as MC-, TS- or K-). These isolating relays operate after the MTC has made a check that required test relays (generally designated MT-) have operated in the DTM.

B1-8.1 INITIAL PRIMING INFORMATION FROM MTC

The CKG2 lead (SFD-B104) and TM lead (SFD-B110) are closed automatically with no control by keys on the MTC. They simulate the CKG lead from the LLMC and the release of the MSK, MAK, and MCK relays of the DTM which occurs on service calls by opening chain paths through MS- relays of the preference control circuit when one or more MS- relays operate.

With the TR2 key (SFD-B106) normal, the TRK lead is grounded to simulate a TRK (first trial) signal from the LL via the LLMC.

With the TR2 key (SFD-B106) operated, the TR2 lead is grounded to simulate a TR2 (second trial) signal from the LL via the LLMC.

With the TRS key (SFD-B106) operated, the TRS lead is grounded to simulate a TRS (transfer start) signal from the LL via the LLMC.

Under control of the RG switch or one of the keys MLF, MF, or RTO-3 (SFD-B105), one of the leads D/MF/MLF/RTO-3 is grounded to simulate closure of ground to an LF- cross-connection by operation of an MS-relay in the PC (SFD-B104), Table D shows various conditions.

TABLE D

Note	RG Switch Provided (STD)	Keys Provided (MD)	Simulates LL Having Lines Request Originating Register in Register Group	TBL Card Designation
	Pos	Keys Opr.		
	D	None	D	D,TGO
	MF	MF	MF	MF,TG1
1	MLF	MLF	D/MF	MLF,(D,TGO)/(MF,TG1)
	RTO	RTO	RO	MLF TG2
	RT1	RT1	R1	TG3
	RT2	RT2	R2	TG4
	RT3	RT3	R3	TG5
2	VPO	MLF,RTO	NOTE 2	MLF, NOTE 2
2	VP1	MLF,RT1	NOTE 2	MLF, NOTE 2
2	VP2	MLF,RT2	NOTE 2	MLF, NOTE 2

NOTES:

1. Use only when there are two register groups, D and MF. Marker VGR- cross-connections determine whether the D or MF register group is required depending on which vertical group is used.

2. Use when there are more than two register groups. Marker VGP- X CONN determines whether D, MF, RO, R1, R2, or R3 register group is required depending on which vertical group is used. Trouble card should always show MLF along with indication of register group D, TGO/MF, TG1/TG2/TG3/TG4/TG5.

B1-8.2 LINE LOCATION INFORMATION

On OR class of test with the NTC (no test connector) key operated or on DT class of test with the NTC key in either position, line location should be set up on keys or switches FT-, FU-, VG-, HG-, and VF- (SFD-B107). On OR class of test, with the NTC key normal, the OTL2 relay will operate to provide line information which has been cross-connected for an originating test line. In this case the line location keys need not be operated. They are ineffective, however if they are inadvertently operated.

Line Link Frame Number on the FT- and FU- leads is closed early to simulate FT- and FU- leads from the LLMC.

Vertical group number on the TVGT- leads is also closed early by either the KVG1, 2 or the CTL2 relays to simulate VGT- leads from the LL via the LLMC. When vertical group selections have been made by the DTM, a VGA- relay is normally operated in the LL via the LLMC. Instead, however, either the KHGT or the VGA relay of the MTC is operated depending on whether line location is being generated by the line location keys or the OTL2 relay, respectively.

Operation of the KHGT or VGA relay in the MTC grounds one of the THGT-leads to the DTM to simulate ground on an HGT- lead from the LL via the LLMC.

By this time, the marker should have connected to the LL via the LLC. When horizontal group selection has been made by the DTM, HGA- and HGB-relays are operated in the LL and close a ground on the HGK lead to operate the HGK relay in the DTM. The HGK relay closes ground on an HGK lead to operate either the KV or the HGK relay of the MTC, again depending on whether the line location information is being generated by keys or switches or by the OTL2 relay. Operation of the HGK relay in the marker applies battery to the BS lead to operate an LG- relay in the LL. Operation of the KV or HGK relay in the MTC grounds a TVFT- lead to the DTM to simulate ground on a VFT- lead from the LL.

B1-8.3 CONTROL LEADS

On a service call, start battery via the MSA lead or MSB lead from the LL operates an MS- relay in the preference control circuit (PC) to bid for a DTM. The same start battery and the ground through the winding of the MS- relay is extended through the LLMC on the MS1 or MS2 lead to operate the OC1 relay in the DTM after the VTK relay has operated. The OC1 relay operates the OC relay which operates the TC and TC1 relays of the LL to open the start battery. The MS- relay of the PC now remains operated to battery through the OC1 relay winding.

To simulate this on a DT or OR class of test, the MTC provides resistance battery to operate the MS relay which simulates an MS- relay of the PC. When the VTK relay of the DTM operates, the OC1 relay of the DTM operates to ground through the winding of the MS relay of the MTC. The OC1 relay of the DTM operates the OC relay which grounds the TC1 lead to the MTC to operate the TC1 relay which simulates the TC and TC1 relays of the LL. The TC1 relay opens the battery which originally operated the MS relay of the MTC and leaves it held in series with the OC1 relay of the DTM. Later, when the marker is ready to release, it operates the DIS1 and DIS2 relays to release the OC1 of the DTM and the MS of the MTC.

The MTC provides a closure between the DTK and G leads (SFD-B106) which simulates a similar closure on service calls via the LLMC, the DT relay of the LL and the LLC.

When the DTM encounters certain trouble or busy conditions on service calls, it grounds either the BT or the TRL lead (SFD-B106) to operate the TRL relay of the LL as a trouble release signal. On DT or OR test calls, if the DTM encounters the same conditions, it again grounds either the BT or TRL leads to operate either the BT or TRL relay and light the BT-OF or TRL lamp in the MTC.

On service calls, operation of the TRL relay in the LL operates the TR relay (SFD-B106). With both relays TRL and TR operated, the path holding the MS- relay of the PC (SFD-B104) is opened to release the connection between the LL and the DTM. On a DT or OR class of test, operation of either the BT or TRL relay of the MTC causes release of the connection from the MTC to the DTM via the MTFC.

B1-9 LINE LOAD CONTROL

Line load control provides the means for temporarily reducing the originating attempts from line link frames. When line load control is provided, the lines on each line link frame are divided into classes A, B, and C. Line load control relays are provided for lines in class B and class C only. These relays are manually controlled from a central point in the office. Vital lines such as police, fire, hospitals, etc. are assigned to class A which is exempted from line load control.

B1-9.1 LOAD INDICATORS

Several indicators are provided on the line load control panel which aid in determining when and how to apply line load control.

B1-9.1.1 Line Link Frame G- Lamps

As noted in SCD-B1-4.3, each line link frame is arranged to light an associated red G lamp at the line load control panel when calls are waiting for an interval greater than 5.4 to 8.0 seconds (SFD-B106, B112).

B1-9.1.2 Originating Register Group Busy ORST- Lamps

Whenever a DTM finds all originating registers in a group busy, the TBTA relay operates to ground a lead which lights a red ORST- lamp corresponding to that register group (SFD-B112). The ground from the DTM is momentary, but it causes the RB2 relay of the group busy circuit to lock up for 9.6 to 13.3 seconds until the RT timer (SFD-B511) times out to release the RB2 relay (SCD-B5-2.20).

B1-9.1.3 Marker Group Busy MBA- Lamps

A series circuit through contacts of the AMB relay of each DTM operates the B1 relay of the all markers busy circuit whenever all markers are busy at the same time (SFD-B112). The B1 relay starts the 40-62 second TM timer. If any marker becomes idle prior to time out, release of the B1 relay recycles the timer. If the timer times out, it operates the T relay which operates the B relay. The B relay lights a red MBA- lamp associated with the group of dial tone markers. The B relay also releases the T relay, locks to the B1, and recycles the timer. If any DTM becomes idle after time out, the release of the B1 relay releases the B and extinguishes the AMB- lamp.

B1-9.1.4 Load Meter

A load meter is provided at the line load control panel which indicates the -48 volt current drain of the whole No. 5 Crossbar office. The meter is actually a millivolt meter calibrated 0-100 and is connected across a shunt in series with the -48V bus which feeds the office. The load meter is not intended to provide an accurate measurement of current, but rather a relative measurement. The interpretation of the meter reading depends on the size of the office. A normal peak load reading for a small office might be 20, while that for a larger office might be 70. Readings much in excess of normal peak readings for the office in conjunction with other load indicators may be indicative of overload conditions. If applications of line load control are effective in reducing the offered load, the reading of the load meter should decrease.

Where more than one office uses the same -48 volt supply, the load meter indicates the combined load for both offices and loses its effectiveness as a load indication for either office.

B1-9.2 APPLICATION OF LOAD CONTROL

Where load control is to be applied to class B lines, the CLB key is operated (SFD-B112). This causes the HB, AB, and B relays to operate. The B relays enable B keys, one for each line link frame. Operating a B key associated with any LL operates the B relay in that line link frame. The B relay lights a B lamp associated with that LL at the line load control panel and also provides a locking ground for the AB and HB relays, so that the B lamp will remain lighted, even though the CLB key is released, as a reminder that the individual B keys should also be released. When the B relay on a LL operates, it opens the operate path for all even VGS- relays (SFD-B102) which do not have a strap from G- to VG- to bypass the break contact of the B relay. Insertion of this strap rates the lines of that vertical group as class A which is not subject to line load control.

To apply line load control to class C lines, CLC and C keys are used in the same manner described for class B lines. This affects lines in odd vertical groups except where a G- or VG- strap converts the vertical group to class A.

B1-9.3 ALARM

When either the AB or AC relay operates, battery is applied to the MJ lead to the alarm circuit (SFD-B112) to sound a major alarm and light the aisle pilot lamp. The alarm may be retired by momentarily operating the nonlocking AR key, operating the RC relay which locks.

B1-9.4 CANCEL GROUND TEST

Whenever line load control is applied, leads are grounded to the JLK circuit to cancel trouble records by completing markers on ground tests to help reduce marker holding time.

SECTION B, PART 2

CONNECTION TO TRUNK LINK FRAME AND ORIGINATING REGISTER

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B2 CONNECTION TO TRUNK LINK FRAME AND ORIGINATING REGISTER

When a DTM has been seized and has received input information through the LLMC, it proceeds to select a trunk link frame (TL) having idle originating registers (OR) of the correct type. It then proceeds to select and connect to an OR.

B2-1 TRUNK LINK FRAME SELECTION

B2-1.1 TEST FOR IDLE ORIGINATING REGISTERS ON TRUNK LINK FRAMES

The operation of one of the relays D, MF, or RO-4 (SFD-B105) causes operation of relays FCDO, 10, 20, FCMO, 10, 20, or FCO-3, 10-13, 20-23 frame connect relays respectively. The operation of the FC- relays causes operation of the FCK relay. When the frame connect relays FCD-, FCM-, or FCR- operate, they extend frame test leads FTC-, one to each trunk link frame (SFD-B202). The FTC- leads terminate in FTC- terminals at the TL which are cross-connected to the FT- terminals of each register on that frame of the associated group. For instance, if FCD- relays are operated they would close through FTC- leads to each TL which are cross-connected to FT- terminals of each dial pulse OR associated with the group intended to be selected when the D relay has been operated via the LLMC.

The FT- terminal associated with each OR is connected to ground in the OR through normal contacts of relays of the OR, so that if the OR is either busy in service or is made busy (MB relay operated), the ground will be open.

B2-1.2 TRUNK LINK FRAME BUSY TEST

To prevent marker delays it is necessary to determine which TLs are occupied by other markers before the TL with an idle OR can be selected. The operation of the BCO, 10, and 20 relays (SFD-B204) extends the windings of the FBO-29 relays (SFD-B202) to their associated TL to check if that frame is busy. If the TL is busy, the associated FB- relay operates. To select a TL, the associated FTC- relay must be operated while the FB- relay is nonoperated.

B2-1.3 TL PREFERENCE ORDER OF SELECTION CONTROLLED BY MEMORY OF PREVIOUSLY SELECTED TL

Frame memory relays (SFD-B205) have been provided to equalize traffic to the TLs. The frame memory group FMG- relay and the frame memory FMO-4 relay will be held operated from the previous call to record the identification of the TL used in that connection. This information is locked in, and on the next call will be used to make the succeeding TL first choice for the marker. However, if the first choice TL is not available for service, the next preferred TL is selected (SFD-B203).

As described in SCD-B2-1.6, after the TL has been selected, the frame memory relays used to identify the last TL used are released. The frame memory relays identifying the TL used in this connection are then operated.

B2-1.4 FRAME SELECTION, OPERATION OF THE FS0-29 RELAYS (SFD-B203)

The operation of a frame select FS0-29 relay (SFD-B203) indicates the TL to be selected to complete this connection. The operation of the FS-relay depends on:

(a) The operation of the FCK relay indicating that either the FCD-, FCM-, or FCR- relays have operated (SFD-B105).

(b) The operation of the FTC- relay with the associated FB- relay released, indicating an idle TL with an idle originating register of the desired type (SFD-B202).

(c) The setting of the FMG- and FM- relays (SFD-B203).

(d) The operation of the FMG relay indicating that the frame memory relays have been held operated from the previous call (SFD-B205).

The FS- relay which operates will generally be associated with the second higher-numbered frame than the frame recorded on the frame memory relays. The reason for advancing the frame selection in steps of twos is in cases of paired TLs where all channels are busy and the marker is recycled, it will always be advanced to a different TL. This prevents the marker from staying in the same TL and allows another set of junctors to be tested.

B2-1.5 TRUNK LINK FRAME SEIZURE (SFD-B204, SD-26039-FS2, 3, 4)

Operation of an FS- relay closes start battery to the preference control circuit associated with the trunk link frame having the same number as the operated FS- relay.

B2-1.5.1 Preference Control Circuit

The preference control circuit associated with trunk link connectors provides two preference relays, MP- (marker preference) and E- (emergency marker preference), per marker for each trunk link connector. There is means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a trunk link frame. Similar independent chains interconnect the E-relays. While the following description is for MP- relays, it applies equally to E- relays.

B2-1.5.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a TL) MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain (shown on SFD-B204 as associated with the last CM or DTM). In periods of heavy traffic two or more markers may initiate request either simultaneously or in rapid succession.

Assume that the first CM and the last CM or DTM (SFD-B204) initiate simultaneous requests (Apply start battery) for connection to the same TL. Both MP- relays will operate and lock. If, however, the last CM or DTM has initiated a request slightly before the first CM, the MP- relay for the first CM could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last CM or DTM.

On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

B2-1.5.1.2 MP- Relay Work Chains

Since it is possible to operate two or more MP- relays at the same time, two work chains determine which MP- relay does the work. The work chains progress through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first CM. If the MP- relay for the first CM is operated, one work chain ground will operate the M trunk link connector relay whether or not other MP- relays are operated. The M- relay operates other connector relays by closing through battery supplied by the marker.

The second work chain grounds the CK lead to the marker which has gained access to the trunk link frame to operate the TFK1 relay in the marker. The operated TFK1 relay provides locking ground for the FS- relay (SFD-B203) which had closed through the start battery to the PC. The TFK1 relay also opens the ground from which the FS- relay had operated.

When the marker which has seized the TL has finished its job and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated now functions as just described. This continues until all operated MP- relays have been served.

B2-1.5.1.3 Emergency Transfer

Two sets of preference relays MP- and E- are provided in the PC (SFD-B204) either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that MP- relays are active. When all MP- relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding and ground through all the break contacts of the work chain which operates connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP- relays are all normal, one side of the CH- relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the ST, CK-, and MC- leads from MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP chain if the TR key is normal or to the E- chain if the TR key is operated.

B2-1.5.1.4 Manual Transfer

By operating the TR key [located at the TLCC (Trunk Link Connector Control) frame] preference control can be manually transferred for the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR-relays to transfer preference back to the MP- relays.

* Although the CH lamp is shown as part of the trunk link connector circuit, it and the alarm release key are located on a frame designated as "trunk link connector control."

B2-1.5.2 Frame Busy Signal

When the trunk link connector relays operate, they ground FB- leads to all markers (DTM and CM) (SFD-B202, 304) as an indication that the trunk link frame is now busy. In all markers except the one that seized the TL, operated FB- relays (SFD-B203) cause the release of associated FS- relays (if operated) and operation of another FS- relay (assuming another FTC- relay is operated with a normal FB- relay). In the marker which had seized the TL, the locking ground from the operated TFK1 prevents release of the FS- relay. The operated TFK1 also prevents operation of any other FS- relay by its removal of the operate ground for FS- relays. Thus, any other markers handling dial tone or outgoing connections will remove their bid for the particular TL and possibly bid for another which had idle originating registers or idle trunks. As will be seen later, completing markers handling incoming trunk calls can only go to one TL and will continue their bid for the same TL.

B2-1.6 RECYCLE OF FRAME MEMORY PREFERENCE (SFD-B205,B004)

After the trunk link frame has been seized, the marker resets the frame memory relays (SFD-B205). 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- releases relay FMK which releases relay FMG. The release of relay FMG, together with the operated relay FS- on this usage, operates the FM- and FMG- relays that correspond to the trunk link frame being used. Relay FMK reoperates. Because relay TRK1 is operated, relay FML (frame memory lock) operates and relay FMG remains nonoperated and provides a locking ground for the FM- and FMG- relays. The operation of relay FML releases relay BCO, 10, and 20 (SFD-B204), opening the trunk link frame test leads (SFD-B202) and releasing the operated FB- relays. The frame memory lock relay (FML) operated opens a break contact in the FMK relay circuit. This now ensures that the FMK relay will remain operated only when <u>both</u> <u>FM-</u> <u>and</u> <u>FMG-</u> relays are operated. The FMK and FML relay operation is represented on the trouble record card by progress punch FML. Failure to lock the new frame memory relays will be detected at the time the dial tone marker prepares to operate the disconnect relays DIS1 and 2 through make-contacts of the FML and FMK relays (SFD-B502). A trouble record will be produced showing no FML punch.

B2-1.7 CONTROL OF TRUNK LINK FRAME SELECTION BY THE MASTER TEST CONTROL CIRCUIT (SFD-B202)

Three methods of controlling trunk link frame selection from the master test control circuit are provided on DT (dial tone marker) and OR (originating register) test calls. They are:

(a) Normal (FS and NTFS keys normal)

(b) Selection of a particular trunk link frame having idle registers (FS key operated)

(c) Selection of a particular trunk link frame whether or not there are idle registers (NTFS key operated).

B2-1.7.1 FS and NTFS Keys Normal

With the FS and NTFS keys normal, the MT4, 14, and 24 and MT9, 19, and 29 relays in the dial tone marker are not operated (SFD-B204). The marker tests for trunk link frames having idle registers in the normal manner, and therefore selects the most preferred trunk link frame just as on a service call.

B2-1.7.2 FS Key Operated

With the FS key operated, the MT4, 14, and 24 relays in the dial tone marker are operated. A check is made that these relays have operated before the test is allowed to proceed (see SFD-B405 and SCD-B4-1.1.1.2). Operation of these MT- relays removes battery from the windings of all FTC- relays and extends the windings to the master test control circuit. Battery from the FTC ballast lamp in the master test control is steered to any desired FTC- relay by having preset the proper FG0, 1, 2 key and the FS- key or switch. In this mode, the dial tone marker functions as on a service call in that the particular FTC- relay can only operate if there is an idle originating register on the trunk link frame.

B2-1.7.3 NTFS Key Operated

The NTFS key is intended for use when it is desired to select an originating register which is maintenance busy and there is no idle originating register which is not maintenance busy on the trunk link frame. It should be noted that with the NTFS key operated, no test is made of the FTC- leads to the trunk link frame. With the NTFS key operated, the KMTS9 relay of the master test control operates. This, in turn, causes the MT9, 19, and 29 relays of the dial tone marker to operate over the MT9 lead. A check is made that the MT9 relay has operated before the test is allowed to proceed (see SFD-B402 and SCD-B4-1.1.1.2). These test relays operated open all the FTC- leads toward the trunk link frames and extend them back to the master test control circuit. Wire spring dial tone markers operate a WSD* relay in master test control circuit.

* Trunk link frame selection with the NTFS key operated for U-type dial tone markers and for all completing markers function quite differently than for wire spring dial tone markers. For this reason, the WSD relay is operated in the master test control when it connects to a wire spring dial tone marker.

The WSD relay opens the MAK1 and provides a ground which is steered under control of preoperated FS- keys or switches and FG0/1/2 keys to directly operate the desired FTC- relay in the dial tone marker.

B2-2 TEST AND SELECTION OF AN IDLE REGISTER (SFD-B208, 209)

As soon as the trunk link frame and connector is seized, the marker proceeds to test and select an idle originating register. The various steps are as follows.

B2-2.1 TRUNK BLOCK AND TRUNK GROUP CONTROL

The marker must indicate to the TL which trunk block and trunk group are used for the originating register route. The TLs provide for a number of trunk blocks† [depending on the type of TL0 and 20 trunk groups (TGs)].

Only trunk block 0 (TB0) and trunk groups 0-5 (TG0-5) are used for originating registers. One TG- is used per register group (or route).

Originating registers are restricted to the "A" appearances on the TLs.

B2-2.2 CROSS-CONNECTION OF TG- TO FA- TERMINALS

Each register has an F lead (SFD-B209). This lead is connected to an FA- terminal. All those FA- terminals corresponding to registers of the same type have the same TG number and are connected to the corresponding TG- terminal.

B2-2.3 BT LEADS

In the register, each F lead is connected through an F relay winding (through contacts which are open while the circuit is busy) and then to a BT terminal. Registers of the same TB number are connected to the terminals on the same TB relay. Thus, a continuous path through the OR or trunk from the F lead to the BT lead indicates an idle OR or T.

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† Most trunk link frames have large trunk switches which provide a total of 160 trunk terminations of which no more than 120 can be used for outgoing trunks and originating registers. Each group of trunks or ORs is assigned one of six TB- numbers (trunk block) and are of 20 TG (trunk group numbers) for a maximum total of 120 routes.

Trunk link frames having minitrunk switches provide a maximum of 200 trunk terminations. Each group of trunks or ORs is assigned one of 10 TB- numbers and are of 20 TG- numbers for a maximum total of 200 routes.

B2-2.4 OPERATION OF THE MARKER TBK AND TSE1,2 RELAYS AND THE TRUNK BLOCK RELAY ON THE TL

Battery potential is extended to the TL over the TBO lead to operate the TBO trunk block relay when the trunk link connector relays operate (SFD-B209). Ground potential transmitted to the marker over the TBK lead from the TL operates the marker TBK relay indicating that the trunk block relay in the TL has operated.

When the TLC relay operates it supplies ground through the TS0-4 break-contacts to operate the TSE1, 2 relays (SFD-B208).

The trunk select end TSE1-2 relays when operated provide off-normal battery for the testing and selection of an idle originating register (SFD-B209).

B2-2.5 OPERATION OF THE TT0-4 RELAYS (FS4)

With the operation of the M- relays of the TLC and the trunk block relay on the TL, ground is extended from the marker TG- lead through the TL and back into the marker over the BT0-9 leads to operate one or more trunk test TT0-4 relays. Since the TT0-4 relays are double-wound, the operation of each one signifies that either one or two originating registers is idle. To identify which one of the two BT- leads is grounded, an odd and even preference lockout scheme is used, as described in SCD-B-2.2.7.

The frame cut-through F relay in the originating register circuit will not be operated in series with the windings of the TT0-4 relays as the resistance of TT0-4 relays is too high.

B2-2.6 OPERATION OF THE TS0-4 RELAYS AND RELEASE OF THE TSE1,2 RELAYS AND TT0-4 RELAYS

When the TSE1, TBK, and MAK1 relays operate, ground is extended through an operated JSQ0-5 relay to the TT0-4 relay preference chain to operate the preferred trunk select TS0-4 relay (SFD-B208). The TS0-4 relay which operates locks to the TLC relay operated, releases the TSE1,2 relays which in turn release all operated TT0-4 relays (SFD-B209).

The JSQ0-5 relay walking circuit rotates the preference to registers and safeguards service by changing entrance points to the chain circuit. The operation of the junctor sequence walking circuit is described in SCD-B4-1.1.

B2-2.7 OPERATION OF THE OTS AND OT RELAYS OR THE ETS RELAY

The release of the TSE1 and the operation of the TS- relay will select two of a possible ten BT- leads. These leads, which indicate idle register circuits when grounded, are extended to an odd (OTS) relay and an even (ETS) relay from which only one of the two BT leads is selected. If at this time only one of the two leads is grounded, the operated or unoperated condition of the sequence relay SQ1 has no significance. Therefore, if the odd BT lead is grounded, the OTS relay operates, and, if the even BT- lead is grounded, the ETS relay operates. If, however, the BT- leads are both grounded, then the operated or unoperated condition of the sequence relay SQ1 determines the selection of either the OTS relay or the ETS relay.

The ETS and OTS are double-wound relays in which the current through the primary winding (10 or 12 ohms) is forward-biasing (tends to operate) and the current through the secondary winding is reverse-biasing (tends to release). When both windings of one of the relays are energized, the current through the reverse-bias winding is of sufficient magnitude to hold the relay unoperated. If the SQ1 relay is nonoperated, the reverse-bias winding of the ETS is opened. Therefore, with ground on both the odd and even BT- leads, the ETS relay would operate and the OTS relay would be biased to nonoperate.

However, if the SQ1 relay were operated, the OTS reverse-bias winding is opened and the OTS relay would be preferred. Operation of either an OTS or ETS relay opens the operating circuit of the other relay.

B2-2.8 SEIZURE OF THE SELECTED REGISTER AND OPERATION OF THE F RELAY IN THE REGISTER

As shown in SFD-B209, the marker makes the OR busy test with the high-resistance TTO-4 relays. The resistance of the TTO-4 relays is large enough to prevent the operation of the originating register F relay when their windings are in series. Therefore, the TTO-4 relay would operate, while the F relay would remain unoperated.

The operation of the ETS or OTS relay provides a low-resistance circuit from battery potential to the winding of the F relay. Therefore, the operation of the ETS or OTS relay operates the F relay. The OTS or ETS relay locks operated in series with the F relay.

B2-2.9 ALL ORIGINATING REGISTERS BUSY

When the FCD-, FCM-, or FCR- relays are operated, the FTC0-29 relays are connected to their respective TL, and operate if there are any idle registers on the TL. The operation of any FTC- relay operates the FTCK and FTCK1 relays as an indication that there are idle originating registers.

B2-2.9.1 All Registers Busy Timing - (Mfr Disc. Option)

If all the originating registers are busy, the TBT relay (SFD-B204) will be operated. The operation of the TBT relay starts the TBT tube timer (SFD-B111). The TBT tube timer provides a delay of from 1.0 to 1.5 seconds before operating the associated TBTA relay. When the TBTA relay operates, the FM relay (SFD-B415) and route advance RAV1 relays (SFD-B206) operate to release the marker.

However, if any of the registers become idle before the TBT tube timer operates, the TBT relay is released and the timer is restored to normal.

B2-2.9.2 All Registers Busy Timing (Standard Option)

With the standard option, the addition of the MAK1 relay back contacts causes the TBTA relay to operate directly from the TBT on service calls so that timing consists only of the operate times of the TBT and TBTA relays. Both the TBT and the TBTA relays are relatively slow operate by comparison with operate times of FTC-, FTCK, and FTCK1 relays, so that if there is an OR available, the TBT will be released before the TBTA relay can operate. If the TBTA relay operates, it operates the FM relay causing the RAV1 relay to operate to release the marker.

B2-2.9.3 All Registers Busy Timing on Test Calls

There are several variations in all registers busy timing on test calls because of controls imposed on selection of trunk link frames and of ORs with certain keys operated as described in SCD-B2-1.7 and B2-2.10.

(a) On any test call, the MT1 and MT11 relays operate. The MT1 relay opens the operate path of the FTCK relay (SFD-B206) giving the MTC control of when or whether it operates. Thus, while FTCK and FTCK1 both operate at the same time on service calls, the operation of the FTCK may be delayed on some test calls. When the FTCK1 relay operates on a test call, the TBT relay remains operated via the MT11 relay contacts until the FTCK relay operates.

(b) On test calls with the NTFS keys operated, the MT9, MT19, and MT29 relays of the DTM operate from the operated KMT9 relay of the MTC (SFD-B202). The operated MT9 causes the marker to select a TL as directed by the MTC whether or not there are any ORs available on the TI (SCD-B2-1.7.3). On test calls with either the FS or NTFS key operated, the MT5 relay of the DTM operates (SFD-B209). This causes the DTM to select only that OR on a TL corresponding to the operated TT- key or setting of the TSU switch. Under any of these conditions the marker does not know that there is an idle OR available on the TL until it actually selects one. For this reason, the TBT relay is reoperated after the MAK1 and TBK relays have operated (SFD-B204), indicating that the trunk link connector relays and trunk link TB- relays have operated. The TBT relay remains operated until the TSE1 relay operates as an indication that an OR has been selected. Since the MAK1 relay is operated, the timer functions to operate the TBTA after an interval of 1.0 to 1.5 seconds with the Mfr Disc. option or after 120 to 185 ms with the standard option.

B2-2.10 CONTROL OF ORIGINATING REGISTER SELECTION BY THE MASTER TEST CONTROL CIRCUIT (SFD-B209, B210)

Three modes of controlling originating register selection by the master test control circuit are provided on DT (dial tone marker) and OR (originating register) test calls.

(a) Normal selection (TS and NTTS keys normal)

(b) Selection of a particular register when it is not maintenance busy (TS key operated)

(c) Selection of a particular register whether it is maintenance busy or not (NTTS key operated).

B2-2.10.1 TS and NTTS Keys Normal

With the TS and NTTS key normal, the MT5 and MT6 relays in the dial tone marker do not operate (SFD-B208). The marker selects originating registers in the normal manner as on service calls.

B2-2.10.2 TS Key Operated

With the TS key operated along with the TT0-9 key or the TSU switch, the MT5 and MT6 relays of the dial tone marker are operated and the TSE2 relay which normally operates in parallel with the TSE1 relay is prevented from operating by the operated MT1 relay of the DTM and the KTS relay of the master test control circuit (SFD-B209).

Windings of TT- relays of the DTM are now not supplied with battery from the TSE2 relay. Instead they are extended back to the MTC which supplies battery only to that TT0-9 lead corresponding to the TSU switch position or TT- key operated. The operated MT6 relay in conjunction with the TSU switch position or operated TT0-9 key closes an operate path to only the ETS relay if set to an even number or to the OTS if set to an odd number. The DTM therefore can detect as idle and select only that register corresponding to the TSU switch position or the operated TT0-9 key.

B2-2.10.3 NTTS Key Operated

With the NTTS key operated, control of originating register selection by the marker is the same as described for the TS key operated. However, in addition, the TST relay in the trunk link frame is operated (SFD-B209). Ground for make-busy jacks for all the originating registers on each trunk link frame is supplied through a back contact of the TST relay for each trunk link frame. When the TST relay operates, all originating registers which are made busy on that trunk link frame are restored to service. (The MB relay releases.) It is, therefore, possible to select a particular originating register which is maintenance busy.

The maintenance busy condition is removed only during the time that the marker engaged on the test call is connected to the trunk link frame. No other DTM, therefore, can select the maintenance busy originating registers for service calls.

B2-3 ROUTE ADVANCE AND RECYCLE

The term "route advance" applies more to the CM than to the DTM. It is a carryover to the DTM from the time when there was a single combined marker incorporating the features of both the DTM and the CM. In the CM when all trunks via one route are busy, the CM route advances to trunks via a different route to the same destination or to tone or other miscellaneous trunks.

When the DTM finds all ORs busy, the FM relay is operated by the TBTA relay (SFD-B415). The FM relay in turn operates the route advance RAV1* relay (SFD-B206). The RAV1 relay operates the DIS1,2 relays (SFD-B502) causing the DTM to release. Since the line in this case would still be off-hook, a new request for dial tone would be initiated.

Recycles as a result of all channels busy also result in operation of the RAV1 relay if no channel is found after the second recycle. This is described in SCD-B4-1.18 and B41-19.

* Some offices have all register busy announcement trunks. In these offices, the RAV1 relay causes a route advance to the announcement trunks whenever all ORs are busy. This SFD and SCD do not cover announcement trunks.

B2-4 CROSS-DETECTION INDICATIONS (SFD-B207)

Numerous cross-detection relays are shown throughout the SFD. Each of the cross-detection relays in operating either operates the MXT relay directly or operates an auxiliary relay which operates the MXT relay (SFD-B207). The MXT relay operates the SP (stop progress) relay (SFD-B502) which opens the operate paths of a number of relays causing a work time-out.

There is an MXT designation on both of the double-sided cards, but not on the single-sided card.

Although most of the cross-detection trouble indicating leads are shown on pages with cross detection relays, all of these leads are repeated on SFD-B207.

SECTION B, PART 3

CONNECTION TO LINE LINK FRAME

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B3 CONNECTION TO LINE LINK FRAME

In establishing a dial tone connection, a line link frame LL connects to a dial tone marker DTM via an associated line link marker connector LLMC as described in SCD-B1. The LLMC closes through most of those leads required exclusively for the dial tone connection. After the DTM has seized a TL, it bids for access to the same LL via the associated line link connector (LLC). The LLC primarily closes through leads which are required for completing marker CM functions as well as for DTM functions. Although the leads necessary for vertical file identification are not closed through until connection through the LLC is established, vertical file identification is described in SCD-B1 to present all line location identification together.

B3-1 LINE LINK FRAME SEIZURE (SFD-B004, B302, B303)

The operation of the TFK1 relay in the DTM, indicating successful TL seizure, closes battery to the LFS lead (SFD-B302) through the associated LLMC (SFD-B303) to the ST lead of the preference control, PC.

B3-1.1 PREFERENCE CONTROL CIRCUIT

The preference control associated with line link connectors provides two preference relays, MP- (marker preference) and E- (emergency marker preference), per marker for each line link connector. There is a means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by two chain circuits, which enable connection of one marker at a time to a line link frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to E- relays.

B3-1.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a LL), MP- relay operation is straightforward. Start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operated chain to ground at the winding of the first relay in the operate chain (shown on B303 as associated with the last DTM). In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first CM and first DTM (SFD-B303) initiate simultaneous requests (apply start battery) for connection to the same LL. Both MP- relays will operate and lock. If, however, the first DTM had initiated a request slightly before the first CM, the MP- relay for the first CM could not have operated because ground for its winding would have been opened by the operated chain at the MP- relay for the first DTM. On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain can subsequently operate its MP- relay.

B3-1.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain starting with ground at a contact of the MP- relay for the first CM. If the MP- relay for the first CM is operated, the work chain ground will operate the M- line link connector relay whether or not other MP- relays are operated. The M- relay operates other M- relays in the connector (SFD-B302) by closing through battery supplied by the marker.

When the marker which has seized the LL has finished its job and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated, now functions as just described. This continues until all operated MP- relays have been served.

B3-1.1.3 Emergency Transfer

Same as B2-1.5.1.3 except for references.

B3-1.1.4 Manual Transfer

Same as B2-1.5.1.4 except for references.

B3-2 CLASS-OF-SERVICE IDENTIFICATION

Originally, No. 5 Crossbar was arranged for a maximum of 30 classes of service, wherein the DTM received class of service from the LL by ground on 1/30 leads. Later two more leads, CGA and CGB were added to increase the number of classes to 60. In this case one out of the original 30 and one of the added two leads were grounded to provide two groups of 30. Still later, the present standard arrangement was substituted. This arrangement grounds one of the first 10 leads CS0-9 as class tens and one of the second 10 leads CS10-19 as class units, thus using 20 leads to provide 100 classes of service. The third group of 10 leads CS20-29 and the CGA and CGB leads are used to provide 20 rate treatment classes.

In a very few offices the original 30 class-of-service arrangement was modified to provide 20 classes of service and 20 rate treatment classes (using the first 20 leads CS0-19 on a 1/20 basis for class of service and using the CS20-29 and CGA, CGB leads to provide two groups of 10 rate treatment classes).

The 20, 30, and 60 class-of-service arrangements are basically the same and are shown on SFD-B304. The tens and units class of service and rate treatment arrangement for a maximum of 100 classes of service is shown on SFD-B305. For a description of the use that the DTM makes of class of service and rate treatment information, refer to SCD-B4-3.3, B4-3.4, and B4-3.5.

B3-2.1 LINE LINK FRAME CROSS-CONNECTIONS

At the right of SFD-B304 and SFD-B305 the cross-connections required for various classes of service and rate treatment arrangements are shown.

B3-2.1.1 30 Classes of Service - Identification by Vertical File

When the FTK1 relay of the DTM operates as a check of vertical file identification (SFD-B107), it closes the V- lead to ground a V- terminal in the LL (SFD-B304). This is cross-connected to a CS0-29 terminal causing one of the CS0-9 relays to operate and one of the CT0-2 relays to operate. If any of the leads CS0-9 are grounded, the CS- relay operates on its primary winding and the CT0 relay operates in parallel. A CS10-19 lead grounded would operate a CS- relay on its secondary winding and operate the CT1 relay and so on.

When a trouble record is taken, the CS0-29 leads cause similar designations to be perforated on the trouble card except for 2/X trouble cards. When 2/X trouble record cards are used, there is a conversion in the MTFC to class tens CTS0-2 on a 1/3 basis and class units CSU0-7 on a 2/5 basis.

B3-2.1.2 60 Classes of Service - Identification by Vertical File (SFD-B304)

The previous description applies also for 60 classes of service except a cross-connection from the VC- terminal of the LL to either the CA or the CB terminal instead of to ground causes either the CGA or the CGB relay in the DTM to operate in series with the VGB- relay.

The CGA or CGB relay operates the CGA1 or CGB1 relay (SFD-B429), which causes a CGA or CGB designation to be perforated if a trouble record card is taken.

B3-2.1.3 20 Classes of Service - Identification by Vertical File (SFD-B304)

The description for 30 classes of service (SCD-B3-2.1.2) applies except that only leads CS0-19 are used for the 20 classes. A cross-connection from VR0-4 to CS20-29 causes one of these leads to be grounded to operate one of the relays CSR0-9. Another cross-connection from VRG0-4 to CA or CB causes CSGA or CSGB to operate.

When a trouble record is taken, the CS0-29 leads are perforated as described in SCD-B3-2.1.2. The grounded rate treatment lead CS20-29 causes a similarly designated punch except on the 2/X trouble card. The MTFC converts CS10-19 in this case to RTE0-7 on a 2/5 basis. The operated CSGA or CSGB relay causes a CGA or CGB punch (SFD-B429).

B3-2.1.4 100 Classes of Service - Identification by Vertical File (SFD-B305)

The 100 class-of-service arrangement is the standard and is now used even though equipment is not necessarily provided for the maximum of 100 classes.

When the FTK1 relay of the DTM operates as a check of vertical file identification (SFD-B107), it closes the V- lead to ground several terminals in parallel but through diodes to prevent backup of ground from one terminal to another. Since class indication from the LL is on a tens and units basis, two cross-connections are required. VT0-4 is cross-connected to CS0-9 to cause one of the relays CST0-9 to operate for class-of-service tens. VU0-4 is cross-connected to CS10-19 to cause one of the relays CSU0-9 to operate for class of service units.

Where rate treatment is provided, VR0-4 is cross-connected to CS20-29 to cause one of the relays CSR0-9 to operate for rate units. VRG0-4 is cross-connected to CA or CB to operate CSGA or CSGB for rate group.

If a trouble record is taken, except for the 2/X card, 3 punches will appear in the CS0-29 designation CS0-9 for class tens CS10-19 for class units and CS20-29 for rate treatment units where provided. For the 2/X trouble card, the MTFC converts CS0-9 to CST0-7, CS10-19 to CSU0-7 and CS20-29 to RTE07 on a 2/5 basis. The CSGA or CSGB relay causes a CGA or CGB punch (SFD-B429).

B3-2.1.5 Identification of Class of Service by Hold Magnet (SFD-B304, B305)

Where identification of class of service is provided on an individual hold magnet basis rather than on a vertical file basis, the V0-4 or VU0-4 terminal is cross-connected to the VFA, VFB, or VFC terminal to operate a VFA, B, or C relay. The HMC terminal is cross-connected to a CS0-29 terminal for 30 or 60 classes, to CS0-19 for 20 classes or to CS10-19 for 100 classes.

If rate treatment is provided, it also may be identified on a hold magnet basis where class of service is so identified by cross connecting from HMR0-9 to CS20-29.

B3-3 CONTROL OF CLASS OF SERVICE BY MASTER TEST CONTROL ON DT AND OR CLASSES OF TEST (SFD-B304, B305)

Because offices may be equipped with any of several class of service and rate treatment arrangements, there are necessarily a number of optional arrangements provided in the MTC for controlling class of service and rate treatment. On a DT or OR class of test when the keys or switches for selecting class of service and rate treatment are in normal or off position, the DTM functions as on a service call to obtain the class of service (and rate treatment if provided) from cross-connections in the LL. When keys or switches are operated to select class of service or rate treatment,* this prevents the DTM from obtaining class of service (and rate treatment if provided) from cross-connections in the LL.

The ground from the marker which is normally steered through line link cross-connections is instead steered through class of service and rate treatment keys of the MTC. Use of these keys to control class of service is intended for use on OR class of test, so that any desired class of service may be set in the DTM for subsequent transfer to the OR.

B3-3.1 30 OR 60 CLASSES OF SERVICE (SFD-B304)

On test calls, the MT11 relay in the DTM is operated. This opens the normal path through which the DTM supplies ground over a V- lead to the LL to determine class of service from cross-connections in the LL.

When the CST- keys or CST switch are in the off position, the KCS0, 1, and 2 relays are normal and bridge the M11 break-contact in the DTM to permit normal determination of class of service from cross-connections in the LL.

When a CST- key or the CST switch is operated to 0, 1, or 2 on a DT or OR class of test, the KCS0, 1, or 2 relay, respectively, is operated. When the FTK1 relay operates, ground via the CSG2 lead is steered through an operated KCS- relay contact and through an operated CSU- key or the CSU switch in position 0-9 and again through contacts of an operated KCS- relay to one of the CS0-29 leads corresponding to the keys or key and switch operated.

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* In some of the older MTCs which have not been updated, class of service and rate treatment keys are not effective on DT class of test. See option D on SFD-B304, B305.

B3-3.1.1 60 Classes of Service (SFD-B304)

When there are 60 classes of service, in addition to the control described above, the MT1 relay which is operated on marker test calls connects the CGA and CGB relay windings in the DTM from the CGA and CGB leads to the CGA1 and CGB1 leads to the master test control. It should be noted that when 60 classes of service are provided, option D (SFD-B304) must be provided. This causes KCS4 to operate on both DT and OR class of test.

The CGB key normal connects the CGA relay to both the CGA and the CGB leads. The CGB key operated connects the CGB relay of the DTM to both the CGA and the CGB leads. Thus, the CGB key position determines whether the CGA or CGB relay of the DTM operates in series with the VGB-relay of the LL regardless of whether the particular VGB- relay VC-terminal is cross-connected to the CA or the CB terminal.

No provision is made for verifying on DT class of test that the cross-connections between VC- and CA or CB terminals are correct.

B3-3.2 20 CLASSES OF SERVICE WITH RATE TREATMENT (SFD-B304)

This is a feature provided in very few offices. Class of service functions as previously described for classes 0-19. The CST2 key or the 2 position of the CST switch is disabled. Instead keys CRU0-9 or the CRU switch are provided.

When the CST- keys or the CST switch and the CSGA and CSGB keys are normal, the KCS0, 1, and 2 relays remain normal. The CS-, CT-, CSR-, and CSGA/B relays of the DTM operate as on a service call from cross connection in the LL.

To control class of service and rate treatment settings in the marker, the CST- keys or CST switch, the CSU- keys or CSU switch, the CRU- keys or CRU switch, and the CSGA/B keys must be set as required. Classes of service 0-19 are controlled as described. The CRU- keys or the CRU switch in any off-normal position cause operation of the KCS2 relay which disconnects the CSG1 lead from the CSG2 lead and extends the CSG2 lead ground to operate one of the CSR- relays in the DTM. Similarly, the operated CSGA or CSGB key extends the CSG2 lead ground to operate the CSGA or CSGB relay of the DTM.

B3-3.3 100 CLASSES OF SERVICE (SFD-B305)

On test calls, the MT11 relay in the DTM is operated. This opens the normal path over which the DTM supplies ground over a V- lead to the LL to determine class of service from cross-connections in the LL. When the CST- keys or CST switch, the CSU- keys or CSU switch, and the CRU- keys or CRU switch are in the normal or off position, the KCSO, 1, and 2 relays are normal. This bridges the MT11 contacts in the DTM to permit normal determination of class of service and rate treatment from cross-connections in the LL.

To control the setting of class of service and rate treatment in the DTM, the CST keys or CST switch, CSU- keys or CSU switch and, if provided, the CRU- keys or CRU switch should be set as desired. This operates the KCSO, 1, and 2 relays to extend the CSG2 lead ground to one out of ten of the CS0-9, CS10-19, and CS20-29 leads to operate a CST-, CSU-, and CSR- relay, respectively, in the DTM. When rate treatment is provided, the CSGA or CSGB key should also be operated. This extends the CSG2 lead ground to operate either the CSGA or CSGB relay of the DTM.

B3-4 LINE LINK FRAME LOCKOUT

When a LL has seized a DTM via its LLMC, it is possible that a CM may seize the LL via its LLC before the DTM can seize the LLC. If the CM is setting up a connection from a calling line to a trunk, it must release the connection already established from that line to an OR before it can set up a new connection from that line to a trunk. When this occurs, the L relay for that line reoperates momentarily. The DTM must be prevented from attempting to identify this operated relay as a request for dial tone. If a CM has connected to a LL before there is a request for dial tone in the LL, the LL is prevented from requesting a DTM until the CM has released the LLC.

B3-4.1 SEIZURE OF DTM VIA LLMC BEFORE CM SEIZES LLC (SFD-B306)

If a LL has connected to a DTM via a LLMC but a CM connects to the same LL via a LLC before the DTM does, the DTM is not permitted to proceed with horizontal group selection until the CM has completed its use of the LLC.

Whenever any VGS- relay operates in a LL, it operates the DT relay (SFD-B306) as an indication that there is a request for dial tone. If a CM seizes the LLC for that LL to establish a connection from a calling line to a trunk, its CB2 relay will be operated. The CB2 relay operates the LOT relay (SFD-B306). When the CM proceeds to the point of operation of the TCHK relay, it grounds the G lead toward the LL via the LLC. If the DT relay is operated in the LL, the ground is extended over the DTK lead to operate the DTK relay in both the CM and the DTM. Operation of the DTK in the DTM opens the operate path of the HGG relay (SFD-B109) on first trial calls. This prevents horizontal group selection, if not already completed, by the DTM until the CM has released the LLC.

The release of the HGG relay opens the HGT- leads (SFD-B109) preventing horizontal group selection. If, however, horizontal group selection had been completed before the DTK relay operates, the HGG relay would have already been released by the operation of the HGK relay and the operation of the DTK relay would have no effect. On second trial calls, the operated TR2B cancels the effect of the DTK relay by closing through the path to the HGG relay around the break contacts of the DTK relay. Later in the call when the TK relay operates, it grounds a G lead to operate the DTK relay (SFD-B306) as a check that the DT relay of the LL has operated. This check is bypassed on second trial calls by the operated TR2A relay which allows the DTK relay to operate locally.

B3-4.2 SEIZURE OF LLC BY CM BEFORE THERE IS A REQUEST FOR DIAL TONE IN THE LL

If a completing marker, setting up a connection from a calling line to a trunk, seizes a LLC and has proceeded to operation of its TCHK relay before a request for dial tone has operated the DT relay in the LL, the LL is prevented from requesting a connection to a DTM until the CM has released the LLC.

When the CB2 relay of the CM operates, it operates the LOT relay (SFD-B306). When the TCHK relay operates, ground on the G lead through the normal DT relay in the LL operates the LO relay in the LL. The LO relay operated opens start battery to the MSA and MSB terminals (SFD-B102) preventing a request for a DTM. Operation of the LO relay also prevents operation of the TM and TM1 relay when a VGS- relay operates, so that the TM timer (SFD-B106) does not start until the LO relay releases.

B3-4.3 CROSS-DETECTION

Whenever the LOT relay of the CM is normal, the XLO relay is connected to the LOK, G, LO, and LOB leads (SFD-B306). If the XLO relay operates, it locks and causes a trouble record showing an XLO punch.

B3-4.4 SIMULATION OF DT RELAY OF LL BY MTC

On a DT or OR class of test, the DTK lead is connected to the G lead (SFD-B306) to simulate an operated DT relay in a LL.

SECTION B, PART 4

NETWORK CONNECTION AND TRANSMISSION OF INFORMATION TO ORIGINATING REGISTER

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B4 NETWORK CONNECTION AND TRANSMISSION OF INFORMATION TO ORIGINATING REGISTER

When the dial tone marker has identified the calling line location and has selected an originating register, it proceeds to establish a connection through the switching network from the line to the originating register. It also transmits line location and other information to the originating register.

B4-1 CHANNEL SELECTION (SFD-402-415)

A tip, ring, and sleeve path through the network is designated a channel. A channel consists of three parts:

(a) A line link is that part of the channel between a horizontal of a line switch and a horizontal of a line junctor switch on the line link frame.

(b) A trunk link is that part of a channel between a vertical of a trunk junctor switch and a vertical of a trunk switch on the trunk link frame.

(c) A junctor is that part of a channel between a vertical of a line junctor switch and a horizontal of a trunk junctor switch.

The distribution of line links on the line link frame and of trunk links on the trunk link frame is uniform for offices of all sizes. The distribution of junctors however varies with the size of the office.

B4-1.1 JUNCTOR SEQUENCE CONTROL (SFD-B404, B405)

The junctor sequence walking circuit advances at the end of each call and is used to shift the order of preference for the following functions:

Function	SFD
Vertical Group Selections	B108
Horizontal Group Selections	B109
Vertical File Selections	B109
Trunk Selection	B209
Junctor Group and Pattern Tens Selection	B403, B407

The junctor sequence walking circuit is shown on SFD-B405. A sequence chart showing the advance of the walking circuit on successive calls is shown on SFD-B404.

When the D, MF, or MLF relay operates at the beginning of each call, it operates the RYC relay which in turn operates the LLC1,2 relays (SFD-B205). If the sequence circuit is in an even position (JSQ0,2 or 4 and JL0 operated), the LLC2 relay operates the JS0 relay which locks. When the LLC2 relay releases at the end of the call or when the RYC relay releases because of a recycle or route advance, the next higher-numbered odd JSQ- relay operates, and, in turn, operates the JLE relay. The JLE relay releases the JSQ-, JL0, and JS0 relays. Similar operation occurs when stepping from an odd to an even JSQ- relay.

Six steps of control for preference circuits are provided by the JSQ0-5 relays. This number is doubled by the operation of the SQ0 and SQ1 relays. If the SQ1 relay is normal when the JSQ0 relay operates, the SQ0 relay operates. If the SQ1 relay is operated when the JSQ0 relay operates, the SQ0 relay releases. Similarly, the SQ1 relay is operated or released depending on the conditions of the SQ0 relay when the JSQ2 relay operates. The SQ0 relay is operated for one complete cycle of the walking circuit, then released for one complete cycle. The same applies to the SQ1 relay. However, since the SQ0 is operated and released by JSQ0, and SQ1 is operated and released by JSQ2, there are steps during which SQ0 and SQ1 may both be operated or both released.

The SQA relay monitors operations of the junctor sequence walking circuit. If the SQA relay operates as a result of trouble in the walking circuit, it operates the MXT relay which causes a trouble record to be produced showing an SQA trouble punch.

The following conditions cause operation of the SQA relay which is slow operate to prevent false operation due to momentary closures as relays change conditions. The SQA relay operates the MXT relay which operates the TR1 relay to cause a trouble record to be taken showing an MXT* and an SQA punch.

Trouble conditions detected between calls (LLC2-normal) occur when:

(a) Both JLE and JL0 are normal.

(b) Both JL0 and JS0 are operated.

(c) Both JLE and JSE are operated.

* There is no MXT designation on the single-sided card.

Trouble conditions detected during calls (LLC2 operated) occur when:

(a) JLO is operated and JSO is normal.

(b) JLE is operated and JSE is normal.

(c) SQ0 and SQ1 are both operated or both are normal when JSQ1 is operated.

(d) SQ0 is operated and SQ1 is normal or SQ0 is normal and SQ1 is operated when JSQ3 is operated.

When the fuse which supplies battery to the walking circuit is inserted, the SQA relay will operate because the JLE and JLO relays are both normal. When the SQA relay operates, it operates the JSQ0 relay which operates the JLO relay which should release the SQA relay if there is no trouble in the walking circuit. This will cause a trouble record to be taken which will show an MXT* punch but no SQA punch unless the SQA remains operated because of trouble.

B4-1.1.1 Control of Junctor Sequence by the Master Test Control on a DT Class of Test (SFD-B404, B405)

On a DT class of test with the JSQ- keys or switch in the off or normal position, there is no control of the junctor sequence walking circuits. It advances in the normal manner at the end of the test call or if a recycle or route advance occurs.

Refer to sequence chart for test call (SFD-B404 to SFD-B405). With JSQ- keys or switch operated, ground from the operated KCH relay of the MTC operates the MT8 relay of the DTM through the operated MT relay. The MT8 relay operates the MT8A relay. The operated MT8 relay opens the locking path to release any operated JSQ- relay and either the SQ0 or SQ1 relay. The release of the JSQ- relay releases the JLE or JLO relay. With both JLE and JLO relays normal, the ground that would normally operate the SQA relay as a trouble condition is transferred by the operated MT8 relay to operate the KJSQ relay of the MTC which locks and transfers the operate path of the MT8 relay of the DTM to ground on the KJSQ lead through the JLE and JLO relays normal. The operated KJSQ relay provides a ground through the JSQ- key of switch to operate the desired JSQ- relay in the DTM. The JSQ- relay operates the JLE or JLO relay. This releases the MT8 and MT8A relays and operates the MC relay of the MTC. The marker junctor walking circuit has been advanced to the desired position and will advance in the normal manner at the end of the call or if there is a route advance or recycle. If JSQ1 step is selected, the SQ0 relay operates. Otherwise SQ0 and SQ1 remain normal for the test call.

* There is no MXT designation on the single-sided card.

B4-1.1.2 Check that Necessary Test (MT-) Relays Have Operated in the DTM

On every test call the MTC verifies that the necessary test (MT-) relays have operated in the marker. Some MT- relays in the marker always operate on test calls. Others only operate when certain keys of the MTC have been operated. A satisfactory verification results in operation of the MC (marker connect) relay of the MTC. The MC relay operates various MC- and K- relays to close through leads either directly or via the MTFC to the DTM. If the check for operation of the MT- relays fails, the test call is blocked.

Table E shows test relays operated and those which are checked in DTM with various test keys operated.

TABLE E

Test Keys or Switches Operated	Relays Operated	Relays Operated	Relays Checked Operated
DT/OR key TSTA (DT/OR) Switch	TS-TKS KCH[1]	MT,MT1,2,11 13, 15	MT,MT1
FS		MT4,14,24	MT4,14,24
NTFS		MT9	MT9
JSQ- key or switch		MT8,MT8A	MT8A

NOTE 1: In some older test frames, KCH relay does not operate on OR class of test.

NOTE 2: Checked operated then released.

When the TS, NTTS, FS, and NTFS keys and the JSQ- keys or switch are normal, ground from the MT1 relay of the DTM passes through normal contacts of the FS and NTFS keys and through normal contacts of the MT8 and MT8A relays of the marker, then through normal contacts of the JSQ- keys or switch and the TS and NTTS keys normal to operate the MC relay. If either the TS or NTTS keys are operated, the KTS relay (see SFD-B208) must have operated. If the FS key is operated, then the MT4, 14, and 24 relays if provided in the marker must operate (SFD-B202). If the NTFS key is operated, the MT9 relay of the marker must operate. If the JSQ- key or switch is operated on a DT class of test [or on an OR class of test with the standard option to operate the KCH relay (SFD-B405)], the MT8 and MT8A relays of the DTM must operate then release as described in SCD-B4-1.1.1 to operate the MC relay.

B4-1.2 OFFICE SIZE - TRUNK LINK FRAMES (SFD-B405)

A cross-connection in each DTM from the SZD terminal (SFD-B405) to one of the terminals SZ2-10 indicates the size of the office in terms of number of single trunk link frames in a nonpaired office, number of pairs of trunk link frames in a paired office, or number of trunk link frame triples in a triple office.

During transition from one size office to another, some trunk link frames may have junctor configurations for one size office while others have other size office junctor configurations. In this case, the SZA, SZB, and SZC terminals are cross-connected to appropriate SZ2-10 terminals in each marker, and the G terminal of each trunk link frame is cross-connected to SZA, SZB, or SZC terminals as required. These cross-connections are changed in individual trunk link frames as the transition progresses. Upon completion of the transition, the SZD terminal of each DTM is cross-connected to the SZ2-10 terminal corresponding to the new office size.

B4-1.3 SINGLE, PAIRED, OR TRIPLE TRUNK LINK FRAME OPERATION (SFD-B408)

A cross-connection in each DTM from the SPF terminal to the SF, PR, or TTF terminal indicates to the DTM whether the office is arranged for single, paired or triple trunk link frame operation. During transitions, however, from single to paired or paired to triple trunk link frame operation, the marker cross-connections are removed and instead cross-connections are made in each TLC. A frame which has not been modified might be cross-connected as a single (STF) trunk link frame while another frame which has been modified might be cross connected as a paired (PR) trunk link frame.

B4-1.4 OFFICE SIZE - LINE LINK FRAMES (SFD-B408)

The marker determines office size in terms of number of line link frames from a combination of the office size in terms of trunk link frames (SCD-B4-1.2) and the indication of single, paired, or triple trunk link frame operation (SCD-B4-1.3) (see SFD-B408). The 20F relay operates for 20 or less line link frames, the 40F relay for 21-40 line link frames, and the 60F relay for 41-60 line link frames.

B4-1.5 PATTERN UNITS (SFD-B402)

In the following size offices all junctor subgroups have 10 junctors.

2TLF	Single, paired, or triple*
2-3TLF	Single, paired, or triple

* Paired or triple 2TLF-size offices require operation of pattern units relays.

5TLF	Single, paired, or triple
10TLF	Single, paired, or triple

All other sizes have some junctor subgroups with less than 10 junctors.

To determine which junctors are equipped, 1 of 10 pattern units (P0-9) relays is operated in the DTM. SFD-B402 shows how a particular pattern units relay is operated for TL0 in an office having single TL operation. It also shows particular pattern units relay operation for either TL of TL pair 0 in an office having paired TL operation. The choice of pattern units relay is determined by the line link frame number FUT0-9 relay and FTB0-3 relay operated and the line link office size relay 20F or 40F operated.

B4-1.6 NUMBER OF JUNCTOR SUBGROUPS (SFD-B407)

This applies only to 6TLF and 7TLF size offices. Both of these office sizes have some junctor groups with two and other junctor groups with three junctor subgroups. With either of the relays 6TLF or 7TLF operated, relays P0,2,3 and 4 operate the 3G (3 junctor subgroup) relay while relays P4-9 operate the 2G (2 junctor subgroup) relay.

B4-1.7 QUAD RELAYS (SFD-B408)

The seven quad (7Q) relay is used only in paired or triple trunk link frame offices of the 7 TLF size. The regular quad relay (RQ) is used only in paired or triple trunk link frame offices of 6TLF, 8TLF, or 9TLF sizes. The term "quad" no longer has a valid meaning since triple trunk link frame operation came into use. Essentially, these relays provide a convenient and more economical method of steering the JC-leads (SFD-B411) than by using contacts of -TLF relays for the particular size offices.

B4-1.8 PATTERN TENS* (SFD-B403)

The PNR relay is always operated by the following office sizes which have no subgroups of less than 10 junctors.

2TLF	Single, paired, or triple
2-3TLF	Single, paired, or triple
5TLF	Single, paired, or triple
10TLF	Single, paired, or triple

* Sometimes referred to as pattern groups.

The PNR relay is also operated for certain other office sizes when the marker is directed by the operated or released condition of the STP1, STP2, and JSQ- relays to junctor subgroups having 10 junctors. When the marker is directed to subgroups having less than 10 junctors, one of the pattern tens relays PA, PB, PC, or PE is operated.

B4-1.9 TEST CHANNEL RELAYS - TEST CHANNEL CHECK (SFD-B412, B415)

The marker determines what channels are equipped in a subgroup by operating the TCH0-9 relays (SFD-B412) from contacts of the operated PNR relay which operates all ten relays or from contacts of a combination of one pattern tens and one pattern units relay which operates only those TCH- relays corresponding to equipped junctors.

The operation of any TCH- relay operates the TCHK relay (SFD-B415) which locks to the GC or to the GCA relay.

B4-1.10 JUNCTOR SUBGROUP SELECTION (SFD-B406, B407)

To simplify the path for operation of the JG relays, SFD-B406 shows operate paths for offices with 2, 2-3, 5, or 10TLF-size while SFD-B407 shows operate paths for all other sizes 3, 4, 6, 7, 8, and 9. Note on SFD-B406 that only the JG0 relay can be operated for 10TLF-size since there is never more than one junctor subgroup. For the 5TLF size either JG0 or JG1 relay may be operated. For the 2-3TLF-size JG0 or JG3 relays may be operated while for the 2TLF size JG0-JG4 relays may be operated. Since no pattern units relay is required for these office sizes, the 1 out of 10 check of the P- relay is bypassed.

Office sizes 3, 4, 6, 7, 8, and 9TLF each have one or more junctor subgroups with less than 10 junctors and therefore must operate pattern units relays. Ground for operating the JG- relays is provided through a 1 out of 10 check of pattern units relays and, if the office has triple trunk link frames, a similar check through pattern auxiliary relays.

For any size office, the STP1 relay (SFD-B415) is always operated at the beginning of a call. As will be described in SCD-4-1.18, if no idle channel is available in the junctor subgroup selected through the STP1 relay, the STP1 relay will be released and STP2 relay operated to operate a different junctor subgroup, JG- relay. This applies to all sizes except 10TLF which only has one junctor subgroup.

As described in B4-1.1, the junctor walking circuit is stepped to a new position at the end of each call for office sizes have more than one junctor subgroup. Different subgroups are given preference according to which JSQ0-5 and JLE or JLO relays are operated.

B4-1.11 JUNCTOR SUBGROUP CONNECTOR RELAYS (SFD-B415, B408)

The GC [or GCA relay in some cases with triple trunk link frame operation (SFD-B415)] operates early in the call from the LLC1 relay. The operated GC or GCA relay steers battery through contacts of an operated JGO-4 relay to operate a junctor subgroup connect relay GO-4 in the trunk link connector (SFD-B408). A one out of five check through the JGO-4 relay ensures that only one relay is operated. To detect crossed G- leads to the TLC, normal JG- relays ground associated leads. If the lead associated with the operated JG- relay is crossed to any other lead, the direct ground causes sufficient current to flow through the XJG relay to operate it. The XJG relay is biased to not operate on the current required to operate the G- relay in the TLC. If the XJG relay operates, it in turn operates the XAJG relay which locks and causes a trouble record showing XJG punch to be taken.

B4-1.12 JUNCTOR CONNECT RELAYS - JUNCTOR CONNECT CHECK (SFD-B411,B417)

Junctor connect relays JC0-9 are associated with regular trunk junctor switches. Relays JC10-19 are associated with extension trunk junctor switches. Relays JC20-29 are associated with supplementary trunk junctor switches. JC0-9 leads are partially closed by the previously operated G0-4 relays in the TLC.

The path for operating the JC- relays is shown on SFD-B411. Battery is supplied through the winding of the XJC relay which is biased through its secondary winding to operate if any of the JC- leads are crossed, so that the XJC relay is connected to ground through more than one JC- relay winding. If the XJC relay operates, it operates the XAJC relay which causes a trouble record showing an XJC punch.

When the GO relay in the TLC is operated, JC0-9 leads from the marker are closed through directly to the JC0-9 leads, respectively, to the TL. However, relays G1-G4 close the JC0-9 leads from the marker to cross-connection terminals G10-19, G20-29, G30-39, and G40-49. The cross-connections required are different for each office size and vary between TLC associated with different TL in the same office. Note 1 on SFD-B409 shows the cross-connections which would be used in an office having six pairs of TL. Refer to BSP-819-220-150 (J27651) for complete cross-connection information.

To steer the activated JC- lead to the proper JC0-9, JC10-19, or JC20-29 relays, the marker operates an RF relay EF or SEF relay (regular, extension or supplementary extension frame) (SFD-B410). Battery to operate one of these relays is fed through the winding of the XF relay which is biased to operate if the RF, EF, or SEF leads are grounded or crossed so that XF relay supplies current to more than one relay. If the XF relay operates, it operates the XAF relay which causes a trouble record showing an XF punch.

JCO relay connects to the sleeve leads of the level 0 junctors on the left and the level 0 junctors on the right of each of the junctor switches 0-9. The JCO relay also connects to the 10 level 0 select magnets, one on each junctor switch 0-9. Similarly, each of the JC1-9 relays connects to sleeve leads and select-magnets associated with levels 1-9, respectively, on each of the junctor switches 0-9. To associate with only the junctors on the right or on the left half of switches, the marker operates R*(RA), ER*(RE), and SER*(RX) relays or L*(LA), EL*(LB) and SEL*(LX) relays (SFD-B410). The ER and EL relays (extension right or left) are only required for paired or triple TL operation. The SER and SEL (supplementary extension right or left) are only required for triple trunk link frame operation. The battery to operate these relays is fed through the winding of the XLR relay. The XLR relay is biased to operate when connected to more than one relay, either L or R when the STF relay is operated for single trunk link frame offices. It is biased to operate when connected to more than two relays R and ER or L and EL when the STF relay is normal, and the PR relay is operated for paired trunk link frame offices. It is biased to operate when connected to more than three relays (R, ER, and SER, or L, EL, and SEL) when the STF and PR relays are normal in triple trunk link frame offices. It should be noted (SFD-B408) that during transitions STF or PR may be operated or nonoperated depending on which TLC is used. A TLC which has not been changed over from single to paired operation would still operate the STF relay while a TLC which had been modified would operate the PR relay.

When a JC- relay operates, the JCK relay on the JSO lead operates to ground through one of the select magnets on the 0 junctor switch as a check that the JC- relay has operated.** The JCK winding resistance and the JCK series resistance limit the current so that although the sensitive JCK relay operates, the select magnet does not.

When R, ER, and SER or L, EL, and SEL operate, the RK or the LK (right check or left check) relay, through contacts of all three relays in series as a check to the marker that they have operated.

B4-1.13 CONNECTION TO LINKS OF HORIZONTAL GROUP ON LINE LINK FRAME (SFD-B107,B414)

Operation of the HGA-, HGB- relays of the line link frame are described in SCD-B1-6.2.8. Operation of these relays is checked by operation of the HGK relay of the DTM. The operated HGB- relay closes through LL0-9 leads to each of the ten links associated with that horizontal group (SFD-B414).

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* Trunk Link Frame (SD-27879-01)

** On trunk link frame SD-27879-01, the JCK relay operation checks the operation of SA- or SB- relay.

B4-1.14 CONNECTION TO LINKS OF TRUNK SWITCH ON TRUNK LINK FRAME (SFD-B209, B421)

Selection of an originating register and operation of its F relay and the associated FA-2 relay in the TL (SFD-B209) is described in B2-2.8. The FA-2 relay (SFD-B421) operates the LV2 relay (BT leads on trunk link frame SD-26032-01 were hard wired and originating registers were assigned to LEV2)†. The FA2 relay also closes the path to operate an LC-relay which is the same number as the trunk switch on which the originating register has an appearance. When an LV- and FA- relay have both operated, the marker gets a check indication by operation of its FAK relay. It also gets a check indication that an LC- relay has operated by operation of the LCK relay. The operated LC- relay connects to sleeve leads of the 20 links associated with the trunk switch on which the originating register appears (SFD-B414). The operated L or R relay closes through ten sleeve leads associated with the left or right half of the trunk switch.

B4-1.14.1 Trouble Shooting Crosses in Multiple to FA- Relays in Operate Path of LC- Relays (SFD-B421)

In normal operation, contacts of LV- relays in the operate path of LC-relay (SFD-B421) are strapped. This reduces marker holding time by allowing the LC- relay to operate earlier. However, in this condition the ALC lead is multipled to over 100 FA- or FB- relays. In the event of a cross on this multiple, removal of straps around the LV- relay contacts break the multiple into ten separate parts to make trouble shooting easier while still permitting the TL to handle traffic with a slight increase in marker holding time. The straps should be replaced after the trouble is cleared.

B4-1.15 CHANNEL TEST (SFD-B414)

Ten channel test relays CHT0-9 are connected through diodes to ten line link sleeves, ten junctor sleeves, and ten trunk link sleeves (SFD-B414). Diodes in each lead prevent a ground on one leg of a channel such as a line link feeding through to another leg of the channel such as the junctor or trunk link while at the same time permitting a ground on the sleeve of any of the three legs to operate the associated CHT-relay. The test paths for the 0 channel are shown in red on SFD-B414. The STX relay (SFD-B207) operates early in the call and provides direct battery to the CHT- relay windings. Between calls the STX relay is released. If any of the channel test leads are falsely grounded to either the line or trunk link connectors, the XCH relay will operate between calls. The XCH relay operates the XACH relay which locks and causes a trouble record showing an XCH punch.

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† On trunk link frame SD-27879-01 the BT leads (BT00-19) and the TB leads (TB0-9) may be associated with Bany location (switch, level and appearance) in the trunk link circuit.

B4-1.16 TEST CHECK (SFD-B415)

The preceding paragraphs have described a number of operations which proceed at the same time in preparation for selection of a channel. Upon successful completion of each operation, a check relay operates. These check relays are summarized below.

- TCHK - Checks that at least one TCH- relay has operated.
- JCK - Checks that a JC- relay in the TL has operated.
- RK/LK - Checks that an R or L relay in the TL has operated.
- FAK - Checks that an FA- relay and an LV- relay in the TL has operated.
- LCK - Checks that an LC- relay in the TL has operated.

When all of the previously listed relays have operated, ground over the MDK lead (SFD-B415) from the TLC operates the TK (test check) relay. The TK relay closes a G lead (SFD-B306) to the LLMC which is extended through an operated DT relay contact in the LL and back over the DTK lead to operate the DTK relay in the DTM. On second trial calls, the operated TR2A relay bypasses the G and DTK leads to operate the DTK relay direclty.

B4-1.17 SELECTION OF A CHANNEL (SFD-B415)

The LLC1 relay and the SLRK relay will have operated early in the call. When the TK and DTK relays operate, ground is closed to operate a CH0-9 relay (SFD-B413). There is a double chain path composed of CHT0-9 relays and TCH0-9 relays which determines which CH0-9 relay, if any, is to be operated. Some or all of the TCH- relays (SFD-B412) will be operated as an indication of which channels are provided in the subgroup being tested. Any channel which is busy (SFD-B414) will have an operated CHT- relay. If the TCH0 relay is operated and the CHT0 relay is normal, the CH0 relay operates and locks. If, however, either TCH0 relay is normal or CHT0 relay is operated, ground is passed to operate the next relay in the chain which has an operated TCH- relay and a normal CHT- relay. When one CH- relay has operated and all others are normal, the CHA relay operates as an indication that a channel has been selected.

B4-1.18 NO IDLE CHANNEL, RECYCLE, FAILURE TO MATCH, ROUTE ADVANCE (SFD-B415)

If there is no idle channel, that is, no CH- relay having both an operated TCH- relay and a normal CHT- relay (SFD-B415), the FMP relay operates in a 10TLF-size office. In all other size offices, the STP relay operates. Refer to the flowchart (SFD-B009) and the sequence chart (SFD-B007, B008) which show the general and detailed sequence of operations under various conditions.

Operation of the STP relay causes release of the STP1 relay and various other relays in the DTM and TL which had operated in preparation for selection of a channel in Step 1. The STP2 relay then operates and an attempt is made to select a channel in Step 2.

If no channel is available in Step 2, the DTM recycles. It releases the TL and OR which had been selected and selects a new TL and OR after which it again attempts to find a channel in Step 1. If unsuccessful, it advances to Step 2 as before. If again unsuccessful, the RAV1 relay of the DTM is operated (SFD-B206). This operates the DIS1, 2 relays causing the marker to release (SFD-B502).

In a 10TLF-size office, the operation of the FMP relay causes immediate recycle without making an STP2 junctor retest since there is never more than one junctor subgroup in any junctor group in a 10TLF-size office.

B4-1.19 CONTROL OF CHANNEL SELECTION BY MASTER TEST CONTROL (SFD-B107, B202)

To select one particular path through an office, a number of controls are required.

(a) Particular horizontal group on a particular LL. Controlled by line location keys or switches (SFD-B107, SCD-B1-8.2).

(b) Particular trunk switch on a particular TL. Controlled by trunk link frame selection keys or switches (SFD-B202, SCD-B2-1.7) and trunk selection keys or switches (SFD-B209, SCD-B2-2.10) and D, MF, or R- keys on the RG switch (SFD-B105, SCD-B1-5.7).

(c) Particular junctor walking circuit position. Controlled by junctor sequence keys or switches (SFD-B405, SCD-B4-1.1.1).

(d) Particular junctor step. Controlled by STP1/STP2 keys (SFD-B413, B415, SCD-B4-1.1.19.1.2).

(e) Particular channel. Controlled by channel selection keys or switch (SFD-B412, B413, SCD-B4-1.1.19.3)

B4-1.19.1 Junctor Step 1 Selection (CH- Key or Switch Normal) (SFD-B412, B413, B415)

To force the DTM to select a channel only in step one, the STP1 key is operated. (Refer to sequence chart for Step 1 on SFD-B413.) The STP1 key operated causes the MT7 relay of the DTM to operate (SFD-B412). When the STP1 relay of the DTM operates, the STP relay of the MTC is operated (SFD-B415). This releases the MT7 relay of the DTM and channel selection proceeds normally, if there is an idle channel. If there is no idle channel (in other than a 10TLF-size office), there is a junctor retest (see sequence chart SFD-B007 and flowchart SFD-B009). The retest results in release of the STP1 relay of the DTM and subsequent operation of the STP2 relay. The release of the STP1 relay of the DTM releases the STP relay of the MTC (SFD-B415) which causes reoperation of the MT7 relay of the DTM. This prevents selection of any channel in Step 2 causing the marker to recycle and reselect a trunk link frame and originating register. In a 10TLF-size office failure to select a channel in step 1 causes the DTM to pass Step 2 and go directly to recycle.

The same operations are repeated after the recycle to permit selection of a channel only in Step 1. If no channel is available in Step 1, the DTM is prevented from selecting a channel in Step 2. It then route advances to disconnect.

Whenever a DTM recycles, the operation of the RCY* relay of the DTM (SFD-B206) also operates the RCY relay of the MTC which locks and lights the RCY lamp. A route advance by the DTM causes the RA1 lamp to light at the MTC.

B4-1.19.2 Junctor Step 2 Selection (CH- Key or Switch Normal) (SFD-B412, B413, B415)

To force the DTM to select a channel only in Step 2, the STP2 key is operated. Refer to sequence chart for Step 2 (SFD-B413). The STP2 key operated causes the MT7 relay of the DTM to operate. This prevents any TCH- relay from operating and therefore no channel can be selected. In other than a 10TLF-size office, this results in a channel retest (see sequence chart on SFD-B007 and flowchart on SFD-B009). The retest results in release of the STP1 relay of the DTM and subsequent operation of the STP2 relay which also operates the STP relay of the MTC (SFD-B415). This releases the MT7 relay of the DTM. The MT7 relay normal now permits TCH- relays of the DTM to operate in normal manner, so that a channel can be selected in Step 2 if an idle channel is available. If no channel is available in Step 2, the marker recycles to reselect a trunk link frame and originating register.

Whenever a DTM recycles, the operation of the RCY relay of the DTM (SFD-B206) also operates the RCY relay of the MTC which locks and lights the RCY lamp.* A route advance by the DTM causes the RA1 lamp to light at the MTC.

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* Many of the older test frames are not equipped with the RCY relay and lamp.

B4-1.19.3 Particular Channel Selection (STP1/STP2 Keys Normal) (SFD-B412)

With the CH- keys or switch and the STP1/STP2 keys normal, there is no control of channel selection from the master test control circuit and a channel is selected at random as on a service call. With the CH- keys or switch operated, the MT7 relay in the marker operates. This opens the grounds normally used by the marker to operate TCH0-9 relays. The operated CH- key or switch provides ground on one end of the TCH0-9 leads to permit only the corresponding TCH0-9 relay to operate only if it normally would have been operated by the combination of pattern relays operated. This then restricts the marker so that it can only operate a channel relay corresponding to the operated CH- key or switch. The CH- relay can only be operated if the channel is idle (as indicated by the corresponding CHT- relay normal).

If the particular channel is not available in Step 1, the DTM makes a retest to try to find a channel in Step 2 (except in a 10TLF-size office) (refer to sequence chart SFD-B007 and flowchart SFD-B009). Again the DTM is restricted to select only the channel corresponding to the operated CH- key or switch. If no channel is available in Step 2, the DTM recycles to reselect a trunk link frame and originating register. The DTM again attempts to select the particular channel number in Step 1 then in Step 2. If the DTM cannot find that channel number idle, it route advances to disconnect. Whenever a DTM recycles, the operation of the RCY relay of the DTM (SFD-B206) also operates the RCY relay of the MTC which locks and lights the RCY lamp. A route advance by the DTM causes the RA1 lamp to light at the MTC.

B4-1.19.4 Combined Particular Junctor Step and Particular Channel Selection (SFD-B412, B413, B415)

When STP1 or STP2 key and a CH- key or switch are operated together, the DTM is restricted to selection of a particular channel within a particular junctor step. The MT7 relay of the DTM remains operated in both Step 1 and Step 2. The STP relay of the MTC is operated during Step 1 with the STP 1 key operated and during Step 2 with the STP 2 key operated. This feeds ground through the operated CH- keys or switch to permit selection of only that channel corresponding to the operated CH- key or switch.

Recycle and route advance may occur as previously described resulting in the lighting of RCY and/or RA1 lamps at the MTC.

B4-2 SELECT MAGNET OPERATION

B4-2.1 LINE LINK FRAME SELECT MAGNET OPERATION (SFD-B416)

Upon operation of a CH- relay, battery through the LS and LSA ballast lamps is closed to the select magnets on the line link frame. This battery is steered by the operated HGA- relay to the prior link select magnets and junctor hold magnets. It should be remembered that the line junctor switches also serve as line switches. One half of the verticals are for junctors; the other half for lines. If the CH0 and HGA0 relays are operated for a line on one of the number 0 line switches to a junctor on the 0 junctor switch, an L0 and an LJ0 select magnet are operated. The LJ0 select magnet would serve a customer on the line side of the line junctor switch. If the CH1 relay and HGA0 relays are operated for a line on one of the number 1 line switches to a junctor on the 0 junctor switch, the LJ1 select magnet for the 0 junctor switch would operate, but the LJ0 select magnet on the number 1 junctor switch would also be operated to serve a line on the line side of the number 1 junctor switch.

When paired line link frame operation is provided, the select magnet leads extend to the auxiliary line link frame, even though the auxiliary line link frame is not used for dial tone calls.

The XLS relay is connected to SM- leads through normal contacts of all but the operated CH- relay. If the SM- lead through the operated CH- relay is crossed to any of the other SM leads, the XLS relay will operate to the applied battery and lock. The XLS relay operates the MXT relay which causes a trouble record to be taken showing an XLS punch.

B4-2.2 TRUNK LINK FRAME JUNCTOR SELECT MAGNET OPERATION (SFD-B417)

Upon operation of a CH- relay, battery is closed to junctor select magnets on the TL. The operated CH- relay closes an SM- lead to a junctor switch of the same number as the CH- relay. An operated JC- relay on the TL closes the SM- lead to a select magnet of the same number as the last digit of the JC- relay. JC0-9 relays are associated with the regular TL. JC10-19 relays are associated with the extension TL, and JC relays 20-29 are associated with the supplementary extension TL.

It should be noted that the JCK relay, which operated as a check that a JC- relay has operated, is released if the CH0 relay operates to apply battery to the SM0 lead. For this reason, the JCK punch will not appear on trouble cards where channel 0 is shown.

Battery to the JS- leads is fed through the XJS relay which is biased to operate if it is connected to ground through more than one select magnet. If the XJS relay operates, it operates the XAJS relay. The XAJS relay operates the MXT relay which causes a trouble record to be taken showing an XJS punch.

B4-2.3 TRUNK LINK FRAME TRUNK SELECT MAGNET OPERATION (SD-26032-01) (SFD-B417)

Upon operation of the FAK relay, battery is closed to the ASM lead to operate two trunk select magnets on the TL. Since all originating registers are on the A appearance of level 2, the LV2 relay and one of the relays FA(0-9)2 will be operated. These relays steer the ASM lead to operate the TO select magnet on the switch corresponding to the first digit of the operated FA(0-9)2 relay and to operate the T2-9 select magnet corresponding to the second digit (which is always two for originating registers) of the operated FA(0-9)2 relay.

Prior to selection of an originating register, the TSE1 relay is operated. This connects the XTS1 lead to the TSX lead. If there is false ground on the lead, the XTS1 relay operates and locks. It operates the MXT relay which causes a trouble record showing an XTS1 punch.

After trunk selection, when the TSE1 relay has released and the FAK relay has operated, the XTS relay is connected to the XTS lead. The XTS relay is biased to operate if it is connected to battery through more than one T2-9 select magnet. If there is a cross which closes the ASM lead to more than one of the select magnets T2-9, the XTS relay operates and in turn operates the XATS relay which operates the MXT relay to cause a trouble record showing an XTS punch.

B4-3 FORWARDING INFORMATION TO ORIGINATING REGISTER

The DTM transmits information to the originating register which will subsequently be transmitted to the completing marker to enable it to establish a call from the calling line to whatever termination is directed by the digits which the customer dials. In preparation for transmitting this information, the following relays are operated (SFD-B428):

- GTL1 - Operated early in the call by the CKG1 relay.
- GTL2 - Operated by the GTL1.
- GTL3 - Operated after channel selection when the CHA relay operates. The GTL3 relay operation is a check that the F relay and its auxiliary F1A and F1B relays in the OR have operated. The GTL3 relay grounds most of the transmitted leads to the OR (SFD-B426, B427, B429).
- GTU - Operated by the GTL3. The GTU relay extends the FT- and FV- leads which are already grounded to the OR (SFD-B426).

B4-3.1 LINE LOCATION (SFD-B426)

Operation of the GTL3 relay grounds contacts of VGT-, HGT-, and VFT- relays to operate VG-, HG-, and VF- relays in the OR on a 2/6, 2/5, and 1/5 basis, respectively, corresponding to the relays VGT-, HGT-, and VFT- which are operated on a 1/X basis. The same grounds also operate the VGC1, VGC2, HGC1, HGC2, and VFC relays which subsequently will serve as check relays that locking ground is returned from operated relays in the OR.

Operation of the GTU relay closes the FT- and FU- leads to the OR, to operate the FT- relays in the OR on a 1/4 or 2/4 basis, and the FU- relays in the OR on a 2/5 basis.

The XVHF relay winding is connected through resistors through normal contacts of VGT-, HGT-, and VFT- relays to all VG-, HG-, and VF- leads which are not grounded by the DTM. If there is a false ground on any of these leads, the XVHF relay operates.

Operation of the XVHF (or the XCS relay to be discussed subsequently) operates the XCF relay (SFD-B428) which locks and operates the MXT relay causing a trouble record showing XCS punch.

B4-3.2 LINE LINK NUMBER AND CLASS-OF-SERVICE UNITS

The completing marker must drop the network connection from calling line to the originating register before it can establish a completing connection from the calling line. Since the original connection is still busy at the time channel test is made, the marker must know the channel number of the link used on the line link frame to be able to use it in case it is the only link available. For this reason the channel number used in setting up the dial tone connection is transmitted to the OR as LL-.

Operation of the GTL3 relay grounds contacts of the CH- relays and of CS- relays to operate LL- relays and CU- relays on a 2/5 basis in the OR and at the same time to operate check relays CLL1, CLL2, CUK1, and CUK2 in the DTM. The XCS relay functions to detect crosses as described for the XVHF relay (SCD-B4-3.1).

B4-3.3 CLASS OF SERVICE TENS, CLASS GROUP A OR B

Class of service tens originally provided for thirty classes of service and was transmitted to the register on a 1/3 basis (SFD-B427). Later, provision was made for 60 classes, CGA, and CGB information was transmitted to the OR to indicate the A or B group of 30 classes of service (SFD-B429). Still later when provision was made for 100 classes of service, class of service tens was transmitted to the OR on a 2/5 basis (SFD-B429).

For class of service tens operation on a 1/2 basis (SFD-B427), the CTL3 relay extends the already grounded CT- lead to the OR.

For class of service tens operation on a 2/5 basis (SFD-B429), operation of the GTL3 relay provides ground to contacts of the CST- relays to operate CT- relays in the CR and the check relays CSTK1 and CSTK2.

When 60 classes of service are provided, operation of the GTL3 relay provides ground to contacts of the CGA and CGB relays to operate the CGA or CGB relay in the OR and the check relays CGA1 or CGB1 in the DTM. The XCS relay also detects crosses on the class tens 2/5 leads as described for the class units and line link channel number leads in SCD-B4-3.1.

B4-3.4 RATE TREATMENT

If rate treatment is provided (SFD-B429, B option), operation of the GTL3 relay provides grounds to contacts of the CSR- relays and to contacts of the CSGA and CSGB relays to operate CRU- relays on a 2/5 basis and either the CGA or CGB relay in the OR. At the same time, the CSRK1, CSRK2, and CSGK check relays are operated. The XCS relay detects crosses on leads in the same manner described in B4-3.1 for the XVHF relay.

B4-3.5 2-PARTY, MANUAL, COIN

Operation of the GTL3 relay supplies ground which is steered through contacts of CT- and CS- relays or contacts of CST- and CSU-, CS- or CSA- relays to terminals which are cross-connected according to class assignment to the 2P, MAN, or CN terminals to operate 2P, MAN, or CN* relays in both the OR and the DTM.

When the CS- terminal is cross-connected to AO (all other) no information is transmitted to the OR in this category.

B4-3.6 REGISTRATION AND MEMORY CHECK (SFD-B428)

The RK1 and RK2 relays are connected in series at opposite ends of a check path (SFD-B428). If all the relays associated with information to be transmitted to the OR (as described in SCD-B4-3.1 through B4-3.5) have properly operated, the RK1 and RK2 relays will operate.

* Cross-connections to 2P, MAN, CN, or AO as shown are typical. Other less frequently used cross-connections have not been illustrated.

Note that either a 1/4 or 2/4 check of the FT- relays is made depending on the type of registration provided. A 2/5 check is made of the FU- relays while a 1/X check is made of other relays such as CS- or CSU- relays. An up check is also made of various check relays such as VGC1, HGC1,2, etc.

Operation of the RK1 and RK2 relays operates the RK3 relay from ground on a contact of the ON relay in the OR. The RK3 relay locks and releases the GTL1 relay which releases the GTL2 relay.

Release of the GTL1 and GTL2 relays removes all of the ground which had been applied or extended by the DTM to the register by operation of GTL3 and GTU relays (SCD-B4-3.1-B4-3.5). Memory relays in the OR should, by this time, have operated and locked to off-normal ground provided by the ON relay of the OR. Each lead which had been grounded by the DTM to the OR should now have locking ground feeding back from the OR to the DTM so that check relays associated with these leads in the DTM remain operated. If the OR fails to return locking ground, indicating that the associated memory relay did not lock up, the associated check relay in the DTM will release causing the RK1 and RK2 relays to release.

B4-4 HOLD MAGNET OPERATION - NETWORK AND LINE TESTS

The sequence of hold magnet operation differs, depending on whether the marker determines that traffic is heavy or light (see sequence chart SFD-B003 and B005). Under heavy traffic conditions all hold magnets are operated at the same time with a minimum of checks and tests to reduce marker holding time. Under light traffic conditions, operation of the line hold magnet is delayed to permit a test of the talking path for crosses. After the line hold magnet has operated, a continuity test of the talking path crosspoints is made.

Headings of the following paragraphs are designated HTR, LTR, or HTR/LTR as an indication that the paragraph applies only to heavy traffic, only to light traffic, or to either heavy or light traffic operation.

B4-4.1 DETERMINATION OF LIGHT OR HEAVY TRAFFIC BY DTM - HTR/LTR (SFD-B410, B411)

Hold magnet operation as well as other marker functions differs according to whether traffic is light or heavy. The DTM determines whether the traffic is light or heavy by measuring the time between seizures of the DTM using the HTT timer (SFD-B111).

At the beginning of a call, the MCB- relays of the DTM are operated over the MB lead from the LLMC (SFD-B110). The MCB0 relay operated extends ground on the TM lead to operate the OAT relay. If the HTR relay is already operated from the last call, it remains locked to ground through normal contacts of the HTT relay (SFD-B111). At the end of the call, the OAT relay releases. If the HTR relay is not already operated, it operates and locks releasing the OAT1 relay. With the OAT and OAT1 relays normal and the HTR relay operated, the shunt around the HTT capacitor (SFD-B111) is opened allowing the HTT capacitor to charge until the HTT tube fires and operates the HTT relay or until the DTM is seized again and the OAT relay operates to stop the timing. If the time between calls is greater than 0.96 to 1.6 seconds, the HTT relay operates releasing the HTR relay so that the next call is handled on a light traffic basis. If the interval is shorter than 0.96 to 1.6 seconds, the HTR relay remains operated and the call is handled on a heavy traffic basis.

B4-4.2 HOLD MAGNET TIMING - HTR/LTR

As described in preceding paragraphs, select magnets are operated on line link and trunk link frames upon operation of a CH- relay. (Refer to sequence chart SFD-B005.) Operation of a CH- relay also operates the CHA relay which starts a hold magnet timing interval. This time interval is necessary to allow select magnets to operate, for select fingers to seat, and for any previously operated hold magnets connected to this channel to release before operating hold magnets for this call.

Prior to operation of the CHA relay, current flows through the primary winding of the HMT relay in a direction to operate it while current through the secondary flows in a direction to release it. The combination of external resistance, winding resistance, and difference in number of turns is such that the current in the secondary prevents the HMT relay from operating. When the CHA relay operates, current in the secondary decreases as the HMT capacitor charges. When the effect of the current in the secondary becomes less than that of the current in the primary, the HMT relay operates. This operate time can be set at 26-30 ms by cross-connecting terminal HMS to HMT or to 40.5-50 ms by cross-connecting terminal HMF to HMT. The longer time interval is required in offices which have some switches which are not equipped with damping cones. Select fingers on these switches take longer to settle down.

Operation of the HMT relay operates the HMT1 relay.

B4-4.3 CHECK OF CHANNEL - HTR/LTR

Early in the call, the SLRK relay operates (SFD-B421) from ground on the LLC1 relay through normal contacts of the following relays to ensure that they are initially normal. SLA, LGCK, TGCK, JGCK, HMT1, LXPA, JXPA, LLTA, and if dual voltage operation is provided, DTK. If dual voltage operation is provided, the SLRK relay subsequently locks when the TK relay operates. If the SLRK relay fails to operate, operation of a CH- relay (SFD-B415) is prevented.

In the process of channel test (SCD-B4-1.15, SFD-B412) busy channels are detected by looking for ground on sleeve leads. If ground is not detected on any of the three parts of a channel, it is presumed to be idle and one of the "idle" channels is selected by operation of a CH- relay (SFD-B415).

A further check of the channel is made after a CH- relay has operated. LGCK, JGCK, and TGCK relays (SFD-B423) are connected to line, junctor, and trunk hold magnet leads, respectively. These are high resistance sensitive relays which operate to battery on hold magnet windings without operating the hold magnets. This provides a positive check that the hold magnets associated with the three parts of the channel are idle (ungrounded). A further check of the sleeve of the line link selected is made by the LLT relay. If the line link is idle (ungrounded), the LLT relay will not operate.

B4-4.4 CROSS CHECK OF TRUNK SLEEVE - HTR/LTR

Prior to operation of the HMS1 relay, the XSL relay is connected to the AST lead (SFD-B423) to detect any cross to ground. If the XSL relay operates, it locks and operates the MXT relay which causes a trouble record showing an XSL punch.

B4-4.5 HOLD MAGNET START (SFD-B421) - HTR/LTR

If the following conditions are satisfied, upon operation of the HMT1 relay, the HMS1 relay is operated (SFD-B421).

(a) The RK3 relay (SFD-B428) has operated, indicating a satisfactory check of transmitting relays.

(b) The LGCK, JGCK, and TGCK relays (SFD-B423) have operated indicating that the hold magnets associated with the channel are idle.

(c) The LLTA relay, which operates from the LLT relay (SFD-B414), is normal, indicating an idle condition (no ground) on the selected line link sleeve.

(d) A number of relays to be operated later for various checks are now normal.

Operation of the HMS1 relay starts the operation of the hold magnets for the channel selected.

B4-4.6 HOLD MAGNET OPERATION HTR/LTR

Over the years a number of changes in method of hold magnet operation have been made. Only the standard dual voltage operation (as shown on SFD-B423) is described here. SFD-B424 shows a simplified drawing of the various options provided in the DTM for hold magnet operation but only those shown on SFD-B423 will be discussed in the SCD.

B4-4.7 DUAL VOLTAGE OPERATION - HTR/LTR

With the standard dual voltage option, all hold magnets except the line hold magnet are operated by a high voltage surge on all calls. The line hold magnet is operated by the high voltage surge except on calls to message rate lines in offices having message registers. This is to avoid the possibility of falsely operating the message register. Determinations of whether or not the line has a message register is made by cross-connections from class of service to relays such as 2P, 2PMR, MAN, CN, MCN, AO, or AOMR (SFD-B429). Of the relays illustrated, all but 2PMR (two party message rate) and AOMR (all other message rate) operate the DVO relay (SFD-B420), and the DVO relay operates the DVA relay. With the DVO and DVA relays operated, a high voltage surge is sent to operate the line hold magnet as described in SCD-B4-4.8.

B4-4.8 OPERATION OF LINE HOLD MAGNETS - HTR (SFD-B423)

Assume a heavy traffic call with a nonmessage rate line. Upon operation of the HMS1 relay, with the HTR, DVO, and DVA relays operated, ground is furnished through the primary winding of the LXP relay in series with the LH capacitor. The LH capacitor (which has previously been charged to +130 volts and acts momentarily like a 130-volt battery) is applied to the winding of the line hold magnet which is connected to -48 volt battery. The effect is as though a battery of 178 volts were connected to the relay winding. The voltage of the LH capacitor rapidly decreases the 0 and then to a fraction of a volt negative at which point the LH diode begins to conduct, so that the hold magnet is held operated to ground potential. Application of high voltage in this manner causes the hold magnet to operate in about 1/3 the time it would take it if 48, rather than 178-volt operation were used.

If the DVO and DVA relays are normal, 48-volt operation is used. That is, the ground through the winding of the LXP relay is applied directly to the hold magnet without the LH capacitor in series.

With or without surge voltage operation, the LXP relay operates in series with the line hold magnet. The LXP relay operates the LXPA relay which locks (SFD-B420).

B4-4.9 CROSSED LINE HOLD MAGNET TEST - LTR

The crossed line hold magnet test is made on light traffic calls only. It is unlike any other cross test in the DTM. It is made using a combination of the LHT relay and the XLH relay. The LHT relay (SFD-B420) operates early in the call and locks around the normal contacts of the FTK1 and XLH relays. It would appear that there would be an XLH punch, if a trouble record were taken any time that the LHT relay is operated. However, operation of the TRST relay releases the LHT relay at the start of a trouble record unless the XLH relay is operated.

With the LHT and CKG relay operated, ground and -48 volts through resistors are fed to one side of the XLH relay secondary winding and ground to the other. This biases the XLH relay in its nonoperated position.

On light traffic calls (HTR relay normal), operation of the HMS1 relay connects the primary winding of the XLH relay to the line hold magnet (LH) lead (SFD-B423). The XLH capacitor is in series with the primary winding so that only a surge of current can flow. The secondary of the XLH relay (SFD-B420) is biased in such a manner that the surge of current through one line hold magnet is not sufficient to operate it. But, if the hold magnet is crossed to a second line hold magnet, the XLH relay will operate. Operation of the XLH relay removes ground from the negative side of the XLH relay secondary winding (the FTK1 relay would be operated at this time) and allows -48 volt battery through the XLH3 resistor to bias the XLH relay in its operate position. The XLH relay also locks the LHT relay so that would not be released by subsequent operation of the TRST or GLH relays. Late in the call, after the DCT1 relay operates and the DCT relay releases, if the LHT relay is operated, the TRR relay operates (SFD-B502) to force a trouble record with a regular release. An XLH condition does not prevent the call from being set up.

B4-4.10 OPERATION OF JUNCTOR AND TRUNK HOLD MAGNETS - HTR/LTR

The HMS1 relay (SFD-B423) closes ground through the JXP relay primary winding in series with the JH capacitor charged to +130 volts over the J- lead to the winding of the J- line junctor hold magnet.

The HMS1 relay also closes ground through the TXP, TXP1 ballast lamps in series with the TH1,2,and 3 capacitors charged to +130 volts over the LH- lead to the trunk and trunk junctor hold magnets. As described for high voltage surge operation of line hold magnets, the magnets operate in about 1/3 of the time required for -48 volt operation. When the capacitor discharges, the magnets continue to be held operated through the diodes to ground through the JXP relay or the TXP, TXP1 ballast lamp. The JXP relay operates in series with the line junctor hold magnet and operates the JXPA relay which locks.

B4-4.11 CROSSPOINT CHECK (SFD-B421,B423) - HTR/LTR

B4-4.11.1 Heavy Traffic

When the hold magnet have operated, the low resistance ground from the TXP, TXP1 ballast lamps operates the SL relay and releases the LXP and JXP relays (SFD-B423) which operate the LXP1 and JXP1 relays, respectively (SFD-B420). The SL relay operates the SLA relay. The LLT relay, which has previously operated when operation of the line junctor hold magnet grounded the line link sleeve (SFD-B414), operates the LLTA relay. Operation of the SLA, LLTA, LXP1 and JXP1 relays closes ground through previously operated HTR relay to operate the GT1 relay which locks (SFD-B421).

B4-4.11.2 Light Traffic

Crosspoint check on light traffic is the same as preceding, except:

(a) Line hold magnet operation does not occur at the same time as operation of the other hold magnets when the HTR relay is not operated (SFD-B423).

(b) Operation of the SLA, LLTA, and JXP1 relays closes ground through the normal HTR, LXPA, and LXP1 relays contacts and previously operated LHT and RK3 contacts to operate the LTR (light traffic) relay (SFD-B421) instead of the GT1 relay.

B4-4.12 FALSE CROSS AND GROUND TEST (SFD-B423) - LTR

On light traffic calls, a test for crosses of the network tip and ring conductors is made. For this reason, the operation of the line hold magnet operation is delayed during the test so that crosses or grounds external to the network are not detected.

Ground through the secondary and battery through the primary windings of the FCG relay are connected to the ATT and the ART leads, respectively (SFD-B425), if the RCTA relay is normal or to the ART and the ATT leads, respectively, if the RCTA relay is operated. The RCTA relay operates only on light traffic calls having the JLO relay normal. The JLO is alternately operated and normal on successive calls (see sequence chart SFD-B404).

The FCG relay will operate, if:

(a) The network T or R lead connected to the secondary winding is crossed to a lead having a voltage negative to ground.

(b) The network T or R lead connected to the primary winding is crossed to a lead having ground or a voltage between -48 volts and ground.

(c) The network T and R leads are crossed to each other. This meets both conditions (a) and (b).

When the LTR relay operates (SFD-B421) indicating that all crosspoints other than those for the line hold magnet have closed, a locking ground is provided for the FCG relay in case it has operated (SFD-B425). If the FCG relay has not operated, the GLH relay operates (SFD-B421).

The GLH relay disconnects the FCG relay from the ATT and ART leads and grounds both leads to discharge any voltage remaining on them from the FCG test.

B4-4.13 DELAYED OPERATION OF LINE HOLD MAGNET - LTR

The GLH relay operates the GLH1 relay (SFD-B421). With both the GLH and GLH1 relays operated, the line hold magnet is connected either directly in series with the LXP primary winding to ground if the DVO and DVA relays are normal or in series with the charged LH capacitor to ground through the LXP primary winding if the DVO and DVA relays are normal (SFD-B423). The LXP relay operates and operates the LXPA relay (SFD-B420). When the line crosspoints close, the LXP relay is caused to release by ground from the TXP and TXP1 ballast lamps. This operates the LXP1 relay.

B4-4.14 CONTINUITY TEST - GENERAL - LTR (SFD-B425)

A continuity test of the talking path through the network is made on light traffic calls. In order to check continuity of the path through the network, a path from tip to ring conductors or from either tip or ring to ground external to the network is required (SFD-B425). Twenty-hertz ringing supply is stepped up to a higher voltage by the CON transformer. With the GLHI relay normal, the output of the CON transformer is open-circuited. There is no current flowing and, therefore, no voltage built up across the CON2 capacitor. When GLH1 relay operates, (assume RCTA relay normal) the CON transformer is connected through the network to the ring side of the line. Ground is connected to the tip side. On nearly all calls, the off-hook status will be connected across the tip and ring so that there will be a relatively low dc resistance in the loop. Current will flow, causing an alternating voltage to appear across the CON2 capacitor. Terminal 1 of the CON tube is connected through the CON1 resistor to the CON2 capacitor. If the voltage at terminal 1 reaches the firing voltage of the CON tube, even momentarily, the CON tube fires and continues to conduct between terminals 2 and 4 to operate the CON relay even though the voltage at terminal 1 is no longer above the firing voltage.

Occasionally the station will go on-hook just before the continuity test is applied. If this is an individual line, the path through the ringer and the series capacitor allows sufficient 20-Hz current to flow to raise the voltage across the CON2 capacitor to the firing voltage. The same holds true for a ring party line. In this case current flows through the network ring lead only, through the ringer and capacity to ground and back through the earth to the central office ground. If there is only a tip party connected to the line, insufficient current may flow and the CON tube may not fire at this time (still assuming that the RCTA relay is normal at the beginning of the continuity test). As described in more detail later, the RCTA relay operates after a short interval to reverse the continuity test. Now current flows through the tip lead through the tip party bell and capacitor back through the earth to the central office ground. If the RCTA relay had been initially operated and only a ring party station had been connected, the RCTA relay would have released to apply the continuity test to the ring side of the line.

On long lines, the cable capacity is sufficient to satisfy the continuity test even if there is no other path through ringers or transmitter.

B4-4.14.1 Continuity Test Reversal Control - LTR

When the ONX relay (SFD-B425) operates from the CKG2 relay early in the call, the RCTB relay is operated. After the LCK relay operates, the RCTA relay operates providing the JLO relay is normal. The RCTA relay normal applies the continuity test to the tip path. Since the JLO is alternately operated or normal on successive calls (SFD-B404, B405), the RCTA relay is alternately normal or operated on successive calls.

Upon operation of the LXP1 relay (which signifies that the line hold magnet has operated), the operate path for the RCTB relay is opened. The RCTB resistance connected across the winding of the RCTB relay slows the release of the RCTB relay to allow time for the continuity test to be completed if there is continuity, in which case the CON1 relay will operate, which as explained in the next section prevents release of the RCTB relay. If the RCTB relay does release, the RCTA relay, if normal, will be operated, or, if operated, will be released so that a second test in the reverse direction to the first is made.

B4-4.14.2 Continuity Test Description - LTR

Operation of the GLH1 relay, in addition to starting operation of the line hold magnet, also starts the continuity test. Stepped up 20-Hz ringing supply voltage through the CON transformer in series with the CON2 capacitor to ground is applied to either the tip or to the ring of the path through the network depending on whether the RCTA relay is operated or normal. Ground is applied to the other side of the path through the network. The GLH1 relay also applied +130 to a voltage divider supplying the winding of the CON relay.

If there is a continuity through the crosspoints and continuity external to the network, the voltage across the CON2 capacitor builds up sufficiently to fire the CON tube. The CON relay operates, in turn operating the CON1 relay which locks. The CON1 relay closes a locking path to prevent release of the RCTB relay (if it has not already released), operates the GT1 relay which locks (SFD-B421), and grounds the control terminal 1 of the CON tube. The GT1 relay removes positive battery from the CON relay allowing it to release. This, combined with the grounding of control terminal 1, extinguishes the CON tube.

The CON1 and CON3 capacitors are small and serve to prevent false firing of the CON tube from electrical noise pulses.

B4-4.14.3 Continuity Failure Trouble Record - LTR

As previously mentioned, if the CON tube fails to fire before the RCTB relay releases, the RCTA is operated if normal or released if operated and a test on the other side of the line is made. If the CON tube again fails to fire, the CON and CON1 relays do not operate and the DTM can not proceed with the call. The work timer which is recycled upon operation of the LXP1 relay (SFD-B005, B111) times out after 245 to 456 milliseconds causing a trouble record showing WT and LTR punches and progress through the DCT punch but not including the CON punch.

B4-4.14.4 Cancel Continuity (SFD-B423) - LTR

On second trial calls, the operation of the GLH1 relay operates the CON1 relay from ground on the operated TR2B thus automatically cancelling the continuity test. On heavy traffic calls, operation of the LXP1 relay with the HTR relay operated operates the GT1 thus cancelling continuity test by bypassing operation of both the CON and CON1 relays.

Continuity test can be cancelled on all calls for all markers by operating the CCT key at the master test frame jack lamp and key panel.

B4-4.14.5 Multiple of Ringing Supply Between Markers and Detection of Loss of Ringing Supply

The multiple arrangement of the ringing supply to all markers is shown on SFD-C427 (for offices having 12 or less markers). Connected to the last marker of the multiple is a detection circuit consisting of a bridge rectifier across the ringing current leads and a relay ACV across the output of the bridge which remains operated as long as there is ringing current voltage. The ACV relay holds the ACV1 relay operated, if there is a loss of ringing voltage. The ACV relay holds the ACV1 relay operated. If there is a loss of ringing voltage for any reason the ACV and ACV1 relays release, in turn lighting the ACV lamp, bringing in a minor alarm and operating the CCT relay which cancels the continuity test in all markers. If the continuity test were not cancelled upon loss of ringing current, markers would time out on light traffic calls.

B4-4.15 DOUBLE CONNECTION CHECK - LTR/HTR

On both light and heavy traffic calls a double connection check is made to ensure that the sleeve of the connection being set up is not crossed with the sleeve of another connection already set up or in the process of being set up. Although operation of the line hold magnet is slightly delayed on light traffic calls, the double connection test is made in the same manner on both light and heavy traffic calls.

When the LXP1, JXP1, and SLA relays have all operated, as previously described, the LXP and JXP relays and the TXP, TXP1 ballast lamps are disconnected from respective leads to line and trunk link frames. At the same time the DCT relay is connected to the LH- lead to the line link frame. The DCT relay winding now provides the only ground from the DTM to keep the hold magnets operated. Bias current through the secondary winding of the DCT relay is such that the DCT relay will operate if there is no other ground feeding the connection such as would occur if the sleeve path were crossed to an established network connection.

B4-4.15.1 Heavy Traffic

On a heavy traffic call the GT1 relay operates upon completion of the cross-point check (SCD-B4-4.11). With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

B4-4.15.2 Light Traffic

On a light traffic call, the GT1 relay does not operate until the CON1 relay has operated as a result of a successful or cancelled continuity test. With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

B4-4.16 HOLD MAGNET SIMULATION AND CONTROL BY MASTER TEST CONTROL ON DT CLASS OF TEST (SFD-B422, B423)

On a DT class of marker test, it is desirable to be able to test the marker using any line location information. To avoid the possibility of having a customers line become locked into the test call if the line should happen to go off-hook during the progress of setting up the test connection, line hold magnet operation is simulated.

B4-4.16.1 NTC Key Normal

The MT11 relay of the DTM is operated on test calls. This opens the path over the LH- lead (SFD-B423) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on a test call the path is extended over the LHMT lead to the MTC and through the MKT2 relay to the LHM relay (NTC key and NTC1 relay normal) (SFD-B422). The LHM relay and the LHM resistance are chosen to present an impedance to the marker equivalent to that of a line hold magnet.

When the HMS1 relay of the marker operates, the marker applies either the high voltage surge for dual voltage or ground through the winding of the LXP relay to operate the LHM relay of the MTC. The LHM relay operates the LHMA relay which extends the LHMT lead to the LLJ lead. The LLJ lead ties into the J lead of the DTM to the trunk link frame at a point ahead of the CH- relay to simulate the path which would have been closed on a service call over the LH- relay lead to the LL, through the junctor and back over the J- lead to the DTM. This permits the marker to go through all the motions of crosspoint and double connection checks. It will actually close junctor crosspoints on the LL, but checks are made through the simulated path just described. The DTM operates and checks crosspoints on the TL in the normal manner.

Upon completion of the DT class of marker test, when supervision has been turned over to the OR, the OR releases because the MTC does not provide a loop closure on the tip and ring path. When the OR removes ground from the sleeve lead, the whole connection releases. The LHM relay of the MTC releases slightly earlier as the marker and various connector relays release to open the paths used for line hold magnet simulation.

B4-4.16.2 NTC Key Operated

The NTC key of the MTC is operated on a DT class of test where it is desired to establish a connection and check the tip, ring, and sleeve path through the line link frame using all crosspoints which would be used on a service call except the line hold magnet crosspoints. Use is made of the no test connector* access to line link frames.

Operation of the NTC key on a DT class of test operates the NTC and NTC1 relays. The NTC relay operated closes battery over the SP lead to the MTFC to bid for the no test connector.

When the MTC gains access to the no test connector, the F1 relay of the MTC is operated. Operation of the F1 relay operates the NTC select magnets (associated with no test connector level assigned to the MTC) on all no test connector switches (see SFD-B431 as well as SFD-B423). The F1 relay also connects the NTB relay of the MTC via the NTH lead. The NTH lead is steered through the DTM and the HGA- relay of the LL to the winding of the NTC hold magnet of the no test connector associated with the line to be simulated. If the NTC hold magnet is in use, ground on

* The no test connector (SFD-B431) will be covered more completely in a subsequent section of the SFD and SCD. Its primary function is to provide access by operators and the local test desk to lines which are connected to a path through the network. The MTC makes use of the no test connector on test calls to provide a simulated line access to any horizontal of any line link frame.

its winding will be fed back to operate the NTB relay of the MTC which locks on its secondary winding and light an NTB lamp to indicate NO TEST BUSY. If this occurs, simulated hold magnet operation by the no test connector is blocked. The DTM work timer times out and a trouble card showing LXPA but no LXP1 would be produced.

If the NTC hold magnet is not in use, the NTB relay does not operate. Later in the call, when the DTM grounds the LHMT lead (which on a regular call would operate the line hold magnet), the NTH relay of the MTC is operated. The NTH relay extends ground from the NTB relay normal to the NTH lead to operate the NTC hold magnet of the no test connector.

The NTH relay also grounds the H lead to the no test connector to provide a holding path for the NTC hold magnet after the MTFC and DTM release. The NTH relay also bridges the LHMT lead to the S lead of the no test connector. The NTH relay, the NTC hold magnet of the no test connector, and the NT hold magnet of the line link frame combine to simulate a line hold magnet. The NTH relay simulates the winding. The NTC and NT hold magnets provide the crosspoint closure for tip, ring, and sleeve.

Upon completion of the DT class of marker test, when supervision has been turned over to the OR, the OR releases because the MTC does not provide a loop closure on the tip and ring path. When the OR removes ground from the sleeve lead, the whole connection releases. The NTH relay of the MTC, which at this point is locked to the sleeve, also releases and releases the NTC hold magnet of the no test connector and the NT hold magnet on the line link frame.

B4-4.16.3 Dual Voltage Test on DT Class of Test

When dual voltage operation is provided, the LHMT, LLJ, and TLH relays of the master test control are connected to the LHMT, LLJ, and TLH leads, respectively. If the DTM applies the high positive voltage surge to each of these leads, the corresponding relays should operate to light the LHMT, LLJ, and TLH lamps, respectively. Current through the lamps also locks the relays. Tests should be made using message register class of service, if provided, to ensure that the high voltage surge is not applied and therefore that the LHMT lamp does not light for these classes. The LHMT lamp should light for all other classes. The LLJ and TLH lamps should light for all classes.

B4-4.17 HOLD MAGNET CONTROL BY THE MASTER TEST CONTROL ON OR CLASS OF TEST

On an originating register (OR) class of test, the master test control establishes a connection through the network to an originating register from either an originating test line or via the no test connector. When the originating test line is used, the only line location information which can be put into the OR is that of the originating test line. By using the no test connector, any desired line location may be simulated and therefore may be transmitted to the OR.

B4-4.17.1 NTC Key Normal

The MT11 relay of the DTM is operated on test calls. This opens the path over the LH- lead (SFD-B423) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on an OR class of test, the path is extended over the LHMT lead to the MTC and through the SRT2 relay (NTC key and NTC1 relay normal) to the LHM lead. The marker therefore connects to the LH- lead as it would on a service call. When the NTC key is normal on an OR class of test, the line location of the originating test line is automatically transmitted to the DTM from the operated OTL2 relay (SFD-B107) so that the line hold magnet operated is that of the originating test line.

B4-4.17.2 NTC Key Operated

An OR class of test with the NTC key operated functions as described in SCD-4-4.16 for the DT class of test with the NTC key operated, except that the AMRST does provide a loop on the tip and ring so that the OR retains a ground on the sleeve to hold up the connection.

It should be noted (SFD-B107) that, with the NTC key and therefore the NTC1 relay operated, the KVG1,2 relays rather than the OTL2 relay are operated. This makes effective the line location keys or switches which permit any line location to be set up.

B4-4.18 TEST OF NETWORK TALKING PATH TROUBLE DETECTION FEATURES OF THE DIAL TONE MARKER

The dial tone marker makes tests of the tip and ring path through the network on light traffic calls. In making the tests described in the following paragraphs, the DTM should be made busy. It will then function on a light traffic basis if there is over about 1-1/2 seconds between the end of the one test call and the start of the next. The DTM can be forced to function on a heavy traffic basis if desired by operating the HTR key of the MTC (SFD-B111).

B4-4.18.1 Test of False Cross and Ground Detection Feature of the Dial Tone Marker (SFD-B425)

B4-4.18.1.1 FCG Key Normal

With the FCG key normal on DT class of test, the FCG relay of the DTM is connected to the network T and R leads prior to operation of the GLH and GLH1 relays. As on service calls, crosses or grounds on the T and R leads will be detected on light traffic calls.

B4-4.18.1.2 FCG Key Operated

With the FCG key operated on DT class of test, the FA resistor is bridged across the TTT and TRT leads to the marker. This applies a current which should operate the FCG relay causing a trouble card to be produced showing an FCG punch. If the HTR key is operated, the DTM should not detect the FCG condition.

B4-4.18.2 Test of Continuity Test Feature of the Dial Tone Marker (SFD-B425)

B4-4.18.2.1 CON and RV Keys Normal, TC Key Operated or Normal

With the CON, RV, and TC keys normal on a DT class of test, an operate condition originating at the voltage divider resistors CL, CM, and CK, through the CG and CF resistors is applied to the TRT lead. On alternate test calls the RCTA relay of the DTM is operated so that the initial continuity test is made on the RING (the TRT lead on a test call). The CON tube should fire and the call should be completed. On calls with the RCTA relay of the DTM normal, the initial continuity test is made on the TIP (the TTT lead on a test call). Since the TTT lead is open, the CON tube does not fire initially, but (as described for a service call) it should fire after release of the RCTA relay applies the continuity test to the TRT lead. Two consecutive calls should be made to ensure one test with RCTA initially normal and one test with RCTA initially operated. With the TC key normal, a negative bias is applied to the operate path of the CON tube. A test should also be made with the TC key operated to apply a positive bias to the CON tube operate path.

B4-4.18.2.2 RV Key Operated, CON Key Normal, TC Key Operated or Normal

Operation of the RV key with the CON and TC keys normal applies the above continuity operate test condition to the TTT lead instead of the TRT lead. Two consecutive tests should be made to ensure one test with RCTA initially operated and one test with RCTA initially normal. As described previously, the TC key may be operated or normal to apply positive or negative bias to the CON tube operate path.

B4-4.18.2.3 CON KEY OPERATED, RV AND TC KEYS NORMAL

With the CON key operated, a loop continuity operate condition is applied across the TRT and TTT leads. The CON tube should fire for OK continuity on its initial attempt whether the RCTA relay is operated or normal.

B4-4.18.2.4 TCT Key

The TCT key is not intended for use in testing dial tone markers.

SECTION B, PART 5

MARKER RELEASE AND DIALING

Index

B5 MARKER RELEASE AND DIALING

Upon completion of the double connection check on heavy traffic or upon completion of both the double connection check and the continuity test on light traffic (SCD-B4-4.15), the DCT1 relay operates. This starts the release of the marker and cuts dial tone through from the originating register to the calling line.

B5-1 MARKER RELEASE (SFD-B006,B502)

The operation of the DCT1 relay, which locks, releases the F relay of the OR (SFD-B209). Release of the F relay of the OR releases the FA-2 relay of the TL (SFD-B421). Release of the FA-2 relay releases the SL relay of the DTM (SFD-B423) and applies low resistance (10-ohm) ground through the S resistance of the OR to the sleeve lead of the connection which, up to this time, had been held up by ground through the primary winding of the DCT relay. The low resistance ground now provides so much of the current to hold up the connection that there is insufficient current through the DCT relay to hold it operated. Release of the DCT relay operates the DIS1,2 relays (SFD-B502). Operation of the DIS1,2 relays (which lock) starts the release of relays in the DTM (SFD-B006) and in various connectors and then the release of the DIS1,2 relays leaving the DTM normal and ready for the next call.

If the LLMC had given the DTM a TRS signal (indicating that there had been a transfer of start leads in the MTFC), the release of the DCT relay would operate the TRR relay. The TRR would operate the TRST relay which would operate the MPR- relay of the MTFC to request a trouble record showing a TRS punch. Upon completion of the trouble record, or if the trouble recorder were busy, the TRB relay of the DTM would be operated. This would operate the DIS1, 2 relays for a regular release of the marker.

If the DTM detects a cross connection, or if the work, short frame, or long frame timer times out, the MXT, WT, SDT or LDT relay is operated (SFD-B207, B111) and in turn operates the SP and TR1 relays. The SP relay opens a number of paths in the DTM to stop marker progress beyond the point of failure. The TR1 relay operates the TRST relay which operates the MPR- relay of the MTFC to request a trouble record. When the trouble record is complete or if the trouble recorder is busy, the TRB relay of the DTM is operated. This operates the TRL and TRLA relays causing the marker to give a trouble release (TRL) signal to the LL (SFD-B106) if the DTM is working on a first trial basis (TR2B normal) or to give a BT trouble release signal if the marker is working on a second trial basis (TR2B operated).

As previously described, the VGR, HGR, and FR relays monitor the request from the LL which resulted in selection of a particular VGT-, HGT-, or VFT- relay, if the subscriber hangs up during the time that the DTM is identifying the line. Release of the VGR, HGR, or FR after selection of a VGT-, HGT-, or VFT- relay operates the DIS1,2 relays causing the marker to release.

B5-1.1 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL ON TEST CALLS

B5-1.1.1 Rec Key Normal

On DT and OR classes of test, the MT1 and MT15 along with other test relays are operated in the DTM. When the DTM progresses to the point of operation of the DCT relay on a test call (SFD-B502), the DCT relay of the MTC is operated. If the REC key of the MTC is normal, the DCT relay of the MTC operates the MO1 relay. This closes ground from the DCT relay operated to operate the DCT1 relay over the TDCT lead. When the DCT relay releases, it operates the LK2 relay of the MTC which locks, lights the LK2 lamp, and extends ground over the LK3 lead to the DTM then back over the DIS1 lead to operate the DIS1 relay of the MTC. The DIS1 relay locks, lights the DIS1 lamp, and grounds the DIS lead to operate the DIS1,2 relays of the DTM allowing the DTM to release.

B5-1.1.2 Rec Key Operated to Request a Trouble Record

On DT and OR classes of test with the REC key operated, operation of the DCT relay of the DTM operates the DCT relay of the MTC (SFD-B502). The DCT relay of the MTC operates the REC relay which extends its operate ground to operate the TRR relay of the DTM. The TRR relay operates the TRST relay which operates the MPR- (marker preference) relay of the MTFC to request a trouble record.

Upon completion of the trouble record or if the trouble recorder is busy, the TRB relay of the DTM operates. The TRB relay operated closes ground through the TRR relay contacts to the MO1 lead via the MTFC and through the REC key and DCT relay operated to operate the MO1 relay. The operated MO1 relay closes ground to the TDCT lead to operate the DCT1 relay of the DTM. Upon release of the DCT relay, the test call progresses to release the marker as described previously.

B5-2 DIALING

All of the preceding description covers the actions taken by the DTM and connecting circuits to establish a dialing path through the network to the originating register. These actions normally take about one tenth of a second. The following description covers the actions taken to make certain checks of the line, to give dial tone as a signal to start dialing, to receive the dialed digits, and to determine when a full number of digits has been dialed.

B5-2.1 DIAL TONE (SFD-B503,B504)

The S1 relay of the OR is operated early (SFD-B507) when the LV2 relay of the TL operates. The S1 relay operates the ON relay. If the call is for a 2-party line as indicated by class of service, the 2P relay is operated in the OR (SFD-B427). Other classes of service such as manual or coin cause the MAN or CN relay to operate.

B5-2.1.1 2-Party Line

If the 2P relay is operated, indicating a 2-party line, the TPD, TPA, and TPT relays operate (SFD-B503). Later when the F relay releases (SFD-B209), it releases the FA2 relay of the TL (SFD-B419) and starts release of the slow release TPD relay which allows time for a test of the tip and ring of the line. The release of the FA2 relay connects the TP relay to both the T and R leads to the line. This is done to determine whether the tip party or the ring party initiated the call. If the tip party is off-hook, there is resistance ground through the ringer to both sides of the line so that the TP relay will operate. The ring party has a capacitor in series with the ringer so that it does not ground the T and R leads. The TP relay may operate momentarily from capacity discharge but will release if only the ring party line is off-hook.

If the TP relay is operated when the TPD slow-release relay releases, it operates the TP1 relay as an indication that the tip party line was off-hook during the first party test. (A second party test made after completion of dialing will be described later.) Release of the TPD relay starts release of the slow-release TPT relay which releases the TPA relay. Release of the TPA relay connects the L relay winding to the ring of the line and ground to the tip. The L relay operates over the loop through the off-hook station. The L relay operates the SR relay which operates the ON1 relay (SFD-B511) to connect dial tone through the TN transformer to the line.

B5-2.1.2 Other Than 2-Party Lines

For other than 2-party lines (TP relay normal), the party test is omitted and dial tone is connected as shown on sequence chart SFD-B504. The release of the FA2 relay of the TL closes through the T and R to operate the L relay over the loop through the off-hook station and back to ground at the TN transformer. The L relay operates the SR relay and in turn the ON1 relay which closes dial tone through the TN transformer to the line.

B5-2.2 SUBSCRIBER DIALING

When the subscriber inserts a finger in a hole in the dial, pulls it to the stop and lets go, the dial opens and closes a contact the number of times corresponding to the digit associated with the hole except for the digit 0. For the digit 0, the dial generates ten pulses. When the dial contact is open, a pulse interval is generated. The time between pulses of a digit (dial contact closed) is referred to as an interpulse interval. The dial contact is also closed between digits. This is known as the interdigital interval. The interdigital interval under normal circumstances is appreciably longer than the interpulse interval. This difference permits the OR to determine the end of each string of pulses for each digit. If the customer forces the dial or slows it, or plays with the switchhook pulse, interpulse, or interdigital intervals may be generated, which are too long or too short so that the OR cannot recognize them properly. Similarly, lines which have excessive leakage or intermittent crosses may distort pulses or may generate false pulses. Any of these conditions outside of the central office may result in misdirection of calls and may or may not produce trouble record cards.

B5-2.3 PULSING RELAY

The L relay of the OR (SFD-B503) is a magnetically biased polarized mercury contact relay with three windings. The primary is used as a line winding and is used to operate the relay in a circuit which includes the customer loop. The tertiary is used as a pulse aiding winding and is wired in series with the pulse help capacitor PH to a make-contact of the L relay. This contact also is wired to the winding of the slow-release supervisory (SR) relay. When the L relay operates and closes ground to the PH capacitor, it charges through the tertiary winding and the current is in a direction to hold the L relay operated. This current is reduced to zero as the capacitor becomes charged and the other windings exercise full control.

When the circuit to the primary winding is opened, the L relay releases to open ground from the PH capacitor which then discharges through the winding of the SR relay. The current in the L tertiary winding is in a direction to hold the L relay released. The tertiary winding and the PH capacitor thus act to ensure that once the L relay operates, it will remain operated for a definite minimum interval. This pulse correcting action makes possible longer maximum loops and higher capacity ringing bridges than would otherwise be possible. The tertiary winding is also used to hold the L relay through the marker connector when the completing marker is engaged and is also used for slight weakening the L relay when operating with ground start coin lines. When the coin (CN) relay operates, it closes a circuit to energize the tertiary winding in a direction to aid the primary winding. This is necessary to prevent "showering," a condition which exists when the line circuit relay operates on a loop which will not hold the register L relay. If a leak condition exists on the line, which will cause operation of the line circuit relay, the dial tone marker will be called to connect the line to a register. Then if the register relay does not operate, the register will release and reconnect the line to the line circuit relay to start the marker action again. To prevent this showering the register, the L relay is biased to hold on any line which will operate the line circuit relay.

The secondary winding is used for slightly altering the sensitivity of the L as it operates and releases. This winding is also connected to the make-contact of L and is so poled that its ampere turns oppose those of the primary winding when L is operated. This has the effect of making L, once it operates, slightly stiffer or easier to release and once it releases, slightly weaker or easier to operate. The value of the LA resistor is chosen to give the optimum benefit from this winding.

The contacts of the L relay consist of a common armature spring No. 3 making contact with two independent front contacts numbered 1 and 2, and two independent back contacts numbered 4 and 5.

The LW capacitor and resistor network connected to the line side of the primary winding of the L relay is for preventing a premature release of the L relay when working with customer lines which have high-capacity ringing bridges. On each open pulse on these lines the line current momentarily dips and then increases as the bridged capacitor charges in series with the inductive ringer. The LW capacitor holds the L relay over the dip in the line current. This network is also used to prevent a false momentary release of L when an inductor holding bridge is inserted into the loop after the dialing of each digit at a PBX.

The winding of the supervisory relay SR is connected to the No. 1 front contact of the L relay and is energized whenever L is operated. This relay is slow-release and will hold over the momentary opens of the L front contact which occurs during the dialing of a digit. It will release, however, to cause release of the register if the customer abandons the call.

B5-2.4 SUPERVISORY CONTROL

The winding of the RA relay (SFD-B507) is connected through an ON1 relay contact to a break contact of L and is energized whenever the L is released with ON1 operated. This relay is made slow-release by the action of its secondary winding which is short-circuited whenever the relay is operated. This secondary is a precision winding with a resistance tolerance of only ±3 percent so that the variation in release time of the relay is held within reasonably close limits. Since this winding is open during the operation of the relay, the relay is reasonably fast in operating. Relay RA will operate during the first dial open pulse when L releases and will remain operated until the inter-digital interval when L is held operated for longer than the release time of the RA relay.

The auxiliary register advance (RA1) relay is controlled from a back contact on RA and works in reverse to RA, operating when RA releases and releasing when RA operates. The RA1 is a fast-operate and fast-release relay.

B5-2.5 DIAL PULSE COUNTER (SFD-B507)

Two methods of showing relay operation of the pulse counter are presented. SFD-B504 uses the conventional sequence chart; SFD-B506 uses a different chart arrangement which shows time relation between the L relay, counting relays and register leads. The upper position of the line associated with each relay or lead designation indicates relay operated or lead grounded. The lower position of each line indicates relay released or lead ungrounded. Shaded portions indicate time during which the magnetic flux of the RA relay reduces to a point where the relay releases. Register leads are grounded between the release of the RA relay and the operate of the RA1 relay. One or both of these charts should be followed while reading the following paragraphs.

The dial pulse counting circuit consists of relays P1 to P5 and P2A. Relays P1 and P2 are used in a pulse-dividing capacity with each relay functioning from the L relay but at half the speed. These relays are controlled by a break and a make contact of L. When L releases on the first dial open with SR operated, P1 is operated through the back of a continuity contact on P2. Relay P1 locks through this continuity contact on P2, through its own make-contact to ON ground. When L reoperates at the end of the first open pulse, ground through L make contact and through contacts of P1 operated, operates P2. Relay P2 locks to the ON ground through P1 operated and opens its operating circuit on a continuity contact, transferring the holding circuit for P1 from the ON ground to the ground at the break contact. On the next release of L, P1 releases. The P1 in releasing opens the holding circuit to the ON ground for P2, but P2 is held to the ground at the break contact of the L relay. The locking circuit of P2 to a contact of P1 will hold P2 over any stagger that may occur between the opening of the L break contact. On the next operation of L, P2 releases. This cycle is then repeated with P1 and P2 remaining operated at the end of each odd-numbered pulse and remaining normal at the end of each even-numbered pulse. Relays P3, P4, and P5 are used in various combinations to count and remember the number of operations of P1 and P2. Relay P3 and P2A operate when P1 releases at the start of the second open pulse. Relay P2A locks to ground from the ON relay for the rest of the call. P4 operates when P2 operates at the end of the third open pulse; and P5 operates when P2 releases at the end of the sixth open pulse.

B5-2.6 PREFIX COUNTER (SFD-B507)

Either a single 1-pulse or two 1-pulse digits may be dialed before the other digits as an indication that some special action is to be taken. Where it is required that the register recognize these prefix digits, the prefix counter, consisting of the relays 11A, 11B, and 11C, is provided (SFD-B507).

The detailed operation of the prefix counter is as follows. When RA releases after the first 1-pulse digit is counted, a circuit is closed for operating 11A. Relay 11A locks and closes a circuit for operating 11B when P1 releases as a result of the operation of RA1. If a second 1-pulse digit is counted, 11C operates through front contacts of 11B after RA releases at the end of the digit. Additional 1s will have no effect until after a digit greater than 1 has been dialed to cause the P2A relay to operate and lock. The P2A relay (when normal) opens the 0 and 1 output leads toward the digit register and steers the 1 lead toward the prefix 1 counter. Operation of the P2A relay opens the 1 lead toward the prefix 1 counter and closes the 0 and 1 leads toward the digit register.

B5-2.7 PULSE COUNTER OUTPUT (SFD-B507)

At the end of a string of pulses representing a digit, the longer inter-digital time allows the RA relay to release operating the RA1 relay. The release of the RA relay (SFD-B507) closes ground through the P-relays to the leads 0, 1, 2, 4, and 7 through steering relay contacts to digit register relays (SFD-B508). Operation of the RA1 relay opens these leads. Since the release of the RA relay starts operation of the RA1 relay, the leads to the digit register are closed only during the operate time of the RA1 relay. This is an adequate time since the digit register reed relays are very fast operate. Refer to chart on SFD-B506.

B5-2.8 DIGIT STEERING

The digit steering relays, AS-STS (SFD-B508), serve to connect to the digit register successively as the digits are received. The steering circuit is also used in conjunction with other circuitry to indicate when dialing is completed. This circuit consists of one relay per digit and its advance is under the control of the RA1 relay.

The A digit steering relay AS is operated when ON operates at the start of the call. Relay AS locks through a back contact on BS. When RA1 operates at the end of the first digit with P2A operated, BS operates through a front contact of AS. The BS locks through a back contact of CS and opens its operating circuit on a continuity transfer contact to the RA1 contact, so that when RA1 releases at the start of the next digit AS releases. This action repeats for each digit with the steering relay for the next digit operating when RA1 operates at the end of a digit and the steering relay for the digit just registered releasing when RA1 releases at the start of the next digit. The five output leads of the pulse counter are carried through individual transfer contacts on the steering relays and are closed to the digit register associated with the lowest lettered operated relay. For example, with both AS and BS operated, the leads are associated with the A digit register. The transfer from one digit register to the next takes place on the release of the lower-lettered relay.

B5-2.9 DIGIT REGISTER

The digit register unit for each digit consists of a dry reed relay, with five independent coils enclosed in a can with each coil associated with two make-contacts. One side of each of the coils is wired internally to one of its associated contacts for locking purposes and a single lead wired to a terminal. One contact of the locking contact pair, one side of the coil, and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both the front and rear of each relay. For ease of wiring, three sets of terminals are strapped internally. These are the battery side of the coils, the locking contact of the relay, and one side of the load contact. Eleven or twelve of these digit register units are provided.

B5-2.9.1 Tool for Reading Digit Registers

It is possible to determine what digit is recorded in a digit register unit by attaching a KS-16751 tool to the front of the unit. The tool contains five lamps designated 0, 1, 2, 4, and 7. Lamps will light corresponding to operated relays within the unit.

B5-2.10 OPERATOR CALLS

When a 0 is dialed as the first digit*, the counter counts 10 pulses and operates the MAN relay (SFD-B507). The A4, A7 relays are also operated in the A digit register. If the calling line has manual class of service, the MAN relay is operated by the DTM (SFD-B429). In either event, operation of the MAN relay causes the OR to connect to a completing marker. If the CN relay is operated, the OR makes a test for coin ground before connecting to the CM. If the 2P relay is operated, the OR makes a second party test before connecting to the CM.

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* There are other optional arrangements such as (0+ calls) where a 0 can be dialed in the first digit followed by the full number for person-to-person and other special calls. These options are not covered in this SFD.

B5-2.11 DIGITS HAVING MORE THAN 10 PULSES

Although dials are arranged to generate a maximum of 10 pulses for a digit, there are times when more than 10 pulses may be received by the L relay of the OR. This may occur as a result of misuse of the dial, jiggling the switchhook or by hits on the line which produce extra pulses. Faulty adjustment of the L or RA relays of the OR might also cause a count of over 10.

At the beginning of an eleventh pulse, operation of the P1 relay opens the locking path of the P3 relay to release it. With the P5 relay operated and the P4 relay normal, there is no path for reoperation of the P3 relay by additional pulses. This opens all but the 0 lead from the output of the counter for any number of pulses greater than 10.

B5-2.12 SUMMARY OF DIAL PULSE COUNTING AND REGISTRATION

The counting and registration of a digit takes place as follows. The L relay responds to the customer dial and the counting circuit counts the number of pulses. After the last pulse of the digit, L remains operated and RA releases. Relay RA closes an ON ground, connected through an MST1 break-contact, through two separate break-contacts to the translating contact of the counting relays. This ground emerges through separate break-contacts of RA1 on two of the output leads 0, 1, 2, 4, and 7 and is connected by the steering relay to a digit register to cause operation of two of the five digit-register relays. Relay RA released also operated RA1 which operates the next steering relay and, with five individual contacts, opens the five output leads of the counting relays. With this type of operation the digit register relays are required to operate during the operate time of RA1. Two other break-contacts on RA1 release the counting relays. The circuit is then ready for the next digit.

B5-2.13 TOUCH-TONE CALLING

Originating registers can also be equipped to handle TOUCH-TONE calling. An additional register group must be established in the DTM and is shown on SFD-B105. The TT OR, is capable of receiving both the TOUCH-TONE and dial pulse digits to the TOUCH-TONE customer that has a TOUCH-TONE and dial pulse set in his home. A description of the functions relating to TOUCH-TONE calling is as follows.

B5-2.13.1 General Operation (SFD-B507, 508, 509)

The translation and registration of a digit takes place as follows. The TT (TOUCH-TONE) receiver responds to the frequencies generated by the customers TOUCH-TONE set and furnishes output grounds to operate the translating relays in the translating circuit in accordance with the frequencies of the keyed digit. At the beginning of a digit the TT receiver also causes STR, steering relay to operate. Off-normal ground, (SFD-B507) through the contacts of the operated translating relays, (SFD-B508) appears on two of the 0, 1, 2, 4 and 7 output leads which are connected by the steering relay to a digit register (SFD-B509) to cause operation of two of the five-digit register relays. The STR operated also operates the STRA, steering auxiliary relay, which in turn operates the next steering relay. At the end of a digit the output of the TT receiver is removed, thereby releasing the translating relays and the STR. The STR released releases the STRA which in turn releases the steering relay of the digit just registered. The circuit is then ready for the next digit.

B5-2.13.2 TOUCH-TONE Detection and Registration

For any digit, a combination of two audio frequencies is generated by the calling customer TOUCH-TONE set. Each combination of frequencies consists of one frequency out of a "high" group of three audio frequencies and one frequency out of a "low" group of four audio frequencies (see Table A). Twelve such combinations are thus available with this arrangement. Then of these are used to represent the digits 0 through 9. The remaining two combinations are designated * (asterisk) and # (number sign) and may be used for special purposes.

TABLE A

DIGIT	Frequencies Cycles Per Second		TT Receiver Output Leads Grounded		Translating Relays Operated		Output Leads Grounded
0	1336	941	HG2	LG4	Z2	Y9	4, 7
1	1209	697	HG1	LG1	Z1	Y0	0, 1
2	1336	697	HG2	LG1	Z2	Y0	0, 2
3	1477	697	HG3	LG1	Z3	Y0	1, 2
4	1209	770	HG1	LG2	Z1	Y3	0, 4
5	1336	770	HG2	LG2	Z2	Y3	1, 4
6	1477	770	HG3	LG2	Z3	Y3	2, 4
7	1209	852	HG1	LG3	Z1	Y6	0, 7
8	1336	852	HG2	LG3	Z2	Y6	1, 7
9	1477	852	HG3	LG3	Z3	Y6	2, 7
*	1290	941	HG1	LG4	Z1	Y9	
#	1477	941	HG3	LG4	Z3	Y9	

Associated with each TOUCH-TONE originating register is a TOUCH-TONE calling receiver circuit which detects the presence of TOUCH-TONE keyed digits and causes translating relays (SFD-B508/C5) to operate, corresponding to the frequencies of the keyed digit. Operation of the translating relays transfers the digital information into digit register units (SFD-B509). The end of a digit is recognized by the STRA steering relay which operates when a key is depressed at the customer set and remains operated until the key is released. This relay controls the transfer of digital information into the proper digit register.

B5-2.13.3 TOUCH-TONE Calling Receiver

The TOUCH-TONE calling receiver is bridged across the incoming T and R leads of the register circuit. Each keyed digit causes the TT receiver to ground one of the four LG1-4 leads, one of the three HG1-3 leads and the STR lead (SFD-B508/C5). The receiver is arranged to maintain these output grounds for a minimum of 50 milliseconds of time to insure that the digit has been registered and the digit register has been advanced. This action prevents a digit from being lost should a customer depress a key for a very short interval.

The grounded LG- lead operates one of the Y0, Y3, Y6, or Y9 translating relays and the grounded HG- lead operates one of the Z1, Z2, or Z3 translating relays. The frequencies received for each digit, the output leads grounded by the TT receiver, and the translating relays operated are as follows. The numerical designation of the operated Y0, Y3, Y6, or Y9 and Z1-3 relays may be added to obtain the corresponding digit for digits 1 through 9.

The receiver is arranged to detect TOUCH-TONE signals and to ignore other signals. It will provide an output of two digit signals and the steering signal for each digit received. The TOUCH-TONE receiver acts as a discriminator and will ground two of the digit leads when it detects a digit. In all other cases it will provide no output.

The MF relay also operates as soon as the first keyed digit is received (SFD-B508). The P2A operates also if the first digit is greater than one. The MF locks to an off-normal ground and informs the register that the call is being originated by a TOUCH-TONE customer. The P2A locks through a continuity transfer contact to an off-normal ground and causes the digit to be registered in the A-digit register unit. The P2A operated also opens the dial tone circuit, closes a ground supply for the output leads of the translating circuit and opens the operating circuit of the AS steering relay.

B5-2.13.4 Digit Translation

The digit translation circuit consists of the Y0, Y3, Y6, Y9, Z1, Z2, and Z3 relays. These relays are under control of the TT calling receiver output leads LG1-4 and HG1-3 and function to translate the 4 by 3 encoded information received from the TT receiver into 2-out-of-5 information required by the digit register units. The outputs of the translating relays appear on the 0, 1, 2, 4, and 7 leads which are connected to the proper digit register unit by the steering relays. The output leads are grounded as indicated in Table A.

If for any reason an unused combination of translating relays should operate, namely, Y9 and Z1 (asterisk) or Z9 and Z3 (number sign), the TB1 punching will be grounded which will cause TBL to operate (SFD-B507). The TBL operates BT which will cause busy tone to be returned to the customer from the register.

B5-2.13.5 Digit Steering

The digit steering circuit serves to connect the output of the translating relays to the digit registers successively as the digits are keyed. The steering circuit is also used to indicate when keying is completed. This circuit consists of one relay per digit and the STS relay which grounds the M7 lead to the marker (SFD-C115) if a digit is stored in the L register. The advance of the steering circuit is under control of relay STRA.

B5-2.14 PRETRANSLATOR START (SFD-B510)

The main function of pretranslation is to determine from the first 2 or 3 digits dialed how many digits should be expected. Although the register may provide its own pretranslation, the SFD shows only pretranslation by connection to a pretranslator.†

With few exceptions, the CR is arranged to go to the pretranslator after dialing the C digit. Upon completion of counting the pulses for the C digit, operation of the RA1 relay operates the DS relay (SFD-B508). This operates the PST relay which locks (SFD-B510). The operation of the PST relay causes the OR to connect to the pretranslator as will be covered in SCD-B6 section.

If there are still any offices using 2-digit office codes, the OR is wired in those offices to go to the pretranslator after dialing the B digit when the CS relay operation operates the PST relay (SFD-B510).

As will be explained later, the output of the pretranslator operates one or none of the relays CMA, CMB, or CMC and may or may not operate the SD relay of the OR.

† Pretranslations within the OR may be covered in a subsequent issue of the SFD and SCD.

B5-2.15 MARKER START (SFD-B510)

Determination of when the OR should start for the CM is made by cross-connection from terminals B through 411 to terminal MST through DL shown on SFD-B510. Which of the terminals CM3A through DL are effective is controlled by the pretranslator output. SFD-B510 shows only one typical cross-connection from the G terminal to the CM2 terminal. This causes the MST relay to operate after 7 digits have been dialed (on other than 2-party or coin lines) provided the pretranslator did not operate any of the relays CMA, CMB, CMC, or SD in the OR. This is called a basic setting from the pretranslator.

On 2-Party or coin lines either a second party test or a coin test, must be made before the MST relay can operate.

B5-2.16 SECOND PARTY TEST (SFD-B503, B510)

If the 2P relay is operated, upon operation of the steering relay beyond the last digit expected, the TPB relay operates (SFD-B510). (Refer to sequence chart on SFD-B503.) The TPB relay operates the TPA relay which for the second time connects the TP relay to both sides of the line and opens the operate path of the TPD relay. If the tip party is off-hook, the TP relay operates. If only the ring party is off-hook, the TP relay may momentarily operate but should release before the slow-release TPD relay releases to operate the TPC relay. The TPC relay extends ground to operate the MST- relay to start the connection of the OR to the marker. The L relay is held operated during the second party test by a combination of TPB relay (operated) and either TPC or TPD relay (normal) until release of the TPA relay reconnects the L relay to the loop. If both the TP1 and TP2 relays are normal at the end of the second party test, an RP signal is transmitted to the CM. If both TP1 and TP2 relays operate, a TP signal is transmitted to the CM. If either relay is operated and the other normal, this is an indication of a party mismatch caused possibly by the tip party going off-hook after the ring party had initiated the call and had been recognized on the first party test. This condition causes both TP and RP leads to be grounded to the CM.

B5-2.17 COIN TEST

The originating register is arranged with several different options for coin tests. The SFD shows only the improved coin test arrangement which works with either dial tone first loop start lines or with coin first ground start lines.

Initially, when the register is seized for coin service, relay CN operates (SFD-B429) followed by the operation of the CNT2 and subsequently CNT3 relays (SFD-B509). The CNT2 relay is held operated over its operate path and a lock path controlled by the CNT1 relay. The CNT3 relay is held operated under control of the CNT2 relay. The primary function of relays CNT2 and CNT3 is to release, in sequence, after the called number has been dialed and before the marker is called, thereby timing the coin test interval. Relays CN and CNT3 operated prepare the register for coin test by transferring the normal operate path of the MST relay to the CNT relay (SFD-B510). At the end of dialing, CNT operates over this path. The function of CNT is to hold the L relay operated (SFD-B509, 503) and then start the coin test cycle. The hold on L is needed to prevent its release during coin test. The CNT operated also locks relay RA1 (SFD-B510) and operates relay MST1 (SFD-B509). This action disables the digit counting and registration circuits. In addition, CNT operates CNT1. With both these relays operated, CNT2 begins to release. The CNT1 operated transfers the tip lead to ground test relay GT, opens the ring lead to prevent the holding ground on L from backing up through the loop to the GT relay, and recycles the TM timing circuit.

When the GT relay is initially connected to the external tip circuit, it may falsely operate due to line surge. If a coin has been deposited at the coin station, thereby grounding the tip lead, GT will operate or remain operated if it has falsely operated. If a coin has not been deposited, GT will not operate or will soon release if falsely operated. Since the final state of GT (operated or nonoperated) at the end of the coin test cycle determines the coin-present or not-present indication to the marker, the slow-release of CNT2 covers the period during which GT may falsely operate and release. Relay GT1 records the final state of GT during the slow-release interval provided by CNT3. The operation of GT1 is under control of both GT and CNT2. Once operated, GT1 locks. When CNT3 releases, it reestablishes the marker start circuit, causing operation of relay MST and summoning the marker. The GT1, if operated, grounds lead SCK to the marker and, if normal, grounds lead SCN.

An operate test of the GT relay is made before the register releases to check that GT is capable of operating under service conditions. This test is made on all coin calls when L releases and RL operates. The register will remain off-normal, if GT does not operate. The locking path of ON1 is closed through a front contact of CN and a back contact of GT1, so that if GT and GT1 fail to operate, ON1 will remain operated and the register TM timing circuit functions to cause an alarm.

To permit this arrangement to function with ground-start coin lines which have more sensitive line circuit relays requires that the L- relay of the OR be made more sensitive so as to operate on a lower value of line current than the line relay to prevent showering.*

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* Showering occurs when lines become leaky as a result of rain or other conditions. If the line relay were more sensitive than the L or the OR, a connection would be established to the OR which releases because its L relay does not operate. Repeatedly, connection to an OR would be set up and released.

To increase the sensitivity of the L relay, the CN relay closes ground through resistance to apply current in the tertiary winding of the L relay in a direction to aid in operation of the L relay.

B5-2.18 ABANDONED CALL

B5-2.18.1 Dial Tone Marker Attached

If the customer abandons the call and replaces the receiver on the switchhook, the closure on the tip and ring conductors is opened. If this occurs before the dial tone marker has completed the dial tone connection, L will not operate to operate SR (SFD-B503) and ON1 (SFD-B511). When S1 releases after the release of F (SFD-B507), ON will release to release the connection (SFD-B423). On a 2-party line the first party test will be made before S1 and ON release. The TPA relay holds the S1 relay operated until the first party test is completed.

B5-2.18.2 After Dial Tone Marker Has Released

If the abandonment occurs after L, SR, and ON1 have operated (see sequence chart SFD-B509), L and SR will release. If abandonment occurs prior to completion of the first party test on a 2-party call, the first party test must be completed before the L relay is connected to the line to recognize the abandonment. On a coin call, if abandonment occurs during the coin test, release of the L and SR relays is delayed until completion of the coin test when the CNT relay releases. On noncoin calls, release of the SR relay operates the release relay RL directly (SFD-B510). On coin calls release of the SR relay operates the CR relay to cause coin return followed by timed operation of CR1 and CR2 relays (SFD-B509) to operate relay RL.

The RL relay opens the tip and ring leads (SFD-B503) to avoid breaking current at the crosspoints of the switches. It also opens the sleeve lead (SFD-B423) to release the dial tone connection. The RL relay locks to ground on the ON relay and opens one locking path for the ON1 relay. On coin calls there is another locking path through the GT1 relay normal. Operation of the RL applies a test condition to operate the GT relay which in turn operates the GT1 relay to release the ON1 relay. On 2-party calls the TP1 relay should have already operated before the abandonment could have been recognized. This would open the second locking path for the ON1 relay on 2-party calls.

The ON1 relay releases the ON relay to cause release of all the relays of the register so that it is ready for the next call.

B5-2.18.3 Completing Marker Attached

If the completing marker has been engaged before the customer disconnects, the L relay will be held over the L lead to the connector where it is connected to the TM lead which is connected to ground through front contacts of MST (SFD-B503). The connection to the trunk will be set up in the usual manner but, since the customer loop is open, the trunk connection will immediately release.

B5-2.19 COIN RETURN ON ABANDONED CALL

The CN relay will have been operated in the OR by the DTM on a coin line call. If the call is abandoned, release of the L relay releases the SR relay (SFD-B503). Release of the SR relay operates the CR (coin return) relay (SFD-B510). The sequence chart (SFD-B509) should be followed for the balance of this description. Operation of the CR relay operates the MST1 relay (SFD-B511), starts the CR1 timer (SFD-B509), opens the operate circuit for the MST relay to prevent seizure of a completing marker during the coin return cycle, disconnects the L relay from the ring lead, removes ground from the tip lead, and prepares for application of coin return potential to the tip lead.

Operation of the MST1 relay closes either +130 or -130 volts (depending on whether positive or negative coin return is used in the area) through the CR1 resistor to the CRL resistor to ground. These resistors reduce the voltage applied to the tip side of the line for coin return. After 500-780 milliseconds the CR1 timer operates the CR1 relay which opens the coin return potential.

Operation of the CR1 relay starts the CR2 timer. After 470 to 750 milliseconds, the CR2 timer operates the CR2 relay which operates the RL relay to release the register.

B5-2.20 REGISTER TIME-OUT

The originating register time measure (TM) timer (SFD-B511) times for various functions of the register to be completed. If they are completed within the time-out interval, the TM timer recycles itself for timing the next function. If the function is not completed, the timer times out and causes the action shown in the table of Note 1 (SFD-B511).

The nonoverload (OVL relay normal) time interval of the TM timer is a nominal 25 seconds for each function timed. If all originating registers are busy (SCD-B5-2.20), the group busy circuit operates the OVL relay of all registers in the group. This reduces the timing for dialing of the first digit to a nominal 12.2 seconds and of each subsequent digit to a nominal 5.7 seconds.

B5-2.20.1 Detailed Operation

Operation of the CN relay operates the TMA relay on its primary winding and in turn operates the TMB relay and starts the TM timer. If the second pulse of a first digit has not been received before the TM timer times out, the TM relay operates the TM1 relay which operates the MST relay to start connection to a completing marker.

If the second pulse of the first digit is received before the TM times out, operation of the P2A relay (SFD-B504, B506, B507) operates the PD relay and opens the holding path for the TMA and TMB relays. The release TMA relay stops and recycles the TM timer. When the slow release TMB relay releases, it reoperates the TMA relay to restart the TM timer. If the OVL relay is operated, the operation of the PD relay reduces the TM timing interval from a nominal 12.2 seconds for the first digit to 5.7 seconds for each subsequent digit. If the OVL relay is not operated, the timing interval remains at a nominal 25 seconds for all digits. When the RA1 relay reoperates after the last pulse of the first digit, the TMB relay reoperates.

For each subsequent digit, release of the RA1 relay at the beginning of the first pulse (SFD-B504, B506, B506) opens the holding path for the TMA and TMB relays. As described above, release of the TMA relay stops and recycles the TM timer. Release of the slow-release TMB relay reoperates the TMA relay to restart the TM timer. Thus a timed interval is allowed for each digit to be dialed.

When the TM timer times out, it operates the TM relay which grounds an LP lead to light a TO (time-out) lamp associated with the OR at the JLK panel. It also operates a DLA relay at the JLK panel over the ALM lead. The ALM lead is multiplied to all originating and incoming registers and senders in the marker group. The DLA relay starts the time-out alarm timer (TOA). Normally the DLA relay will only operate momentarily since the OR is released shortly after its time measure timer times out. If there is a trouble condition which holds the DLA relay operated long enough (10.5 to 15.7 seconds), the TOA timer operates the TOA relay which lights the TOA (time out alarm) lamp and operates the MJ relay of the alarm circuit over the MJ lead. The MJ relay lights the aisle and main aisle major alarm pilot lamps and causes a major audible alarm to be sounded (not shown).

B5-2.21 OVERLOAD CONTROL (SFD-B511)

If no trunk link frame having an idle OR is available (SCD-B2-1.3), the TBT timer operates the TBTA relay (SFD-B111). When this occurs, the DTM (SFD-B511) grounds an RB (register busy) lead to the group busy circuit associated with that group of ORs to operate an RB1 relay which operates an RB2 relay and grounds an ORB lead to operate a B- relay in the traffic register circuit. The B- relay locks under control of a TR-AR key at the JLK panel or, if provided, under control of the alarm sending circuit. The B- relay lights an ORB (originating registers busy) lamp at the JLK panel and opens one of the locking grounds for the RB1 relay. The RB2 relay in operating locks and removes the second locking ground for the RB1 relay so that it releases when the DTM removes ground from the RB lead. The RB2 relay operates relays RB3-6. Relays RB2-6 ground OVL leads to each of the originating registers in the group to reduce timing intervals as described in SCD-B5-2.19.

When the DTM releases the RB1 relay with the RB2 relay operated, the release (RT) timer is started. The release timer times for 9.6 to 15.3 seconds then operates the RT relay which opens the locking path to release the RB2 relay which releases the RB3-6 relays to remove ground on the OVL leads. If a DTM should reoperate the RB1 relay before the RT timer times out, the RC capacitor is discharged to recycle the timer. When the RB1 relay again releases, the timer is restarted.

Operation of the B- relay of the traffic register circuit extends battery from the JLK panel to operate the MN relay of the alarm circuit which lights aisle and main aisle minor alarm pilot lamps associated with the aisle in which the JLK panel is located. The MN relay operates the MN1 relay which causes a minor audible alarm to be sounded (not shown). Thus, the audible alarm calls attention to the fact that there is a problem. The aisle pilots indicate the aisle in which the JLK panel is located and the previously mentioned ORB lamp indicates an all originating register busy condition. Momentary operation of the TR-AR key will restore the audible alarm and extinguish the lamps.

SECTION B, PART 6

PRETRANSLATION

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B6 PRETRANSLATION

From the A, B, and C dialed digits, it is possible, in most cases, to determine the total number of digits required to be dialed. The OR needs this information so that it can request connection to a completing marker as soon as the required number of digits have been dialed. Determination of this information from the A, B, and C digits is called pretranslation. Pretranslation may be performed within the OR or by pretranslator circuits* common to all ORs.

In offices where the determination of the number of digits required for various codes is not economical or, in some cases, impossible when using the translators built into the individual registers, a pretranslator circuit is provided. This circuit can translate as many codes as required, and is common to the group of registers. This translation is transferred to the register so that the register can connect to the marker after the proper number of digits have been registered. The register makes a multiple lead connection to the pretranslator by means of the pretranslator connector. The register will connect to the pretranslator after three digits have been registered.†

B6-1 CONNECTOR ACCESS TO PRETRANSLATORS (SFD-B603)

The block diagram (SFD-B603) illustrates the connector access arrangements between ORs and PTRs. As many as three connectors may be provided. The ORs associated with each connector are divided into as many as three subgroups with a maximum of 24 ORs to a subgroup. In order to connect a register to a pretranslator, it is necessary to operate register connector relays (PR--), subgroup connector relays (G--), and pretranslator connector relays (P--).

B6-2 SEIZURE OF A PRETRANSLATOR BY AN ORIGINATING REGISTER (SFD-B602, B604)

The following description assumes that the connection is made to the pretranslator after the third digit has been registered in the OR.

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* This issue of the SFD and SCD deals only with common pretranslator circuits. A description of pretranslation within the OR may be added in a subsequent issue.

† There may still be a few offices having 2-digit office codes. In these cases the OR would connect to the pretranslator after the second digit. This SCD will only discuss operation with 3-digit office codes.

When the C digit has been registered in the OR, its DS relay will operate. The DS relay operates the pretranslator start relay PST (SFD-B512) which locks and starts selection of a pretranslator by connecting battery to the start (ST) lead to the pretranslator connector circuit originating register part (SFD-B604). The PST relay grounds the TM lead to the pretranslator connector pretranslator part to operate the TM relay (SFD-B611). The TM relay operates the TM1 relay which starts the PRTC work timer (SFD-B609). The PST relay also opens the operating circuit of the overload timing (OVL) relay (SFD-B513) to ensure that register timing during the pretranslator stage of the call will be at the 25-second nominal rate.

Three separate preference controls are used to operate:

(1) Register connector relays
(2) Subgroup connector relays
(3) Pretranslator connector relays.

B6-2.1 PREFERENCE FOR OPERATION OF REGISTER CONNECTOR RELAYS

Reference should be made to the sequence chart (SFD-B602).

B6-2.1.1 PRS- Relay Operate Chain

In periods of very light traffic (assuming only one OR at a time is operated in a subgroup), when the OR applies start battery to bid for a pretranslator, PRS relay operation is straightforward. Start signal battery from the OR is applied to the associated PRS- relay winding which is connected through the PRS- operate chain* to ground at the winding of the first PRS- relay in the operate chain (shown on SFD-B604 as associated with last OR). In periods of heavy traffic, two or more ORs may initiate requests simultaneously or in rapid succession.

Assume that the first OR and an intermediate OR (SFD-B604) initiate simultaneous requests (apply start battery). Both PRS- relays will operate and lock. If, however, the intermediate OR had initiated a request slightly ahead of the first OR, the PRS- relay for the first OR could not have operated because ground for its winding would have been opened by the operate chain at the PRS- relay for the intermediate OR. On the other hand, if the first OR initiated a bid first, any other OR ahead of it in the operate chain can subsequently operate its PRS- relay.

B6-2.1.2 PRS- Relay Work Chain

Since it is possible to operate two or more PRS relays at the same time, a work chain determines which PRS- relay does the work. The work chain

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* Note that there are paralleled break contacts in the operate chain. This is done in many of the paths of both the pretranslator connector and the pretranslator to improve reliability.

progresses through contacts of the PRS- relays in the opposite direction to the operate chain, starting with ground at a contact of the PRS-relay for the first OR. If the PRS- relay for the first OR is operated, the work chain ground will operate the PRA-, PRB-, and the series GS-relay whether or not other PRS- relays are operated within the subgroups as will be explained in SCD-6-2.1 the above is true for 0 subgroup in light or heavy traffic. For other subgroups there is further control which may delay GS- relay operation in heavy traffic for other than the 0 subgroup.

When an OR which has its PRA-, PRB- connector relays operated has received its information from the pretranslator and opened the start lead, the PRS- relay for that OR releases. If there are any other PRS- relays operated, the next PRS- relay in the work chain which is operated now functions as described to operate its PRA-, PRB- relays and the same GS-relay. This continues until all operated PRS- relays have been served.

B6-2.2 PREFERENCE FOR OPERATION OF SUBGROUP CONNECTOR RELAYS

B6-2.2.1 GS- Relay Operate Chain

Although there is no actual chain of contacts in the GS- relay operate path, there are contacts of GS- relays in the operate path of each GS-relay which serve the same purpose.

In periods of very light traffic (assuming only one OR in a connector applies start battery to bid for a pretranslator), GS- relay operation is straightforward. When a PRS- relay operates, it operates PRA-, PRB-relays and the series GS- relays. In periods of heavy traffic, PRS-relays may operate in two or three subgroups at the same time or they may operate in rapid succession.

Assume that the PRS- relays in subgroups 0 and 2 operate at the same time. Relays PRA-, PRB-, and GS- relays for both subgroups will operate. GS2 relay will lock and both GS- relays will remain operated. If GS0 relay had been operated slightly before GS2 relay, the GS2 relay operate path would have been opened by a contact of GS0. If, however, GS2 relay had operated first, GS0 could have subsequently been operated.

B6-2.2.2 GS- Relay Work Chain

Since it is possible to operate two or more GS- relays at the same time, a work chain determines which GS- relay does the work. The work chain progresses through contacts of GS- relays in the reverse direction to the effective operate chain; that is, the higher-numbered subgroup has work preference while the lower-numbered subgroup has operate preference. If the GS- relay for subgroup 2 has its GS2 relay operated, the GC2 relay will operate whether or not other GS- relays are operated. When the OR having its PRA-, PRB-, and GS- relay operated is finished, it causes GS- to release. If there is any other GS- relay operated, the next GS- in the work chain which is operated now functions as just described to operate its GC- relay. This continues until all GS- relays have been served.

B6-2.3 PREFERENCE FOR OPERATING PRETRANSLATOR CONNECTOR RELAYS

Three chain circuits are used in selecting a pretranslator and closing the PC- connecting relays. The operation of this portion of the pretranslator connector is similar to operation of the line link marker connector.

B6-2.3.1 CB- Relay Chain (SFD-B605)

An operated CB- relay indicates that the associated pretranslator is busy to the connector. A CB- relay operated for a preferred pretranslator advances the start lead to the next preferred pretranslator (SFD-B605). If the CB relay for that pretranslator is operated, the start lead is transferred to the next preferred, etc. Usually only two pretranslators are provided.

B6-2.3.2 PS- Relay Operate Chain

In periods of very light traffic (and assuming no pretranslators busy), PS- relay operation is straightforward. When PRA-, PRB-, and GC- relay have operated, start battery is applied to the STA lead if the Z relay is normal and to the STB lead if the Z relay is operated (SFD-B604). (The Z relay is operated on every other call.) A start signal on either STA or STB operates the PS- relay associated with the PS- terminal to which the start lead is cross-connected.

In periods of heavy traffic, one or more pretranslators may be busy and calls may initiate from more than one connector simultaneously or in rapid succession.

Assume that the STA lead of connector 1 and the STB lead of connector 1 are closed simultaneously (SFD-B605). The PS0 relay in both connectors will operate to the PSG ground in the pretranslator. An early make-contact on the PS0 relay for connector 0 will provide locking ground for that PS0 relay before the break-contact for the PS0 relay in connector 1 opens the operate path from the PSK ground. Thus, both relays will operate and lock.

If, however, connector 1 closed its start lead slightly ahead of connector 0, the PS0 relay for connector 0 could not operate. If, on the other hand, the 0 connector closed its start lead first, a subsequent closure by the 1 connector could operate its PS0 relay.

B6-2.3.3 PS- Relay Work Chain (SFD-B605)

Since it is possible to operate two or more PS- relays at the same time, the work chain determines which PS- relay does the work. Ground for the work chain initiates in the pretranslator at the PCG cross-connection. It should be noted that the work chain proceeds through contacts of the PS- relays in a reverse direction to the preference PSK chain. Contacts on the PS0 relay for connector 0 are therefore enabled to operate connector relay PC0 whether or not any other PS0 relay is operated (SFD-B605). The PC0 relay operates PA0 and PB0 relays which in turn operate the PCA0 relay. The PC0 relay also operates the PK relay (SFD-B609).

Upon operation of the PCA0 relay, the MB relay of pretranslator 0 is operated (SFD-B605). The MB relay operates CB0 relays in connectors other than the one which seized the pretranslator. Resistance battery to the winding of this CB0 relay is shunted by the operated PC0 relay. If this CB0 relay were allowed to operate, the start battery power over which the PS0 relay operated would be opened.

If two or more PS0 relays had operated, the start battery lead for each connector which failed to get a pretranslator would be advanced to the next preferred pretranslator. If, however, no other pretranslators were available, the calls would have to wait until one becomes available and would again bid for preference.

When a PS- relay operates, it releases normally operated check relays PC and PS for the associated pretranslator (SFD-B605). Release of either of these relays or operation of the PC- connector relay operates the TM relay of the pretranslator (SFD-B608). Operation of the TM relay starts the WT (work timer) of the pretranslator (SFD-B609).

Release of the PS or PC check relays or operation of the TM relay lights an in-use lamp PRT at the JLK panel (SFD-B611).

B6-3 W AND Z RELAY CIRCUIT FOR TRANSFERRING START LEADS (SFD-B604, 609)

If only one start lead were provided, then, under light traffic conditions, a particular connector might seize the same pretranslator for every usage. If this were in trouble, all calls from that connector might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, two start leads are provided for each connector. By alternating the use of these start leads, two pretranslators serve alternately as first choice thereby providing more even wear on the connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

In the following description, assume that relay TRS (Transfer Start) is normal.

B6-3.1 FIRST CONNECTOR USAGE (SFD-B609)

Assume that both W and Z relays are normal. Operation of the PC- relay for any pretranslator in the connector applies ground to the windings of both the W and the Z relays (SFD-B609). A break-contact of the Z relay also closes ground to the other side of the Z relay shunting down the resistance battery to the winding, so that both sides of the winding are at ground potential. Only the W relay can operate. The W relay locks to ground. At the end of the pretranslator usage, the PC- relay releases removing the ground which shunted down battery to the Z relay which now operates.

B6-3.2 SECOND CONNECTOR USAGE (SFD-B609)

The next time a PC- relay operates in the connector, it applies ground through a make-contact of the Z relay to shunt down the resistance battery to the W relay causing it to release (SFD-B609). When the PC- relay releases, it removes ground from the Z relay winding causing it to release. Thus, the W and Z relays are alternately operated on one call and released on the next.

B6-4 CONNECTOR TIMING

When any OR in a connector operates its PST relay, it grounds the TM lead to the connector (SFD-B609). The TM relay operates the TM1 relay and the TRS1 relay. These relays start two timers in the connector.

B6-4.1 CONNECTOR TRANSFER START TIMER

The transfer start timer allows an interval of 150 to 360 milliseconds for the connector to establish a connection to a pretranslator. The timer is stopped when either the MB relay or the pretranslator operates (SFD-B605) which releases the TRS1 relay (SFD-B611) or the PK relay of the connector operates (SFD-B609) which releases the TM relay and, in turn, releases the TRS1 relay (SFD-B611). In either event, the PC- relays of the connector would have operated indicating that a connection to the pretranslator had been established.

If the transfer start timer is not stopped within its timeout interval, the TRS relay is operated (SFD-B609). The TRS relay locks under control of the TM1 and PK relays and it opens the start lead STA or STB which previously used and closes the other start lead (SFD-B604). If the call has proceeded to the operation of the PRA-, PRB-, and GC- relays which close battery to the STA and STB leads, a new attempt to connect to a pretranslator using the other start lead will be made. If a pretranslator is seized using the other start lead, a TRS signal is transmitted to the pretranslator (SFD-B611) which will cause it to produce a trouble record showing a TRS punch. If, however, the call is blocked prior to operation of the GC- relays, the transfer of start leads will have little effect.

B6-4.2 CONNECTOR WORK TIMER (SFD-B609)

The work timer has a longer timing interval (0.93 to 2.22 seconds) than the transfer start timer and covers a failure to connect to a pretranslator after the transfer start timer has timed out. The work timer is started when the TM1 relay operates (SFD-B609) and continues to time until the PK relay operates indicating a connector PC- relay has operated. Operation of the PK relay recycles the timer and also releases the TM relay and in turn the TM1 relay. When the TM1 relay releases with the PK relay operated, the timer is restarted to time for release of the connector as indicated by release of the PK relay. If the pretranslator should take a trouble record while the timer is timing for release of the connector, operation of the PRA relay in the MTFC operates the RCCK relay of the pretranslator (SFD-B611) which reoperates the TM1 relay of the connector and recycles the timer. Upon completion of the trouble record, the TM1 relay releases and again starts the timer.

If the work timer times out, it operates the CA relay which locks under control of the PRTC-AL alarm release key at the JLK panel. The CA relay also lights a PRTC- lamp at the JLK panel. This lamp is lighted momentarily on each call during the time that the PK relay is operated. When the CA relay operates, the lamp remains steadily lighted until released by momentary operation of the PRTC-AL key at the JLK panel. The CA relay also closes resistance battery from the JLK to operate the MJ relay in the alarm circuit to sound a major alarm.

B6-5 FALSE GROUND ON PRL OR RLK LEADS

The register circuit release relay is double-wound. The PRL lead connects to one winding and the RLK lead to the other. A trouble ground on either of these leads would cause calling registers to be released falsely. Such a condition, however, is indicated as follows.

For each register subgroup, the PRL and RLK leads are connected through normal contacts of PSR and GCA to the primary winding of the CA relay. A false ground on these leads with the corresponding GCA relay normal consequently causes the CA relay to operate.

The PRL and RLK leads between the subgroup connector relays and the pretranslator connector relays are also connected to the CA relay through normal contacts of PK, so that the CA relay will operate if these leads are falsely grounded.

The CA relay operated as above performs the function described previously under the work timer.

B6-6 BASIC SETTING RELEASE

A basic setting release jack BSR is provided in the jack, lamp, and key circuit for each register subgroup. When a plug is inserted in this jack, ground is connected to the BSR lead, operating the BSR- relays for the subgroup (SFD-B609). This relay operated returns ground to the jack, lamp, and key circuit over lead SGL to light a guard lamp, and it disconnects the PRL and RLK leads from the CA relay. It also connects ground to the PRL and RLK leads and removes ground from the G1 and G2 leads. This causes calling registers in the subgroup to release immediately under operation of their PRS relays, without any further operations taking place.

Registers released in this manner will call the marker in accordance with the number of digits required for the basic setting. For domestic calls this is usually 7 digits and corresponds to the number of digits used for the home office. For IDDD calls a repetitive timer is employed after 7 digits have been registered. Domestic calls normally using the regular pretranslator, and requiring more or less digits than the number represented by the basic setting, will not be completed, while IDDD calls will be completed.

The basic setting release feature does not interfere with zero operator calls as they do not use the pretranslator. This applies also to calls using 11X codes as service codes.

In view of the service reaction caused by this feature, it is to be used only when a greater reaction would be caused by removing the registers from service.

The PRL and RLK leads are disconnected from the CA relay to prevent operation of the CA relay and the consequent sounding of the major alarm while the make-busy feature is in operation.

B6-7 INFORMATION RECEIVED BY PRETRANSLATOR

B6-7.1 LEADS FROM REGISTER THROUGH CONNECTOR

The register circuit connects grounds to leads A0, 1, 2, 4, and 7; B0, 1, 2, 4, and 7; and C0, 1, 2, 4, and 7, in accordance with the A, B, and C digits which it has received on a 2-out-of-5 basis. The connector closes these leads through to the pretranslator, thereby causing operation of relays AC-, BC-, and CC- which correspond to grounded leads (SFD-B603).

If the A digit preceded by an 11 foreign area directing code is to be translated, the LT and 11X relays are provided. In this case the register connects ground to the LT lead on calls requiring translation of a home area office code or an X11 code, or to the 11 lead for translation of the A digit preceded by an 11 foreign area directing code. This causes the operation of relay LT or 11X.

B6-7.2 LEADS CLOSED BY CONNECTOR

On second trial calls, the connector closes ground to the TR2 lead, operating the TR2 relay (SFD-B609). This relay performs no useful functions, if the call is properly completed. Its action under trouble conditions is covered later.

If a pretranslator is selected after the transfer start feature in the connector has operated, ground is closed to the TRS lead, operating the TRS relay (SFD-B611). This causes a trouble record to be taken as herein described.

B6-8 TRANSLATION

The following paragraphs describe the cross-connection for this circuit and the operation of the translation features for home area office codes in areas where all such codes consist of three digits. The translation for X11 codes, 11 foreign area directing codes and restricted codes, and the treatment of certain vacant codes as applying to all areas, is also described.

As a result of translation, ground is connected to one of a maximum of 10 transmitting punchings BS- and CM- (SFD-B607), the punching used for each codes being in accordance with local requirements. These punchings represent start indexes and control the transmission of information to the register as follows:

(a) Point BSS represents the basic setting. It is used also for foreign areas requiring the same total number of digits, exclusive of an 11 prefix.

(b) Point BSP provides for the number of digits corresponding to the basic setting with station delay. It is used for codes to manual offices with station letters, having party lines which require this setting.*

(c) CMS3 signals the register to call the marker, without returning a coin, after 3 digits have been dialed.

(d) CMP3 signals the register to call the marker after 3 digits have been dialed, but before doing so it signals the register to return the coin on coin lines.

* Since there are now few if any No. 5 Crossbar offices having dial access to manual offices, these cross-connections are seldom used.

(e) CMSA and CMSB are used for additional settings and may represent any numbers of digits, except ten, without stations delay, as determined by the originating register cross-connections.

(f) CMSC is used for additional settings and may represent any numbers of digits, including ten, without stations delay as determined by the originating register cross-connections.

(g) CMPA, CMPB, and CMPC represent the same numbers of digits as for the corresponding S punchings, but in addition set the register for stations delay.*

The operations involved in transmitting the previous information and additional features of the circuit are covered in the following sections.

B6-8.1 METHOD OF TRANSLATION (SFD-B606)

Since practically all No. 5 Crossbar offices are now arranged to use only 3 digit office codes, neither this description nor the SFD show 2 digit code options.

If local translation is required on a call (LT† relay operated by originating register), the pretranslator translates the 3 digit office code comprised of the A digits 2-9, the B digit 0-9, and the C digit 1-9 (or 0-9 if the office is arranged to use office codes with 0 in C digit). The end result as described in SCD-B6-7.1 is to be able to inform the OR of how many digits it should expect and in some cases whether or not to return a coin or coin lines.

The B digit which is received in a 2/5 code is translated into a 1/10 code to operate one of the sets of relays B0, BA0, CZ0 through B9, BA9, and CZ9 (SFD-B606). The three relays operated in series are required to provide sufficient contacts to perform subsequent portions of the overall translation.

One through 9 of the C digit is translated into two separate 1/3 codes (SFD-B606) as follows:

C Digit	Relay	C Digit	Relays
1, 2, or 3	CR	1, 4, or 7	CU, CUA
4, 5, or 6	CS	2, 5, or 8	CV, CVA
7, 8, or 9	CT	3, 6, or 9	CW, CWA

* Since there are now few if any No. 5 Crossbar offices having dial access to manual offices, these cross-connections are seldom used.

† In some cases, only local translation is required and the LT relay is not provided. In this case, most of the leads which would go through its contacts are looped.

The 0 of the C digit is translated to operate the CZC relay if the office is arranged to used office codes with 0 in the C digit. If the office is not arranged to used office codes with 0 in the C digit, the 0 translation grounds the VCR terminal which, as will be covered later, is cross connected to treat 0 in the C digit as a vacant code.

Translation of the A digit is combined with the results of the previous two translations. (It should be noted that there will never be a 0 or 1 in the A digit when local translation is required since the OR will not connect to a pretranslator if there is a 0 in the A digit and will not store a 1 in the A digit.*) The first portion of this translation (SFD-B606) results in grounding of one of the terminals 20R through 99T or (if the office uses codes with 0 in the C digit) one of the terminals 200 through 990 is grounded.

Each of the 80 terminals 200 - 990 represents an individual code with a C digit 0.

Each of the 240 terminals 20R through 99T represents any of 3 codes as follows:

The first digit of the terminal designation is the A digit, the second is the B digit, and the letter indicates the C digit as below:

R = C1, 2, or 3
S = C5, 5, or 6
T = C7, 8, or 9

Further translation of this output is required to sort each code into 1 of 3 categories. For this purpose, there is provision for cross-connection from the 20R through 99T terminals to terminals P0-26.

Typical cross-connections are shown on SFD-B606.

Assume that each of codes 291, 292, and 293 represented by terminal 29R (SFD-B606) require that the register wait for 7 digits. Refer to Table A of Note 2 on SFD-B610. Terminal 29R should be cross-connected to terminal P0.

Assume that of the three codes represented by terminal 20S:

* This is not true if two digits 1 are dialed first as a directory code. In this case, however, the OR will signal the pretranslator for use of the 11 translator rather than the LT translator.

204 is an area code requiring 10 digits.
205 is an area code to a manual office which may require either 10 or 11 digits.†
206 is a vacant area code (3 digits).

Refer to Table B of Note 2 on SFD-B610. Terminal 20S should be cross-connected to terminal P5. (Code 204 will be closed to terminal W1 by operation of the CU relay; code 205 will be closed to terminal W2 by the CV relay; and code 206 will be closed to terminal W3 by the CW relay.)

Similarly, if it is assumed that the three codes associated with terminal 92T are all vacant office codes (3 digits), Table A of Note 2 on SFD-B610 shows that terminal 92T should be cross-connected to terminal P26 which connects directly to the W3 terminal.

If the office does not use area codes, the W1, W2, and W3 terminals are cross-connected to BS- or CM- terminals (B607) in accordance with Note 1 on SFD-B610. Since most offices do use area codes, the columns in tables associated with offices which do not use office codes have been cross-hatched.

B6-8.1.1 Segregation of Office Codes and Area Codes

In offices which use area codes, a further translation is required to handle office codes and area codes differently.* In this case terminal W1 is connected to WA and W2 is connected to WB. If the B digit is either 0 or 1, the CZ0 or CZ1 relay connects the W1 terminal to W5 and the W2 terminal to W7. If the B digit is 2-9, the CZ2-9 relays connect the W1 terminal to W4 and the W2 terminal to W6. Cross-connections from the W3, W4, W5, W6, and W7 terminals should be made as shown in Note 1 of SFD-B610.

B6-8.1.2 Codes With 0 in C Digit

As previously mentioned, codes with 0 in the C digit cause one of the 80 terminals 200-990 to be grounded. These terminals should be cross-connected as shown in Note 1 of SFD-B610.

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† Even though there are few if any manual offices left, this example is used to illustrate the additional flexibility that is still included in the pretranslator even though no longer required.

* Generally area codes can be distinguished from office codes because they have either 0 or 1 in the B digit. Eventually it is planned that office codes and area codes will be interchangeable; that is, any combination of 3 digits could be either an office code or an area code. Interchangeable codes will not be covered in this issue of the SFD or SCD.

B6-8.1.3 3-Digit Service or Operator Codes X11

Whenever the B digit and the C digit are both 1, the regular B and C digit translators are disabled since they both require that either a BC1, 4, or 7, or a CC1, 4, or 7 relay be operated and neither will be operated if both the B and C digits are 1 (SFD-B606). Instead the X11 terminal is grounded regardless of what the A digit is. All X11 codes are either 3-digit service calls or vacant codes and are handled in the same manner. Terminal X11 should be cross-connected as shown in Note 1 of SFD-B610.

B6-8.1.4 Foreign Area Directing Codes†

When the originating register grounds the 11 lead instead of the LT lead, the LT translator is not enabled. Instead, translation of the A digit causes one of the terminals 11X0-9 to be grounded. These terminals should be cross-connected in accordance with Note 1 of SFD-B610.

B6-9 INFORMATION TRANSMITTED TO REGISTER

As previously described the translation of a code causes ground to be connected to one of a maximum of 10 transmitting punchings BX- and CM-. These punchings are used as follows for transmitting information to the register.

(a) Point BSS represents the basic setting for 7 digits. It is used also for foreign areas requiring 7 digits, exclusive of an 11 prefix.

(b) Point BSP‡ provides for the number of digits corresponding to the basic setting with stations delay. It is used for manual offices and foreign areas requiring this setting.

(c) CMS3 signals the register to call the marker, without returning a coin, after 3 digits have been dialed. It is used for vacant and for X11 service codes and ABX manual straightforward codes if the register is not to return a coin before calling the marker.

† The use of the 11 digits as directing codes has diminished to the point that very few No. 5 Crossbar offices still use it. For this reason the portion of the table in Note 1 of SFD-B610 relating to 11X directing codes has been cross-hatched.

‡ Terminals BSP, CMPA, CMPB, and CMPC provide stations delay which is only required for codes to manual offices. Few if any No. 5 Crossbar offices still require stations delay.

(d) CMP3 signals the register to call the marker after 3 digits have been dialed, but before doing so to return the coin on coin lines. It is used for vacant codes and X11 service codes, and for X11 and ABX manual straightforward codes when they require this feature.

(e) CMSA and CMSB are used for additional settings and may represent any numbers of digits except ten without stations delay, as determined by originating register cross-connections.

(f) CMSC is used for additional settings and may represent any numbers of digits, including ten, without stations delay, as determined by the originating register cross-connections.

(g) CMPA*, CMPB*, and CMPC* represent the same numbers of digits as for the corresponding S punchings, but in addition set the register for stations delay.

B6-9.1 CLOSURE OF TRANSMITTING LEADS (SFD-B607)

Closure of ground to one of the above punchings causes one of relays BS, CM3, CMA, CMB, or CMC, and one of relays SW or PW to operate in series with the primary winding of XR, to battery through TM relay operated. The XR relay does not operate except under trouble conditions as described later. The SW relay operates if the secondary winding of the BS relay or a CM- relay is involved. If it operates, it, in turn, operates SW1. The PW relay operates, operating PW1, if the primary winding of BS or CM- is used.

If one of the relays CM3, CMA, CMB, or CMC operates, it closes ground through the winding of CCM, normal contacts of KTR, through its own operated contacts, to the correspondingly designated lead to the pretranslator connector circuit. If the PW1 relay operates, ground is closed through the winding of CSD, normal contacts of KTR, operated contacts of PW1, to the SD lead to the pretranslator connector circuit. Double contacts, connected in series or in parallel, are used at a number of points in this circuit to guard against failures which would otherwise occur because of a locked contact or an open contact. This applies in particular to failures in the checking features which would make them inoperative.

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* Terminals BSP, CMPA, CMPB, and CMPC provide stations delay which is only required for codes to manual offices. Few if any No. 5 Crossbar offices still require stations delay.

The association of the aforementioned terminals, relays and leads is as shown in Table E

TABLE E

Punchings	Relays Operated	Leads Closed
BSS	BS, SW, and SW1	None
BSP	BS, PW, and PW1	SD
CMS3	CM3, SW, and SW1	CM3
CMP3	CM3, PW, and PW1	CM3, SD
CMSA	CMA, SW, and SW1	CMA
CMPA	CMA, PW, and PW1	CMA, SD
CMSB	CMB, SW, and SW1	CMB
CMPB	CMB, PW, and PW1	CMB, SD
CMSC	CMC, SW, and SW1	CMC
CMPC	CMC, PW, and PW1	CMC, SD

The register circuit is equipped with CM3 and SD relays, and CMA, CMB, and CMC relays, if required, which correspond to the above leads and operate from grounds connected thereto through the windings of relay CCM, normal contact of XR and CSD, as previously described. Cross-connections in the register cause it to call the marker after 7 digits, in accordance with the basic setting, if no leads are grounded. If the CM3 lead is grounded, this basic setting is cancelled and the marker is called after three digits. Ground connected to one of leads CMA, CMB, or CMC also cancels the basic setting and causes the marker to be called at any other desired points as determined by cross-connections in the register. Connection of ground to the SD lead alone causes stations delay to be provided in connection with the number of digits required for the basic setting. The SD lead in combination with CMA, CMB, or CMC adds stations delay to the values assigned thereto. The SD lead in combination with CM3 causes a coin to be returned on coin lines.

If the register transmits more than 2/5 code digit indications to the pretranslator, the pretranslator will detect trouble as described in SCD-B6-12. The register will be released with none of its CM- relays operated (basic setting). This will cause the register to select a marker after the number of digits dialed is the number dialed for the majority of the calls. All such calls will be completed satisfactorily. Stations delay will be inserted where this signal is received from the pretranslator.

6-10 CHECK OF TRANSMITTING LEADS USED AND RELEASE OF CIRCUIT

6-10.1 CONTINUITY CHECK (SFD-B607)

Relay CCM is provided to check the continuity of lead CM3, CMA, CMB, or CMC on calls requiring one of these leads. Relay CSD is provided to check the continuity of the SD lead on calls requiring it. These relays operate in series with a CM- relay or the SD relay in the register circuit upon closure of the paths described in 6-8.2, if the associated leads are continuous through the connector circuit and through the windings of the register circuit relays to battery.

6-10.2 CONTROL OF CONNECTOR RELEASE AND RESTART

Operation of PW1 or SW1 or both causes HD to operate (SFD-B608). This path goes through LSD and LCM normal so that the circuit will fail and call for a trouble record if either or both of these relays should be falsely operated. Such a condition would interfere with the lock check feature for the register circuit relays, as described later, and would not otherwise be indicated. The HD relay locks through LSD or LSM normal to ground at PW1.

Operation of the register circuit release PRL relay, as described later, causes battery to be removed from the start lead from the register to the connector (SFD-B604). This ordinarily would release the register start relay and the pretranslator start relay in the connector, thereby causing the connection to break down. Since it is desired to make certain checks after the register release relay has been operated, the HD relay closes a supplementary battery to the HD lead to hold the connector start relays (SFD-B605). The HDK relay is provided to check this path and operates when it is closed.

To ensure adequate recycle time between calls, it is necessary for the pretranslator to take control of certain start grounds normally closed by the pretranslator connector circuit. For this purpose, the HD relay operated closes ground through TRL normal to the G1 and G2 leads to the connector (SFD-B605 and B608). These leads are bridged. Two leads and a series parallel contact arrangement are used because of the importance of this feature.

The grounds closed to the G1 and G2 leads, as previously mentioned, overlap and replace the start grounds normally closed by the connector. The HD relay operated also closes ground through TRB normal to the GR lead to the connector (SFD-B608). This causes a ground removal relay, designated GR, in the connector to operate and to disconnect the corresponding grounds originating in that circuit. Upon the release of the connection, this relay delays the reclosure of these grounds sufficiently to prevent false overlap between successive calls.

Upon operation of the GR relay in the connector, ground is connected to the PCK lead to the pretranslator, operating the PCK relay (SFD-B608). This closure indicates that all of the required control relays in the connector have operated to ensure transfer of connector control to the pretranslator.

B6-10.3 OPERATION OF REGISTER CIRCUIT RELEASE RELAY

Upon operation of the HDK relay (SFD-B605), indicating that the HD lead is properly closed, ground is connected to the PRL lead to the connector (SFD-B608) provided that the continuity check of the transmitting leads (SCD-B6-9.1) is satisfactory on calls requiring such leads. This path is traced from ground at normal contacts of the XR relay, through contacts of XT normal, HDK operated, TRB normal, CCM or BS operated, CSD or SW1 operated, HD operated, RLK normal, WT normal and TRTR normal to the PRL lead to the connector. The BS relay will have been operated if none of the CM leads are required, and the SW1 relay will have been operated if the SD lead is not required.

Ground connected to the PRL lead as above is closed through the connector to the register and operates the register circuit release relay PRL. This relay is double-wound. The PRL lead connects to one winding and the RLK lead to the other. When operated, it opens the start lead from the register to the connector (SFD-B604), it provides a locking ground for the register circuit (CM-) and (SD) relays (SFD-B607), and it locks through both of its windings, thereby returning ground to the pretranslator on the PRL and RLK leads (SFD-B608). Opening of the start lead has no effect as the start lead battery has previously been replaced by battery connected to the HD lead as described in SCD-B6-9.2. Ground connected to the RLK lead is closed through contacts of TRTR normal, RLK normal, TRB normal, and PCK operated to the winding of the RLK relay, causing it to operate. The RLK relay locks to ground on the RLK lead from the register and to ground on the PRL lead. It also closes a holding circuit for the TM relay (SFD-B608) to cause a timeout if ground should not be removed from the RLK or PRL lead, due to trouble, upon the release of the circuit.

B6-10.4 LOCK CHECK

Relay LCM (SFD-B607) is provided to check that the CM3, CMA, CMB, or CMC relay in the register circuit locks on calls requiring the operation of one of these relays. Relay LSD is provided to check that the SD relay in the register circuit locks, when it is required. If a CM relay and the SD relay are required, both relays BS and SW1 will be normal. The operation of RLK closes ground through normal contacts of BS, operating KTR. It also closes another path to operate KTR from ground through normal contacts of SW1.

Check transfer relay KTR operated as described disconnects the CM- lead from the winding of the CCM relay and connects it to the winding of the LCM relay. It also disconnects the SD lead from the winding of the CSD relay and connects it to the winding of the LSD relay. This causes CCM and CSD to release, if not previously released due to being shunted by the locking grounds for the register circuit relays. It also causes the LCM and LSD relays to operate from these grounds, thereby indicating that the associated register circuit relays have locked.

The minimum time interval (from the closure of ground from the XR relay normal through the winding of the CCM relay to a CM- lead, or from the closure of ground through the winding of the CSD relay to the SD lead, until these paths are opened by operation of the KTR relay) is greater than the maximum operate time of the register circuit CM- and SD relays, provided that the latter relays are properly adjusted.

If a CM- relay in the register circuit is required and the SD relay is not required, the operation of RLK closes ground through normal contacts of BS to operate KTR as described previously. This releases CCM and operates LCM, if the register circuit CM- relay has locked. Since SW1 relay would be operated in this case, RLK operates LSD directly.

If the SD relay is required and none of the CM- relays are required, RLK operates RTR through SW1 normal, thereby releasing CSD and operating LSD if the register circuit SD relay has locked. Since the BS relay would be operated in this case, RLK operates LCM directly.

If none of the above register circuit relays are required, the KTR relay does not operate as neither of its operating paths are closed, and the LCD and LCM relays are operated directly by the RLK relay through BS and SW1 relays operated.

From the foregoing it is evident that the BS relay operated cancels the continuity and lock checks which would otherwise be made in connection with a CM lead, and the SW1 relay cancels these checks for the SD lead.

In many of the above mentioned cases, the LCM relay operated locks to ground on the PW1 relay for a reason given later (SCD-B6-11). It also locks to ground on the RLK relay to prevent the breaking of current at the BS relay contacts, in case BS should release before RLK in disconnection. A lock* of these contacts would otherwise make the lock check feature inoperative without any indication thereof. The LSD relay locks to ground at the RLK to prevent the breaking of current at contacts of SW1 for the same reason.

* Repeated breaking of current by contacts on U-type relays causes a build up on one contact and a pit on the other. Occasionally the pit and build up will lock together holding the contacts permanently closed.

B6-11 RETURN TO NORMAL

With both LCM and LSD operated, parallel locking paths for the HD relay previously described are opened causing HD to release. Release of HD removes battery from the HD lead to the connector and releases HDK. It also removes ground from the G1, G2, and GR leads to the connector.

The removal of battery from the HD lead and the removal of ground from the G1 and G2 leads causes the connector circuit to release. These leads are opened simultaneously to prevent false starts in the connector which might otherwise occur if the HD lead were opened first.

Release of the connector opens the receiving leads thereby releasing any of relays AC-, BC-, CC-, LT, and 11X that were operated (SFD-B603) and causes release of the pretranslator as shown in the sequence chart SFD-B602.

Release of the connector also opens the PCK and MB leads releasing the PCK and MB relays. The MB relay released removes ground from the CB leads and connects ground to the TRS1 lead. Release of the receiving relays AC- etc. causes the operated translator relays, the operated BS or CM- relay, PW or SW, and PW1 or SW1 to release. Release of PW1 or SW1 releases LCM, thereby restoring the circuit to normal. The locking path for LCM to ground on the PW1 is provided to prevent false momentary operation of the HD relay during disconnection.

B6-12 ABANDONED CALL

The pretranslator is arranged to restore to normal at any state of a call if the originating register is released due to premature disconnection by the subscriber. Release of the register in this case removes ground from the receiving leads, releasing the operated AC-, BC-, CC-, LT and 11X relays. This in turn releases any operated translator relays and transmitting relays. If HD is operated, it is released due to the release of PW1 or SW1. This opens the HD, G1, and G2 leads. The connector restores to normal when these leads are opened, or due to the release of the register if they have not been closed. Release of the connector causes the pretranslator to restore to normal.

B6-13 TROUBLE CONDITIONS

CROSS-DETECTION

The XR relay operates if ground is connected to two or more of the BS- and CM- terminals (SFD-B607). Such a condition may be caused by crosses or locked contacts at the register or translator relays, or by external trouble resulting in the connection of ground to three or more receiving leads for the A, B, or C digit, or to both of leads LT and 11.

A cross-condition which might cause both PW and SW relays to operate even though only one CM- or BS relay is operated causes both PW1 and SW1 relays to operate (SFD-B607). This removes the bias from the secondary winding of the XR relay causing it to operate even though there is current through only one CM- or BS relay.

Transmitting leads CM3, CMA, CMB, CMC, and SD are connected through normal contacts of relays CM3, CMA, CMB, CMC, and PW1, respectively, and through resistors to the winding of XT. Trouble release lead PTR is also connected to the XT relay through normal contacts of FA1, RLK, PRL, TR2, and TRB1 and through a resistor. A false ground on any of these leads with the circuit normal or on any lead not used during the progress of a call causes XT to operate. The resistors are provided to prevent backups which might cause additional false operations and would complicate the trouble record.

The operation of XR or XT opens the ground supply for the PRL lead (SFD-B608). This prevents the release of the circuit if a call is in progress in order that a trouble record may be taken and a second trial may be made if the call is a first trial call. To prevent registrations in the register in the event that XR operates, the ground feeding all the CM-leads from relay CCM (SFD-B607) is placed under control of the back contact of relay XR. To prevent a backup when relay TRB operates on second trials, a back contact of relay TRB is inserted in the PRL lead. Operation of XR or XT also operates relay TR, for taking the record as described later.

A false ground on the PRL lead with the circuit normal is closed through normal contacts of TRTR, WT, RLK, and HD, operating XRL (SFD-B608). A false ground on the RLK lead with the circuit normal is closed through normal contacts of TRTR, RLK, TRB, PCK, and HD operating XRL. Relay XRL operated operates TR.

Make-contacts of the HDK relay closes ground to the PRL lead (SFD-B608) and if they should lock, an open HD lead would not be detected.

Such a trouble, however, causes the TR relay to operate with the circuit normal, from ground through normal contacts of XR and XT, the locked contacts HDK, and normal contacts of TM, to the TR relay. Operation of the TR relay will start the TRTR timer which will time out to give an alarm and will hold the pretranslator out of service. This path is open while the PRL lead is being used on a call due to TM operated.

B6-14 TIMERS IN PRETRANSLATOR

B6-14.1 WORK TIMER (SFD-B611)

The work timer is started when the TM relay operates at the time the pretranslator is seized and continues timing until the TM relay releases upon release of the pretranslator or until it times out after 200 to 400 milliseconds. If the work timer times out, it operates the WT relay. The WT relay operates the TR relay (SFD-B608) which operates the TRST relay to initiate a request for a trouble record.

B6-14.2 TROUBLE RECORD TIMER (SFD-B611)

The TR relay (SFD-B608) is operated by the WT relay as a result of work timer timeout, by operation of the XRL, XR, or XT cross-detection relays or by falsely closed or locked HDK contacts when the TM relay is normal. As noted above, the TR relay operates the TRST relay to cause a trouble record to be taken. The TR relay also starts the trouble timer (SFD-B611) which times for 1.87 to 3.73 seconds which is long enough to allow for a trouble record to be taken under normal conditions. If the TRTR timer times out before the trouble record has been completed and caused the TR relay to release, the TRTR relay operates.

The TRTR relay operated locks from 130-volt battery through resistor TRT4, to ground at TR operated. TRTR opens the battery supply for the TRST lead so that the master test frame connector will be released if this has not already taken place. TRTR connects ground to the PRL and RLK leads (SFD-B608) to operate the register circuit release relay and at the same time connects battery to the HD lead (SFD-B605) to hold the connection even though the release relay in the register operates. TRTR also operates TRA (SFD-B611) which locks to ground on the AR lead from the miscellaneous circuit for all frames, connects ground to the TRT lead to that circuit to light a trouble time-out TRT lamp, and connects battery to the MJ lead to the alarm circuit to actuate a major alarm.

Relay TRA also opens the HD lead (SFD-B605). The control of the HD lead by TRTR and TRA is provided to ensure operating TRA before the connector releases. With the PRL and RLK leads grounded and the HD lead open the connector should release. However, a further alternate release path is provided by operating TRBA and TRL from TRA and TRTR. This provides for releasing the connector by control of the G1, G2, and GR leads as previously described.

The MB relay is held operated by relays TR, TRL, and TRB1 so that the circuit will be held busy if any of these relays should remain operated falsely due to trouble.

The TRA relay remains operated until ground is momentarily removed from the AR lead due to release of the alarm. If trouble records are called for during this interval, the TRB relay will operate from ground connected to the TRB lead by the TRA relay, and the master test frame connector will therefore appear to be busy.

B6-15 TROUBLE RECORD

B6-15.1 TROUBLE RECORD REQUEST

The TR relay operated as in any of the above cases (SCD-B6-13.2) closes ground to hold the MB relay (SFD-B611), it connects the TRB lead from the master test frame connector to the winding of the TRB relay, and it operates relay TRST. It also starts the trouble record timer TRTR. If the circuit releases after the trouble record is taken, or without a record if the master test frame connector is busy, the trouble timer is recycled without operating the TRTR relay. Its action upon failure of the circuit to release is described later.

If the master test frame connector is idle, as indicated by the absence of ground on the TRB lead, the TRB relay does not operate. Operation of the TRST consequently closes battery to the TRST lead to the master test frame connector circuit to operate the PPR relay of the MTFC to bid for preference to the trouble recorder.*

The TRST relay also closes a locking path for the TR2 relay which is operated on second trial calls and it connects ground on the LK lead from the master test frame connector circuit through normal contacts of TR2 to the MN lead to the jack, lamp, and key circuit or through operated contacts of TR2 to the MJ lead. This provides a minor alarm on first trial failure or a major alarm on second trial failure. The TRST relay also opens the operating path of the WT relay, to prevent it from operating if it has not already done so.

Due to closure of battery to the TRST lead, the master test frame connector advances and connects ground to the RCCK lead, operating relay RCCK as an indication that the call has received preference. This relay locks and connects ground to the CTM lead to the pretranslator connector, to cancel the time measure in that circuit (SFD-B611). This is done to prevent a connector time alarm due to the delay caused by taking a record.

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* The PTA lead to the MTFC and the PTP- relays of the MTFC are used in establishing test calls to pretranslators and will be described in the maintenance section along with a more complete description of a trouble recorder.

Grounds connected to any of the A-, B-, C-, LT, and 11 receiving leads, the CM- and SD transmitting leads, and the PCK, PRL, RLK, PTR, TR2, and TRS control leads are forwarded to the master test frame connector circuit over multiples of these leads, for control of the interposer magnets in the trouble recorder. Ground is connected to the XX lead if relays XR, XT, or XRL are operated, or if contacts of HDK are crossed (SFD-B608). Ground at normal contacts of TR2 is connected to the TRK lead on first trial failures. The pretranslator connector also closes leads to the master test frame subgroup CN- and register RG- involved in the trouble.

Under certain conditions the CCM and CSD relays, if not already operated, may operate momentarily from battery through the trouble recorder interposer magnets, during the progress of the recording. This, however, will not cause the circuit to advance falsely.

If the continuity check feature is made ineffective for any reason such as crossed contacts of CCM or CSD relays or crosses at the contacts of BS or SW1 relays which parallel them, a continuity failure will appear as a lock check failure (SCD-B6-9.4). The appearance of a lock check failure will also be caused if the RLK lead becomes falsely grounded during a call, thereby causing the RLK and KTR relays to operate before the register circuit CM- and SD relays have operated. This also applies if the latter relays are out of adjustment and are extremely slow.

The LT lead is wired in all installations. The LT indication will be shown on trouble records in offices which do not have the LT and 11X relays equipped. In these offices the LT lead will be grounded on all calls.

B6-15.2 TROUBLE RECORD COMPLETE OR TROUBLE RECORDER BUSY

Upon completion of the trouble record or if the trouble recorder is busy at the time of a bid for the trouble recorder, the master test frame connector connects ground to the TRB lead, operating the TRB relay through operated contacts of TR (SFD-B609). The TRB relay opens the TRST lead which causes the master test frame connector to restore to normal, and it locks to relay TRST operated. It also opens the GR lead (SFD-B608) so that the pretranslator connector circuit GR relay may be released if a second trial is to be made, and it connects battery through the HD ballast lamp and TRL normal to the HD lead so that when the TRL relay operates, battery is removed from the HD lead at the same time that ground is removed from the G1 and G2 leads (SCD-B6-15.4) (SFD-B605). The TRB relay operates the TRB1 relay (SFD-B611) which puts ground on the TR lead to the master test frame plant register circuit provided the TR2 relay is normal indicating a first trial call. If the TR2 relay is operated indicating a second trial call, ground is put on the PST lead to the master test frame plant register circuit. Ground on the TR and PST leads is provided through a back- contact of a test relay PTT- in the master test frame connector. This is to prevent trouble record registration on test calls. TRB1 also connects resistance battery to the PTP lead to the master test frame connector to prevent reestablishing the plant register ground on test calls before TRB1 releases. Grounds on the TR or PST lead will cause the plant register circuit to count the number of first and second trial troubles. Also on a second trial call the TR2 relay is locked operated through a contact of the TRB1 relay. Operation of the TRB1 relay also places ground on the MB lead to the pretranslator connector circuit to hold the pretranslator busy until TRB1 releases (SFD-B611).

B6-15.3 TROUBLE RELEASE AFTER A REQUEST FOR A TROUBLE RECORD

Upon completion of a trouble record or if the trouble recorder is busy at the time the trouble record is requested, the TRB and TRB1 relays operate. If the PTR has not progressed far enough to have operated the PRL relay of the OR (PRL and RLK relays normal in PTR) operation of the TRB1 relay grounds the trouble release lead PTR to the connector (SD-B607, B608).

Ground connected to the PTR lead is closed through contacts of the operated PCA- relay of the connector (SFD-B609) and through PTR1 normal, operating PTR. This ground is also closed to one side of the winding of PTR1. Relay PTR operated connects ground through the operated GC relay to the other side of the winding of PTR1, short-circuiting it so that it does not operate at this time and the PTR- relay also opens the locking path of the GR- relay, causing it to release if operated. Release of GR- recloses the G1 and G2 lead grounds to hold the PRA-, PRB, and GS relays (SFD-B604) so that the register connector and subgroup connector relays will remain operated after the pretranslator is disconnected.

The PTR relay operated operates TR2 of the PTRC (SFD-B611) which releases the PS relay (SFD-B604) by opening the STA, STB, and HD leads. This in turn releases the operated PC relay (SFD-B605), PA, PB, and PCA relays and the PK relay (SFD-B611), thereby disconnecting the pretranslator. Since the PC relay releases before the pretranslator removes ground from the CB leads, the associated CB relay (SFD-B605) operates. It locks to ground on the LCB lead unless all CB relays are operated. This causes a different pretranslator to be selected for the second trial, if one is available. Release of the PC relay also causes the Z relay to operate or release (SFD-B609) as previously described (SCD-B6-3).

When the PTR lead is opened by release of PCA, the PTR1 relay operates and the PTR relay locks in series. The PTR1 recloses the locking ground for the GR relays and releases TR2. The TR2 recloses the STA, STB, and HD leads (SFD-B605) which causes a pretranslator to be selected for second trial, the PS, PC, PA, PB, PCA, and PK relays operated as previously described. The TR2 is locked to W and Z if one of these relays is operated and the other released. This prevents reseizure of a pretranslator until Z has transferred the start lead preference. The TR2 relay is made slightly slow-release by the TR2 resistance so that the CB relay of the pretranslator which was just released will be operated before reselection of a pretranslator is attempted. The operated PTR1 relay grounds the TR2 lead (SFD-B611) to signal the newly seized pretranslator that this is a second trial.

B6-15.4 REGULAR RELEASE AFTER A REQUEST FOR A TROUBLE RECORD

If the pretranslator encounters trouble on a first trial call which has progressed far enough to operate the register circuit release relay, or on any second trial call, it does not connect ground to the PTR lead because one of the relays PRL, RLK, or TR2 will have been operated (SFD-B607). After the trouble record is taken, or if the trouble recorder is busy, it connects ground to the GR lead to operate the GR relay if it has not already been operated. On second trial calls, it also connects ground to the RLK lead to operate the register circuit release if it is normal (SFD-B608). The connector is then released in the regular manner due to the simultaneous opening of the HD, G1, and G2 leads by the pretranslator.

If the pretranslator encounters trouble on a first trial call which has progressed far enough to operate the PRL relay of the OR (as indicated by either or both the PRL and RLK relay operated in the PTR) the PTR lead is not grounded (SFD-B607). The PTR lead is not grounded on any second trial call because of the operated TR2 relay.

Under the above conditions, upon completion of a trouble record or if the trouble recorder is busy, the TRB relay operates (SFD-B611) and in turn operates the TRB1 and TRBA relays. On second trial calls operation of the TRB relay also ground the RLK lead from ground on the TRL relay normal to operate the PRL relay or the OR if it has not already been operated.

The TRBA relay connects ground to the G1, G2, and GR leads (SFD-B608) to operate the GR relay of the PTRC which opens grounds to the G1 and G2 leads from the PTRC thus transferring control to the pretranslator. The TRB1 relay is a slow-acting relay to that there is a slight delay from the time that the TRB relay operates until the TRBA and TRB1 relays operate the TRL relay (SFD-B611). When the TRL relay operates, it removes ground from the G1 and G2 leads and on second trial calls from the RLK lead (SFD-B608). The operation of the TRL relay also opens battery to the HD lead (SFD-B605). This simultaneously releases the PRS and PS relays of the PTRC via the HD lead along with the PRA, PRB, and GS relays via the G1 and G2 leads. This in turn releases other connector relays (SFD-B604, B605, B609). Upon release of the connector relays, all operated relays of the PTR release.

B6-15.5 CALL ABANDONED WHILE TROUBLE RECORD IS BEING TAKEN

If the subscriber disconnects while a trouble record is being taken, the pretranslator restores to normal as described in SCD-B6-11, thereby releasing the relays operated because of the trouble condition. The consequent removal of battery from the TRST lead causes the master test frame connector to restore to normal. A partial trouble record will result.

B6-15.6 MASTER TEST FRAME CONNECTOR BUSY

If the master test frame connector is busy when a trouble record is called for, ground on the TRB lead operates relay TRB upon operation of TR relay (SFD-B611). This prevents the closure of battery to the TRST lead to the master test frame connector circuit. The RCCK relay does not operate. Upon operation of TRB, the DL relay operates. The DL relay locks and connects ground to the DL lead to the jack, lamp, and key circuit to light a display lost lamp (DL). This relay remains operated until battery is momentarily removed from the DLB lead by the JLK circuit.

The TRB relay opens the GR lead (SFD-B608) and connects battery to the HD lead independently on the HD relay (SFD-B605) as previously described, and causes the operations described in SCD-B6-14.2 to take place.

B6-16 TEST CALLS

The pretranslator may be tested from the master test control circuit over paths closed by the master test frame connector circuit. The operation of the circuit on test calls is as previously described for regular calls, except that the PS and PC relay (SFD-B605) do not release. The receiving lead grounds and other incoming signals to the pretranslator are provided by the master test control circuit, and the outgoing signals are returned to it to light lamps at the MTC. The pretranslator connector is not involved in these calls.

If a test call is started while the pretranslator is busy on a service call, the test connection is delayed until the service call is completed. The busy condition in this case is indicated by ground on the TM lead to the master test frame connector circuit.

B6-16.1 SELECTION OF PRETRANSLATOR AND CONNECTION TO PRETRANSLATOR VIA MTFC

Selection of a pretranslator and connection to it via the MTFC will be described in the maintenance section.

B6-16.2 SIGNAL TO OPERATE KEY CONNECTING RELAYS

Ground on the TS lead from the master test frame connector operates the TS relay which operates the PC1 relay through previously operated PT1 and SR relays (SFD-B608). The PC1 relay:

(a) Operates KA, KB, and KC relays to closed through the A, B, and C key or switch contacts (SFD-B603).

(b) Operates PC2 relay and, if OT and PTR keys are normal, operates the PC3 relay (SFD-B608).

(c) Locks around contacts of the SR relay.

Relays PC1, PC2, and PC3 are connecting relays which close through leads via the master test frame connector to the pretranslator and also furnish grounds to the TR2/TRS key and to the 11 key or the TRNA switch (SFD-B603) which control the grounds applied to the TR2, TRS LT, and 11 leads.

B6-16.3 REGULAR PRETRANSLATOR TEST

When the pretranslator receives a code and a ground on the LT or the 11 lead and has translated the code accordingly, it returns ground on one or more of the transmitting leads SD, CM3, CMA, CMB, or CMC through low-resistance continuity check relays (SFD-B607). These grounds operate corresponding relays of the test circuit and light lamps.

When the pretranslator has completed its translation, it operates its HD relay (SFD-B608) which grounds GR and G1T leads and closes battery through its low-resistance HDK relay to the HD lead. The PST relay of the test circuit, having been operated from resistance battery, extends this battery and ground through its winding to the HD lead. The HDK relay of the pretranslator operates to ground (SFD-B605) and the GR and G1 relay of the test circuit also operate (SFD-B608).

Upon operation of the HDK relay, if the pretranslator has been satisfied on its continuity checks of the transmitting leads, it grounds the PRL lead. The PRL lead is closed through the test circuit relays PST, GR, and G1 operated, to operate the PRL relay. The PRL relay locks on both windings and extends ground back to the RLK lead, lights the PRL lamp, provides locking ground for the SD, CM3, CMA, CMB, and CMC relays (SFD-B607), and opens the operate circuit of the PST relay which holds to the HD lead (SFD-B608).

Upon receiving ground on the RLK lead, the pretranslator checks that there is now locking ground on the transmitting leads which it had previously grounded (SFD-B607) (SCD-B6-9).

If the lock check is satisfactory, the HD relay of the pretranslator releases, opening the G1T, GR, and HD lead to release G1, GR, and PST relays of the test circuit which closes a path through the PRL relay operated to operate the MFC relay which in turn operates MFC1 relay to release the MTFC (to be covered in maintenance section). When the master test frame connector has restored to normal, it releases the TS relay.

The PTT, PTR, and those lamps of the CM3, SD, CMA, CMB, and CMC group corresponding to the translation remain lighted at the end of the test.

The G1 and GR lamps flash momentarily but are extinguished at the end of the test.

Operation of the RL key operates the KR and KR1 relays which remove locking grounds allowing the release of the circuit.

B6-16.4 CHECK THAT PRETRANSLATOR APPLIES AND REMOVES GROUND ON GR AND G1 LEADS

The slow-release SR relay is operated through back-contacts of the G1, GR, and PTR1 relays when the PST relay operates. Since the PC1 relay is operated through a make-contact of the SR relay, a check is made that SR is operated before the test starts (SFD-B608).

When the HD relay of the pretranslator operates, it should apply ground to both GR and G1T leads. If either GR or G1 relays fail to operate, the operate path for the PRL relay is held open and the SR relay starts to release. Release of the SR extends locking ground for PST, GR, and G1 relays to hold whichever are operated and also operates MFC relay to release the connection. It is possible that the work timer of the pretranslator might time out to cause a partial record before the SR relay releases under this condition.

The PTT, HD, and either GR or G1 lamps should remain lighted at the end of the test.

If, on an otherwise satisfactory call one or two of the G1T, GR, and HD leads are opened but not all, the MFC relay is prevented from operating until the SR relay releases. When the SR has released, it provides locking circuits for G1, GR, and PST relays to hold up whichever are operated and operates the MFC relay to release the connection. It is possible that the pretranslator may time out and take a partial record before the SR releases under these conditions.

At the end of the test, the PRL, proper SD, CM3, CMA, CMB, and CMC lamps and one or two of the HD, GR, or G1 lamps remain lighted.

B6-16.5 OPEN PRL LEAD - PRL KEY

Operating the PRL key (SFD-B608) opens the PRL lead. When the pretranslator advances to the point of grounding the PRL lead, it blocks because it does not receive ground back on the RLK lead and takes a trouble record which should indicate NO RLK. Upon completion of the trouble record, the pretranslator, having determined that neither the PRL nor RLK leads are grounded, grounds the PTR trouble release lead unless it is handling a second trial call (TR2 key operated). Ground on the PTR lead operates PTR1 relay of the test circuit which starts release of slow-release SR relay and opens the operate path of the PST relay. The pretranslator should maintain battery on the HD lead and ground on the G1T lead but should open the GR lead. The SR relay, being slow, allows time for the PST, GR, and G1 relays to release before closing locking circuits. Upon release of the SR relay, the MFC operates to release the test connection.

The HD, G1, and PTR lamps should remain lighted at the completion of the test. The GR lamp should not be lighted. Some of the SD, CM3, CMA, and CMB or CMC lamps may have lighted during the test but will not remain lighted at the completion of the test because the PRL relay will not have operated to lock them in (SFD-B607).

If the TR2 key (SFD-B611) is operated to simulate second trial, the pretranslator, upon completion of the trouble record, grounds the RLK lead during the operate time of the TRBA and TRL relays of the pretranslator (SFD-B608). The GR lead is opened momentarily then reclosed, and the HD and G1T leads are then opened. Upon operation of the PRL relay of the test circuit over the RLK lead, the SR relay starts to release. Release of the SR relay operates the MFC relay to release the connection and provides a locking circuit for the GR relay.

At the end of the test the PRL, GR, and the proper SD, CM3, CMA, CMB, and CMC lamps should remain lighted.

If the TR2 and RLK keys are operated in addition to the PRL key to simulate second trial failure with both PRL and RLK leads open, the test proceeds as described previously except that the PRL relay does not operate. The SR relay starts to release when the HD and G1 relays release.

At the end of the test the GR, and the proper SD, CM3, CMA, CMB, and CMC lamps should remain lighted.

B6-16.6 OPEN RLK LEAD - RLK KEY

Operating the RLK key (SFD-B608) opens the RLK lead. When the pretranslator advances to the point of grounding the PRL lead, the PRL relay operates but because it cannot return ground on the RLK lead, the pretranslator blocks and takes a trouble record. Upon completion of the trouble record, operation of the TRB relay of the PTR (SFD-B611) removes ground from the GR lead (SFD-B608). Because there is ground on the PRL lead, the PRL relay of the PTR operates. The TRBA relay of the PTR (SFD-B611) is then operated. The TRBA relay recloses ground to the GR lead and operates the TRL relay which removes ground from the G1T lead. The PTR lead is not grounded. THe PST and G1 relays release, starting release of the SR relay. The SR provides a locking circuit for the GR relay.

The PRL, GR, and the proper SD, CM3, CMA, CMB, and CMC lamps should remain lighted at the end of the test. The test should be the same whether the TR2 key is operated or normal.

B6-16.7 OPEN TRANSMITTING LEADS - OT KEY

Operating the OT key prevents the operation of the PC3 relay (SFD-B608) which is the connecting relay for the transmitting leads (SFD-B607). For any code having a translation which would ground one of the transmitting leads (SD, CM3, CMA, CMB, and CMC), the pretranslator will not detect battery on that lead, will recognize a continuity failure, and will take a trouble record.

With the OT key operated, the test functions, after the trouble record, as previously described for PRL key. The lamps SD, CM3, CMA, CMB, or CMC will not be lighted.

B6-16.8 FAILURE TO RECEIVE LOCKING GROUND ON TRANSMITTING LEADS - LK KEY

Operating the LK key prevents locking any of the relays SD, CM3, CMA, CMB, or CMC. On codes having other than the basic translation; i.e., having translations which require grounding some of the transmitting leads, the pretranslator blocks when it does not detect locking ground returned on those leads, and takes a trouble record. Upon completion of the record, the pretranslator momentarily opens the GR lead, then having detected ground on the PRL and RLK leads, recloses the GR lead and opens the HD and G1T leads. The PST and G1 relays releasing start the release of the SR relay. The SR relay releasing locks the GR relay and operates the MFC relay to release the connection.

The PRL and GR lamps should remain lighted upon completion of the test. The proper SD, CM3, CMA, CMB, or CMC lamps will light momentarily but will not remain lighted. The test functions the same with TR2 key operated or normal.

B6-16.9 OPEN PTR LEAD - PTR KEY

For this test the TR2 key should be normal and a code having other than a basic translation should be used. One test should be made with the PRL key operated and another with RLK key operated to test that the pretranslator grounds both RLK and PRL leads.

Operating the PTR key opens the PTR lead and also opens the operate path of the PC3 relay to produce an open transmitting lead condition. When the pretranslator detects this condition, it takes a trouble record, opens the GR lead, and grounds the PTR lead.

The PTR1 relay does not operate, however, because the PTR lead is open. The pretranslator times out on its TRTR timer, brings in an alarm on the pretranslator frame, and grounds the PRL, RLK, and GR leads and then opens HD, G1T, PRL, and RLK leads. The PRL and GR relays should operate. The PST and G1 relay should release. Release of the PST or G1 relays starts release of the SR relay which operates the MFC relay to release the connection. A make-contact of the PTR key prevents release of the SR relay upon release of the GR relay.

At the completion of the test, the GR and PRL lamps should be lighted and there should be an alarm at the pretranslator frame.

B6-16.10 CROSSED OR OPEN RECEIVING LEADS

An older test frame having pushbutton A, B, and C keys, by operating more than one button on the A, B, or C keys, more than 2/5 receiving leads are grounded. If the translations of the code combinations are the same, the pretranslator will detect no trouble and will return the correct translation to the test frame. If, however, the translations of the code are different, the pretranslator will detect the cross and take a trouble record, indicating an XX punch and showing which receiving leads are grounded.

To produce a condition giving the maximum resistance path which is normally expected to operate the crossed-receiving lead detection relay, a combination of buttons on the C key (or the 2CD key with the C switch) should be operated to produce codes having translations which ground only two of the cross-connection points BS, CMP3, CMPB, and CMPC or only two of the cross-connection points BS, CMS3, CMSA, CMSB, and CMSC in the pretranslator.

The C leads grounded by C switch with 2CD key operated are shown in Table F.

TABLE F

Position	Normally Grounded	Extra Lead Grounded With 2CD Key Operated
0	4,7	1
1	0,1	4
2	0,2	4
3	1,2	7
4	0,4	7
5	1,4	0
6	2,4	0
7	0,7	2
8	1,7	2
9	2,7	1

If no button is operated on one of the A, B, or C keys or if one of the A, B, or C switches is in the OFF position (so that an incomplete code is received,) the pretranslator will time out and take a trouble record showing the data received.

B6-16.11 TRANSFER START - TRS KEY

Operating the TRS key simulates a connector transfer start condition by grounding the TRS lead. The pretranslator functions as it would otherwise except that it takes a trouble record before opening the HD and G1T leads, causing the GR lamp to remain lighted. In service this record would show the pretranslator connector used, but this information is lacking on a test call because no pretranslator connector is used.

B6-17 PRETRANSLATOR TROUBLE RECORD CARD ANALYSIS

If it is determined from the trouble analysis flowcharts in SFD-A5 that a trouble record card was produced by a pretranslator, see the pretranslator sequence chart (SFD-B602).

Since the translator job performed by a pretranslator is simple by comparison with the job performed by a marker, analyzation of trouble is much less complex. Designations which may be perforated on the card are listed on the following page.

TI	Trouble detected by pretranslator
MTPT	Pretranslator test call
SRT	Originating register test call
PRT	Pretranslator trouble record
DR-	Pretranslator Number
FR-	Frame } Originating register Identification - (not present on pretranslator test calls)
CN-	Connector
RG-	Register
ITR or TRK	1st trial
2TR or TR2	2nd trial
A-	
B-	Input digits to pretranslator
C-	
LT	Local Translator
11	Foreign Area Translator } Input to pretranslator
CM3/CMA/CMB/ CMC/-SD/-	Output from pretranslator
PCK	Connector control transferred to pretranslator
XX	Cross-condition detected
PRL	Release signal to originating register
RLK	Release Check
PTR	Pretranslator trouble release signal to connector.

B6-17.1 CROSS-DETECTION, XX PUNCH

If the XX indication is punched, there is generally not too much that can be determined from the card directly as a clue to what is crossed. A test call using the same input information to the pretranslator should be set up (SFD-B714). If there is a trouble in the pretranslator it should produce cards similar to the one produced in service. If pretranslator tests do not cause the pretranslator to fail, the trouble may be in the connector or originating register. An OR class of test using the ABC code shown on the trouble record should be set up (SFD-B712) during a period when traffic load will permit all pretranslators made busy but the one which produced the trouble card. This will use all the same circuitry used on the call which produced the trouble record. If the call fails on test calls, it is usually necessary to run repeated tests and to observe relay operation such as XT, XR, XRL, and TM to determine which type of cross was detected to cause the XX punch (SFD-B608).

B6-17.2 TROUBLE RECORDS OTHER THAN XX

For trouble records other than those having an XX punch, verify that there is an LT or 11 punch. The A, B, and C digits should be punched. Observe that there are two and only two punches in each. Where 11 is punched, there may be only the A digit in some cases. Verify from office records that the proper output designations are punched. There may or may not be a PRL or RLK punch depending on how far the pretranslator progressed before the trouble record was produced.

A frequent cause of pretranslator trouble records is from mutilated digits in the originating register (more or less than two leads grounded in the A, B, or C digits). The majority of such trouble is caused by outside plant conditions or by customer dialing habits (SCD-B5-2.2, B5-2.11); however, crossed leads in the OR or the PRTC or fault adjustment of relays in the OR may also cause mutilated digits.

As described in SCD-B6-17.1, PTR test calls or OR test calls should be set up to locate and clear trouble indicated by the trouble record.

SECTION B, PART 7

MAINTENANCE

Index

B7 MAINTENANCE

This part of the B section covers some of the aspects of the use of the master test frame to detect, locate, and clear trouble.

B7-1 USE OF THE MASTER TEST CONTROL TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORDS

Analysis of trouble record cards using the trouble analysis chart and sequence charts of part B0 localizes the trouble to an area which may involve a path through one or two relay contacts within one circuit or may involve a path through many relay contacts in several circuits. Generally, it is impossible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a fraction of a second during marker holding time. Frequently, the path which produced the failure is used only when a particular configuration of circuits or network paths is used. For this reason, it is desirable to be able to reproduce the same condition which caused the trouble in the beginning. The master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

B7-2 USE OF SIMULATION TABLES AND ILLUSTRATED TROUBLE RECORD CARDS

The purpose of simulation tables in SFD-B702, B704, B706, B714, B716 and B718 is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame, which should be operated to provide input or control to the dial tone marker or pretranslator when simulating a trouble record card. Included, for easier reference, is a trouble card designation location for different types of trouble cards. The three types of trouble record cards illustrated are E-5488 (2/X double-sided shown on SFD-B703 and B715, E-4393 (1/X double-sided) shown of SFD-B705 and B717, and E-3638 (1/X single-sided) shown on SFD-B707 and B719.

The drawings in SFD-B703, B705, B707, B715, B717, and B719 depict a trouble record card which includes all of the possible designations (colored) which might be perforated on a record produced by DT (dial tone) or PRT (pretranslator) type call. A color key arrangement is used to indicate the different functions of designations regarding dial tone marker or pretranslator input or output information, progress of call, circuits or paths used, etc.

B7-2.1 FUNCTIONS OF DIAL TONE CLASS OF CALL (DT)

One of the tables on SFD-B702, B704 or B706 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left-hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right-hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in above tables.

(a) To select the dial tone class of marker test, the DT key must be operated or if provided, the TSTA switch must be set to position DT.

(b) Select the particular DTM which produced the record.

(c) Set up the same line location indicated by the card.

(d) In some of the older offices, class-of-service keys are not effective on DT class of test. The class-of-service keys are effective on DT class of test as a standard feature in new (or updated) offices and offices arranged for 60 classes of service. In general, class-of-service keys should not be operated on DT class of test. With class-of-service keys normal, the DTM determines class of service from cross-connections in the line link frame associated with the line location. If class-of-service keys are operated (in offices where they are effective), the class-of-service keys simulate and bypass the class-of-service cross-connections in the line link frame. In offices having 60 classes of service, the CGA and CGB cross-connections of the line link frame cannot be tested or verified. A test trouble card will always show a CGA punch if the CGB key is normal or a CGB punch if the CGB key is operated as long as either the CGA or CGB cross-connection is provided.

(e) Set up the same rate treatment, if provided, as indicated by the trouble record card.

(f) With the FS/NTFS key normal, the DTM selects a trunk link frame in the same manner that it would on a service call. By operating the FS key along with the FG(0-2) and an FS(0-9) key or the FS(0-9) switch, the DTM selects a marker in the normal manner but is restricted to selecting only that trunk link frame corresponding to the operated FS(0-9) key or switch. Ordinarily the NTFS key should not be used on a DT class of test since it causes the marker to operate in an abnormal manner for trunk link frame selection.

(g) With the TS/NTTS key normal, the DTM selects an OR in the normal manner. With the TS key operated along with the TS0-9 key or the TSU0-9 switch, the DTM selects an OR in the normal manner but is restricted to selecting only that OR corresponding to the operated TS0-9 key or the setting of the TSU switch. Ordinarily the NTTS key should not be used on a DT class of test since it causes the marker to operate in an abnormal manner for originating register selection.*

(h) Refer to table in SCD-B1-5.7 for operation of keys or switches to control register group selection and to test associated cross-connections.

(i) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk switch of a trunk link frame is defined by channel number and junctor group.

(1) Operation of a CH0-9 key or the CH0-9 switch will direct the DTM to select that channel number.

(2) Selection of a particular junctor group is not as straightforward as it seems. Reference should be made to the chart on SFD-B708 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in 2 or more junctor sequence positions and is dependent on junctor step position 1 or 2.

(3) The trouble card will show the junctor group and junctor step position. Junctor step position may be selected by operating the STP1/STP2 key.

* If the OR to be selected is made busy, the NTFS and NTTS keys should be used to permit selection of the OR. It should be recognized, however, that this does not test normal trunk link frame and OR selection.

(4) The JSQ (0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ (0-5) key or switch might be set in any of several positions to select the desired junctor group.

(j) With OBS key normal, a nonobserved call is simulated, operating the OBS key which simulates an observed call.

B7-2.2 FUNCTIONS OF PRETRANSLATOR CLASS OF CALL (PRT)

Use one of the tables on SFD-B714, B716 or B718 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed. The tables are divided into two parts. The left-hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right-hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in the above tables.

(a) To select the pretranslator class of test, the PTT key must be operated, if provided, or the TSTA switch must be set to position PTT.

(b) Select the particular PRT which produced the trouble record. The selection is made by the operation of the MT key or MTU switch. This key or switch is also used for the selection of markers and transverters.

(c) Set up translation (LT or 11) as indicated by trouble record.

(d) Set A through C digits with a known good office code.

B7-3 USE OF CLASS-OF-TEST TABLES

The class-of-test tables shown on SFD-B710 through B713 and B720 summarizes, in tabular form, the key(s) and switch(es) used to establish the particular class of test. A single line is used to separate a particular function with its associated figure, option, key or switch. The double line within the single lines is used to separate the various options or vintages of master test control frames. The note column and sheet notes are as follows:

(a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment be selected for test.

(b) Note 2 indicates the key(s) or switch(es) to be operated to simulate the trouble record. Refer to simulation tables in SFD-B702, B704, B706, B714, B716 or B718 and their associated colored trouble record card on the opposite page of the simulated table selected. The tables and colored trouble record cards, along with the class-of-test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.

(c) Note 3 indicates those key(s) or switch(es) used for additional marker tests but they are not necessarily required for trouble record test or simulation test.

B7-3.1 DIAL TONE CLASS OF TEST

The SFD-B710 and B711 summarize, in tabular form, the key(s) and switch(es) used to establish a dial tone class of test and to perform certain specific dial tone marker tests.

On a dial tone class-of-marker test the master test control circuit simulates a line on a line link frame and a line link connector. The marker is primed with the line equipment location and other information which it would normally receive from these simulated circuits. The marker then proceeds to seize an originating register as it would in processing a service call.

When the connection is established, the marker and all established linkages release. However, information regarding the test is locked in the master test control circuit in the form of operated relays or lighted lamps under control of the RL key. If the REC key is operated, a trouble record is taken just prior to the release of the marker.

B7-3.2 ORIGINATING REGISTER CLASS OF TEST

The SFD-B712 and B713 summarize, in tabular form, the key(s) and switch(es) used to establish an originating register class of test.

Regular test calls of originating registers are usually made by using the originating test line as the calling line. On this type of test, the master test control circuit extends the originating test line to the monitor where subscriber line and dialing conditions are simulated. The test connections are set up by the marker under control of the master test control circuit. The key(s) or switch(es) of the master test control circuit are operated to select the marker to establish the test connection, to set up the called number to be sent to the register, to set up the class of service of the calling line, to select the trunk link frame location of the desired register, and to select the desired register.

The keys of the monitor are operated to prepare the circuit for a test, to set up the speed of pulsing, and to establish the calling subscriber line condition which matches the class of service set up on the master test control circuit.

B7-3.3 PRETRANSLATOR CLASS OF TEST

The SFD-B721 summarizes, in tabular form, the key(s) and switch(es) used to establish a pretranslator class of test.

Pretranslator tests are made by seizing the pretranslator directly from the master test control circuit. The office code to be translated by the pretranslator is set up on the A-, B-, and C- key(s) or switch(es) of the master test control circuit. The master test control circuit simulates an originating register and passes the information to the pretranslator by way of the master test frame connector, which now simulates a pretranslator connector. The pretranslator under test translates the code received and transmits information to the master test control circuit. The translated information indicates the number of digits the OR should receive, if station delay is required, and if the OR should wait before grounding a start lead to seize a completing marker. This information is displayed on the pretranslator test lamp on the master test control panel. The test circuit also simulates various trouble conditions to make tests of the pretranslator checking features.

SECTION C, PART 0

SUBSCRIBER OUTGOING CALL TROUBLE CARD ANALYSIS

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CO SUBSCRIBER OUTGOING CALL TROUBLE CARD ANALYSIS

The trouble analysis flow charts in the A2 Section of the SFD direct the reader to one of the rounded boxes† at the left of SFD-C002 for subscriber outgoing call trouble record cards.

CO-1 CROSS DETECTION, SEQUENCE FAILURE (SFD-C002)

For either of the double sided trouble cards, there is an MXT designation which is punched if there is a cross detected (X--) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single sided trouble card, there is no MXT punch and it is necessary to scan all the X-- designations and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y (yes) if the designation is punched or the statement is true or N (no) if the designation is not punched or the statement is not true. If there is no MXT, cross or sequence failure, the procedure beyond that point is the same for all trouble record cards.

CO-2 TIMING FUNCTIONS

The DTM and CM are designed in such a way that they are timed from seizure until release. Critical functions are timed separately. Understanding the purpose and function of timing circuits will aid the crafts person in understanding the behavior of the marker. General functions of the OAT, WT, SDT/LDT, and TRS timers will be discussed in this section. More detailed description of operations will be discussed in the C1 section.

CO-2.1 OVERALL TIMER (OAT)

The OAT is started when the CM is seized and is stopped when the marker is restored to normal. The timing interval is 9.6 to 15.4 seconds which is greater than the time required on any normal marker usage. This timer guards against failure of any of the other timers. Operation of the timer causes the marker to release without a trouble record but will sound a major alarm.

† Symbols used in flowcharts are described on SFD-A103.

CO-2.2 WORK TIMER (WT)

The WT timer is started when the marker is seized and is stopped when the marker is restored to normal. The timing interval is 450 to 605 milliseconds. This short timer is used to detect troubles as soon as possible in order to quickly release the marker. The WT timer is recycled as the call progresses. Operation of the WT causes the marker to take a trouble record before releasing and will be the timer that will most often generate a trouble record.

CO-2.3 SHORT DELAY TIMER (SDT) AND LONG DELAY TIMER (LDT)

The SDT provides a delay of 2.6 to 4.5 seconds on service calls and 1.1 to 1.9 seconds on no-test calls. The LDT provides a delay of 4.6 to 7.5 seconds. Both timers are started by the operation of the seize frame (SF) and seize frame timer (SFT) relays. The operation of the SF stops the WT timer. The SF and SFT relays operate when the marker closes a start lead to select a frame such as the LL, TL, NG, OSC or FAT. The SF and SFT relays also operate on various test calls and on completion of the sender trunk guard test. The SDT timer always functions first unless the trouble recorder is busy. This condition requires the longer timing provided by the LDT. If the SDT should fail, the LDT, which is also timing will function as a back up.

CO-2.4 TRANSFER START TIMER (TRS)

The TRS circuit functions to transfer the marker connector start leads to the alternate marker preference whenever a marker is not seized in approximately one second. If the WT, SDT/LDT are not punched and the TRS is punched, the trouble record indicates that the marker connector could not connect to a CM within the transfer start timing interval and had to transfer its start leads.

CO-3 FALSE CROSS-GROUND TEST (FCG)

The FCG is the next punch designation which must be considered on the flow chart (SFD-C002) and will be discussed briefly at this time. During light traffic conditions the CM operates all hold magnets except the line hold magnet. The FCG relay is connected to the tip and ring leads and will operate if there is a cross between the tip and ring, a false ground on the ring conductor, or a false battery on the tip conductor. The FCG relay will lock operated, stop the marker progress, and force a WT time out.

CO-4 TROUBLE ANALYSIS SEQUENCE CHART (SFD-C003)

Standard sequence charts generally show a sequence of relay operation and release. All relays are shown that relate to a particular function. Trouble record punch indications are shown at the point in the sequence when ground is applied to or removed from the lead to the trouble recorder. Trouble analysis sequence charts omit relays shown on the regular sequence chart, except those relays associated with the trouble record designations (SFD-A103). A designation on the trouble analysis sequence chart without a punch symbol indicates the point in the sequence where that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

CO-4.1 USE OF FLOW CHART AND TROUBLE ANALYSIS SEQUENCE CHART

This section will demonstrate the use of the flow chart (SFD-C002) and the trouble analysis sequence chart (SFD-C003). A crafts person experienced in the use of trouble record cards may find this section basic, but the procedures shown here (even though they may become automatic) are the procedures a qualified crafts person must perform.

Without a selection of trouble record cards to distribute to the reader, certain functions must be assumed. It is assumed that all trunks, trunk links, line links, senders etc. vary. The only equipment that remains the same on all cards is the marker. Following the flow chart (SFD-C002), it is identified that the MXT punch <u>is not</u> indicated. The path to follow is marked N (No). The WT punch <u>is</u> indicated on the trouble record. The path to follow is marked Y (Yes). This procedure continues through the FCG N (No), the TK Y (Yes), the HMS1 Y (Yes), and the DCT1 N (No). The flow chart directs the reader to SFD-C003.

The trouble analysis sequence chart, and all sequence charts, operate from the top of the page to the bottom. To identify the trouble area the reader must start at that point of major failure and back-track to the point where all punch indications (leading to the branch in trouble) are shown.

To demonstrate: Working back from the DCT1, the GT2 is indicated, the DCT is indicated, and the AVK1 is not indicated. (The reader must now follow the path from the AVK1). The RSC is indicated, the SLK2 is not indicated, and the SLK1 is indicated. There are no other paths leading to the SLK2. The problem exists between the SLK1 and SLK2 indications. The page coordinate A7 shows the portion of the trouble analysis sequence chart that is shown in detail on C202. Use of the sequence chart will be shown in paragraph CO-5.

CO-5 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts, except as noted on SFD-A103.

The example in CO-4.1 continues on SFD-C202. The SLK1 punch checks that the SLK relay operates. The SLK relay checks that the SHKA operates. The relays now involved are the SH hold magnet (OSL), ON, CT and LR relays in the sender, D and the S1 in the trunk, and the release of the SLK in the marker. Caution is necessary at this point. When conditions were established for this example, the only equipment that remained unchanged on all cards was the marker. One might assume that relays in the senders, trunks and OSL (and their operations) could be eliminated. However, this is definetely not true. The physical wiring and apparatus can be eliminated, but the lead to operate the S1 relay in the trunk extends to the marker and cannot be eliminated. The S1 relay should be checked to see if it operates, and then the path to the SLK2 checked.

SECTION C, PART 1

ESTABLISHING AN OUTGOING TRUNK CONNECTION

Index

C ESTABLISHING AN OUTGOING TRUNK CONNECTION

The general sequence of operation of an outgoing trunk connection is as follows:

After dialing is completed, the originating register seizes a completing marker in competition with other originating registers through preference and control circuits. The OR passes line location, class of service, line linkage (dial tone channel used), dialed digits, coin and 2-party information to the marker. The completing marker determines from the translation of the dialed number and other input information received from the originating register, the required route and operates the route relay.

A No. 5 crossbar office is required to supply information to a connecting office when a call is routed through or completed in the connecting office. Senders are used to store the calling information received from the markers and pass digit information to the connecting office. The completing marker determines the type of sender needed and then selects and connects to a sender through the outsender connector. The marker transfers digit, delete, and outpulsing information to the sender. If AMA is required, additional information will be passed to the sender. The completing marker performs many functions at the same time. Two functions performed at approximately the same time are sender and trunk functions. After the marker selects the trunk, and the F relay operates (part C3), the marker closes a path from the sender to the trunk through the outgoing sender link frame.

While the sender connection is being established (part C2) the completing marker proceeds to select a trunk link frame having an idle trunk of the correct type. It then proceeds to select and connect to a trunk.

Following seizure of the trunk link frame, the line link frame on which the calling line is located is seized. This gives the CM access to, and control of, the calling line select and hold magnets.

Following hold magnet operation, the channel is checked for crosses, continuity and double connections. The sender and trunk information is checked to insure its proper transmission. Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL, and the junctor switch and trunk switch crosspoints on the TL. The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Upon the successful completion of the double connection test and the ground test, the completing marker transmits an advance signal to the outgoing sender as an indication that the outgoing sender should assume supervision and complete the call. The marker then checks the functions in the outgoing sender, that the linkage is properly set up, and releases. The outgoing sender, having prepared the distant register or sender to accept pulses, awaits a signal from the distant end and then starts outpulsing. After all digits are outpulsed, supervision of the call is turned over to the trunk, and the sender is released.

C1 INPUT TO THE COMPLETING MARKER AND CODE TRANSLATION

After dialing is completed, the originating register seizes a completing marker in competition with other originating registers through preference and control circuits. The OR passes line location, class of service, line linkage (dial tone channel used), dialed digits, coin and 2-party information to the marker. The completing marker determines from the translation of the dialed number and other input information received from the originating register, the required route and operates the route relay.

C1-1 MARKER SEIZURE

Upon operation of a MST relay in the originating register (SFD-C104), start battery is applied to activate a marker start STA lead or a marker start STB lead to start seizure of a completing marker. As will be seen later, the Z relay is operated and released on alternate calls so that the STA and STB start leads are alternately activated on successive calls. Each register is given preference to one completing marker for an STA start and to another for an STB start by cross-connecting MSA and MSB punchings on SFD-C104 to appropriate MS- punchings on SFD-C105.

C1-1.1 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-C105)

Three chain circuits are used in selecting a completing marker and closing the connector relays between the register and the marker selected. The description of these chains which follows is typical of chains in other connectors.

C1-1.2 CB- (MARKER CONNECTOR BUSY) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

C1-1.3 MS- (MARKER START OR PREFERENCE) RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS-relay operation is straightforward. A start signal from a register operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more registers may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last registers (SFD-C105) initiate simultaneous marker requests. Also assume that both start leads are connected to MSO (that is both prefer marker 0). The MSO relay associated with each of the two registers will operate through the MSK cross-connection to ground in the marker. An early make contact on the MSO relay for the first register will provide locking ground for that MSO relay before the break contact on the MSO relay for the last register opens the MSK ground. Thus, both relays will operate and lock.

If, however, the last register initiated a request for a marker slightly ahead of the first register, the MSO relay for the first register could not operate. On the other hand, if the first register initiated a marker request first, a subsequent request by the last register could operate the MSO relay for that frame.

C1-1.4 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain originates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MSO relay in a reverse direction to the preference MSK chain. Contacts on the MSO relay for the first register are, therefore, enabled to operate connector relays MA- through ME- whether or not any other MSO relay is operated.

Upon operation of the originating register marker connector relays MA- through ME-, the MCB- relays of the selected marker are operated over the MB lead (SFD-C106). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-C105). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MSO relay is not released when the associated CBO relay operates.

If two or more MSO relays had operated for different registers, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other markers were available, no new MS- relay would operate until some marker became available, at which time one or more MS- relays for that marker would operate. This would continue until all registers had been served.

During periods of heavy traffic when all completing markers become busy, a traffic control circuit gates requests by registers for CMs as described in a subsequent section, so that all registers requesting service are served once before any register is served a second time. Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-C105). The release of any one of these relays operates relay TM (SFD-C108) which starts marker timing.

C1-1.5 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-C104)

If only one start lead is provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that register might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, 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 connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

In the following description, assume that relay TRS (transfer start) is normal.

The W and Z relay combination (SFD-C104) operates as follows:

(a) FIRST CONNECTOR USAGE

(1) Marker seizure - Assume that relays MA- through ME- of the originating register marker connector and W and Z of the preference control circuit are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS cross-connection. Relay MS- causes the operation of relays MA- through ME-. Relay MD- operates relay MK in the preference control circuit (SFD-C104), which in turn operates relay W which locks.

(2) Connector release - When the connector releases, release of the MD- relay releases relay MK which causes the Z relay to operate through the operated W. Relay Z locks operated from the ground of relay W which remains operated but the locking ground for W is now through the operated Z to the released MK. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

(1) Marker Seizure - At this time relays MA- through ME- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the MS- cross-connections. Relay MS- causes relays MA- through ME- to operate. The operation of relay MK, this time, opens the locking path of the W allowing it to release.

(2) Connector Release - The release of relay MK when the connector releases 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 connector usage. For subsequent usages the actions described above repeat.

C1-2 TIMING FUNCTIONS IN THE PREFERENCE CONTROL CIRCUIT

Timing circuits in the preference control circuit control marker seizure and once the marker is seized, time its overall function. These timing circuits are discussed below.

C1-2.1 TRANSFER START TIMER (SFD-C108)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the OR to connect to a CM (unless all CMs are busy). If the connection is not established in this time interval, the preference control circuit transfers the start leads and gives a TRS signal to the CM to cause a trouble record to be taken showing that there was a transfer start condition.

The operation of the MST relay in the OR operates the TM relay (SFD-C108). The TM relay operates the TM1 and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will normally be grounded unless all CMs are busy, in which case operation of the IM relay is delayed until a CM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the connector relays MA- through ME- operate. The check that the connector relays have operated, the MA- relay connects ground to the CKG lead to operate CKG1,2 relays. The CKG1,2 relay connects ground to the MTFC as a check that the connector relays operate. The MC- relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the preference control circuit. The operated TC and TC1 relays in the PC opens the path to the IM relay (SFD-C108) which stops and recycles the TRS timer.

If a marker is not seized in approximately one second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-C104), releases the TM relay, in the preference control and holds the TM1 relay operated (SFD-C108). The TM relay is released to open the signal leads CWA and TCA (SFD-C108) to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-C108). The TM1 relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TM1 relay. When a marker is obtained over the new start lead, the TM1 relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the OR which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

C1-2.2 OVERALL TIMER (SFD-C107)

An overall timing circuit is provided which sounds the major alarm if an OR calling for a marker has not been connected to one within 4.6 to 10 seconds. It functions as follows: Upon the start of a call, operation of a relay operated the TM relay at the same time that battery is connected to the start leads for marker seizure. The TM relay operates the TM1 relay which starts the overall TM timer (SFD-C108).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay from the operated marker multi-contact connector relays in the originating register marker connector circuit. The MK relay releases the TM and TM1 relays. During the releasing time of the TM and TM1 relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TM1 relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not break down. However, should the marker exceed this time interval because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the ORMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in-use indication for the ORMC. When it remains steadily lighted, it serves as an ORMC alarm indication.

The MK relay releases at the end of the call upon release of the originating register marker connector circuit multicontact relays and discharges the A capacitor to recycle the TM timer for the next call.

C1-2.3 WORK TIMER

When a marker is seized, the released MAK, MCK or MSK relay operates relay TM, timing marker off normal, which operates relay TMS, timing start. Relay TMS places a ground on one side of capacitor WT and opens the path through resistor WT3 which was shunting it. The WT capacitor becomes charged from the +130 volts battery placed on the side of it through resistor WT1. This causes the voltage on the control anode, terminal 1, of the WT tube to gradually increase through resistor WT2. If after .450 to .605 seconds the marker does not complete the particular function that is being timed, the control anode of the WT tube is increased to positive 72 volts, thereby causing the WT tube to conduct. When the tube conducts, it operates relay WT, work timer. Release of the TMS relay causes the WT capacitor to discharge through the WTS resistor. Because many marker usages exceed the short time interval provided, this timer is recycled as the call progresses. Operation of the WT timer causes the marker to take a trouble record before releasing. The SDT, LDT, TRTR, OAT and HTT tube timing circuits work basically the same as the WT tube timing circuit.

C1-3 INFORMATION FROM THE ORMC TO THE CM

When the ORMC- marker part multicontact relays (MA-ME) operate, information leads from the OR are extended to the CM. The information that passes to the CM is as follows:

Lead Designation (From ORMC)	SFD Location	Lead Description
A2/5 - L2/5 M7	C-115	Called numbers
LT, LT1 11,	C-110	Translator to be used for translating area or office code.
CTA 2/5, CU 2/5, CRU 2/5, CGA, CGB, TP, RP	C-113	Subdivisions of customer class of service and treatment.
MF, D	C-111	Type of customer signaling, TOUCH-TONE® or dial.
FAC, OR	C-110	Type of call.

Lead Designation (From ORMC)	SFD Location	Lead Description
FT 2/4, FU 2/5, VG 2/6, HG 2/5, VF 1/5, LL 2/5	C-114, C-111	Line equipment location on line link frame.
MRL, RL, BT, TRL, BRL	C-107	Release signals to register for normal busy, and trouble releases.
PS, PD, CR, SCN, PK, SCK, CNR	C-112	Trouble and check signals from register, permanent signal partial dial, coin return, stuck coin, permanent signal-partial dial check, stuck coin-coin return check.
CKG, TM, MB	C-108	Marker seizure from register.
OBS, NOB	C-111	Service observing or no service observing.
TRK, TR2, TRS	C-108	First and second trial, and start lead transfer signals.

The leads listed in the table above will operate related relays except the following:

(a) A 2/5 - C 2/5 will operate the AC 2/5 - CC 2/5 relays.

(b) D 2/5 - M 2/5 will extend through make contacts in the marker when the sender is seized and operate relays in the sender.

(c) The LT1 lead will operate the ELT relay.

(d) The CTA 2/5 leads will operate the CT 2/5 relays.

(e) The CU 2/5 leads will operate the CUA 2/5 relays.

(f) The 11 lead will operate the 11X relay.

(g) The D lead will operate the DP relay.

C1-4 GROUNDING A CODE POINT

The marker action for any call depends on directing information received from the register. The information required may come from a direct signal or from the translation of an office or area code. Marker translation consists of changing the code digit information into a single indication which is called a code point. Thus, the result of translation is to "mark a code point." Each digit is received on a 2/5 code basis. The called number information can be in any of various numbering plans, but in general, the number consists of the following:

(a) 4 numerical digits

(b) 1, 2, or 3 digit office code plus 4 numerical digits

(c) A 3 digit area code, 3 digit office code and 4 numerical digits.

The examples used in this SCD will be 3 digit office code plus 4 numerical digits. Grounding or marking a code point requires three separate functions for a 3 digit office code, the A digit translator, the B digit translator and the C digit translator. The example will illustrate how to ground code point C983.

C1-4.1 A DIGIT TRANSLATOR (SFD-C120)

The ground to operate the A digit translator originates on SFD-C120. Ground through XTA 5B (break) through CKG2 6M (make) through OR 12M through FAC 12B, through SCN 8B, through SCK 8M, through CR 7B, through PS 4B, through PD 6B, through PK 6M, through PK 4M, through SCN 6B, through OR 11M, through AC-0 4B, through AC-1 4B, through AC-2 4M, through AC-4 6B, through AC-7 6M, through AC-2 5M, through AC-7 2M through LT 10M to the cross-connect punching LTA 9. This punching is cross connected to ATW 9 and operates the A digit translator relay, AT 9.

C1-4.2 B DIGIT TRANSLATOR (SFD-C121)

The ground to operate the B digit translator originates on SFD-C121. Ground through CKG2 8M, BC-0 4B, BC-1 4M, BC-2 6B, BC-4 6B, BC-7 6M, BC-1 5M, BC-7 5M, and AT-9 9M to ground punching AT98. The same ground extends through BC-1 10M and BC-7 10M to operate the B258 relay. The cross-connect punching AT98 is cross-connected to BT9T (see table SFD-C121) to operate the BT9T relay.

C1-4.3 C DIGIT TRANSLATOR (SFD-C122)

The ground to operate the C digit translator originates on C122. Ground through CKG2 7M, CC-0 4B, CG-1 4M, CC-2 6M, CC-4 8B, CC-7 8B, CC-1 3M, CC-2 3M, B258 4M and BT9T 23M to ground code point C983.

C1-5 SERVICE TREATMENT, PREROUTE RELAY AND ROUTE SERIES RELAY OPERATION

A route is not necessarily identified by the grounded code point alone, but usually requires a combination of code point and class of service, service treatment, and may require preroute and route series relay operation.

C1-5.1 S-RELAY OPERATION, SC-, USC- AND S- CROSS-CONNECTIONS

As previously described, the translation of a code grounds a code point. Customers and trunks are assigned classes to aid in determining the route a call will use. The process of combining code point and class to identify a route is called service treatment. This service treatment is accomplished by using S-, screening relays and their associated cross-connects. The S-relay contacts are wired to USC- and S- punchings (SFD-C127-134). Cross-connections between S-punchings and route relays control the selection of a route when service treatment is required. All classes, customer and trunk, (trunk class will be discussed in detail in SFD Section D) are served by a common group of service treatment relays. The marker has capacity for a maximum of 180 relays; 60 of them are located on the translator and code treatment frame, 60 are located on the supplementary service treatment frame, and 60 are located on the auxiliary supplementary service treatment frame. These relays are furnished on single mounting plate units. Each unit has 12 relays each having 12 make contacts and two D type terminal strips. The control winding terminal of each relay is wired to an SW- punching on terminal strip TA. The SW- punching number will be the same as the S-relay number. The 12 fixed contacts on each relay are wired in multiple to three other relays on the same unit and the common multiple is connected to 12 punchings designated USC0-11 on the terminal strip. The 12 make contacts of each relay are wired to 12 individual service treatment punchings S0-11 on terminal strip TM. The S- relay contacts count 1-12 so that the USCO punching is wired to S- relay 1 fixed. The SO punching is wired to S- relay 1 make. The wiring pattern on each mounting plate unit gives three sets of four relays and each set of relays has 12 USC-punchings on the unit terminal strip.

The marker is arranged for 120 service common SC- punchings, which appear on cross-connection terminal strips on the translation and code treatment frame. Sets of 12 SC- points; SC0-11, SC12-23, etc. are connected by means of loose wire on the rear of the frame to USC-points on the S-relay unit terminal strips. The loose wire is assigned on a job basis to multiple the required number of S- relays, in groups of four relays, to each set of 12 SC- points. In offices with relatively few classes, it is probably desirable to order one S- relay per class. In offices with more complex service treatment patterns, substantial reductions in the number of relays are often possible by use of group sort treatments. The "sort" arrangement in the marker basically provides either two or four separate output points (SWC- punchings for each class of service).

In other words, one class of service may operate up to four S- relays (SFD-C126A0). The SC- points for which treatments are variable from class to class, with no particular pattern must be handled on an individual treatment basis; one S- relay furnished per class of service, per 12 SC- points. The SC- points for which two or more classes of service are always treated alike may be served on a group sort basis, one relay may represent several classes for this group of SC- points.

C1-5.2 PREROUTE RELAYS

A preroute relay is considered an auxiliary to the route relay and provides extra contacts, not available on the route relay, for other functions. Examples of preroute relays and their functions are LPA and LPB, DRO-3, and OPSO and 1 as explained below.

C1-5.2.1 LPA or LPB Local Physical Office A or B Relays (SFD-C128)

The SFD-C128 shows typical route relay operations. One example uses preroute relays LPA and LPB, local physical office A and B. This informs the marker that the call terminates within the marker group. When the code point C765 or 766 is grounded the local completion relays LPA or LPB operates. This operates the desired route relay on 1AO calls. 1AO calls will be covered later in SFD- E section.

C1-5.2.2 Diverted or Denied Route Relays (SFD-C129, 130)

The DRO-7 (diverted route), relays may be arranged to deny service to certain classes of customers (such as PBX lines not allowed to place toll calls). On diverted service the S- points connect to a DRO-7 relay (SFD-C129) which prevents the R- route relay from operating because of the high resistance winding of the DR- relays but the DR- relay will operate. The operation of the DR- relay acts as a preroute to operate the desired route relay for the route assigned to the customer who is being denied access to the route requested.

C1-5.2.3 Operator Routes (SFD-C130)

The OPSO and 1 relays are preroute relays and are provided on operator routes when the marker is required to pass a class signal to the trunk over the "TC" lead. The signal usually results in a tone signal to the operator which indicates the class of the calling customer. There are other preroute relays not covered by this SCD but can be found in CD-26002-01 Section II.

C1-5.3 ROUTE SERIES

The route relay does not furnish the information as to what charge condition is to be met in the trunk, the call is free (flat rate), or a message register must be operated, etc. This is accomplished by inserting a route series relay between the route relay and battery. These route series relays (NCNC, MBS-) appear on the translator and code treatment frame.

C1-6 TYPICAL ROUTE RELAY OPERATIONS

The SFD-C128-C134 shows a few typical route relay operations. The purpose is to give the crafts person an overview of screening and route relay operation. The SD-26002-01 Section D Note 400 series illustrates many more typicals. The examples above may be used in the established format by the operating company or may vary depending on the complexity of their routes. In all cases, the office cross-connect records should be examined to determine the local assignments. Two examples of route relay operation will be demonstrated.

Example #1, assume a call originates from the 765 office (office A) to the 253 office in the same area code and the class of service is 1 party flat rate (1F). The operation of the route and route series relays is as follows. The service treatment relay (S28) operates per the table on SFD-C127. Ground on code point, C253 (SFD-C129), extends from C253 to the SC12 punching, to the USCO punching, through the S28 1M, to the S28 punching, to the SG13 punching, to the RC30 punching, through the route relay R30, to the R30 punching, to the NN punching through the non-charge-non-coin (NCNC) relay, to the route series battery. This operates the route and route series relays.

Example #2, assume a call originates from the 766 office (office B) to the 222 office in the same local area code and the subscriber class of service is 2-party message rate (2MR), the operation of the route and route series relays is as follows. The service treatment relay (S38) operates per the table on SFD-C128. Ground on code point C222 (SFD-C129) extends from C222 to the RC32 punching, through the route relay, R32, to the R32 punching, to the SC14 punching, to the USC2 punching, through the S38 3M, to the S38 punching, to the MBS1 punching, through the message billing series (MBS1) relay to the route series battery to operate the R32 and MBS1 relays.

C1-7 INFORMATION TRANSMITTED THROUGH CONTACTS OF THE ROUTE RELAYS, R--- AND FC--- (SFD-C119)

The route relay controls the marker functions required for trunks and senders. Service cross-connects in the CM and TL permit the information controlled by a route relay to vary, depending on the office requirements. The R--- (route relay), provides 30 make contacts. The FC--- (frame test lead cut-in), relay is an additional route relay required in offices having more than 20 trunk link frames. When the FC--- relay is provided it operates in parallel with the route relay. Functionally, the FC--- relay may be considered as part of the route relay. The FC--- relay provides 12 make contacts. The assignment of contacts for the R and FC relays is shown in table A on the next page.

TABLE A

ROUTE RELAY CONTACT ASSIGNMENT

RELAY	CONTACT	TERMINAL DESIGNATION	RELAY	CONTACT	TERMINAL DESIGNATION
R000-R399	00	TB-	R000-R399	33	FTC 8
R000-R399	10	OS-	R000-R399	43	FTC 13
R000-R399	20	DL-	R000-R399	53	FTC 18
R000-R399	30	FTC 5	R000-R399	04	OF-
R000-R399	40	FTC 10	R000-R399	14	FTC 1
R000-R399	50	FTC 15	R000-R399	24	FTC 4
R000-R399	01	TG-	R000-R399	34	FTC 9
R000-R399	11	CL-	R000-R399	44	FTC 14
R000-R399	21	CP-	R000-R399	54	FTC 19
R000-R399	31	FTC 6	FC000-FC399	1	FTC 20
R000-R399	41	FTC 11	FC000-FC399	2	FTC 21
R000-R399	51	FTC 16	FC000-FC399	3	FTC 22
R000-R399	02	RA-	FC000-FC399	4	FTC 23
R000-R399	12	CR-	FC000-FC399	5	FTC 24
R000-R399	22	FTC 2	FC000-FC399	6	FTC 25
R000-R399	32	FTC 7	FC000-FC399	7	FTC 26
R000-R399	42	FTC 12	FC000-FC399	8	FTC 27
R000-R399	52	FTC 17	FC000-FC399	9	FTC 28
R000-R399	03	PC-	FC000-FC399	10	FTC 29
R000-R399	13	FTC 0	FC000-FC399	11	FCK 3
R000-R399	23	FTC 3	FC000-FC399	12	Operate XFC REL.

C1-8 TABLE B, TERMINAL STRIP LOCATION FOR ROUTE RELAY AND SERVICE TREATMENT CROSS-CONNECTIONS USED IN THE SFD-C SECTION

The location for the route relay and service treatment cross-connects may be found in SD-26002-01 Section D, cross-connect punching index. The route relay cross-connections used in the SFD-C section are listed in the following table (TABLE B) for easy reference.

TABLE B

TERMINAL DESIGNATION	LOCATION			FUNCTIONAL MEANING
	TERMINAL BLOCK	SECTION	FRAME	
AMA	CF	3	CE	AMA-2W
APR	TF	1	TR	Office "A" Physical Route
BL	TN	1	TR	Busy Line
BPR	TF	1	TR	Office "B" Physical Route
C000-C499	TK	1,2,3	TR	3 Digit Code Points
C500-999	TH	2,3,4	TR	3 Digit Code Point
CA	TE,PA LD	3	TR,ARM RM	Catch-All Auxiliary
CC	PA	3	ARM	Coin Collector
CC	TC	2&4	TR	Coin Collector
CC	LD,TN	2,3,4	RM,TR	Coin Collector
CG00-59	TF,TJ LA	1-4	TR,RM	Code Grouping
CG60-119	LA,TJ	2,1-4	RM T&CT	Code Grouping
CLC	TD	4	TR	Class Control
CNS	TN	1	TR	Coin Signal
DR-	TL	1	TR	Diverted Route
ETA-	TK	4	TR	Extra Translation "A" Code Points

TABLE B (Cont)

TERMINAL DESIGNATION	TERMINAL BLOCK	LOCATION SECTION	FRAME	FUNCTIONAL MEANING
FVD-	TK	4	TR	5 Digit Code Point
HTR	TN	2	TR	Heavy Traffic
LR	TE	2	TR	Route Advance
MBS-	TC,TN	1,3	TR	Message Billing Series
NC	TC,TN	1,3	TR	Non Charge Coin
NN	TC,TN	1,3	TR	Non Charge Non Coin
NS1	RB	2	RR	No Sender Intraoffice
OP-	TF	2	TR	Operator Code Point
OSC-	CF *	3	CE	Outsender Connector
OV	TD,TF	2,1	TR	Overflow
PB	TE,LD	2,3	TR,RM	Paths Busy
PC	TD	3,4	TR	Preroute Charge
PCS-	TL,STB	1	TR,SST	Peg Count Service
PD	TF	4	TR	Partial Dial
PM	PA,LD, TN	3,3, 1	ARM,RM, TR	Permanent Signal Coin
PN	PA,LD, TN	3,3, 1	ARM,RM, TR	Permanent Signal Non-Coin
PP	PA,LD, TN	3,3 1	ARM,RM, TR	Permanent Signal PBX
PS	TF	4	TR	Permanent Signal
R---	TD	1,2, 3,4	TR	Route Relay R-Terminal

* Other Locations

TABLE B (Cont)

TERMINAL DESIGNATION	LOCATION: TERMINAL BLOCK	SECTION	FRAME	FUNCTIONAL MEANING
RA---	RA,RC, RD	2	RR	Route Advance
RAG--	TF,LA, PC	2,4, 4	TR,RM ARM	Route Advance Grouping
RB	PA,LO RC,TN	3,3, (2,4)(2,4)	ARM,RM TR	Route Battery
RC---	LH,TG TL	(1-4)(2-3)	RM,TR	Route Relay RC - Terminal
RGT	TD	4	TR	Ringer Test
RGTA	TF	1	TR	Ringer Test per Route
ROA	TE,TJ, TN	3,1, (2,4)	TR	Reorder Auxiliary
RPA/RPB	TJ	1	TR	Ringer Test Off "A/B" Physical
RR-	TF	4	TR	Diverted Route
RV	TD	4	TR	Reverting
S--	TM,STB	(1,2,3,4) (1,2,3,4)	TR,SS	Service Screening
SC--	TE,TJ *	(1,2,3) 1	TR	Service Control
SCG	TD	4	TR	Service Control Ground
SCN	TF	4	TR	Stuck Coin
SG--	TF,TN *	1-4	TR	Service Screen Group
TAV	TF	4	TR	Tandem Vacant Code

* Other Locations

TABLE B (Cont)

TERMINAL DESIGNATION	LOCATION TERMINAL BLOCK	SECTION	FRAME	FUNCTIONAL MEANING
TN	LD,TC,TN *	1,3	RM,TR	Talking Charge Noncoin
TO	TC,TN *	(2,4)(2,4)	TR	Intertoll Route Series
TOV	TF	4	TR	Toll Vacant Code
USC-	TS on Service Treatment Unit		TR	Unit Terminal Punchings for SC-
VCG	TJ,TE	(3-5),3	TR	Vacant Code Grouping
VC-HB	TP	4	TR	Vacant Code Hundreds Intercept - Block
VCI				Vacant Code Vacant Intercept - Code
VC-ST				Vacant Code Intercept - Start
VC-TB				Vacant Code Tens Intercept - Block
VC-U				Vacant Code Intercept - Units

* Other Locations

C1-9 OPERATION OF THE CKG1,2; GC, GCA, LLC1,2; ONX, TLC1,2 AND BX RELAYS

To provide a large number of off normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; LLC1,2; and TLC1,2 relays will be operated.

The operation of the ORMC MA- through ME- relays will extend ground to the CKG lead and will operate the CKG1,2,4,5,6 relays in the marker (SFD-C108). The CKG- relays provide off normal grounds.

The CKG2 relay in operating will operate the BX relay (SFD-C109). The CKG1 relay in operating will operate the ONX relay (SFD-C108). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the CKG2 relay will operate the TLC1,2 relays (SFD-C306). The TLC1,2 relays provide battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The operation of the CKG4 relay will operate LLC1,2 relays (SFD-C307). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-C525).

C1-10 ROUTE RELAY FUNCTIONS (SFD-C119)

When the route relay operates, ground is extended through the route relay to operate information relays that will be used to complete the call. They are FTC 0-29, TB 0-5 (TB0-9), TG 0-9, CR 0-4, CP 0-10, DL 0-6 and CL 0-9.

C1-10.1 FTC 0-29 RELAY OPERATIONS (SFD-C304)

When the route relay operates, the marker determines which trunk link frame has at least one usable trunk available by closing ground to operate a FTC-, frame test common, relay.

C1-10.2 TB0-5 (SD-26032-01) OR TB0-9 (SD-27879-01), TG0-9 AND TGP OR TGS

Trunks are located in terms of trunk block and trunk group. When the route relay operates, ground is extended through its make contact to operate the TB0-5 (TB0-9) trunk block; TG0-9, trunk group and TGP, trunk group primary or TGS, trunk group secondary, relays. The TB- relay in the marker operates the TB- relay in the TL to cut through all BT00-19 leads associated with the trunk block. The TG- relay, with the TGP or TGS, cuts through a TG- lead to test all idle trunks of a particular route.

C1-10.3 CR 0-4, COMPENSATING RESISTANCE, RELAYS

The CR 0-4, compensating resistance, relays may be required when a PC1, panel call indicator, (Manual Office) or RP, revertive pulse, senders are required. Also, the CR 0-4 and CRP or CRS relays will operate if it is desirable to outpulse one arbitrary digit.

C1-10.4 CL 0-8, CLASS, RELAY OPERATION

The operation of the CL 0-8, class, relays determines the class information which is used to indicate a variety of control signals to the senders: for type of trunk and type of call information for CAMA, with MF senders; number of digits in the office code with revertive senders; type of trunk, type of pulsing and pulse speed, with dial pulse senders.

C1-10.5 CP 0-9, CODE PATTERN, RELAY OPERATION

The CP 0-9, code pattern, information is used on AMA calls to indicate the structure of the called number. It tells the sender how many digits are in the office code and whether the numericals consist of 4 or 5 digits (party letters).

C1-11 MONITORING ORIGINATING REGISTERS

In monitoring, the AMRST (automatic monitor register sender and test) circuit monitors registers (and senders) at random and independently records the number pulsed into a register. This number is compared with the number the register sends to the marker. If these numbers do not agree, a trouble card is perforated identifying the circuit in trouble and giving other information relative to the trouble. If the numbers agree, the monitor releases. In either case, the service call is not affected by the action of the ARMST.

C1-11.1 PULSE END AND CONNECTION TO A MARKER

When the register recognizes that pulsing is completed, the register connects to a marker through the marker connector. At the same time, the monitor connects to the marker through the MTFC to obtain the information transmitted from the OR to CM.

When the OR starts to select a CM, ground is removed from the MST lead causing the RPE1, register pulse end one, relay to operate. The RPE1 relay breaks the pulse circuit from the P, pulse repeater, relay to the L, line, relay to prevent the monitor from registering any further pulses. To prevent the monitor from receiving a false pulse, ground is received on the MST1, marker start from OR, at the start of any operations. This ground operates the EMP, end monitor pulse, relay to break the monitor pulsing circuit. The RPE1 relay operates the PEA, pulse end auxiliary, relay. The PEA relay opens the MST lead, recycles and changes the monitor timing interval. Ground from the PEA is closed through break contacts of the PH, pulse help, relay to operate the PE, pulse end, relay. The operated PE relay closes a path to operate the A7-M7 register relay of the digit beyond the last pulsed digit.

When the marker connector connects the register to a marker, a circuit is established from the MM, marker selected on monitor calls, relay to operate the MON, monitor, relay in the marker to prepare it for a monitored call. The MM and MON relays operate in series. The MM relay operation completes the circuit to operate the monitor preference relay in the master test frame connector.

Assuming that the MTFC is not busy, battery on the TRST lead operates the monitor preference relay in the MTFC which operates the CI, cut in, relay. The CI relay closes ground to the ON lead to operate the ON, off-normal, relay. Relay CI also operates the CT1, cut in, relay which operates the multicontact relays MCA and MCB. The MCA and MCB relays connect groups of leads from the monitor to the MTFC. Relay CI also connects ground to the MKB lead to the marker. This lead is multipled to all markers but is effective only in the marker with an operated MON relay. The monitor is now connected to the marker through the MTFC and has registered information necessary for monitoring purposes.

When the MTFC is busy, it operates the TRB, master test frame connector busy, relay of the monitor which opens the TRST lead to prevent seizure of the MTFC until it is fully released. If the TRB is operated when the MM operates, a circuit is closed to operate the NRR, no record release, relay. The NRR relay opens the TRST lead to prevent any further attempt to seize the MTFC. The monitor does not attempt to check the number under this condition but releases after the register and marker release.

C1-11.2 REGISTRATION OF INFORMATION FROM THE MARKER

The physical location of the calling line is recorded through the MCA relay. This information is stored for use if a trouble record is made. The relays used to store this information are VG 2/6, vertical group; VF 1/5, vertical file; HG 2/5, horizontal group; FU 2/5, line link frame units; FT 1/4, line link frame tens.

The number of the marker handling the call is recorded through the MCA relay. One of the M0-9, marker units number, relays operates for the units number and if there are more than 10 markers one of the MKT0-1, marker tens, relays operate for the tens number.

The called number information passed from the register to the marker is closed through the MCB relay. Five leads for each of eleven digits are provided and an M7 lead to register a 7 beyond the last digit. KA 2/5 - KS 2/5, check A-L digits, relays operate in each digit position to correspond to the information passed from the register to the marker. The operated relays lock and control the number checking path in combination with the register relays previously operated by the monitor.

C1-11.3 RELEASE OF THE MASTER TEST FRAME CONNECTOR

When the marker has reached the point of operating the channel hold magnets, it grounds the HMS1 lead to operate the RTC1, release master test frame connector relay. The RTC1 operates the RTC2 and releases the MON and MON1 relays.

When the monitor preference relay in the MTFC releases, the CI releases to remove ground from the ON lead to the MTFC so that the MTFC can completely release. The release of the CI releases the MTFC cut-in relays, the CI1 relay, the MCA and MCB relays at the monitor, and the MTR1 relay. The release of the MTR1 relay closes the TRB lead. This control of the TRB lead prevents operation of the TRB during release of the MTFC.

The operation of the RTC2 relay prevents the monitor from interpreting normal release of the register as an abandoned call. The RTC2 relay operates the MPC2, monitor plant register call counting relay, which in turn operates the MPC1 relay. This releases the MPC2 to cause operation of the CKS, number check start, relay. The operation of the MPC2 also causes the peg count register to operate. The RTC2 relay causes the MB relay to operate. The MB relay is operated so that the register can be held busy at the end of the call until the monitor has checked the number and made a trouble record, if necessary.

C1-11.4 NUMBER CHECKING

The CKS relay locks operated and connects resistance battery to the check path. Each relay used in registering the pulsed number as received by the monitor is paired with a corresponding relay which records the number passed from the register to the marker. This check path is wired in such a way that the two numbers must be exactly the same. If the numbers recorded are the same the CKN, number check, relay operates. The CKS also operates the CKE, number check ended. The CKE relay is a slow operate to permit the CKN to operate if the check path is complete. When the CKE operates ground is extended through break contacts to operate the TRR1, trouble recorder release, relay or through a make contact of the CKN to release the monitor and register.

C1-11.5 FAILURE OF NUMBERS TO MATCH AND TROUBLE RECORD

If the TRR1 relay operates, it locks and operates TRR2. The TRR1 relay grounds the MN lead to the MTF jack, lamp and key circuit to indicate with an audible alarm that a trouble record is being made. The TRR2 relay opens the OK lead to prevent a late number check from releasing the monitor. The TRR2 also closes a ground through the ORN, originating register off-normal, relay to operate a plant register which indicates the number of originating register troubles encountered. The MKB lead is opened by the TRR1 relay to prevent operating marker cut-in relays.

The TRR1 relay also closes battery to the TRST lead to operate the monitor preference relay in the MTFC. If the MTFC is idle the monitor gains access and operates the CI and CI1 relays. The CI1 relay grounds the STR lead. This ground prepares the trouble recorder and MTFC to receive a trouble record. The CI1 also operates the multicontact relays MCA, MCB and MCE relays.

The relays previously operated to record the calling line location, marker number and the called number passed from register to marker extend their locking grounds into the MTFC through the MCA and MCB relays. The called number registered directly by the monitor is extended through the MCE relay to the MTFC. The MOR lead to the MTFC is grounded through the ORN and MCA relays to indicate that the trouble record is being made on a monitored originating register call.

The register may release but the M, monitor, relay and the MB, make busy, relays in the register will be held operated from the monitor. The M relay is held operated to allow identification of the register by extending the RG, register group, FR, frame; and CN, connector, leads through the M and MCA relays.

After a trouble record has been perforated the TRC, trouble record complete, relay operates. The TRC relay operates the RN, return monitor to normal, relay. The RN relay operates and opens the register holding path and both register and monitor release.

C1-11.6 MONITOR RELEASE

In restoring the monitor to normal, the RN relay is operated from the TRC relay if a trouble record has been made or an OK relay if the number check was satisfactory. An OK release signal is also received if a call is abandoned or if a trouble release is received from the marker. The RN relay initiates a series of events that allows the marker, register and monitor to completely release as shown on SFD-C144.

SECTION C, PART 2

SENDER SELECTION AND CONTROL

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C2 SENDER SELECTION AND CONTROL

A No. 5 crossbar office is required to supply information to a connecting office when a call is routed through or completed in the connecting office. Senders are used to store the call information received from the markers. The senders may be required to convert information to multifrequency signals or pulse trains (a string of pulses) that can be used by the connecting offices. The connecting offices may be of various types and each office type may require a different sender type to work with that office. Senders are arranged into sender groups, with a maximum of ten senders in a group. The senders in a sender group have the same type of pulsing. There can be a maximum of twelve sender groups in an office (marker group). Each sender group is subdivided into sender subgroup A and sender subgroup B, with a maximum of five senders in a subgroup.

C2-1 IDLE SENDER TEST (SFD-C204)

If the route selected requires a sender, the marker grounds its OS- punching through the operated route relay. The OS- punching is cross-connected to an OSG- punching to select an outsender group. Operation of the OSGO-11, outsender group, relay operates marker off-normal relays, OGC, OSC, and SON. These relays prime the marker to work with the sender. The operation of the OSG- relay extends test leads from the marker to the selected group of senders to determine which subgroup within the selected group has idle senders. Ground on the SIE, sender idle even, (for even numbered markers) or ground on SIO, sender idle odd (for odd numbered markers) from subgroup A or B will operate SIA and/or SIB relays depending on whether one or both sender subgroups have idle senders.

C2-2 SENDER SUBGROUP SELECTION (SFD-C205)

It is necessary to determine if the outsender connector associated with subgroup A or B is busy. The OSG- relay extends the GBE, group busy even (for even numbered markers) and GBO, group busy odd (for odd numbered markers) leads from the outsender connector to the marker. The presence of ground on either lead indicates the connector is busy. This ground also operates GBA or GBB relays. The operation of the SIA or SIB relay or the GBA or GBB directs the marker to seize one of two connectors. The OSC, outsender connector, is seized when the marker extends battery over the start lead to operate the MP-, marker preference, relay in the OSC preference control circuit. To check that the MP- relay operates, ground is extended through the MP- relay to the completing marker to operate the SKA or SKB, sender connector check subgroup A/B.

C2-3 SENDER SELECTION (SFD-C206)

The operation of the SKA or SKB operates the OSGA or OSGB relay in the OSC associated with the selected subgroup. The operation of the OSGA or OSGB relay extends the OSO-4 leads from the marker to the selected sender. Ground on any of the OSO-4 leads indicate an idle sender and operates the associated OS- relay(s). If more than one OS- relay operates, the setting of the marker junctor sequence circuit will determine which sender is perferred. The operation of one or more OS- relays operates the OSE and OSE1, outsender end, relays. The operation of the OSE relay indicates that the sender has been seized. After the sender is selected, the OSE1 relay tests the OS- lead to check that the OS- relay was not operated falsely. When the SB (sender busy) relay operates, ground from the sender is removed and the OSE1 should release. If more than one OS- relay is operated (indicating more than one sender is available) the preferred OS- is lock operated and all others released.

C2-4 CONNECTION OF SENDER TO A TRUNK

The marker connects the sender to the outgoing trunk through the crossbar switches in the OSL, outgoing sender link, frame. The outgoing senders are connected to the horizontals of the crossbar switch and the outgoing trunks connected to the verticals. The OSL select magnet is operated when the sender is selected and the trunk link is seized. The operation of the hold magnet must wait until the outgoing trunk connection is complete. The completing marker is performing many functions as it connects to the sender. The selection of the trunk link and trunk coincide with the sender functions, even though these functions are described later in the SCD.

C2-4.1 OPERATION OF THE OSL SELECT MAGNET (SFD-C206)

The operation of the SKA or SKB relay operates the SSA or SSB relay. Contacts of these relays close the ten select magnet leads either to the XSS relay or to the OSO-4 relays. With the nonpreferred OS- relays released and the SSA or SSB relay operated, the OSL select magnet SS- associated with the selected sender operates.

C2-4.2 OPERATION OF THE OSL HOLD MAGNET (SFD-C206)

After the SS- select magnet operates, battery is extended from the winding of the hold magnet, through the make-contact of the trunk F relay, through the off-normal contact of the OSL select magnet to the winding of the high resistance polar relay SHK, sender link hold check. The high resistance winding of the SHK relay prevents the SH hold magnet from operating, but tests the lead by operating the SHK. The operation of the SHK operates the SHKA (sender link hold check auxiliary), relay.

If the dual voltage method of operating the OSL hold magnet is used, the operation is as follows. When the SON relay operates prior to the operation of the SHKA relay, the SH1-2 capacitors are charged to +130 volts with respect to ground. The operation of the SHKA relay isolates the +130 volt charging source and completes the circuit through the SH1-2 capacitors, the SLK (sender link check) relays, and the SH- hold magnet. The SH1-2 capacitors discharge through the primary winding of the SLK relay to ground, through the -48 Volt battery source, through the SH- hold magnet, to the side of the SH1-2 capacitors. This applies 178 volts to the circuit, the +130 charge in series with the -48 volts on the hold magnet, to cause fast operation of the SH-hold magnet. The current flowing through the SLK relay primary winding overcomes the bias and operates the SLK relay. When the charge in the SH1-2 capacitors discharges to the level that -1/2 volt is standing on the SH diode with respect to ground, the SH diode is forward biased to allow steady current to hold the SH- hold magnet and the SLK relay operated. The operation of the SLK relay operates the SLK1 (sender link check auxiliary) relay to indicate that OSL crosspoints <u>should</u> be closed. The ground holding the OSL hold magnet operated extends through the OSL crosspoints to operate the sender ON (off-normal) relay. The ON relay operates the sender CT (cut-through) relay and cuts through the tip and ring leads to the trunk. The ON relay also operates the trunk D (disconnect) relay which removes the tip and ring leads of the outgoing trunk from the trunk pair. This allows the sender to signal the distant office to set up the connection in that office. The LR (line release) relay in the sender operates to provide a holding ground for the OSL hold magnets. The operation of the D relay operates the trunk S1 (supervisory) relay which provides holding ground for the LL and TL hold magnets. The operation of the S1 is checked at this time by the operation of the LR. When the LR relay operates, ground is extended to the ON relay to lock it operated, back through the OSL crosspoints to control the OSL hold magnets, back to the marker SLK relay to shunt the primary winding of the SLK. The release of the SLK operates the marker SLK2 relay which indicates control of the OSL has been turned over to the sender, and the OSL crosspoints <u>are</u> closed.

C2-5 OPERATION OF THE INDIVIDUAL AND COMMON CHANNELS

The operation of the OSKA (outsender check auxiliary) relay and the preferred OS- relay in the marker operates the S- relay in the OSC to establish an individual channel between a particular marker and a particular sender. This individual channel relay is used to operate the sender part of the common channel, to pass AMA recorder number class, advance and reorder information between the marker and the sender. It is necessary to pass this information through the S- relay because the common channel releases early to free the OSC for use on other calls.

The common channel consists of two parts, the marker part and the sender part. The relays are multicontact relays designated MA1-2, MB1-2, and MC1-2 for the marker part, and SA1-2, SB1-2, and SC1-2 for the sender part. The physical location of the MA-, MB-, MC- relays is on the OSC frame. The physical location of the SA-, SB-, SC- relays is on the sender frame.

C2-6 CALLED NUMBER TRANSFER TO THE SENDER AND DIGIT CHECK (SFD-C208, C209)

When operating with trunk circuits, the OGC relay operates the KG (called number digit cut-in ground) relay. This relay operates the KA, KBC, KDE, KFG, KHJ, and KKL, cut-in for the A digit for the B and C digits, etc. These relays are used to cut through the A2/5-L2/5 leads from the register, through the marker to the sender. The A2/5-L2/5 relays operate in the marker and in the sender. The operation of the ORK1 and ORK2 (outgoing registration check) relays indicates that the proper number of A2/5-L2/5 relays operated. If the ORK1, ORK2 relays remain operated after the digit cut-in relays have released, they indicate that the registration relays in the sender locked operated. On some calls, the sender is not required to transmit the A, AB or ABC digits and is not required to receive them even though they are registered in the marker. Since the ORK1,2 must remain operated to indicate a successful transfer of all digits, the ORK1,2 operating path is arranged to bypass the digit check relay contacts of the deleted A, AB, or ABC digits. When the sender relays with the deleted digits fail to return a locking ground to the associated marker digit check relays, the release of these relays does not open the operate path of the ORK1,2.

C2-7 MARKER INPUTS TO THE SENDER (SFD-C210-212)

The ground to operate the CL-, DL-, CR-, CP- etc., relays in the sender and related check relays in the marker originates in the marker through the operated TGS1 and TGS2, transmitting ground supply, relays. The TGS2 relay operates only on AMA calls. The circuits function the same to check information stored in the sender but only one typical circuit will be discussed. On SFD-C211, the operation of the TGS1 relay operates the DLK1 relay and extends ground through the DL- relay through the OSC frame to operate a DL- relay in the sender. The operation of the ON1 relay in the sender locks the DL- relay operated through its own make-contacts. When the OST2 relay operates at a later time, the TGS1 relay releases. The ON1 ground in the sender should extend back to the marker to keep the DLK1 relay operated as a check that the DL- relay in the sender is locked operated. If the DLK1, CLK1,2 etc. fail to remain operated when the TGS1 releases, the completing marker will stop its progress at the RSC relay, time out, and deliver a trouble record.

C2-8 OST, OST1 AND OST2, OUTGOING SENDER REGISTRATION TIMING (SFD-C203, 214)

The purpose of the OST, OST1 and OST2 relays is to allow sufficient time for the sender registration relays to operate. The outgoing sender registration timing is started when the cut-through relays operate and ground is extended over the TSR lead. On non-AMA calls, ground is extended through the OSC multicontact relays, through the KK, TGS1, ORK1/2, the OST released, and the OST2 released to operate the OST1 relay. The OST1 locks operated under control of the KK and TGS1 relays. Also, the OST1 removes the shunt from the OST relay allowing the capacitor OST to charge. When the OST capacitor is fully charged, the bias on the secondary winding is removed allowing the OST relay to operate. The operation of the OST relay transfers the TSR ground through its make-contacts through the OST1 make-contacts to operate the OST2 relay. The operation of the OST2 relay releases the cut-through, TGS1 and other relays. The release of the KK and TGS1 relays release the OST1 relay. Ground on the OST2 make-contact (SFD-C214/F3) extends through the OSE1 released, the OST1 released the RK3 operated, the OST released, the OST2 operated, through sender information check relays operated to operate the RSC (release sender connector) relay.

C2-9 SENDER ADVANCE (SFD-C206, 207)

After the marker has checked that the connection has been established, as indicated by the operation of the DCT (SFD-C533, C534) and the GT1 (SFD-C531) relays, and that the information has been transferred satisfactorily (as indicated by the operation of the RSC relay SFD-C214) an advance signal is given to the sender. The marker operates the advance relay in the sender. If the call is AMA, it is necessary to also check that the recorder number information has been checked by the RNK1,2 relays (SFD-C214).

The sender AV relay operates in series with the primary winding of the AVK relay and the AVK1 resistor. The operate current for the AV relay flows in the direction to hold the AVK relay nonoperated. The AV relay is operated just before the marker disconnects from the connection, after determining that all checks are satisfactory.

After the AV relay has operated, it locks to ground in the sender. This locking ground is extended to the marker over the AV lead from the OSC. The AV lead is through the individual channel (S relay part of the OSC) as the common channel has been released. This locking ground is extended to the primary winding of the AVK relay and causes current to flow in a direction to operate the relay. The operation of the AVK relay indicates that the sender AV relay is locked operated.

After operating, the AVK relay operates the advance check auxiliary relay. The operation of the AVK1 relay causes the marker to perform linkage checks and then to disconnect (SFD-C5 and C6 sections).

C2-10 TRUNK GUARD TEST (SFD-C215)

Markers are arranged on light traffic to delay disconnect from the sender until the sender makes a TGR (trunk guard) test. A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. The marker retains control of the sender by holding the individual channel. If the sender finds an open trunk toward the distant office, the marker will time out, take a trouble record and set the sender to return a reorder signal to the trunk. The marker TG relay is operated when the sender ON relay operates. The sender grounds the TG lead until it detects battery and ground on the tip and ring conductors with the operation of the OF1 relay. If the sender trunk guard test is satisfactory, the marker LK1 linkage check relay operates the marker D1S1,2 (disconnect) relays. If the sender trunk guard test is not satisfactory, the marker LK1 relay operates the marker TGT relay. The TGT relay holds the OSC S- relay operated, operates the D1S1,2 relays to allow the rest of the marker to release, starts the SFT (seize frame timer) holds the MCBO, 1 relays operated so that the marker cannot be seized, holds the TS-, FS- and TB relays operated to identify the trunk and holds the OSG- and OS- relays operated to identify the sender involved.

C2-10.1 TRUNK GUARD TEST SATISFACTORY

The sender starts the TG test when the marker operates the sender AV relay. If the sender TG relay operates before the marker SDT timer functions, the marker TG and TGT relays release and the marker disconnects.

C2-10.2 TRUNK GUARD TEST FAILURE

If the trunk is open, the sender TG relay does not operate and the marker SDT timer functions and causes a trouble record to be taken. When the trouble record is taken, the TRB1 (trouble recorder busy) relay operates. Operation of the TRB1 grounds the RO lead to the sender which sets the trunk to reorder. The TRB1 relay in operating also releases the TG and TGT relays which release the marker.

C2-11 SUBSCRIBER OUTGOING FUNCTIONS WITH AMA

C2-11.1 ROUTE SERIES

The message billing information is required only on AMA calls for charging purposes. One MBSO-9, message billing series, relay is operated in series with the route relay when the code point is grounded.

C2-11.2 MARKER CONTROL FUNCTIONS WITH AMA

The operation of the route relay for an outgoing call that requires a sender operates an OSG- relay. The OSG- relay operates the OGC relay. On AMA calls, the OGC relay operates the TGS2 (transmitting ground supply), RN (recorder number), and SCC (service call), or TVA (transverter test call) relays. Since the TGS2 relay operates only on AMA calls, it extends ground to circuits that are concerned only with AMA functions.

The code pattern information is used on AMA calls to indicate the structure of the called number. The marker determines the code pattern and number structure information by operating one of the CPO-9 (code pattern) and CPP (code patern primary), or CPS (code pattern secondary) relays. The operation of these relays determine the code pattern and number structure information transferred to the sender over the CP2/5; 4DG (4-digit number structure), 5DG (5-digit number structure), L5D (lettered 5-digit number structure), LST (lettered station number structure) leads.

C2-11.3 INDIVIDUAL AND COMMON CHANNEL IN THE OSC

The operation of the S- relay in the OSC establishes an individual channel between a particular marker and a particular sender. The operation of the MA-, MB-, MC- (on AMA calls), SA-, SB- and SC- (on AMA calls) multicontact relays establish a common channel between the markers and senders.

C2-11.4 MARKER INPUTS TO THE SENDER ON AMA CALLS

When the channels are established between the marker and the sender, ground is extended from the marker to the sender to record information in the sender to be passed on to the AMA transverter at a later time. The operated TGS2 relay operates check relays in the marker and extends grounds through information relays to the sender. The TGS2 operates the MBK 1-4, NSK1, and CPK1-2 relays in the marker and grounds leads to the sender to operate the MB2/5, AMA, SC/TVT, CP2/5, TP/RP and 4DG/5DG/L5D/LST relays.

The GTL2 relay, which operated earlier in the call, extends ground through the calling line location information relays to the sender. These information relays are FT2/4 (frame tens), FU2/5 (frame units), HG2/5 (horizontal group), VG2/6 (vertical group), and VF1/5 (vertical file).

C2-11.5 TRANSMITTING AND CHECK OF RN-RECORDER NUMBER (SFD-C214)

The RNT (recorder number timer) circuit is used to determine if RN-, OBS/NOB, and CL- information has been sent to the sender and locked to ground in the sender.

The RNT relay operates when the AMA5 relay operates. Ground on the TSR lead provides a path to operate the RNT1 relay if the RN- and MBK5 relays are operated. The operation of the RNT1 indicates that ground is being transmitted to the sender over the RN-, OBS/NOB, and CL- leads. Operation of the RNT1 also causes the RNT to start operating as determined by the charge time of the RNT capacitor. When the RNT relay operates, it operates the RNT2, which causes the RN relay to release and open the ground path to the RN-, OBS/NOB, and CL- relays. These relays release if corresponding relays in the sender have not operated and locked to ground. The release of the RN also releases the RNT1, which causes the RNT to release as timed by the discharge of the RNT capacitor. This time is provided to permit the RN- relay to release if the sender relays did not lock to ground. When RNT releases, the RNK1-2 relays operate through the RN- and MBK5 as an indication that the information has been transmitted and locked in the sender.

C2-11.6 RSC, RELEASE SENDER CONNECTOR RELAY OPERATION ON AMA CALLS (SFD-C214)

The RSC relay checks that the correct information was sent to the sender, and this information is locked to ground. On AMA calls, the operation of the RSC is different. When the OST2 relay operates, the GTL and GTL2 relays release. Ground through all the check relays reoperates the GTL and GTL2 relays. The reoperation of the GTL, with the OST2 operated, operates the RSC.

SECTION C, PART 3

CONNECTION TO A TRUNK LINK FRAME AND TRUNK

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C3 CONNECTION TO A TRUNK LINK FRAME AND TRUNK

When a completing marker has been seized and has received input information through the ORMC, it proceeds to select a TL having an idle trunk of the correct type. It then proceeds to select and connect to a trunk.

C3-1 TRUNK LINK FRAME SELECTION

C3-1.1 TEST FOR IDLE TRUNKS ON TRUNK LINK FRAMES

The completing marker determines which trunk link frames have at least one usable trunk when it operates a route relay. All trunks of the same route on a trunk link frame have the FT leads multipled together and cross connected to the FTC (frame test common) terminal for that particular route. At the trunk link end, the FTC lead corresponds to the route relay number. At the marker end, the FTC lead corresponds to the trunk link frame number. The operated route relay closes through individual FTC leads to each trunk link. If at least one trunk is idle, ground from the trunk will ground the associated FTC lead and operate an associated FTC relay in the marker. The FTC leads are used in common by the markers, and one or all markers can connect to the same FTC lead at the same time.

C3-1.2 TRUNK LINK FRAME BUSY TEST

To prevent marker delays, it is necessary to determine which TLs are being used by other markers. The operation of the BCO (busy cut-in), BC10, and BC20, (busy cut-in auxiliary) relays extends the windings of the FB029 (frame busy) relays to the associated TL to check if the frame is busy. If the TL is busy, the associated FB- relay operates. To select a TL, the associated FTC relay must be operated while the FB- relay is non-operated.

C3-1.3 TL PREFERENCE ORDER OF SELECTION CONTROLLED BY MEMORY OF PREVIOUSLY SELECTED TL

Frame memory relays have been provided to equalize traffic to the trunk link frames. The FMG (frame memory group) relay and the FM- (frame memory) relay will be held operated from the previous call to record the identification of the TL used in that connection. This information is locked in the marker and on the next call will be used to make the succeeding TL first choice for the marker. However, if the first choice TL is not available for service, the next preferred TL is selected.

As described in paragraph C3-1.6, after the TL has been selected, the frame memory relays which have been locked operated to identify the last TL used are released. The frame memory relays identifying the TL used in this connection are then operated.

C3-1.4 FRAME SELECTION, OPERATION OF THE FSO-29 RELAYS

The operation of a FSO-29 (frame select), relay indicates the TL to be selected to complete this connection. The operation of the FS- relay depends on:

(a) The operation of the FTC- relay with the associated FB- relay nonoperated, indicating an idle TL with an idle trunk of the desired type.

(b) The setting of the FMG- and FM- relays.

(c) The operation of the FMG relay indicating that the frame memory relays have been held operated from the previous call.

The FS- relay which operates will generally be associated with the second higher numbered frame than the frame recorded on the frame memory relays. The reason for advancing the frame selection in steps of two is in the event of paired trunk links where all channels are busy and the marker is recycled, it will always be advanced to a different TL. This prevents the marker from staying in the same TL and allows another set of junctors to be tested.

C3-1.5 TRUNK LINK FRAME SEIZURE

Operation of an FS- relay closes start battery to the preference control circuit associated with the trunk link frame having the same number as the operated FS- relay.

C3-1.5.1 Preference Control Circuit

The preference control circuit associated with trunk link connectors provides two preference relays MP (marker preference) and E (emergency marker preference) per marker for each trunk link connector. There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a trunk link frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to the E- relays.

C3-1.5.1.1 MP - Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a TL), MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain. In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first and last markers in the preference chain initiate simultaneous request for connection to the same TL. Both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

C3-1.5.1.2 MP - Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, two work chains determine which MP- relay does the work. The work chains progress through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, one work chain ground will operate the M trunk link connector relay whether or not other MP- relays are operated. The M relay operates other connector relays by closing through battery supplied by the marker.

The second work chain grounds the CK lead to the marker which has gained access to the trunk link frame to operate the TFK1-2 (trunk frame check) relays in the marker. The TFK1 relay provides a locking ground for the FS relay which had closed through the start battery to the preference control circuit. The TFK1 relay also opens the ground from which the FS relay had operated. When the marker which has seized the TL has finished its job and opened the start lead to the preference control, its MP relay is released. If there are any other operated MP relays, the next MP relay in the work chain which is operated will function as just described. This procedure continues until all operated MP relays have been served.

C3-1.5.1.3 Emergency Transfer (SFD-C306)

Two sets of preference relays MP and E are provided in the preference control, either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR- relay are normal so that MP relays are active. When all MP relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding, and ground through all the break contacts of the work chain which operated connector relays is connected to the other side. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again, the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK, and MC leads from MP relays to E relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP chain if the TR key is normal or to the E chain if the TR key is operated.

C3-1.5.1.4 Manual Transfer

By operating the TR key, located at the TLCC (trunk link connector control frame), preference control can be manually transferred from the MP to the E relays. The TR key operates the TR relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E relays. If the CH relay operates, it operates the TR relay which locks and releases the TR-relays to transfer preference back to the MP relays.

C3-1.5.1.5 Frame Busy Signal (SFD-C304, 305)

When the trunk link connector relays operate, they ground FB leads to all markers as an indication that the trunk link frame is now busy. In all markers except the one that seized the TL, operated FB relays cause the release of associated FS relays (if operated) and operation of another FS relay (assuming another FTC relay is operated with a normal FB relay). In the marker which had seized the TL, the locking ground from the operated TFK1 prevents release of the FS relay. The operated TFK1 also prevents operation of any other FS relay by its removal of the

* Although the CH lamp is shown as part of the trunk link connector circuit, it and the alarm release key are located on a frame designated as "trunk link connector control".

operate ground for FS relays. Thus, any other markers establishing outgoing connections will remove their bid for the particular TL and possibly bid for another which had idle trunks. As will be seen later, completing markers handling incoming trunk calls can only go to one TL and will continue their bid for the same TL.

C3-1.6 RECYCLE OF FRAME MEMORY PREFERENCE (SFD-C307)

After the trunk link frame has been seized, the marker resets 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- releases relay FMK, frame memory check, which releases relay FMG. The release of relay FMG, together with the operated relays FS, TFK1 and TFK2 on this usage, operates the FM- and FMG- relays that correspond 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 and provides a locking ground for the FM- and FMG- relays. The operation of relay FML releases relay BC0, 10, and 20, opening the trunk link frame test leads and releasing the operated FB relays. The FML relay operated opens a break contact in the FMK (frame memory check) relay circuit. This now ensures that the FMK relay will remain operated only when both FM- and FMG- relays are operated. The FMK and FML relay operation is represented on the trouble record card by progress punch FML. Failure to lock the new frame memory relays will be detected at the time the marker prepares to operate the disconnect relays DIS1 and 2, disconnect, relays through make-contacts of the FML and FMK relays (SFD-C605). A trouble record will be produced showing no FML punch.

C3-2 TEST AND SELECTION OF AN IDLE TRUNK (SFD-C308, C309)

As soon as the trunk link frame is seized, the marker proceeds to test and select an idle trunk. The various steps are as follows.

C3-2.1 TRUNK BLOCK AND TRUNK GROUP CONTROL

Most trunk link frames (SD-26032-01) have ten level crossbar switches which provide a total of 160 trunk terminations of which no more than 120 can be seized by the completing or dial tone markers. Each group of trunks or originating registers is assigned one of six TB- (trunk block) numbers and are of 20 TG (trunk group) numbers for a maximum total of 120 routes.

The marker indicates which TB- and TG- relays will be used by operating its route relay. The marker identifies a particular route by placing a battery on the TB- lead and ground on the TG- lead. The battery on the TB- lead operates a TB- relay in the trunk link frame. The operation of the TB- relay in the TL cuts through 20 BT leads, BT00-19 to the completing marker to battery.

C3-2.2 CROSS CONNECT OF THE TG- TO F- PUNCHINGS

Each trunk has an F lead. This lead is connected to an F punching. All these F punchings, for trunks which have the same TG- number, are connected to the corresponding TG- punching.

C3-2.3 BT00-19, BUSY TEST, LEADS

In the trunk, each F lead is connected through an F relay winding (through contacts which are open while the circuit is busy) and then to a BT punching. In testing for an idle trunk, the marker grounds one TG lead. This results in the grounding of the F leads of all trunks of the desired route as well as those of other routes of the same TG-number. The marker also operates the TB- relay corresponding to the TB- number of that route. Only BT- leads corresponding to trunks of the desired route will have resistance ground on them because the TB- relay selected only those with the proper TB- number and the TG- lead provided ground to only those of the proper TG- number.

The TB- relay connects 20 BT leads into the marker. Any number of the BT00-19 leads may be assigned to one route. However, it should be noted that some of the routes may be unavailable because all of the BT- leads may be in use for other routes. For example, suppose that a route in TB3 has 18 trunks associated with it on one trunk link frame, then there will be only 2 BT- leads left for the other routes in TB3. Consequently, only a maximum of three routes out of twenty can be used on TB3, on that frame.

C3-2.4 OPERATION OF THE TB- RELAY IN THE TRUNK LINK; THE TBK, TRUNK BLOCK CHECK, AND THE TSE 1,2, TRUNK SELECT END, RELAYS IN THE MARKER

To check that the TB- relay operates in the TL, ground is extended back to the marker on the TBK lead to operate the TBK (trunk block check) relay. When the TLC1,2 (trunk link control) relays operate they permit the marker to determine that none of the TS- (trunk select) relays are operated by the operation of the TSE1,2 relays. The operated TSE2 relay provides the battery for operating the TT0-9 (test trunk) relays.

C3-2.5 OPERATION OF THE TT0-9 RELAYS

The TT0-9 relays are double wound with each winding being connected to one of the BT00-19 leads. An idle trunk is indicated by the operation of a TT- relay. The operation of any TT- relay does not alone indicate the particular trunk that is idle. The marker must determine which one of the two is grounded with an odd and even preference lockout circuit.

C3-2.6 OPERATION OF THE TS0-9 RELAYS AND RELEASE OF THE TSE1,2 AND TT0-9 RELAYS

After the TLC1, TSE1, TBK and MAK1 relays operate, ground is extended through the marker junctor sequence circuit to operate the TS0-9 (trunk select) relays. The operated TS- relay locks under control of the TLC1 relay and releases the TSE1,2 relays. The TSE2, in turn, releases the TT0-9 relays. With the operation of the TS- relay, marker selection of a trunk is directed to one of the two trunks which appear on a particular TS- relay. These leads, which indicate idle trunks when grounded, are extended to an OTS (odd trunk selection) or ETS (even trunk selection) relay to permit selection of one of the two trunks.

C3-2.7 OPERATION OF THE OTS AND OT OR THE ETS RELAY

The ETS and OTS relays are double wound polar relays. The current through the primary winding is in a direction to operate the relays, and the current through the secondary windings is in a direction to hold the relay non-operated. When both windings are energized, the current through the bias, secondary, winding is sufficient to hold the relay non-operated.

The TZ-, trunk preference (Z), relay is used to change preference on each marker usage.

If the TZ relay is non-operated, the bias winding of the ETS is opened. Therefore, with ground on both the odd and even BT- leads the ETS relay operates and the OTS relay is biased non-operated. However, if the TZ relay is operated, the OTS bias winding is open and the OTS and OT relays operate.

C3-2.8 SEIZURE OF THE TRUNK AND OPERATION OF THE F RELAY IN THE TRUNK

The busy test (test for idle trunks) is made with high resistance TT- relays. The F relay of the trunk does not operate in series with the TT- relay. The operation of the OTS or ETS relay changes the high resistance to a low resistance, which locks the OTS or ETS operated and operates the F relay in the trunk.

C3-3 SENDER NO DIGIT AND TRUNK TT- RELAY CONTROL (SFD-C310)

The sender may be used on calls which require no dialing. Trunk test calls are of this type. Also, in some cases, the sender is used to obtain a path for operating the tandem relay of the trunk. Another type of no dialing call is the intra-office AMA, when the sender is used in connection with the initial entry record.

For these types of calls, the marker primes the sender with the usual digits and AMA information, and in addition operates the STS (start digit steering) relay over the ND (no digit) lead. The STS relay operates the EP (end of pulsing) relay. The STS, rather than the EP, is connected to the ND lead because the marker requires a fast operating relay on this lead. The EP is slow operating so it will not operate falsely on a regular dialing call from a pulse which may occur if the RR- relays are normal during a changeover from one digit to another.

The MT12 (marker test) relay operates only on marker test calls and certain trunk tests when the marker is required to operate the TT relay in the trunk.

The OTT (operate trunk test) relay operates under the following conditions:

(a) OGT - Outgoing trunk type of test from the master test control frame.

(b) SDR - Sender test using the AMRST (automatic monitor, register, and sender test circuit).

(c) LV3 - Line verification test circuit in the master test control frame.

(d) ITDO - Incoming trunk in the distant office test from the master test control frame.

To operate the OTT under the above conditions, the MT12 and OGC relays are operated and the NSI (no sender intra-office) relay is released.

The operation of the OTT relay extends ground through the TT- cross connects, through level relays in the TL to operate the TT relays in the trunk. This same ground operates the TTK, OTT relay check in the marker, and if the TT relay in the trunk is locked operated, keeps the TTK from releasing when the SK, S1 relay (trunk) check, relay operates.

C3-4 OPERATION OF CONTROL RELAYS IN THE TL FRAME (SFD-C311)

When the F relay in the trunk is operated, it operates an FA- or FB- relay. The FA- or FB- then operates a LVO-9 (level connector) relay. There is one of these relays associated with each of the levels (horizontals) of the trunk switches.

Assume that an A appearance is involved and the FA- relay operates. When one FA- and one LV- relay operates, several leads are connected to the marker through the TLC. These are the following:

(a) The FAK informs the marker that the trunk is on the A appearance and checks the operation of the FA relay.

(b) The AST connects the crosspoint sleeve into the marker for test purposes when cross points are being set up.

(c) The ASM connects the associated directing and trunk select magnets into the marker.

(d) The ALC connects an operating circuit, for the link connector relay associated with the trunk switch in which the trunk appears, into the marker.

The marker uses the LVK lead to check that only one LV- relay operates. If the trunk is connected to a B appearance, the FB- (B appearance trunk connector) relay operates, operating the LV- relay. A similar set of leads is closed through to the marker except the designations have a B instead of A, ie., FBK, BST, BSM and BLC.

As soon as the FA- or FB- relay operates, it operates an LC0-9 (link connector) relay. One of these relays is associated with each trunk switch and it grounds the LCK lead to enable the marker to check its operation and, in conjunction with R (right side of frame), and L (left side of frame), relays connect ten links of the associated switch into the marker for channel test purposes (SFD-C502).

C3-5 TRUNK CLASS CONTROL AND TRUNK CHARGING (SFD-C312, 313)

As previously shown, a route relay may be associated with various route series relays to control the transmission of trunk class information to the trunks. The various types of trunk class information are as follows:

(a) Charge or noncharge - the presence or absence of a signal on the TC lead indicates a charge or noncharge condition respectively.

(b) Tip and ring party - the presence or absence of a signal on the TP lead indicates a tip or ring calling party respectively, and is used with a charge call when a distinction must be made to charge the right party. The TP signal may be used on terminating calls to operate a ringing selection switch hold magnet.

(c) Coin or noncoin - the presence or absence of a signal on the CN lead indicates a coin or noncoin calling customer respectively. This signal is used by the trunk to control the selection of control equipment when required.

Where the aforementioned signals are not required for the conditions stated for a particular trunk, the same signal may be used for other purposes.

For example, a signal on the TC lead may be used to identify calls to an operator that would normally be charged for, and notify the operator by a tone that a ticket should be made on the call.

The marker insures that the trunk class signals are locked in the trunk when making the linkage check by checking the operation of either the NOC (no class transmitted) or the CLK (class check) relays.

C3-6 TRUNK BUSY TIMING

The trunk busy test timer starts where the marker begins testing the trunk group for an idle trunk. If the marker does not detect a TL with an idle trunk within 27.5 to 30.5 milliseconds on service calls or 79.5 to 95.5 milliseconds on test calls, the TBT (trunk busy timing) relay operates to indicate an all trunks busy condition.

The trunk busy test timer is started by seizure of the trunk link frame and operation of the TBK (trunk block check) relay. If a trunk is not selected, the TBT relay operates to indicate all trunks busy when the TA (trunk available) relay is released or an open BT or TG lead if the TA relay is operated. If the TA relay is operated a trouble record is requested on first trials and a route advance on second trials.

SECTION C, PART 4

CONNECTION TO LINE LINK FRAME

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C4 CONNECTION TO LINE LINK FRAME

Following seizure of the trunk link the line link on which the calling line is located is seized. This gives the CM (completing marker) access to and control of the calling line select and hold magnets.

C4-1 LINE LOCATION CONTROL (SFD-C402, C403, C412)

On an outgoing call the CM does not use the FLG (forward linkage), but does use the SCB (call back linkage). The call back linkage connects a trunk on a TL to the calling line. On an OGT call the CM starts the call back linkage as soon as the call is indicated as a SOG (subscriber outgoing call). From the selected route the CM obtains a SON (sender off normal) or a NSO (no sender outgoing) indication which operates the SOG1 and SOG2 relays, in turn, operating CB, CB1, CB2, CB3, CB4, and CB5 (call back) relays. The CM receives calling line identification from the OR which is registered on the FT-, FU-, VG-, HG- and VF- relays and produces the FT'-, FU'-, VG'-, HG'-, and VF'- prime punches. This information along with the LL- (indicating which line linkage was used on the dial tone call) gives a translation as to the line location of the calling line, through the operated CB, CB1-5 relays. This is further checked in the CM, by checking the proper number of relays operated and if the correct number of relays are operated, operates the RK1, RK2, and RK3 (line link location check) relays. The RK2 and RK3 progress punches are an indication of the line link location check. The calling line location is registered on the FTT-, FUT-, VGT-, HGT- and VFT- relays. The FTT- and FUT- relays in operating select the LL. The VGT- and the HGT- relays then operate the associated VGB- and HG- relays in the LL. The HG- relay in operating closes through the LB- and LL test leads for testing the LL, and closes through the SM- leads to operate the LL select magnet. The VGB- and the HG- relays operate the associated LG- relay in the LL. The operation of the LG- relay closes through the LG- leads to the VFT- relay for controlling the operation of the proper LL hold magnet.

C4-2 LINE LINK FRAME SEIZURE (SFD-C402, C404, C405)

On SOG calls the seizure of the LL is made after the TL has been selected. The CK punch is an indication that a proper TL selection has been made. The LFS battery from the CM is applied to the LL-ST lead through the operated LLC2, TFK2, SOG1, FUT- and FTT- relays in the CM to the ST- lead of the LLC-PC circuit to operate the MP- relay and associated LLC multicontact relays. The LFK punch is an indication that all LLC relays have properly operated.

C4-2.1 PREFERENCE CONTROL CIRCUIT

The preference control associated with LLC provides two preference relays, MP- (marker preference) and E- (emergency marker preference) per marker for each LLC. There is a means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by two chain circuits, which enable connections of one marker at a time to an LL frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to E- relays.

C4-2.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a LL), MP- relay operation is straightforward. Start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operated chain to ground at the winding of the first relay in the operate chain. In periods of heavy traffic two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first CM and the first DTM initiate simultaneous request (apply start battery) for connection to the same LL. Both MP- relays will operate and lock. If, however, the first DTM had initiated a request slightly before the first CM, the MP- relay for the first CM would not have operated because ground for its winding could have been opened by the operated chain at the MP- relay for the first DTM. On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain can subsequently operate its MP- relay.

C4-2.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain starting with ground at a contact of the MP- relay for the first CM. If the MP- relay for the first CM is operated, the work chain ground will operate the M- LLC relay whether or not other MP- relays are operated. The M- relay operates other M- relays in the connector by closing through battery supplied by the marker.

When the marker which has seized the LL has finished its work and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated, now functions as just described. This continues until all operated MP- relays have been served.

C4-2.1.3 Emergency Transfer

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that MP relays are active. When all MP relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding and ground through all the break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again, the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP relays are all normal, one side of the CH relay winding will have ground, and the other will have resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open, or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other, and will operate.

If the CH relay operates even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK- and MC- leads from the MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

C4-2.1.4 Manual Transfer

By operating the TR key the preference control can be manually transferred for the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP- relays.

C4-3 CLASS-OF-SERVICE IDENTIFICATION

Originally, No. 5 crossbar was arranged for a maximum of 30 classes of service, wherein the CM received class of service from the ground extended through the LL on 1/30 leads. Later, two more leads (CGA and

CGB) were added to increase the number of classes to 60. In this case one out of the original 30, and one of the added two leads were grounded to provide two groups of 30. Still later the present standard arrangement was substituted. This arrangement grounds one of the first 10 leads CS0-9 as class tens and one of the second 10 leads CS10-19 as class units, thus using 20 leads to provide 100 classes of service. The third group of 10 leads CS20-29 and the CGA and CGB leads are used to provide 20 rate treatment classes.

In a very few offices the original 30 class-of-service arrangement was modified to provide 20 classes of service and 20 rate treatment classes (using the first 20 leads CS0-19 on a 1/20 basis for class of service and using the CS20-29 and CGA, CGB leads to provide two groups of 10 rate treatment classes).

The 20, 30, and 60 class-of-service arrangements are basically the same and are shown on SFD-C406. The tens and units class of service and rate treatment arrangement for a maximum of 100 classes of service is shown on SFD-C407.

C4-3.1 LINE LINK FRAME CROSS-CONNECTIONS

The right side of SFD-C406, C407 shows the cross-connections required for various classes of service and rate treatment arrangements.

C4-3.1.1 30 Classes of Service - Identification by Vertical File

When the FTK1 relay of the CM operates as a check of vertical file identification (SFD-C403), it closes the V-lead to ground a V- terminal in the LL (SFD-C406). This is cross-connected to a CS0-29 terminal in the LL frame. The CS0-29 leads are extended through LLC to the CM CS0-29 terminals, and to the MTFC to produce the trouble recorder punches CS0-29. The CS0-29 terminals in the CM are also cross-connected to the following terminals CN (coin), MR (message register), or AOC (all other classes). See SFD-C406 Note 1 for trouble card perforation on 1/x or 2/x basis.

C4-3.1.2 60 Classes of Service - Identification by Vertical File

The previous description applies also for 60 classes of service except there is an additional cross-connection from the VC- terminal of the LL to either the CA or CB terminal instead of to the ground terminal. The ground to operate the VGB0-11 (SFD-C406) originates through the normal MT11 relay contact and is extended to the LL via the CGA and CGB leads.

C4-3.1.3 20 Classes of Service-Rate Treatment-Identification by Vertical File

The description for 30 classes of service (SCD-C4-3.1.1) applies for rate treatment except that only leads CS0-19 are used for the 20 classes.

Leads CS20-29 are used for rate treatment as indicated on SFD-C406. Cross-connections in the LL provide this information. The VR0-4 cross-connection terminals are cross-connected to class-of-service terminals 20-29 and terminals VRG0-4 are cross-connected to class-of-service terminals CA and CB to give 20 possible rate treatments. The CS 20-29 leads give the units digit of the rate treatment number and the CA or CB leads give the tens digit.

C4-3.1.4 100 Classes of Service - Identification by Vertical File

The 100 classes-of-service arrangement is the standard and is now used even though equipment is not necessarily provided for the maximum of 100 classes.

When the FTK1 relay of the CM operates as a check of vertical file identification (SFD-C403) it closes the V0-4 lead to ground several terminals in parallel through diodes to prevent backup of ground from one terminal to another. Since class indications from the LL is on a tens and unit basis, two cross-connections are required. VT0-4 is cross-connected to CS0-9 to cause one of the relays CST0-9 to operate for class-of-service tens. VU0-4 is cross-connected to CS10-19 to cause one of the relays CSU0-9 to operate for class-of-service units.

Where rate treatment is provided, VR0-4, is cross-connected to CS 20-29 for rate units indication. The VRG0-4 is cross-connected to CA or CB for rate tens indication.

C4-3.1.5 Identification of Class of Service by Hold Magnet (SFD-C406, C407)

Where identification of class of service is provided on an individual hold magnet basis rather than on a vertical file basis, the V0-4 or VU0-4 terminal is cross-connected to the VFA, VFB or VFC terminal to operate a VFA, B or C relay. The HMC- terminal is cross-connected to a CS0-29 terminal for 30 or 60 classes, to CS0-19 for 20 classes or to CS10-19 for 100 classes. This method is used with line link pad control on line link pulsing only.

If rate treatment is provided, it may also be identified on a hold magnet basis where class of service is so identified by cross-connecting from HMR0-9 to CS20-29.

C4-4 CONTROL OF CLASS OF SERVICE BY MASTER TEST CONTROL (SFD-C406, C407)

Because offices may be equipped with any of several class-of-service and rate treatment arrangements, there are necessarily a number of optional arrangements provided in the MTC for controlling class of service and rate treatment. On an OR class of test when the keys or switches for selecting class of service and rate treatment are in normal or off position, the CM functions as on a service call to obtain the class of service (and rate treatment is provided) from cross-connections in the LL. The ground from the marker which is normally steered through LL cross-connections is, instead, steered through class-of-service and rate treatment keys of the MTC. Use of these keys to control class of service is intended for use on OR class of test, so that any desired class of service may be set in the DTM for subsequent transfer to the OR.

C4-4.1 30 OR 60 CLASSES OF SERVICE (SFD-C406)

On test calls, the MT27 relay in the CM is operated. This opens the normal path through which the CM supplies ground over a V-lead to the LL to determine class of service from cross-connections in the LL.

When the CST- keys or CST switch are in the off position, the KCS0, 1 and 2 relays are normal and bridge the M27 relay break-contact in the CM to permit normal determination of class of service from cross-connections in the LL.

When the CST- key or the CST switch is operated to 0, 1 or 2 on an OR class of test, the KCS0, 1 or 2 relay, respectively, is operated. When the FTK1 relay operates, ground via the CSG2 lead is steered through an operated KCS- relay contact and through an operated CSU- key or the CSU switch in position 0-9 and again through contacts of an operated KCS- relay to one of the CS0-29 leads corresponding to the keys or key and switch operated.

C4-4.2 60 CLASSES OF SERVICE (SFD-C406)

When there are 60 classes of service, in addition to the control described above, the MT11 relay is operated on marker test calls and connects the CGA and CGB leads in control of the KCSA relay.

C4-4.3 20 CLASSES OF SERVICE WITH RATE TREATMENT (SFD-C406)

This is a feature provided in very few offices. Class-of-service functions as previously described for classes 0-19. The CST2 key or the 2 position of the CST switch is disabled. Instead, keys CRU0-9 or the CRU switch are provided.

To control class-of-service and rate treatment settings in the marker, the CST- keys or CST switch, the CSU- keys or switch, the CRU- keys or CRU switch, and the CSGA/B keys must be set as required.

C4-4.4 100 CLASSES OF SERVICE (SFD-C407)

On test calls, the MT27 relay in the CM is operated. This opens the normal path over which the CM supplies ground over a V- lead to the LL to determine class of service from cross-connections in the LL. When the CST- keys or CST switch, the CSU- keys or CSU switch, and the CRU-keys or CRU switch are in the normal or off position, the KCSO 1 and 2 relays are normal. This bridges the MT27 contacts in the CM to permit normal determination of class of service and rate treatment from cross-connections in the LL.

To control the setting of class of service and rate treatment in the CM, the CST- keys or CST switch, CSU- keys or CSU switch and, if provided, the CRU- keys or CRU switch should be set as desired. This operates the KCSO, 1 and 2 relays to extend the CSG2 lead ground to one out of ten of the CS0-9, CS10-19 to operate a CST- and CSU- relay, respectively, in the CM. When rate treatment is provided, the CSGA or CSGB key should also be operated.

C4-5 LINE LINK FRAME LOCKOUT

When a LL has seized a DTM via its LLMC, it is possible that a CM may seize the LL via its LLC before the DTM can seize the LLC. If the CM is setting up a connection from a calling line to a trunk, it must release the connection already established from that line to an OR before it can set up a new connection from that line to a trunk. When this occurs, the L relay for that line reoperates momentarily. The DTM must be prevented from attempting to identify this operated relay as a request for dial tone. If a CM has connected to a LL before there is a request for dial tone in the LL, the LL is prevented from requesting a DTM until the CM has released the LLC.

C4-5.1 SEIZURE OF DTM VIA LLMC BEFORE CM SEIZES LLC (SFD-C408)

If a LL has connected to a DTM via a LLMC but a CM connects to the same LL via a LLC before the DTM does, the DTM is not permitted to proceed with horizontal group selection until the CM completed its use of the LLC.

Whenever any VGS-relay operates in a LL, it operates the DT relay (SFD-C408) as an indication that there is a request for dial tone. If a CM seizes the LLC for that LL to establish a connection from a calling line to a trunk, its CB2 relay will be operated. The CB2 relay operates the LOT relay (SFD-C408). When the CM proceeds to the point of operation of the TCHK relay, it grounds the G lead toward the LL via the LLC. If the DT relay is operated in the LL, the ground is extended over the DTK lead to operate the DTK relay in both the CM and the DTM. Operation of the DTK in the DTM opens the operate path of the HGG- relay (SFD-C408) on first trial calls. This prevents horizontal group selection, if not already completed, by the DTM until the CM has released the LLC.

The release of the HGG relay opens the HGT- leads (SFD-B109) preventing horizontal group selection. If, however, horizontal group selection had been completed before the DTK relay operates, the HGG relay would have already been released by the operation of the HGK relay and the operation of the DTK relay would have no effect.

C4-5.1.2 Seizure of LLC by CM Before There is a Request for Dial Tone in the LL

If a completing marker, setting up a connection from a calling line to a trunk, seizes a LLC and has proceeded to operation of its TCHK relay before a request for dial tone has operated the DT relay in the LL, the LL is prevented from requesting a connection to a DTM until the CM has released the LLC.

When the CB2 relay of the CM operates, it operates the LOT relay (SFD-C408). When the TCHK relay operates, ground on the G lead through the normal DT relay in the LL operates the LO relay in the LL. The LO relay operated opens start battery to the MSA and MSB terminals (SFD-B102) preventing a request for a DTM. Operation of the LO relay also prevents operation of the TM and TM1 relay when a VGS- relay operates, so that the TM timer (SFD-C408) does not start until the LO relay releases.

C4-6 LINE LINK FRAME CONTROL NON PAIRED OPERATION (SFD-C409)

The marker obtains access to the LL frame through the preference control and make-busy circuit and LLC circuit.

The marker will place HGB resistance battery on the HG- lead corresponding to the horizontal group number which it obtained from the register. The operation of the MA1 relay in the LLC will extend the HG- lead to operate the HGA- and HGB- relays in the LL.

The marker will place VGB resistance battery on the VGB- lead corresponding to the vertical group number which it obtained from the register. The operation of the MA1 relay in the LLC will extend the VGB- lead to operate the VGB- relay in the LL.

With HGA, HGB- and VGB relays operated, a path is closed from the LG- relay to the BS lead. However, the BS lead does not have battery connected to it by the marker until the marker receives ground on the HGK lead. The purpose of this is to insure closing the operating current of the LG- relay in the marker rather than through the HGA-, HGB- or VGB- relay contacts so that protection can be provided on the basis of one per frame instead of one per LG- relay. The VGB- relay will operate before the closure of lead BS occurs.

C4-6.1 CROSS-DETECTION (SFD-C409)

The marker employs the operate test to detect trouble on the HGA-, HGB-, LG- or VGB- relays in the LL. If, for some reason, more than one HGA- or HGB- relay operated in the LL the XHG relay would operate in the marker. This condition would stop progress of the call. The HGK punch would not be present on a trouble card.

If, for some reason, more than one LG- relay operated in the LL the XLG relay would operate in the marker. The operation of the XLG relay would produce the XLG trouble punch.

If, for some reason, more than one VGB- relay operated in the LL the XVGB relay would operate in the marker. The operation of the XVGB relay would extend ground to operate the XAVG relay in the marker and produce the XVGB trouble punch.

C4-7 PAIRED LINE LINK FRAMES

Paired line link operation is possible on all types of linkage except dial tone. Before paired line link operation can be applied to a marker group, the junctor groups must be wired as one of the following sizes; 60LL-30TL, 40LL-20TL, 20LL-10TL.

An auxiliary LL frame consists primarily of ten 200-point crossbar switches split into right and left halves. The verticals of the right half are multipled to the junctor switch verticals of the even-numbered line link frame while the horizontals serving these verticals become an extension of the line links of the odd LL frame. A similar transposed appearance of even frame links and odd frame junctors exist on the left half. In effect, linkage is provided from the line switches of one line link frame to the junctor of its mate.

C4-7.1 PAIRED LL FRAME AUXILIARY LL FRAME IDENTIFICATION (SFD-C410)

In a particular office, the marker recognizes a paired line link frame by the presence of solid ground on the LFK lead when the associated line link connector is operated. This ground operates the marginal PRL and LFKA relays. The LFKA in turn operates the LFK relay. A nonpaired LL frame will have resistance ground on its LFK lead, in which case only the LFKA relay operates. Relay LFKA operated, operates the LFK relay ane marker operation continues.

Relay PRL operated, operates the PRLL relay and also operates the PRLLA relay (if provided). These relays have no effect until such time that a channel test is made. With the 10TLF relay operated, and no channels available, the operate path for the FMP relay is diverted by the PRLL relay to the STP relay. Relay STP operated, with the sequential release of GC relay and operation of STP3 relay initiates the junctor step. Subsequently, STP1 relay releases, relay STP2 operates. Relay JGO releases and JG1 relay operates.

C4-7.2 PAIRED LINE LINK FRAME MATE SEIZURE (SFD-C410)

Relay STP3 operated with PRLL relay operated and MFK relay normal operates the STPA relay. Relay STPA operated locks around the contact of MFK relay, and places resistance battery on the MPP lead toward the LLC. This MPP lead connects to the MPP relay in the line link preference control circuit of the mate LL frame.

Relay MPP operated has two features:

(a) It closes its contact in the work preference control circuit in order to seize the auxiliary LL frame when preference is gained.

(b) It closes solid ground toward the LLC for the LL frame associated with that preference control circuit. If this particular LL frame should have its connector closed to some other marker, solid ground on the MFK lead will operate the MFK and MFL relays in that marker, opening the operate path for the STPA relay and preventing that marker from attempting mate operation.

When preference is gained in the mate LL frame preference control circuit, the auxiliary LL frame associated with this pair of LL frames is seized. Relays operate in this frame to cut through the select magnet leads from the LL frame to the select magnets of the auxiliary frame junctor switches. The choice of select magnets will be controlled by the horizontal group relays in the LL frame, and will correspond to those select magnets that can be chosen on the LL frame junctor switch.

Seizure of the auxiliary LL frame will transmit resistance ground on the MFK lead through the connector in the marker. Relay MFK alone operates and with STPA relay operated, completes the operate path for the TK relay.

During this time, the STP2 and JG1 relays, in combination with the PRL and PRLL relays operated, have selected the opposite half of the trunk switch, and reoperated those relays, such as the PNR, pattern normal relay, in the junctor step and control circuits in preparation for channel test. With the operation of the TK relay, channel test is again made.

C4-7.3 PAIRED LINE LINK FRAME AUXILIARY LINE LINK CONTROL (SFD-C411)

When the MPP relay operates it places ground, on the LV lead to the auxiliary LL frame, through the operated HGB- relays of the LL frame. This ground will operate a LV- relay and a EV- or ODD- relay in the auxiliary LL frame. The numerical designation of the LV- relay operated will be the same as the HG- relay operated in the LL.

The operation of the LV- relay and the EV- or ODD- relay will parallel the select magnets on the auxiliary LL frame with the select magnets on the original LL frame. The operation of the EV or ODD relay will close a resistance ground to the marker over the MFK lead as an indication of mate frame lockout and select magnet cut-through.

C4-8 PAIRED LINE LINK FRAME - MARKER GLARE CONDITION (SFD-C410)

There is a possibility that two markers could have simultaneous calls to mated LL frames. As described previously, the marker expects a resistance ground on the MFK lead as an indication that the MPP relay has the work preference in the preference control circuit. If there is another marker in the mate LL frame also attempting a mate frame lockout, both markers would receive direct rather than resistance ground on the MFK lead. Both markers would recognize direct ground on the MFK lead as a glare condition and set the trunk to overflow.

C4-9 PAIRED LINE LINK FRAME AUXILIARY LINE LINK-MAKE BUSY (SFD-C410)

The auxiliary LL frame is made busy by inserting make-busy plugs into both the MBO and the MBE jacks. A make-busy plug in either the MBO or MBE jack will indicate to the marker, when it is attached to the LLC, that the LL is nonpaired rather than paired.

SECTION C, PART 5

CHANNEL SELECTION AND HOLD MAGNET OPERATION

Index

C5 NETWORK CONNECTIONS

Following hold magnet operation, the channel is checked for crosses, continuity and double connections. The sender and trunk information is checked to insure its proper transmission (SFD-C502, 503).

Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL, and the trunk switch and junctor switch crosspoints on the TL.

The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch and the trunk on the trunk switch, and on the channel selected.

C5-1 CHANNEL ARRANGEMENTS

A channel is made up of a line link, a junctor and a trunk link, which are tested, selected and treated as a unit when establishing a connection between a line and a trunk or between two trunks.

The line links consist of the line switch banjo wiring, the line junctor switch banjo wiring, and the wiring between these switches.

The trunk links consist of the trunk switch vertical unit, the trunk junctor switch vertical unit, and the wiring between the two switches.

The junctors consist of the line junctor switch vertical unit, the trunk junctor switch banjo wiring, and the wiring between the line junctor and trunk junctor switches.

The marker in selecting a channel, tests a maximum of ten channels at a time. The CHT- (channel test) relay tests a line link, a junctor, and a trunk link with numbers corresponding to the CHT- relay numbers. These tests are made simultaneously. Ground on any of the test leads operates a CHT- relay to indicate a busy channel. The channel number corresponds to the junctor switch number 0-9 on both the LL and the TL, the horizontal level 0-9 on the LL line switch, and the vertical number of the trunk switch on the TL.

C5-1.1 JUNCTOR SEQUENCE CONTROL (SFD-C506, 507)

The number of junctors in a junctor group may vary from a maximum of fifty junctors to a minimum of ten junctors. Since the marker is equipped to simultaneously test a maximum of ten channels and, therefore, to test a maximum of ten junctors, each junctor group is subdivided into junctor subgroups consisting of ten or less junctors. The marker selects those junctors within one junctor subgroup when testing for an idle channel. The selection of the subgroup of ten or less junctors is, in general, determined by the following factors:

(a) The number of TLs in the marker group as indicated by the 2-10 TLF relays.

(b) The LL number.

(c) The junctor sequence position JSQ 0-5 which is used to equalize and rotate the traffic among the subgroups.

(d) The junctor step STP1/2 position.

The selected subgroup of junctors is assigned to the ten channels so that the numerical designation of the junctor switch on both the LL and the TL to which the junctor connects is also the numerical designation of the channel of which the junctor is a part.

The junctor sequence walking circuit is shown on SFD-C507. A sequence chart showing the advance of the walking circuit on successive calls is shown on SFD-C506.

In the beginning of the call when the CKG4 relay operates, CKG4 in turn operates the LLC1,2 (Line Link Control) relays. If the sequence circuit is in an even position (JSQ0,2 or 4 and JLO operated), the LLC2 relay operates the JSO relay which locks. When the LLC2 relay releases at the end of the call, the next higher numbered odd JSQ- relay operates, and, in turn, operates the JLE relay. The JLE relay releases the JSQ-, JLO and JSO relays. Similar operation occurs when stepping from an odd to an even JSQ relay.

Six steps of control for preference circuits are provided by the JSQ 0-5 relays. This number is doubled by the operation of the SQ0 and SQ1 relays. If the SQ1 relay is normal when the JSQ0 relay operates, the SQ0 relay operates. If the SQ1 relay is operated when the JSQ0 relay operates, the SQ0 relay releases. Similarly, the SQ1 relay is operated or released depending on the condition of the SQ0 relay when the JSQ2 relay operates. The SQ0 relay is operated for one complete cycle of the walking circuit, then released for one complete cycle. The same applies to the SQ1 relay. However, since the SQ0 is operated and released by JSQ0, and SQ1 is operated and released by JSQ2, there are steps during which SQ0 and SQ1 may both be operated or both released.

The SQA relay monitors operations of the junctor sequence walking circuit. If the SQA relay operates as a result of trouble in the walking circuit, it operates the MXT (master cross test) relay which causes a trouble record to be produced showing an SQA trouble punch.

The following conditions cause operation of the SQA relay which is a slow operate relay to prevent false operation due to momentary closures as relays change conditions. The SQA relay operates the MXT relay which operates the TR1 relay to cause a trouble record to be taken showing an MXT and an SQA punch. The MXT is not shown on a single-sided card.

Trouble conditions detected between calls (LLC2-normal) occur when:

(a) Both JLE and JLO are normal

(b) Both JLO and JSO are operated

(c) Both JLE and JSE are operated

Trouble conditions detected during calls (LLC2 operated) occur when:

(a) JLO is operated and JSO is normal

(b) JLE is operated and JSE is normal

(c) SQ0 and SQ1 are both operated or both are normal when JSQ1 is operated

(d) SQ0 is operated and SQ1 is normal or SQ0 is normal and SQ1 is operated when JSQ1 is operated

When the fuse which supplies battery to the walking circuit is inserted, the SQA relay will operate because the JLE and JLO relays are both normal. When the SQA relay operates, it operates the JSQ0 relay which operates the JLO relay which should release the SQA relay if there is no trouble in the walking circuit. This will cause a trouble record to be taken which will show an MXT punch, but no SQA punch unless the SQA remains operated because of trouble. The MXT is not shown on a single-sided card.

C5-1.1.1 Control of Junctor Sequence by Master Test Control (SFD-C507)

With one of the JSQ0-5 keys or switches operated and the KCH relay operated, the MT8 relay of the marker is operated after the master test frame connector has operated the MT relay of the marker. The MT8 relay of the marker operated, releases the operated JSQ0-5 relay of the marker by opening its locking circuit. The released JSQ- relay releases the JLE or JLO relay of the marker and the released JLE or JLO in turn operates the KJSQ relay. The KJSQ relay closes ground from a back contact of the MT8K relay through the operated JSQ0-5 key or switch to operate the corresponding JSQ0-5 relay of the marker. This operates the JLE or JLO relay of the marker which removes ground from the KJSQ lead to release the MT8 relay of the marker whose operate path has been transferred to the KJSQ lead by the KJSQ relay of the test circuit when it operated and locked to ground on the KCH relay operated. The MT8 relay normal, closes the MT8K lead to operate the MT8K relay of the test circuit. The MT8K relay operated, locks to the KCH relay, removes ground from the JSQ0-5 lead, and extends ground to operate the MC relay. With all JSQ0-5 keys normal or the switch in the off position, or with the KCH relay normal the junctor sequence relays of the marker function in a normal manner.

If no JSQ0-5 key or switch is operated, the MTF lead to the marker is open and the MT8K lead is closed to the MC relay through normal contacts of the JSQ0-5 key or switch. The KCH relay normal bridges the MT8K lead around contacts of the JSQ0-5 keys or switches.

C5-1.2 OFFICE SIZE TRUNK LINK FRAMES (SFD-C507)

A cross-connection in each CM from the SZD terminal to one of the terminals SZ2-10 indicates the size of the office in terms of the number of single trunk link frames in a nonpaired office, number of pairs of trunk link frames in a paired office, or number of trunk link frame triples in a triple office.

During transition from one size office to another, some trunk link frames may have a junctor pattern for one size office while others have a different size office junctor pattern. In this case, the SZA, SZB and SZC terminals are cross-connected to appropriate SZ2-10 terminals in each marker, and the G terminal of each trunk link frame is cross-connected to SZA, SZB or SZC terminals as required. These cross-connections are changed in individual trunk link frames as the transition progresses. Upon completion of the transition, the SZD terminal of each CM is cross-connected to the SZ2-10 terminal corresponding to the new office size.

C5-1.3 SINGLE PAIRED OR TRIPLE TRUNK LINK FRAME OPERATION (SFD-C510)

A cross-connection in each CM from the SPF terminal to the SF, PR, or TTF terminal indicates to the CM whether the office is arranged for single, paired, or triple trunk link frame operation. During transitions, however, from single to paired, or paired to triple-trunk link frame operation, the marker cross-connections are removed and cross-connections are made in each TLC. A frame which has not been modified might be cross-connected as a STF (single trunk link frame) while another frame which has been modified might be cross-connected as a PR (paired trunk link frame).

C5-1.4 OFFICE SIZE LINE LINK FRAMES (SFD-C510)

The marker determines office size in terms of number of line link frames from a combination of the office size in terms of trunk link frames (SCD-C5-1.2) and the indication of single, paired, or triple trunk link frame operation (SCD-C5-1.3). The 20F relay operates for 1-20 line link frames, the 40F relay for 21-40 line link frames and the 60F relay for 41-60 line link frames.

C5-1.5 PATTERN UNITS (SFD-C504)

In the following size offices all junctor subgroups have 10 junctors.

2TLF Single, paired or triple.

2-3TLF Single, paired or triple.

5TLF Single, paired or triple.

10TLF Single, paired or triple.

All other sizes have some junctor subgroups with less than 10 junctors.

To determine which junctors are equipped, one P0-9 (pattern unit) relay is operated in the CM. The SFD-C504 shows how a particular pattern unit relay is operated for TL0 in an office having single TL operation. It also shows particular pattern unit relay operation for either TL of TL pair 0 in an office having paired TL operation. Also shown is a particular pattern unit relay operation for any TL of TL triple 0 in an office having triple TL operation. The choice of a pattern unit relay is determined by the line link frame number (FUT0-9 relay and FTB0-3 relay operated) and the line link office size relay 20F, 40F, or 60F operated.

C5-1.6 NUMBER OF JUNCTOR SUBGROUPS (SFD-C508, C509)

This applies only to 6 TLF and 7 TLF size offices. Both of these office sizes have some junctor groups with two, and other junctor groups with three junctor subgroups. With either relay 6 TLF or 7 TLF operated, relays P0, 2, 3 and 4 operate the 3G (3 junctor subgroup) relay while relays P4-9 operate the 2G (2 junctor subgroup) relay.

C5-1.7 QUAD RELAYS (SFD-C510)

The 7Q (seven quad) relay is used only in paired or triple trunk link frame offices of the 7 TLF size. The RQ (regular quad) relay is used only in paired or triple trunk link frame offices of 6TLF, 8TLF or 9TLF sizes. The term "quad" no longer has a valid meaning since triple trunk link frame operation came into use. Essentially, these relays provide a convenient and more economical method of steering the JC- leads (SFD-C521) than by using contacts of TLF for a particular size offices.

C5-1.8 PATTERN TENS (SFD-C505)

The PNR relay is always operated by the following office sizes which have no subgroups of less than 10 junctors.

2TLF Single, paired or triple

2-3TLF Single, paired or triple

5TLF Single, paired or triple

10TLF Single, paired or triple

The PNR relay is also operated for certain other office sizes when the marker is directed by the operated or released condition of the STP1, STP2, and JSQ relays to junctor subgroups having 10 junctors. When the marker is directed to subgroups having less than 10 junctors, one of the pattern tens relays PA, PB, PC, or PE is operated.

C5-1.9 TEST CHANNEL RELAYS - TEST CHANNEL CHECK (SFD-C522, 525)

The marker determines which channels are equipped in a subgroup by operating one, two, etc. or all TCH0-9 relays (SFD-C522). The PNR relay operates all ten TCH- relays. The combination of one pattern tens and one pattern units relay operates only those TCH- relays corresponding to equipped junctors.

The operation of any TCH relay operates the TCHK relay (SFD-C525) which locks to the operated CHA relay.

C5-1.10 JUNCTOR SUBGROUP SELECTION (SFD-C508, C509)

To simplify the path for operation of the JG relays, SFD-C508 shows operate paths for offices with 2, 2-3, 5, or 10 TLF-size while SFD-C509 shows operate paths for all other sizes 3, 4, 6, 7, 8, and 9. Note on SFD-C508 that only the JG0 relay can be operated for the 10TLF size since there is never more than one junctor subgroup. For the 5TLF size either JG0 or JG1 relay may be operated. For the 2-3TLF size, JG0 or JG3 relays may be operated. For the 2TLF size; JG0-JG4 relays may be operated. Since no pattern units relay is required for these office sizes, the 1-out-of-10 check of the P- relay is bypassed.

Office sizes 3, 4, 6, 7, 8, and 9TLF each have one or more junctor subgroups with less than 10 junctors and, therefore, must operate a pattern unit relay. Ground for operating the JG-relays is provided through a 1-out-of-10 check of pattern unit relays, and if the office has triple trunk link frames, a similar check through pattern auxiliary relays.

For any size office, the STP1 relay (SFD-C525) is always operated at the beginning of a call. If no idle channel is available in the junctor subgroup selected through the STP1 relay, the STP1 relay will be released and the STP2 relay operated to operate a different junctor subgroup, JG- relay. This applies to all sizes except 10TLF which has only one junctor subgroup.

The walking circuit is stepped to a new position at the end of each call for office sizes having more than one junctor subgroup. Different subgroups are given preference according to which JSQ0-5 and JLE or JL0 relays are operated.

C5-1.11 JUNCTOR SUBGROUP CONNECTOR RELAYS (SFD-C525, C510)

The GC or GCA relay in some cases with triple trunk link frame operation (SFD-C525) operates early in the call from the LLC1 relay. The operated GC or GCA relay steers battery through contacts of an operated JG0-4 relay to operate a junctor subgroup connect relay G0-4 in the trunk link connector (SFD-C510). A one-out-of-five check through the JG0-4 relay ensures that only one relay is operated. To detect crossed G-leads to the TLC, normal JG- relays ground associated leads. If the lead associated with the operated JG- relay is crossed to any other lead, the direct ground causes sufficient current to flow through the XJG relay to operate it. The XJG relay is biased to not operate on the current required to operate the G- relay in the TLC. If the XJG relay operates, it in turn operates the XAJG relay which locks and causes a trouble record showing XJG punch to be taken.

C5-1.12 JUNCTOR CONNECT RELAYS - JUNCTOR CONNECT CHECK (SFD-C521, C527)

Junctor connect relays JC0-9 are associated with regular trunk junctor switches. Relays JC10-19 are associated with extension trunk junctor switches. Relays JC20-29 are associated with supplementary trunk junctor switches. The JC0-9 leads are partially closed by the previously operated G0-4 relays in the TLC.

The path for operating the JC- relays is shown on SFD-C521. Battery is supplied through the primary winding of the XJC relay so that the XJC relay is connected to ground through more than one JC relay winding. The XJC relay is biased through its secondary winding. If more than two JC leads are crossed or grounded, the current through the primary winding is sufficient to overcome the bias of the secondary and operate the XJC relay. When the XJC relay operates, it operates the XAJC relay which causes a trouble record showing a XJC punch.

When the G0 relay in the TLC is operated, JC0-9 leads from the marker are closed through directly to the JC0-9 leads, respectively, to the TL. However, relays G1-G4 close the JC0-9 leads from the marker to cross-connection terminals G10-19, G20-29, G30-39, and G40-49. The cross-connections required are different for each office size and vary between TLC associated with different TL in the same office.

To steer the activated JC lead to the proper JC0-9, JC10-19, or JC20-29 relays, the marker operates an RF, EF, or SEF relay (regular, extension, or supplementary extension frame, SFD-C520). Battery to operate one of these relays is fed through the winding of the XF relay which is biased to operate if the RF, EF, or SEF leads are grounded or crossed so that the XF relay supplies current to more than one relay. If the XF relay operates, it operates the XAF relay which causes a trouble record showing an XF punch.

The JCO relay (SFD-C529) connects to the sleeve leads of the level 0 junctors on the left and the level 0 junctors on the right of each of the junctor switches 0-9. The JCO relay also connects to ten different level 0 select magnets, one on each junctor switch 0-9. Similarly, each of the JC1-9 relays connect to sleeve leads and select magnets associated with levels 1-9, respectively, on each of the junctor switches 0-9. To associate with the junctors located on the right or left half of the switches, a marker operates R, ER, and SER relays or L, EL, and SEL relays (SFD-C520). The ER and EL relays (extension right and left) are required only for paired and tripled TL operation. The SER and SEL relays (supplementary extension right and left) are required only for triple TL frame operation. The battery to operate these relays is fed through the winding of the XLR relay. The XLR relay is biased to operate when connected to more than one relay, either L or R when the STF relay is operated for single TL frame offices. It is biased to operate when connected to more than three relays (R, ER, and SER, or L, EL, and SEL) when the STF and PR relays are normal in triple trunk link frame offices. It should be noted (SFD-C510) that during transitions STF or PR may be operated or nonoperated depending on which TLC is used. A TLC which has not been changed over from single to paired operation would still operate the STF relay while a TLC which had been modified would operate the PR relay.

When a JC relay operates, the JCK relay (SFD-C527) on the JSO lead operates to ground through one of the select magnets on the 0 junctor switch as a check that the JC relay has operated. The JCK winding resistance, and JCK series resistance, limit current so that although the sensitive JCK relay operates, the select magnet does not operate.

When R, ER, and SER or L, EL, and SEL operate, the RK or LK (right check or left check SFD-C520) relay operates through contacts of all three relays in series as a check to the marker that they have operated.

C5-1.13 CONNECTION TO LINKS OF HORIZONTAL GROUP ON LINE LINK FRAME (SFD-C409, C524)

Operation of the HGA, HGB relays of the LL frame are shown on SFD-C409. Operation of these relays is checked by operation of the HGK relay of the CM. The operated HGB relay closes through LL0-9 leads to each of the ten links associated with that horizontal group (SFD-C524).

The selected group of ten line links is assigned to ten channels so that the numerical designation of the channel is identical with the numerical designation of the line link test lead LL0-9. The designation also agrees with the numerical designation of the junctor switch and the horizontal level of the line switch which are connected by the line link.

C5-1.14 CONNECTION TO LINKS OF TRUNK SWITCH ON TRUNK LINK FRAME (SFD-C311, C529)

The selected trunk F relay controls the operation of the FA or FB relay in the TL (SFD-C311). Operation of the FA or FB operates the proper LV2-9 (level connector) and LC0-9 (link connector) relays in the TL for marker control of the select magnet operation, channel test, and hold magnet operation (SFD-C529). The A or B appearance and the horizontal level of the trunk switch is checked by the operation of the FAK or FBK relay in the marker (SFD-C311). To check that the LC relay operated, the LCK relay in the marker operates. The operated LC relay connects to sleeve leads of the links associated with the trunk switch on which the trunks appear (SFD-C529). The operated L or R relay closes through ten sleeve leads associated with the left or right half of the trunk switch (SFD-C529).

The selected group of ten trunk links are assigned to the channels so that the numerical designations of the channel of which the trunk link is a part is identical with the numerical designation of the trunk link test lead LH0-9, and with the numerical designation of the TL junctor switch to which the trunk link connects.

C5-1.15 CHANNEL TEST (SFD-C524)

Ten channel test relays CHT0-9 are connected through diodes to ten line link sleeves, ten junctor sleeves and ten trunk link sleeves (SFD-C524). Diodes in each lead prevent a ground on one leg of a channel such as a line link feeding through to another leg of the channel such as the junctor or trunk link while at the same time permitting a ground on the sleeve of any of the three legs to operate the associated CHT relay. The test paths for the 0 channel are shown in red on SFD-C524. The STX relay (SFD-C109) operates early in the call and provides direct battery to the CHT relay windings. Between calls the STX relay is released. If any of the channel test leads are falsely grounded to either the line or trunk link connectors, the XCH relay will operate between calls. The XCH relay operates the XACH relay which locks and causes a trouble record showing an XCH punch.

C5-1.16 TEST CHECK (SFD-C525)

The preceding paragraphs have described a number of operations which proceed at the same time in preparation for selection of a channel. Upon successful completion of each operation, a check relay operates. These check relays are summarized below.

TCHK - Checks that at least one TCH relay has operated.

JCK - Checks that a JC relay in the TL has operated.

RK/LK - Checks that a R or L relay in the TL has operated.

FAK/FBK - Checks that a FA/FB relay and an LV relay in the TL has operated.

LCK - Checks that a LC relay in the TL has operated.

HGK - Checks that a HGA and HGB relay in the LL has operated.

SCCK - Checks that originating class of service relays have operated.

SON - If SON relay is operated, indicating a sender required, ORK1 and 2 relays must be operated, indicating that the digit information to be transmitted has been received from the originating register.

When all of the above relays have operated, ground from the operated JCK relay operates the TK (test check) relay.

C5-1.17 SELECTION OF A CHANNEL (SFD-C525)

The LLC1, CHT, SLRK and CB5 relays will have operated early in the call. When the LOT and DTK (SFD-C408) relays operate, ground is closed to operate a CH0-9 relay. There is a double chain path composed of CHT0-9 relays and TCH0-9 relays to determine which CH0-9 relay, if any, is to be operated. Some or all of the TCH- relays (SFD-C522) will be operated as an indication of which channels are provided in the subgroup being tested. Any channel which is busy (SFD-C524) will have an operated CHT relay. If the TCH0 relay is operated and the CHT0 relay is normal, the CH0 relay operates and locks. If, however, either TCH0 relay is normal or CHT0 relay is operated, ground is passed to operate the next relay in the chain which has an operated TCH relay and a normal CHT- relay. When one CH- relay has operated and all others are normal, the CHA relay operates as an indication that a channel has been selected.

C5-1.18 NO IDLE CHANNEL, RECYCLE, FAILURE TO MATCH, ROUTE ADVANCE (SFD-C525, C512, C513, C514, C515, C517, C519)

If there is no idle channel, that is, no CH- relay having both an operated TCH- relay and a normal CHT- relay (SFD-C525), the FMP relay operates in a 10TLF size office. In all other size offices, the STP relay operates. Refer to the flowchart (SFD-C512) and the sequence charts (SFD-C513, C514, C515) which show the general and detailed sequence of operations under various conditions.

The marker recycles when it is unable to find a channel between a line or trunk appearance on the LL and a trunk appearance on the TL. On recycles caused by failure to match, the marker makes a second attempt to complete the call by using trunks to another TL in the same route. The marker then tests the new group of channels to complete the call.

All office sizes except 10TL nonpaired, 20TL paired, or 30TL tripled have more than one subgroup of junctors. Since the marker can test only one subgroup of junctors at a time, facilities are provided to shift junctor subgroups if the marker finds all channels busy when testing the choice subgroup.

The STP operates when all available CHT0-9 relays are operated because all channels are busy. The operated STP releases the GC, and causes the marker to select another junctor subgroup.

If testing the second subgroup of junctors also results in an all channels busy indication, the operation of the CHT- will cause the FMP relay to operate.

The FMP causes the FM (failure to match) to operate and control the operation of two sets of counting relays. One set of counters (1F, 1FA, 2F and 2FA) counts the total failures to match, the RF, RFA counts the matching failures within a route.

Failures to match causes the following marker action:

1st failure causes recycle or allotter advance.

2nd failure within route causes route advance.

3rd failure causes route advance; register returns busy-tone.

Route advance occurs when the marker cannot find an idle channel. The R- (route) relays are divided into blocks with each block being wired to one of the GS- ground supply relays. Each GS- relay supplies ground to the contacts of the R- relays in the block.

The marker provides six ground supplies. Depending on the office involved, the route relays are assigned to the ground supplies to provide the required direct and alternative routing.

Ground supplies one through four are used for direct and alternate routes. Ground supply five is used for tone trunks. Ground supply six is used for common overflow trunks.

C5-1.19 ROUTE ADVANCE CONTROL BY MASTER TEST CONTROL (SFD-C516)

Route advance is controlled by an RA0-3 key (or RA switch, or RAU switch and RAT1 key) which is operated to cause the marker to route advance a number of times corresponding to the key operated or position of the switch, and to allow the marker to select a trunk link frame only after it has route advanced that number of times, but not after it has route advanced more than that number of times. The RA(1-11) lamps indicate the number of route advances.

C5-1.20 CONTROL OF CHANNEL SELECTION BY MASTER TEST CONTROL (SFD-C522, C523

The marker can be directed to select a particular channel under control of the CH0-9 keys or switch, and to select a particular junctor step position under control of the STP1/STP2 key.

C5-1.20.1 Particular Channel Selection (SFD-C522, C523)

With the CH- keys or switch and the STP1/STP2 keys normal, there is no control of channel selection from the master test control circuit and a channel is selected at random as on a service call. With the CH- keys or switch operated, the MT7 relay in the marker operates. This opens the grounds normally used by the marker to operate TCH0-9 relays. The operated CH-key or switch provides ground on one of the TCH0-9 leads to permit the corresponding TCH0-9 relay to operate but only if it would normally have been operated by the combination of pattern relays operated. This procedure restricts the marker so that it can operate only a channel relay corresponding to the operated CH- key or switch. The CH- relay can be operated only if the channel is idle (as indicated by the corresponding CHT- relay normal).

If a particular channel is not available in STP1, the marker makes a retest to try to find a channel in STP2 (except in 10TLF, 20TLF and 30TLF size office) (SFD-C523). Again the marker is restricted to select only the channel corresponding to the operated CH- key or switch.

C5-1.20.2 Combined Particular Junctor Step and Channel Selection (SFD-C522)

When a STP1 or STP2 key and a CH- key or switch are operated together, the CM is restricted to selection of a particular channel within a particular junctor step. The MT7 relay of the CM remains operated in both Step 1 and Step 2. The STP relay of the MTC is operated during Step 1 with the STP1 key operated and during Step 2 with the STP2 key operated. This feeds ground through the operated CH- keys or switch to permit selection of only that channel corresponding to the operated CH- key or switch.

C5-2 SELECT MAGNET OPERATION

C5-2.1 LINE LINK FRAME SELECT MAGNET OPERATION (SFD-C526)

Upon operation of a CH- relay, battery through the LS and LSA resistance lamps is closed to the select magnets on the line link frame. This battery is steered by the operated HGA- relay to the proper link select magnets and junctor hold magnets. It should be remembered that the line junctor switches also serve as line switches. One-half of the verticals is for junctors and the other half is for lines. If the CH0 and HGA0 relays are operated for a line on one of the number 0 line switches to a junctor on the 0 junctor switch, an L0 and an LJ0 select magnet are operated. The LJ0 select magnet would serve a customer on the line side of the line junctor switch. If the CH1 relay and HGA0 relays are operated for a line on one of the number 1 line switches to a junctor on the 0 junctor switch, the LJ1 select magnet for the 0 junctor switch would operate, but the LJ0 select magnet on the number 1 junctor switch would also be operated to serve a line on the line side of the number 1 junctor switch.

When paired LL frame operation is provided, the select magnet leads extend to the auxiliary LL frame. The XLS relay is connected to SM- leads through normal contacts of all but the operated CH- relay. If the SM- lead through the operated CH- relay is crossed to any of the other SM- leads, the XLS relay will operate to the applied battery and lock. The XLS relay operates the MXT relay which causes a trouble record to be taken showing an XLS punch.

C5-2.2 TRUNK LINK FRAME JUNCTOR SELECT MAGNET OPERATION (SFD-C527)

Upon operation of a CH- relay, battery is closed to junctor select magnets on the TL. The operated CH- relay closes an JS- lead to a junctor switch of the same number as the CH- relay. An operated JC- relay on the TL closes the JS- lead to a select magnet of the same number as the last digit of the JC- relay. The JC0-9 relays are associated with the regular TL. The JC10-19 relays are associated with the extension TL, and JC20-29 are associated with the supplementary extension TL.

It should be noted that the JCK relay, which operated as a check that a JC- relay has operated, is released if the CH0 relay operates to apply battery to the JS0 lead. For this reason, the JCK punch will not appear on trouble cards where channel 0 is shown.

Battery to the JS- leads is fed through the XJS relay which is biased to operate if it is connected to ground through more than one select magnet. If the XJS relay operates, it operates the XAJS relay. The XAJS relay operates the MXT relay which causes a trouble record to be taken showing an XJS punch.

C5-2.3 TRUNK LINK FRAME TRUNK SELECT MAGNET OPERATION (SFD-C527)

When the FAK or FBK relay in the marker operates, the battery is extended to the TL on the ASM or BSM lead. This battery is directed by the operated LV- and FA- or FB- relays in the TL to operate a select magnet on the A or B trunk switch steering level and on the level of the selected trunk. Ground for the trunk level select magnets is provided by the marker on the TSX lead. This ground is present upon the release of TSE1 relay immediately following the selection of an idle trunk.

After trunk selection, when the TSE1 relay has released and the FAK or FBK relay has operated, the XTS relay is connected to the TSX lead. The XTS relay is biased to operate if it is connected to battery through more than one T2-9 select magnet. If there is a cross which closes the ASM lead to more than one of the select magnets T2-9, the XTS relay operates and in turn operates the XATS relay which operates the MXT relay to cause a trouble record showing an XTS punch.

C5-3 HOLD MAGNET OPERATION-NETWORK AND LINE TEST

The sequence of hold magnet operation differs, depending on whether the marker determines that traffic is heavy or light. Under heavy traffic conditions all hold magnets are operated at the same time with a minimum of checks and tests to reduce marker holding time. Under light traffic condition, operation of the line hold magnet is delayed to permit a test of the talking path for crosses. After the line hold magnet has operated, a continuity test of the talking path crosspoints is made.

Headings of the following paragraphs are designated HTR, LTR or HTR/LTR as an indication that the paragraph applies only to heavy traffic, only to light traffic, or to either heavy or light traffic operation.

C5-3.1 DETERMINATION OF LIGHT OR HEAVY TRAFFIC BY CM-HTR/LTR

Hold magnet operation, as well as other marker functions, differ according to whether traffic is light or heavy. The CM determines whether the traffic is light or heavy by measuring the time between seizures of the CM using the HTT timer (SFD-C137).

At the beginning of a call, the MCB- relays of the CM are operated over the MB lead from the ORMC (SFD-C106). The MCB1 relay operated extends ground on the TM lead to operate the OAT relay. If the HTR relay is already operated from the last call it remains locked to ground through normal contacts of the HTT relay (SFD-C137). At the end of the call, the OAT relay releases. If the HTR relay is not already operated, it operates and locks releasing the OAT1 relay. With the OAT and OAT1 relays normal and the HTR relay operated, the shunt around the HTT capacitor (SFD-C137) is opened allowing the HTT capacitor to charge until the HTT tube fires and operates the HTT relay or until the CM is seized again and the OAT relay operates to stop the timing. If the time between calls is greater than 0.96 to 1.6 seconds, the HTT relay operates releasing the HTR relay so that the next call is handled on a light traffic basis. If the interval is shorter than 0.96 to 1.6 seconds, the HTR relay remains operated and the call is handled on a heavy traffic basis.

C5-3.2 HOLD MAGNET TIMING - HTR/LTR (SFD-C530)

As described in preceding paragraphs, select magnets are operated on line link and trunk link frames upon operation of a CH- relay. Operation of a CH- relay also operates the CHA relay which starts a hold magnet timing interval. This time interval is necessary to allow select magnets to operate, for select fingers to seat, and for any previously operated hold magnets connected to this channel to release before operating hold magnets for this call.

Prior to operation of the CHA relay, current flows through the primary winding of the HMT relay in a direction to operate it, while current through the secondary flows in a direction to release it. The combination of external resistance, winding resistance, and difference in number of turns is such that the current in the secondary prevents the HMT relay from operating. When the CHA relay operates, current in the secondary decreases as the HMT capacitor charges. When the effect of the current in the secondary becomes less than that of the current in the primary, the HMT relay operates. This operate time can be set at 43-50 ms by cross-connecting terminal HMT1 to HMT3 or to 63-75 ms by cross-connecting terminal HMT1 to HMT2. The longer time interval is required in offices which have some switches which are not equipped with damping cones, since the select fingers on these switches take longer to settle down. Operation of the HMT relay operates the HMT1 relay.

C5-3.3 CHECK OF CHANNEL - HTR/LTR

Early in the call, the SLRK relay operates (SFD-C531) from ground on the LLC3 relay through normal contacts of the following relays to ensure that they are initially normal: SLA, TGCK, JGCK, GLH1, GT2, HMT1 and CHA1. The SLRK locks when the TK relay operates. If the SLRK relay fails to operate, operation of a CH- relay (SFD-C525) is prevented.

In the process of channel test (SCD-C5-1.15, SFD-C524) busy channels are detected by looking for ground on sleeve leads. If ground is not detected on any of the three parts of a channel, it is presumed to be idle and one of the "idle" channels is selected by operation of a CH- relay (SFD-C525).

A further check of the channel is made after a CH- relay has operated. The JGCK and TGCK relays (SFD-C533) are connected to junctor and trunk hold magnet leads, respectively. These are high resistance sensitive relays which operate to battery on hold magnet windings without operating the hold magnets. This provides a positive check that the hold magnets associated with the channel are idle (ungrounded). A further check of the sleeve of the line link selected is made by the LLT relay. If the line link is idle (ungrounded) the LLT relay will not operate (SFD-C524).

C5-3.4 CROSS CHECK OF TRUNK SLEEVE - HTR/LTR

Prior to operation of the HMS1 relay, the XSL relay is connected to the AST or BST lead (SFD-C533) to detect any cross to ground. If the XSL relay operates, it locks and operates the MXT relay which causes a trouble record showing an XSL punch.

C5-3.5 HOLD MAGNET START - HTR/LTR, (SFD-C531)

With the HMT1, JGCK, TGCK, and SLRK relays operated, and other check relays released, the HMS1 relay operates to start hold magnet operation. The operation of the HMS1 relay closes circuits for operating the LL and TL hold magnets and the line hold magnet of the channel.

C5-3.6 HOLD MAGNET OPERATION - HTR/LTR (SFD-C533)

The operation of the HMS1 closes the operate circuit over the LH-, J-, and LH-(TL) leads to the LL and TL hold magnets of the selected channel. Relay HMS1 operated extends the +130 volts on the LH, JH-, and TH- capacitors to the winding of the hold magnets. The capacitors discharge through the hold magnets, causing them to operate. When the voltage across the capacitor drops to about -.5 volts the LH, JH-, and TH- diodes become forward biased and pass a steady current to hold the hold magnets operated.

The TL trunk and junctor hold magnets and the LL junctor hold magnet are always operated on a dual voltage basis.

C5-3.7 DUAL VOLTAGE OPERATION - HTR/LTR (SFD-C533)

With the standard dual voltage option, all hold magnets except the line hold magnet are operated by a high voltage surge on all calls. The line hold magnet is operated by the high voltage surge except on calls to message rate lines in offices having message registers. This is to avoid the possibility of falsely operating the message register. Lines equipped with message registers are indicated to the marker over the class-of-service leads from the LL. The class-of-service indication is received over the CS00-29 leads, which in turn are cross-connected to operate relay CNA (coinline auxiliary), AOA (all other auxiliary), MRA (message registers auxiliary), or CGS (centrex station). The operation of the CNA, AOA, or CGS relays operates the DVO relay, which in turn operates the DVA relay indicating that the marker should use dual voltage to operate the line hold magnet. The operation of the MRA indicates 48 volt operation for the line hold magnet.

With DVA or MRA operated and the HMT operated, ground is closed to operate the HMT1 relay.

C5-3.8 OPERATION OF LINE HOLD MAGNETS - HTR (SFD-C533)

Assume a heavy traffic call with a nonmessage rate line. Upon operation of the HMS1 relay, with the HTR, DVO and DVA relays operated, ground is furnished through the primary winding of the LXP relay in series with the LH capacitor. The LH capacitor (which has previously been charged to +130 volts and acts momentarily like a 130 volt battery) is applied to the winding of the line hold magnet which is connected to -48 volt battery. The effect is as though a battery of 178 volts were connected to the relay winding. The voltage of the LH capacitor rapidly decreases to 0 and then to a fraction of a volt negative at which point the LH diode begins to conduct, so that the hold magnet is held operated to ground potential. Application of high voltage in this manner causes the hold magnet to operate in about 1/3 the time it would take if 48 rather than 178 volt operation were used.

If the DVO and DVA relays are normal, 48-volt operation is used. That is, the ground through the winding of the LXP relay is applied directly to the hold magnet without the LH capacitor in series.

With or without surge voltage operation, the LXP relay operates in series with the line hold magnet. The LXP relay operates the LXPA relay which locks (SFD-C531).

C5-3.9 OPERATION OF JUNCTOR AND TRUNK HOLD MAGNETS - HTR/LTR (SFD-C533, C531)

The HMS1 relay closes ground through the JXP relay primary winding in series with the JH capacitor charged to +130 volts over the J- lead to the winding of the line link junctor hold magnet.

The HMS1 relay also closes ground through the TXP, TXP1 resistance lamps in series with the TH1, 2 and 3 capacitors charged to +130 volts over the LH- lead to the trunk and trunk junctor hold magnets. As described for high voltage surge operation of line hold magnets, the magnets operate in about 1/3 of the time required for 48-volt operation. When the capacitor discharges, the magnets continue to be held operated through the diodes to ground through the JXP relay or the TXP, TXP1 resistance lamp. The JXP relay operates in series with the line junctor hold magnet and operates the JXPA relay which locks.

C5-3.10 CROSSPOINT CHECK - HTR/LTR (SFD-C533, C531, C524)

C5-3.10.1 Heavy Traffic

When the hold magnets have operated, the low resistance ground from the TXP, TXP1 resistance lamps operates the SL relay and releases the LXP and JXP relays which operate the LXP1 and JXP1 relays, respectively. The SL relay operates the SLA relay (SFD-C533). The LLT (SFD-C524) relay, which has previously operated when operation of the line junctor hold magnet grounded the line link sleeve, operates the LLTA relay. Operation of the SLA, LLTA, LXP1 and JXP1 relays closes ground through the previously operated HTR relay to operate the GT1 relay, which locks.

C5-3.10.2 Light Traffic

Crosspoint check on light traffic is the same as preceding, except:

(a) Line hold magnet operation does not occur at the same time as operation of the other hold magnets when the HTR relay is not operated.

(b) Operation of the SLA, LLTA and JXP1 relays closes ground through the normal HTR, LXPA and LXP1 relay contacts to operate the LTR (light traffic) relay instead of the GT1 relay.

C5-3.11 FALSE CROSS AND GROUND TEST - LTR (SFD-C535)

On light traffic calls, a test for crosses on the network tip and ring conductors is made. For this reason, the operation of the line hold magnet operation is delayed during the test so that crosses or grounds external to the network are not detected.

Ground through the secondary, and battery through the primary windings of the FCG relay are connected to the ATT or BTT and ART or BRT leads, respectively.

The FCG relay will operate if there is a false ground on the ring conductor at any point from the nonoperated LL line hold magnet crosspoints to the primary winding of the FCG relay. If there is a false battery on the tip conductor at any point, the FCG is operated by current through the secondary winding. Or, if there is a false cross between the tip and ring conductors at any point, the FCG relay is operated by current through the primary and secondary windings. The operation of the FCG relay would stop the progress of the call and produce a trouble record showing the FCG punch.

When the LTR relay operates, indicating that all crosspoints other than those for the line hold magnet have closed, a locking ground is provided for the FCG relay in case it has operated. If the FCG relay has not operated, the GLH relay operates (SFD-C530).

The GLH relay disconnects the FCG relay from the ATT or BTT and ART or BRT leads and grounds both leads to discharge any voltage remaining on them from the FCG test.

C5-3.12 DELAYED OPERATION OF LINE HOLD MAGNET - LTR (SFD-C530)

The GLH relay operates the GLH1 relay. With the GLH1 relays operated, the line hold magnet is connected either in series with the LXP primary winding to ground (if the DVO and DVA relays are normal) or in series with the charged LH capacitor to ground through the LXP primary winding, if the DVO and DVA relays are operated. The operated LXP relay operates the LXPA relay. When the line crosspoints close, the LXP relay is forced to release by ground from the TXP and TXP1 resistance lamps. This operates the LXP1 relay.

C5-3.13 CONTINUITY TEST, GENERAL - LTR (SFD-C535)

A continuity test of the talking path through the network is made on light traffic calls. In order to check continuity of the path through the network, a path from tip to ring conductors or from either tip or ring to ground external to the network is required. Twenty-cycle (AC-DC-AUD) ringing supply is stepped up to a higher voltage by the CON2 transformer. With the GLH1 relay normal, the output of the CON2 transformer is open-circuited. There is no current flowing and, therefore, no voltage buildup across the CON2 capacitor. When GLH1 relay operates (assume RCTA relay normal) the CON2 transformer is connected through the network to the ring side of the line. Ground is connected to the tip side. On nearly all calls, the off-hook status will be connected across the tip and ring so that there will be a relatively low dc resistance in the loop. Current will flow, causing an alternating voltage to appear across the CON2 capacitor. Terminal 1 of the CON tube is connected through the CON1 resistor to the CON2 capacitor. If the voltage at terminal 1 reaches the firing voltage of the CON tube, even momentarily, the CON tube fires and continues to conduct between terminals 2 and 4 to operate the CON relay even though the voltage at terminal 1 is no longer above the firing voltage.

Occasionally the station will go on-hook just before the continuity test is applied. If this is an individual line, the path through the ringer and the series capacitor allows sufficient 20-cycle (AC-DC-AUD) frequency current to flow to raise the voltage across the CON2 capacitor to the firing voltage. The same holds true for a ring party line. In this case, current flows through the network ring lead only through the ringer and capacitor to ground and back through the earth to the central office ground. If there is only a tip party connected to the line, insufficient current may flow and the CON tube may not fire at this time (still assuming that the RCTA relay is normal at the beginning of the continuity test.) As described in more detail later, the RCTA relay operates after a short interval to reverse the continuity test. Now, current flows through the tip lead through the tip party bell and capacitor, back through the earth to the central office ground. If the RCTA relay had been initially operated and only a ring party station had been connected, the RCTA relay would have released to apply the continuity test to the ring side of the line.

On long lines, the cable capacity is sufficient to satisfy the continuity test even if there is no other path through ringers or transmitter.

C5-3.13.1 Continuity Test Reversal Control - LTR (SFD-C535)

The RCTB relay operates from ground through the HTR relay contacts normal, and prevents the RCTA relay operation for ring party stations. On continuity test of a multiparty line, the ring side of the line is tested first. If the continuity test is satisfactory, the operation of the CON1 relay locks the RCTB relay operated. If the continuity test is not satisfactory, the RCTB relay releases when the LXP1 operates, and causes the RCTA relay to operate. The operated RCTA removes the continuity test from the ring and applies it to the tip conductor.

C5-3.13.2 Continuity Test Description - LTR (SFD-C535)

Operation of the GLH1 relay, in addition to starting operation of the line hold magnet, also starts the continuity test. Stepped up 20-cycle ringing supply voltage through the CON2 transformer in series with the CON2 capacitor to ground is applied to either the tip or to the ring of the path through the network depending on whether the RCTA relay is operated or normal. Ground is applied to the other side of the path through the network. The GLH1 relay also applied +130 volts to a voltage divider supplying the winding of the CON relay.

If there is continuity through the crosspoints and continuity external to the network, the voltage across the CON2 capacitor builds up sufficiently to fire the CON tube. The CON relay operates, in turn operating the CONA relay. The CONA relay operates the CON1 relay which locks. The CON1 relay closes a locking path to prevent release of the RCTB relay (if it has not already released), operates the GT1 relay which locks, and grounds the control terminal 1 of the CON tube. The GT1 relay removes positive battery from the CON relay allowing it to release. This, combined with the grounding of control terminal 1, extinguishes the CON tube.

The CON1 and CON3 capacitors are small and serve to prevent false firing of the CON tube from electrical noise pulses.

C5-3.13.3 Continuity Failure Trouble Record - LTR

If the CON tube fails to fire, the CON and CON1 relays do not operate, and the CM cannot proceed with the call. The work timer which is recycled upon operation of the GLH relay (SFD-C137) times out after 450 to 605 milliseconds. This causes a trouble record showing WT, GLH and all progress punches through the DCT (but does not include the CON punch).

C5-3.13.4 Cancel Continuity - LTR (SFD-C530, C531, C535)

On second trial calls, the operation of the GLH1 relay operates the CON1 relay from ground on the operated TR2C (SFD-C530), thus, automatically canceling the continuity test. On heavy traffic calls, operation of the LXP1 relay with the HTR relay operated (SFD-C531) operates the GT1 relay, thus, canceling continuity test by bypassing operation of both the CON and CON1 relays.

Continutiy test can be cancelled on all calls for all markers by operating the CCT key at the master test frame jack lamp and key panel (SFD-C535).

C5-3.14 DOUBLE CONNECTION TEST - HTR/LTR (SFD-C533)

On both light and heavy traffic calls a double connection test is made to ensure that the sleeve of the connection being set up is not crossed with the sleeve of another connection already set up or in the process of being set up. Although operation of the line hold magnet is slightly delayed on light traffic calls, the double connection test is made in the same manner on both light and heavy traffic calls.

When the LXP1, JXP1 and SLA relays have all operated, as previously described, the LXP and JXP relays and the TXP and TXP1 resistance lamps are disconnected from respective leads to line and trunk link frames. At the same time the DCT relay is connected to the LH- lead to the line link frame. The DCT relay winding now provides the only ground from the CM to keep the hold magnets operated. Bias current through the secondary winding of the DCT relay is such that the DCT relay will operate if there is no other ground feeding the connection such as would occur if the sleeve path were crossed to an established network connection.

C5-3.14.1 Heavy Traffic

On a heavy traffic call the GT1 relay operates upon completion of the crosspoint check (SCD-C5-3.10.1). With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

C5-3.14.2 Light Traffic

On a light traffic call, the GT1 relay does not operate until the CON1 relay has operated as a result of a successful or cancelled continuity test. With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

C5-3.15 HOLD MAGNET SIMULATION AND CONTROL BY MTC (SFD-C532, C533)

On an originating class of marker test, it is desirable to be able to test the marker using any line location information. To avoid the possibility of having a customers line become locked into the test call if the line should happen to go off-hook during the progress of setting up the test connection, line hold magnet operation is simulated.

C5-3.15.1 NTC Key Normal

The MT11 relay of the CM is operated on test calls. This opens the path over the LH- lead (SFD-C533) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on a test call the path is extended over the LHMT lead to the MTC and through the MKT2 relay to the LHM relay (NTC key and NTC1 relay normal) (SFD-C532). The LHM relay and the series LHM resistance are chosen to present an impedance to the marker equivalent to that of a line hold magnet.

When the HMS1 relay of the marker operates, the marker applies either the high voltage surge for dual voltage or ground through the winding of the LXP relay to operate the LHM relay of the MTC. The LHM relay operates the LHMA relay which extends the LHMT lead to the LLJ lead. The LLJ lead ties into the J lead of the CM to the trunk link frame at a point ahead of the CH- relay to simulate the path which would have been closed on a service call over the LH- relay lead to the LL, through the junctor and back over the J- lead to the CM. This permits the marker to go through all the motions of crosspoint and double connection checks. It will actually close junctor crosspoints on the LL, but checks are made through the simulated path just described. The CM operates and checks crosspoints on the TL in the normal manner.

C5-3.15.2 NTC Key Operated (SFD-C532, C533, and C537)

The NTC key of the MTC is operated on an originating class of test where it is desired to establish a connection and check the tip, ring and sleeve path through the line link frame using all crosspoints which would be used on a service call except the line hold magnet crosspoints. Use is made of the no test connector access to LL frames.

Operation of the NTC key on originating class of test operates the NTC and NTC1 relays. The operation of the NTC and NTC1 relays prepares the test circuit for operation with the no-test connector.

When the MTC gains access to the no test connector, the F1 relay of the MTC is operated over the SPC lead (SFD-C532). Operation of the F1 relay operates the NTC select magnets (associated with no test connector level assigned to the MTC) on all no test connector switches (see SFD-C537 as well as C533). The F1 relay also connects the NTB relay of the MTC to the no test connector via the NTH lead. The NTH lead is steered through the CM and the HGA- relay of the LL to the winding of the NTC hold magnet of the no test connector associated with the link to be simulated. If the NTC hold magnet is in use, ground on its winding will be fed back to operate the NTB relay of the MTC which locks on its secondary winding and lights an NTB lamp to indicate NO TEST BUSY. If this occurs, simulated hold magnet operation by the no test connector is blocked. The CM work timer times out and a trouble card showing LXPA but not LXP1 would be produced followed by release.

If the NTC hold magnet is not in use, the NTB relay does not operate. Later in the call, when the CM grounds LHMT lead (which on a regular call would operate the line hold magnet), the NTH relay of the MTC is operated. The NTH relay extends ground from the NTB relay normal to the NTH lead to operate the NTC hold magnet of the no test connector, extends the LHMT lead to the S lead, and closes the tip and ring leads to the test circuit trunk appearance on the no-test connector (SFD-C535).

On an originating test the LK1 relay is operated through the operated MC7 relay (SFD-C604). The operated LK1 relay opens the H lead to the no-test connector to release the no-test connector hold magnet which opens the S lead and releases the NTH relay (SFD-C532). At the completion of the terminating stage the marker operates the SCB relay which recloses the H lead so that the no-test connector may be used again for the originating stage.

C5-3.15.3 Dual Voltage Test (SFD-C533)

When dual voltage operation is provided, the LHMT, LLJ and TLH relays of the MTC are connected to the LHMT, LLJ and TLH leads, respectively. If the CM applies the high positive voltage surge to each of these leads, the corresponding relays should operate to light the LHMT, LLJ and TLH lamps, respectively. Current through the lamps also locks the relays. Tests should be made using message register class of service, if provided, to ensure that the high voltage surge is not applied and, therefore, that the LHMT lamp does not light for these classes. The LHMT lamp should light for all other classes. The LLJ and TLH lamps should light for all classes.

C5-3.16 TEST OF FALSE CROSS AND GROUND DETECTION FEATURE (SFD-C535)

C5-3.16.1 FCG Key Normal

With the FCG key normal, the FCG relay of the CM is connected to the network T and R leads prior to operation of the GLH and GLH1 relays. As on service calls, crosses or grounds on the T and R leads will be detected on light traffic calls.

C5-3.16.2 FCG Key Operated

With the FCG key operated, the FA resistor is bridged across the TTT and TRT leads to the marker. This applies a current which should operate the FCG relay causing a trouble card to be produced showing a FCG punch. If the HTR key is operated, the CM should not detect the FCG condition.

C5-3.17 TEST OF CONTINUITY TEST FEATURES (SFD-C535)

C5-3.17.1 CON, RV, AND TCT Keys Normal, TC Key Operated or Normal

With the CON, RV, TCT, and TC keys normal, an operate condition originating at the voltage divider resistors CL, CM and CK, through the CF resistor is applied to the TRT lead. On alternate test calls the RCTA relay of the CM is operated so that the initial continuity test is made on the RING lead (the TRT lead on a test call). The CON tube should fire and the call should be completed. On calls with the RCTA relay of the CM normal, the initial continuity test is made on the TIP lead (the TTT lead on a test call). Since the TTT lead is open, the CON tube does not fire initially, but (as described for a service call) it should fire after release of the RCTA relay applies the continuity test to the TRT lead. Two consecutive calls should be made to ensure one test with RCTA initially normal and one test with RCTA initially operated. With the TC key normal, a negative bias is applied to the operate path of the CON tube. A test should also be made with the TC key operated to apply a positive bias to the CON tube operate path.

C5-3.17.2 RV Key Operated, CON and TCT Keys Normal, TC Key Operated or Normal

Operation of the RV key with the CON, TCT, and TC keys normal applies the aforementioned continuity operate test condition to the TTT lead instead of the TRT lead. Two consecutive tests should be made to ensure one test with RCTA initially operated and one test with RCTA initially normal. As described previously, The TC key may be operated or normal to apply positive or negative bias to the CON tube operate path.

C5-3.17.3 CON Key Operated, RV, TCT, and TC Keys Normal

With the CON key operated, a loop continuity operate condition is applied across the TRT and TTT leads. The CON tube should fire for OK continuity on its initial attempt whether the RCTA relay is operated or normal.

SECTION C, PART 6

COMPLETING MARKER RELEASE AND OUTGOING SENDER OPERATION

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C6 COMPLETING MARKER RELEASE AND OUTGOING SENDER OPERATION

Upon successful completion of the double connection test and the ground test, the completing marker transmits an advance signal to the outgoing sender as an indication that the outgoing sender should assume supervision and complete the call. After the advance signal is sent to the sender, the marker checks that the functions in the sender are complete and that the linkage between the sender and the trunk are properly set up. If these tests are successful the marker releases. The outgoing sender, having prepared the distant register or sender to accept pulses, awaits a signal from the distant end to start outpulsing. After all the digits are outpulsed, supervision of the call is turned over to the trunk and the sender is released.

C6-1 COMPLETING MARKER RELEASE

The marker may encounter numerous conditions that require disconnect, and when these conditions occur the marker has various methods of disconnection.

C6-1.1 MARKER NORMAL RELEASE - OPERATION OF THE DIS1,2 RELAYS (SFD-C605)

When the marker has completed all functions successfully without encountering any trouble, the LK1 (linkage check) relay will operate causing the DIS1,2 (disconnect) relays in the CM to operate.

The DIS1,2 relays, operating, release the CKG1,2 relays in the CM and grounds the MRL lead into the OR (originating register) to operate the MRL relay (SFD-C107). The MRL relay, operating, releases the MS- relay in the ORMC, and by opening the start lead into the connector prevents a second trial (SFD-C104).

C6-1.1.1 Trouble Record - Operation of the TRR Relay (SFD-C605)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the TRR (trouble record regular) release relay. These conditions are as follows:

When the marker receives a permanent signal indication from the OR, the PS relay in the CM operates. If the APS (all permanent signal) key is operated at the JLK bay, the PSR relay in the CM operates. The PSR and PS relays operate the TRR relay in the CM and a trouble record is taken. The permanent signal trouble record is used to obtain the line information.

When the start lead is shifted to an alternate marker in the ORMC due to a delay in the selection of a marker, the TRS (transfer start) relay in the PC circuit operates. After the alternate marker is selected, the

TRS relay in the CM operates. The TRS relay operates the TRR relay in the CM and a trouble record is taken. The TRS trouble record is used to identify the connector used on the call.

A time out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal) and the dialing connection has released (CB5, CHA, and TK relays operated), the TRR relay in the CM operates and a trouble record is taken. A second trial is not possible on this type of call because the OR has already released.

When the trouble record is completed, the DIS1,2 relays in the CM operate from the operated TRR, TRB1, RDL, and TRSA relays. The marker then releases on a normal basis.

C6-1.2 MARKER TROUBLE RELEASE - OPERATION OF THE TRL RELAY (SFD-C605)

If the CM encounters trouble while trying to complete the call, the TRL (trouble release) relay in the marker will operate. The TRL relay operating releases the CKG1,2 relays in the CM and grounds the TRL lead into the PC (preference control circuit) operating the TRL relay (SFD-C107). The TRL relay operating releases the MS- (marker start) relay in the ORMC. The Z relay in the PC changing condition shifts the ST (start lead) to the alternate marker and a second attempt is made to complete the call (SFD-C104). A trouble release permits a second trial providing the MRL or BT relays in the OR (originating register) are normal.

C6-1.2.1 Line Link Frame Make Busy (SFD-C605)

When a plug is inserted into the LMB jack at the LLF, the MB relay operates in the PC circuit. The MJ relay in the JLK circuit then operates and a major alarm is sounded.

As a result of the MB relay operating, the LLB relay in the marker (SFD-C405) operates and removes battery from the start lead. The LLB relay operates the RBT relay which operates the RDL and then the TRL which releases the marker on a trouble basis.

C6-1.2.2 Trouble Record - Operation of the TR1 Relay (SFD-C605)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the trouble record trouble release TR1 relay. These conditions are as follows.

A time out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal) and the dialing connection has not released (CB5, CHA, or TK relays normal), the TR1 relay in the CM operates and a trouble record is taken. A second trial is possible on this type of call because the OR is still attached to the circuit. If the marker usage is a second trial, TR2C relay operated, the TR1 relay in the CM operates and a trouble record is taken. Since the marker usage is a second trial, the BT relay in the OR will operate opening the start lead preventing another attempt to complete the call.

When the trouble record is completed, the TRL relay in the CM operates from the operated TR1, TRB1, RDL, and TRSA relays. The marker then releases on a trouble basis.

C6-1.3 MARKER OVERALL TIME-OUT RELEASE - OPERATION OF THE MRL, MRL1 RELAYS (SFD-C137)

If the marker fails to complete the call within the allotted interval of 9.6 to 15.4 seconds, the OAT timer functions and causes the MRL (marker release) relay to operate. The MRL relay operates the MRL1 relay (SFD-C605) which operates the busy test BT and MRL relays in the OR (SFD-C107). The MRL relay operating releases the MS- relay in the ORMC and by opening the start lead into the connector prevents a second trial (SFD-C104).

On this type of release, a trouble record is not taken but the TA (timing alarm) lamp will be lighted on the equipment frame.

C6-1.4 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL CIRCUIT (SFD-C604 AND 605)

On test calls certain MT- (marker test) relays operate in the CM. These test relays operating allow the MTC circuit to interact with the marker.

With the MT17 relay operated in the CM, the DCT1 relay operating path is extended into the MTC circuit over the TDCT lead. The DCT1 relay operating ground is extended over the DCT lead into the MTC circuit to operate the DCT relay. With the REC key normal, the operation of the DCT relay in the MTC circuit operates the MO1 relay. The MO1 relay in the MTC circuit operating connects ground to the TDCT lead into the CM operating the DCT1 relay. The CM then continues its progress on a normal basis.

With the MT1 relay operated in the CM, the DIS1,2 relays operating path is extended into the MTC circuit over the DIS lead. After the LK1 (linkage check) relay in the CM operates, ground is extended over the LK2 lead into the MTC circuit. The LK2 relay in the MTC operates, lighting the LK2 lamp. Ground is now transmitted over the LK3 lead through the CM and back into the MTC on the DIS1 lead. The DIS1,2 relays in the MTC circuit operate, lighting the DIS1 lamp, and ground is extended over the DIS lead into the CM operating the DIS1,2 relays. The CM then gives a normal release. It may be noted that if the LK2 and DIS1 lamp at the MTC panel are both lighted, the marker has completed setting up the connection and released.

C6-1.4.1 Requesting Trouble Record Using MTC Circuit - Operation of the REC Relay (SFD-C605)

When it is desired to obtain a record of the progress of the CM when making a test call, the REC key (record request) should be operated at the MTC panel. The REC key operates the REC relay in the MTC after the DCT relay has operated. Thus, the REC relay is operated prior to the completing marker DCT1 relay. The REC relay operated extends ground into the CM over the TRR lead to operate the TRR relay. The TRR relay operates the TRST (trouble recorder start) relay in the CM which operates the MPR- marker preference relay in the MTFC to request a trouble record. A trouble record is taken and the CM releases on a normal basis. These trouble records requested by the test equipment can be distinguished from service or legitimate trouble records by the absence of the TI (trouble indication) punch on the trouble record card.

C6-1.5 TROUBLE RECORDER REQUESTS (SFD-C607)

When the marker encounters a trouble condition, the TRR or TR1 relay will operate in the CM and cause the trouble recorder to be seized by the trouble recorder start relay operating (SFD-C605). The TRST operates the TRSA relay in the marker. On first trial calls, the MN relay in the JLK circuit operates and a minor alarm is sounded. On second trial calls, the MJ relay in the JLK circuit operates and a major alarm is sounded. The marker preference MPR- relay in the MTFC circuit is then operated (SFD-C607) from battery on the TRST lead. The MPR- relay connects ground to the CI lead which operates the MKA, MKB, and MKB1 relays in the MTFC. The MKA relay operates the MTR (marker test repeat) relay which operates the CIC (cut-in connector) relay in the MTFC (SFD-C607) and a trouble record is taken.

After the trouble record is complete, ground over the TRC lead from the TRC (trouble recorder control) circuit operates the TRC and TRC1 (trouble record complete) relays in the MTFC. The RM (release marker) relay in the MTFC operates and ground is transmitted over the TRB lead into the CM to operate the TRB1,2 (trouble recorder busy) relays. The TRB1 relay operating removes battery from the TRST lead releasing the MPR- and MKA relays in the MTFC. The TRB2 relay operates the RDL (release delay) relay in the marker. The marker will then release on a normal or trouble basis.

C6-1.5.1 Trouble Recorder Busy - (SFD-C607)

When a trouble record is requested by the marker with the operation of the TRR or TR1 relays and there is a previous trouble record in progress with the TRB1 relay operated, the DL (display lost) relay in the marker will operate. The DL relay operating will cause the DL- (display lost) lamp in the JLK circuit to light, indicating the loss of a trouble record. The marker will then release on a normal or trouble basis.

C6-2 MF SENDER OPERATION

After the sender is connected to the completing marker, it registers the digits dialed and transmits them over the tip and ring conductors to the distant register or sender. When all digits are transmitted, supervision of the call is turned over to the trunk and the sender releases.

C6-2.1 MF SENDER - DIGIT REGISTRATION (SFD-C610)

The MF sender is designed to handle up to eleven digits, as recorded in the originating register. The digits are registered on dry reed relays, A through L, each relay having five independent coils with two make contacts. The marker operates these independent coils of the digit registration relays on a 2-out-of-5 basis from ground through the OSC circuit.

Since the number of digits an outgoing sender receives on different calls may vary, an indication is needed to mark the end-of-digit registration. This is the end-seven registration and consists of operating only the seven coil of the digit register one beyond the last registered digit.

The completing marker is able to detect missing digits since the registration must consist of 2-out-of-5 in each position up to the end-seven which is followed by a none-out-of-five. Should any of the digit registration relay coils in the sender fail to lock operated, the ORK1,2 (outgoing registration check) relays in the completing marker will not operate and the punch indication A'(2/5) - L'(2/5) will be missing from the trouble record card.

C6-2.2 MF SENDER-ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-C610)

Provision is made in the sender for registering up to three arbitrary digits. These arbitrary digits originate in the marker and are used for code conversion and code prefixing. Any digits registered on the arbitrary digit registers will be transmitted ahead of digits registered on the A through L digit registers. These digits are registered on the AR, BR, and CR digit register relays.

C6-2.3 MF SENDER - STEERING CIRCUIT (SFD-C611)

The MF sender digit steering circuit consists of a KP (key pulse) relay, one steering relay per digit, AS to LS, a SP (start pulse) relay, and an EP (end-of-pulsing) relay.

When both the AV (advance) and ATM (auxiliary timer) relays have operated, the KP relay in the OS (outgoing sender) will operate. After the OS receives on-hook supervision, indicated by the OF (off-hook) relay in the OS releasing, the SP relay will operate (SFD-C615) to cause the steering relay for the first digit to be transmitted to operate.

The steering relay for the first digit operates through its own normal contacts and locks through the normal contacts of the remaining non-operated steering relays. This steering relay associates the RR 2/5 (recapture) relays with the digit register for the first digit to be transmitted (SFD-C612). A second make-contact of the steering relay operated transfers the locking circuit for the KP relay from the direct ON1 ground to the operating ground for the digit steering relay (SFD-C611). When this locking circuit is opened, as it will be when the PG1 relay operates to terminate the key-pulse signal, KP releases. When the PG1 relay releases, the ON1 ground is closed through the operated steering relay contacts for the first digit to cause the operation of the steering relay for the second digit. The circuit progresses in a similar manner for each digit to be transmitted with the PG1 releasing to cause the operation of the steering relay for the next digit to be transmitted and operating to cause the release of the steering relay for the digit just transmitted.

C6-2.4 MF SENDER - RECAPTURE PRINCIPLE (SFD-C612)

The use of reed-type register relays AR to L with a limited number of contacts, necessitates the use of a set of translating or recapture relays for obtaining additional contacts for use at the time the digit is to be transmitted. The recapture relays consist of five general purpose relays RR-(2/5) (SFD-C612), which are associated with the digit registers successively by the steering circuit. In an MF sender, the recapture relays are used for connecting the proper combination of frequencies to the tip and ring for transmission of the registered digits to the distant office. The recapture relays are also used to operate the end-of-pulsing relay after the last digit is transmitted.

C6-2.5 MF SENDER - LAST DIGIT INDICATION (SFD-C610)

The steering relays control the LD (last digit) relay, which is used to indicate the number of digits registered in the sender. Relay LD is operated initially on its primary winding when the ON relay in the sender operates. After the first digit steering relay operates, the locking ground for the digit register relay, two digits beyond, is transferred to the LD relay secondary winding locking circuit. This provides a holding circuit for the LD relay when the primary winding operating path is opened, and enables the sender to determine two digits ahead when a no-digit or end-seven signal is registered on the digit register relay.

After the key-pulse signal is transmitted, the primary winding of the LD is opened by the release of the KP relay. With the steering relay for the first digit operated, the second digit steering relay will operate to provide a new holding circuit for the LD relay when the steering relay for the first digit is released. The LD relay will release after the release of the steering relay for the next to last digit registered in the sender.

C6-2.6 MF SENDER - TRUNK GUARD TEST

A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. If the sender finds an open trunk toward the distant office, the marker will time-out, take a trouble record, and set the sender to return a reorder signal to the trunk. If the sender recognizes correct supervision and the TG test is performed satisfactorily, the marker will then release on a normal basis. (See SCD-C2 for a more detailed description.)

C6-2.7 MF SENDER - TRUNK TEST TIMING (SFD-C613)

The trunk cover-up interval is timed by the ATM timer. On a regular class call, this interval is timed before the tip and ring loop is closed to insure that the trunk is fully released from a previous connection. After the ON relay in the sender operates connecting the ATM3 resistor to the timing circuit, it will take 460 to 900 ms for the ATM capacitor to become sufficiently charged to operate the auxiliary timer ATM relay. At this time the AV relay in the sender will usually be operated, and when it is operated, the KP relay in the sender will operate and open the circuit for the ATM relay.

The ATM relay releases and, with the KP relay operated, operates the ATC relay in the sender (SFD-C615) to restart the timer for timing the intersender interval.

C6-2.8 MF INTERSENDER TIMING (SFD-C613)

Intersender timing is performed by the ATM timer. After the ATC (auxiliary timer control) relay in the sender operates, the ATM capacitor charging path is through the ATM5 resistor. With the ON and ATC relays operated in the sender, it will take from 4.4 to 8.4 seconds for the ATM capacitor to become sufficiently charged to operate the ATM tube and relay.

Under normal operating conditions, a distant register or sender will be attached to the OS without delay and the SP (start pulsing) relay in the sender will operate to open the circuit to the ATM relay before it is able to operate. However, if the connection of a register or sender is delayed beyond 8.4 seconds, the ATM relay will operate and, with the ATC operated, close a path from the winding of the RO (reorder) relay (SFD-C615) over the WA lead to the outgoing sender group release circuit. The marker finding an all-sender or register busy condition in the distant office will operate the release relay of the sender group release circuit which in turn will ground the WA lead. When the WA lead is grounded, with the SP relay normal, the RO relay will operate to release the sender. Relay RO operates the OF (overflow) relay (SFD-C213) of the OGT and releases the CT relay causing the sender to release.

C6-2.9 MF SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-C616)

Regular class includes all one-way trunks except intertoll and any trunk in which the CL2 (class) relay remains normal. The sender requires a change in supervision from off-hook to on-hook as a start pulsing signal. These trunks, in general, are on-hook when normal, change to off-hook when the line is connected to a distant register or sender and then revert to on-hook when the distant end is ready to accept pulses.

When the marker has completed its job of establishing the connection, the sender AV relay has operated, the sender has timed the cover-up interval, and the sender KP relay has operated, the tip and ring leads are closed to the windings of the TG and OF relays in the OS. With the CO (cut-off) relay in the incoming trunk normal, the supervision is on-hook and the battery and ground from the A relay in the trunk will operate the outgoing sender TG (trunk guard) relay and the OF (off-hook) relay will bias or remain normal. The TG1 relay in the OS then operates and opens the TG lead to the marker. When the CO relay in the incoming trunk operates the supervision is changed to off-hook and the A relay battery and ground is removed from the tip and ring leads. The tip and ring leads are now connected to the IR (incoming register) where the battery and ground from the line supervisory A relay is in a direction to operate the OF relay in the OS. The TG and OF1 relays in the outgoing sender will also operate at this time.

C6-2.10 MF SENDER - START PULSING SIGNAL (SFD-C617)

The outgoing sender must receive a change in supervision from off-hook to on-hook before it can start outpulsing.

The operation of the RV (reversal) relay in the distant incoming register reverses the polarity of the tip and ring leads to the OS. When the reversal is recognized by the outgoing sender, the OF relay will release changing the supervision to on-hook. The TG relay in the OS will also release, but only momentarily, and then reoperate to cause the SP (start pulsing relay) to operate through the still operated, slow release OF1 relay contacts, and the normal OF relay contacts (SFD-C615).

C6-2.11 MF SENDER - PULSE GENERATOR (SFD-C613)

The pulse generator consists of the PG and PG1 relays and their associated capacitors and resistors. The mercury-type polarized PG relay is nonbiasing and can be operated in both directions to its front or back contacts.

When the ON relay in the sender operates, the PG relay will operate from current flowing through its primary winding. The PG relay will remain operated until the PG capacitor becomes charged and then release through its secondary winding. The PG relay will remain normal until the SP relay in the OS operates.

When the SP relay operates, the PG relay will operate from current flowing through its secondary winding. The PG and SP operated will cause the PG1 relay in the OS to operate. The PG1 relay operating reverses the circuits through both windings of the PG again, causing the PG relay to release. This cycle is repeated as long as the PG relay maintains control of the PG1 relay. When it is desired to stop the pulse generator an alternate circuit to the PG1 relay is closed, thus, preventing release of the PG1 relay and stopping the interrupter.

C6-2.12 MF SENDER - GENERATION OF FREQUENCIES (SD-26051-FS12)

Where it is economical, a frequency generator will be provided per sender. The six multifrequency signals are generated in the sender by transistor oscillators. The power for starting the oscillators is applied when the sender is seized and the ON relay operates (SFD-C616).

C6-2.13 MF SENDER - ASSIGNMENT OF FREQUENCIES

The six frequencies generated in the MF outgoing sender are assigned in steps of 200, from 700 to 1700 cycles. The first five frequencies are assigned on a 2-out-of-5 basis to the digits 0 to 9 and the sixth is used in combination with others of the first five as the key pulse and start pulse signal. The frequencies are assigned designations 0, 1, 2, 4, 7 and 10 so as to fit in with the standard additive 2-out-of-5 code. The frequencies and their assignments are as follows:

	FREQUENCY					
	700	900	1100	1300	1500	1700
DIGIT	DESIGNATION					
	0	1	2	4	7	10
0				x	x	
1	x	x				
2	x		x			
3		x	x			
4	x			x		
5		x		x		
6			x	x		
7	x				x	
8		x			x	
9			x		x	
Key Pulse			x			x
ST Pulse					x	x

C6-2.14 MF SENDER - TRANSMISSION OF FREQUENCIES (SFD-C616 AND C617)

The outgoing sender frequencies are connected to the input side of the repeating coil by the KP and RR-(2/5) relay contacts. When the KP and SP relays in the OS are operated, the key pulse signal (frequencies 2 and 10) is transmitted over the tip and ring leads into the MF receiver at the distant end (SFD-C617). The key pulse signal acts as a gate opener, activating the MF receiver to enable it to start accepting subsequent pulses from the OS. After a timed interval, the PG1 relay in the sender operates, disconnecting the key pulse signal from the tip and ring leads to release the KP relay. When the PG1 relay releases, the frequencies for the first digit (stored on the RR2/5 relays) are transmitted over the tip and ring leads into the MF receiver. After a timed interval, the PG1 relay will again operate, disconnecting the frequencies associated with the first digit from the tip and ring leads. The PG1 relay operating, releases the steering relay for the first digit, thus, placing the RR2/5 relays under control of the next digit steering relay (SFD-C612). As the PG1 relay releases and reoperates, the process just described will continue until all digits have been transmitted.

After all registered digits have been transmitted, the RR2/5 relays will be associated with a digit register relay which has only the -7 relay operated. This will cause the start pulse signal, frequencies 7 and 10, to be transmitted over the tip and ring leads to notify the MF receiver at the distant end that all of the digits have been transmitted. The PG1 relay will then operate to terminate the start pulse signal and release the steering relay. With all of the RR- relays normal the EP (end pulsing) relay will operate to start the release of the sender.

C6-2.15 MF SENDER - TWO-OUT-OF-FIVE CHECK (SFD-C613)

A feature is provided in the pulse generator circuit to check that only two of the five recapture RR-(2/5) relays are operated for each digit transmitted. As the recapture relays are transferred from one digit to the next, the PG1 relay will not release to advance to send the next digit unless the 2/5 check is satisfied. If the PG1 relay fails to release, the timing circuit will function and cause the sender to release.

C6-2.16 MTC AND AMRST CONTROL OF SENDER OUTPULSING (SFD-C614)

On test calls the MTC (master test control circuit) is used to prime the completing marker and establish the connection between the AMRST (automatic monitor register and sender test) circuit and the OS. The AMRST, after being connected to the outgoing sender by the operation of the M relay in the sender, monitors the operations in the sender by receiving data over a number of leads.

C6-2.16.1 Sender Reorder Test - Operation of the ROT Relay (SFD-C614)

To simulate a reorder condition in the OS using the MTC circuit, the ROT (reorder test) key should be operated at the MTC panel. The ROT key operates the ROT relay in the MTC circuit. With the KOR (connect originating class) relay operated, ground is transmitted over the ROT lead through the MTFC, CM, and OSC into the sender and operates the RO relay. When the sender returns the locking ground over the RO lead the CK2 relay in the MTC circuit operates. The CK1 relay will then operate lighting the CK1 lamp.

C6-2.16.2 Start Pulse Signal to AMRST (SFD-C614)

When the sender is ready to start outpulsing and the AMRST circuit is attached to the sender by the M relay, operating ground is transmitted over the PL lead to operate the DSM (dial pulse) or PL (pulsing) relay in the AMRST depending upon the type of sender used. The pulses are then received and checked by the AMRST.

C6-2.16.3 End Pulsing Signal to AMRST (SFD-C614)

After outpulsing has been concluded and the sender EP (end pulsing) relay has operated, ground is connected to the SPE lead into the AMRST circuit operating the pulse end SPE or SPE1 relay, depending upon the type sender used.

C6-2.16.4 Trouble Block Test - Operation of the TB1 Relay (SFD-C614)

On a test call, as the result of a test failure, the TB1 (trouble block test) relay in the AMRST circuit operates. This causes the TBL (trouble) relay in the AMRST circuit to operate, lighting the TBL lamp.

C6-2.16.5 Test Completion and Release of AMRST

On a test call when the sender starts to release the TAC2 (test abandoned call) relay operates in the AMRST circuit. The OK relay will then operate, lighting the OK lamp and will release the sender (followed by the AMRST circuit). However, the AMRST circuit will not release completely until the STT key is restored to normal.

C6-2.17 RELEASE OF THE MF SENDER (SFD-C615)

The MF sender is designed to outpulse the registered digits and then turn the supervision over to the trunk and release. After the last digit has been transmitted, all of the RR2/5 relays will remain normal and cause the EP (end pulsing) relay to operate. The EP relay operating, releases the outgoing trunk D relay and the sender CT (cut-through) relay. The LR (line release) relay will then release causing the ON and ON1 relays in the sender to release. After the ON1 relay releases, the SB (sender busy) relay releases reclosing the busy test leads, restoring the sender to normal.

C6-2.18 MF SENDER - TM TIMER (SFD-C613)

The sender TM timer measures the interval between the seizure and release of the sender. If the sender operation is not completed within the allowable interval of 12.7 to 24 seconds, the TM timer functions and operates the TM relay in the OS.

The TM relay operates the TRL relay in the sender (SFD-C615), which grounds the stuck sender register lead SS into the plant register circuit, grounds the LP lead into the JLK circuit, lighting the TO lamp, grounds the ALM lead into the JLK circuit to start the office timer, and operates the RO (reorder relay) in the sender (SFD-C615). The RO relay operating connects a resistance battery to the AB lead through the OSL to operate the marginal overflow OF relay in the OGT, transfers the LR relay from the AB lead to an ON ground, and releases the slow release CT relay (SFD-C213). Relay CT in releasing disconnects the resistance battery from the AB lead, disconnects ground from the stuck sender plant register lead, and releases the LR relay in the sender.

If the CTR (cancel timed release) key on the JLK bay is normal (pushed in) the release of the LR relay will cause the release of the ON relay followed by other operated relays in the sender. The TRL relay will release from the ON1 and remove grounds from the LP and ALM leads into the JLK circuit (SFD-C615). If the CTR key is operated (pulled out) the ON relay will be held operated through the TRL contacts (SFD-C213) and will maintain the grounds on the LP and ALM leads into the JLK circuit. The ground on the LP lead will light the TO lamp (SFD-C615) while the ground on the ALM will cause the major alarm to operate with the register sender time-out alarm indication. If the sender MB relay is operated by the insertion of a plug in the MB jack at the JLK bay, the ground is removed from the ALM lead which retires the major alarm and leaves the TO lamp lighted. When the CTR key is restored to normal (pushed in), the ON relay will release, allowing the release of the operated relays in the sender. When the ON1 relay releases, the TRL relay releases and extinguishes the TO lamp.

C6-3 DP SENDER OPERATION

After the sender is connected to the completing marker, it registers the digits dialed and transmits them over the tip and ring conductors to the distant register or sender. When all the digits are transmitted, supervision of the call is turned over to the trunk and the sender releases.

C6-3.1 DP SENDER - DIGIT REGISTRATION (SFD-C620)

The DP sender is designed to handle up to eleven digits, as recorded in the originating register. The digits are registered on dry reed relays, A through L, each relay having five independent coils with two make contacts. The marker operates these independent coils of the digit registration relays on a 2-out-of-5 basis from battery through the OSC circuit.

Since the number of digits an outgoing sender receives on different calls may vary, an indication is needed to mark the end-of-digit registration. This is the end-seven registration and consists of operating only the seven coil of the digit register one beyond the last registered digit.

The completing marker is able to detect missing digits since the registration must consist of 2-out-of-5 in each position up to the end-seven which is followed by a none-out-of-five.

Should any of the digit registration relay coils in the sender fail to lock operated, the ORK1,2 (outgoing registration check) relays in the completing marker would not operate and the punch indication A'(2/5) - L'(2/5) would be missing from the trouble record card.

C6-3.2 DP SENDER - ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-C620)

Provision is made in the sender for registering up to three arbitrary digits. These arbitrary digits originate in the marker and are used for code conversion and code prefixing. Any digits registered on the arbitrary digit registers will be transmitted ahead of digits registered on the A through L digit registers. These digits are registered on the AR, BR, and CR digit register relays.

C6-3.3 DP SENDER - STEERING CIRCUIT (SFD-C621)

The DP sender digit steering circuit consists of one steering relay per digit, AS to LS.

When both the AV (advance) and ON1 (off-normal) relays have operated in the OS (outgoing sender), the steering relay for the first digit to be transmitted will operate.

The steering relay for the first digit operates through its own normal contacts and locks through the normal contacts of the remaining non-operated steering relays. This steering relay associates the RR(2/5) (recapture) relays with the digit register for the first digit to be transmitted (SFD-C622). After the OS receives on-hook supervision, indicated by the off-hook OF relay in the OS releasing, the TT1 (trunk test completed) relay in the OS will operate (SFD-C624) to cause the operation of the steering relay for the second digit.

When transmission of the first digit is completed, the Z relay in the OS will operate and cause the steering relay for the first digit to release (SFD-C621). The second digit steering relay is now controlling the operation of the RR(2/5) relays. The circuit progresses in a similar manner for each digit to be transmitted with the Z relay releasing to cause the operation of the steering relay for the next digit to be transmitted and operating to cause the release of the steering relay for the digit just transmitted.

C6-3.4 DP SENDER - RECAPTURE PRINCIPLE (SFD-C622)

The use of reed-type register relays AR to L with a limited number of contacts, necessitates the use of a set of translating or recapture relays for obtaining additional contacts for use at the time the digit is to be transmitted. The recapture relays consist of five general purpose relays RR(2/5) (SFD-C622), which are associated with the digit registers successively by the steering circuit. In a DP sender, the recapture relays are used to change the two-out-of-five registration to a one-out-of-ten translation for control of the dial pulse generator (SFD-C625). The recapture relays are also used to operate the end-of-pulsing relay after the last digit is transmitted.

C6-3.5 DP SENDER - CANCEL OFF-HOOK INDICATION (SFD-C620)

The steering relays control the COF (cancel off-hook) relay, which is used to indicate the number of digits registered in the sender. Relay COF is operated initially on its primary winding when the ON1 relay in the sender operates. After the first digit steering relay operates, the locking ground for the digit register relay, two digits beyond, is transferred to the COF relay secondary winding locking circuit. This provides a holding circuit for the COF relay when the primary winding operating path is opened, and enables the sender to determine two digits ahead when a no-digit or end-seven signal is registered on the register relay.

Before the first digit is transmitted, the primary winding of the COF is opened by the operation of the TT1 relay. With the steering relay for the first digit operated, the second digit steering relay will operate to provide a new holding circuit for the COF relay when the steering relay for the first digit is released. The COF relay will release after release of the steering relay for the next-to-last digit registered in the sender.

C6-3.6 DP SENDER - TRUNK GUARD TEST

A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. If the sender finds an open trunk toward the distant office, the marker will time-out, take a trouble record, and set the sender to return a reorder signal to the trunk. If the sender recognizes correct supervision and the TG test is performed satisfactorily, the marker will then release on a normal basis. (See SCD-C2 for a more detailed description.)

C6-3.7 DP SENDER - TRUNK TEST TIMING (SFD-C623)

The trunk cover-up interval is timed by the ATM timer. On a regular class call, this interval is timed before the tip and ring loop is closed to insure that the trunk is fully released from a previous connection. After the ATC (auxiliary timer control) relay in the sender operates connecting the ATM3 resistor to the timing circuit, it will take 0.62-to-1.2 seconds for the ATM capacitor to become sufficiently charged to operate the ATM (auxiliary timer) relay. At this time the AV relay in the sender will usually be operated, and when it is operated, the ATC relay in the sender will release and open the circuit for the ATM relay.

The ATM relay releases and, with the TTK relay operated, operates the ATC1 relay in the sender (SFD-C624) to restart the timer for timing the intersender interval.

C6-3.8 DP INTERSENDER TIMING (SFD-C623, C624)

Intersender timing is performed by the ATM timer. After the ATC1 (auxiliary timer control) relay operates, the ATC relay in the sender will reoperate. With the TTK, ATC1, and ATC relays in the sender operated, the ATM5 resistor becomes effective in the ATM capacitor charging circuit. It will take from 4.4 to 8.4 seconds for the ATM capacitor to become sufficiently charged to operate the ATM tube and relay.

Under normal operating conditions, a distant register or sender will be attached to the OS without delay and the TT1 (trunk test completed) relay in the sender will operate to release the ATC relay and open the circuit to the ATM relay before the ATM relay is able to operate. However, if the connection of a register or sender is delayed beyond 8.4 seconds, the ATM relay will operate and, with the ATC1 operated, close a path from the winding of the RO relay (SFD-C624) over the WA lead to the outgoing sender group release circuit. The marker finding an all-sender or all-register busy condition in the distant office will operate the release relay of the sender group release circuit which in turn will ground the WA lead. When the WA lead is grounded the RO (reorder) relay will operate to release the sender. Relay RO operates the OF (overflow) relay (SFD-C213) of the outgoing trunk circuit and releases the CT relay allowing the sender to release.

C6-3.9 DP SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-C626)

Regular class includes all one-way trunks except intertoll and any trunk in which the CL2 (class) relay remains normal. The sender requires a change in supervision from off-hook to on-hook as a start pulsing signal. These trunks, in general, are on-hook when normal, change to off-hook when the line is connected to a distant register or sender and then revert to on-hook when the distant end is ready to accept pulses.

When the marker has completed its job of establishing the connection, the sender AV (advance) relay will operate. The AV relay will operate the BD relay in the OS to remove the short from around the TG and OF relay windings. The BD relay operating will close the tip and ring leads to the windings of the TG and OF relays in the OS. With the CO (cut-off) relay in the incoming trunk normal, the supervision is on-hook and the battery and ground from the A relay in the incoming trunk will operate the outgoing sender TG (trunk guard) relay and the OF (off-hook) relay will bias or remain normal. The TG1 relay in the OS then operates and opens the TG lead to the marker. When the CO relay in the incoming trunk operates, the supervision is changed to off-hook and the A relay battery and ground is removed from the tip and ring leads. The tip and ring leads are now connected to the IRDP where the battery and ground from the line supervisory L relay is in a direction to operate the OF relay in the OS. The TG and TT relays in the outgoing sender will also operate at this time.

C6-3.10 DP SENDER - START PULSING SIGNAL (SFD-C624)

The outgoing sender must receive a change in supervision from off-hook to on-hook before it may start outpulsing.

The operation of the RV (reversal) relay in the distant incoming register reverses the polarity of the tip and ring leads to the OS. When the reversal is recognized by the outgoing sender, the OF relay will release changing the supervision to on-hook. The TG relay in the OS will also release but only momentarily and then reoperate to cause the trunk test completed TT1 relay to operate through the normal OF relay contacts (SFD-C624). The TT1 relay operates the digit steering relay for the second digit and also places the sender P relay under control of the BD, W, and SP relays (SFD-C623). The ATC1 relay will also release, followed by the TGT and BD relays, which allows the first digit to be dial pulsed.

C6-3.11 DP SENDER - PULSE GENERATOR (SFD-C623)

The pulse generator consists of the P and PG relays, and their associated capacitors and resistors. The mercury-type PG (polarized) relay is non-biasing and can be operated in both directions to its front or back contacts.

When the ON relay operates, the P relay in the OS will operate through the SP, W, and TT1 relays normal. The PG relay will then operate from current flowing through its primary winding. The PG relay will remain operated until the PG capacitor becomes charged and then release through its secondary winding. The PG relay will remain normal until the P relay in the OS releases.

When the P relay releases, the PG relay will operate from current flowing through its secondary winding. The PG relay operating causes the P relay to reoperate, reversing the circuits through both windings of the PG again, causing the PG relay to release. This cycle is repeated as long as the PG relay maintains control of the P relay. When it is desired to stop the pulse generator, an alternate circuit to the P relay is closed, thus, preventing release of the P relay and stopping the interrupter.

C6-3.12 DP SENDER - PULSE COUNTING CIRCUIT - OPERATION OF THE P1 THROUGH P5 RELAYS (SFD-C623)

The DP sender counting circuit is used to count the number of dial pulses generated in the OS and then recycled to count the interdigital interval pulses.

The DP counting circuit consists of relays P1 through P5. The P1 and P2 relays are wired as a pulse divider and the P3, P4, and P5 relays are used in various combinations to count and remember the number of operations of P1 and P2. These relays are controlled by the sender P relay operating and releasing. When the ON relay operates, the P and LR relays in the OS operate. After the trunk test completed TT1 relay operates, the P relay releases and causes the P1 relay in the OS to operate. At the end of the first open pulse the P relay will reoperate to operate relay P2. On the next release of P, the P2 relay releases. This cycle is repeated with the P1 and P2 relays remaining operated at the end of each odd numbered pulse and normal at the end of each even numbered pulse.

The counting circuit has a feature which enables it to detect when a count of more than 10 pulses is reached. This condition will leave the P5 operated with the P3 and P4 relays normal. If this condition is reached, the TRL relay in the OS will operate, indicating a trouble condition exists (SFD-C625).

The following table gives a sequence of these operations.

Pulse	P	P1	P2	P3	P4	P5	Counting Relays Remaining Operated
1	RLS	O					
	OPR		O				P1, P2
2	RLS	R		O			
	OPR		R				P3
3	RLS	O					
	OPR		O		O		P1, P2, P3, P4
4	RLS	R					
	OPR		R				P3, P4
5	RLS	O		R			
	OPR		O				P1, P2, P4
6	RLS	R					
	OPR		R			O	P4, P5
7	RLS	O					
	OPR		O				P1, P2, P4, P5
8	RLS	R		O			
	OPR		R				P3, P4, P5
9	RLS	O					
	OPR		O		R		P1, P2, P3, P5
10	RLS	R					
	OPR		R				P3, P5
11	RLS	O		R			
	OPR		O				P1, P2, P5
12	RLS	R					
	OPR		R				P5

C6-3.13 DP SENDER - DIGIT CONTROL CIRCUIT (SFD-C625)

The digit control circuit consists of the BD (between digit) relay, the SP (stop pulsing) relay, and the function dividing relays W and Z.

When the AV (advance) relay has operated, the BD relay in the OS operates removing the short from the TG and OF relay windings (SFD-C626). After the trunk test has been completed the TT1 relay in the OS operates releasing the BD relay allowing the first digit to be dial pulsed.

The SP relay is used to terminate the dial pulses for each digit and for each interdigital interval. As the DP generator functions, the number of P relay operations is counted on the P1 to P5 relays. The SP winding is connected to the P1 to P5 relay contacts which are wired to the corresponding RR-(2/5) relays or through the Z relay contacts. When the P- relays have counted to the combination closed by the operated RR-(2/5) relays, the ON ground will operate the SP relay. One-half pulse cycle later, with the SP operated and P normal, the P1 through P5 counting relays are recycled and release. The SP relay operating also operates the W relay. The SP relay will release one pulse cycle later when the P relay operates. When the W relay is operated, the SP relay releasing will operate the Z relay. The Z relay operates the BD relay in the OS enabling the supervisory TG and OF relays. The Z relay also closes a circuit around the RR- relay contact to the P-, counting relay, contacts controlling the SP relay operation after a predetermined number of interdigital pulse cycles of the pulse generator. The number of interdigital pulse cycles is determined by the ID to ID- cross-connect (SFD-C625). The ID to ID5 cross-connect allows for an interdigital interval of 5 1/2 pulse cycles. At the end of the fourth interdigital pulse, with the P and Z relays operated, the SP relay operates and releases the W relay. At the end of the fifth interdigital pulse, the P relay operating releases the SP followed by the Z and BD relays. With both the W and SP relays normal, the next release of relay P opens the tip and ring conductors (SFD-C626). With the Z relay normal, the SP relay is again under the control of the RR-(2/5) relays. The release of the SP relay also releases the BD relay allowing the next digit to be dial pulsed.

This entire operation can be summarized as follows and is repeated for each digit. The BD relay releases and the digit is dial pulsed. The SP relay operates to terminate the digit and operates the W relay and recycles the counting relays. The SP relay releases, operating the Z relay which sets the counting relays to count to the interdigital interval and operates the BD relay. At the end of the fourth interdigital pulse, the SP relay operates releasing the W relay and recycling the counting relays. At the end of the fifth interdigital pulse, the SP relay releases followed by the Z which places the SP relay under the control of the P1 to P5 counting and RR-(2/5) relays. The SP releasing also releases the BD relay allowing the next digit to be dial pulsed.

C6-3.14 DP SENDER - TRANSMISSION OF DIAL PULSES (SFD-C626 AND C627)

After the OS receives on-hook supervision and the TT1 relay has operated, the BD relay in the OS will release causing the P relay in the pulse generator circuit to release (SFD-C623). The P relay in the OS releases the L relay in the distant IRDP. When the P relay reoperates, the L relay will also reoperate. With the BD and SP relays normal, the P relay in the OS (releasing and operating) opens and closes the tip and ring conductors which release and operates the L relay in the IRDP.

As long as the P relay maintains control of the tip and ring closure, the L relay in the IRDP will count the dial pulses transmitted by the OS.

When the SP relay in the OS operates, an auxiliary tip and ring closure is established around the P relay contacts and the L relay in the IR will remain operated. This indicates to the IR the end of the digit pulses and the start of the interdigital interval in the OS.

C6-3.15 RELEASE OF DP SENDER (SFD-C624)

The DP sender is designed to outpulse the registered digits and then turn the supervision over to the trunk and release. After the last digit has been dial pulsed the SP relay in the OS operates releasing the P1 to P5 counting relays. One pulse cycle later, when the P relay operates, the SP relay will release operating the Z relay which releases the last digit steering relay. The last digit steering relay releasing will place the RR-(2/5) relays under control of the last operated steering relay and the digit registration relay having only the -7 operated. This will cause only the RR7 relay to operate. With the COF relay normal and the TT1 relay operated, the EP relay will operate through the normal RR0,1,2, and 4 relays. The EP relay operating will close an auxiliary circuit to relay P holding it operated and stopping the pulse generator. The EP relay operating also releases the outgoing trunk D relay and the sender CT relay. The LR relay will then release causing the ON and ON1 relays in the sender to release. After the ON1 relay releases, the SB relay releases reclosing the busy test leads restoring the sender to normal.

C6-3.16 DP SENDER TM TIMER (SFD-C623)

The sender TM timer measures the interval between the seizure and release of the sender. If the sender operation is not completed within the allowable interval of 19 to 37 seconds, the TM timer functions and operates the TM relay in the OS.

The TM relay operates the TRL relay in the sender (SFD-C624), which grounds the SS (stuck sender) register lead into the plant register circuit, grounds the LP lead into the JLK circuit lighting the TO lamp, grounds the ALM lead into the JLK circuit to start the office timer, and operates the RO (reorder relay) in the sender (SFD-C624). The RO relay operating connects a resistance battery to the AB lead through the OSL to operate the marginal OF (overflow) relay in the OGT, transfers the LR relay from the AB lead to an ON ground, and releases the slow release CT relay (SFD-C213). Relay CT in releasing disconnects the resistance battery from the AB lead, disconnects ground from the stuck sender plant register lead, and releases the LR relay in the sender.

If the CTR (cancelled timed release) key on the JLK bay is normal (pushed in) the release of the LR relay will cause the release of the ON relay followed by other operated relays in the sender. The TRL relay will release from the ON1 and remove the grounds from the LP and ALM leads into the JLK circuit (SFD-C624). If the CTR key is operated (pulled out) the ON relay will be held operated through the TRL contacts (SFD-C213) and will maintain the grounds on the LP and ALM leads into the JLK circuit. The ground on the LP lead will light the TO lamp (SFD-C624) while the ground on the ALM will cause the major alarm to operate with the register sender time-out alarm indication. If the sender MB relay is operated by the insertion of a plug in the MB jack at the JLK bay the ground is removed from the ALM lead retiring the major alarm leaving the TO lamp still lighted. When the CTR key is restored to normal (pushed in), the ON relay will release, allowing the release of the operated relays in the sender. When the ON1 relay releases the TRL relay releases and extinguishes the TO lamp.

SECTION C, PART 7

NO SENDER OPERATION

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C7 NO SENDER OPERATION

Sender operation and selection is controlled via the OS- punching associated with an operated route relay. Cross-connections permit the CM (completing marker) to select a sender of the desired type or indicate NSO (no sender operation). Typical trunks using NSO are operator trunks, service code trunks, revertive call trunks, and tone trunks.

C7-1 NSO RELAY OPERATION (SFD-C702, C704)

The destination or service requested by the calling customer will be indicated by the code digits passed to the CM from the OR (originating register). After receiving the customers dialed digits, the CM makes whatever translation is required for the purpose of grounding a code point. This grounded code point is the markers record of the customers request on this call.

This code point is cross-connected to operate a preroute or route relay (SFD-C706), which indicates the type of call.

The operation of the route relay will extend ground through the OS- to NSO cross-connection in the CM to operate the NSO relay (SFD-C704).

The sequence chart for operator trunks and service codes, shown on SFD-C702, is only a partial sequence chart showing the operation of the NSO relay. For complete overall operation SFD-C102, C116 and C302 must be used.

(a) SFD-C102 - Sequence chart for seizure of completing marker by the originating register.

(b) SFD-C116 - Sequence chart of translation, screening and routing.

(c) SFD-C302 - Sequence chart, trunk link frame selection, and trunk selection.

C7-1.1 NSO - ZERO OPERATOR (SFD-C704, C706)

When the OR records the single digit 0 (A4 and A7 on 2/5), it engages a CM without waiting for any additional digits. The CM establishes a channel between the calling line and an outgoing trunk to an operator and releases. The customer hears an audible ringing signal until the operator answers.

The method for grounding code point ZO is shown on SFD-C704. Route relay operation for 0 operator is shown on SFD-C706.

C7-1.2 NSO - MANUAL CALLS (SFD-C704, C706)

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

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

The grounding of the ZO code point will be the same for a manual call as for a zero operator call shown on SFD-C704. The operation of the AC4 and AC7 relays for a manual call is shown on SFD-C704.

C7-1.3 NSO-X11 SERVICE CODE CALLS (SFD-C704, C706)

For service code calls, information, repair service, business office, etc, the OR receives the service code digits, engages a CM, and transmits the digits to the CM. The CM then sets up a channel between the calling customer and an outgoing trunk connected to the proper operator or desk and releases.

The illustration of grounding the code points and operating the route relays is shown on SFD-C704, C706, using the X11 translator. Only the A digit is passed from the OR to the CM for translation.

C7-1.4 NSO - REVERTIVE CALL TRUNK (SFD-C702, C703, C705, C706)

A reverting call is a call to a customer on the same line as the calling customer.

When a reverting call is required, a connection is established from the customers line through the LL and TL switches to:

(a) a reverting trunk if charging is not required, or

(b) an operator trunk if charging is required or reverting trunks are not furnished.

Customers instructions for making a reverting call vary, as described in the circuit descriptions for the reverting call trunks. However, all instructions require dialing the directory number of the called party, which in turn is transmitted to the marker through the ORMC.

Since all customers on the same line have the same line location, the CM makes the reverting test by matching the calling line location against the call line location, and if a match is made the call is handled as a reverting call.

The general sequence of operation is as follows (SFD-C703).

(a) The calling line location is received from the OR and is stored in the CM. The called number is also received and translation of its office code causes the call to proceed as an ITR call with FLG linkage.

(b) When translation from the number group is received and recorded, an operate circuit for the RV1,2 relays (SFD-C705) is closed in the calling and called line location match circuit. The RV relay operates from the operated RV1,2 relays indicating a reverting call.

(c) The CM route advances, sequence chart SFD-C702, dropping the ITR trunk connection and selects a reverting trunk (RV) route (SFD-C706).

(d) The call is now handled as an SOG call between the calling customer and the reverting trunk.

(e) Since it is a reverting call, the ringing selection switch is operated. The ringing combination required was obtained from the number group translation and held in the CM by the operation of the RV relay. The number group line location relays release on route advance.

(f) The CM passes the ringing information to the trunk and checks the ringing switch before releasing. The connection is left under supervisory control of the reverting trunk.

C7-1.5 NSO-ROUTE ADVANCE-TONE TRUNKS (SFD-C702, C705)

On any type of call, the CM may receive a signal or detect a condition indicating that the call cannot be completed in a normal manner and, therefore an alternative action is necessary. The alternative action taken by the marker depends on the type of call and the reason the call could not be completed.

Some of the more common reasons for alternative actions are:

(a) TBTA, all trunks busy.

(b) ASB, all senders busy.

(c) FM, failure to match.

(d) LBTA, called line busy.

Some of the more common alternative actions that may be taken by the marker are:

(a) RAV1-2, route advance.

(b) RCY, recycle.

(c) RBT, originating register returns busy tone.

The CM provides six ground supplies. Depending on the office involved, the route relays are assigned to the ground supplies to provide the required direct and alternative routing.

Assignment of routes to ground supplies may be obtained from the office permanent record list, marker cross-connections, code point and route assignment.

When assigning the various routes to route relays, the following must be observed.

(a) For route relays in ground supplies one-through-four, an advance can be made to any other ground supply.

(b) A ground supply can be used only once on any call; that is, the marker cannot route advance to a ground supply, if the associated GS- relays are operated.

(c) Routes in ground supply five, used for tone trunks, can be direct routes, but in general, are alternate routes for those in ground supplies one-through-four.

(d) Routes in ground supply six, used for common overflow, are usually alternate routes for those in ground supply five.

(e) Route advance out of ground supply six results in setting the originating register to return busy tone.

The relay operation for route advance is shown on SFD-C514 sequence chart. The operation of the RAV1,2 results in the operation of the RDL, RYC, GS-, and the release of off-normal control relays such as the LLC1-3, TLC1,2, CKG4, ONX and HMS1.

The above relay action results in:

(a) Release of trunk and TL.

(b) Release of LL.

(c) Release of TL and LL select and hold magnet controls.

(d) Releases all route relay information in the ground supply of the operated GS- relay except the route advance information.

(e) Releases all linkage check and selection check relays.

(f) Advances the junctor sequence relays.

When the marker has released to the point where functions associated with the new route can start, the SNK (SFD-C307) relay releases and permits the RAV1,2 (SFD-C517) relays to release.

The release of the RAV1,2 relays causes the following action:

(a) Release the RYC and RDL (SFD-C517).

(b) Permits the ONX (SFD-C108), TLC1,2 (SFD-C306), LLC1,2,3 and CKG4 (SFD-C307) control relays to reoperate.

(c) Releases the RA- (SFD-C119) relay, which causes the new R- (SFD-C132) relay to operate.

SECTION C, PART 8

MAINTENANCE

Index

C8 MAINTENANCE

This part of the C section covers some of the aspects of the use of the master test control frame to detect, locate, and clear trouble on outgoing type calls.

C8-1 USE OF THE MASTER TEST CONTROL FRAME TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORDS

Analysis of trouble record cards using the trouble analysis chart and sequence charts of part CO localize the trouble to an area which may involve a path through one or two relay contacts within one circuit, or may involve a path through many relay contacts in several circuits. Generally, it is impossible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a fraction of a second during marker holding time. Frequently, the path which produced the failure is used only when a particular configuration of circuits or network paths is used. For this reason, it is desirable to be able to reproduce the same condition which caused the trouble in the beginning. The master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

C8-2 USE OF SIMULATION TABLE AND ILLUSTRATED TROUBLE RECORD CARDS

The purpose of simulation tables in SFD-C802, C804, and C806, is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame, which should be operated to provide input or control to the CM when simulating a trouble record card. Included, for easier reference, is a trouble card designation location for different types of trouble cards. The three types of trouble record cards illustrated are E-5488 (2/X double sided) shown on SFD-C803, E-4393 (1/X double sided) shown on SFD-C805, and E-3638 (1/X single sided) shown on SFD-C807.

The drawing in SFD-C803, C805, and C807 depict a trouble record card which includes all of the possible designations (colored) which might be perforated on a record produced by an outgoing type call. A color key arrangement is used to indicate the different functions of designations regarding marker input or output information, progress of call, circuits or paths used, etc.

C8-2.1 FUNCTIONS OF ORIGINATING CLASS OF CALL (SOG)

One of the tables on SFD-C802, C804, or C806 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in above tables.

(a) Select the SOG class of marker test, by operating the ORIG, SDR, OGT, MISC, or ITDO key, if provided, or set the TSTA or TSTB switch to the required position.

(b) Select class of call and type of translation. On some types of master test control frames local translation is prewired and no key need be operated.

(c) Select the particular CM which produced the record.

(d) Digits A (0-9) through K (0-9) can be operated to simulate the called number registered on the trouble record card.

(e) Set up the line location indicated by the trouble record card. (Used only on ORIG and SDR class of test.)

(f) Operate the class-of-service key(s) or switch(es) as indicated on the trouble record card.

(g) With the FS/NTFS key normal, the CM selects a trunk link frame in the same manner that it would on a service call. By operating the FS key along with the FG(0-2) key and an FS(0-9) key or the FS(0-9) switch, the CM selects a trunk link frame in the normal manner but is restricted to selecting only that trunk link frame corresponding to the operated FS(0-9) keys or switch. The NTFS key is intended for use when it is desirable to select a trunk which is maintenance busy. An operated NTFS key permits selection of a particular trunk link frame (under control of the FG(0-2) and FS(0-9) keys without first testing for idle trunks on that trunk link frame.

(h) With the TS/NTTS key normal, the CM selects a trunk in the normal manner. With the TS key operated (along with the TS0-19 key or the TST1 key with TSU0-9 switch), the CM selects a trunk in the normal manner, but is restricted to selecting only that trunk corresponding to the operated TS0-19, or the setting of the TST1 key and TSU switch. With NTTS key operated, control of trunk selection by the marker is similar to TS key operated. However, in addition, the TST relay in the trunk link frame is operated. When the TST relay operates, all trunks which are made busy on the trunk link frame are restored to service (MB relay releases). It is, therefore, possible to select a particular trunk with TS(0-9) key operated, which is maintenance busy. The maintenance busy condition is removed only during the time that the marker (engaged on the test call) is connected to the trunk link frame.

(i) If allotted trunk groups are furnished, the GPA or GPB key is operated. The marker will operate with the corresponding allotter group and will not advance from one to another.

(j) Outgoing sender selection, if used, can be selected by operating SGA/SGB key for subgroup A or B, with OSS key operated. The SGA or SGB key operated directs the marker to connect to the A or B subgroup of senders respectively without first testing for an idle sender. The operated OS(0-4) key or switch allows the marker to select only the sender which corresponds to the operated key. The plug-busy condition is removed from all senders of the subgroup after the marker gains access to the subgroup.

(k) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk switch of a trunk link frame is defined by channel number and junctor group.

    (1) Operation of a CH(0-9) key or the CH(0-9) switch will direct the CM to select that channel number.

    (2) Selection of a particular junctor group is not quite as straightforward. Reference should be made to the chart on SFD-C809 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in two or more junctor sequence positions and is dependent on junctor step position 1 or 2.

(3) The JSQ(0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ(0-5) key or switch might be be set in any of several positions to select the desired junctor group.

(ℓ) With the TR2 key normal, a first trial call is simulated. Operating the TR2 key simulates a second trial call.

(m) With the OBS key normal, a nonobserved call is simulated, and operating the key simulates an observed call.

C8-3 USE OF CLASS OF TEST TABLES

The class-of-test tables shown on SFD-C810 through C822 summarize, in tabular form, the key(s) and switches(es) used to establish a particular class of test. A single line is used to separate a particular function with its associated figure, option, key, or switch. The double line within the single lines is used to separate the various options on vintages of master test control frames. The note column and sheet notes are as follows:

(a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment must be selected for test.

(b) Note 2 indicates the key(s) or switch(es) to be used to simulate the trouble record. Refer to simulation tables in SFD-C802, C804, or C806 and their associated colored trouble record card on the opposite pages (C803, C805, or C807) of the simulated table selected. The tables and colored trouble record cards, along with the class of test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.

(c) Note 3 indicates those key(s) or switch(es) used for additional marker tests but they are not necessarily required for trouble record test or simulation test.

C8-4 ORIGINATING CLASS OF MARKER TEST SFD-C810, C811

On an originating class of marker test, the MTC (master test control) circuit simulates an originating register. To perform this task, the master test frame is first primed with code and digits, originating line location, class of service, and other information which it would normally receive from an originating register. After receiving input information from the MTC, the marker proceeds to function in accordance with its translation of the information received to set up a connection.

The originating class of marker test can be used in different types of call arrangements which are listed below.

(a) SOG - Establishes a path from the originating line location to an outgoing trunk with or without a sender attached (SFD-C810 and C811).

(b) IAO - Establishes a path from the terminating line location to an intraoffice trunk (terminating stage) or from the originating line location to the intraoffice trunk, (originating stage) with sender attached if AMA is required.

(c) IMG - Establishes a path from the originating line location to an intermarker group trunk with sender attached.

(d) REV - Establishes a path from the originating line locato a reverting trunk (SFD-C812 and C813).

NOTE: The test arrangements for paragraphs (b) and (c) above will be described in maintenance sections of SCD-E and SCD-F respectively, in Issue 4.

C8-5 SENDER CLASS OF TEST, GENERAL DESCRIPTION

Tests of regular calls using outgoing senders, without AMA, are usually made using the originating test line as the calling line location. On this type of test the MTC (master test control) circuit extends the originating test line to the AMRST (automatic monitor, register and sender test) to simulate the calling customer action after the customer has dialed the number. The test connections are set up by the completing marker, under control of the MTC. The keys of the MTC are operated to select the marker used on this test, to set up the called number to be outpulsed by the sender, to set up the class of service of the calling line, to select the sender to be tested, and to select the outgoing trunk, if a trunk is required. A particular outgoing trunk may be used for the test by selecting a trunk that has access to the desired sender, and by operating the proper trunk selection keys.

The keys of the AMRST are operated to prepare the circuit for test, to select the sender group, and to establish certain test conditions to be applied to the sender as simulated trunk and trunk conductor conditions.

When the AMRST is ready for test, the MTC connects to the MTFC (master test frame connector) which seizes the selected marker. The MTC simulates an originating register which has received a dialed number from a calling customer. The marker, having received the required information, determines the route, selects the desired sender, and selects an outgoing trunk that has access to that particular sender. The marker then establishes a connection from the trunk link frame location of the trunk to the line link frame location of the originating test line. The marker selects and seizes the desired sender through the OSC (outsender connector) and OSL (outsender link) circuits and connects the sender to the outgoing trunk. The marker then passes the called number, along with class signals and other information, to the sender. The marker makes its usual checks and releases, leaving the connection held operated under control of the test circuit. With this connection, the test circuit simulates the calling customer and incoming trunk in the distant office. The sender makes the required test of trunk conductors and trunk conditions and then starts to pulse out the called number. The outgoing end of the trunk is connected to the monitor which receives and records the pulses from the sender. The monitor then matches the called number received from the sender against the called number received from the master test control circuit. If they match, an OK lamp lights on the monitor panel; if they do not match, the TBL lamp lights and a trouble recorder card is perforated.

C8-5.1 SENDER TEST, DP AND MF USING MASTER TEST CONTROL FRAME, SFD-C814

On a sender class of test, the MTC connects to the monitor and after determining that the monitor is ready for a test, signals the monitor and proceeds to connect to a marker. The MTC directs the marker to set up a test connection to the originating test line. When the marker has completed setting-up the connection, the marker gives a release signal to the MTC which releases the marker and connector, leaving the connection to the sender held up by the monitor.

C8-5.2 SENDER TEST, DP AND MF

The SFD-C814 and C815 summarize, in tabular form the keys and switches necessary to establish a sender class of test using the MTC. The keys listed are associated only with the MTC frame with the exception of MAC, STT, SG SEL(0-10) and SGT which are located on the AMRST frame and are necessary for proper sender selection.

The other AMRST keys required for testing other features and the manner in which the AMRST performs tests of the MF and DP senders will be covered in Section J of the SFD which covers test frame operation.

C8-6 REVERTING CLASS OF TEST (SFD-C812)

A reverting call is a call to a customer on the same line as the calling customer.

When a reverting call is required, a connection is established from the customers line through the LL and TL switches to:

(a) a reverting trunk if charging is not required, or

(b) an operator trunk if a reverting trunk is provided and charging is required

Since all customers on the same line have the same line link location, the marker makes the reverting test by matching the calling line link location against the called line link location, and if a match is made the call is handled as a reverting call.

When this type of call is simulated on the MTC (master test control) frame, a ring party line location is selected that does not require charging on an intraoffice route. Select the telephone number A- through G- associated with this line location and select class of service and rate treatment as required for access to selected route.

When the called number is received and translated, the office code causes the call to proceed as an ITR call with FLG linkage. However, when translation from the number group is received and recorded, an operate circuit in the marker for the RV1,2 relays is closed in the calling and called line location match circuit. This operates the RV1,2 relays which operate the RV relay, indicating a reverting type call. The marker will route advance to select a reverting trunk.

Sheet SFD-C812 summarizes, in a tabular form, the keys and switches necessary to test a reverting type call from the master test control frame.

C8-7 OGT CLASS OF TRUNK TEST SFD-C816 AND C817

The OGT class of trunk test is used for testing outgoing trunks which require senders, and for testing subscriber to trunk intermarker group trunks. The MTC (master test control) circuit connects to the trunk test circuit and signals it to prepare for a test of an outgoing trunk. The test circuit simulates an originating class of call and proceeds to connect to a marker which it directs to set up a connection from the originating test line, to the outgoing trunk to be tested. The marker is signaled to operate the TT relay in the trunk which gives the trunk test circuit access to the outgoing end of the trunk. An ND (no digits) signal is given to the sender to allow it to release without pulsing.

After the TT relay in the outgoing trunk circuit (or in the subscriber to trunk intermarker group trunk circuit) has operated, the TT relay connects the outgoing tip and ring, TO and RO, of the trunk circuit into a multiple which is extended to the trunk test circuit.

In the trunk test circuit, the OGT, TTK, ST relays, and the TLK key are operated. The originating end of the outgoing trunk circuit is held by the originating supervision circuit. The OGT relay connects the tip and ring of the outgoing trunk circuit to the simulated incoming trunk circuit consisting of relays A, IS, and T.

The OGT relay also connects the terminating side of the simulated trunk to the contacts of the ANS relay, so that when the ANS key is operated, the IS relay operates. The IS relay operates the T relay which in turn reverses battery supplied from the winding of A relay toward the CS relay in the outgoing trunk circuit. The operation of the CS relay is checked by lighting the OGT-CS lamp on the trunk test circuit panel.

The SFD-C816 and C817 summarize, in a tabular form, the keys and switches necessary to test an OGT type call from the master test control frame.

C8-8 MISC CLASS OF TRUNK TEST SFD-C818 AND C819

The MISC class of trunk test is primarily designed for testing miscellaneous types of trunks that are not furnished with TT relays but are selected by marker route relays. The MISC class of test is also used to test regular types of outgoing trunk circuits when the TT relays are not operated.

The MTC connects to the trunk test circuit, signals the trunk test circuit to prepare for miscellaneous class of test, and after receiving a signal that the trunk test circuit is normal, grounds its start lead and proceeds to connect to a marker (which, in turn, is directed to set up a connection from the originating test line to the trunk to be tested.)

The test circuit functions as described for OGT class of test except the marker does not operate the TT relay in outgoing trunks, nor does it give an ND signal to senders. The connection is completed to a terminating office as directed by the dialed digits and class of service given to the marker.

A number of miscellaneous trunks may be tested with MISC class. These trunks are similar to outgoing trunks in that they have route relay assignments. They differ, however, in that they do not have TT relays. The trunks generally used in this class are:

(a) Recording Completing Special Service or Vacant Code Trunk Circuit

(b) Tone or Partial Dial Trunk Circuit

(c) Trunk to Test Desk

(d) Repair or Information Trunk Circuit

(e) Permanent Signal Holding Trunk Circuit

(f) Common Overflow Trunk Circuit

(g) Revertive Ringing Trunk Circuit

(h) Station Ringer Test Circuit

(i) Stuck Coin Trunk Circuit

The originating test line is connected to the trunk circuit under test using a regular channel. The originating supervision, coin, originating sleeve supervision, ringing bridge, dialing, and talking circuits can be used in testing the miscellaneous trunk circuits.

No detailed procedure will be provided in this SCD for testing the miscellaneous trunk circuits because most of the required tests are obvious. However, some of the unusual features will be discussed.

In testing noncoin recording completing trunks, the PK lamp should not light until the attendant answers. The attendant should be able to bring in the R- lamp by ringing back on the connection with the TLK key operated. In testing coin recording completing trunks, the attendant should be able to provide coin collect and return pulses to the trunk test circuit.

Associated with permanent signal holding trunks, tests can be made of the permanent signal concentrating circuit features such as ringing, coin control, and howler application. The permanent signal holding circuit has a timeout feature which causes the associated line lamp at the test frame to change from a steadily lighted condition to a flashing condition. The timeout can be speeded up by operating key PS1/PS2 first to position PS1 and then to position PS2.

In testing revertive ringing trunk circuits, the RVC key should be operated to connect the gas tube ringing detection circuit to the originating tip and ring so that ringing can be checked.

When testing MISC class of test on regular outgoing trunks or on other types of miscellaneous trunks it is always advisable to use the BSP sections for proper key and lamp operations for any trunk circuit being tested.

The SFD-C818 and C819 summarize in a tabular form the keys and switches necessary to test a MISC type call from the master test control frame.

C8-9 ITDO CLASS OF TRUNK TEST SFD-C820 AND C821

The ITDO class of trunk test is used for testing certain features of incoming trunks in distant offices. The master test control circuit connects to the trunk test circuit and signals it to prepare for a test of an incoming trunk in a distant office. The test circuit directs a marker to set up a connection from the originating test line to an outgoing trunk. This outgoing trunk must be connected to an incoming trunk in the distant office which is to be tested. The TT relay of the outgoing trunk circuit is operated to give the trunk test circuit access to the outgoing end of the outgoing trunk over the tip and ring to the distant incoming trunk. The selected sender is primed with information the incoming trunk uses to establish connection in the distant office. Pulses from the sender direct the setting up of the connection in the distant office to the called line.

The marker operates the TT relay in the outgoing trunk circuit when the ITDO class of trunk test is performed. The ST, ITDO, and TT relays operate in the trunk test circuit. It is assumed that the TLK key is operated prior to the tests. The TT relay in the operated outgoing trunk circuit connects the trunk circuits outgoing tip and ring leads, TO and RO, through front (make) contacts of the ITDO relay and connects the A and B resistors to the trunk conductors tip and ring, T1 and R1 leads, respectively. In other words, the A and B resistors are inserted in series with the outgoing loop. The ITDO relay also connects the front contact of the CS relay of the outgoing trunk circuit to the OGT-CS lamp.

The completing marker in the distant office is directed to set up a call to an incoming trunk test line. This test line trips ringing and sends flashing supervision and tones back to the originating office. The OGT-CS lamp located in the originating office should follow the flashing supervision. This flashing supervision is of such a nature that it should not cause charge conditions to be set up in the outgoing trunk circuits.

Although this class of test is primarily for testing the trunk circuits in the distant office, noncharge features of the outgoing trunk circuit are tested as a by-product. For this reason, the tests may be made simulating flat rate, AMA, coin, or message rate calls.

The SFD-C820 and C821 summarize, in a tabular form, the keys and switches necessary to test an ITDO type call from the master test control frame.

C8-10 TEST CALL SET UP FOR TRUNK TRANSMISSION SFD-C823, C824, AND C825

Trunk circuits are tested to a precision transmission test line using MISC class of test. If an intraoffice trunk circuit is involved, the call is directed to a transmission test line which trips ringing and supplies a signal of standard level milliwatt supply which is measured by the transmission measuring set connected to the test termination circuit that is part of the master test frame, jack, lamp, and key circuit.

If an outgoing trunk is involved and the MISC class of test is used, the TT relay of the outgoing trunk circuit will not be operated. The call is directed to a transmission test line located in the distant office. This transmission test line will automatically trip ringing and connect the trunk to a transmission test line with milliwatt supply.

C8-10.1 ONE WAY TRANSMISSION TESTS

Transmission tests to local offices on 2-wire trunks that are either nonrepeaters or use E- type repeaters are tested from the master test control frame using MISC class of test. These types of trunks are referred to as one-way transmission measurements. The TM1 jack of the master test frame jack, lamp, and key circuit is patched to the test termination circuit. A transmission measuring set is connected to the test terminating circuit. Operation of the master test control circuit start key initiates a connection to the distant office transmission test line. When the connection is established, 1000-cycle tone will be heard in the master test frame telephone set. To measure the loss on the circuit, a test key in the test termination circuit is operated and a transmission measuring set is connected to the REC1 jack. The TM1 key associated with the TM1 jack of the master test frame jack, lamp, and key circuit is operated which cuts off the master test frame telephone circuit and cuts through the trunk test circuits tip and ring to the measuring test set. The 1000-cycle tone can now be measured on a far-to-near (F-N) basis.

C8-10.2 TWO WAY TRANSMISSION TESTS

Transmission tests to local offices, on trunks which operate with carriers of 4-wire facilities, are tested from the master test control frame using MISC class of test. These types of trunks are referred to as 2-way transmission measurements, performed on a loop-around type of test. Trunks of this type, which may have different losses in the two directions of transmission, are tested in two steps.

Step 1 consists of making a far-to-near (F-N) transmission test as described in paragraph C8-10.1.

Patch cords are arranged to connect the TM1 and TM2 jacks to the auxiliary jack (TRK2) and the regular jack (TRK1) respectively of the test termination circuit. The measuring set is connected to the auxiliary jack (REC2) of the test termination circuit and the milliwatt supply is connected to the regular jack (SD) of the test termination circuit.

A connection is established to the first loop-around test line at the distant office via a reference trunk (1st APP). Test keys are operated in the auxiliary termination circuit and the master test frame jack, lamp, and key circuit to cut through the transmission path and return ground via the sleeve of the TM1 jack to operate relay TM1 in the trunk test circuit. Relay TM1 transfers the telephone circuit to the tip and ring of the originating test line and grounds the TM1 lead to the master test control circuit for use in Step 2 of the tests. The connection is held from the auxiliary termination circuit independent of the master test control circuit which is then released. The trunk to be tested (2nd APP) and the second loop-around test line number are then selected at the master test control circuit.

<u>Step 2</u> is initiated by operation of the control start key. Ground on lead TM1 causes the control circuit to change marker priming information pertaining to the calling line location to that of the combined originating and terminating test line. A connection is, therefore, established from the telephone circuit via the combined test line to the second loop around test line location at the remote office.

Operation of test keys in the test termination circuit will now cut through the milliwatt supply transmission path and extend ground via the TM2 jack to operate relay TM2. Relay TM2 cuts off the telephone circuit and cuts through the tip and ring from the test termination circuit to the combined test line.

The loss, as measured in Step 2, is the sum of the F-N loss of trunk (1st APP) and the N-F loss of trunk (2nd APP). Subtracting the loss measured in Step 1 now gives the value of the N-F loss for trunk (2nd APP).

SECTION D, PART 0

TERMINATING CALL TROUBLE CARD ANALYSIS

Index

DO TERMINATING CALL TROUBLE CARD ANALYSIS

The trouble analysis flow charts in the A2 Section of the SFD direct the reader to one of the rounded boxes† at the left of SFD-D002 for terminating call trouble record cards.

DO-1 CROSS DETECTION, SEQUENCE FAILURE (SFD-D002)

For either of the double sided trouble cards, there is an MXT designation which is punched if there is a cross detected (X--) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single sided trouble card, there is no MXT punch and it is necessary to scan all the X-- designations and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y (yes) if the designation is punched or the statement is true or N (no) if the designation is not punched or the statement is not true. If there is no MXT, cross or sequence failure, the procedure beyond that point is the same for all trouble record cards.

DO-2 TIMING FUNCTIONS

The DTM and CM are designed in such a way that they are timed from seizure until release. Critical functions are timed separately. Understanding the purpose and function of timing circuits will aid the crafts person in understanding the behavior of the marker. General functions of the OAT, WT, SDT/LDT, TRS and LR timers will be discussed in this section.

DO-2.1 OVERALL TIMER (OAT)

The OAT is started when the CM is seized and is stopped when the marker is restored to normal. The timing interval is 9.6 to 15.4 seconds which is greater than the time required on any normal marker usage. This timer guards against failure of any of the other timers. Operation of the timer causes the marker to release without a trouble record but will sound a major alarm.

† Symbols used in flowcharts are described on SFD-A103.

DO-2.2 WORK TIMER (WT)

The WT timer is started when the marker is seized and is stopped when the marker is restored to normal. The timing interval is 450 to 605 milliseconds. This short timer is used to detect troubles as soon as possible in order to quickly release the marker. The WT timer is recycled as the call progresses. Operation of the WT causes the marker to take a trouble record before releasing and will be the timer that will most often generate a trouble record.

DO-2.3 SHORT DELAY TIMER (SDT) AND LONG DELAY TIMER (LDT)

The SDT provides a delay of 2.6 to 4.5 seconds on service calls and 1.1 to 1.9 seconds on no-test calls. The LDT provides a delay of 4.6 to 7.5 seconds. Both timers are started by the operation of the seize frame (SF) and seize frame timer (SFT) relays. The operation of the SF stops the WT timer. The SF and SFT relays operate when the marker closes a start lead to select a frame such as the LL, TL, NG, OSC or FAT. The SF and SFT relays also operate on various test calls and on completion of the sender trunk guard test. The SDT timer always functions first unless the trouble recorder is busy. This condition requires the longer timing provided by the LDT. If the SDT should fail, the LDT, which is also timing will function as a back up.

DO-2.4 TRANSFER START TIMER (TRS)

The TRS circuit functions to transfer the marker connector start leads to the alternate marker preference whenever a marker is not seized in approximately one second. If the WT, SDT/LDT are not punched and the TRS is punched, the trouble record indicates that the marker connector could not connect to a CM within the transfer start timing interval and had to transfer its start leads.

DO-2.5 LINK RELEASE (LR) WITH OR WITHOUT DCK

Since the IRL (incoming register link) circuit contains no timing feature and since a link failure would block calls from numerous incoming trunks, the IR (incoming register) is arranged to time for completion of link functions and to cause a CM (completing marker) connection and release of the IR if they are not completed within 325 milliseconds nominal. Timing is accomplished with the LR (link release) tube, LR relay, and the associated capacitor-resistor network.

The LR relay function in the IR, grounds the LR lead to the CM, so that the CM can take appropriate action. If the DCK is operated, it indicates that a link crosspoint has been closed and that no double connection exists. If the DCK is not operated and the LR is operated, the IRL failed to pass information through its cross-connects to the IR.

DO-3 FALSE CROSS-GROUND TEST (FCG)

The FCG is the next punch designation which must be considered on the flow chart (SFD-D002) and will be discussed briefly at this time. During light traffic conditions the CM operates all hold magnets except the line hold magnet. The FCG relay is connected to the tip and ring leads and will operate if there is a cross between the tip and ring, a false ground on the ring conductor, or a false battery on the tip conductor. The FCG relay will lock operated, stop the marker progress, and force a WT time out.

DO-4 TROUBLE ANALYSIS SEQUENCE CHART (SFD-D003)

Standard sequence charts generally show a sequence of relay operation and release. All relays are shown that relate to a particular function. Trouble record punch indications are shown at the point in the sequence when ground is applied to or removed from the lead to the trouble recorder. Trouble analysis sequence charts omit relays shown on the regular sequence chart, except those relays associated with the trouble record designations (SFD-A103). A designation on the trouble analysis sequence chart without a punch symbol indicates the point in the sequence where that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

DO-4.1 USE OF FLOW CHART AND TROUBLE ANALYSIS SEQUENCE CHART

This section will demonstrate the use of the flow chart (SFD-D002) and the trouble analysis sequence chart (SFD-D003). A crafts person experienced in the use of trouble record cards may find this section basic, but the procedures shown here (even though they may become automatic) are the procedures a qualified crafts person must perform.

Without a selection of trouble record cards to distribute to the reader, certain functions must be assumed. It is assumed that all trunks, trunk links, line links, incoming registers etc. vary. The only equipment that remains the same on all cards is the marker. Following the flow chart (SFD-D002) it is identified that the MXT punch <u>is not</u> indicated. The path to follow is marked N (No). The WT punch <u>is</u> indicated. The path to follow is marked Y (Yes). This procedure continues through the FCG N (No), the TK Y (Yes), the HMS1 Y (Yes), and the DCT1 N (No). The flow chart directs the reader to SFD-D003.

The trouble analysis sequence chart, and all sequence charts, operate from the top of the page to the bottom. To identify the trouble area the reader must start at that point of major failure and back-track to the point where all punch indications (leading to the branch in trouble) are shown.

To demonstrate: Working back from the DCT1, the DCT is indicated, the RCK3 is indicated, the RNG is not indicated. The chart directs the reader to coordinate K21 to continue back-tracking. The operated VTK1, HTK1, FTK1, FUT-, and FTT- indicate translation is complete.

The page coordinate P6 shows the portion of the trouble analysis sequence chart that is shown in detail on D402. Use of the sequence chart will be shown in paragraph SCD-DO-5.

DO-5 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts, except as noted on SFD-A103.

The example in DO-4.1 continues on SFD-D402. Most paths leading to the RNG relay (relay responsible for the DCT1 not operating) can be eliminated from information punched on the trouble record card. The CS- indication checks the VTK1, HTK1 and FTK1 relays have operated. The TK checks that the HGK, LFK, and other relays have operated. The HGK and LFK, in turn, check that the FTT- and FUT- have operated.

The remaining relays should be checked, which include the RCL-, RCT-, and LA relay. These will have to be visually checked since there are no punches for these relays. If they are operated, the operation of the HTK1 should be checked. The trouble record card shows the HTK1 punch but if the winding is open the punch would still be there. If all relays checked are operated, the path to operate the RNG relay should then be checked.

SECTION D, PART 1

INCOMING TRUNK SEIZURE, INCOMING REGISTER SELECTION AND PULSING

Index

D ESTABLISHING AN INCOMING TRUNK CONNECTION

Incoming calls may be received from an operator or from a calling customer in a connecting office. The digital information is received by the IR (incoming register) which is connected to the CM (completing marker) through the IRMC (incoming register marker connector). The CM will determine from the information passed to it from the IR whether to process the incoming call as a terminating call, a toll or tandem through switched call, or a pulse conversion call.

A terminating call is one placed to a customer served within the marker group which requires a connection to be established between the trunk link appearance of the incoming trunk and the called customer's line appearance on the LL.

A route relay is not required on a TER call. Direct signals or translation determines that the call is to be completed locally and that FLG linkage is required.

The general sequence of operation of an incoming trunk connection is as follows:

The closure of the loop from the outgoing sender in the distant office to the incoming trunk causes the A relay to operate in the incoming trunk. This A relay closes battery to the IRL (incoming register link) and in response to this signal, the IRL functions to connect an idle IR to this trunk.

The IRL sends to the IR information consisting of class of trunk and trunk link frame number. This information will be used by the CM in processing the call. A crosspoint is closed in the IRL to connect the IR to the trunk. When this connection has been established, all checks satisfactorily completed, and a timed interval has passed, the IR takes control of the connection, reverses the tip and ring leads to signal the distant office that the IR is ready to receive pulses.

The IR may be of two types, DP (dial pulse) or MF (multifrequency). For DP, the signal is passed directly to the IR where it is stored to be passed to the CM. For MF, the signal (two frequencies) is received by a signal receiver, which converts the signal to direct current to be used by the office. These signals are also stored by the IR to be passed to the CM. After the IR receives all digits, it prepares the trunk to assume control of the connection. The IR then establishes a connection to the CM through the IRMC and passes information to the CM that is used to complete the call.

When a CM has been seized and has received input information through the IRMC, it proceeds to connect to the TL (trunk link) frame which contains the incoming trunk.

After the TL preference circuit operates, the CM connects to the incoming trunk. Trunk class information is passed from the trunk to the completing marker. The completing marker determines the location of the trunk on the TL and operates control relays and select magnets.

In a No. 5 crossbar office, there is no permanent or prearranged association of directory numbers with switch positions on the LL (line link) frames. A CM upon receiving the number for a terminating call must determine which of the many switch verticals in the office is associated with that particular directory or trunk number so that a connection may be established. The marker obtains this information from the NG (number group) frame. This frame is a large central memory kept up to date with the latest directory number assignments, to which each CM in turn applies for the necessary translation.

The LL containing the called line is seized to enable the CM control of the desired select and hold magnets. An LL seizure is also necessary whenever a connection to a called line location on a tandem type call is required. This connection is referred to as FLG (call forward linkage). The FLG is used on an INC TER (incoming terminating), TAN (tandem), and IAO (intraoffice) type calls.

Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL, and the junctor switch and trunk switch crosspoints on the TL. The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Following hold magnet operation, the channel is checked for crosses, continuity, and double connections. The number group is released and the ringing switch crosspoints are operated. If all tests are satisfactory, the CM proceeds to disconnect and restores to normal.

D1 INCOMING REGISTER SELECTION AND PULSING

D1-1 TRUNK AND REGISTER PREFERENCE

The general overview of sheet D104 shows the TP- relay operation, selection and hold magnet operation in relation to the IRL and the incoming trunk. The association of TP00 to the AMRST (automatic monitor register sender test) circuit is also shown. The IRL basic and supplementary switches of the first, intermediate, and last horizontal groups are shown with their associated select and hold magnet leads.

The interconnecting leads ST, RB, BL, LK, and SM- are carried over to sheets D106 and D107 which show the incoming registers and their association with register preference between the different horizontal groups on the IRL frame.

Register preference shown on sheets D106 and D107 are layed out in block diagram style and alphabetized to indicate first, intermediate and last appearances in the horizontal group of the IRL frame. Block diagrams are shown of the different appearances of incoming registers 0 through 9. Refer to Notes 1 through 5 on sheet D107 for explanation and proper use of the multiple leads and preference blocks in relation to chain circuit leads and preference chains. The vertical blocks A through C are associated with the incoming register designated E at the bottom of each row. A combination of the same blocks in horizontal rows are associated with the horizontal groups. Therefore work chains and preference chains can be followed to the end.

On SFD-D105 a block diagram can be used to trace through the incoming register link chain circuits. The colors used are red for the ST lead chain, blue for the B (B, B1, and B2) lead preference chain, and green for various work chain leads (SFD-D105).

D1-2 OPERATION OF TRUNK PREFERENCE RELAYS (SFD-D104)

When an incoming trunk requires connection to a register it connects battery on the ST- lead to operate its TP- (trunk preference) relay as shown in D104.

Since all the TP- relays in a horizontal group are in a chain of preference, only one trunk can proceed at a time. The operation of a TP- relay such as the one shown for an intermediate trunk opens ground from the windings of all the higher numbered TP- relays. Lower numbered TP- relays may operate but can do no work since all of the work leads are in a chain running in the opposite direction and these are opened at higher numbered relays. If during the time one call is being served and other TP- relays operate, these trunks will be served in order starting from the highest numbered. Trunks which cannot operate their TP- relays must wait until the last operated TP- relay is released before being served.

D1-3 SELECTION OF IDLE REGISTERS (SFD-D106, D107)

The register control circuit consists of relays RP- and RB- which are furnished one per register per horizontal group. The RP- (register preference) relays carry a number of work leads in chains and the RB- (register busy) relays perform the function of controlling the start lead from the trunk preference relays.

A ground from the operated TP- relays (SFD-D104) is furnished to prepare the operation of the RP- relay of the first idle register in the chain of preference over the ST lead through the RB- relay contacts (SFD-D106).

On SFD-D106, note that the battery for operating the RP- relays is supplied by the associated incoming register over the B lead and then taken through a chain of contacts on the RP- relays associated with that register. To simplify this arrangement of multipling between other registers on link switch levels an arbitrary lead designation has been shown. For example, B lead from block A splits into two leads designated B1 and B2 for easier reference of chain operation. Block A represents the start of the preference chain and end of the work chain. Block B is an intermediate representation of both chains, and Block C represents the start of the work chain and end of the preference chain.

D1-3.1 OPERATION OF REGISTER PREFERENCE

The operation of a RP- relay prepares a path for the operation of C-relay over TF lead from incoming register. Note here that the battery side of C relay has been given the arbitrary designation C lead as it multiples between other horizontals and finally connects to the B or battery supply from the incoming register in Block A on sheet D106.

If the preferred register is idle, its register preference relay operates; but if it is busy, its register busy relay will be operated advancing the start lead to the succeeding register.

The operation of the RP- relay constitutes seizure of the register. The register preference relay operates an ON (off-normal) relay in the IR which prepares the register for operation. A RB (register busy) relay in the IR operates which causes operation of link register busy relays for this register in all other horizontal groups. Operation of the RB relay in the IR operates the RB- relays in the IRL on all horizontal groups except the one being served. The RB- relay in the selected horizontal group is held shunted down by ground on the LO lead until the RLK relay in the IR operates to allow the RB- relay associated with the IR in the IRL to operate.

D1-3.2 CLOSURE OF SWITCH CROSSPOINTS (SFD-D104)

Operation of the register off normal relay and an IRL select magnet closes a circuit through the operated trunk preference relay to operate the hold magnet for the trunk being served. This operating ground is extended through crosspoints to operate relay H which opens the circuit through the trunk preference relay and closes the circuit to the DCK (double connection check) relay. The DCK operates unless there is a ground already on the crosspoints which would occur if two crosspoints were closed to the same register. The DCK would be shunted down and a marker would be called in for a trouble record. Otherwise, this DCK locks and the hold magnet is held over the HM lead through the crosspoints. The operated H relay releases the select magnet.

D1-3.3 REGISTRATION OF INCOMING TRUNK CLASS (SFD-D108)

The IRL sends to the IR information consisting of class of trunk, trunk link frame number and trunk location for translation to a trunk number (if a trunk number is required). This information sent to the IR will be used by the CM to establish a connection to the incoming trunk.

The RP- relay in the IRL operates associated relays designated C and CA from ground on the TF lead.

One out of eleven leads is grounded by an operated TP- relay to indicate the trunk class to the register. In all cases except for Phase I and II centrex transfer type trunks and 2 way operator office trunks the class indication is determined by a cross-connection from TPC- to CL00-10. The other end of the eleven leads CL00-10 are brought out to the register frame for cross-connection to six nonspecial and special class combinations. The designation of these cross-connection punches are as follows:

- OA - Where four digits calls are received for termination in office A.
- OB - Where four digits calls are received for termination in office B.
- AB - Where five digits calls are completed and the initial digit indicates the required office number.
- OAS - Same as OA for calls received on a special call basis (OPR and local test desk).
- OBS - Same as OB for calls received on a special call basis (OPR and local test desk).
- ABS - Same as AB for calls received on a special call basis (OPR and local test desk).

If the trunk class is one of the special combinations the CLS relay will operate and will in turn operate the CLT relay. The CLT relay then connects the OAS, OBS, or ABS leads to the corresponding OA, OB or AB relays to cause operation of the proper relay.

D1-3.4 REGISTRATION OF TRUNK LINK NUMBER (SFD-D109)

Similar to class registration, trunk link information is furnished by grounding one of 40 TPU- cross-connection punchings, which represent the location of the incoming trunk in the incoming register link. The TPU- to TFU- cross-connect is determined by the units digit of the trunk link frame on which the incoming trunk is located.

The FG- to G- cross-connection is determined by the horizontal group and FG (or tens digit) of TL frame number on which the incoming trunk is located. The FGO-2 leads are connected directly to the corresponding FGO to FG2 relays to determine the proper horizontal group information in the incoming register.

One of the leads TFO to TF9 in the incoming register will be grounded on each call, when the connecting relay of the IRL horizontal group associated with the selected incoming register operates. This TF- lead causes operation of one-out-of-five TF- relays in the IR. The one TF-2/5 relay, in operating, locks and operates the TFT (trunk frame transfer) relay which transfers the incoming TF lead from the one TF-2/5 relay to another TF-2/5 relay. The two TF2/5 relays connected to each lead have the numerical designation of the lead. For example, a ground on lead TF2 will initially cause operation of relay TF2. The TF2 will operate TFT which connects lead TF2 to relay TFO, operating the TFO relay.

Each of the operated TF- relays will ground a correspondingly numbered lead to the marker connector. A contact of TFT is placed in the CK relay operating path to insure that TFT is operated. This insures that a ground has been received on one of the TF- leads. If a ground is not present on one of the TFO-9 leads, TFT will not operate and the LR (link release) timer will function to cause connection to a marker with a LR failure indication. If a trouble record is taken at this time, it will indicate the link groups involved in the call.

D1-4 REGISTER PULSING, MF

D1-4.1 PREPARATION FOR RECEIPT OF PULSES

The RLK operates at the completion of the link functions. It opens the discharge path of the RV timing circuit and closes a charging path from the RV relay to the RV capacitor to start timing. The RV relay operates after 190 milliseconds nominal time and locks to its secondary winding. The operation of relay RV reverses the polarity of the tip and ring leads to the outgoing trunk in the originating office. This signals the outgoing trunk or operator that pulsing should start. The register is ready to receive pulses at this time because relay ON1, which operated from the ON, has connected battery on leads BAT1 and BAT2 to the signal receiver circuit. The digit register has been prepared for registration of digits by operation of the first steering relay AS from the ON relay.

D1-4.2 PULSING PATH DESCRIPTION (SFD-D110,D111)

The SFD-D110, D111 shows the complete pulsing path from the OSMF in the originating office to the IRMF in the terminating office. This path extends through OSL with an outgoing trunk attached, through the main distributing frame jumpers to cable conductors that connect to the distant terminating office, through the incoming trunk circuit which connects to the IRL and IR and finally to the end circuit MF receiver associated with the IR.

Each digit transmitted by multifrequency consists of a pulse of two-out-of-five audio frequencies. These frequencies are 700, 900, 1100, 1300, and 1500 cycles per second, designated 0, 1, 2, 4, and 7 respectively. In addition, a key pulse using frequency 1100 and 1700 cycles is transmitted as a gate opener. Also, a start pulse using frequencies 1500 and 1700 cycles is transmitted after the last digit as a start signal for the terminating IR to complete its function. The entire code digits used are as follows:

D1-4.2.1 MF Frequency Chart

Digit	Designations	Actual Frequencies Cycles per Second
0	4, 7	1300, 1500
1	0, 1	700, 900
2	0, 2	700, 1100
3	1, 2	900, 1100
4	0, 4	700, 1300
5	1, 4	900, 1300
6	2, 4	1100, 1300
7	0, 7	700, 1500
8	1, 7	900, 1500
9	2, 9	1100, 1500
KP	2, 10	1100, 1700
START	7, 10	1500, 1700

D1-4.3 MF RECEIVER CIRCUIT SD-95536-01 (SFD-D112)

The receiver circuit is maintained in a disable condition until it receives the key pulse (gate opener) so that it will not react to unwanted signals that may appear on the line due to inductive pick up. The KP signal is received entirely by the signal receiver without operating relays in the register. Each subsequent digit causes the receiver SP (signal present) tube and relay to operate. The SP relay in turn causes operation of receiver relay LK over the leads J and L, shown on SFD-D113. The LK relay connects +130 volt battery to the receiver channel relays and when the channel thyratron tubes (corresponding to the frequencies received) operate causes associated receiver channel relays to operate. The operation of two channel relays ground the corresponding leads 0, 1, 2, 4, or 7 causing operation of the corresponding A2/5-L2/5 digit register relays and also operates the RA relay over the S lead, shown on sheet SFD-D112 and D113. The operating path of the receiver channel relays includes the winding of the receiver relay CK2 which operates and causes operation of register relay 2CK over lead H.

Operation of RA operates the next digit steering relay and with 2CK operated opens the J and L leads to the receiver which releases relay LK. The release of LK releases the channel relays and relay CK2. If by this time the signal is ended, relays 2CK and RA release and allow release of the steering relay for the digit just received. If, however, the signal pulse is still present, relays RA and 2CK will be locked to the receiver signal present relay SP over lead J. These interlocking features are provided to insure that each pulse locks in until it has been recorded and that the register does not advance to the next digit until the end of pulse.

D1-4.4 DIGIT REGISTRATION (SFD-D113)

The digit register unit consists of a dry reed relay pack with five independent coils inclosed in a can and with each coin associated with two make contacts. One terminal of each of the coils is wired internally to one of its associated contacts for locking purpose and a single lead is wired to a terminal. One contact of the locking contact pair, one terminal of the coil and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both front and back of the dry reed relay pack for ease of wiring and testing. Also for ease of wiring, three sets of terminals are strapped internally. These terminals are the battery side of the coils, the locking contact of the relays, and one side of the load contacts.

D1-4.5 DIGIT STEERING CIRCUIT (SFD-D113)

The digit steering circuit consists of a single relay per digit AS-LS. Each steering relay is advance by a contact on the RA (register advance) relay. At the time of seizure, the register relay ON operates in turn operating the AS which locks through series back (break) contacts of all the steering relays. The RLK opens the operating circuit of AS. On the first operation of RA, the BS relay operates through contacts of AS. The BS locks through a back contact of CS and opens its operating circuit on one set of continuity transfer contacts. The BS, on another set of continuity transfer contacts, transfers the locking circuit of AS from the off-normal ground to the RA controlled ground so that when RA releases AS will release. The next operation of RA will operate CS through back contacts of AS and front contacts of BS and the next release of RA will release BS. This action continues with each operation of RA operating the steering relay for the next digit and each release of RA releasing the steering for the digit just registered.

D1-4.6 REGISTRATION OF THE A DIGIT (SFD-D113)

The AS (A digit steering) relay is operated from the ON relay when the register is seized. When the A digit frequencies enter the receiver, the MF receiver SP (signal present) tube and relay operate. The SP connects ground on lead J which is connected through back contacts on relays MST, TEN, STS (and depending on the number of digit registers equipped), BS, DS, FS, HS, and KS to lead "L" to the winding of receiver relay LK. The steering relay part of this path is paralled by a circuit through a back contact of 2CK. The LK operates and connects battery to the receiver channel relays and when the channel thyratron tubes (corresponding to the frequencies received) operate cause associated channel relays to connect ground to corresponding leads to the register. These grounds are carried through the contacts of AS relay to operate the corresponding A digit register relays which lock.

When the receiving circuit detects one or more frequencies, the corresponding numerically designated relays of the receiving circuit operate and cause operation of RA over lead S. When the receiver circuit detects two frequencies and two of the numerically designated relays operate, the receiver CK2 relay operates causing operation of the 2CK relay. Both RA and 2CK lock to the J lead which is controlled by the SP and the CK2 relays of the receiver. The RA operates BS which opens one leg of the circuit between the J and L leads in the register and when 2CK operates the J lead is disconnected from the L lead allowing release of the LK relay of the receiver. The LK, in turn, releases the receiver CK2 and numerically designated relays. If the signal pulse has ended or when it ends, SP will release. With both SP and CK2 released, RA and 2CK will release. The RA, in releasing, completes the steering advance by causing release of AS which recloses one leg of the circuit between the J and L leads. The release of 2CK relay recloses the other leg of the circuit between the J and L leads. Either leg being closed enables the relays of the receiver to respond to the next digit signal.

D1-4.7 REGISTRATION OF THE B DIGIT

The B digit is recorded in the same manner described for the A digit. When the frequencies are detected, the receiver SP relay operates. The LK relay operates to enable the receiver channel relays. Two of the channel receiver relays operating will cause operation of CK2. Register relays RA and 2CK operate the steering relay CS to open the J and L leads to relay LK which, in turn, releases the receiver channel relays and CK2. The B digit register relays operate from the receiver channel relays. Subsequent digits are received and recorded in a similar manner.

D1-4.8 PULSE CONSISTING OF MORE THAN TWO FREQUENCIES (SFD-D112)

If a trouble condition exists that causes more than two receiver channel relays to operate, the current drawn by the receiver channel relays will exceed the minimum required to operate the receiver relay CK3. Operation of CK3 grounds lead RO which operates the RO (reorder) relay. The RO relay causes the marker to be seized with a reorder indication.

D1-5 REGISTER PULSING, DP

D1-5.1 GENERAL DESCRIPTION

The dial pulse incoming register is used to receive information in the form of dial pulses over a trunk from another office and when the entire number is received to transfer this information to the marker so that a connection can be set up between the incoming trunk and the called line.

D1-5.2 TYPES OF TRUNKS

The register is arranged to receive pulsing from two different types of trunks. By-link pulsing trunks are those originating principally in SXS offices on which pulsing may start soon after the trunk is seized. For these trunks an early or by-link pulsing path is established through the control relays of the IRL to carry the pulsing signals until the IRL switch contacts close the regular path. Direct pulsing trunks are those on which pulsing will not start until a signal, either dial tone or a trunk reversal, is returned by the register. When a direct pulsing trunk is connected to the register a relay is operated in the trunk which gives the register sole access to the tip and ring from the calling office and it receives pulses directly from that source. All trunks on a particular IRL switch must be of the same type in respect to the type of pulsing.

D1-5.3 LINK CONTROL

In cooperation with the IRL circuit the register establishes a connection from the trunk to the register through the IRL switch contacts, checking that there is no double connection. The register prepares to receive pulses and distinguishes whether the connection is to a by-link or direct pulsing trunk. After all required information has been received the IRL control relays are released. If a direct pulsing trunk is connected to the register, the battery and ground supplied by the register to the tip and ring of the trunk are reversed after a time interval and dial tone is connected when required by the trunk circuit as a start pulsing signal.

D1-5.4 DIGIT COUNTING AND REGISTRATION

The register then counts the number of pulses in each digit and when the dialing is completed transfers this count to the digit register and recycles to make itself ready for reception of the next digit. By recognizing the start and completion of each digit it controls the progress of the register steering circuit. A digit register unit with five elements is provided for each digit, better known as reed type storing relays. These relays operate on two-out-of-five basis. A steering circuit which is controlled by a RA1 (register advance relay) progressively associates the register units with the counting circuit as digits are received. The steering circuit consists of one relay for each group of register relays (AS, BS, CS, etc.).

D1-5.5 TRUNK CLASS

When all digits have been received the register operates the MST (marker start) relay to start seizure of a marker. The steering relays are used to indicate when particular digits have been registered. As these relays operate they ground the C to L terminals with the terminal designation corresponding to a digit being grounded following registration of that digit. For example, when the D digit is registered, the ES relay is operated to ground O terminal. These terminals with their cross connections, and in some cases permanent wiring to contacts of the class relays (OA, OB, and AB) are used to operate the MST (marker start) relay. Since the register does not receive the same number of digits from all incoming trunks, the operation of MST is controlled either directly or indirectly by the class relays. For instance, for a four digit local completing incoming trunk with the OA class relay operated, the MST will be operated when ES operates after the fourth digit is registered. For a five digit local completing incoming trunk with the AB class relay operated, the MST will be operated when FS operates after the fifth digit is registered.

The MST terminal is connected directly to the MST relay winding and a ground at this terminal will cause selection of the marker without delay.

D1-5.6 ABANDONED CALL TIMING - DIRECT PULSING TRUNK

The abandoned call timing in the dial pulse register is accomplished with the AC cold cathode tube, AC relay, and the associated AC resistors and timing capacitor. The AC capacitor is discharged between calls through normal contacts of the BL and CK relays and the operation of CK opens this path.

After the line reversal start dialing signal is transmitted, the L relay is under control of the calling office and L relay controls the ACC relay. During the dialing of each digit, the L relay will release to open the circuit to ACC. The ACC may or may not release depending on the length of the open pulse but if it does release it will reoperate on the next closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open indicating that the call has been abandoned.

After all the digits have been registered, the L and ACC relays will release but TC1 will operate to prevent the timer from functioning. If the call is abandoned after TC1 operates, the release of TC1 will cause operation of the timer. If the discharge shunt around the AC capacitor is removed for a nominal time of 190 milliseconds the tube ionizes and AC operates. The AC relay operates the MRL to cause release of the register.

D1-6 REGISTER AND LINK TIMING (SFD-D114)

D1-6.1 TIMING DESCRIPTION

Since the IRL circuit contains no timing feature and since a link failure would block calls from numerous incoming trunks, the register is arranged to time for completion of link functions and to cause a marker connection and release of the register if they are not completed within a nominal timing period.

When the register is seized, two trouble condition timers are started. These are the LR (link release) and the TM (overall timer). The LR timer will detect a trouble condition which prevents the IRL from completing its functions and indicate this to the CM so that appropriate action can be taken.

The RLK relay, when operated, cancels the LR timer. The two key relays that must be operated to satisfy RLK operation are the CK and DCK. The CK relay operates if all class information is received properly from IRL and DCK will operate if no problems are encountered with IRL switch linkage.

The overall timing in the register is accomplished by the TM relay, TM tube, and the associated resistor-capacitor network. A period of 25 seconds nominal is allowed for all digits to be recorded. If MST (marker start) relay does not operate within the interval (after register seizure) the register will time out and call in a marker for a reorder connection. Once MST has operated, a second period of 25 seconds nominal is allowed for completion of the marker functions and register release.

If the register does not release within this interval, an abandoned call is simulated in an attempt to release the register. In case the register fails to release, the office alarm is operated.

D1-7 SELECTION OF REGISTER BY AMRST (SFD-D116, D117)

D1-7.1 MONITOR PREPARATION

Before the AMRST (automatic monitor, register and sender test) is connected to the register to be tested, it is necessary to prepare the AMRST (monitor) for testing. The Incoming Register key (IR) should be operated, followed by the operation of the STT key. This operates the STT relay which serves as a general off-normal relay for testing operation of the monitor. The number to be pulsed is set up on keys or switches on the MTC (master test control) circuit. The particular test and pulsing conditions are also set up on the keys or switches as necessary.

The number of the register in its incoming register link group is set up by setting the corresponding numbers on the SRS switch or SRS key. The number of the incoming register group is then set up by setting the IG-switch or operating a IG- key to the position numbered to correspond with the number of the incoming register group in which the register to be tested is located. Ground from STT relay contacts through the IG-switch or IG- key operates the MIR1 relay for multifrequency group. The MIR1 relay operation creates a path for operating all the SPR- relays. The SPR- relays open the paths by which the IRP- relays are operated from the incoming links. The PC- relay operates through the SPR- relay selected by the IG switch or by an IG- key. The PC- relay connects the windings of the 10 IRP- relays of its incoming register group to positions 0-9 on the SRS switch or to the 10 units on the SRS key.

If MIR1 operates, it operates MR and MF to prepare those circuits for multifrequency operation. The MIR1 also operates BT1 relay which connects battery to the N lead to the MTC circuit to make the start key of that circuit effective. When the start key is operated, it connects ground to operate the BT2 relay through the MIR1 relay. The operation of BT2 relay operates the IRP- relay associated with the register selected by connecting operating battery and ground for the IRP- relays through the operated PC- relays and SRS switch or key to ground. The BT2 relay also opens the operating path of BT1 relay.

D1-7.2 PARTICULAR REGISTER SELECTION

The IRP- relay, operating, will prepare the path for the operation of the M relay in that particular selected incoming register. The purpose of the M relay is to connect the incoming register to the test frame for monitoring or testing. If a call is in progress, the ground which holds ON relay operated will also hold the BT1 relay operated. When the register becomes idle, BT1 releases and closes ground to the IRP- relay contact associated with the last register.

For MF registers, MIR2 will operate through contacts of MIR1. The MIR2 relay serves as a cut-in relay for the leads from register to monitor previously closed at the register end by the M relay.

The relay BT1 is slow-release to extend the operate time of IRP- and M and also to permit the register to fully release before it is reseized. With the register now idle but held busy to service calls, MIR2 operates the IRST (incoming register start) relay to start selection of the register through the incoming register link circuit. When the register has been found to be idle, the IRST operates. The IRST relay supplies several off-normal grounds, one which lights the RB progress lamp, one which closes a circuit from battery through resistor ST, through a front contact of relay IRST, through back contacts of C, LKT, and BL1, through a front contact of an operated PC- relay to ST lead to the IRL and, through the winding of TP00 (trunk preference) relay to ground. The complete operating path of TP- relay is found on SFD-D104.

D1-7.2.1 Selection with Incoming Register Link

Operation of relay TP00 in the IRL locks out all trunks in horizontal group 0 which have not already operated their preference relays. The test circuit must wait until all trunks which have preference relays operated have been served. When all preference relays of horizontal group 0 are normal except the test preference relay, the IRL grounds lead B, operating the associated trunk class relay TCL- (SFD-D117). This relay operates the associated lock-out relays and operate register preference relays LO- and ORP-.

The LO- relay closes a register busy lead RB from ground through the primary winding of the RB1 relay to the register under test on a circuit through a back contact of RB2, back contact of C, front contact of IRST, through the SRS selector switch or key, front contact of LO-, the RB lead to the IRL, and the RB0 lead from the IRL link to the register. Since the register has been made busy by the test circuit, the register should have 226 ohm battery connected to lead RB, which will operate relay RB1. The RB1 relay locks operated on its secondary winding.

The RB1 relay operates relay RB2, which operates the preference relay in the IRL by connecting ground from a back contact of C relay, through a front contact of RB2, through the selector switch SRS or an operated key unit of the SRS key, through a front contact of relay ORP- to the RP lead in the link. The RB2 relay also changes progress lamps, lighting LO, and transfers the RB lead to the winding of relay RB3. The IRL RP-relay connects the RB lead to LO to the register, where there should be solid ground. The RB3 relay tests for this ground. If the ground is missing, the RB lead will be connected in the link and register to 100 ohm ground and 226 ohm battery. Since relay RB3 is supplied with 200 ohm battery and 100 ohm ground, it will operate if direct ground is connected to the register LO lead, but will not operate otherwise because it will then be in a balanced bridge circuit.

D1-7.3 PROGRESS LAMPS (SFD-D116)

When the RB3 relay operates, it locks operated, transfers the progress indications from lamp LO to lamp LK, and connects lead LK from the IRL to the winding of relay LK (SFD-D104). The register has resistance battery connected to lead LK, which will operate relay LK. This places the IRL connection under control of the register by connecting the LK lead to lead ST. The LK relay, in operating, transfers the progress indication from LK lamp to OH lamp and connects lead OH from the IRL to the winding of relay OH (SFD-D104). The register should operate its IRL select magnets and ground lead OH to the IRL. The select magnet off-normal contacts should close the OH lead through to the test circuit, operating relay OH. The OH relay locks operated and transfers lead OH from its winding to lead HM to the IRL, operating the test circuit hold magnet in the IRL.

The OH relay transfers the progress indication from lamp OH to lamp CO and closes an operating circuit for the C relay. The C relay locks operated, extinguishes the CO progress lamp, and connects D lead from the IRL to the winding of D relay. The subsequent operations depend on whether the test is bylink, dial pulse, or multifrequency.

D1-8 STANDING CROSS RELAY TROUBLE INDICATION (SFD-D115)

For either of the double sided trouble cards (1/X type CD-25805-01 or 2/5 type CD-27718-01), there is a MXT designation which is punched if there is a cross detected (X-) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single sided trouble card (1/X type CD25805-01), there is no MXT punch and therefore it is necessary to scan all the X-designations and the SQA designation to determine if there is a cross of sequence failure.

After the particular cross relay operates, its contact sends a ground toward the master test frame connector circuit for trouble indication display through the trouble recorder circuit.

D1-9 MASTER TRAFFIC CONTROL

D1-9.1 GENERAL DESCRIPTION OF OPERATION

The master traffic control and frame control circuits govern the traffic between connectors and markers during periods of heavy load or, more particularly, whenever requests for markers overlap. When several connectors with several calls each are requesting markers, the most equitable service is given by serving one call out of each waiting connector before serving a second call from any connector. By this means, the connectors with slow-start circuits are not blocked by connectors with faster-start circuits and one connector with several calls backed up cannot block other connectors for an unduly long time.

This process of locking out connectors once served is called "gating" which is the major function of the master traffic control, frame control, and connector control circuits. When a connector is prevented by its control circuit from obtaining a marker, the connector is said to be "gated", and conversely, when it is free to obtain a marker it is said to be "ungated."

The TC and TC1 relays in the connector control circuit, controlling marker start STA and STB leads, determines the gating. When these relays are operated, the connector is prevented from obtaining a marker, and when they are released, the connector can seize a marker.

With dial tone marker operation a short-cycle gate traffic control is used with line link marker connectors and a long-cycle gate traffic control is used with originating and incoming register marker connectors.

Duplicate tube timing circuits are provided and their function is to ungate the connectors in case of trouble and to give a major alarm. One of these circuits is associated with the STA lead and one with the STB lead. The ALA and ALB relays which are operated by the timers are held under control of the MC-AR key in the master test frame. The circuits for ungating the connectors are also under control of keys on the master test frame.

D1-9.2 CONTROL OF TRAFFIC THROUGH INCOMING REGISTER MARKER CONNECTORS (SFD-D132, D133, AND D134)

D1-9.2.1 Circuit Normal (SFD-D134)

When all associated connectors are idle, relays TCA1 and TCB1 in master traffic control circuit are operated and all other relays are nonoperated. The two timing circuits are prevented from functioning by TCA1 and TCB1. Any trouble which would cause relays TMA, TMB, CWA or CWB to operate when the connectors are not in use, will bring in a major alarm.

D1-9.2.2 Single Request for a Marker - No Gating (SFD-D134)

A single connection to a marker which is completed and released before a second request is initiated does not involve gating. In the connector, the control circuit will shift its start lead preference after its use so that a succeeding call will prefer a different marker.

The TM relay in the preference control circuit, operating in response to a request for a marker by an incoming register closes ground to the TCA and TCB leads, and either the CWA or CWB lead (SFD-D134). The CWA or CWB lead is determined by connector control Z relay which also determines whether the STA or STB lead will be used. When Z is normal, the STA and CWA leads are closed, and when Z is operated the STB and CWB leads are closed. The TM also connects the IM relay in the preference control circuit to the IM lead.

If a call is waiting to be served, the TCA and TCB relays operate and then lock to the TCA and TCB leads. The SRA and SRB relays operate and open the TCA and TCB operating path. When the TCA and TCB relays operate, the TCA1 and TCB1 relays release.

With the Z relay normal, CWA is operated. Therefore TMA timer starts to time and the TMB timer is stopped by battery being closed to the control anode through TCB1 contacts. The TMA and TMB relays will be normal if markers are available. The IM relay in the master traffic control circuit also operates and applies ground on IM lead to the preference control circuit, with relay TM operated. The IM relay in the preference control circuit operates and permits transfer timing in that circuit to start (SFD-D210).

The connector multicontact relays operate as a result of STA lead closure to the marker preference relay. The TC and TC1 relays in the preference control operate and open the circuit for the TCA and TCB relays. The TCA and TCB relays release and prevent the operation of the frame control relays FC and FC1. The CWA also releases and TCA1 and TCB1 relays operate to stop timing in the master traffic control circuit. The IM relay in the master traffic control releases to stop the transfer timing in the preference control circuit. The SRA and SRB relays release and the circuit is normal.

If relay Z had been operated, then CWB relay would have been operated on marker request. The TMB timer would have started timing and the TMB timer would have been stopped. Also, start lead STB would have been used on marker seizure.

D1-9.2.3 Overlapping Requests for Marker - Gating

If other requests are being made for markers, other connector control circuit TM relays will be operated and the TCA and TCB relays will remain locked. Since some connectors will be using the STA and some the STB leads, both relays CWA and CWB will be operated and both timers will be timing. As the available completing markers are seized by the connectors, the TC and TC1 relays are operated in those connectors and open their start leads. If other request for markers are being made, the timers will continue timing due to relays CWA and CWB remaining operated and relays TCA and TCB will remain locked. With the TCA and TCB relays operated, frame control relays FC and FC1 operate in all connector frames having any one pair of TC and TC1 relays operated, in turn locking all TC and TC1 relays in those frames. Those connectors are gated, that is, they are prevented from obtaining a marker, since their marker start leads are opened by the TC and TC1 relays. They will remain gated until the TCA and TCB relays release.

The SRA and SRB relays are released. These relays are slow to release to prevent reclosing the TCA and TCB lead until all FC, FC1, TC, TC1 relays are released, since another request during this ungating period could prevent proper release. This interval also allows the last marker connected to finish its work and release in order to prevent gating that connector for another gating cycle.

If the all-markers-busy condition is encountered during the gating cycle, the TMA and TMB relays will operate from the all-markers-busy circuit. The IM relay will release which in turn will release the IM relays in any preference control preventing them from making an ineffectual transfer of the start circuit.

SECTION D, PART 2

COMPLETING MARKER SEIZURE

Index

D2 COMPLETING MARKER SEIZURE

After the IR receives all digits and the incoming trunk has been prepared to assume control of the connection, the IR establishes a connection to the CM through the IRMC and passes information to the CM that is used to complete the call.

D2-1 SEIZURE AND INPUT TO COMPLETING MARKER

Upon operation of a TC2 relay in the incoming register and RB relay in the IRMC (SFD-D204), start battery is applied to activate a marker start STA lead or a marker start STB lead to start seizure of a completing marker. As will be seen later, the Z relay is operated and released on alternate calls so that the STA and STB start leads are alternately activated on successive calls. Each register is given preference to one completing marker for an MSA start and to another for an MSB start by cross-connecting MSA and MSB punchings on SFD-D204 to appropriate MS- punchings on SFD-D205.

D2-1.1 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-D205)

Three chain circuits are used in selecting a completing marker and closing the connector relays between the register and the marker selected. The following are typical descriptions of chains also used in other connectors.

D2-1.2 CB- (MARKER CONNECTOR BUSY) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

D2-1.3 MS- (MARKER START OR PREFERENCE) RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS- relay operation is straightforward. A start signal from an incoming register operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more incoming registers may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last incoming registers (SFD-D204, D205) initiate simultaneous marker requests. Also assume that both start leads are connected to MSO (that is both prefer marker 0). The MSO relay associated with each of the two registers will operate through the MSK cross-connection to ground in the marker. An early make contact on the MSO relay for the first register will provide locking ground for that MSO relay before the break contact on the MSO relay for the last register opens the MSK ground. Thus, both relays will operate and lock.

If, however, the last register initiated a request for a marker slightly ahead of the first register, the MSO relay for the first register could not operate. On the other hand, if the first register initiated a marker request first, a subsequent request by the last register could operate the MSO relay for that frame.

D2-1.4 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain initiates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MSO relay in a reverse direction to the preference MSK chain. Contacts on the MSO relay for the first incoming register are, therefore, enabled to operate connector relays MA- through ME- whether or not any other MSO relay is operated.

Upon operation of the incoming register marker connector relays (MA- through ME-), the MCB- relays of the selected marker are operated over the MB lead (SFD-D206). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-D205). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MSO relay is not released when the associated CBO relay operates.

If two or more MSO relays had operated for different incoming registers, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other marker was available no new MS- relay would operate until some marker became available at which time one or more MS- relays for that marker would operate. This would continue until all registers had been served.

During periods of heavy traffic when all completing markers become busy, a traffic control circuit gates requests by incoming registers for CMs as described in the SFD-D1 section so that all registers requesting service are served once before any register is served a second time.

Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-D205). The release of any one of these relays operates relay TM (SFD-D206) which starts marker timing.

D2-1.5 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-D204)

If only one start lead was provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that register might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, 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 connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay MK provides the necessary transfer.

In the following description, assume that relay TRS (transfer start) is normal. The W and Z relay combination (SFD-D204) operates as follows:

(a) FIRST CONNECTOR USAGE

Marker seizure - Assume that relays MA- through ME- of the incoming register marker connector and W and Z of the preference control circuit are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS cross-connection. Relay MS- causes the operation of relays MA- through ME-. Relay MA- operates relay MK in the preference control circuit (SFD-D204), which in turn operates relay W which locks.

Connector release - When the connector releases, release of the MA- relay releases relay MK which causes the Z relay to operate through the operated W. Relay Z locks operated from the ground of relay W which remains operated but the locking ground for W is now through the operated Z of the released MK. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

Marker seizure - At this time relays MA- through ME- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the MS- cross-connection. Relay MS- causes relays MA- through ME- to operate. The operation of relay MK, this time, opens the locking path of the W allowing it to release.

Connector release - The release of relay MK when the connector releases removes the Z relay holding ground, allow-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 connector usage. For subsequent usages the actions described above repeat.

D2-2 TIMING FUNCTIONS IN THE PREFERENCE CONTROL CIRCUIT

Timing circuits in the preference control circuit, control marker seizure and once the marker is seized, time its overall function. These timing circuits are discussed below.

D2-2.1 TRANSFER START TIMER (SFD-D210)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the IRMC to connect to a CM (unless all CMs are busy). If the connection is not established in this time, the preference control circuit transfers the start leads and gives a TRS signal to the CM to cause a trouble record to be taken showing that there is a transfer start condition.

The operation of the TC2 relay in the IR operates the TM relay (SFD-D210). The TM relay operates the TM1 and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will normally be grounded unless all CMs are busy, in which case operation of the IM relay is delayed until a CM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the connector relays MA- through ME- operate. To check that the connector relays have operated, the MA-relay connects ground to the CKG lead to operate CKG1,2 relays. The CKG2 relay connects ground to the MTFC as a check that the connector relays operate. The MC- relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the preference control circuit. The operated TC and TC1 relays in the PC opens the path to the IM relay (SFD-D210) which stops and recycles the TRS timer.

If a marker is not seized in approximately one second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-D204), releases the TM relay in the preference control, and holds the TM1 relay operated (SFD-D210). The TM relay is released to open the signal leads CWA and TCA (SFD-D210) to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-D210). The TM1 relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TM1 relay. When a marker is obtained over the new start lead, the TM1 relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the IR which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

D2-2.2 OVERALL TIMER (SFD-D207)

An overall timing circuit is provided which sounds the major alarm if an IR calling for a marker has not been connected to one within 4.8 to 10 seconds. It functions as follows: Upon the start of a call, operation of a TC2 relay operates the TM relay in the Preference Control circuit (SFD-D210) concurrently with battery connection to the start leads for marker seizure. The TM relay operates the TM1 relay which starts the overall TM timer (SFD-D207).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay (SFD-D207)from the operated marker multicontact connector relays in the incoming register marker connector circuit. The MK relay releases the TM and TM1 relays. During the releasing time of the TM and TM1 relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TM1 relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not fire. However, should the marker exceed this time because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the IRMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in-use indication for the IRMC. When it remains steadily lighted, it serves as an IRMC alarm indication.

The MK relay releases at the end of the call upon release of the incoming register marker connector circuit multicontact relays, and discharges the A capacitor to recycle the TM timer for the next call.

D2-3 INFORMATION FROM THE IRMC TO THE CM

When the IRMC is operated, it closes through a large group of leads between the register and the marker in order that the register can transmit many pieces of information at the same time. The information transmitted through the IRMC is shown in Table A on the following page.

TABLE A

Information transmitted through the incoming register marker connector is:

A 2/5 - L 2/5, M7	Called Number
LT, FVD	Translator to be used for translating office codes.
OA, OB	Local completion codes, office codes not received with called number. No translation required.
INC	Type of call for incoming trunk calls.
TFU 2/5, FGO-2	Trunk link frame.
TRK, TR2, TRS	First and second trial, and start lead transfer signals.
RO, LR, DCK	Trouble and check signals from the register.
CKG, TM, MB	Marker seizure from the register.
MRL, BT, TRL	Release signals to register for normal, busy, and trouble release.
ECN, OCN	Even or odd register marker connector.

D2-3.1 <u>CALLED NUMBER INPUT FROM THE IRMC TO THE CM, AC2/5 - CC2/5, D2/5 - L2/5,M7 (SFD-D212)</u>

The called number may contain from 1-11 digits, A-L. Each digit is received on a two-out-of-five code basis. There are various numbering plans that can be used, but in general the numbers consist of the following:

(a) 4 numerical digits.

(b) 1, 2, or 3 digit office code, plus 4 numerical digits.

(c) A 3 digit area code, 3 digit office code and 4 numerical digits.

The SCD will discuss (a) and (b).

D2-3.2 TYPES OF TRANSLATORS

The marker provides several types of translators to handle the various offices. The type of translator to be used is always indicated to the CM by the register. The various translator indications are:

(a) Local translator

(b) Toll translator

(c) FVD translator

(d) No translator (OA, OB)

In this section of the SCD the local translation, the five digit translation and the OA and OB (no translation) will be discussed.

D2-3.2.1 LT, Local Translator

This indication requests the CM to use the translator provided for the three digit local office code. This translator is useful on incoming calls when the C digit conflicts with C digits of other office codes in the same marker group.

D2-3.2.2 FVD, Five Digit, Translator

The FVD (five digit) translator is used for an incoming type trunk when translation of only the A digit is required to indicate the office code.

When a call in a connecting office is routed to an office that has more than two office subdivisions (office codes), it may be connected to an incoming trunk that has a FVD incoming class. The sender in the connecting office receives a delete 2 indication (with a seven digit call) from its CM. The sender will outpulse starting with the C digit. The C digit received by the incoming register will be stored in the A reed pack of the incoming register, the D digit from the sender in the B reed pack, etc.

The IR will pass information to the CM on the A 2/5 - E2/5 leads (SFD-D212). Grounds on the A 2/5 - C 2/5 leads will operate the AC 2/5 - CC 2/5 relays. The AC 2/5 relays with the FVD and INC relays operated will operate a local translation, LPA/LPB, etc., relay depending on the office cross-connects (SFD-D211). The operation of the FVD and a local translation relay will operate the N2 relay (SFD-D213). The operation of the N2 relay will allow the B 2/5 leads ground to operate the TH 2/5 relays (SFD-D213). The operation of the TH-, HU-, T-, and U- relays will start NG (number group) seizure as shown on SFD-D402. Although the digit information is passed to the OS on SFD-D213, the CM would not operate the KA-KKL (cut-through) relays except on outgoing type calls (SOG, TOG, etc).

D2-3.2.3 No Translation (OA, OB) (SFD-D208)

A marker group may serve several office subdivisions with number groups associated with each office subdivision.

Incoming trunk calls may reach the marker group with only the numerical digits of the called number. To reach the proper number groups, the incoming trunk indicates to the register, and in turn to the marker the office subdivision to which the call should be completed. The trunk may represent a particular office code and is translated in the incoming register to a certain office subdivision. This arrangement is of value for high traffic between nearby offices as it allows the use of four digit called numbers.

When a call in a connecting office is routed to an office that has trunks dedicated to a particular office subdivision, the incoming class may be OA or OB.

The sender in the connecting office receives a delete 3 indication (with a seven digit call) from its CM. The sender will outpulse starting with the D digit. The D digit received by the incoming register will be stored in the A reed pack of the incoming register. The E digit from the sender in the B reed pack, etc.

The IR will pass information to the CM on the A 2/5-D 2/5 leads (SFD-D212). Grounds on the A 2/5 - C2/5 leads will operate the AC 2/5 - CC 2/5 relays. The operation of the OA or OB relay will operate the N1 relay. The operation of the N1 relay will allow the AC 2/5 leads ground to operate the TH 2/5 relays (SFD-D213). The BC 2/5 leads ground to operate the HN 2/5, etc. The operation of the TH-, HN-, T- and U-relays will start NG seizure as shown on SFD-D402. Although the digit information is shown passed to the OS on SFD-D213, the CM would not operate the KA-KKL (cut-through) relays except on outgoing type calls (SOG, TOG, etc.)

D2-4 DIRECT SIGNALS USED IN CONJUNCTION WITH TRANSLATORS

D2-4.1 RO, REORDER

This condition is caused by a register timeout or register detection of a dialing error.

D2-4.2 LR, LINK RELEASE

A link release trouble is due to failure of the register to receive information from the incoming register link.

D2-4.3 DCK, DOUBLE CONNECTION CHECK (SFD-D113)

With the double connection check is operated in the CM, it indicates that the LR indication was not caused by a double connection at the IRL. The DCK punch indication will be shown when a trouble record is taken in conjunction with the LR and the trouble is not caused by a double connection.

D2-4.4 FIRST OR SECOND TRIAL (SFD-D210)

Ground on the TRK lead indicates to the CM a first attempt to complete the call. If the CM fails to complete the call and a second attempt is possible, the CM grounds the TRL (trouble release) lead to the connector which causes the connector to shift start leads and make a second attempt to complete the call.

On the second attempt the TR2 (second trial) lead is grounded and the second trial relay in the CM operates when the marker is seized. The TR2 relay causes the CM to shift preference circuits, to cancel line tests, and causes a BT or trouble release signal to be sent to the register in case trouble prevents completion of the call.

D2-4.5 TRUNK LINK FRAME IDENTIFICATION (SFD-D211)

The trunk link frame number is in two parts, the frame tens number and the frame units number. The tens number is on a one-out-of-three basis and is designated FG0-2. Frame units is two-out-of-five and is designated TF0,1,2,4,7. This information originates from cross-connects in the IRL and passed to the CM from the IR.

D2-4.6 NUMERICAL DIGIT TRANSLATION

The marker must determine which digits of the called number are the office code digits and which are the numerical digits, in order to operate the correct thousands, hundreds, tens and units digit relays. Since the number received may have 0, 1, 2 or 3 digits in the office code (ahead of the line number), the marker provides the N1, N2, N3 and N4 (number translator cut-in) relays which connect the digits registered in the IR to the TH 2/5, HN 2/5, T 2/5, and U 2/5 relays appropriately (SFD-D213).

D2-4.7 TERMINATING CLASS (SFD-D210)

When an INC class signal is received from the IR the TCCK (trunk class check) relay operates. The operation of the TCCK and the OA/OB or the LPA/LPB, etc, relays operate the TER1,2 relays to indicate that the call is terminating in this office. The operation of the TER1,2 relays cause the FLG (forward linkage ground) relay to operate to cause a linkage from the incoming trunk to a line link appearance to be established as shown on SFD-D603.

D2-5 OPERATION OF THE CKG1,2 GC, GCA, LLC1,2, ONX, TLC1,2 AND BX RELAYS

To provide a large number of off normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; LLC1,2; and TLC1,2 relays will be operated.

The operation of the IRMC MA- through ME- relays will extend ground to the CKG lead and will operate the CKG1,2,4,5,6 relays in the marker (SFD-D210). The CKG- relays provide off normal grounds.

The CKG1 relay will operate the BX and ONX relays (SFD-D209). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the CKG2 relay will operate the TLC1,2 relays (SFD-D209). The TLC1,2 relays provide battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The operation of the CKG4 relay will operate LLC1,2 relays (SFD-D209). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-D617).

D2-6 TEST CALL DIGIT CONTROL (SFD-D217, D218)

On all trunk test classes, when the marker connector relays are operated, the TTL (terminating test line) relay operates. The TTL relay operated, connects the winding of the KA, KB, and KC relays to ground through contacts of any operated A(0-9), B(0-9), and C(0-9) keys or switches (SFD-D212), respectively, and also extends ground to make effective the TTL and BB (busy back) keys (SFD-D217, D218).

The TTL relay operates the K relay which operates the K1 relay (SFD-D217). The K1 is slow operating to allow the slowest K(A-L) relay to operate before continuing the function of the circuit. The operated K1 relay provides ground for the K(A-L) relay contact chain. The last operated K(A-L) relay extends the ground to lead 7 of the next higher lettered digit as an indication to the marker that no further digits are to be expected.

Although any called number can be set up on the A(0-9) through L(0-9) keys or switches, there are certain test numbers which will be used for the majority of tests. An area may have office codes of variable numbers of code digits which means that the numerical digits following a one-digit office code would have to be set on B, C, D, and E keys while the numerical digits following a three-digit office code would have to be on the D, E, F, and G keys.

The TTL key is used to automatically prime the marker with the line number of the terminating test line to the trunk test circuit on IAO and ITNP classes of test which operates the TTL1, TTL3, TTL5, or TTL8 relay depending on the type of terminating test line required.

The TTL key is used to automatically prime the marker with the line number common in the area for the incoming trunk terminating test line circuit on OGT, MISC, and ITDO classes of test which operate the TTL1, TTL2, or TTL7 relay depending on the type of terminating test line required.

The BB key is used to prime the marker with the line number common in the area for a permanently busy line on IAO, ITNP, OGT, MISC, and ITDO classes of test which operates the BB relay.

To use the TTL or BB keys, the office code for the route which includes the trunk to be tested is set up on the called number keys.

A 1-digit code is set up on the A(0-9) key or switch.

A 2-digit code is set up on the A(0-9) and B(0-9) keys or switch.

A 3-digit code is set up on the A(0-9), B(0-9), and C(0-9) keys or switch.

If there is no office code, no called number keys are operated.

When the TTL relay operates, the KA relay operates if any A(0-9) key or switch is operated, the KB relay operates if any B(0-9) key or switch is operated, and the KC relay operates if any C(0-9) key or switch is operated (SFD-D218).

Operation of any TTL- or BB- relay operates the K2 relay which is sufficiently slow-operate to allow time for the KA, KB, and KC relays to operate (if they are going to). The K2 grounds a lead which feeds through transfer contacts of the KA, KB, and KC relays to operate the NA and NA1, number connector, relays (if KA, KB, and KC relays are all normal), to operate NB and NB1 relays (if only KA is operated and KB and KC normal), to operate NC and NC1 relays if only KA and KB are operated and KC normal, and to operate ND and ND1 if KA, KB, and KC relays are operated.

The NA and NA1 relays close the thousands cross-connections of the TTL- and BB- relays to the A leads, hundreds to the B 2/5 leads, tens to the C 2/5 leads, and units to the D 2/5 leads, and grounds the E7 lead. The NB and NB1 relays shift the TH-, H-, T, and U- cross-connections to the B, C, D, and E 2/5 leads, and grounds the F7 lead. The NC and NC1 relays shift the TH-, H-, T-, and U- cross connects to the C, D, E and F 2/5 leads, and grounds the G7 lead. The ND and ND1 relays shift the TH, H, T, and U cross-connections to the D, E, F, and G 2/5 leads and ground the H7 lead.

SECTION D, PART 3

CONNECTION TO THE TRUNK LINK FRAME

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D3 CONNECTION TO THE TRUNK LINK FRAME

When a completing marker has been seized and has received input information through the IRMC, it proceeds to connect to the trunk link frame which contains the incoming trunk.

After the trunk link preference circuit operates, the CM connects to the incoming trunk. Trunk class information is passed from the trunk to the completing marker. The completing marker determines the location of the trunk on the trunk link and operates control relays and select magnets.

D3-1 TRUNK LINK FRAME SEIZURE (SFD-D304)

When the incoming trunk is connected to the incoming register, the trunk link number is transmitted and recorded in the register on the FG0-2 and TFU 2/5 relays (SFD-D1). When the register is connected to the marker through the IRMC, the information is recorded on the marker FG0-2 and TFU 2/5 relays (SFD-D211, D304). The FG- and TFU- relays in conjunction with the TER1 relay closes one of the ST00-29 leads to the TL to operate the preference (MP-/E-) relay, which in turn operates the multicontact connector relays and the marker TFK3 relay.

D3-1.1 PREFERENCE CONTROL CIRCUIT (SFD-D304)

The preference control circuit associated with the trunk link connectors provides two preference relays MP- and E- (marker preference) per marker for each trunk link connector.

There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a trunk link frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to the E- relays.

D3-1.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a TL), MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP relay winding which is connected through the MP-operate chain to ground at the winding of the first relay in the operate chain.

In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assuming that the first and last markers in the preference chain initiate simultaneous request for connection to the same TL, both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

D3-1.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, two work chains determine which MP- relay does the work. The work chains progress through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, one work chain ground will operate the M trunk link connector relay whether or not other MP- relays are operated. The M relay operates other connector relays by closing through battery supplied by the marker.

The second work chain grounds the CK lead to the marker which has gained access to the trunk link frame to operate the TFK3 (trunk frame check) relay in the marker.

When the marker which has seized the TL has finished its job and opened the start lead to the preference control, its MP relay is released. If there are any other operated MP relays, the next MP relay in the work chain which is operated now functions as just described. This continues until all operated MP relays have been served.

D3-1.1.3 Emergency Transfer

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that MP relays are active. When all MP relays are normal, ground through all break contacts of the operate chain is connected to one side of the CH relay winding. The ground through all break contacts of the work chain which operated connector relays is connected to the other side of the CH relay winding. The CH relay cannot operate with ground on both sides of its winding. When one or more MP relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK, and MC leads from MP relays to E relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP chain if the TR key is normal or to the E chain if the TR key is operated.

D3-1.1.4 Manual Transfer

By operating the TR key, located at the trunk link connector control frame, preference control can be manually transferred from the MP to the E relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP relays.

D3-2 TRUNK SEIZURE (SFD-D306)

On INC type calls, trunk seizure is straightforward. The trunk that initiates the request and information where the trunk is located on the trunk link frame is passed to the completing marker. The actual connection of the marker to the trunk is as follows.

The operated TFK3 relay connects battery to the F lead through the IRMC and the IRL to operate the F relay of the trunk involved on the call. The F relay, in operating, operates its associated FA-- or FB-- relay in the trunk link frame so that operating and test leads may be cut-through to the marker.

* Although the CH lamp is shown as part of the trunk link connector circuit, it and the alarm release key are located on a frame designated as "trunk link connector control".

D3-3 LOCAL TERMINATING CLASS (SFD-D306)

Local terminating class of calls require that an indication be sent to the completing marker to determine which office the call will complete to. An incoming trunk RCA/RCB to RC-- cross-connect at the TL (SD-27879-01) and the KT to ONN-9NP cross-connect at the TL (SD-26032-01), through the operated FA-- or FB-- relays, is the source of trunk class relay (ONN-9NP) operation in the marker. These relays in the marker do triple duty as originating trunk recorder numbers, pulse conversion trunk OS class, and incoming trunk office indication and type of supervision. Table A shows the terminating class information and its component parts.

TABLE A

TERMINATING CLASS

SD-27879-01	SD-26032-01	RECORDER NO.	SUPERVISION*	OFFICE**
RC09	9NP	9	N	P
RC08	8SP	8	S	P
RC07	7RN	7	R	N
RC06	6NT	6	N	T
RC05	5ST	5	S	T
RC04	4NE	4	N	E
RC03	3NA	3	N	A
RC02	2SA	2	S	A
RC01	1SE	1	S	E
RC00	ONN	0	N	N

* N - No supervision required on free numbers

S - Supervision required

** P - Physical

T - Theoretical

E - Extra-theoretical

A - All 5-7 digit incoming

D3-3.1 NUMBER SERIES GROUP

A marker group is arranged to handle a maximum of six office codes spread over six number series with a maximum of 40,000 numbers.

A maximum of three discriminating treatments by office codes is permissible within a number series group. The local completion discriminating marks for a 5, 6, or 7-digit terminating connection are LPA, LTA, and LEA for number series group A and LPB, LTB, and LEB for number series group B. For a 4-digit incoming connection the incoming trunk group discriminating marks are 8SP or 9NP, 5ST or 6NT and 1SE or 4NE, with a nondiscriminating mark 2SA or 3NA. For a 4-digit incoming connection the number series group mark is 0A or 0B.

D3-3.2 SUPERVISION REQUIRED

Supervision may be required to insure that a called line answer indication is transmitted back to the calling office so that a charge can be made.

Supervision is in the form of a tip and ring reversal caused by the operation of the trunk, T, relay.

To operate the T relay, trunk classes (8SP, 5ST, etc.) redirect free number ringing combinations to set the ringing switch to level 6. Ringing combination 6 insures that the trunk, T, relay operates on called line answer and disallows a free number (no charge) termination.

D3-3.3 NONSUPERVISION REQUIRED

Terminating classes (9NP, 6NT, etc.) are used when the call is free (not billed).

Free number NG ringing combinations 08 and 09, together with no-supervision trunk classes, set the ringing switch to level 8 which does not provide operate ground for the trunk, T, relay.

D3-4 OPERATION OF CONTROL RELAYS AND SELECT MAGNETS IN THE TRUNK LINK (SFD-D307)

When the F relay in the trunk is operated, it operates an FA-- or FB-- relay. The FA-- or FB-- then operates a LV0-9 relay. There is one LV0-9 relay associated with each of the levels (horizontals) of the trunk switches.

Assume that a B appearance is involved and the FB-- relays operates. When one FB-- and one LV-- relay operates, several leads are connected to the marker through the TLC. These are the following:

(a) The FBK informs the marker that the trunk is on the B appearance and checks the operation of the FB-- relay.

(b) The BST connects the crosspoint sleeve into the marker for test purposes when crosspoints are being set up.

(c) The BSM connects the associated directing and trunk select magnets into the marker.

(d) The BLC connects an operating circuit, for the link connector relay associated with the trunk switch in which the trunk appears, into the marker.

If the A appearance is involved, the leads would be FAK, AST, ASM, and ALC respectively.

SECTION D, PART 4

CONNECTION TO THE NUMBER GROUP FRAME

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D4 CONNECTION TO A NUMBER GROUP

In a No. 5 crossbar office, there is no permanent or prearranged association of directory numbers with switch positions on the line link frames. A marker upon receiving the number for a terminating call must determine which one of the many switch verticals in the office is associated with that particular directory or trunk number so that a connection may be established. The marker obtains this information from the number group frame. This frame is a large central memory kept up to date with the latest directory number assignments, to which each marker in turn applies for the necessary translation.

D4-1 CAPACITY OF THE NUMBER GROUP

The No. 5 crossbar marker group is equipped for a maximum of 40,000 numbers (directory and trunk) arranged for six number series, as follows:

Number Series Group A	Number Series Group B
No. Series 0	No. Series 1
No. Series 2	No. Series 3
No. Series 4	No. Series 5

Each 1000 directory numbers comprise a number group. A marker group can accommodate 40 such number groups or a total of 40,000 directory numbers including trunk numbers. Number groups are provided to fill the needs of the respective number series and should be considered as independent of number series groups. The frames are numbered as they are added from 00 through 39.

D4-2 NUMBER SERIES START, NSSO-5 (SFD-D407)

The number series start relays are used to direct the completing marker to a start lead to seize a number group frame.

Ground is extended through the relays in the completing marker associated with the directory number of the called customer to be translated. This is a check that the two-out-of-five relays have operated which are the U2/5, T2/5, HN2/5, and TH2/5. The ground also extends through local translation relays, for 5- and 7-digit calls or through terminating class relays if the incoming call is 4 digits.

When the TFK3 relay (SFD-D302), the SNG2 (SFD-D408) and TH2/5 relays operate, the MP- (marker preference) relay in the number group preference control and make-busy circuit operates (SFD-D409). This seizes the NGC (number group connector), which connects the marker to the NG by operating the connector multicontact relays. The connection to the NG by the marker is checked by the operation of the NGK and NGK1 relays and their associated punches.

In offices where unused hundred series of numbers exist in a number group, a second thousand series of numbers in the same office code group may be put into the NG to use the unused hundred series of numbers. In such offices, the ST- terminal associated with the added thousand series is cross-connected to the AS terminal and causes the operation of the AST (additional start), relay. Battery is then extended through the AST relay and an NSS- relay to an ASTO-5 terminal, which is cross-connected to the ST- terminal of the NG containing the partially used series. The MP- relay associated with the marker then operates (SFD-D408,D409).

D4-3 OFF NORMAL CONTROL

When the FLG (forward linkage ground) relay and local translation relays operate, the completing marker operates relays that will control information to and from the number group.

The FLG operates the SNG1,2 relays. These relays control the operation of the MCB-MCE relays in the NGC (SFD-D408) and in conjunction with the HN-, TN-, and U- relays will operate translation relays in the number group (SFD-D410). The local translation relays, LPA/LPB, etc, will operate the LLI (line link idle) relay, the NGC (number group control) relay, and the UC (units cut-in) relay to further control the translation of the called directory numbers to a line location and ringing combination.

D4-4 PREFERENCE CONTROL CIRCUIT (SFD-D409)

The preference control circuit associated with the number group connectors provides two preference relays MP- and E- (marker preference) per marker for each number group connector.

There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a number group frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to the E- relays.

D4-4.1 MP- RELAY OPERATE CHAIN

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a NG), MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain.

In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first and the last markers in the preference chain initiate simultaneous request for connection to the same NG. Both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

D4-4.2 MP- RELAY WORK CHAIN (SFD-D409)

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, the work chain ground will operate the number group connector, MCA, relay whether or not other MP- relays are operated. The MCA relay operates the MCB-MCE relays by closing through battery supplied by the marker.

When the marker which has seized the NG has finished its job and opened the start lead to the preference control, its MP-relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated now functions as just described. This continues until all operated MP- relays have been served.

D4-4.3 EMERGENCY TRANSFER (SFD-D409)

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that the MP- relays are active. When all MP- relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding. The ground through all the break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP- relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the ST-, TMB, and MC leads from MP- relays to E-relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

D4-4.4 MANUAL TRANSFER

By operating the TR key, located at the connector control frame, preference control can be manually transferred from the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR-relays to transfer preference back to the MP- relays.

D4-5 NUMBER GROUP TRANSLATION

After seizing the number group, the marker connects -48 volts through resistance lamps, to the hundreds, tens, and units leads, as determined by the operated HN-, TN-, and U- relays, to select one terminal from the 1000 sets of number terminals. The number group translates the directory number, represented by this one terminal, into line location and ringing combination and passes this information to the marker.

* Although the CH lamp is shown as part of the number group connector circuit, it and the alarm release key are located on a frame designated as "number group connector control."

D4-5.1 HUNDREDS BLOCK, HB0-9 (SFD-D410)

A HB0-9 relay in the NG is associated with the hundreds digit of the called number. Battery is extended to the NG over the HB0-9 leads associated with the HN2/5 relays to operate a HB0-9 relay in the NG.

D4-5.1.1 Rate Treatment Discrimination (Physical, Theoretical, and Extra-Theoretical Numbers) (SFD-D411)

The operation of the NG HB0-9 relay places ground on the PT cross-connection terminal associated with the HB relay. The cross-connections for the PT terminals are made in accordance with the cross-connection information shown in the NG. These cross-connections provide discriminating marks which are designated PN, TN, EN and PTN or if the number is part of an added thousand series, the designations are PN1, TN1, EN1, and PTN1. If the PN1, TN1, EN1, or PTN1 terminal is grounded the marker compares this fact with the operated AST relay. If they do not agree, the blank number thousands relay operates. The information received from the number group (PN,TN, EN, or PTN) is matched against the local completion relay information that the marker used in selecting the NG. If a match is made, the PTK relay operates (SFD-D411).

D4-5.2 TENS BLOCK, TB00-99 (SFD-D410)

A TB00-99 relay in the NG (associated with the tens and hundreds digit of the called number) is operated to indicate the 100 groups of ten directory numbers in which the called number is located. The PN, TN, EN, or PTN relay closes battery to the NG over the one TB0-9 lead associated with the operated T2/5 relays. The TB- lead is extended in the NG through the HB- relay contacts to operate the one TB00-99 relay associated with the tens digit and hundreds digit of the called number. The marker TBW (tens block wetting) relay, operates in series with the NG TB- relay and checks that the operate path has been completed.

D4-5.2.1 Tens Block Screening Provided

When tens block screening is provided, cross-connections are made in the number group so that TBS1/4 relays in the number group operates in series with the TB-- relay. This indication is passed to the marker to operate the corresponding TBS- relay in the marker (SFD-D410). The particular TBS- relay that is operated can screen certain ringing combinations to give four different meanings to each ringing combination depending on the group of tens blocks in which the line is located.

D4-5.3 UNITS NUMBERS, U0-9 (SFD-D413)

A U0-9 relay in the NG is operated when the NGC relays close the U0-9 leads from the marker to the NG. Battery is closed through the operated U2/5 relays, and through the UC (units cut-in) relay, in the marker to one of the U0-9 leads to the NG. The operation of the NG U- relay extends ground over the UK lead to the marker, operating the UK (units check) relay, which checks that the NG units relay has operated.

D4-5.4 TRANSLATED INFORMATION PASSED TO THE COMPLETING MARKER (SFD-D414)

Each of the 1000 numbers in a NG has three terminals designated L, G, and F. Each of the 1000 numbers also has three separate fields of cross-connection terminals. These three fields consist of the LL, VHG, and RF terminals. The translator gives information about the called number over two sets of leads from each cross-connection.

The hundreds, tens, and units digit transmitted to the NG by the marker determine which set of L, G, and F terminals are connected to battery from the marker over the WL, WG, and WF leads.

The L terminals is cross-connected to an LL- terminal, which extends battery over the FT0-5 leads and FU0-9 leads to cause operation of the proper FTN0-5 (frame tens number) relay, and FUN0-9 (frame units number) relay in the marker.

The G terminal is cross-connected to a VHG- terminal, which extends battery over the HG0-9 leads and VG0-11 leads to cause operation of the proper HGN0-9 (horizontal group number) relay, and VGN0-11 (vertical group number) relay in the marker.

The F terminal is cross-connected to an RF- terminal, which extends battery over the RC1-15 and VF0-4 leads to cause operation of the proper RCN1-15 (ringing combination number) relay, and VFN0-4 (vertical file number) relay in the marker.

This information is then stored on the corresponding FTT-, FUT-, VGT-, HGT-, VFT-, and RCT- relays which lock through their associated FTL, FUL, VGL, HGL, VFL, and RCL relays located on SFD-D415, D417.

To check that the lock relays operate, the LA (lock auxiliary) relay operates in the marker (SFD-D417). To check that one and only one line location relay has operated, the HTK1, VTK1 and FTK1 relays operate and ground the associated punch (SFD-D417).

D4-6 INTERCEPT TREATMENT

The marker connects the calling line to intercept under the following conditions:

(a) A blank number is called.

(b) A changed or disconnected number is called.

(c) A temporarily disconnected number is called.

(d) A number associated with the line link appearance of a trunk is called.

(e) The physical and theoretical match is not made.

The conditions listed above cause the operation of one of the intercept relays listed below:

(a) BN - This causes the calling line to be connected to a no-such-number tone trunk or a machine intercept announcement.

(b) RI - This causes the calling line to be connected to a regular intercept trunk.

(c) OVC/PMO - This causes the overflow tone ringing condition to be set up on the ringing selection switch.

(d) RIP - This causes the calling line to be connected to a PBX recorded announcement.

D4-6.1 BLANK NUMBER AND REGULAR INTERCEPT

Some of the intercept conditions listed above are enabled by removing one or more number group cross-connections as described in paragraphs SCD-D4-6.1.4 and D4-6.1.5. In order to determine if intercept is required, the marker starts the TYM timing circuit when relay HTUK operates (SFD-D411). If the called number is not to be intercepted, it is translated, the number group released, and the TYM timer recycled before the end of the timing period. Under this condition the call proceeds in the usual manner. However, if the called number is to be intercepted, the TYM timer times-out and operates the TYM and TYMA relays (SFD-D403, D411).

The operation of relay HTUK removes ground from the secondary winding of the TYM and the short circuit from the TYM1,2 capacitors. This permits the TYM1,2 capacitors to charge through the secondary winding of the TYM relay and TYMO resistor. After an interval of time, the capacitor will be fully charged and the current flow through the secondary winding will cease. The TYM relay then operates on its primary winding in series with the TYM1 resistor.

The operation of relay TYM operates the TYMA relay, which extends ground through the nonoperated line identification relays to the intercept cross-connection terminals (SFD-D419).

D4-6.1.1 Called Number Associated with Unequipped Number Group

When the called number thousands digit represents an unequipped NG, the marker proceeds with its functions up to the selection and seizure of a NG. Then, when the marker extends battery to an ST- lead, a NG is not seized. The battery on this ST- lead is extended to the associated ST- cross-connection terminal. This ST- cross-connection terminal is cross-connected to the BNTH cross-connection terminal, thereby extending battery to operate the blank number thousands or hundreds BNTH relay (SFD-D408, D411).

D4-6.1.2 Called Number Associated with Blank Hundreds Group

When the called number is one of a blank hundreds group, the marker proceeds until NG translation is required. Then, the operation of the number group HB- relay extends ground to the PT cross-connection terminal in the NG. When the hundreds group has only blank numbers, the PT cross-connection terminal is cross-connected to the BNK terminal in the NG thereby, extending ground over the BNK lead to operate the BNTH relay in the marker (SFD-D411).

The operation of the BNTH relay extends ground to the BTI cross-connection terminal. These terminals are cross-connected to the BN, RI, or RO cross-connection terminals (SFD-D419).

D4-6.1.3 Called Number is a Changed or Disconnected Number or is an Individual Blank Number that is Treated as a Disconnected Number

When the called number is a changed or disconnected number, or is an individual blank number that is treated the same as a disconnected number, the marker proceeds with its functions until NG translation is required. However, in the NG, the cross-connections to the L-, G-, and F- cross-connection terminals for this called number are omitted. Therefore, the called line identification relays in the marker do not operate. The operation of the timer extends ground to the NI cross-connection terminal which is cross-connected to the appropriate intercept relay (SFD-D419).

D4-6.1.4 Called Number is an Individual Blank Number that is Treated Differently from a Disconnected Number

When the called number is an individual blank number or an unassigned number, and it is treated differently from a disconnected number, the marker proceeds with the connection until NG translation is required. In the NG, the cross-connections to the L- and F- terminals are omitted, but the G- terminal associated with the called number is cross-connected to the VHG- terminal. Battery is extended through the NG and operates the VGN- and HGN- relays in the marker. The VGN- and HGN- relays cause the VGL and HGL relays in the marker to operate as described in SCD-D4-5.4.

The TYM timing circuit functions as described. Upon timing out the TYMA relay extends ground to the GI cross-connection terminal through the operated VGL and HGL relay contacts and the nonoperated VFL, RCL, FTL, and FUL relay contacts. This terminal is cross-connected to the RI or BN terminals depending on the type of intercept treatment desired (SFD-D419).

D4-6.1.5 Called Number is an Individual Number that is Temporarily Disconnected

When the called number is an individual number that has been temporarily disconnected, the marker proceeds with the connection until NG translation is required. In the NG the G- and F- cross-connection terminals are cross-connected to the VHG- and RF- terminals. The cross-connection to the L- terminal in the NG is omitted. Marker relays VGL, HGL, VFL, and RCL are operated as a result of these cross-connections in the NG and the FTL and FUL relays in the marker are nonoperated.

Since a complete NG translation cannot be made the TYM timer times-out and operates the TYMA relay. The TYMA relay causes ground to be extended through the operated VGL, HGL, VFL, and RCL relay contacts, and the nonoperated FTL and FUL relay contacts to the TI cross-connection to the RI or BN terminals for the desired intercept treatment (SFD-D419).

D4-6.1.6 Physical and Theoretical Match

If the physical and theoretical check between the trunk class or local completion relays and the output of the number group does not match, ground is placed on the NMI punching. This terminal is cross-connected for the desired intercept treatment (SFD-D409, D419).

D4-6.2 TROUBLE INTERCEPT CONNECTION

When the marker determines that a connection to the called number cannot be completed because the customer's line is out-of-service, the marker connects the calling customer to a trouble intercept trunk. The trouble intercept trunk connects the calling customer to an operator.

The trouble intercept trunks terminate on the LL. Therefore, in setting up a trouble intercept trunk connection, a connection is established from the LL associated with the trouble intercept trunk to the TL associated with the ITR or TER trunk.

D4-6.2.1 Call to a Non-PBX Number

If the call is for a non-PBX number, the line out-of-service is plugged-up on the MDF. When the line is plugged-up, battery on the ring conductor and ground on the tip connector indicate to the marker that the call should be routed to a trouble intercept trunk.

D4-6.2.2 Call to a PBX Number

On calls to nonhunting numbers, which are plugged-up, the marker distinguishes the plugged-up condition by finding the proper potential on the tip and ring conductors. This method cannot be used on calls to hunting numbers, because improper operation of the PBX may present a condition on the tip and ring conductors that looks to the marker like the plugged-up line signal.

If it is desired to take out of service one or more lines, but not all lines of a PBX line group, those lines that are to be removed from service are made busy. The marker in performing the terminal hunting functions selects only those lines in the PBX line group that are idle or not made busy. The marker operation for this condition is similar to that described for terminal hunting covered in SCD-D4-7.

If it is desired to take out of service all of the lines in a PBX line group, they are all made busy, except the first PBX line, which is the directory number. The G- and F- cross-connection terminals in the NG which are associated with the first PBX line, are disconnected. Therefore, the marker, in performing the NG translation, recognizes that only the L- terminal is cross-connected in the NG and a connection to a trouble intercept trunk is established.

The marker proceeds to the usual manner until NG translation is received. In the NG, the cross-connections to the G- and F- cross-connection terminals are omitted and only the L- terminal is cross-connected to the LL-terminal. Battery is extended through the NG to operate the FTN- and FUN- relays in the marker, and the FUL and FTL relays, in the marker are operated.

The marker starts the TYM timing circuit when the HTUK relay operates, and a time-out results. The TYMA relay, in operating, extends ground through the operated FUL and FTL relay contacts and nonoperated VGL, HGL, VFL, and RCL relay contacts to the winding of the PUL relay, which operates. The PUL relay operates the trouble intercept TBL relay to start a connection to a trouble intercept trunk (SFD-D419).

D4-6.3 VACANT AND DENIED CODE INTERCEPT

The marker is arranged to intercept unused or vacant codes usually contained in the area numbering plan and certain codes denied to specific types of incoming trunks because of rate discrimination. Incoming trunks with only trunk link frame appearances may be arranged to return reorder on vacant or denied line numbers, or these trunks may be arranged to set vacant or denied line numbers to intercept trunks on the line link frame.

Denied or nonworking code points (in some cases screened through the S relay) that enter the marker group over incoming trunks are either cross-connected to operate the DCI (denied code intercept) relay, or the VCI (vacant code intercept) relay. The operation of the DCI or VCI relay will operate the BN and RI relays respectively, as well as the TER1-2 relays which marks this call as a terminating call, the BN relay with the DCI relay operated will operate the DCIA (denied code intercept auxiliary) relay. The RI relay with the VCI relay operated will operate the VCIA (vacant code intercept auxiliary) relay. The call then progresses as a terminating call that has encountered a blank number or regular intercept condition. The marker transmits the DCIA or the VCIA line number information to the number group and obtains from it the line link frame location of the intercept trunk. This intercept trunk link number is placed on the HB-, TB-, and U- leads to the NG by associated cross-connections (SFD-D410, D413).

D4-7 TERMINAL HUNTING (SFD-D406)

Terminal hunting is the function performed by the CM (completing marker) and NG (number group) in searching for an idle line or trunk in a group of lines or trunks. If the called line or trunk is busy, another line or trunk within the group may be selected.

Terminal hunting is used when more than one line or trunk is grouped with one number such as:

(a) A number used to identify a PBX line group.

(b) A number used to identify a group of trunks appearing on line positions and used for calls requiring regular or trouble intercept.

(c) A number used to identify a group of trunks appearing on line positions and used as a routing for calls where the dialed number is a blank number.

Lines in a terminal hunting group require different treatment in the NG than nonterminal hunting lines as follows:

(a) All the lines in a terminal hunting group must use the same office code.

(b) A nonallotted terminal hunting group may be distributed among several tens and hundreds blocks, but must remain within one NG.

(c) The cross-connection for the G, L, and F terminals in the NG are the same for terminal hunting and nonhunting lines. However, for terminal hunting the F terminal is always cross-connected to an RF terminal associated with ringing combination RC10.

D4-7.1 PBX HUNTING

On PBX lines, the CM and NG proceed to translate the called directory number into equipment location and ringing combination in the same manner as for a non-PBX line. However, after the equipment location and ringing combination of the called line have been received, the CM recognizes from the ringing combination that terminal hunting is required. Ringing combination RC10 is used to indicate that a line is in a terminal hunting group.

When the CM recognizes RC10, it releases the called line location identification relays. The CM and NG then proceed with the selection of an idle line. To allow the CM and NG to hunt for an idle line within the terminal hunting group, the sleeve conductors within a tens block are extended to the CM. The CM tests these conductors for an idle condition (battery through the line hold magnet is recognized as an idle indication) and selects an idle line. The NG then transmits to the CM the line location information of the selected line.

D4-7.1.1 Hunting Within One Tens Block

The circuit operation for a call to a terminal hunting line is the same as that for a nonhunting line up to the ringing combination indication. The CM operates the RCN10 and RCT10 relays indicating ringing combination ten is to be used (SFD-D415). The PBX1-2 relays operate, indicating that the directory number is in a PBX (Private Branch Exchange) terminal hunting group (SFD-D418).

To extend the sleeve conductors of lines in a PBX group to the marker, a number group SC- relay is provided for each tens block. In addition, a TBA relay is provided for those tens blocks that have more than one PBX group (SFD-D425). In tens blocks where lines of a single PBX appear, the SC- relay operates in parallel with the NG TB00-99 relay.

In tens blocks where more than one PBX appears, the NG TBA relay operates with the tens block relay. The selection of the proper SC- relay is determined by the TBA and U0-9 relays. The SLCK (sleeve check) relay is closed through to the NG over the SCK lead and operates to check the operation of the NG SC- relay (SFD-D425). The SLCK relay operating:

(a) Operates the SAC (SA- connector) relay allowing registration of idle line information (SFD-D418).

(b) Locks under control of the GB (group busy) relay released.

(c) Operates the CKO (check relays operated) which release the LLI (lock line identification) relay and the SNG1,2 relays (SFD-D419, D408).

The line identification and NG multi-contact relays release. After the line identification relays are released, the CKR (check release) relay operates to prepare for the new line identification and provision is made, through the CKO relay make contact, to operate the RYT for recycling the WT timer (SFD-D418).

D4-7.1.2 Sleeve Test

The NG SC- relay extends the sleeves of the lines over the S0-9 leads to the marker SL0-9 (sleeve test) relays (SFD-D424). Cross-connections are provided to connect the sleeves of lines within a terminal hunting group. If the line is busy, ground is applied to the sleeve lead, or if the line is idle, battery is applied through the LL hold magnets. Therefore, an SL0-9 relay in the marker operates for each idle line within the selected tens block. A set of SA0-9 relays records those PBX hunting lines that are idle at that time (SFD-D424). To prevent any interference from other PBX lines that may become idle after the sleeve test, the SA- relays operated, operate the SAE (sleeve auxiliary end) relay, which releases the SAC relay (SFD-D418), opening the SA- relay operate path. The lowest numbered operated SA- relay, equal to or greater than the called number units digit closes its U- lead to the NG (SFD-D413). The SAE relay operated also reoperates the SNG1,2 relays which reoperate the NG multi-contact relays (SFD-D408). The NG now proceeds to provide a translation for the idle PBX line.

D4-7.2 BLOCK HUNT/SELECT OPERATION (SFD-D406)

Where lines of a terminal hunting group are distributed over one or more tens blocks, the CM and NG first test for an idle line in the first tens block. Where the hunting group is confined to a single tens block, and all lines of the hunting group are busy an EG (end of group) relay operates to inform the CM that no further hunting should be attempted (SFD-D425). The GB (group busy) relay also operates and causes the call to be connected to a tone trunk (SFD-D413).

Where more than one tens block is involved in the hunting group and no lines are idle in the first tens block, the CM and NG advance to another tens block. In this manner, all terminal hunting lines within all tens blocks of the hunting group can be tested until an idle line is found. Advancing from one tens block to another can be accomplished by the BLOCK HUNT or BLOCK SELECT method, depending on which of these features is used.

In the block hunt method, after the CM has determined that no idle lines of the terminal hunting group exist in the tens block being tested, it advances to another tens block. The CM then hunts through this tens block. The order of advance is predetermined by cross-connections in the NG.

In the block select method, after the CM has determined that no idle lines of the terminal hunting group exist in the tens block being tested, it tests for a tens block having idle lines of the terminal hunting group and selects the tens block. The order of advance is predetermined, but it is contingent on the existence of idle lines in a tens block.

The completing marker A(advance) relay operates from the SLCK relay and locks under control of the SCR (SC- release check) relay normal (SFD-D418, D425). The A relay operated prepares for block hunt or select to allow selection of a second tens block. The operation of the A relay extends battery over the OA lead to the A cross-connection terminal in the NG. By means of NG cross-connections A to AD or A to AS, the A relay or SA (sample) relay operates for either block hunt or block select, respectively (SFD-D425). To check the operation of either of these relays, ground is extended over the AK lead to the marker which operates the AK (advance check) relay (SFD-D418).

The A or SA relay in the NG operates so that if there are no idle PBX lines within the first tens block, the CM is able to select a second tens block in the hunting group.

To provide sufficient time for any SA- relays to operate from the first tens block, the AK relay operates the TYMA (SFD-D411). When the TYMA relay operates, and if none of the SA- relays are operated, the GB relay operates to indicate that all lines within the first tens block are busy (SFD-D413). The GB relay causes the release of the NG hundreds and tens block relays by removing the battery from the LHB lead (SFD-D410) and ground from SCK lead (SFD-D425), to the NG. This also causes the release of the SLCK relay (SFD-D425) when the CM advances to test the lines associated with the hunting group in the second tens block, it must be able to select any one of the lines regardless of the number dialed. The UT (units transfer) relay operates to start the hunting, beginning with the first line in the tens block (SFD-D420). This is done by transferring the operating path of the NG U0-9 from the control of the CM U2/5 relays to the UT relay (SFD-D413).

The CM SCR relay has been shunted by the NG SC relay operated. The release of the SC relay is thus checked by the operation of the SCR relay. The SCR relay operates in series with the winding of the NG A or SA relay, which was previously operated and releases the CM A relay.

If the NG is arranged for block hunt operation, battery on the OTB lead is extended from the CM to operate a predetermined TB- (tens block) relay and an SC- relay associated with the second tens block of the hunting group. If block select operation is used, the NG TB- and SC- relays operate in tens block in which idle lines of this terminal hunting group appear.

The CM GB relay releases and causes the SLCK relay to reoperate over the SCK lead. This checks the operation of the NG SC- relay for the second tens block. The CM and NG then test for an idle line in this tens block of the hunting group in the same manner as previously described.

Whether the NG is arranged for block hunt or block select operation, it is possible that all lines of the terminal hunting group in the second tens block are busy. In block hunt operation, since selection of a second tens block is predetermined by cross-connections, it is possible that all lines in the second tens block are busy prior to its selection. In block select operation, where a second tens block is chosen on the basis that idle lines appear there, it is still possible for another CM to make a connection to the last idle line in the tens block during the interval of selecting the second tens block and the start of hunting by this CM.

If all the lines of a terminal hunting group are found busy, the NG and CM advance from tens block to tens block until informed by the CM EG relay operation that the last tens block of the hunting group has been reached. When arranged for block select operation and all lines are found busy, the EG relay operates immediately and no further hunting is attempted.

Where lines are found idle during the hunting operation, the CM SA0-9 relays operate to identify these lines. The SAE relay operates to signal the NGC (number group connector) relays to reoperate and close through the U0-9 leads to the CM. The NGK1 (number group check) operates over the W lead to check the additional operation of NG multicontact relays. During first trial calls with the TR1A relay operated, the selection of the NG U0-9 relay is made through the lowest numbered SA0-9 relay operated. Under second trial conditions, the selection is reversed through the highest numberes SA0-9 relay operated. With the units number recorded in the NG the CM is able to proceed with a translation of the number of the selected line into its associated equipment location (SFD-D413).

D4-7.3 PBX ALLOTTER (SFD-D404)

The PBX allotter feature provides means of recognizing calls to as many as 10 PBX terminal hunting groups. The lines of each terminal hunting group may be distributed over as many as 8 NG's. The lines of a PBX terminal hunting group are referred to as an allotter group, and the lines of this allotter group may be referred to as belonging to line groups on each NG containing lines of the allotter group.

As many as 5 such line groups, each associated with a different allotter group may appear on one NG. Only 4 of the possible 10 allotter groups may have lines distributed over 8 NG's. The other 6 allotter groups must have its lines confined to 4 or less NG's.

In these offices equipped with the PBX allotter feature, the CM first examines the called number to see if the number is an allotted directory number. Only directory numbers can be so recognized. If the number is allotted, the marker tests for an idle line in the same line group of this allotter group before seizing a NG. When the marker subsequently seizes the NG containing an idle line, it is prepared to hunt for the idle line.

If a call is made to a number in the allotter group other than the directory number, the CM does not recognize it as an allotted number, and treats it as an ordinary PBX line. In this case, the NG is seized first and ringing combination 10 indicates a PBX line. The marker then proceeds to select an idle line by the terminal hunting operation as described in SCD-D4-7.1.

D4-7.3.1 Identification of Allotted Number

Various operating grounds for the allotter operation are supplied by the ANON (allotted number off-normal) relay, which is operated by the CKG6 relay, when the marker is seized (SFD-D420).

The marker is arranged to handle a maximum of 40,000 lines distributed over as many as six number series. To indicate the office number series of a called number, the marker operates one NSS0-5 relay. An ALS0-5 (allotter start) relay is operated in parallel with the NSS- relay and starts the PBX allotting functions for the particular office number series (SFD-D407).

Where particular office number series do not contain any allotted numbers, cross-connections are provided for seizure of a NG without any allotter functions. The ALS0-5 cross-connection terminal is cross-connected to the NAN terminal for those number series containing no allotted numbers. This cross-connection provides a saving of marker holding time when no allotting is necessary in a particular number series.

Where office number series contain allotted numbers, the PBX allotter must first determine if the called number is or is not in an allotted hunting group.

An allotted directory number is indicated by the operation of the AN (allotted number) relay (SFD-D423). The ANA0-9 relay, operating in series with the AN relay, indicates the hunting group to be selected. The PBX allotter feature is canceled for special calls when the SPL1 relay operates.

To direct the marker in selecting the particular ANA0-9 relay that contains the directory number, the thousands THT0-9, hundreds HBT0-9, and tens TBT0-9 cross-connection terminals are cross-connected to the ATH-, AHB-, and ATB- terminals, respectively (SFD-D421, D423). The directory number units digit is always zero.

As an indication of whether the allotted number is distributed over a maximum of 4 or 8 number groups, the 4NG or 8NG relay operates from the ANA- relay (SFD-D423).

To provide for auxiliary contacts for the ANA- relay, the ANB0-9, ANC0, 4, 5, 9 and AND0, 4, 5, 9 relays are provided. They operate when the ANA0-9 relay operates (SFD-D423).

D4-7.3.2 Allotted Number Timing

Sufficient time must be allowed for the operation of the AN and ANA- relays if the called number is in an allotted hunting group.

The allotted start ALS0-5 relay operates the ADVA (allotted number series auxiliary) relay which in turn operates the ANT (allotted number timer) relay (SFD-D407, D420). The operate time interval of these two relays allows enough time for the AN and ANA- relays to operate if the number is allotted. If the called number is in an allotted hunting group, the ANT relay operates the ANS relay.

Failure to operate the AN relay, by the time the allotter timing relay ANT operates, causes the operation of the NANS (nonallotted number series relay). This indicates that the called number, within the number series containing allotted numbers, is not an allotted hunting group. For this condition the start battery for seizure of the NG is extended through the operated ANT relay contacts and nonoperated AN relay contacts (SFD-D408). The NG is then seized in a manner similar to that used when no allotted PBX is provided.

D4-7.3.3 Allotted Number Operation and Busy Test

If the called number is an allotted directory number, the allotter tests to determine which number groups have idle lines, and then causes the CM to select one of these number groups for service. This arrangement saves CM and NG holding time, since the CM causes line busy to be returned to the calling customer without seizing a NG when all lines of the PBX are busy. The CM is then provided with the thousands, hundreds, tens, and units digit information of the first line of this allotted PBX in the selected number group. To accomplish the seizure of an idle NG after the allotter has determined that the called number is allotted, relay ANS operates the NAR1,2 (no allotter recycle) relays. The NAR2 closes ground to operate the CKO relay. The start battery path through the allotter for seizure of the selected NG is closed when CKR relay operates the PBX1 relay.

The operation of the ANA-, ANB-, ANC-, and AND- relays close the windings of the NGTA-H (number group test) relays to the AN- leads of all number groups of an allotted hunting group. If all the lines in a number group in this allotted PBX are busy, battery is extended from the NG over the AN- lead operating the associated NGTA-H relay (SFD-D421). The operated NGTA-H relay indicates that all the lines are busy by operating the AB relay.

An NGA-NGH terminal is cross-connected to an AN- terminal for each NG with which the allotted number is associated. There is one AN- test lead for each NG. When the marker is arranged to work with nonwire-spring-relay type number groups, there is a maximum of four PBX allotter groups per NG; therefore, four test leads, ANO-3, are extended to the marker. When arranged to work with wire-spring-relay type number groups, five test leads, ANO-4 are extended to the marker. These leads permit a maximum of five PBX allotter groups to be served by one number group.

The PBX allotter selects one of a maximum of 8 line groups, A-H, contained within the allotter group, by the operation of NGSA-H (number group selected) relay (SFD-D422). The ANS relay furnishes a ground to the NGSA-H relays through normal contacts of the line group test relays NGTA-H. The selection of the preferred allotter line group is controlled by the NS1 to A1-H1 cross-connections.

If all lines in all number groups in this allotted PBX are busy, the ground, which otherwise operates one of the NGSA-H relays, is extended to operate the AB (all allotted number busy) relay. The operation of the AB relay indicates that busy tone should be transmitted to the calling customer. The AB relay operated also extends ground over one of the OVFO-9 leads to operate an overflow traffic register.

D4-7.3.4 Listed Directory Number Line Group Selected

If the NGSA relay has operated, the selected NG contains the directory number. For this condition the marker selects and controls the NG in accordance with the dialed number. The marker extends battery over the NG start (STO-9) lead, through the operated TH2/5 relays corresponding to the thousands digit of the dialed number, and through the selected NSSO-5 relay contacts. The number group MP- relay operates after relay PBX1 has operated (SFD-D408, D409). Battery is also extended over the HB0-9 and TB0-9 leads, through the operated HN2/5 and T2/5 relay contacts, respectively. The HB0-9 relay and TB0-9 relay that operate correspond to the hundreds and tens digit of the dialed number. An AN (allotted number) relay is connected in parallel with the TB- relay in the NG for the directory number tens block only. The AN relay operates in parallel with the TB- relay in the NG and extends ground back to the marker over the ANK lead to operate the AHG (allotted hunting group) relay (SFD-D420). With the AHG and NGSA relays operated, battery is extended to the UO lead for the units digit information. The first trial TR1A relay is operated and one or more SA0-9 (sleeve test auxiliary) relays are operated to cause the marker to hunt from 0 to 9 for the first idle line (SFD-D424).

D4-7.3.5 Other then Listed Directory Number Line Group Selected

If an NGSB-H relay operates, the selected NG does not contain the listed directory number. THe PBX1 relay closes the start lead corresponding to the thousands digit of the first line in the B-H number groups, to operate the MP- relay in the number group.

The NGSB-H relay and the ANA-, ANB-, ANC-, and AND- relays control the selection of the NG hundreds and tens block relays. Battery is extended over the HB0-9 and TB0-9 leads corresponding to the hundreds digit and tens digit, respectively, of the first line of the hunting group in the B-H number groups. These leads are extended to the NG to control the selection of the NG hundreds block and tens block relays. With the AHG and NGSA nonoperated, battery is extended over the UO lead for the units digit information.

D4-7.3.6 Recycle (SFD-D405)

Conditions that cause recycle are:

(a) CM fails to find an idle line when hunting in the NG.

(b) CM finds the chosen line busy when testing the line at the LL. This may occur if another marker selects the line between PBX idle test and line busy test.

(c) CM finds it necessary to reroute the call to intercept or no-such-number trunk.

(d) CM finds the selected NG made busy.

(e) CM finds the LL made busy.

(f) CM encounters a failure to match.

When the CM encounters a recycle condition the NG is released.

The ANR (allotted number recycle) relay operates the ANR2 relay which in turn releases the operated NGSA-H relay. This causes the release of the thousands, hundreds, tens, and units information.

After the marker has completed this recycle, the ANR1 relay operates and again initiates the selection of a NG containing the allotted PBX by reoperating an NGSA-H relay. The preference for operating the NGSA-H relays is changed by the operation of the ANR2 relay (SFD-D420).

D4-7.3.7 Test Call Functions

The TNA (test number group allotter) relay is operated from the master test control circuit when it is desired to operate the NGTA-H relays for a test call. The TNA relay extends the operating circuit for the NGTA-H relays to the master test control circuit. By the operation of associated keys in the master test control circuit, the NGTA-H relays may be operated for test calls.

D4-7.3.8 Trouble Detecting

(a) If an allotted hunting group is falsely identified as a nonallotted hunting group, the marker detects this condition while terminal hunting in the first tens block of the NG. Under this condition, the ANS relay in the marker is nonoperated. Since the hunting group is allotted, the NG grounds the ANK lead to operate the AHG relay in the marker. Therefore, with the ANS nonoperated and the AHG operated, the XAH (cross allotted hunting group) relay is operated. The operation of the XAH relay indicates failure for the first trial only. For second trial, this trouble detection feature is canceled by the operation of relay TR2B. This opens the XAH relay operating circuit and results in the completion of the call.

    The XAN trouble recorder card indication is punched, but the AN indication is not punched, when this type of failure occurs. This indicates that the call has progressed into or beyond NG seizure.

(b) The marker is prevented from completing the connection when false allotting of a nonallotted hunting number occurs. This condition is detected while hunting in the first tens block of the NG. For this condition the NGSA relay is operated, but the AHG relay is nonoperated; therefore, the operating path of the units digit relay in the NG is opened, resulting in a marker time-out.

The AN trouble recorder card indication is punched, but the U- indication is not punched. This indicates that the number should not be treated as an allotted number, and that the call has progressed into or beyond NG seizure.

(c) A crossed allotted number is indicated by the operation of the XAN relay when the ANA0-9, ANB0-9, ANC0, 4, 5, 9 and AND0, 4, 5, 9, relays, associated with two or more hunting groups, are operated. This prevents seizure of any NG by opening the operate circuit to the NGSK relay and results in a marker time-out. Both the XAN and AN trouble recorder card indications are punched, indicating that the call has not progressed to NG seizure.

When both a nonallotted and allotted number identification is made, the XN relay operates. This produces a trouble record card on which the XN indication is punched.

When more than one number series identification is made, the XNS relay operates. The XNS relay operates the XN relay, which causes a trouble record to be taken. The XN indication is punched.

D4-8 VERIFICATION OF PBX LINES OR OTHER LINES HAVING RC10 CROSS-CONNECTION IN THE NUMBER GROUP (SFD-D426)

The MTC provides means for detecting omitted or transposed sleeve cross-connections on lines having RC10 number group cross-connections.

In order to gain access to both ends of the number group sleeve cross-connection, the marker is directed to complete a connection to the line, but is prevented from operating the line hold magnet. The release of the number group is delayed to allow access to the line end and the number group end of the sleeve at the same time.

The MTC then tests both ends of the sleeve for battery (line idle condition). If both ends of the sleeve have battery, the MTC applies ground to the line hold magnet end of the sleeve and awaits removal or shunting of battery at the number group sleeve. (This may be the direct shunting of the line hold magnet battery or may be controlled through an auxiliary line circuit.)

If battery is removed at the number group end of the sleeve, MTC removes the ground at the line hold magnet end and awaits restoration of a line idle (battery) condition at the number group end.

D4-8.1 SLEEVE CHECK VERIFICATION

When the RC10 key is operated, operation of the LV relay operates the VER6 relay of the MTC to prepare it for verification of the sleeve cross-connection from the line hold magnet to the number group.

The VER6 relay operated, closes leads MT10, MT19, and HTR to signal the marker to extend the S(0-9) leads to the number group, to delay the release of the number group, to open the operate path for the line link frame select magnets, and to handle calls on a heavy traffic basis.

The VER6 relay operates VER7 which extends the S(0-9) lead, corresponding to the units digit of the number being verified, through the operated D(0-9) key or switch by way of the marker to the number group.

When the marker connects to the number group and the S(0-9) lead has been closed to the NS punching corresponding to the number, the NST relay operates if there is battery on the lead. (It should be noted that operation of the NST at this time indicates only that there is battery from some source on the NS punching. It may or may not be associated with the proper line hold magnet.)

When the marker connects to the line link frame, the marker operates the LHM relay which simulates a line hold magnet. The LST relay of the MTC is connected to the actual line hold magnet and, if the line is idle, operates to the line hold magnet battery (provided the NST relay has operated to provide ground to the winding of the LST relay).

If the LST operates, it operates the LI (line idle) relay which grounds the LHM lead, shunts down the LST relay, operates the line hold magnet, and extends ground to the number group sleeve (directly or by way of an auxiliary circuit which causes the battery at the number group sleeve to be shunted or removed). This ground shunts down the NST relay.

With both LST and NST normal, the NS relay operates to remove ground from the LHM lead. The NST relay should reoperate immediately if there is a direct sleeve cross-connection or after a short interval if auxiliary circuits are cross-connected between the line sleeve and the number sleeve. If battery is restored at the number sleeve, NST operates, closing ground to winding of LST which reoperates to battery from the line hold magnet and in turn operates the SLK relay which locks and lights SLK lamp as a sleeve check indication. If a trouble record card is taken, the CMC designation is punched as a sleeve check indication. If the sleeve and all other cross-connections check, the MLVM lamp is lighted and LVM designation is punched.

In order to be able to operate the line hold magnet and check the sleeve independently of tests which the marker makes on the line links, the marker is prevented from operating the line select magnets so that, upon operation of the line hold magnet, no crosspoints are closed.

D4-8.2 SLEEVE CHECK FAILURE

If both the NST and LST relays operate initially and operate the LI relay, indicating an idle line condition, the LI relay starts the SLKT timer to allow an interval of 1.05 to 1.6 seconds for sleeve check verification to allow for operation of certain slow auxiliary circuits.

Upon operation of the DCT relay by the marker, either the MLVM or MLVF relay operates depending on whether all check relays (other than sleeve check) operated or one or more of them is normal.

If MLVM operates, the circuit awaits either operation of the SLK relay indicating sleeve check or the SLKT relay as a result of failure to check within the allowed time interval. In either event, a trouble record is taken only if the REC key is operated. The verification of cross-connections other than sleeve is indicated by the CK lamp, or the CMA punch on the card. THe MLVF lamp is lighted and the LVF designation is punched if the sleeve fails to check.

If MLVF operates because of other than a sleeve check failure, an immediate trouble record is produced, the MLVF lamp is lighted, and an LVF designation is punched.

SECTION D, PART 5

CONNECTION TO LINE LINK FRAME

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D5 CONNECTION TO LINE LINK FRAME

The LL (line link) containing the called line is seized to enable the marker control of the desired select and hold magnets. An LL seizure is also necessary whenever a connection to a called line location on a tandem type call is required. This connection is referred to as FLG (call forward linkage). The FLG is used on an INC TER (incoming terminating), TAN (tandem), and IAO (intraoffice) type calls.

D5-1 LINE LINK FRAME SEIZURE (SFD-D502, D504, D505)

On INC TER calls the seizure of the LL is made after the TL (trunk link) and NG (number group) have been selected. If trouble is encountered in the progress of the call, at this point, the CK punch will be an indication that the proper TL selection is made (SFD-D302). The NGK punch indicates the marker has seized the NG and operated its marker cut-in (MCA) relay (SFD-D402). The LFS battery from the CM is applied to the LL-ST lead through the operated LLC2, PTK, RCL, FLG1, FUT-, and FTT- relays in the CM to the ST- lead of the LLC-PC (line link connector preference control) circuit operating the MP- relay and associated LLC multicontact relays. The LFK punch is an indication that all LLC relays have properly operated.

D5-1.1 PREFERENCE CONTROL CIRCUIT (SFD-D505)

The preference control associated with the LLC provides two preference relays, MP- (marker preference) and E- (emergency) marker preference, per marker for each LLC. There is a means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by two chain circuits, which enable connections of one marker at a time to an LL frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to E- relays.

D5-1.1.1 MP- Relay Operate Chain

In periods of very light traffic, (assuming only one marker at a time applies start battery to bid for seizure of a LL) MP- relay operation is straightforward. Start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operated chain to ground at the winding of the first relay in the operate chain. In periods of heavy traffic two or more markers may initiate request either simultaneously or in rapid succession.

Assume that the first CM and the first DTM initiate simultaneous request (apply start battery) for connection to the same LL. Both MP- relays will operate and lock. If, however, the first DTM had initiated a request slightly before the first CM, the MP- relay for the first CM could not have operated because ground for its winding would have been opened by the operated chain at the MP- relay for the first DTM. On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain can subsequently operate its MP- relay.

D5-1.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain starting with ground at a contact of the MP- relay for the first CM. If the MP- relay for the first CM is operated, the work chain ground will operate the M- LLC relay whether or not other MP- relays are operated. The M- relay operates other M- relays in the connector by closing through battery supplied by the marker.

When the marker which has seized the LL has finished its work and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated, now functions as just described. This continues until all operated MP- relays have been served.

D5-1.1.3 Emergency Transfer

Two sets of preference relays (MP- and E-) are provided in the preference control, either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR- relays are normal so that MP- relays are active. When all MP- relays are normal, ground through all break contacts of the operate chain is connected to one side of the CH relay winding, and ground through all break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP- relays are normal, one side of the CH relay winding will have ground and the other side will have resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other side and will operate.

If the CH relay operates even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK-, and MC- leads from the MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

D5-1.1.4 Manual Transfer

By operating the TR key, the preference control can be manually transferred for the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP- relays.

D5-2 LINE LINK FRAME CONTROL NONPAIRED OPERATION (SFD-D507)

The marker obtains access to the LL frame through the preference control and make-busy circuit and LLC circuit.

On an FLG linkage, a translation is necessary from the number group to translate the called customers number into the line location on the LL. This location is registered on the FTT-, FUT-, VGT-, HGT-, and VFT- relays in the marker as shown on SFD-D417.

With the seizure of the TL and the information received from the NG the marker can now close battery to the ST- lead to seize the LLC (SFD-D504, D505). The FTT-, and FUT- relays determine the LL and the VGT-, HGT, and VFT relays determine the customers line location on a particular switch.

The marker will place HGB resistance battery on the HG- lead corresponding to the horizontal group number which it obtained from the NG. The operation of the MA1 relay in the LLC will extend the HG- lead to operate the HGA- and HGB- relays in the LL (SFD-D507).

The marker will place VGB resistance battery on the VGB- lead corresponding to the vertical group number which it obtained from the NG. The operation of the MA1 relay in the LLC will extend the VGB- lead to operate the VGB- relay in the LL (SFD-D507).

With the HGA-, HGB-, and VGB relays operated, a path is closed from the LG- relay to the BS lead. However, the BS lead does not have battery connected to it by the marker until the marker receives ground on the

HGK lead. The purpose of this is to insure closing the operating current of the LG- relay in the marker rather than through the HGA-, HGB-, or VGB- relay contacts so that protection can be provided on the basis of one per frame instead of one per LG- relay. The VGB- relay will operate before the closure of lead BS occurs.

D5-2.1 CROSS DETECTION (SFD-D507)

The marker employs the operate test to detect trouble on the HGA-, HGB-, LG-, or VGB- relays in the LL. If, for some reason, more than one HGA- or HGB- relay operated in the LL, the XHG relay would operate in the marker. This condition would stop progress of the call. The HGK punch would not be present on a trouble card.

If, for some reason, more than one LG- relay operated in the LL the XLG relay would operate in the marker. The operation of the XLG relay would produce the XLG trouble punch.

If, for some reason, more than one VGB- relay operated in the LL the XVGB relay would operate in the marker. The operation of the XVGB relay would extend ground to operate the XAVG relay in the marker and produce the XVGB trouble punch.

D5-3 PAIRED LINE LINK FRAMES

Paired line link operation is possible on all types of linkage except dial tone. Before paired line link operation can be applied to a marker group, the junctor groups must be wired as one of the following sizes, 60LL-30TL, 40LL-20TL, 20LL-10TL.

An auxiliary LL frame consists primarily of ten 200 point crossbar switches split into the right and left halves. The verticals of the right half are multipled to the junctor switch verticals of the even numbered line link frame while the horizontals serving these verticals become an extension of the line links of the odd LL frames. A similar transposed appearance of even frame links and odd frame junctors exist on the left half. In effect, linkage is provided from the line switches of one line link frame to the junctors of its mate.

D5-3.1 PAIRED LL FRAME AUXILIARY LL FRAME IDENTIFICATION (SFD-D508)

In a particular office, the marker recognizes a paired line link frame by the presence of solid ground on the LFK lead when the associated line link connector is operated. This ground operates the marginal PRL and LFKA relays. The LFKA in turn operates the LFK relay. A nonpaired LL frame will have resistance ground on its LFK lead, in which case only the LFKA relay operates. Relay LFKA operated operates the LFK relay and marker operation continues.

Relay PRL operated operates PRLL relay and also operates the PRLLA relay (if provided). These relays have no effect until a channel test is made. With 10TLF relay operated, and no channels available, the operate path for the FMP relay is diverted by the PRLL relay to the STP relay. Relay STP operated, with the sequential release of GC relay and operation of STP3 relay, initiates the junctor step. Subsequently, STP1 relay releases and relay STP2 operates. Relay JG0 releases and JG1 relay operates.

D5-3.2 PAIRED LL FRAME MATE SEIZURE (SFD-D508)

Relay STP3 operated (with PRLL relay operated and MFK relay normal) operates the STPA relay. Relay STPA operated locks around the contact of MFK relay, and places resistance battery on the MPP lead toward the LLC. This MPP lead connects to the MPP relay in the line link preference control circuit of the mate LL frame.

Relay MPP operated has two functions:

(1) It closes its contact in the work preference control circuit in order to seize the auxiliary LL frame when preference is gained.

(2) It closes solid ground toward the LLC for the LL frame associated with that preference control circuit. If this particular LL frame should have its connector closed to some other marker, solid ground on the MFK lead will operate the MFK and MFL relays in that marker, opening the operate path for the STPA relay and preventing that marker from attempting mate operation.

When preference is gained in the mate LL frame preference control circuit, the auxiliary LL frame associated with this pair of LL frames is seized. Relays operate in this frame to cut through the select magnet leads from the LL frame to the select magnets of the auxiliary frame junctor switches. The choice of select magnets will be controlled by the horizontal group relays in the LL frame, and will correspond to those select magnets which are chosen on the LL frame junctor switch.

Seizure of the auxiliary LL frame will transmit resistance ground on the MFK lead through the connector to the marker. Relay MFK alone operates and with STPA relay operated, completes the operate path for the TK relay.

During this time the STP2 and JG1 relays, in combination with the PRL and PRLL relays operated, have selected the opposite half of the trunk switch, and reoperated those relays, such as the PNR (pattern normal) relay, in the junctor step and control circuits in preparation for channel test. With the operation of the TK relay, channel test is again made.

D5-3.3 PAIRED LL FRAME AUXILIARY LL CONTROL (SFD-D509)

When the MPP relay operates, it places ground on the LV lead to the auxiliary LL frame, through the operated HGB- relays of the LL frame. This ground will operate a LV- relay and a EV or OD- relay in the auxiliary LL frame. The numerical designation of the LV- relay operated will be the same as the HG- relay operated in the LL.

The operation of the LV- relay and the EV or ODD relay will parallel the select magnets on the auxiliary LL frame with the select magnets on the original LL frame. The operation of the EV or ODD relay will close a resistance ground to the marker over the MFK lead as an indication of mate frame lockout and select magnet cut-through.

D5-4 PAIRED LINE LINK FRAME - MARKER GLARE CONDITION (SFD-D508)

There is a possibility that two markers could have simultaneous calls to mated LL frames. As described previously, the marker expects a resistance ground on the MFK lead as an indication that the MPP relay has the work preference in the preference control circuit. If there is another marker in the mate LL frame also attempting a mate frame lockout, both markers would receive direct rather than resistance ground on the MFK lead. Both markers would recognize direct ground on the MFK lead as a glare condition and set the trunk to overflow.

D5-5 PAIRED LL FRAME AUXILIARY LL - MAKE BUSY (SFD-D508)

The auxiliary LL frame is made busy by inserting make-busy plugs into both the MBO and MBE jacks. A make-busy plug in either the MBO or MBE jack will indicate to the marker, when it is attached to the LLC, that the LL is nonpaired rather than paired.

D5-6 CLASS OF SERVICE (SFD-D502, D510, D511)

Class of service progress information for incoming terminating class of calls is shown on SFD-D502, D510, and D511. Although class of service is not required by the CM for controlling the INC call, the class of service is required to control dual voltage operation to operate the line hold magnets. Dual voltage is the application of 178 volts to the hold magnets.

Dual voltage operation of line hold magnets equipped for message register service may cause false operation of the message register. Accordingly the marker must operate all line hold magnets used with lines that are equipped with message registers, using only 48 volts.

Lines equipped with message registers are indicated to the marker over the class of service leads from the LL. The class of service indication is received over the CS00-29 leads which in turn are cross-connected to operate the CNA (coin line auxiliary), MRA (message register auxiliary), or AOA (all other auxiliary) relays. The operation of CNA or AOA relays operates the DVO relay which in turn operates the DVA relay indicating that the marker should use dual voltage to operate the line hold magnet. The operation of the MRA indicates 48 volts operation for the line hold magnet.

For more detailed information of 20, 30, 60, and 100 classes of service see SFD Section C or E.

SECTION D, PART 6

CHANNEL SELECTION, HOLD MAGNET OPERATION AND RINGING SELECTION SWITCH CONTROL

Index

D6 NETWORK CONNECTIONS

Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL (line link), and the junctor switch and trunk switch crosspoints on the TL (trunk link). The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Following hold magnet operation, the channel is checked for crosses, continuity, and double connections. The NG (number group) is released and the ringing switch crosspoints are operated (SFD-D602, D603).

D6-1 CHANNEL ARRANGEMENTS

A channel is made up of a line link, a junctor and a trunk link, which are tested, selected and treated as a unit when establishing a connection between a line and a trunk or between two trunks.

The line links consist of the line switch banjo wiring, the line junctor switch banjo wiring, and the wiring between these switches.

The trunk links consist of the trunk switch vertical unit, the trunk junctor switch vertical unit, and the wiring between the two switches.

The junctors consist of the line junctor switch vertical unit, the trunk junctor switch banjo wiring, and the wiring between the line junctor and trunk junctor switches.

The marker in selecting a channel, tests a maximum of ten channels at a time. The CHT- (channel test) relay tests a line link, a junctor, and a trunk link with numbers corresponding to the CHT- relay numbers. These tests are made simultaneously. Ground on any of the test leads operates a CHT- relay to indicate a busy channel. The channel number corresponds to the junctor switch number 0-9 on both the LL and the TL, the horizontal level 0-9 on the LL line switch, and the vertical number of the trunk switch on the TL.

D6-1.1 JUNCTOR SEQUENCE CONTROL (SFD-D606,D607)

The number of junctors in a junctor group may vary from a maximum of fifty junctors to a minimum of ten junctors. Since the marker is equipped to simultaneously test a maximum of ten channels and, therefore, to test a maximum of ten junctors, each junctor group is subdivided into junctor subgroups consisting of ten or less junctors. The marker selects those junctors within one junctor subgroup when testing for an idle channel. The selection of the subgroup of ten or less junctors is, in general, determined by the following factors:

(a) The number of TLs in the marker group as indicated by the 2-10 TLF relays.

(b) The LL number.

(c) The junctor sequence position JSQ 0-5 which is used to equalize and rotate the traffic among the subgroups.

(d) The junctor step STP1/2 position.

The selected subgroup of junctors is assigned to the ten channels so that the numerical designation of the junctor switch on both the LL and the TL to which the junctor connects is also the numerical designation of the channel of which the junctor is a part.

The junctor sequence walking circuit is shown on SFD-D607. A sequence chart showing the advance of the walking circuit on successive calls is shown on SFD-D606.

In the beginning of the call when the CKG4 relay operates, CKG4 in turn operates the LLC1,2 (Line Link Control) relays. If the sequence circuit is in an even position (JSQ0,2 or 4 and JLO operated), the LLC2 relay operates the JSO relay which locks. When the LLC2 relay releases at the end of the call, the next higher numbered odd JSQ- relay operates, and, in turn, operates the JLE relay. The JLE relay releases the JSQ-, JLO and JSO relays. Similar operation occurs when stepping from an odd to an even JSQ relay.

Six steps of control for preference circuits are provided by the JSQ 0-5 relays. This number is doubled by the operation of the SQ0 and SQ1 relays. If the SQ1 relay is normal when the JSQ0 relay operates, the SQ0 relay operates. If the SQ1 relay is operated when the JSQ0 relay operates, the SQ0 relay releases. Similarly, the SQ1 relay is operated or released depending on the condition of the SQ0 relay when the JSQ2 relay operates. The SQ0 relay is operated for one complete cycle of the walking circuit, then released for one complete cycle. The same applies to the SQ1 relay. However, since the SQ0 is operated and released by JSQ0, and SQ1 is operated and released by JSQ2, there are steps during which SQ0 and SQ1 may both be operated or both released.

The SQA relay monitors operations of the junctor sequence walking circuit. If the SQA relay operates as a result of trouble in the walking circuit, it operates the MXT (master cross test) relay which causes a trouble record to be produced showing an SQA trouble punch.

The following conditions cause operation of the SQA relay which is a slow operate relay to prevent false operation due to momentary closures as relays change conditions. The SQA relay operates the MXT relay which operates the TR1 relay to cause a trouble record to be taken showing an MXT and an SQA punch. The MXT is not shown on a single-sided card.

Trouble conditions detected between calls (LLC2-normal) occur when:

(a) Both JLE and JLO are normal

(b) Both JLO and JSO are operated

(c) Both JLE and JSE are operated

Trouble conditions detected during calls (LLC2 operated) occur when:

(a) JLO is operated and JSO is normal

(b) JLE is operated and JSE is normal

(c) SQ0 and SQ1 are both operated or both are normal when JSQ1 is operated

(d) SQ0 is operated and SQ1 is normal or SQ0 is normal and SQ1 is operated when JSQ1 is operated

When the fuse which supplies battery to the walking circuit is inserted, the SQA relay will operate because the JLE and JLO relays are both normal. When the SQA relay operates, it operates the JSQ0 relay which operates the JLO relay which should release the SQA relay if there is no trouble in the walking circuit. This will cause a trouble record to be taken which will show an MXT punch, but no SQA punch unless the SQA remains operated because of trouble. The MXT is not shown on a single-sided card.

D6-1.1.1 Control of Junctor Sequence by Master Test Control (SFD-D607)

With one of the JSQ0-5 keys or switches operated and the KCH relay operated, the MT8 relay of the marker is operated after the master test frame connector has operated the MT relay of the marker. The MT8 relay of the marker operated, releases the operated JSQ0-5 relay of the marker by opening its locking circuit. The released JSQ- relay releases the JLE or JLO relay of the marker and the released JLE or JLO in turn operates the KJSQ relay. The KJSQ relay closes ground from a back contact of the MT8K relay through the operated JSQ0-5 key or switch to operate the corresponding JSQ0-5 relay of the marker. This operates the JLE or JLO relay of the marker which removes ground from the KJSQ lead to release the MT8 relay of the marker whose operate path has been transferred to the KJSQ lead by the KJSQ relay of the test circuit when it operated and locked to ground on the KCH relay operated. The MT8 relay normal, closes the MT8K lead to operate the MT8K relay of the test circuit. The MT8K relay operated, locks to the KCH relay, removes ground from the JSQ0-5 lead, and extends ground to operate the MC relay. With all JSQ0-5 keys normal or the switch in the off position, or with the KCH relay normal the junctor sequence relays of the marker function in a normal manner.

If no JSQ0-5 key or switch is operated, the MTF lead to the marker is open and the MT8K lead is closed to the MC relay through normal contacts of the JSQ0-5 key or switch. The KCH relay normal bridges the MT8K lead around contacts of the JSQ0-5 keys or switches.

D6-1.2 OFFICE SIZE TRUNK LINK FRAMES (SFD-D607)

A cross-connection in each CM from the SZD terminal to one of the terminals SZ2-10 indicates the size of the office in terms of the number of single trunk link frames in a nonpaired office, number of pairs of trunk link frames in a paired office, or number of trunk link frame triples in a triple office.

During transition from one size office to another, some trunk link frames may have a junctor pattern for one size office while others have a different size office junctor pattern. In this case, the SZA, SZB and SZC terminals are cross-connected to appropriate SZ2-10 terminals in each marker, and the G terminal of each trunk link frame is cross-connected to SZA, SZB or SZC terminals as required. These cross-connections are changed in individual trunk link frames as the transition progresses. Upon completion of the transition, the SZD terminal of each CM is cross-connected to the SZ2-10 terminal corresponding to the new office size.

D6-1.3 SINGLE PAIRED OR TRIPLE TRUNK LINK FRAME OPERATION (SFD-D610)

A cross-connection in each CM from the SPF terminal to the SF, PR, or TTF terminal indicates to the CM whether the office is arranged for single, paired, or triple trunk link frame operation. During transitions, however, from single to paired, or paired to triple-trunk link frame operation, the marker cross-connections are removed and cross-connections are made in each TLC. A frame which has not been modified might be cross-connected as a STF (single trunk link frame) while another frame which has been modified might be cross-connected as a PR (paired trunk link frame).

D6-1.4 OFFICE SIZE LINE LINK FRAMES (SFD-D610)

The marker determines office size in terms of number of line link frames from a combination of the office size in terms of trunk link frames (SCD-D6-1.2) and the indication of single, paired, or triple trunk link frame operation (SCD-D6-1.3). The 20F relay operates for 1-20 line link frames, the 40F relay for 21-40 line link frames and the 60F relay for 41-60 line link frames.

D6-1.5 PATTERN UNITS (SFD-D604)

In the following size offices all junctor subgroups have 10 junctors.

2TLF	Single, paired or triple.
2-3TLF	Single, paired or triple.
5TLF	Single, paired or triple.
10TLF	Single, paired or triple.

All other sizes have some junctor subgroups with less than 10 junctors.

To determine which junctors are equipped, one P0-9 (pattern unit) relay is operated in the CM. The SFD-D604 shows how a particular pattern unit relay is operated for TL0 in an office having single TL operation. It also shows particular pattern unit relay operation for either TL of TL pair 0 in an office having paired TL operation. Also shown is a particular pattern unit relay operation for any TL of TL triple 0 in an office having triple TL operation. The choice of a pattern unit relay is determined by the line link frame number (FUT0-9 relay and FTB0-3 relay operated) and the line link office size relay 20F, 40F, or 60F operated.

D6-1.6 NUMBER OF JUNCTOR SUBGROUPS (SFD-D608,D609)

This applies only to 6 TLF and 7 TLF size offices. Both of these office sizes have some junctor groups with two, and other junctor groups with three junctor subgroups. With either relay 6 TLF or 7 TLF operated, relays P0, 2, 3 and 4 operate the 3G (3 junctor subgroup) relay while relays P4-9 operate the 2G (2 junctor subgroup) relay.

D6-1.7 QUAD RELAYS (SFD-D610)

The 7Q (seven quad) relay is used only in paired or triple trunk link frame offices of the 7 TLF size. The RQ (regular quad) relay is used only in paired or triple trunk link frame offices of 6TLF, 8TLF or 9TLF sizes. The term "quad" no longer has a valid meaning since triple trunk link frame operation came into use. Essentially, these relays provide a convenient and more economical method of steering the JC- leads (SFD-D613) than by using contacts of TLF for a particular size offices.

D6-1.8 PATTERN TENS (SFD-D605)

The PNR relay is always operated by the following office sizes which have no subgroups of less than 10 junctors.

2TLF	Single, paired or triple
2-3TLF	Single, paired or triple

5TLF Single, paired or triple

10TLF Single, paired or triple

The PNR relay is also operated for certain other office sizes when the marker is directed by the operated or released condition of the STP1, STP2, and JSQ relays to junctor subgroups having 10 junctors. When the marker is directed to subgroups having less than 10 junctors, one of the pattern tens relays PA, PB, PC, or PE is operated.

D6-1.9 TEST CHANNEL RELAYS - TEST CHANNEL CHECK (SFD-D614,D617)

The marker determines which channels are equipped in a subgroup by operating one, two, etc. or all TCHO-9 relays (SFD-D614). The PNR relay operates all ten TCH- relays. The combination of one pattern tens and one pattern units relay operates only those TCH- relays corresponding to equipped junctors.

The operation of any TCH relay operates the TCHK relay (SFD-D617) which locks to the operated CHA relay.

D6-1.10 JUNCTOR SUBGROUP SELECTION (SFD-D608,D609)

To simplify the path for operation of the JG relays, SFD-D608 shows operate paths for offices with 2, 2-3, 5, or 10 TLF-size while SFD-D609 shows operate paths for all other sizes 3, 4, 6, 7, 8, and 9. Note on SFD-D608 that only the JG0 relay can be operated for the 10TLF size since there is never more than one junctor subgroup. For the 5TLF size either JG0 or JG1 relay may be operated. For the 2-3TLF size, JG0 or JG3 relays may be operated. For the 2TLF size, JG0-JG4 relays may be operated. Since no pattern units relay is required for these office sizes, the 1-out-of-10 check of the P- relay is bypassed.

Office sizes 3, 4, 6, 7, 8, and 9TLF each have one or more junctor subgroups with less than 10 junctors and, therefore, must operate a pattern unit relay. Ground for operating the JG-relays is provided through a 1-out-of-10 check of pattern unit relays, and if the office has triple trunk link frames, a similar check through pattern auxiliary relays.

For any size office, the STP1 relay (SFD-D617) is always operated at the beginning of a call. If no idle channel is available in the junctor subgroup selected through the STP1 relay, the STP1 relay will be released and the STP2 relay operated to operate a different junctor subgroup, JG- relay. This applies to all sizes except 10TLF which has only one junctor subgroup.

The walking circuit is stepped to a new position at the end of each call for office sizes having more than one junctor subgroup. Different subgroups are given preference according to which JSQ0-5 and JLE or JLO relays are operated.

D6-1.11 JUNCTOR SUBGROUP CONNECTOR RELAYS (SFD-D617, D610)

The GC or GCA relay in some cases with triple trunk link frame operation (SFD-D617) operates early in the call from the LLC1 relay. The operated GC or GCA relay steers battery through contacts of an operated JG0-4 relay to operate a junctor subgroup connect relay G0-4 in the trunk link connector (SFD-D610). A one-out-of-five check through the JG0-4 relay ensures that only one relay is operated. To detect crossed G-leads to the TLC, normal JG- relays ground associated leads. If the lead associated with the operated JG- relay is crossed to any other lead, the direct ground causes sufficient current to flow through the XJG relay to operate it. The XJG relay is biased to not operate on the current required to operate the G- relay in the TLC. If the XJG relay operates, it in turn operates the XAJG relay which locks and causes a trouble record showing XJG punch to be taken.

D6-1.12 JUNCTOR CONNECT RELAYS - JUNCTOR CONNECT CHECK (SFD-D613, D619)

Junctor connect relays JC0-9 are associated with regular trunk junctor switches. Relays JC10-19 are associated with extension trunk junctor switches. Relays JC20-29 are associated with supplementary trunk junctor switches. The JC0-9 leads are partially closed by the previously operated G0-4 relays in the TLC.

The path for operating the JC- relays is shown on SFD-D613. Battery is supplied through the primary winding of the XJC relay so that the XJC relay is connected to ground through more than one JC relay winding. The XJC relay is biased through its secondary winding. If more than two JC leads are crossed or grounded, the current through the primary winding is sufficient to overcome the bias of the secondary and operate the XJC relay. When the XJC relay operates, it operates the XAJC relay which causes a trouble record showing a XJC punch.

When the G0 relay in the TLC is operated, JC0-9 leads from the marker are closed through directly to the JC0-9 leads, respectively, to the TL. However, relays G1-G4 close the JC0-9 leads from the marker to cross-connection terminals G10-19, G20-29, G30-39, and G40-49. The cross-connections required are different for each office size and vary between TLC associated with different TL in the same office.

To steer the activated JC lead to the proper JC0-9, JC10-19, or JC20-29 relays, the marker operates an RF, EF, or SEF relay (regular, extension, or supplementary extension frame, SFD-D612). Battery to operate one of these relays is fed through the winding of the XF relay which is biased to operate if the RF, EF, or SEF leads are grounded or crossed so that the XF relay supplies current to more than one relay. If the XF relay operates, it operates the XAF relay which causes a trouble record showing an XF punch.

The JC0 relay (SFD-D621) connects to the sleeve leads of the level 0 junctors on the left and the level 0 junctors on the right of each of the junctor switches 0-9. The JC0 relay also connects to ten different level 0 select magnets, one on each junctor switch 0-9. Similarly, each of the JC1-9 relays connect to sleeve leads and select magnets associated with levels 1-9, respectively, on each of the junctor switches 0-9. To associate with the junctors located on the right or left half of the switches, a marker operates R, ER, and SER relays or L, EL, and SEL relays (SFD-D612). The ER and EL relays (extension right and left) are required only for paired and tripled TL operation. The SER and SEL relays (supplementary extension right and left) are required only for triple TL frame operation. The battery to operate these relays is fed through the winding of the XLR relay. The XLR relay is biased to operate when connected to more than one relay, either L or R when the STF relay is operated for single TL frame offices. It is biased to operate when connected to more than three relays (R, ER, and SER, or L, EL, and SEL) when the STF and PR relays are normal in triple trunk link frame offices. It should be noted (SFD-D610) that during transitions STF or PR may be operated or nonoperated depending on which TLC is used. A TLC which has not been changed over from single to paired operation would still operate the STF relay while a TLC which had been modified would operate the PR relay.

When a JC relay operates, the JCK relay (SFD-D619) on the JS0 lead operates to ground through one of the select magnets on the 0 junctor switch as a check that the JC relay has operated. The JCK winding resistance, and JCK series resistance, limit current so that although the sensitive JCK relay operates, the select magnet does not operate.

When R, ER, and SER or L, EL, and SEL operate, the RK or LK (right check or left check SFD-D612) relay operates through contacts of all three relays in series as a check to the marker that they have operated.

D6-1.13 CONNECTION TO LINKS OF HORIZONTAL GROUP ON LINE LINK FRAME (SFD-D507,D616)

Operation of the HGA, HGB relays of the LL frame are shown on SFD-D507. Operation of these relays is checked by operation of the HGK relay of the CM. The operated HGB relay closes through LL0-9 leads to each of the ten links associated with that horizontal group (SFD-D616).

The selected group of ten line links is assigned to ten channels so that the numerical designation of the channel is identical with the numerical designation of the line link test lead LL0-9. The designation also agrees with the numerical designation of the junctor switch and the horizontal level of the line switch which are connected by the line link.

D6-1.14 CONNECTION TO LINKS OF TRUNK SWITCH ON TRUNK LINK FRAME (SFD-D306,D621)

The selected trunk F relay controls the operation of the FA or FB relay in the TL (SFD-D306). Operation of the FA or FB operates the proper LV2-9 (level connector) and LC0-9 (link connector) relays in the TL for marker control of the select magnet operation, channel test, and hold magnet operation (SFD-D621). The A or B appearance and the horizontal level of the trunk switch is checked by the operation of the FAK or FBK relay in the marker (SFD-D307). To check that the LC relay operated, the LCK relay in the marker operates. The operated LC relay connects to sleeve leads of the links associated with the trunk switch on which the trunks appear (SFD-D621). The operated L or R relay closes through ten sleeve leads associated with the left or right half of the trunk switch (SFD-D621).

The selected group of ten trunk links are assigned to the channels so that the numerical designations of the channel of which the trunk link is a part is identical with the numerical designation of the trunk link test lead LH0-9, and with the numerical designation of the TL junctor switch to which the trunk link connects.

D6-1.15 CHANNEL TEST (SFD-D616)

Ten channel test relays CHT0-9 are connected through diodes to ten line link sleeves, ten junctor sleeves and ten trunk link sleeves (SFD-D616). Diodes in each lead prevent a ground on one leg of a channel such as a line link feeding through to another leg of the channel such as the junctor or trunk link while at the same time permitting a ground on the sleeve of any of the three legs to operate the associated CHT relay. The test paths for the 0 channel are shown in red on SFD-D616. The STX relay (SFD-D115) operates early in the call and provides direct battery to the CHT relay windings. Between calls the STX relay is released. If any of the channel test leads are falsely grounded to either the line or trunk link connectors, the XCH relay will operate between calls. The XCH relay operates the XACH relay which locks and causes a trouble record showing an XCH punch.

D6-1.16 TEST CHECK (SFD-D617)

The preceding paragraphs have described a number of operations which proceed at the same time in preparation for selection of a channel. Upon successful completion of each operation, a check relay operates. These check relays are summarized below.

TCHK - Checks that at least one TCH relay has operated.

JCK - Checks that a JC relay in the TL has operated.

RK/LK - Checks that a R or L relay in the TL has operated.

FAK/FBK - Checks that a FA/FB relay and an LV relay in the TL has operated.

LCK - Checks that a LC relay in the TL has operated.

HGK - Checks that a HGA and HGB relay in the LL has operated.

TCCK - Checks that terminating class of service relays have operated.

When all of the above relays have operated, ground from the operated JCK relay operates the TK (test check) relay.

D6-1.17 SELECTION OF A CHANNEL (SFD-D617)

The LLC1, CHT and SLRK relays will have operated early in the call. With the LLC1 relay operated, ground is closed to operate a CH0-9 relay. There is a double chain path composed of CHT0-9 relays and TCH0-9 relays to determine which CH0-9 relay, if any, is to be operated. Some or all of the TCH- relays (SFD-D614) will be operated as an indication of which channels are provided in the subgroup being tested. Any channel which is busy (SFD-D616) will have an operated CHT relay. If the TCH0 relay is operated and the CHT0 relay is normal, the CH0 relay operates and locks. If, however, either TCH0 relay is normal or CHT0 relay is operated, ground is passed to operate the next relay in the chain which has an operated TCH relay and a normal CHT- relay. When one CH- relay has operated and all others are normal, the CHA relay operates as an indication that a channel has been selected.

D6-1.18 NO IDLE CHANNEL (SFD-D617, D615)

If there is no idle channel, that is, no CH- relay having both an operated TCH- relay and a normal CHT- relay (SFD-D617), the FMP relay operates in a 10 TLF size office. In all other size offices, the STP relay operates. The FMP relay operates the FM relay in turn operating and controlling the operation of two sets of counting relays. One set of counters (1F, 1FA, 2F, 2FA) counts the total failures to match. The RF and RFA counters counts the matching failures within a route. On a first failure to match, RF relay operated, the marker sets the trunk to overflow on TER type calls.

D6-1.19 CONTROL OF CHANNEL SELECTION BY MASTER TEST CONTROL (SFD-D614, D615)

The marker can be directed to select a particular channel under control of the CH0-9 keys or switch, and to select a particular junctor step position under control of the STP1/STP2 key.

D6-1.19.1 Particular Channel Selection (SFD-D614, D615)

With the CH- keys or switch and the STP1/STP2 keys normal, there is no control of channel selection from the master test control circuit and a channel is selected at random as on a service call. With the CH- keys or switch operated, the MT7 relay in the marker operates. This opens the grounds normally used by the marker to operate TCH0-9 relays. The operated CH-key or switch provides ground on one of the TCH0-9 leads to permit the corresponding TCH0-9 relay to operate but only if it would normally have been operated by the combination of pattern relays operated. This procedure restricts the marker so that it can operate only a channel relay corresponding to the operated CH- key or switch. The CH- relay can be operated only if the channel is idle (as indicated by the corresponding CHT- relay normal).

If a particular channel is not available in STP1, the marker makes a retest to try to find a channel in STP2 (except in 10TLF, 20TLF and 30TLF size office) (SFD-D615). Again the marker is restricted to select only the channel corresponding to the operated CH- key or switch.

D6-1.19.2 Combined Particular Junctor Step and Channel Selection (SFD-D614)

When a STP1 or STP2 key and a CH- key or switch are operated together, the CM is restricted to selection of a particular channel within a particular junctor step. The MT7 relay of the CM remains operated in both Step 1 and Step 2. The STP relay of the MTC is operated during Step 1 with the STP1 key operated and during Step 2 with the STP2 key operated. This feeds ground through the operated CH- keys or switch to permit selection of only that channel corresponding to the operated CH- key or switch.

D6-2 SELECT MAGNET OPERATION

D6-2.1 LINE LINK FRAME SELECT MAGNET OPERATION (SFD-D618)

Upon operation of a CH- relay, battery through the LS and LSA resistance lamps is closed to the select magnets on the line link frame. This battery is steered by the operated HGA- relay to the proper link select magnets and junctor hold magnets. It should be remembered that the line junctor switches also serve as line switches. One-half of the verticals is for junctors and the other half is for lines. If the CH0 and HGA0 relays are operated for a line on one of the number 0 line switches to a junctor on the 0 junctor switch, an L0 and an LJ0 select magnet are operated. The LJ0 select magnet would serve a customer on the line side of the line junctor switch. If the CH1 relay and HGA0 relays are operated for a line on one of the number 1 line switches to a junctor on the

0 junctor switch, the LJ1 select magnet for the 0 junctor switch would operate, but the LJ0 select magnet on the number 1 junctor switch would also be operated to serve a line on the line side of the number 1 junctor switch.

When paired LL frame operation is provided, the select magnet leads extend to the auxiliary LL frame. The XLS relay is connected to SM- leads through normal contacts of all but the operated CH- relay. If the SM- lead through the operated CH- relay is crossed to any of the other SM- leads, the XLS relay will operate to the applied battery and lock. The XLS relay operates the MXT relay which causes a trouble record to be taken showing an XLS punch.

D6-2.2 TRUNK LINK FRAME JUNCTOR SELECT MAGNET OPERATION (SFD-D619)

Upon operation of a CH- relay, battery is closed to junctor select magnets on the TL. The operated CH- relay closes an JS- lead to a junctor switch of the same number as the CH- relay. An operated JC- relay on the TL closes the JS- lead to a select magnet of the same number as the last digit of the JC- relay. The JC0-9 relays are associated with the regular TL. The JC10-19 relays are associated with the extension TL, and JC20-29 are associated with the supplementary extension TL.

It should be noted that the JCK relay, which operated as a check that a JC- relay has operated, is released if the CHO relay operates to apply battery to the JSO lead. For this reason, the JCK punch will not appear on trouble cards where channel 0 is shown.

Battery to the JS- leads is fed through the XJS relay which is biased to operate if it is connected to ground through more than one select magnet. If the XJS relay operates, it operates the XAJS relay. The XAJS relay operates the MXT relay which causes a trouble record to be taken showing an XJS punch.

D6-2.3 TRUNK LINK FRAME TRUNK SELECT MAGNET OPERATION (SFD-D619)

When the FAK or FBK relay in the marker operates, the battery is extended to the TL on the ASM or BSM lead. This battery is directed by the operated LV- and FA- or FB- relays in the TL to operate a select magnet on the A or B trunk switch steering level and on the level of the selected trunk. Ground for the trunk level select magnets is provided by the marker on the TSX lead. This ground is present upon the release of TSE1 relay immediately following the selection of an idle trunk.

After trunk selection, when the TSE1 relay has released and the FAK or FBK relay has operated, the XTS relay is connected to the TSX lead. The XTS relay is biased to operate if it is connected to battery through more than one T2-9 select magnet. If there is a cross which closes the ASM lead to more than one of the select magnets T2-9, the XTS relay operates and in turn operates the XATS relay which operates the MXT relay to cause a trouble record showing an XTS punch.

D6-3 HOLD MAGNET OPERATION-NETWORK AND LINE TEST

The sequence of hold magnet operation differs, depending on whether the marker determines that traffic is heavy or light. Under heavy traffic conditions all hold magnets are operated at the same time with a minimum of checks and tests to reduce marker holding time. Under light traffic condition, operation of the line hold magnet is delayed to permit a test of the talking path for crosses. After the line hold magnet has operated, a continuity test of the talking path crosspoints is made.

Headings of the following paragraphs are designated HTR, LTR or HTR/LTR as an indication that the paragraph applies only to heavy traffic, only to light traffic, or to either heavy or light traffic operation.

D6-3.1 DETERMINATION OF LIGHT OR HEAVY TRAFFIC BY CM-HTR/LTR

Hold magnet operation, as well as other marker functions, differ according to whether traffic is light or heavy. The CM determines whether the traffic is light or heavy by measuring the time between seizures of the CM using the HTT timer (SFD-D215).

At the beginning of a call, the MCB- relays of the CM are operated over the MB lead from the IRMC (SFD-D206). The MCB1 relay operated extends ground on the TM lead to operate the OAT relay. If the HTR relay is already operated from the last call it remains locked to ground through normal contacts of the HTT relay (SFD-D215). At the end of the call, the OAT relay releases. If the HTR relay is not already operated, it operates and locks releasing the OAT1 relay. With the OAT and OAT1 relays normal and the HTR relay operated, the shunt around the HTT capacitor (SFD-D215) is opened allowing the HTT capacitor to charge until the HTT tube fires and operates the HTT relay or until the CM is seized again and the OAT relay operates to stop the timing. If the time between calls is greater than 0.96 to 1.6 seconds, the HTT relay operates releasing the HTR relay so that the next call is handled on a light traffic basis. If the interval is shorter than 0.96 to 1.6 seconds, the HTR relay remains operated and the call is handled on a heavy traffic basis.

D6-3.2 HOLD MAGNET TIMING - HTR/LTR (SFD-D622)

As described in preceding paragraphs, select magnets are operated on line link and trunk link frames upon operation of a CH- relay. Operation of a CH- relay also operates the CHA relay which starts a hold magnet timing interval. This time interval is necessary to allow select magnets to operate, for select fingers to seat, and for any previously operated hold magnets connected to this channel to release before operating hold magnets for this call.

Prior to operation of the CHA relay, current flows through the primary winding of the HMT relay in a direction to operate it, while current through the secondary flows in a direction to release it. The combination of external resistance, winding resistance, and difference in number of turns is such that the current in the secondary prevents the HMT relay from operating. When the CHA relay operates, current in the secondary decreases as the HMT capacitor charges. When the effect of the current in the secondary becomes less than that of the current in the primary, the HMT relay operates. This operate time can be set at 43-50 ms by cross-connecting terminal HMT1 to HMT3 or to 63-75 ms by cross-connecting terminal HMT1 to HMT2. The longer time interval is required in offices which have some switches which are not equipped with damping cones, since the select fingers on these switches take longer to settle down. Operation of the HMT relay operates the HMT1 relay.

D6-3.3 CHECK OF CHANNEL - HTR/LTR

Early in the call, the SLRK relay operates (SFD-D623) from ground on the LLC3 relay through normal contacts of the following relays to ensure that they are initially normal: SLA, TGCK, JGCK, GLH1, GT2, HMT1 and CHA1. The SLRK locks when the TK relay operates. If the SLRK relay fails to operate, operation of a CH- relay (SFD-D617) is prevented.

In the process of channel test (SCD-D6-1.15, SFD-D616) busy channels are detected by looking for ground on sleeve leads. If ground is not detected on any of the three parts of a channel, it is presumed to be idle and one of the "idle" channels is selected by operation of a CH- relay (SFD-D617).

A further check of the channel is made after a CH- relay has operated. The JGCK and TGCK relays (SFD-D625) are connected to junctor and trunk hold magnet leads, respectively. These are high resistance sensitive relays which operate to battery on hold magnet windings without operating the hold magnets. This provides a positive check that the hold magnets associated with the channel are idle (ungrounded). A further check of the sleeve of the line link selected is made by the LLT relay. If the line link is idle (ungrounded) the LLT relay will not operate. (SFD-D616).

D6-3.4 CROSS CHECK OF TRUNK SLEEVE - HTR/LTR

Prior to operation of the HMS1 relay, the XSL relay is connected to the AST or BST lead (SFD-D625) to detect any cross to ground. If the XSL relay operates, it locks and operates the MXT relay which causes a trouble record showing an XSL punch.

D6-3.5 HOLD MAGNET START - HTR/LTR, (SFD-D623)

With the HMT1, JGCK, TGCK, and SLRK relays operated, and other check relays released, the HMS1 relay operates to start hold magnet operation. The operation of the HMS1 relay closes circuits for operating the LL and TL hold magnets and the line hold magnet of the channel.

D6-3.6 HOLD MAGNET OPERATION - HTR/LTR (SFD-D625)

The operation of the HMS1 closes the operate circuit over the LH-, J-, and LH-(TL) leads to the LL and TL hold magnets of the selected channel. Relay HMS1 operated extends the +130 volts on the LH, JH-, and TH- capacitors to the winding of the hold magnets. The capacitors discharge through the hold magnets, causing them to operate. When the voltage across the capacitor drops to about -.5 volts the LH, JH-, and TH- diodes become forward biased and pass a steady current to hold the hold magnets operated.

The TL trunk and junctor hold magnets and the LL junctor hold magnet are always operated on a dual voltage basis.

D6-3.7 DUAL VOLTAGE OPERATION - HTR/LTR (SFD-D625)

With the standard dual voltage option, all hold magnets except the line hold magnet are operated by a high voltage surge on all calls. The line hold magnet is operated by the high voltage surge except on calls to message rate lines in offices having message registers. This is to avoid the possibility of falsely operating the message register. Lines equipped with message registers are indicated to the marker over the class-of-service leads from the LL. The class-of-service indication is received over the CS00-29 leads, which in turn are cross-connected to operate relay CNA (coinline auxiliary), AOA (all other auxiliary), MRA (message registers auxiliary), or CGS (centrex station). The operation of the CNA, AOA, or CGS relays operates the DVO relay, which in turn operates the DVA relay indicating that the marker should use dual voltage to operate the line hold magnet. The operation of the MRA indicates 48 volt operation for the line hold magnet.

With DVA or MRA operated and the HMT operated, ground is closed to operate the HMT1 relay.

D6-3.8 OPERATION OF LINE HOLD MAGNETS - HTR (SFD-D625)

Assume a heavy traffic call with a nonmessage rate line. Upon operation of the HMS1 relay, with the HTR, DVO and DVA relays operated, ground is furnished through the primary winding of the LXP relay in series with the LH capacitor. The LH capacitor (which has previously been charged to +130 volts and acts momentarily like a 130 volt battery) is applied to the winding of the line hold magnet which is connected to -48 volt battery. The effect is as though a battery of 178 volts were connected to the relay winding. The voltage of the LH capacitor rapidly decreases to 0 and then to a fraction of a volt negative at which point the LH diode begins to conduct, so that the hold magnet is held operated to ground potential. Application of high voltage in this manner causes the hold magnet to operate in about 1/3 the time it would take if 48 rather than 178 volt operation were used.

If the DVO and DVA relays are normal, 48-volt operation is used. That is, the ground through the winding of the LXP relay is applied directly to the hold magnet without the LH capacitor in series.

With or without surge voltage operation, the LXP relay operates in series with the line hold magnet. The LXP relay operates the LXPA relay which locks (SFD-D623).

D6-3.9 OPERATION OF JUNCTOR AND TRUNK HOLD MAGNETS - HTR/LTR (SFD-D625, D623)

The HMS1 relay closes ground through the JXP relay primary winding in series with the JH capacitor charged to +130 volts over the J- lead to the winding of the line link junctor hold magnet.

The HMS1 relay also closes ground through the TXP, TXP1 resistance lamps in series with the TH1, 2 and 3 capacitors charged to +130 volts over the LH- lead to the trunk and trunk junctor hold magnets. As described for high voltage surge operation of line hold magnets, the magnets operate in about 1/3 of the time required for 48-volt operation. When the capacitor discharges, the magnets continue to be held operated through the diodes to ground through the JXP relay or the TXP, TXP1 resistance lamp. The JXP relay operates in series with the line junctor hold magnet and operates the JXPA relay which locks.

D6-3.10 CROSSPOINT CHECK - HTR/LTR (SFD-D625, D623, D616)

D6-3.10.1 Heavy Traffic

When the hold magnets have operated, the low resistance ground from the TXP, TXP1 resistance lamps operates the SL relay and releases the LXP and JXP relays which operate the LXP1 and JXP1 relays, respectively. The SL relay operates the SLA relay (SFD-D625). The LLT (SFD-D616) relay, which has previously operated when operation of the line junctor hold magnet grounded the line link sleeve, operates the LLTA relay. Operation of the SLA, LLTA, LXP1 and JXP1 relays closes ground through the previously operated HTR relay to operate the GT1 relay, which locks.

D6-3.10.2 Light Traffic

Crosspoint check on light traffic is the same as preceding, except:

(a) Line hold magnet operation does not occur at the same time as operation of the other hold magnets when the HTR relay is not operated.

(b) Operation of the SLA, LLTA and JXP1 relays closes ground through the normal HTR, LXPA and LXP1 relay contacts to operate the LTR (light traffic) relay instead of the GT1 relay.

D6-3.11 FALSE CROSS AND GROUND TEST - LTR (SFD-D627)

On light traffic calls, a test for crosses on the network tip and ring conductors is made. For this reason, the operation of the line hold magnet operation is delayed during the test so that crosses or grounds external to the network are not detected.

Ground through the secondary, and battery through the primary windings of the FCG relay are connected to the ATT or BTT and ART or BRT leads, respectively.

The FCG relay will operate if there is a false ground on the ring conductor at any point from the nonoperated LL line hold magnet crosspoints to the primary winding of the FCG relay. If there is a false battery on the tip conductor at any point, the FCG is operated by current through the secondary winding. Or, if there is a false cross between the tip and ring conductors at any point, the FCG relay is operated by current through the primary and secondary windings. The operation of the FCG relay would stop the progress of the call and produce a trouble record showing the FCG punch.

When the LTR relay operates, indicating that all crosspoints other than those for the line hold magnet have closed, a locking ground is provided for the FCG relay in case it has operated. If the FCG relay has not operated, the GLH relay operates (SFD-D622).

The GLH relay disconnects the FCG relay from the ATT or BTT and ART or BRT leads and grounds both leads to discharge any voltage remaining on them from the FCG test.

D6-3.12 DELAYED OPERATION OF LINE HOLD MAGNET - LTR (SFD-D622)

The GLH relay operates the GLH1 relay. With the GLH1 relays operated, the line hold magnet is connected either in series with the LXP primary winding to ground (if the DVO and DVA relays are normal) or in series with the charged LH capacitor to ground through the LXP primary winding, if the DVO and DVA relays are operated. The operated LXP relay operates the LXPA relay. When the line crosspoints close, the LXP relay is forced to release by ground from the TXP and TXP1 resistance lamps. This operates the LXP1 relay.

D6-3.13 CONTINUITY TEST, GENERAL - LTR (SFD-D627)

A continuity test of the talking path through the network is made on light traffic calls. In order to check continuity of the path through the network, a path from tip to ring conductors or from either tip or ring to ground external to the network is required. Twenty-cycle (AC-DC-AUD) ringing supply is stepped up to a higher voltage by the CON2 transformer. With the GLH1 relay normal, the output of the CON2 transformer is open-circuited. There is no current flowing and, therefore, no voltage buildup across the CON2 capacitor. When GLH1 relay operates (assume RCTA relay normal) the CON2 transformer is connected through the network to the ring side of the line. Ground is connected to the tip side. On nearly all calls, the off-hook status will be connected across the tip and ring so that there will be a relatively low dc resistance in the loop. Current will flow, causing an alternating voltage to appear across the CON2 capacitor. Terminal 1 of the CON tube is connected through the CON1 resistor to the CON2 capacitor. If the voltage at terminal 1 reaches the firing voltage of the CON tube, even momentarily, the CON tube fires and continues to conduct between terminals 2 and 4 to operate the CON relay even though the voltage at terminal 1 is no longer above the firing voltage.

Occasionally the station will go on-hook just before the continuity test is applied. If this is an individual line, the path through the ringer and the series capacitor allows sufficient 20-cycle (AC-DC-AUD) frequency current to flow to raise the voltage across the CON2 capacitor to the firing voltage. The same holds true for a ring party line. In this case, current flows through the network ring lead only through the ringer and capacitor to ground and back through the earth to the central office ground. If there is only a tip party connected to the line, insufficient current may flow and the CON tube may not fire at this time (still assuming that the RCTA relay is normal at the beginning of the continuity test.) As described in more detail later, the RCTA relay operates after a short interval to reverse the continuity test. Now, current flows through the tip lead through the tip party bell and capacitor, back through the earth to the central office ground. If the RCTA relay had been initially operated and only a ring party station had been connected, the RCTA relay would have released to apply the continuity test to the ring side of the line.

On long lines, the cable capacity is sufficient to satisfy the continuity test even if there is no other path through ringers or transmitter.

D6-3.13.1 Continuity Test Reversal Control - LTR (SFD-D627)

The RCTB relay operates from ground through the HTR relay contacts normal, and prevents the RCTA relay operation for ring party stations. On continuity test of a multiparty line, the ring side of the line is tested first. If the continuity test is satisfactory, the operation of the CON1 relay locks the RCTB relay operated. If the continuity test is not satisfactory, the RCTB relay releases when the LXP1 operates, and causes the RCTA relay to operate. The operated RCTA removes the continuity test from the ring and applies it to the tip conductor.

D6-3.13.2 Continuity Test Description - LTR (SFD-D627)

Operation of the GLH1 relay, in addition to starting operation of the line hold magnet, also starts the continuity test. Stepped up 20-cycle ringing supply voltage through the CON2 transformer in series with the CON2 capacitor to ground is applied to either the tip or to the ring of the path through the network depending on whether the RCTA relay is operated or normal. Ground is applied to the other side of the path through the network. The GLH1 relay also applied +130 volts to a voltage divider supplying the winding of the CON relay.

If there is continuity through the crosspoints and continuity external to the network, the voltage across the CON2 capacitor builds up sufficiently to fire the CON tube. The CON relay operates, in turn operating the CONA relay. The CONA relay operates the CON1 relay which locks. The CON1 relay closes a locking path to prevent release of the RCTB relay (if it has not already released), operates the GT1 relay which locks, and grounds the control terminal 1 of the CON tube. The GT1 relay removes positive battery from the CON relay allowing it to release. This, combined with the grounding of control terminal 1, extinguishes the CON tube.

The CON1 and CON3 capacitors are small and serve to prevent false firing of the CON tube from electrical noise pulses.

D6-3.13.3 Continuity Failure Trouble Record - LTR

If the CON tube fails to fire, the CON and CON1 relays do not operate, and the CM cannot proceed with the call. The work timer which is recycled upon operation of the GLH relay (SFD-D215) times out after 450 to 605 milliseconds. This causes a trouble record showing WT, GLH and all progress punches through the DCT (but does not include the CON punch).

D6-3.13.4 Cancel Continuity - LTR (SFD-D622, D623, D627)

On second trial calls, the operation of the GLH1 relay operates the CON1 relay from ground on the operated TR2C (SFD-D622), thus, automatically canceling the continuity test. On heavy traffic calls, operation of the LXP1 relay with the HTR relay operated (SFD-D623) operates the GT1 relay, thus, canceling continuity test by bypassing operation of both the CON and CON1 relays.

Continutiy test can be cancelled on all calls for all markers by operating the CCT key at the master test frame jack lamp and key panel (SFD-D627).

D6-3.14 DOUBLE CONNECTION TEST - HTR/LTR (SFD-D625)

On both light and heavy traffic calls a double connection test is made to ensure that the sleeve of the connection being set up is not crossed with the sleeve of another connection already set up or in the process of being set up. Although operation of the line hold magnet is slightly delayed on light traffic calls, the double connection test is made in the same manner on both light and heavy traffic calls.

When the LXP1, JXP1 and SLA relays have all operated, as previously described, the LXP and JXP relays and the TXP and TXP1 resistance lamps are disconnected from respective leads to line and trunk link frames. At the same time the DCT relay is connected to the LH- lead to the line link frame. The DCT relay winding now provides the only ground from the CM to keep the hold magnets operated. Bias current through the secondary winding of the DCT relay is such that the DCT relay will operate if there is no other ground feeding the connection such as would occur if the sleeve path were crossed to an established network connection.

D6-3.14.1 Heavy Traffic

On a heavy traffic call the GT1 relay operates upon completion of the crosspoint check (SCD-D6-3.10.1). With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

D6-3.14.2 Light Traffic

On a light traffic call, the GT1 relay does not operate until the CON1 relay has operated as a result of a successful or cancelled continuity test. With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

D6-3.15 HOLD MAGNET SIMULATION AND CONTROL BY MTC (SFD-D624, D625)

On an incoming class of marker test, it is desirable to be able to test the marker using any line location information. To avoid the possibility of having a customers line become locked into the test call if the line should happen to go off-hook during the progress of setting up the test connection, line hold magnet operation is simulated.

D6-3.15.1 NTC Key Normal

The MT11 relay of the CM is operated on test calls. This opens the path over the LH- lead (SFD-D625) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on a test call the path is extended over the LHMT lead to the MTC and through the MKT2 relay to the LHM relay (NTC key and NTC1 relay normal) (SFD-D624). The LHM relay and the series LHM resistance are chosen to present an impedance to the marker equivalent to that of a line hold magnet.

When the HMS1 relay of the marker operates, the marker applies either the high voltage surge for dual voltage or ground through the winding of the LXP relay to operate the LHM relay of the MTC. The LHM relay operates the LHMA relay which extends the LHMT lead to the LLJ lead. The LLJ lead ties into the J lead of the CM to the trunk link frame at a point ahead of the CH- relay to simulate the path which would have been closed on a service call over the LH- relay lead to the LL, through the junctor and back over the J- lead to the CM. This permits the marker to go through all the motions of crosspoint and double connection checks. It will actually close junctor crosspoints on the LL, but checks are made through the simulated path just described. The CM operates and checks crosspoints on the TL in the normal manner.

D6-3.15.2 NTC Key Operated (SFD-D624, D625, and D631)

The NTC key of the MTC is operated on an incoming class of test where it is desired to establish a connection and check the tip, ring and sleeve path through the line link frame using all crosspoints which would be used on a service call except the line hold magnet crosspoints. Use is made of the no test connector access to LL frames.

Operation of the NTC key on incoming class of test operates the NTC and NTC1 relays. The operation of the NTC and NTC1 relays prepares the test circuit for operation with the no-test connector.

When the MTC gains access to the no test connector, the F1 relay of the MTC is operated over the SPC lead (SFD-D624). Operation of the F1 relay operates the NTC select magnets (associated with no test connector level assigned to the MTC) on all no test connector switches (see SFD-D631 as well as D625). The F1 relay also connects the NTB relay of the MTC to the no test connector via the NTH lead. The NTH lead is steered through the CM and the HGA- relay of the LL to the winding of the NTC hold magnet of the no test connector associated with the link to be simulated. If the NTC hold magnet is in use, ground on its winding will be fed back to operate the NTB relay of the MTC which locks on its secondary winding and lights an NTB lamp to indicate NO TEST BUSY. If this occurs, simulated hold magnet operation by the no test connector is blocked. The CM work timer times out and a trouble card showing LXPA but not LXP1 would be produced followed by release.

If the NTC hold magnet is not in use, the NTB relay does not operate. Later in the call, when the CM grounds LHMT lead (which on a regular call would operate the line hold magnet), the NTH relay of the MTC is operated. The NTH relay extends ground from the NTB relay normal to the NTH lead to operate the NTC hold magnet of the no test connector, extends the LHMT lead to the S lead, and closes the tip and ring leads to the test circuit trunk appearance on the no-test connector (SFD-D627).

On an incoming test the LK1 relay is operated through the operated MC7 relay (SFD-D704). The operated LK1 relay opens the H lead to the no-test connector to release the no-test connector hold magnet which opens the S lead and releases the NTH relay (SFD-D624). After the LK1 relay has operated, it releases the no-test hold magnets and the NTH relay.

D6-3.15.3 Dual Voltage Test (SFD-D624, D625)

When dual voltage operation is provided, the LHMT, LLJ and TLH relays of the MTC are connected to the LHMT, LLJ and TLH leads, respectively. If the CM applies the high positive voltage surge to each of these leads, the corresponding relays should operate to light the LHMT, LLJ and TLH lamps, respectively. Current through the lamps also locks the relays. Tests should be made using message register class of service, if provided, to ensure that the high voltage surge is not applied and, therefore, that the LHMT lamp does not light for these classes. The LHMT lamp should light for all other classes. The LLJ and TLH lamps should light for all classes.

D6-3.16 TEST OF FALSE CROSS AND GROUND DETECTION FEATURE (SFD-D627)

D6-3.16.1 FCG Key Normal

With the FCG key normal, the FCG relay of the CM is connected to the network T and R leads prior to operation of the GLH and GLH1 relays. As on service calls, crosses or grounds on the T and R leads will be detected on light traffic calls.

D6-3.16.2 FCG Key Operated

With the FCG key operated, the FA resistor is bridged across the TTT and TRT leads to the marker. This applies a current which should operate the FCG relay causing a trouble card to be produced showing a FCG punch. If the HTR key is operated, the CM should not detect the FCG condition.

D6-3.17 TEST OF CONTINUITY TEST FEATURES (SFD-D627)

D6-3.17.1 CON, RV, AND TCT Keys Normal, TC Key Operated or Normal

With the CON, RV, TCT, and TC keys normal, an operate condition originating at the voltage divider resistors CL, CM and CK, through the CF resistor is applied to the TRT lead. On alternate test calls the RCTA relay of the CM is operated so that the initial continuity test is made on the RING lead (the TRT lead on a test call). The CON tube should fire and the call should be completed. On calls with the RCTA relay of the CM normal, the initial continuity test is made on the TIP lead (the TTT lead on a test call). Since the TTT lead is open, the CON tube does not fire initially, but (as described for a service call) it should fire after release of the RCTA relay applies the continuity test to the TRT lead. Two consecutive calls should be made to ensure one test with RCTA initially normal and one test with RCTA initially operated. With the TC key normal, a negative bias is applied to the operate path of the CON tube. A test should also be made with the TC key operated to apply a positive bias to the CON tube operate path.

D6-3.17.2 RV Key Operated, CON and TCT Keys Normal, TC Key Operated or Normal

Operation of the RV key with the CON, TCT, and TC keys normal applies the aforementioned continuity operate test condition to the TTT lead instead of the TRT lead. Two consecutive tests should be made to ensure one test with RCTA initially operated and one test with RCTA initially normal. As described previously, The TC key may be operated or normal to apply positive or negative bias to the CON tube operate path.

D6-3.17.3 CON Key Operated, RV, TCT, and TC Keys Normal

With the CON key operated, a loop continuity operate condition is applied across the TRT and TTT leads. The CON tube should fire for OK continuity on its initial attempt whether the RCTA relay is operated or normal.

D6-4 RINGING SELECTION SWITCH CONTROL

The marker receives the equipment location and the ringing information from the NG at the same time. The marker controls the selection of the ringing selection switch for ringing the called station or for returning line busy or overflow signals to the trunk.

One of two ringing selection switch select magnets (levels 0 or 1) is operated to select the tip and ring conductor to which the ringing should be applied. One of seven other select magnets (levels 2 to 8) is operated to select the proper ringing supply. The remaining select magnet (level 9) is used to control the line busy or overflow signals returned to the trunk. For this condition the 0 and 1 magnets distinguish between busy and overflow. By operating a hold magnet associated with the selected trunk, the proper ringing supply is connected through the crossbar switch crosspoints.

D6-4.1 SETTING THE RINGING SELECTION SWITCH (SFD-D628, D629)

The marker identification of the ringing combination translation is made by the one operated RCT1-15 relay, which operates two of the associated ringing selection RS0-9 relays. The RS2-9 relays operate select magnets

2-9 first. The CM RSK (ringing switch select magnet check) relay checks for operation of select magnets 2-9. The operated RSK relay provides battery for operation of select magnets 0 or 1. The CM SRK (start ringing check) relay operates when the select magnets are operated.

D6-4.2 RINGING SWITCH HOLD MAGNET OPERATION (SFD-D629)

The CM checks that an idle channel is available before operating the LI (link idle) relay. The operated LI relay extends ground on the RC lead to operate the RC (ringing control) relay in the trunk. After operation of relay RC, ground is extended from the marker on lead TP to operate the RSW (ring switch) hold magnet. Through the operated RSW crosspoints ground is returned on lead RC through RCK2 resistor to -48 volts to operate the RCK1 (ringing switch check) relay, which operates the RCK2 relay. Through the operated RCK2 and LCH or TCH relays the RCK3 relay is operated, which allows the call to complete.

D6-4.3 RINGING SWITCH SELECT MAGNET SIMULATION BY MTC (SFD-D628)

The KRS relay is operated by the F relay and closes the RS0-9 leads from the marker to the windings of the RS0-9 relays which simulate ringing switch select magnets.

The marker normally grounds the RS0 or RS1 lead and one of the RS2-9 leads, operating the corresponding relays which lock on secondary windings to ground on the RSH relay. Any of the RS0-9 relays operated, grounds the RSK lead to the marker.

Lamps are lighted, on the test panel, by the operated RS0-9 relay to indicate the ringing condition which would have been set up by a ringing switch.

D6-4.4 RINGING SWITCH HOLD MAGNET SIMULATION BY MTC (SFD-D629)

The marker having operated the RC relay, grounds the TP' lead to the RSH (ring switch hold magnet) relay which operates, simulating the operation of a ringing switch hold magnet.

When the F relay releases, the holding path of the RSH relay is through the operated RSH and N1 relays to ground through normal contacts of the KR relay.

D6-4.5 RINGING SELECTION SWITCH CONTROL FOR BUSY TONE (SFD-D628)

On a TER call, a line busy condition operates a BY (busy) relay. This releases the LL by releasing the LLCI relay in the marker. The BY relay also releases the RS- relay, which releases the previously selected ringing switch select magnets and in turn, releases the RSK relay. The

RSK and SRK, in releasing, operate the OFH (overflow hold magnet) relay and cause the operation of the ringing switch select magnets 1 and 9 (SFD-D628), which is the combination for signaling the trunk to return busy tone.

D6-4.6 RINGING SELECTION SWITCH CONTROL FOR OVERFLOW TONE (SFD-D630)

On a TER call, all channels busy condition operates an OV (overflow) relay. This releases the LL by releasing the LLC1 relay in the marker. The OV relay also releases the RS- relay which releases the previously selected ringing switch select magnets and, in turn, releases the RSK relay. The RSK and SRK, in releasing, operate the OFH relay and cause the operation of the ringing switch select magnet 0 and 9 (SFD-D628) which is the combination for signaling the trunk to return overflow tone.

D6-4.7 RINGING SELECTION SWITCH CONTROL FOR REORDER (SFD-D630)

The incoming registers are equipped with overall timers (SCD-D1-6). This timer serves to prevent any trunk from holding the register out of service for a long period of time. It is recycled on an interdigital basis so as to keep its time reasonably short and yet allow sufficient time for normal functions.

In the event the seizure interval or any of the interdigital intervals exceed the allowable time, the TM relay will operate to operate the RO (reorder) relay. The operated RO will ground the RO lead to the marker to operate the RO relay in the marker as an indication that a time out has taken place. The RO operates the ROA which operates the OV. With the operation of the OV relay, the operation will continue as described in paragraph SCD-D6-4.6.

SECTION D, PART 7
COMPLETING MARKER RELEASE

Index

D7 COMPLETING MARKER RELEASE, RINGING CALLED SUBSCRIBER, AND DISCONNECT

The completing marker may encounter numerous conditions that require disconnect, and when these conditions occur the CM has various methods of disconnection.

When the F relay in the incoming trunk is released, the ringing selection switch supplies ringing to the called subscriber. After the called subscriber answers and conversation is complete, there may be two types of disconnect. The calling subscriber may disconnect first or the called subscriber may disconnect first.

D7-1 MARKER NORMAL RELEASE - OPERATION OF THE DIS1,2 RELAYS (SFD-D702, D704, D705)

When the marker has completed all functions successfully without encountering any trouble, the LK1 (linkage check) relay will operate causing the DIS1,2 (disconnect) relays in the CM to operate.

The DIS1,2 relays, operating, release the CKG1,2 relays in the CM and grounds the MRL lead into the IR (incoming register) to operate the MRL relay (SFD-D207). The MRL relay, operating, releases the MS- relay in the IRMC, and by opening the start lead into the connector prevents a second trial (SFD-D204).

D7-1.1 TROUBLE RECORD - OPERATION OF THE TRR RELAY (SFD-D702, D705, D708)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the TRR (trouble record regular) release relay. These conditions are as follows.

When the start lead is shifted to an alternate marker in the IRMC due to a delay in the selection of a marker, the TRS (transfer start) relay in the PC circuit operates. After an alternate marker is selected, the TRS relay in the CM operates. The TRS relay operates the TRR relay in the CM and a trouble record is then taken. The TRS trouble record is used to identify the connector used on the call.

If the F terminal of a number in the NG is connected to the PBN or PMO lead, the CM will cause the line busy or overflow signal to be returned on calls to these numbers. The PBN feature is also used on test calls to test the ability of trunk circuits to return a line busy signal where a busy line is encountered (SFD-D414).

When the trouble record is completed, the DIS1,2 relays in the CM operate from the operated RDL, TRB1, TRSA and TRR relays. The marker then releases on a normal basis.

D7-2 MARKER TROUBLE RELEASE - OPERATION OF THE TRL RELAY (SFD-D705)

If the CM encounters trouble while trying to complete the call, the TRL (trouble release) relay in the marker will operate. The TRL relay operating releases the CKG1,2 relays in the CM and grounds the TRL lead into the PC (preference control circuit) operating the TRL relay (SFD-D207). The TRL and TR relays operating release the MS- (marker start) relay in the IRMC. The Z relay in the PC changing condition shifts the ST (start lead) to the alternate marker and a second attempt is made to complete the call (SFD-D204). A trouble release permits a second trial providing the MRL or TRL relays in the IR (incoming register) are normal.

D7-2.1 TROUBLE RECORD - OPERATION OF THE TR1 RELAY (SFD-D705)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the trouble record trouble release TR1 relay. These conditions are as follows.

A time out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal), the TR1 relay in the CM operates and a trouble record is taken. A second trial is possible on this type of call because the IR is still attached to the circuit. If the marker usage is a second trial, TR2C relay operated, the TR1 relay in the CM operates and a trouble record is taken. Since the marker usage is a second trial, the TRL relay in the IR will operate opening the start lead preventing another attempt to complete the call.

When the trouble record is completed, the TRL relay in the CM operates from the operated TR1, TRB1, RDL, and TRSA relays. The marker then releases on a trouble basis.

D7-3 MARKER OVERALL TIME-OUT RELEASE - OPERATION OF THE MRL, MRL1 RELAYS (SFD-D207, D705)

If the marker fails to complete the call within the allotted interval of 9.6 to 15.4 seconds, the OAT timer functions and causes the MRL (marker release) relay in the CM to operate. The MRL relay operates the MRL1 relay (SFD-D705) which operates the TRL and MRL relays in the IR (SFD-D207). The MRL relay operating releases the MS- and connector relays in the IRMC and by opening the start lead into the connector prevents a second trial (SFD-D204). The MRL relay in the IR operated opens the locking path of the TRL allowing the TRL relay to release.

On this type of release, a trouble record is not taken but the TA (timing alarm) lamp will be lighted on the right COM EQPT marker frame.

D7-4 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL CIRCUIT (SFD-D704 AND D705)

On test calls certain MT- (marker test) relays operate in the CM. These test relays operating allow the MTC circuit to interact with the marker.

With the MT17 relay operated in the CM, the DCT1 relay operating path is extended into the MTC circuit over the TDCT lead. The DCT1 relay operating ground is extended over the DCT lead into the MTC circuit to operate the DCT relay in the MTC. With the REC key normal, the operation of the DCT relay in the MTC circuit operates the MO1 relay (SFD-D705). The MO1 relay in the MTC circuit operating connects ground to the TDCT lead into the CM operating the DCT1 relay (SFD-D704). The CM then continues its progress on a normal basis.

With the MT1 relay operated in the CM, the DIS1,2 relays operating path is extended into the MTC circuit over the DIS lead. After the LK1 (linkage check) relay in the CM operates, ground is extended over the LK2 lead into the MTC circuit. The LK2 relay in the MTC operates, lighting the LK2 lamp. Ground is now transmitted over the LK3 lead through the CM and back into the MTC on the DIS1 lead. The DIS1,2 relays in the MTC circuit operate, lighting the DIS1 lamp, and ground is extended over the DIS lead into the CM operating the DIS1,2 relays. The CM then gives a normal release. It may be noted that if the LK2 and DIS1 lamp at the MTC panel are both lighted, the marker has completed setting up the connection and released.

D7-4.1 REQUESTING TROUBLE RECORD USING MTC CIRCUIT - OPERATION OF THE REC RELAY (SFD-D705, D709)

When it is desired to obtain a record of the progress of the CM when making a test call, the REC key (record request) should be operated at the MTC panel. The REC key operates the REC relay in the MTC after the DCT relay has operated. Thus, the REC relay is operated prior to the completing marker DCT1 relay. The REC relay operated extends ground into the CM over the TRR lead to operate the TRR relay. The TRR relay operates the TRST (trouble recorder start) relay in the CM which operates the MPR- marker preference relay in the MTFC to request a trouble record. A trouble record is taken and the CM releases on a normal basis. These trouble records requested by the test equipment can be distinguished from service or legitimate trouble records by the absence of the TI (trouble indication) punch on the trouble record card.

D7-5 TROUBLE RECORDER REQUESTS (SFD-D709)

When the marker encounters a trouble condition, the TRR or TR1 relay will operate in the CM and cause the trouble recorder to be seized by the trouble recorder start relay operating (SFD-D705). The TRST operates the TRSA relay in the marker. On first trial calls, the MN relay in the JLK circuit operates and a minor alarm is sounded. On second trial calls, the MJ relay in the JLK circuit operates and a major alarm is sounded. The marker preference MPR- relay in the MTFC circuit is then operated from battery on the TRST lead. The MPR- relay connects ground to the CI lead which operates the MKA, MKB, and MKB1 relays in the MTFC. The MKA relay operates the MTR (marker test repeat) relay which operates the CIC (cut-in connector) relay in the MTFC and a trouble record is taken.

After the trouble record is complete, ground over the TRC lead from the TRC (trouble recorder control) circuit operates the TRC and TRC1 (trouble record complete) relays in the MTFC. The RM (release marker) relay in the MTFC operates and ground is transmitted over the TRB lead into the CM to operate the TRB1,2 (trouble recorder busy) relays. The TRB1 relay operating removes battery from the TRST lead releasing the MPR- and MKA relays in the MTFC. The TRB2 relay operates the RDL (release delay) relay in the marker. The marker will then release on a normal or trouble basis.

D7-5.1 TROUBLE RECORDER BUSY (SFD-D709)

When a trouble record is requested by the marker with the operation of the TRR or TR1 relays and there is a previous trouble record in progress with the TRB1 relay operated, the DL (display lost) relay in the marker will operate. The DL relay operating will cause the DL- (display lost) lamp in the JLK circuit to light, indicating the loss of a trouble record. The marker will then release on a normal or trouble basis.

D7-6 RINGING THE CALLED SUBSCRIBER (SFD-D707)

When the CM releases the F relay in the incoming trunk, control of the ringing selection switch hold magnet is transferred to the incoming trunk. Ground is removed from the FA lead releasing the TL auxiliary relays. On "one ring" codes, the PU relay operates from ground on the PKU lead as soon as the crosspoints close. On other than "one ring" codes, the PU relay is operated by a ground pulse from the ringing machine on the PU lead just before the start of a complete ringing cycle. In either case, the PU relay locks to ground through the D relay under control of the RC relay and connects ringing current through the winding of RT relay and contacts of RC relay to the called line. Ringing current is returned to the calling subscriber through the T1 and R1 capacitors as an audible indication that ringing has begun.

The operated ringing switch hold magnet closes crosspoints of the two selected levels to extend ringing current and ground to the T and R leads of the trunk circuit (SFD-D706). The path of ringing current may be traced from the ringing supply through crosspoints of selected level 2-8, to the RT lead, through the RT relay in the incoming trunk circuit, to the RB lead, through crosspoints of level 0 or 1, to T or R lead, through called subscribers sub-set back to level 0 or 1 to ground.

D7-7 CALLED SUBSCRIBER ANSWERS

When the called subscriber removes the receiver to answer the call, the RT (ringing trip) relay operates from the increased current flow through the sub-set. The RT relay opens the locking path for the RC relay causing it to release. The released RC relay reconnects the called line to the S relay causing the S relay to operate. The released RC relay also causes a 10 ohm ground to be connected to the channel of the called line to hold the channel operated and releases the PU relay. The S relay is also in the path to keep the channel operated and, if supervision is required for billing purposes, operates the T relay.

D7-8 DISCONNECT (SFD-D707)

After conversation has ended, disconnect from the line varies, depending on whether the called subscriber or the calling subscriber disconnects first.

D7-8.1 CALLED SUBSCRIBER DISCONNECTS FIRST

When the called subscriber disconnects, the S relay releases. The released S relay removes the holding ground from the sleeve lead and releases the T relay (if it is operated). The T relay restores the original trunk polarity as a disconnect signal to the distant office. When the calling end disconnects, the A relay in the incoming trunk releases, opening the locking path of the D relay. The released D relay releases the CO relay, the ringing switch vertical and the connection to the calling line. This restores the trunk and network connection to normal.

D7-8.2 CALLING SUBSCRIBER (OR STATION) DISCONNECTS FIRST

When the calling subscriber disconnects first, the A relay releases, in turn releasing the D relay. The released D relay releases the CO relay, the ringing selection switch, and opens one holding path to the called subscribers channel. The channel to the called subscriber will be held operated through the S relay operated and the RC relay released.

The CO relay released with S relay operated establishes a path to the heater element of the thermo controlled RL relay. In 13-32 seconds, the RL relay operates and causes the RC relay to operate. The operated RC relay opens the path to the called subscribers channel. This releases the channel which opens the T and R to the trunk. The open T and R leads release the S, RC, and RL relays and restores the trunk to normal.

SECTION D, PART 8
SPECIAL MARKER OPERATIONS

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D8 SPECIAL MARKER OPERATIONS

There are certain test calls that require special handling. The first two CMs in a marker group are equipped as special markers to handle these calls. Some of these are No-Test, No-Hunt, and Special-Hunt calls.

No-Test calls originate from a local or central DSA switchboard or test desk. These calls establish a connection between an IT (incoming trunk) and a busy line.

No-Hunt calls originate from the message register rack or master test control circuit. These calls test line message register operation and line failures.

Special-Hunt calls originate from a local or central test desk and are used to make voltmeter and other miscellaneous tests.

D8-1 ESTABLISHING THE CONNECTION

After the IR is attached to the trunk and ready to receive pulses, the numerical digits of the called line are dialed or keyed. The IT special class informs the IR by way of the IRL that a special marker is needed. The PC (preference control) circuit then selects a special CM (completing marker) and the CM is informed by the IRMC of the special nature of the call. The IT also tells the CM the type of special call by operating the no-test, no-hunt, or special-hunt relay. On no-hunt and special-hunt calls after marker seizure and preference are completed, the call is similar to a regular TER call except that the CON and GT tests are cancelled. On no-test calls after marker seizure and preference are completed and if the called line is busy, it is necessary to use the NTC circuit to connect the no-test IT to the called line. In offices that are equipped with message register operation, it is necessary to guard against false operation of the called line message register by the no-test circuitry.

The remainder of the NT call is similar to a regular TER call except that the CON and GT tests are cancelled.

D8-1.1 MARKER SEIZURE (SFD-D804)

After the IR (incoming register) is attached to the IT by the TP- relay in the IRL (incoming register link) the CLS relay in the IR operates. The class of the IT is determined by the TPC-- to CLO-10 cross connect in the IRL frame. The CLS relay operating causes the SPL relay in the PC circuit to operate which operates the CB- relay in the PC for all non-special markers in the same connector. Thus, the only markers in the connector available for seizure are the special markers. After the marker connector relays have operated, the SPL relay in the PC operating extends ground over the SPL lead into the CM to operate the SPL, SPL1 relays which tells the CM that this is a special type call.

D8-1.2 SPECIAL MARKER PREFERENCE CONTROL (SFD-D804)

The SPO-2 relays in the MTFC circuit are provided to allow only one special call to proceed in case of simultaneous overlapping attempts by two or more circuits. These relays are associated with special markers 0(SPO), 1(SP1), and the MTC (SP2). They are wired so that the lowest SP- relay is perferred and operated from marker battery on the corresponding SP lead. The highest SP- relay is in the preferred position for returning ground on its SPC lead.

D8-1.3 INCOMING TRUNK AND RINGING SWITCH CONTROL (SFD-D805)

The IT indicates to the CM through the TLC (trunk link connector) the type of special call by grounding the NT (no-test), NN (special-hunt), or NH (no-hunt) lead, thus operating the associated relay. Ringing switch control is handled in the usual manner (SCD-D6-4).

D8-1.4 LINE IDLE AND LINE BUSY TESTS (SFD-D806)

The LI and LB tests are made and the call proceeds to take the appropriate action. On no-hunt and special-hunt calls if the called line is idle or busy the call proceeds similar to a regular TER call. On no-test calls if the called line is idle the call is similar to a regular TER call, but if the called line is busy the NTT relay in the CM operates calling in the no-test train..

D8-2 NO-HUNT AND SPECIAL-HUNT CALLS

The no-hunt and special-hunt calls must use special markers 0 and 1. No-hunt calls originate from the message register rack and MTC circuit, and test the operation of line message registers and test for line failures. Special-hunt calls originate from a local or central test desk and make voltmeter and other miscellaneous tests. Marker seizure and preference control are as described in D8-1.1 and D8-1.2. The IT indicates to the CM the type of special call by grounding a NH (no-hunt), or NN (special-hunt) lead (SFD-D805).

On a no-hunt call if the called line is busy, the IT sets the call to a busy condition.

On a special-hunt call, the operated SPH relay in the marker permits terminal hunting. A connection may be established to the called line in the terminal hunting group if the line is idle. If the called line is busy, the marker selects the next preferred idle line within the terminal hunting group. If all lines within the hunting group are busy the marker starts the operations required to cause the IT to return a busy tone.

D8-3 NO-TEST CALLS

No-test calls must use special markers 0 and 1. No-test calls originate from a local or central DSA switchboard or test desk. They establish a connection between an IT and a busy line. The CM seizure and preference control are as described in D8-1.1 and D8-1.2. The IT indicates to the CM the type of special call by grounding the NT (no-test) lead (SFD-D805).

On no-test calls if the called line tests busy, the marker sets up a connection to the called line through the no-test connector and no test vertical on the line link frame. If the called line tests idle, the call proceeds similiar to a TER terminating call.

D8-3.1 NO-TEST, CALLED LINE BUSY

A called line busy condition indicates to the marker that a connection exists between the called line on the LL and a trunk on the TL. When the called line is busy, the marker is unable to establish a connection between the incoming trunk and the called line in the usual method. A NTC circuit provides means for connecting the no-test trunk to the busy called line. The NTC circuit consists of a crossbar switch having its horizontals connected to the no-test verticals on the LL frames (SFD-D808). By operating the proper NTC select and hold magnets and the proper LL line switch select and no-test vertical hold magnets, a connection can be made between the no-test incoming trunk and the LL on which the busy line is located.

D8-3.1.1 Connection of the No-Test Trunk to the Called Line Through the No-Test Connector

When the marker determines that the called line is busy, the LBTA (line busy test auxiliary) relay operates. The operated LBTA relay operates the NTT (no-test train) relay in the completing marker. The NTT initiates the operations required for connecting the no-test incoming trunk to the called line through the NTC circuit.

Upon seizure of the special marker, the SPL relay operates the NTC (no test timing) relay in the marker (SFD-D804). Although the NTC relay is operated on all special calls it is used only when the marker completes a no-test call via the NTC circuit. The slow release NTC relay is operated at this time to give it sufficient time to become fully saturated to make its long release time effective. The NTC relay is used to time the seizure of a channel from the time a low positive potential of 10 volts is applied to the line links until the channel is selected. When failure to detect a channel occurs, or if the CH- relay fails to operate, the NTC relay releases to operate the BY relay and the call is set to busy tone.

After the F relay in the no-test IT operates, the NT relay in the completing marker operates (SFD-D805). This causes the NTH (no-test hold magnet) relay to operate which starts the operation of the slow operate NTR relay (SFD-D804). The NTH relay tests for an idle no-test junctor between the LL and NTC during the NTR relay slow operate time. The NTH relay extends the no-test connector H- hold magnet operate ground from the no-test IT over the NT lead through the LLC into the marker to operate the JB (junctor busy) relay if the no-test junctor is busy (SFD-D808). The JB relay operates the marker OV relay and overflow tone is returned by the trunk. If the no-test junctor is idle the NTR (no-test release) relay operates which in turn operates the NT5 relay.

The NT1 through NT5 relays operate to control the necessary circuit operations when the call is to be completed via the NTC. When the CHT relay operates after the channel test is made, and the NTT relay has operated, NT1, NT2, NT3, and NT4 relays in the CM operate.

D8-3.1.2 Identification of the Line Link (SFD-D808)

To make a connection between the LL no-test vertical and the called line, it is necessary to identify the line link connected to the called busy line. The sleeve conductors of the five lines within the selected line group are extended from the LL to the marker over the LH0-4 leads. The NT3 and NT4 marker relays operated cause a +10 volt potential to appear on the one busy sleeve of the called line. This low positive voltage is obtained by the voltage divider effect of the NT1 and NT2 resistors (SFD-D808). Tests leads designated LL0-9 are extended to the marker from the group of ten line links, within which the line link connected to the called line is located. In the marker, the LF0-9 (line link frame identifier) relays test for the presence of the +10 volts on the LL0-9 leads. One LF0-9 relay is operated. The operated LF0-9 relay operates the corresponding CH0-9 relay which operates the CHA and CHA1 relays (SFD-D809).

D8-3.1.3 No-Test Connection to Busy Line

The CM operates the F relay in the no-test IT over the F lead via the IRMC and IRL frames (SFD-D805). The F relay then operates the F1 relay in the no-test trunk which extends ground over the JC0-7 leads into the NTC circuit to operate the associated S- select magnet. The CH0-9 relay also operates the CHA, which releases the NTH relay. Ground is then extended from the CM over the NT lead to the NTC circuit to operate the H- hold magnet (SFD-D808). The H- hold magnet make contacts in the NTC extends its operating ground into the LL frame over the H lead to operate the NT hold magnet. With the H- and NT hold and L- select magnets operated, crosspoints are established between the LL and NTC, and the busy sleeve ground is extended into the no-test IT over the S lead to operate the H relay. Relay H provides a holding ground over the H lead for the H- and NT hold magnets.

After the channel has been selected and the NTH relay releases, the slow release NTR relay starts to release. The slow release of the NTR relay allows sufficient time for the operation of the hold magnets in the NTC and LL, along with the H relay in the no-test IT, before the LK1 relay in the CM is operated. The operation of the LK1 relay causes the marker DIS1, DIS2 relays to operate which releases the marker.

After the marker releases, no-test connection is maintained until either the operator or test deskperson disconnects, or the busy condition of the called line is removed.

D8-3.2 NO-TEST CALLS WITH MESSAGE REGISTER OPERATION

Message register operation is provided in an office to count the number of originating calls completed by a line. A message register is associated with a particular sleeve lead. On SOG and ITR calls the message register operates from potential provided by the trunk after the called customer answers. On no-test calls it is necessary to insure that the no-test connection does not interfere with the normal operation of the message registers.

On special calls the SPL relay operates in the CM. This causes the MN1 (monitor for no-test) relay in the marker to operate. Although the MN1 relay operates on every special call it is only used when the marker completes a NT call via the NTC and the office is equipped for message register operation.

D8-3.2.1 Message Register Potential Detected Early on Sleeve

On a no-test call if message register potential is detected on the sleeve after the NT1 operates, but before the NT3 relay operates, the message register potential will be extended from the LL to the CM over the LL0-9 lead and the associated PT0-9 tube conducts.

After the PT0-9 tube conducts, the MPT relay in the CM operates which releases the NT2 relay. The NT2 relay releasing prevents the marker from advancing to the point where a +10 volts is applied to the sleeve to operate the LF0-9 relays. When the message register potential is removed from the LL0-9 leads, the PT0-9 tube and MPT relay release reoperating the NT2 relay in the CM. The NT3 and NT4 relay then operates and a +10 volts from the voltage divider circuit is applied to the LH0-4 lead through the LL frame and over the LL0-9 lead to operate the LF0-9 relay in the marker. The operated LF0-9 relay operates the corresponding CH0-9 relay which operates the CHA and CHA1 relays (SFD-D809).

D8-3.2.2 Message Register Potential Detected on Sleeve while the LFO-9 Relays are Connected to the Line Links

On a no-test call if message register potential is detected on the sleeve after the NT3 relay operates and the +10 volts is extended to the LLO-9 leads, the M- (monitor for no-test) relay in the CM operates. The operated M- relay releases the NT1 relay and locks through its secondary winding in series with the MN relay in the marker, which also operates. The released NT1 relay releases relays NT2, NT3, and NT4 and removes the shunting effect of the LFO-9 relays from the 10 sleeve conductors. If this shunt is not removed the message register potential is reduced below that required to operate the message register. Relay MN operating releases relay MN1, which releases relay M- and MN. The MN1 relay reoperates and operates relay NT1, which connects the sleeve conductors through to the PTO-9 tube. If message register potential is still present on the sleeve, the associated PTO-9 tube conducts and the marker functions are as in D8-3.2.1. If no message register potential is present on the sleeve the marker proceeds to identify the LL by operating the LFO-9 relays.

D8-4 SIMULATING SPECIAL CALLS FROM THE MTC CIRCUIT

To test the special features of markers 0 and 1, the MTC circuit simulates the functions of special incoming trunks. The SPL key on the MTC panel is operated to inform the marker of the special nature of the call. The SPL key operates the SPL and SPL1 relays in the marker and the MTC then operates its F relay.

D8-4.1 SIMULATING NO-HUNT CALLS

On no-hunt calls with the F relay and NH key operated in the MTC, the NH relay in the marker operates. With the LB and LBL keys normal, simulating called line idle, the marker sets up a connection to the called line. With the LB key operated, simulating called line busy, the marker does not hunt and sets the relays simulating the RSW (ringing switch) in the MTC for a busy.

D8-4.2 SIMULATING SPECIAL-HUNT CALLS

On special-hunt calls with the F relay and NN key operated in the MTC, the SPH relay in the marker operates. The marker then hunts and establishes a connection to an idle line within the terminal hunting group. If all lines within the hunting group are busy, the marker sets the relays simulating the RSW in the MTC for a busy.

D8-4.3 SIMULATING NO-TEST CALLS

On no-test calls with the F relay and NT key operated in the MTC, the NT relay in the marker operates. With the LB and LBL keys normal, simulating called line idle, the marker sets up a connection to the called line in the normal manner. With the LB key operated, simulating called line busy, the marker proceeds to set up a connection to the called line through the NTC. The operated MT16 (marker test) relay transfers the LL0-9 and LH0-4 (NTLH) leads from the LL to the MTC circuit. When the marker applies a +10 volts to the NTLH lead, it extends into the MTC circuit through the NA resistor and operated S0-9 key or switch to the LL0-9 lead into the marker to operate the LF0-9 relay. After the LF0-9 relay operates, the marker proceeds to set up the no-test connection. When testing from the MTC, the NTC hold magnet is operated, but, because the no-test IT is simulated, the select magnet in the NTC is not operated.

D8-4.3.1 Simulating No-Test Calls with Message Register Operation

The MTC circuit provides a means for testing the ability of the CM to detect message register potential on the sleeve when completing a no-test call. This is done by testing the operation of the marker PT0-9 tube, the PTL tube, and MPT relay.

The operated MT16 (marker test) relay transfers the LL0-9 and LH0-4 (NTLH) leads from the LL to the MTC. After the marker NT1 relay operates the PT0-9 tubes are connected to the LL0-9 leads. The MTC connects a positive potential from the voltage divider circuit to the LL0-9 leads by way of the make contacts of the NTT relay, break contacts of the LF1 relay, the PTL key normal, and S0-9 key or switch operated. The corresponding PT0-9 tube in the CM will then conduct. The PT0-9 tube conducting operates the MPT relay in the CM which operates the MPT relay in the MTC circuit. THe MPT relay in the MTC operating removes the positive potential from the LL0-9 leads, thus releasing the PT0-9 tube and MPT relay in the CM.

When the marker NT3 and NT4 relays operate a +10 volts is transmitted over the NTLH lead into the MTC circuit which operates the LF relay. The operated LF relay in the MTC circuit operates the LF1 relay in the MTC. The LF1 relay operating releases the MPT relay in the MTC. With the LF1 relay and S0-9 key or switch operated, the MPT relay normal in the MTC connects a positive potential to the LL0-9 lead which operates the M0-9 relay in the CM. The operated M0-9 relay releases the NT1 and operates the MN relay in the CM. The marker NT1 relay releasing removes the marker +10 volt potential from the NTLH lead. With the positive potential removed from the NTLH lead, the LF relay in the MTC releases. The LF relay releasing operates the M relay in the MTC. The operation of the M relay reoperates the MPT relay in the MTC circuit. The operated marker MN relay releases the MN1 which releases the M0-9 and MN relay in the CM. The MN relay releasing reoperates the marker MN1 relay which operates relay NT1 and once more the PT0-9 tubes are connected to the LL0-9 leads. The MTC again connects a positive potential to the

LL0-9 leads from the voltage divider circuit and with the PTL key normal, the PT0-9 tube in the CM conducts. The PT0-9 tube conducting operates the MPT relay in the CM which operates the MPT relay in the MTC circuit. The MPT relay in the MTC operating removes the positive potential from the LL0-9 leads, thus releasing the PT0-9 tube and MPT relay in the CM. With the marker NT1, NT3, and NT4 relays operated, a +10 volts is applied to the NTLH leads into the MTC circuit through the M and MPT relays operated, and with the S0-9 keys or switch operated the corresponding LF0-9 relay in the CM operates. After the LF0-9 relay operates, the marker proceeds to set up the no-test connection.

With the PTL key operated in the MTC this test is as previously described except that an operate test of the PTL tube in the CM is substituted for the operate test of a PT0-9 tube by transferring the positive potential from the LL0-9 lead to the NTLH lead.

SECTION D, PART 9

MAINTENANCE

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D9 MAINTENANCE

This part of the D section covers some of the aspects of the use of the master test control frame to detect, locate, and clear trouble on incoming type calls.

D9-1 USE OF THE MASTER TEST CONTROL FRAME TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORDS

Analysis of trouble record cards using the trouble analysis chart and sequence charts of part D0 localizes the trouble to an area which may involve a path through one or two relay contacts within one circuit or may involve a path through many relay contacts in several circuits. Generally, it is not possible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a fraction of a second during marker holding time. Frequently, the path which produced the failure is only used when a particular configuration of circuits or network paths are used. For this reason, it is desirable to be able to reproduce the same condition which caused the trouble in the first place. The master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

D9-2 USE OF SIMULATION TABLE AND ILLUSTRATED TROUBLE RECORD CARD

The purpose of simulation tables on SFD-D902, D904, and D906 is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame which should be operated to provide the input or control to the CM when simulating a trouble record card. Included is the trouble card designation location for the different types of trouble cards for easier reference. The three types of trouble record cards illustrated are E-5488 (2/x double sided) E-4393 (1/x double sided) and E-3638 (1/x single sided) shown on SFD-D903, D905, and D907 respectively.

The drawing in SFD-D903, D905, and D907 depict a trouble record card which includes all the possible designations (colored) which might be perforated on a record produced by an incoming type call (TER). A color key arrangement has been used to indicate the different functions of designations regarding marker input or output information, progress of call, circuits or paths used, etc.

D9-2.1 FUNCTIONS OF INCOMING CLASS OF CALL (TER)

One of the tables on SFD-D902, D904, or D906 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left-hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right-hand side of the chart list the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangement and their relationship to the trouble designation for each of the functions listed in above tables.

(a) Select the TER class of marker test, by operating the INC, IR, ITNP, LT, or MLV key, if provided, or the TSTA or TSTB switch to the required position.

(b) Select the class of call according to office A or B, physical or theoretical, and whether four or five digits are required.

(c) Use the proper incoming trunk class according to the class of call. Only local charge (LCH) trunk classes are shown.

(d) To simulate a special incoming trunk, the special key (SPL) must be operated to provide the marker with information normally supplied by an incoming register connected to a special incoming trunk. In addition, the NH key should be operated to simulate a no-hunt trunk. The NN key should be operated to simulate a trunk which is neither no-test nor no-hunt. The NT key should be operated to simulate a no-test trunk and one of the S (0-9) key or switch should be operated to direct the marker to the desired hunting features.

(e) Select the particular CM which produced the record card.

(f) Digits A (0-9) through E (0-9) should be operated to simulate the called number registered on the trouble record card. This chart is confined to four or five digit numbers. Also shown are the NGCU(0-9), HN(0-9), T(0-9), and U(0-9) which may be indicated on the trouble record card if the trouble record is taken during number group failure.

(g) Trunk link frame selection is simulated by the operation of FS(0-9) key or switch in conjunction with the FG(0-2) key which indicates tens digits of the trunk link frame. On incoming calls, the FG(0-2) and TF-2/5 indicates trunk link frame used.

(h) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk link switch of a trunk link frame is defined by channel number of junctor group.

(1) Operation of a CH(0-9) key or CH(0-9) switch will direct the CM to select that channel number.

(2) Selection of a particular junctor group is not quite as straightforward. Reference should be made to the chart of SFD-D908 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in two or more junctor sequence positions and is dependent on junctor step position 1 or 2.

(3) The JSQ(0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ(0-5) key or switch might be set in any of several positions to select the desired junctor group.

D9-3 USE OF CLASS OF TEST TABLES

The class of test tables shown on SFD-D910 through D915 summarizes, in tabular form, the key(s) and switch(es) used to establish the particular class of test. A single line is used to separate a particular function with its associated figure, option, key, or switch. The double line within the single lines is used to separate the various options on vintages of master test control frames. The note column and sheet notes are as follows:

(a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment be selected for test.

(b) Note 2 indicates that the key(s) or switch(es) to be used to simulate the trouble record. Refer to simulation tables on SFD-D902, D904, or D906 and their associated colored trouble record card on the opposite pages (D903, D905, or D907) of the simulated table selected. The tables and colored trouble record cards, along with the class of test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.

(c) Note 3 indicates those key(s) or switch(es) used for additional marker tests, but they are not necessarily required for trouble record test or simulation test.

D9-4 INCOMING CLASS OF MARKER TEST (SFD-D910, D911)

On incoming class of marker test, the master test control circuit simulates an incoming trunk, incoming register, and incoming register marker connector. Through the operation of control key(s) and switch(es), the marker is primed with called number, trunk link location, and other information which it would normally receive from the incoming register.

The marker then functions in accordance with the information with which it is primed to establish a connection from the called line location to the trunk link frame on which the trunk is made to appear. Operation of the trunk link hold magnets is simulated.

The operation of the line hold magnet is simulated if the NTC key is not operated. If the NTC key is operated, the no-test hold magnet in the associated horizontal group is operated to extend the channel connection back to the master test control frame.

Once incoming class of marker test is established, other test features of the marker can be tested with various key(s) and switch(es) such as link release, reorder, double connection test, and continuity and ground tests. The PBX and EBH hunt features of PBX lines can also be performed along with PBX allotter features.

Special marker test for no-test, no-hunt, and neither no-test nor no-hunt can also be tested.

D9-5 SUBSCRIBER LINE CLASS OF TEST (SFD-D912)

The subscriber line class of test is used to set up a connection from the master test control frame voltmeter test circuit to any line to be tested. The master test control frame simulates a no-hunting incoming trunk that has an appearance on a trunk link frame and an incoming register. It extends this trunk to the master test control frame voltmeter test circuit where tests for foreign potentials, crosses, leakage, and opens are made.

After the master test control frame has seized the selected marker through the master test frame connector, the MTC provides the marker with the necessary information to set up the connection. The marker proceeds to seize the selected line and to establish a connection between the line and the simulated trunk. When the connection is established, the marker operates the line hold magnet and then releases. The connection is held under control of the MTC and the voltmeter test circuit. The test personnel can apply the necessary test on the line, which includes ringing, talking, and listening from the master test control frame telephone set.

D9-6 MARKER LINE VERIFICATION CLASS OF TEST (SFD-D913)

The MLV (marker line verification) class of test is used to verify the cross-connections in the number group and class-of-service cross-connections in the line link frame for any line and for intercept and similar trunks to which arbitrary class of service and line number have been assigned.

A complete MLV test is made in three stages

(a) First Stage - the test circuit connects to a marker and matches the line location, tens block, terminating treatment, and ringing control information which the marker receives from the number group and class-of-service information which it receives from the line link frame against information previously set up on keys and switches. Lamps are lighted to indicate verification match or failure. If there is a match and if the TLV key had been operated at the start of the test, the test circuit recycles to stage 2.

(b) Second Stage - consists of directing a marker to set up a connection to a sender and priming it with the line location and tip or ring party identification from the same keys which were used to verify the line location and rering control cross-connections of the number group. When the connection to the sender has been set up and the marker gives a release signal, the test circuit recycles to stage 3 to be ready to be connected to a transverter which the sender will have seized.

(c) Third Stage - the transverter which was seized by the sender connects to the test circuit and to a translator to which it transmits the line location. The test circuit verifies that the line number (which the transverter receives from the translator) matches the line number being verified.

The MLV test, first stage, verifies the number group and line link crossconnects and is discussed in SCD-D9-8.1.

D9-6.1 FIRST STAGE - VERIFICATION OF LINE CROSS-CONNECTIONS IN NUMBER GROUP AND LINE LINK FRAME

The numerical digits, the line location, the ringing combination, and the office code (in terms of office A or B) of the line to be verified, are set up on keys and switches of the MTC. The test circuit, simulating a no-hunt incoming trunk and incoming register, connects to and primes a marker with the office indication and the number of the line. The marker connects to a number group to obtain the line location and then connects to the line link frame to which it is directed by the number group. The line location and ringing combination received from the number group and the class of service received from the line link frame are matched against the operated keys of the test circuit. If there is a mismatch, a MLVF (marker line verification failure) lamp is lighted and a trouble record is taken which indicates the mismatch and the actual line cross-connection. If there is a match, a MLVM (marker line verification match) lamp is lighted but a record is taken only if the REC key is operated.

D9-7 INCOMING REGISTER CLASS OF TEST (SFD-D914)

On an IR (incoming register) class of test, the MTC is used only to provide the called number and certain incoming class information which the IR normally receives from the IRL (incoming register link) circuit. The IR group key(s) or switch(es) of the AMRST (automatic monitor register sender test) circuit are operated to prepare the MTC for selection of the incoming register group and IR to be tested. Also, various key(s) for test conditions of IR and IRL, and selected speed of pulsing are operated.

The test circuit seizes the desired IR through the special test appearance at the IRL. In each IRL group, the "0" vertical of horizontal group 0 is reserved for the AMRST appearance. The test vertical appears in the IRL group in the same manner as an incoming trunk. The AMRST calls for the desired IR through the trunk preference chain in the IRL group as an incoming trunk does. When the AMRST has seized the IR, it makes preliminary tests and then pulses the called number into the IR.

After the number is pulsed and recorded in the IR, it seizes its associated IRMC and selected marker. The called number is then passed to the marker and AMRST circuit through the MTFC. The AMRST matches the received called number with the number received from the MTC frame. If they match, the OK lamp lights on test panel. Failure to match results in the TBL lamp lighting and a trouble record card is perforated.

On this type of test, the marker does not establish any connections to line link or trunk link frames.

D9-8 INCOMING TRUNK TEST - NO PULSING (ITNP) CLASS OF TEST (SFD-D915)

The ITNP test is used for testing incoming trunks in the No. 5 crossbar office. Before proceeding with the test, the trunk test circuit is patched to the incoming trunk to be tested. The MTC (master test control) frame connects to the trunk test circuit and signals it to prepare for an ITNP class of test.

The trunk test circuit closes a loop on the tip and ring leads to the incoming trunk and grounds its D lead. The trunk connects to an incoming register and extends the grounded D lead which causes the register to recognize that it is handling a test call. The register connects to a marker without waiting for a number to be pulsed and operates the TST relay in the marker as a test signal. The marker, upon receiving the test signal, connects through the master test control circuit which supplies the number of the line that must be connected to the trunk. The marker proceeds to set up a connection from the incoming trunk to the line location determined by the MTC.