

TRUBLE ANALYSIS
 NO. 4A TOLL SWITCHING OFFICES

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		<u>1. GENERAL</u>	
		1.01 This section covers suggested pro- cedures of analyzing troubles in a No. 4A toll switching system. It is divided into four parts as follows:	

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Part 1 is a general discussion of trouble analysis.

Part 2 describes the No. 4A trouble recorder card by divisions.

Part 3 describes aids for trouble analysis.

Part 4 deals with analyzing and locating troubles and illustrates typical troubles.

1.02 The standards of design, manufacture, installation, and maintenance of a No. 4A toll office combine to provide a high grade of service. Even with such precautions, however, irregular operating conditions do occur. Consequently, it is necessary that the maintenance forces judge whether an irregular operating condition is the result of trouble or overload conditions. If the condition is due to trouble, it must be promptly analyzed and cleared.

1.03 The analysis and location of troubles is based on the use of operational sketches (OS's), sequence charts (SC's), and reference material (RM's) as listed in Section A128.819. Where the OS's are not adequate for completing trouble analysis, reference should be made to the schematic drawings (SD's), circuit descriptions (CD's) and other drawings such as wiring lists, etc.

1.04 Whenever a decoder, marker, or controller encounters a trouble in the completion of a service or test call, the circuit endeavors to connect to the trouble recorder and leave a record on a trouble record card. An attempt to connect to a trouble recorder or to leave a record will be made when these circuits detect false grounds or crosses on certain leads.

1.05 The purpose of the trouble recorder is to indicate as nearly as possible the source of trouble encountered during the completion of a service or test call. The trouble recorder may also be utilized on test calls to register progress of the call. For the operation of the trouble recorder see Section A728.101.

2. DESCRIPTION OF THE TROUBLE RECORDER CARD

2.01 The trouble recorder card form E-3825 is illustrated on Fig. 1, attached. The lettered numerals, such as S8, on the side of the card correspond to the scanning relay number in the trouble recorder and the row number of the card as used in describing the card. The numerals on the top of the card correspond to the scanning relay contact numbers and to the punch position for each row.

2.02 The lettered numerals, together with the punch position, provide the card coordinate. For example, S8 0 indicates punch position 0 in row S8.

2.03 The divisions of the card indicated by the heavy lines group the same general type of information. For purposes of the explanation herein, the card as shown on Fig. 1 has letters arbitrarily assigned to each one of these divisions.

2.04 The card divisions (by the heavy lines), as for example "A", are further subdivided by light lines. Each group thus formed is suitably designated to provide the indications of the punchings. For example, in row S8 punch positions 0 to 6 indicate the "Source of Record".

2.05 To facilitate locating the punch designations on the operational sketches, certain group names have letters added in parentheses. (These letters are not provided on the actual cards.) As an example, the designation (TE) is added after translator engaged in row S5. The punch 0 on row S5 is shown as "TE H" on the OS's. Likewise punch 4 in this same row is shown as "TE T1" and so forth. However, where no conflict in punch designations is probable, the punch designation as shown on the actual card is used. As an example, the CKG punch in position 0, row R2, under decoder progress and the CKG punch in position 15, row R1, under marker progress are used on the OS's without the supplementary designations.

2.06 A brief description of the information given in the divisions formed by the heavy lines on the card is given below. This is followed by the trouble analysis chart which gives a description of each punch position of the card.

2.07 Division A indicates the source and type of record and the particular decoder, marker, sender, translator and decoder connector involved on a trouble record.

2.08 Division B indicates the code bar operating leads which are grounded to the card translator and the code bars which were operated in the card translator.

2.09 Division C indicates the miscellaneous leads grounded by the sender to the decoder, which miscellaneous code bars were operated in card translator, and the route advance information supplied to the decoder and marker.

2.10 Division D indicates the complete card output as read by either the decoder or marker.

2.11 Division E indicates routing instructions which were set up in the decoder and in the marker, and were transmitted to the sender. Also shown here are the frame identification frequencies as recorded in the marker.

2.12 Division F indicates decoder and marker progress points. (See Figs. 2 and 3.)

2.13 Division G indicates the check relays which were operated to show satisfactory transmission of information from the marker to the sender.

2.14 Division H indicates the decoder or marker cross-detecting (X-) relays operated and the position of decoder and marker timing circuits.

2.15 Division I indicates the particular trunk block connector, trunk block, and position of the selected trunk in the trunk group (sometimes called terminal number).

2.16 Division J indicates the particular incoming frame, the odd or even frame, the incoming switch, and the select magnet on the incoming frame.

2.17 Division K indicates the outgoing frame, the odd or even frame, the odd or even connector, and the switch on the outgoing frame. It also indicates the odd or even incoming connector, the odd or even trunk block connector, and the connector preference of the marker. Also shown is the number of the junctor control and junctor pattern relays operated, the channel selected, and the position of the junctor walking circuit.

2.18 Division L indicates the class of call and certain test results as set by the decoder-marker test circuit.

2.19 Division M indicates the particular controller equipment used, the controller progress points, the controller cross indications, and the test results by controller test circuit. (See Fig. 4.)

3. AIDS FOR TROUBLE ANALYSIS

(A) General

3.01 Trouble analysis is the examination of all trouble indications that are present to help in locating any defective equipment or apparatus. The existence of trouble may be manifested in a number of different ways, such as alarms, lamp signals, trouble recorder cards, reports from the test board or traffic operators, routine tests, etc.

3.02 The analysis of certain troubles, such as a blown fuse, etc., are simple since the indications are direct.

Other troubles, however, are complex and therefore are more difficult to analyze. The troubles indicated by the trouble recorder cards are generally of this type.

3.03 Trouble analysis for the more complex troubles is broken down into two stages, namely: over-all analysis, and detailed analysis.

3.04 Over-all analysis is applied when a trouble condition is manifested by a trouble record card being punched for an irregular operating condition. In this analysis an attempt is made to assign the trouble to a particular unit of equipment as "controller 6" or "IT marker 4". The switchman's attention is then directed to the circuit function that probably failed in the equipment unit, for example, marker continuity failure. The complete over-all analysis of troubles obtained from trouble record cards is generally made in the maintenance center.

3.05 Knowing the faulty circuit function and the particular equipment unit involved, the switchman's attention is then directed to locating the fault. This is called detailed analysis and is usually made at the equipment unit in trouble. For example, a trouble record card was punched because in IT marker 4 the RCK relay failed to operate. The detailed analysis involves a check of the operating path of the RCK relay in marker 4 to locate the cause of the failure.

3.06 The following paragraphs describe the drawings which are used to locate trouble and they also give some general rules that will help the switchman in examining troubles.

(B) Drawings, Charts, etc.

3.07 The sequence charts (SC's) as listed in Section A128.819 are a valuable aid for use in trouble analysis. They should be referred to whenever there is any doubt as to the sequence of operation of the circuit being analyzed. By using the sequence charts the progress of the call recorded on the trouble record card or trouble report can be traced. The trouble punches are indicated on the SC's so that the punches on the cards can be easily located.

3.08 The operational sketches (OS's) as listed in Section A128.819 are another valuable aid for use in trouble analysis. The OS numbers that show the circuits for trouble recorder card punches are given on the abbreviated sequence charts (see Figs. 2, 3 and 4), and on RM's 3-10, 3-11 and 3-12 as listed in Section A128.819.

3.09 The reference material, RM 1-1 to RM 1-20, as listed in Section

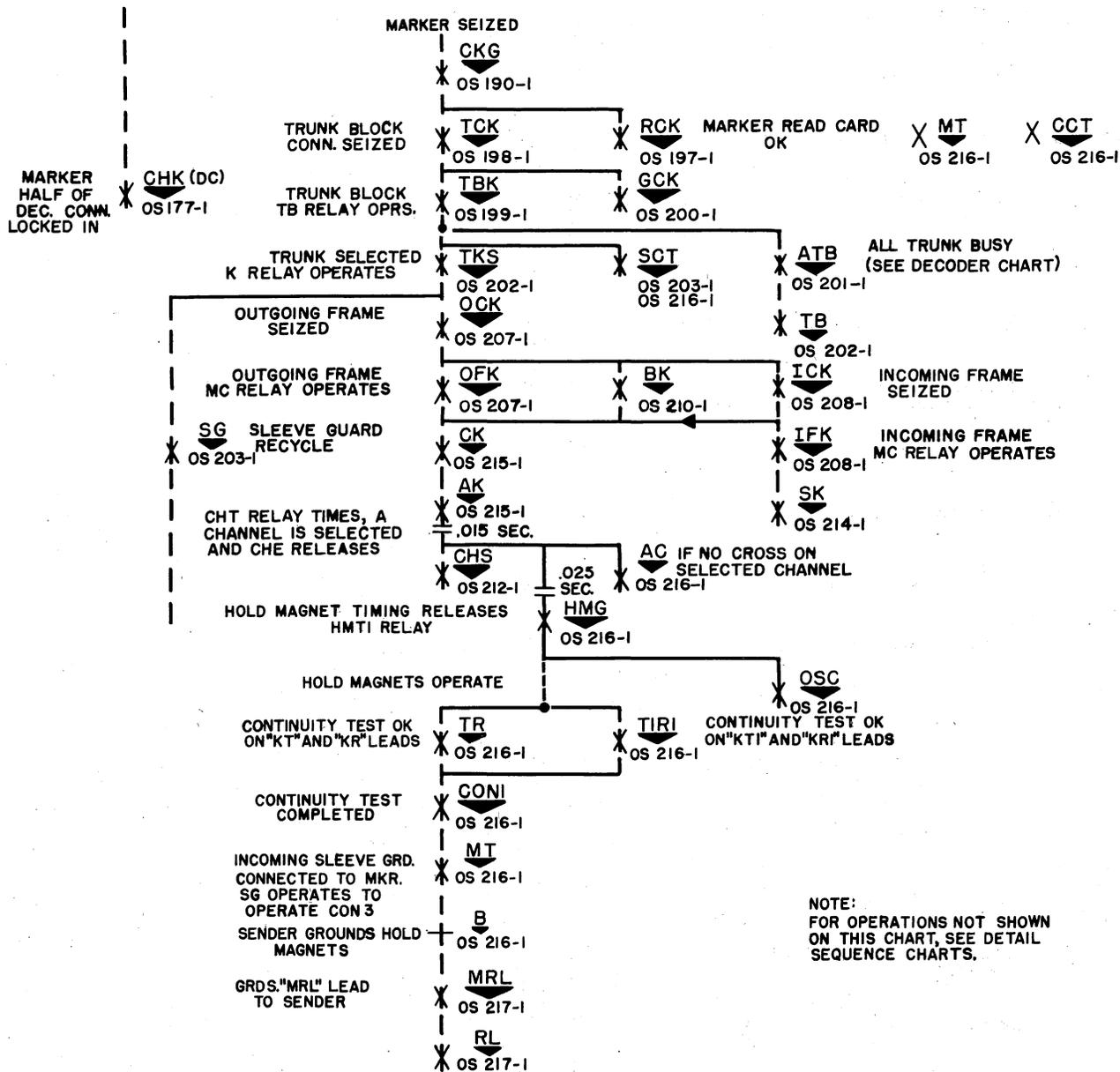


FIG. 3-ABREVIATED SEQUENCE CHART
MARKER PROGRESS POINTS

NOTE:
FOR OPERATIONS NOT SHOWN
ON THIS CHART, SEE DETAIL
SEQUENCE CHARTS.

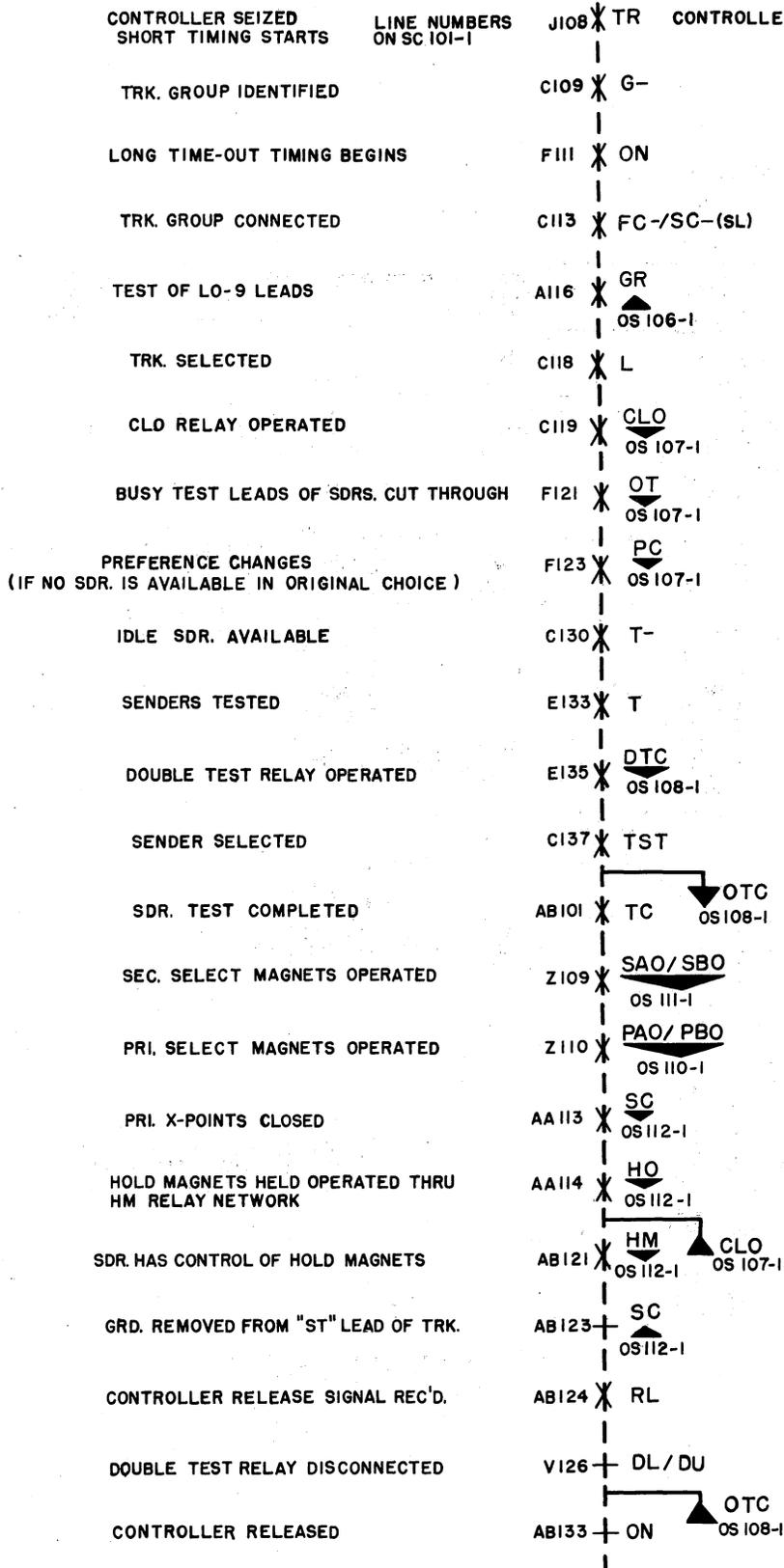


FIG. 4- ABBREVIATED SEQUENCE CHART
CONTROLLER PROGRESS POINTS

A128.819, index the relays by equipment units and list the OS that has the operating path of the relay.

3.10 The index of the SC's, OS's and RM's as shown in the checking list for Section A128.819 should enable the switchman to locate the proper OS for any function.

3.11 The SC's and OS's alone may not be adequate for a complete trouble analysis if a particular trouble is encountered for the first time. For example, if a card shows a continuity failure it may be helpful, and sometimes necessary, to read the part in Sections A828.121.1 to A828.121.18 which describes this operation. Section A828.121.2 supplies a detailed description of the operation with reference to the OS's and SC's showing the simplified circuit and its operation. If this description is not adequate, the circuit description (CD) of the circuits involved may give the needed information.

3.12 Schematic drawings (SD's) are needed at times to locate a particular relay when it is one of several of a kind, to identify certain multiple paths, or in any other case where the OS does not supply sufficiently detailed information.

3.13 The sections, or charts, on taking equipment out of service give the switchman directions for making busy and isolating a faulty unit of equipment.

3.14 The sections, or charts, on methods of handling alarms and other signals will aid the switchman in locating certain types of troubles.

(C) Test Frames and Equipment

3.15 Test calls aid in trouble location by checking the results of card analysis, trouble reports, or alarm signals. When the analysis identifies a possible source of trouble, test calls establish the results of the analysis by indicating whether or not the suspected source was the actual cause of the failure. If a trouble card analysis is not adequate for trouble location, test calls are used to examine possible causes of the trouble. Finally test calls check that the trouble has been cleared and that operations are proceeding normally. A 32A test set is generally used when test frames are employed. It can be used to start and release a test connection from any frame in the central office by means of remote control jacks. A headset, preferably a high resistance type, is used to check for battery or ground. If testing for ground, it is advisable to use a high resistance headset since large current flow may damage the receiver. A 528- or a 716-type headset may be modified for this

purpose by placing a small 1/2-watt resistor of approximately 10,000 ohms in series with the receiver. A small switch to bypass the resistance is also desirable, thus making the headset more flexible in its uses.

(D) Making Equipment Busy

3.16 If one piece of equipment indicates a failure which is affecting a large number of calls, its rapid removal from service is essential until the trouble is located and cleared. Where a failure is affecting a large number of calls and the defective equipment is not evident, a rapid check may be made by removing certain suspected circuits from service for short periods of time. Whenever this is done, the circuits that are made busy should be under very close observation by the person making them busy.

3.17 It is essential that service be restored as quickly as possible to prevent a back-up of traffic that will extend to and affect many other toll centers.

3.18 Under extreme conditions where a major piece of equipment is failing and affecting the calls in the entire office, its removal from service is necessary. Where such a removal is necessary, it should be done with extreme caution and under close supervision.

(E) Reduction of Man-Made Troubles

3.19 The switchman can reduce the amount of trouble and maintenance required by eliminating, as far as possible, certain sources of trouble. Most troubles, such as cross-connection errors, solder crosses, and even dirty contacts, are man-made. Often the repair of one trouble may result in several new ones. When a broken wire is replaced, crosses may be caused by wire clippings or dropped solder. Dust in the air or dirt stirred up by repair work may cause contact failure at some future date, regardless of whether the dust covers are closed. Since dirty contacts and wiring troubles, the two main sources of circuit failures, are preventable, care should be taken to reduce troubles from these sources.

4. ANALYSIS OF TYPICAL TROUBLES

(A) General

4.01 As previously discussed, the analysis of the more complex troubles is divided into two stages; namely, over-all and detailed. In this part, then, are described the suggested procedures for performing the over-all and detailed analysis of a number of typical troubles as manifested by trouble record cards.

4.02 Also included herein are analyses of typical troubles indicated by stuck senders, test frames and trouble reports.

4.03 Troubles may be traced either with or without the use of the test frames. It is generally more advantageous to use the test frame to simulate the trouble condition, thereby making for faster and more accurate analyses. Analyses can also be made by blocking relays operated or released, insulating contacts, and similar manual methods. In this part, the controller troubles are described as cleared by manual techniques; the decoder and marker troubles by use of the test frames.

(B) Controller Troubles

General

4.04 When the trouble recorder produces a trouble card originating from the controller, it is usually desirable to examine several record cards to see if more than one card is punched for the same type of trouble. These additional cards can be identified by noting that:

- (a) The same source of trouble is indicated by punchings S8 0 to 6.
- (b) The same progress or cross punches are indicated.
- (c) At least one of the associated equipment units is repeated; namely a controller, a controller connector, a link frame or a sender.

4.05 Five cases of typical controller troubles are analyzed in the following paragraphs. As will be noted, the analysis of each trouble is based upon two or more trouble cards.

Trouble No. 1

Over-All Analysis

4.06 The switchman studies the trouble record cards as shown on Figs. 5A and 5B, attached, for this particular trouble. It will be noted on both cards that:

- (a) The trouble recorder was seized by a controller (C punch S8 2).
- (b) The same controller (1A) is involved (R4 30 and R4 37 punches).
- (c) The same cross (HX) is indicated (R1 50 punch).

The defective controller 1A is made busy by inserting a make-busy plug in the associated LCB jack on the trouble recorder frame.

4.07 By consulting the Index of Controller Punches, RM 3-12, in Section A128.819, the indication of the HX punch and the OS drawing on which it is shown is determined. The HX punch is shown on OS 108-1*. The punch was obtained because one of the following conditions was present:

- (a) Crossed contacts of the HT relay.
- (b) Crossed 1-2T contacts on the TO-24 relays.
- (c) Falsely grounded hold magnet leads at the controller connector.

*Note: The HX relay provides a test for crosses while the controller is idle. When a controller is in use the NX relay is operated, which cuts off the operating circuit of the HX relay.

Detailed Analysis

4.08 The switchman then completes the analysis and locates the trouble at controller 1A.

The following procedure is suggested:

- (a) Block the TBR relay (OS 113-1) normal and operate the AR key to retire the alarm.
- (b) Observe which relay (BTO-4) is holding the HX relay operated (OS 108-1).
- (c) Determine what is causing the BT-relay to be operated at this time.

4.09 Assume that the BTO relay is found operated. Insulate the bottom 2 and 3 contacts of the HT relay. In this case the BTO relay remains operated, but the possibility of a false ground on the HAO lead is eliminated. Insulate the top 8 and 7 contacts of the HP relay. The BTO relay releases, which eliminates the possibility of a cross at the HA or TE relay. Remove the insulator from the top 8 and 7 contacts of the HP relay. The BTO relay reoperates. To further isolate the trouble, insulate, in turn, the following contacts of the HP relay and observe when the BTO relay releases:

- (a) Top 4 and 3 contacts.
- (b) Top 2 and 1 contacts.
- (c) Bottom 4 and 3 contacts.
- (d) Bottom 2 and 1 contacts.

4.10 In this case of trouble, the BTO relay releases when the bottom 2 and 1 contacts of HP are opened. This

indicates that the cross is on one of the T0-T4 relays and thus eliminates the T5-T24 relays as a possible cause of the trouble. Remove the insulator from the bottom 2 and 1 contacts of the HP relay. The BTO relay reoperates. Insulate the top 2 and 3 contacts of the T4-T0 relays. Using a test receiver, test for the presence of ground at the top 2 contact of these relays. In this case of trouble, ground was present on the top 2 contact of the T0 relay. It was caused by a piece of solder across the top 1 and 2 contacts in back of the T0 relay.

4.11 After the trouble is cleared, the blocking and insulating tools are removed. The controller should be tested with the controller test circuit to verify that the controller is functioning properly. The controller is then returned to service by removing the make-busy plug at the trouble recorder.

Trouble No. 2

Over-All Analysis

- 4.12 On Figs. 6A and 6B, attached, it will be noted that:
- The trouble recorder was seized by a controller.
 - The same controller (1A) is involved.
 - The same progress punches (TT, CLO, and SC) are recorded.
 - The same trunk level (9) is recorded.
 - Different sender link frames (MFO5 and MF40) are recorded.
 - Different controller connectors (0 and 2) are recorded.
 - Different trunk groups (6 and 1) are recorded.

From these observations it is determined that the trouble is in controller 1A. The controller should be made busy.

4.13 Further, by consulting the Index of Controller Punches, RM 3-12, in Section A128.819, it is found that:

- The TT punch indicates that the tube timer has functioned (OS 113-1).
- The CLO punch indicates that the CLO relay is operated (OS 107-1).
- The SC punch indicates that the link frame primary crosspoints are closed, or that the trunk sleeve is falsely grounded.

4.14 A link controller progress chart is shown on Fig. 4. This chart indicates:

- The controller operations in the order that they occur.
- The controller relays involved in the operations.
- The line numbers on the over-all sequence chart where these relays operate or release.
- The card punches associated with the operations.
- The OS drawing that the progress punches are shown on.

4.15 Referring to the progress chart, it can be seen that the TT punch may come in any time after the TR relay operates on line number J108 of SC 101-1. The GR punch is inoperative if the GR relay operates on line A116. The CLO punch occurs when the CLO relay operates on line C119. The next controller operation is to cut through the busy test leads of the senders. If this takes place, the OT relay will operate on line F121 and the OT punch would indicate that this operation is successful. No controller operations are recorded between line numbers C119 and A113; therefore the SC punch is premature. In this case the SC punch indicates that the trunk sleeve is falsely grounded. However, since different trunks and different controller connectors are involved, as previously mentioned, the trouble is within the controller and apparently occurs only when a trunk on level 9 is being served. The progress chart indicates that the SC punch is shown on OS 112-1.

Detailed Analysis

4.16 To duplicate the condition that occurred when the controller timed out, it is suggested that the controller L relay be blocked operated and the L9 relay be manually operated. In this case of trouble, the operated L9 relay operates the SC relay. The trouble was caused by a wire clipping which grounded lower 7 contact of L9 relay to the mounting plate.

4.17 After the trouble is cleared, the blocking tools should be removed. The controller should be tested with the controller test circuit to verify that the controller is functioning properly before returning it to service.

Trouble No. 3

Over-All Analysis

4.18 On Figs. 7A and 7B, attached, it will be noted that:

- (a) The recorder was seized by a controller.
- (b) The same controller (1A) is involved.
- (c) The same progress punches (CLO, OT, DTC, OTC and PA) are recorded.
- (d) The same cross indication (SX) is recorded.
- (e) The same secondary switch level (SSL 3) is recorded.
- (f) Different sender link frames (MFO5 and MFO8) are recorded.
- (g) Different controller connectors (0 and 2) are recorded.

From these observations it is determined that the trouble is in controller 1A. The controller should be made busy.

4.19 By consulting the Index of Controller Punches, RM 3-12, in Section A128.819, it is seen that the SX punch (RL 49) indicates crossed secondary select magnet leads SAO-9 or SBO-9 and that the SX punch is shown on OS 111-1.

4.20 The controller progress chart indicates by the CLO, OT, DTC and OTC punches that the next controller operation is to operate the secondary select magnets (line 146 on SC 101-1). Since the cross was detected by the SX relay during this operation, the SA punch is not recorded.

4.21 The switchman completes the analysis and locates the trouble at controller 1A.

Detailed Analysis

4.22 The following procedure is suggested:

- (a) Block the SX1 relay normal to prevent the TBR relay from operating while tests are being made (OS 113-1).
- (b) Determine from the record card and OS 111-1 which relays in the operating path of the SX relay were operated when the failures occurred.
- (c) Block these relays operated.
- (d) Determine what is operating the SX relay.

4.23 Tracing the operating path of the SX relay on OS 111-1, it can be seen that it goes through the contacts of the LM or UM relays and through the contacts of one of the A to E relays. The DL punch is shown on OS 107-1. Since the cards show the DL punch, the LC relay is

operated. Therefore, the LM relay on OS 111-1 is operated. The secondary switch level 3 punch is shown on OS 109-1. Since the cards show this punch, the D relay was operated when the trouble occurred. The DTC punch is shown on OS 109-1. Since the cards show this punch, the DTC relay was operated when the trouble occurred.

4.24 When the DTC, D and LM relays are blocked operated, the SX relay operates as a result of the trouble. With the D, LM and DTC relays operated, battery is applied to the No. 3 select magnet lead. The operated SX relay indicates, in this case, that the No. 3 lead is crossed with the 0, 1, 2 or 4 lead. Insulate, in turn, the top 3 and 4, 5 and 6, 7 and 8, and 11 and 12 contacts of the LM relay to determine which lead is crossed with the No. 3 select magnet lead. In this case, the SX relay releases when the top 11 and 12 contacts of the LM relay are insulated; this indicates that the No. 3 and No. 4 leads are crossed. This trouble was caused by a wire clipping lying across the bottom 8 and 10 contacts of the SSA relay.

4.25 If the SX relay did not operate as stated above, when the DTC, D and LM relays were operated, further analysis of the card would have been necessary to determine whether the SSA or SSB relay was operated when the trouble occurred. This can be ascertained by the fact that the PA punch is recorded. The trouble analysis chart shows that the PA punch indicates that the select magnets on the primary "A" switches are operated, and that the PA punch is shown on OS 110-1. Since the "A" primary select magnets operated, the PSA relay is operated. Therefore the SSA relay operated as shown on OS 110-1. If the cross exists on the SAO-SA9 leads, the SSA relay would have to be blocked operated in addition to the DTC, D, and LM relays, as previously described. It can be located by insulating contacts of the SSA relay in a manner similar to that described for the LM relay contacts.

4.26 After the trouble is cleared, the blocking and insulating tools should be removed. The controller should be tested with the controller test circuit to verify that the controller is functioning properly before returning it to service.

Trouble No. 4

Over-All Analysis

4.27 Fig. 8, attached, represents several trouble recorder cards which indicate that:

- (a) The recorder was seized by a controller.

- (b) The same controller (1A) is involved.
- (c) All trunk level punches (0-9) are recorded.
- (d) The same progress punches (TT and GR) are recorded.
- (e) Different controller connectors are recorded.
- (f) Different sender link frames are involved.
- (g) Different sender choices (DU, DL) are recorded.
- (h) Different trunk groups are recorded.

4.28 From these observations, it is determined that the trouble is in controller 1A. The controller should be made busy.

4.29 By consulting the Index of Controller Punches, RM 3-12, in Section A128.819, it is found that:

(a) The GR punch (R1 32) indicates that the trunk group connector relay of the sender link frame failed to operate, or that all the primary switch level relays of the controller failed to operate.

(b) The GR punch is shown on OS 106-1.

(c) The trunk level punches are shown on OS 106-1.

4.30 The controller progress chart (see Fig. 4) shows that the continuity test of the LO-L9 leads has not been successful because if the GR relay operated (line A116), the GR punch would not be recorded.

4.31 The record card indicates that all the trunk level relays operated (0 to 9 punches).

Detailed Analysis

4.32 To locate the trouble the following procedure is suggested:

(a) Block the LO to L9 relays operated.

(b) Manually operate the ST relay. This should operate the OD relay, which operates the GR relay.

4.33 In this case of trouble, the OD relay failed to operate because of a broken wire at the top 2 contact of the GX relay. The trouble was located by testing for the ST relay ground at the contacts of the LO, GX, and GX1 relays.

4.34 After the trouble is cleared, the blocking tool should be removed. The controller should be tested with the controller test circuit to verify that the controller is functioning properly before returning it to service.

Trouble No. 5

Over-All Analysis

4.35 Fig. 9, attached, represents several recorder cards which indicate that:

(a) The trouble recorder was seized by a controller.

(b) The same controller (1A) is involved.

(c) The same sender choice (DL) is recorded.

(d) The same progress punches (TT and CLO) are recorded.

(e) Different sender link frames are recorded.

(f) Different controller connectors are recorded.

(g) Different trunk groups and levels are recorded.

4.36 From these observations it is determined that the trouble is in controller 1A. The controller should be made busy.

4.37 By referring to the controller progress chart (see Fig. 4) and the record card, it can be determined that the controller operation which failed to take place occurred at line F121 of the chart. This assumption is made because:

(a) The GR punch is absent, indicating that the GR relay was operated.

(b) The CLO punch is recorded, indicating that the CLO relay is operated.

4.38 The next controller operation on the progress chart is to cut through the sender busy test leads to the controller. If this operation is successful, the OT punch would be recorded.

4.39 The progress chart shows that the OT punch is on OS 107-1. On the OS drawing, it can be seen that the OT punch is effective when the OT relay operates as a result of the operated TUO and TUL, or the operated TLO and TLL relays in the sender link and connector circuit. Since

the over-all analysis shows that different sender link and connector frames were involved, these relays are eliminated as a possible cause of the trouble. However, the operating circuit of these relays originates in the controller. Also, as previously mentioned, it was noted that the DL punch is recorded on each failure. Therefore, the trouble apparently was caused by the failure of the controller to operate the TLO and TLI relays in the sender link and connector circuit. From the DL and CLO punches it is evident that the CLO and LC relays were operated when the failure occurred.

Detailed Analysis

4.40 To locate this trouble, it is suggested that the CLO and LC relays be blocked operated, and that the TLO lead be tested for the presence of battery. This trouble was caused by a dirty contact on the top 2 and 1 contacts of the LC relay.

4.41 After the trouble is cleared, the blocking tools should be removed. The controller should be tested with the controller test circuit to verify that the controller is functioning properly before returning it to service.

4.42 For additional examples of similar controller troubles, Figs. 10 to 14, attached, are provided.

(C) Decoder-Marker Troubles

General

4.43 Trouble analysis of decoder or marker troubles shown on trouble record cards begins by examining the various card divisions described in Part 2. This examination, which is made in a definite order, permits the switchman to make a rapid appraisal of the trouble. A general procedure for analyzing the trouble is given and is followed by an explanation of typical troubles.

4.44 Cards that indicate similar troubles should be analyzed together. An experienced switchman will be able to detect those cards which indicate the same or similar troubles. A general way of locating trouble cards resulting from the same trouble is to watch for the same equipment units being involved, the same progress points failing to be punched, or the same general pattern of punches appearing. The divisions of the card are examined in the following order.

4.45 Examination of Division A of the trouble card is generally the starting point. This gives the equipment unit involved and the source and type of trouble record. If more than one card is punched for the same trouble, a check should be

made to see if the trouble was caused by the same equipment units. If any one equipment unit is recorded on several trouble cards it will strongly indicate that trouble exists in that particular equipment unit. As an example, if the same sender unit is recorded on several cards but the other equipment units varied then it would be assumed that the sender was contributing to or was the source of the trouble.

4.46 Examination of Division H should generally be next to determine if any cross troubles are evident. If there are cross troubles, detailed analysis can begin from the cross punches indicated. If no cross troubles are indicated, this division can be disregarded.

4.47 Examination of Division F follows. This gives the progress points of the decoder and marker. Reference to the abbreviated sequence charts, Figs. 3 and 4, and to the regular sequence charts should be made to review the order in which the punches should appear. When the progress point that indicates the failure is determined, reference to other card divisions should then be made to obtain additional information when available. For example, if the progress point shows a failure to transmit information from the card translator to the marker, then Division D which shows this information should be checked for a failure. Other failures will point to one or more divisions of the card to be checked.

4.48 If trouble is not apparent in Division F, then a check of Divisions C and D should be made. Division C gives decoder and marker route advance information, decoder input from the sender, and code bars operated in the card translator. For example, if an RO punch appears in row S1 17 but no ROR punch in row S1 29, it indicates that the marker failed to operate the ROR relay to route the call to reorder. Division D gives the translator card output as read by the decoder or the marker. This division should be checked for the proper transmission of information on a two-out-of-five, one-out-of-two, one-out-of-three, etc., basis.

4.49 Divisions E and G are examined next. Division E gives decoder and marker routing instructions and registration, code conversion registration and transmission of this information to the sender, routing instructions transmitted to the sender, and frame identification recorded in the marker. Division G shows the check relays operated in the marker after transmitting information from the marker to the sender. When checking routing information refer to RM 3-10 in Section A128.819. For example, one of the SK- punches in row R3 15-17 is punched

and the SKA in row RO 20 is missing; this indicates unsatisfactory transmission of the skip information from the marker to the sender.

4.50 Divisions I, J and K should be examined next for outgoing trunk location, incoming trunk location, connector information, and channel information. Part 2 describes these divisions in detail.

4.51 The trouble cards illustrated were punched using experimental equipment as set up in the Bell Telephone Laboratories for development purposes; therefore a limited number of equipment units is shown, for example, marker O and decoder O.

4.52 The analysis of typical troubles is given below to show how the general procedure for analysis and location of trouble is applied to particular cases. Each analysis outlines the steps to be taken to locate the faulty equipment.

Trouble No. 1

Over-All Analysis

4.53 Two cards are punched on this trouble; the first card is shown on Fig. 15A, attached, and the second card on Fig. 15B, attached. By checking Division A of the cards it will be found that the cards show a failure in decoder O, with the same sender and the same decoder connector used on both calls. The first card shows the decoder in first trial and the second card shows the decoder in second trial. Under normal operating conditions, the same sender, or any other equipment unit, appearing on several trouble recordings indicates trouble in that equipment unit. Since these recordings were made with laboratory equipment, the same equipment unit is repeated on these two cards; therefore it does not indicate trouble in these units. These remarks apply to all troubles described herein.

4.54 Division H is checked next and since no cross failures are indicated this division is disregarded.

4.55 Division F is generally the next part of the card to check. By checking this division it is seen that the decoder progress punches are not complete. By referring to the abbreviated sequence chart, Fig. 2, it is seen that the SMCO punch is the stopping point of the decoder progress. The next point should be either the IT or TC punch as shown on Fig. 2. To find which of these punches is required, it is necessary to know on which train the incoming trunk appears and on which train the outgoing trunk appears. The train for the incoming frame can be determined by referring to the SMI or SMC punch

in row R2 2 and 3, Fig. 2, and OS 168-1. It is seen that both the SMI and the SMC punches are punched to indicate that the incoming trunk appears on both frames.

4.56 By referring to Division D, row SO 4, it is seen that the outgoing trunk appears on the IT train. With this information it is seen that an intertoll marker is required to be connected to the decoder.

4.57 As the failures were on decoder O, this decoder should be made busy. A detailed analysis should then be made to ascertain why the IT progress point was not punched.

Detailed Analysis

4.58 By referring to OS 188-1, OS 168-1 and SC 113-1, it is seen that the decoder failed to indicate the selection of an intertoll marker. The IT punch is shown on OS 188-1 and is the result of the operation of the IT2 relay in the decoder. SC 113-1 shows that the IT1, SMCO, and IT2 relays in the decoder should operate to cause the IT progress point to be punched. Since the SMCO progress point is shown punched, the next progression in the decoder should be the operation of the IT2 relay. The decoder-marker test circuit should be set up to test decoder O. The operation of the decoder-marker test circuit is described in Section A728.101. By observing the IT2 relay when the decoder marker test circuit is testing the decoder, it is seen that the IT2 relay fails to operate.

4.59 The path for operating the IT2 relay is shown on OS 168-1. By examining Division D of the card it is seen that the NCA designation is punched to indicate that the NCA relay in the marker operated. The CAK punch is indicated in Division F of the card. This traces the operating path of the IT2 relay through the operated NCA and CAK relays. This path can be tested by connecting one side of a receiver test set to 48 volts and the test pick is placed to the 9T contact of the NCA relay. The decoder-marker test circuit is started by use of the remote control key, and as the marker functions, a click should be heard in the receiver. If a click is heard, the test pick should be moved to a contact closer to the winding of the IT2 relay. If a click is not heard, the test pick should be moved toward the starting point of the operating ground. This procedure should be continued until the open circuit is located.* For the trouble

*The general rule when locating troubles in a long series path is to divide the circuit in half, then further subdivide the circuit again, then again, or as many times as is necessary to isolate the trouble.

illustrated, the IT2 relay winding was open. It was located by the switchman who noticed a click in the receiver on one side of the winding but not on the other side of the winding. It should be noted that the windings of most relays can be tested from the front of the relays. The test points are the terminals that are used for connecting the 35D test set to the relay when making apparatus adjustments.

4.60 After the IT2 relay is changed and adjusted, the decoder-marker test circuit is used to test the decoder and if an OK test is indicated the decoder is restored to normal.

Trouble No. 2

Over-All Analysis

4.61 Two cards are punched on this trouble, the first card is shown on Fig. 16A, attached, and the second card on Fig. 16B, attached. By checking Division A of the cards it is seen that marker O failed on the first and second trial. The remarks about the sender and decoder connector made in the analysis on Trouble No. 1, Par. 4.38, also apply to this trouble.

4.62 Division H does not show any cross indications and can be disregarded.

4.63 Examination of Division F is the next logical step to take in analyzing this trouble. By referring to the abbreviated sequence chart, Fig. 3, and noting the marker progress points it is seen that the IFK and CHS progress points are missing. By referring to OS 212-1, as shown under CHS on Fig. 3, it is seen that the CHS punch is made when the CHE relay in the marker releases. The release of the CHE relay depends upon the operation of a CH- relay when a channel is selected. The operating path of a CH- relay is traced through various relays, one of them being the operated IFK relay. Therefore the logical source of the trouble points to the IFK relay not operating in the marker. The marker should be made busy.

Detailed Analysis

4.64 Note that the AK, BK and CK progress points are shown; this indicates that the incoming links, outgoing links and junctors had been connected to the marker. These punches are shown on OS 210-1 and OS 215-1. The IFK punch is shown on OS 208-1. The IFK relay operating path is direct to the contacts on the MC- relays of all incoming frames. Since the cards on this trouble indicate the same marker, the trouble points directly to the IFK relay. By connecting ground to one side of the winding and

connecting the receiver test set to 48 volts, the winding of the IFK relay can be tested. In this trouble the winding is open and the ground cannot be tested through the winding.

4.65 If on a similar trouble where the IFK progress point failed to show and various markers are indicated, but the same incoming frame is repeating, the trouble would indicate toward the incoming frame connector relays.

4.66 After the IFK relay is changed and adjusted, the decoder-marker test is used to test the marker, and if an OK test is indicated the marker is restored to normal.

Trouble No. 3

Over-All Analysis

4.67 Two cards are punched on this trouble; the first card is shown on Fig. 17A, attached, and the second card on Fig. 17B, attached. By checking Division A of the cards it is found that the cards show marker O failing on the first and second trial.

4.68 Division H shows no cross indications; therefore the next step is to check Division F.

4.69 Division F shows marker progress points incomplete. By referring to the abbreviated sequence chart, Fig. 3, and noting progress points it is seen that the GCK is the last progress point punched. Therefore the TKS or SCT progress point is missing in marker O and the marker should be made busy.

Detailed Analysis

4.70 By referring to OS 202-1 it is seen that the TKS punch is taken from the operated TKS relay. The TKS relay operation is dependent upon the operation of a K- relay with the TKE relay normal. By referring to OS 203-1 and OS 216-1 it is seen that the SCT punch is taken from the operated SCT relay. The SCT relay operating path is through an operated K- relay to battery through the winding of an outgoing trunk relay. SC 122-1 shows that after the TBK relay in the marker has operated, the TKT relay and a K- relay must operate before either the TKS or the SCT relay can operate. OS 201-1 shows the operating paths of the TKT and K- relays and the releasing path of the TKE relay. By use of the decoder-marker test circuit and by observation at the marker frame it can be ascertained whether the TKT relay is operating. Since the decoder is not attached for this recording and it is desired to set the test call to the same group of trunks, it is necessary to check Division I of the card to get the trunk block

connector and the trunk block number. Division D will give the group start and group end position of the trunk in the trunk block. By referring to the office records for the trunk block connector frame the trunk destination can be ascertained.

4.71 If the TKT relay is not operating, the fault is probably due to poor mechanical adjustment of the TKT relay and it should be readjusted.* If this does not clear the trouble, the operating and releasing paths of the TKT relay should be tested with a receiver test set.

*Experience has shown that when a capacitor timed relay fails to operate, it is generally due to faulty adjustment and analysis time is generally saved if the relay is readjusted according to the circuit requirement table.

4.72 If the TKT relay operated on test, then the trouble points to the operating path of the K- relays or to an individual K- relay being in trouble.

4.73 If on a test call no K- relay is seen to operate, the common operating path can be checked in the following manner. Connect one side of a test receiver to 48-volt battery and the test pick of the test receiver to the top 1 contact of the TR1A relay. By using the remote control key start a test call through the marker. As the test call is made a click should be heard when the TKT relay operates. If no click is heard, the test pick should be moved toward the operating ground at the TCK relay, for example, the 4B contact of the TBK relay as this is about the middle of the path starting at the TR1A relay. The test pick should be moved to the various contacts until the open circuit is located.

4.74 If a click is heard at the 1T of the TR1A relay, it indicates that the trouble is at one of the K- relays. By examination of Division D of the cards it is seen that group start tens 1 and units 4, as well as group end tens 1 and units 4, is indicated. By referring to the description of the card in Part 2, it is seen that the GS28 relay is the trunk test starting point, and the GE29 relay is the trunk test terminating point. Test calls can be started in the marker and the receiver test pick can be placed on the contacts of the GS28, T28, GE29, and T29 relays to test for the click as the test call proceeds.

4.75 If the clicks are heard on the contacts of the T- relays it is an indication that the paths to this point are "OK."

4.76 To check the windings of the K- relays and the common battery path, connect the test receiver to ground. With

the marker normal, the test pick is connected to the various contacts of the common path beginning at the 2B contact of the ATB relay. If the battery path tests "OK" to the windings of the K- relays it is assumed that a K- relay is open. To test for this, connect the test pick to the T- relay contacts and the battery click should be heard and the corresponding K- relay should operate. For this illustration the K28 relay winding is open.

4.77 If on a test call a K- relay operated, the test call will complete satisfactorily; but since the trouble card indicates that a K- relay failed to operate, it can be assumed that the trunk busy condition is such that the defective path for operating the particular K- relay in trouble was not used on the test call and a test must be made to test all K- relays within the group start and group end positions. This can be done by connecting the receiver test set to ground and by testing the contacts of the first T- relay in the group, as indicated by the GS- relay, to check the operating path of the first K- relay. If the path tests "OK," the first T- relay can be blocked operated and a test can be made at the 2T contact of the GS- relay to test the second K- relay. If this path tests "OK," the second T- relay is also blocked operated and the test is made at the 2T contacts of the GS- relay to test the third K- relay. This procedure is continued until the operating paths of all K- relays are tested and the trouble is located.

4.78 After the trouble is cleared the marker is retested, and if an "OK" test is indicated the marker is restored to service.

Trouble No. 4

Over-All Analysis

4.79 Two cards are punched on this trouble; the cards are shown on Figs. 18A and 18B, attached. By examination of Division A of the cards it is seen that marker 1 failed on the first and second trial.

4.80 Division H does not show any cross indications and can be disregarded.

4.81 By examination of Division F it is seen that the marker progress points are not complete. Referring to the abbreviated sequence chart, Fig. 3, it is seen that the TR progress punch is missing. Upon further examination it is seen that the SCT punch is also missing.

4.82 By referring to OS 216-1 it is seen that the operating path of the SCT relay in the marker is to battery through a relay winding in the outgoing trunk. It

can also be seen that the operating paths of the hold magnets are taken through operated contacts of the SCT1 relay. Since the SCT relay did not operate to operate the SCT1 relay, there are no paths closed to operate the hold magnets. The marker cannot close the crosspoints and consequently the marker failed to complete continuity test. This trouble illustration indicates a marker failure on one progress point but the indication is a result of an earlier failure. The switchman should always be on the alert for this kind of indication. The next step in the analysis of this trouble is to determine if the trouble points toward the outgoing trunk or toward the marker. By referring to Division I of the cards it is seen that the same trunk was involved. The office records for the trunk block connector frame will give the trunk equipment information. Another assumption that can be made is that since a trunk was selected, as indicated by the TKS progress point, the sleeve is not grounded and therefore it must be open. Under normal operating conditions only one of the equipment units would be indicated more than once on the trouble records; for this illustration it is assumed that the outgoing trunk was and the trouble seems to be located in the trunk.

Detailed Analysis

4.83 When the outgoing trunk equipment information is obtained from the office records, the switchman can test the MS lead at the assignment distributing frame. With the test receiver, the trunk terminal at the horizontal side of the ADF can be tested for battery. Upon inspection of the terminal it is seen that the cross-connection is missing. Division I of the card gives the location of the trunk on the trunk block connector frame. The missing cross-connection should be replaced and the proper records made.

4.84 If the trouble appears to be between the trunk and the ADF, the receiver tests can be continued in the outgoing trunk equipment unit until the trouble is located.

Trouble No. 5

Over-All Analysis

4.85 Two cards are punched on this trouble; these are shown on Figs. 19A and 19B, attached. By examining Division A of the cards it is seen that marker O failed on the first and second trial.

4.86 Examination of Division H shows no cross indications and therefore can be disregarded.

4.87 By examination of Division F and by reference to the abbreviated sequence

chart, Fig. 3, it is seen that marker progress punches are not complete. The CHS progress point is not punched. Since failure occurred on marker O, first and second trial, this marker should be made busy.

Detailed Analysis

4.88 By referring to OS 212-1 it is seen that the CHS punch is taken from the release of the CHE relay in the marker. The release of the CHE relay is dependent upon the operation of a CH- relay. By examining Division L of the card, it is seen that there are no channel punches indicated. By referring to OS 212-1 it is seen that the channel punches are taken from an operated CH- relay in the marker. Since the AK, BK and CK punches are present, a channel should have been selected. By referring to SC 122-1 and OS 212-1 it is seen that the CHT relay and a CH- relay should operate when the AK and BK relays operate. This trouble could be due to the failure of the CHT relay to operate, a defective operating path to the CH- relays, or a defective CH- relay.

4.89 By use of the decoder-marker test circuit and by observation at the marker frame it can be determined whether the CHT relay or the CH- relays fail to operate. If the CHT relay fails to operate it is probably due to faulty adjustment and should be readjusted. If the CHT relay still fails to operate, the operating paths of the CHT should be tested with a receiver test set.

4.90 If the CHT relay operates and a CH- relay does not operate, the paths for operating the CH- relays can be tested with the marker normal. The general procedures to be followed are the same as those described for Trouble No. 3. When the trouble has been cleared the marker should be tested by using the decoder-marker test circuit and restored to service.

4.91 For additional examples of similar decoder and marker troubles, Figs. 20 to 23, attached, are provided.

(D) Stuck Sender Troubles

General

4.92 A stuck sender condition occurs when a sender fails to complete its functions and release in the allotted time. The procedure to be followed in response to a stuck sender alarm is described in Section A329.052 for incoming senders.

4.93 To determine the cause of a stuck sender, it is necessary to inspect the setting of several relays in the sender. The operated or non-operated position of these relays indicates the

approximate progress made by the sender up to the time of the failure. For instance, if an incoming sender is stuck, the following should be observed:

- (a) The type of the incoming sender (MF or DP).
- (b) The code and number registered (operated A-, B-, C-, D-, etc. relays).
- (c) Whether or not relay RT is operated.
- (d) The class of outpulsing recorded (M, DC, MF, etc. relays).
- (e) Whether or not relay MS2 is operated.
- (f) Whether or not relay MRL is operated.
- (g) Whether or not relay PS is operated.
- (h) The outsteering relay (ASO, BSO, etc.) operated.
- (i) Whether or not the SST relay in a dial pulse sender or the SST1 relay in a multifrequency sender is operated.
- (j) Whether or not relay AV is operated.

4.94 If an outgoing sender is stuck, the following should be observed:

- (a) The class of outgoing trunk recorded (CI, PX, etc. relays).
- (b) Whether or not relay CLK is operated.
- (c) The number registered (TH-, H-, etc. relays).
- (d) Whether or not relay ST is operated.
- (e) Whether or not trunk test has been completed (FS relay operated on panel or crossbar calls; CIL relay operated on PCI calls).
- (f) The selection sequence relays (S1 and S1' to S6 and S6') operated.
- (g) Whether or not relay CT is operated.

4.95 In cases of stuck incoming senders, it is often necessary to determine the incoming and outgoing link information by tracing the held connection from the incoming trunk to the outgoing trunk because the trouble may be in the equipment beyond the sender. In cases of stuck

outgoing senders, it may be necessary to have the connecting local central office equipment traced to determine the cause of the trouble.

4.96 When analyzing sender troubles, frequent use of the sequence charts for general sender operation will aid the switchman to make the proper analysis of a trouble condition.

4.97 A record of the above information (items (a) to (j) under incoming senders, items (a) to (g) under outgoing senders, and the information obtained by tracing a connection) should be entered on a trouble ticket.

Trouble No. 1

Detailed Analysis

4.98 Assume that an examination of a stuck incoming sender reveals the following facts:

- (a) The sender is a dial pulse sender.
- (b) The code and number registered is 949-3876.
- (c) The RT relay is operated (KTL and KRL leads transferred to the outpulsing circuit).
- (d) The SXD relay is operated (outpulse on simplex basis).
- (e) The MS2 relay is operated (marker called in).
- (f) The MRL relay is operated (marker released).
- (g) The PS relay is not operated.
- (h) No outsteering relays are operated.

4.99 Since the sender has received a regular release signal from the marker (MRL relay operated), some outsteering relay should be operated. The outsteering circuit is shown on OS 126-1. The particular outsteering relay that should operate on the call depends on the skip (NSK, SK3, SK6) and code conversion (CU²) relays operated by the marker. Assume in this case that the SK3, CC, and CCl relays are operated; therefore the CSO steering relay should operate as shown on OS 126-1.

4.100 To locate the trouble, the CSO relay is blocked in the non-operated position to prevent its accidental operation while testing. (If the CSO relay were accidentally operated at this time, it would cause the sender to advance beyond the trouble condition and release before the trouble is located.) Using a test

receiver, a test is made for the presence of battery (from the winding of the CSO relay) at the bottom 2 and 3 contacts of the CA1 relay. If it is present at this point the CA, CA1, CB, CBI, CC, and CCI relays and associated wiring are eliminated. By continuing the process of elimination through the circuit, the entire path can be tested and the trouble located.

Trouble No. 2

Detailed Analysis

4.101 In this case assume that the stuck sender considered in Example No. 1 has advanced further and that the steering relay HSO is operated. The next progress indication to be noted is whether or not the SST relay is operated. Assuming that it is operated, the next progress indication to be noted is whether or not the AV relay is operated (see sequence charts 104-1 to 110-1). Assuming that relay AV is not operated, its operating circuit may be traced on OS 126-1. For the class of outpulsing on this call (SXD relay operated) the DP relay should be operated (OS 126-1). In addition to the DP relay, the OP1 relay must be operated to complete the operating path of the AV relay. To operate the OP1 relay (OS 128-1) the OP relay must operate. The OP relay operates when the SL relay releases.

4.102 Assume that the SL relay failed to release, thus preventing the AV relay from operating. Since outpulsing has been completed (SST relay operated), the sender should indicate this to the outgoing trunk circuit by connecting a low resistance ground (through the 170-ohm winding of the SL relay) to the OT and OR leads (OS 127-1). The outgoing trunk circuit should recognize this signal by operating its marginal SL relay, as shown on OS 127-1. Operation of the trunk circuit SL relay should release the sender SL relay. The released SL relay in the sender would then have completed the operating circuit of the OP relay in the sender.

4.103 Since the sender SL relay failed to release, it must be determined whether the trouble was caused by the sender or by the trunk circuit. Because the sender is under observation, it is more expedient to test for the above-mentioned signals at this location than to trace the connection at this time to observe the condition of the trunk SL relay.

4.104 To locate the trouble, the sender SL relay is blocked operated to prevent its accidental release while testing. A test is made for the presence of low resistance ground (170 ohms) at

the top 2 and 1 contacts of the AV relay (OS 127-1). If low resistance ground is present at the contacts of the AV relay, a loud click will be heard in the receiver. To distinguish between the high resistance ground (8700 ohms) and the low resistance ground (170 ohms) at the contacts of the AV relay, the top 2 and 1 contacts of the SL1 relay are insulated. A click will be heard in the receiver when the top 2 contact of AV is tested for ground. The insulator is removed from the top 2 and 1 contacts of the SL1 relay. The click should be much louder at the AV contacts due to the lower resistance through the 170-ohm winding of the SL relay.

4.105 If low resistance ground is missing at the AV relay contacts, the trouble is located by testing at the various contacts in the circuit, as shown on OS 127-1. If the low resistance ground is present at the AV relay contacts, the top and bottom 8 and 9 contacts of the MT relay are tested next. If it is present at the MT relay contacts, the connection to the outgoing trunk circuit must be traced. This can be done by inserting a make-busy plug in the associated sender make-busy jack to call in the trouble indicator for the purpose of locating the incoming trunk, as outlined in Section A329.052.

4.106 After the connection is traced to the outgoing trunk circuit, the bottom 11 and 12 contacts of the OS relay in that circuit are tested for the presence of low resistance ground. If it is present at the contact of the OS relay (through both windings of the A retard coil and the LO relay), the trouble is located toward the SL relay in the trunk circuit, which may be out of adjustment. However, if low resistance ground is not present at the OS relay, the OT and OR leads must be tested at various points in the linkage, as shown on OS 127-1.

Trouble No. 3

Detailed Analysis

4.107 Assume in this case that the stuck sender considered in Example Nos. 1 and 2 has advanced still further and that the AV relay has operated. Since the sender has completed all of its functions as determined by the operated AV relay, the sender should have released from the connection. On SC 105-1 and SC 106-1 (release of sender) it can be seen that the next relay to operate after AV is AV1. If the AV1 relay (which is the last relay to operate in the sender) is not operated, the operating circuit shown on OS 126-1 is checked. If the AV1 relay is operated, the release of the sender relays is checked in the order shown on SC 105-1, beginning with the SP relay. When the relay failing

to release is located, a check is made of the circuit on the OS drawing which shows the relay.

Trouble No. 4

Detailed Analysis

4.108 In this case assume that an outgoing sender is stuck and that an examination of the sender shows:

- (a) The class of outgoing trunk is panel (PX relay operated, SC 111-1).
- (b) The CLK relay is operated (class check completed).
- (c) The number registered is 9999.
- (d) The ST relay is operated (start signal received).
- (e) Trunk test has not been completed (FS relay unoperated).
- (f) The S6 and S6' selection sequence relays are operated.

4.109 Since this is a call to a panel office and the FS relay is normal with relays S6 and S6' operated, the next function to take place is trunk test. If the TG relay is operated, trunk test should proceed as shown on SC 111-1. If the TG relay has not operated, the trouble is in the fundamental circuit. Assume that the TG relay has failed to operate. The trunk test circuit is shown on OS 148-1.

4.110 To locate the trouble, the TG relay is blocked in the non-operated position to prevent its accidental operation while testing. The top 6 and 7 contacts of the R relay are insulated to remove the panel office L relay from the fundamental circuit. A test is made for the presence of ground (from the panel office) at the top 7 contact of the R relay. If the ground is missing at the top 7 contact, the bottom 4 and 5 contacts of the R relay are tested. If the ground is present at the bottom 4 and 5 contacts, various points in the circuit can be tested for ground to locate the trouble. If the ground is present at the top 7 contact of the R relay, the insulator is removed from the top 6 and 7 contacts of the R relay. Using high resistance ground (to prevent operation of the panel L relay), the top 6 and 7 contacts of the R relay are tested for the presence of battery. If the battery is missing at the top 6 contact of the R relay, battery is tested for at the sender link crosspoints. The outgoing sender link frame can be located by inserting a make-busy plug into the make-busy jack of the sender at the sender make-busy frame.

4.111 If the battery or ground is missing at the sender link crosspoints, the outgoing trunk should be tested using the voltmeter at the trunk test jack, which is located on the outgoing toll connecting trunk test and make-busy frame. If the battery or ground is missing at the test jack or if the voltage is insufficient, the panel office switchman is called to have the incoming equipment traced. If the proper battery and ground is present in the sender at the R relay contacts and if the continuity test of the fundamental circuit is satisfactory but the TG relay fails to operate, the relay is probably out of adjustment and should be tested with the 35F test set.

Trouble No. 5

Detailed Analysis

4.112 Assume for this example that the stuck sender discussed in Trouble No. 4, has completed its trunk test and has progressed to the point where the S2 and S2' selection sequence relays are operated. (S6 and S6' relays released after trunk test; S1 and S1' released after incoming brush selection.) SC 111-1 shows that, with the S2 and S2' relays operated, the sender should proceed with incoming group selection. To make incoming group selection, the fundamental circuit is closed when the FO3 relay operates; this should operate the L relay in the panel incoming trunk circuit and the STP relay in the sender, shown on OS 149-1.

4.113 Since 9999 is registered and the S2 and S2' relays are operated, the counter relays 3 and 3', 2 and 2', 1 and 1', 0, BO', and FO' should operate in this order from the contacts of the STP relay. If neither the STP relay nor any counters are operated, the fundamental circuit should be tested for battery and ground in a manner similar to that described in Trouble No. 4. If all of the above counters are operated, it should be observed whether or not relays S3, FO1, and FO2 are operated (SC 111-1). The operating paths for these relays are shown on OS 149-1. If the trouble is not located in the sender or sender link, the panel switchman should be called to check the equipment in the panel office.

(E) Miscellaneous Troubles

Test Frames

4.114 Analysis of test frame failures requires the application of over-all and detailed analysis as described in Part 3, Aids for Trouble Analysis, of this section. Observation of lighted lamps, of the position of certain switches, and of relays as to whether they are operated or normal is also required. The test circuit checks the ability of the circuit under test to perform the same functions

as on a service call. In some cases marginal tests of certain leads are made. The test circuit checks the circuit under test to assure that the functions of the circuit were completed satisfactorily. When a failure is encountered the test circuit blocks, and with lighted lamps and switches in certain positions, indicates the circuit involved and the approximate progress and trouble condition of the test call.

4.115 When a failure occurs, the switchman should determine from the test frame:

- (a) The circuit involved.
- (b) The progress of the test call.
- (c) The trouble as indicated by test circuit.

4.116 He should determine from the operated or released condition of the relays in the circuit under test:

- (a) Whether or not the circuit has properly recorded the signals sent to it by the test frame.
- (b) The reason wrong signals or no signals were sent to the test frame by the circuit.
- (c) The progress of the call in the circuit under test in relation to that indicated by test circuit.
- (d) What function of the circuit failed or what function operated falsely.

4.117 For a description of the operation of the test circuits, see Sections A728.101 to A728.106 covering the type of test circuit involved.

Trouble Reports

4.118 Trouble reports as received from the traffic operator and all other sources vary in their explanation of the

trouble encountered. For this reason the switchman should be extra careful in analyzing these reports. Experience in other systems shows that if a careful analysis is not made, the trouble ticket is closed as a "found OK" and the trouble still exists. Better results from an analysis standpoint will be achieved if it is always assumed by the switchman that each report received was given because the call was not completed in a normal manner and there is some reason for it. Repeater records on certain trouble reports might be desirable.

4.119 The process of analyzing the reports are the same as described under Aids to Trouble Analysis in Part 3 of this section.

Lamp Signals and Alarms

4.120 Major alarms, bells or signals, minor alarm bells, main aisle pilot lamps, aisle pilot lamps, and signals on the individual frames direct the switchman to the circuit involved in the alarm. Refer to the sections on methods of handling alarms and other signals, and methods of taking equipment out of service.

4.121 The No. 4A toll office is provided with an audible and a visual alarm system. The audible alarms are divided into two classifications, major and minor alarms. A major alarm is the result of a failure which may jeopardize service; it sounds a resonant tone bar continuously and, by lighting visual signals, indicates the general location of the failure. For example, a major alarm results from a marker connector time-out. A minor alarm is the result of a failure which does not affect service; it is indicated by an intermittent bell and visual signals. For example, a minor alarm results when a link controller seizes an available trouble recorder and releases. However, there may be instances where a minor alarm changes to a major alarm; for example, when a marker attempts to seize a trouble recorder which is busy.

Bell Telephone Laboratories, Inc.

Attachments: Figs. 1 and 5 to 23

	0	5	10	15	20	25	29
S8	SOURCE OF RECORD		D M		DECODER		
S7	TYPE OF RECORD		MARKER-TI OR COMB		MARKER-TC		
A S6	TYPE OF RECORD		SDR FR TENS (SF)		SDR FR UNITS		DP SDR MFP SDR
S5	TRANSLATOR ENGAGED (TE)		DECODER CONNECTOR (DC)				
B S4	DECODER INPUT CODE (DIC)						
S3	CODE BARS (CB)						
C S2	DECODER INPUT		LATCH MAGNETS		CARD GROUP (CG)		CSI CS2
S1	DECODER ROUTE ADVANCE		MKR ROUTE ADVANCE				
D S0	OCT APP TS		6D TRANSLATOR (6DT)		CLASS (CL)		
R8	ALTERNATE ROUTE (AR)		ROUTING INST. (RI)		CDC		
R7	CODE CONVERSION (CC)						
R6	TRUNK BLOCK CONNECTOR (TBC)		TRUNK BLOCK (TB)		GROUP START (GS)		GROUP END (GE)
R5	DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION (CC)				
E R4	MARKER REGISTRATION		MKR-SDR TRANSMITTED CODE CONVERSION (CC)				
R3	TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION				
R2	DECODER PROGRESS						
F R1	DECODER PROGRESS		MARKER PROGRESS				
R0	MARKER PROGRESS		MKR-SDR TRANSMITTING				G

TOLL SWITCHING SYSTEM
NO 4A
TROUBLE RECORDER CARD

	30	35	40	45	50	55	59
S8	DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT		OFFICE
S7	MARKER CROSS (X-)						DATE
S6	INCOMING FRAME GROUP (I)		INC SWITCH (SW)				
S5	SELECT MAGNET (SM)		OUT SWITCH (SW)				J 000
S4	INC. FR. OUT FR. TB. CONN. OUT. CONN. INC. CONN.		CONN. PREF. CONTROL		JUNCTOR WALKING		
S3	OUTGOING FRAME GROUP (O)		OUT. SWITCH (SW)				
S2	JUNCTOR CONTROL (JC)		CHANNEL (CH)				
S1	JUNCTOR PATTERN (JP)		CHANNEL (CH)				K TIME
R8	DECODER-MARKER TEST						
R7	LPD CLI2		NCF CHKMSK XPS SMG SMB				
R6							L
R5							
R4	CONT. GROUP (CG)		CONTROLLER (C)		CONTROLLER CONNECTOR		LK FR-TENS (LFT)
R3	TRUNK GROUP (TG)		TRUNK LEVEL (TL)		SEC. SW (SS)		SDR TYPE
R2	PREFERENCE (PF)		SEC SW LEVEL (SSL)				DU DL
R1	CONTROLLER PROGRESS		CROSS		CONTROLLER TEST		
R0							

FIG. 1 - TROUBLE RECORDER CARD

0	5	10	15	20	25	29
SOURCE OF RECORD			DECODER			
D M C DT MT TV CT	TRI TR2	TRI TR2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17			
TYPE OF RECORD			MARKER-IT OR COMB.			
FIF MFT CFR DSTIMSTI RTRF TST SDT	OGT	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9			
SDR. FR. TENS			SDR. FR. UNITS			
RO PRO	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 0 1 2			
TRANSLATOR ENGAGED			DECODER CONNECTOR			
H EM TO TI UO	1 2 3 4 5 6 7 8 9	TO TI T2 UO	1 2 3 4 5 6 7 8 9	CO	1 C2	
DECODER INPUT CODE			CODE BARS			
A0 1 2 4 A7 B0	1 2 4 B7 C0	1 2 4 C7 D0	1 2 4 D7 E0	1 2 4 E7 F0	1 2 4 F7	
DECODER INPUT			CARD GROUP			
3D 6D 6DA VO NVO	NRO CKI CFM PF	TSA TSB TSC 5BD	LI L2 L3 L4	VO NVO CGO	1 2 CG4	
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE			
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO	G1 G2 G3 GB RLS MB	RO ROIT ROTC				
OCT APP			CLASS			
NCA CA4 CA5 CA6	IT TC ITC	0 1 2 TPC	0 1 2 H TO TI UO	1 2 4 7 TO TI	UO 1 2 4 U7	
ALTERNATE ROUTE			ROUTING INST.			
CDC MAC AC AHA AFA	TO 1 2 4 T7 UO	1 2 4 U7	0 1 2 4 7	0 1 2 4 7		
TRUNK BLOCK CONNECTOR			GROUP START			
DIM RD	TO 1 T2 UO	1 2 4 U7	0 1 2 4 7 TO TI UO	1 2 4 U7 TO TI UO	1 2 4 U7	
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION			
CC CR RR FOF FMB FRO FST	PCR NPCR	HN TN UN HO	1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7	
MARKER REGISTRATION			MKR.-SDR. TRANSMITTED CODE CONVERSION			
MB RO PRO FOF FMB FRO FST HLD	MLCT CLCT ODG 4DG 5DG NDG	HO 1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7		
TRANSMITTED-MARKER TO SENDER			FRAME IDENTIFICATION			
M DC MF SXD LPD XDD XSG DLC SXR 20C	ODG 4DG 5DG	NSK SK3 SK6	IC OC FA FB FC FD FE FF FG FH			
DECODER PROGRESS			MARKER PROGRESS			
CKG HTK SMI SMC CK3 CCK CBK NCT NC	VCR COP1 COP2 ARST CAK HBA SMO TID TBY	DBS RHC R6D TCK 6DK IT	TC RCRR ME	RCD RCA HBI		
DECODER PROGRESS			MARKER PROGRESS			
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RL	CHK	CKG RCK TCK TBK GCK TKS SCT ATB TB	SG OCK ICK OFK IFK SK			
MARKER PROGRESS			MKR.-SDR. TRANSMITTING			
AK BK CK CHS A C HMG GCT TR TIRI CONI MT	B OSC MRL RL	CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT				

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

30	35	40	45	50	55	59
DECODER CROSS (X-)			DECODER TIME-OUT			
CA REC IK CRK 6DT TRB CF	TRL DRL RL	WT FTD MD TBD			TMC TMI TM2 TM3	
MARKER CROSS (X-)			MARKER TIME-OUT			
X IS IPS TB ST MS K O I	JP ILS OLS JS SM SMI SMO TL RCK TKS	TR TRL STR MRL TIF TOF				
TC	TC	TC	TC	TC	TC	
TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	20 21 22 23 24 25 26 27 28 29	30 31 32 33 34 35 36 37 38 39	
INCOMING FRAME GROUP			INC. SWITCH			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	0 1 2 3 4 5 6 7 8 9				
SELECT MAGNET			JUNCTOR WALKING			
30 31 32 33 34 35 36 37 38 39	INC. FR. E 0	OUT. FR. E 0	T.B. CONN. OUT. CONN. INC. CONN. E 0 E 0 E 0	CONN. PREF. CONTROL	CNO CNE TCB OCB ICB	
OUTGOING FRAME GROUP			OUT. SWITCH			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	0 1 2 3 4 5 6 7 8 9				
JUNCTOR CONTROL			CHANNEL			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	LO 1 2 3 4 5 6 7 8 L9				
JUNCTOR PATTERN			CHANNEL			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17	JPN RO 1 2 3 4 5 6 7 8 R9				
DECODER-MARKER TEST			CONTROLLER TEST			
LPD CL12	NCF CHK MSK XPS SMG SMB					
CONT. GROUP			CONTROLLER			
A B C D E F	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 4 7	0 1 2 4 7		
TRUNK GROUP			TRUNK LEVEL			
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	AO AI	BO BI	DP MFP OS		
PREFERENCE			SEC. SW. LEVEL			
A B C D E	0 1 2 3 4	DU DL				
CONTROLLER PROGRESS			CONTROLLER TEST			
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM	GX PX SX HX	CLX A B C SR AR NF TR				

FIG. 5A

0	5	10	15	20	25	29
SOURCE OF RECORD			DECODER			
D M C DT MT TV CT	TRI TR2	TRI TR2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17			
TYPE OF RECORD			MARKER-IT OR COMB.			
FIF MFT CFR DSTIMSTI RTRF TST SDT	OGT	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9			
SDR. FR. TENS			SDR. FR. UNITS			
RO PRO	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 0 1 2			
TRANSLATOR ENGAGED			DECODER CONNECTOR			
H EM TO TI UO	1 2 3 4 5 6 7 8 9	TO TI T2 UO	1 2 3 4 5 6 7 8 9	CO	1 C2	
DECODER INPUT CODE			CODE BARS			
A0 1 2 4 A7 B0	1 2 4 B7 C0	1 2 4 C7 D0	1 2 4 D7 E0	1 2 4 E7 F0	1 2 4 F7	
DECODER INPUT			CARD GROUP			
3D 6D 6DA VO NVO	NRO CKI CFM PF	TSA TSB TSC 5BD	LI L2 L3 L4	VO NVO CGO	1 2 CG4	
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE			
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO	G1 G2 G3 GB RLS MB	RO ROIT ROTC				
OCT APP			CLASS			
NCA CA4 CA5 CA6	IT TC ITC	0 1 2 TPC	0 1 2 H TO TI UO	1 2 4 7 TO TI	UO 1 2 4 U7	
ALTERNATE ROUTE			ROUTING INST.			
CDC MAC AC AHA AFA	TO 1 2 4 T7 UO	1 2 4 U7	0 1 2 4 7	0 1 2 4 7		
TRUNK BLOCK CONNECTOR			GROUP START			
DIM RD	TO 1 T2 UO	1 2 4 U7	0 1 2 4 7 TO TI UO	1 2 4 U7 TO TI UO	1 2 4 U7	
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION			
CC CR RR FOF FMB FRO FST	PCR NPCR	HN TN UN HO	1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7	
MARKER REGISTRATION			MKR.-SDR. TRANSMITTED CODE CONVERSION			
MB RO PRO FOF FMB FRO FST HLD	MLCT CLCT ODG 4DG 5DG NDG	HO 1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7		
TRANSMITTED-MARKER TO SENDER			FRAME IDENTIFICATION			
M DC MF SXD LPD XDD XSG DLC SXR 20C	ODG 4DG 5DG	NSK SK3 SK6	IC OC FA FB FC FD FE FF FG FH			
DECODER PROGRESS			MARKER PROGRESS			
CKG HTK SMI SMC CK3 CCK CBK NCT NC	VCR COP1 COP2 ARST CAK HBA SMO TID TBY	DBS RHC R6D TCK 6DK IT	TC RCRR ME	RCD RCA HBI		
DECODER PROGRESS			MARKER PROGRESS			
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RL	CHK	CKG RCK TCK TBK GCK TKS SCT ATB TB	SG OCK ICK OFK IFK SK			
MARKER PROGRESS			MKR.-SDR. TRANSMITTING			
AK BK CK CHS A C HMG GCT TR TIRI CONI MT	B OSC MRL RL	CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT				

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

30	35	40	45	50	55	59
DECODER CROSS (X-)			DECODER TIME-OUT			
CA REC IK CRK 6DT TRB CF	TRL DRL RL	WT FTD MD TBD			TMC TMI TM2 TM3	
MARKER CROSS (X-)			MARKER TIME-OUT			
X IS IPS TB ST MS K O I	JP ILS OLS JS SM SMI SMO TL RCK TKS	TR TRL STR MRL TIF TOF				
TC	TC	TC	TC	TC	TC	
TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	20 21 22 23 24 25 26 27 28 29	30 31 32 33 34 35 36 37 38 39	
INCOMING FRAME GROUP			INC. SWITCH			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	0 1 2 3 4 5 6 7 8 9				
SELECT MAGNET			JUNCTOR WALKING			
30 31 32 33 34 35 36 37 38 39	INC. FR. E 0	OUT. FR. E 0	T.B. CONN. OUT. CONN. INC. CONN. E 0 E 0 E 0	CONN. PREF. CONTROL	CNO CNE TCB OCB ICB	
OUTGOING FRAME GROUP			OUT. SWITCH			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	0 1 2 3 4 5 6 7 8 9				
JUNCTOR CONTROL			CHANNEL			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	LO 1 2 3 4 5 6 7 8 L9				
JUNCTOR PATTERN			CHANNEL			
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17	JPN RO 1 2 3 4 5 6 7 8 R9				
DECODER-MARKER TEST			CONTROLLER TEST			
LPD CL12	NCF CHK MSK XPS SMG SMB					
CONT. GROUP			CONTROLLER			
A B C D E F	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 4 7	0 1 2 4 7		
TRUNK GROUP			TRUNK LEVEL			
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	AO AI	BO BI	DP MFP OS		
PREFERENCE			SEC. SW. LEVEL			
A B C D E	0 1 2 3 4	DU DL				
CONTROLLER PROGRESS			CONTROLLER TEST			
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM	GX PX SX HX	CLX A B C SR AR NF TR				

FIG. 5B

FIG. 5 - TROUBLE RECORDER CARDS - CONTROLLER TROUBLE NO. 1

0	5	10	15	20	25	29
SOURCE OF RECORD		D M		DECODER		
DT MT TV CT		TRI TR2		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		
TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC		
FIF MFT CFR DSTIMSTI RTRF TST SDT		OGT		0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9		
TYPE OF RECORD		SDR. FR. TENS		SDR. FR. UNITS		DP SDR. MFP SDR.
RO PRO		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9 0 1 2 0 1 2		
H EM TO TI UO		1 2 3 4 5 6 7 8 9 U9		TO TI T2 UO 1 2 3 4 5 6 7 8 U9 CO 1 C2		
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0 1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7		
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0 1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7		
3D 6D 6DA VO NVO		NRO CKI CFM PF		TSA TSB TSC 5BD		L1 L2 L3 L4 VO NVO CGO 1 2 CG4 CSI CS2
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO		GI G2 G3 GB RLS MB RO ROIT ROTC		MKR. ROUTE ADVANCE		RS1 RS3 OF MBR ROR
NCA CA4 CA5 CA6		IT TC ITC		0 1 2 TPC 0 1 2 H TO TI UO 1 2 4 7		TO TI UO 1 2 4 U7
CDLCNAC AC AHA AFA		TO 1 2 4 T7 UO 1 2 4 U7		0 1 2 4 7 0 1 2 4 7		
DIM RD		TO 1 T2 UO 1 2 4 U7		0 1 2 4 7 TO TI UO 1 2 4 U7		TO TI UO 1 2 4 U7
CC CR RR FOF FMB FRO FST		PCR NPCR		HN TN UN HO 1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7		
MB RO PRO FOF FMB FRO FST HLD		MLCT CLCT ODG 4DG 5DG NDG		HO 1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7		
M DC MF SXD LPD XDD XSG DLC SXR 2OC		ODG 4DG 5DG		NSK SK3 SK6 IC OC FA FB FC FD FE FF FG FH		
CKG HTK SMI SMC CK3 CCK CBK NCT NC		VCR COP1 COP2 ARST CAK HBA SMC O TID TBY DBS RHC R6D TCK 6DK IT TC RCRR ME RCD RCA HBI				
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RL		CHK		CKG RCK TCK TBK GCK TKS SCT ATB TB SG OCK ICK OFK IFK SK		
AK BK CK CHS A C HMG CCT TR TIRI CONI MT		B OSC MRL RL		CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT		

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

FIG. 6 A

30	35	40	45	50	55	59
DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT		
CA REC IK CRK 6DT TRB CF TRL DRL RL		WT FTD MD T8D		TMC TMI TM2 TM3		
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS		TR TRL STRMRL TIF TOF				
TC TO 1 T2		TB TBMS		MS		
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		
TC TO 1 T2		TC MS		MS		
UO 1 2 3 4 5 6 7 8 9 U9		20 21 22 23 24 25 26 27 28 29		30 31 32 33 34 35 36 37 38 39		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		20 21 22 23 24 25 26 27 28 29		
30 31 32 33 34 35 36 37 38 39		INC. FR. OUT. FR. T.B. CONN. OUT. CONN. INC. CONN.		CONN. PREF. CONTROL		JUNCTOR WALKING
E O E O E O E O		CNO CNE TCB OCB ICB		CHB RTA RTB RTC RTD		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		LO 1 2 3 4 5 6 7 8 L9		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17		JPN RO 1 2 3 4 5 6 7 8 R9		
LPD CLI2		NCF CHK MSK XPS SMG SMB				
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		LK. FR.-TENS LK. FR.-UNITS
A B C D E F 0		1 2 3 4 5		1 2 3 4 5 0 1 2		7 0 1 2 7
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		SDRTYPE
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		AO AI BO BI		DP MFP OS
PREFERENCE		SEC. SW. LEVEL		DU DL		
A B C D E		0 1 2 3 4				
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM		GX PX SX HX		CLX A B C SR AR NF TR		

OFFICE DATE
TIME
000

0	5	10	15	20	25	29
SOURCE OF RECORD		D M		DECODER		
DT MT TV CT		TRI TR2		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		
TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC		
FIF MFT CFR DSTIMSTI RTRF TST SDT		OGT		0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9		
TYPE OF RECORD		SDR. FR. TENS		SDR. FR. UNITS		DP SDR. MFP SDR.
RO PRO		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9 0 1 2 0 1 2		
H EM TO TI UO		1 2 3 4 5 6 7 8 9 U9		TO TI T2 UO 1 2 3 4 5 6 7 8 U9 CO 1 C2		
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0 1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7		
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0 1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7		
3D 6D 6DA VO NVO		NRO CKI CFM PF		TSA TSB TSC 5BD		L1 L2 L3 L4 VO NVO CGO 1 2 CG4 CSI CS2
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO		GI G2 G3 GB RLS MB RO ROIT ROTC		MKR. ROUTE ADVANCE		RS1 RS3 OF MBR ROR
NCA CA4 CA5 CA6		IT TC ITC		0 1 2 TPC 0 1 2 H TO TI UO 1 2 4 7		TO TI UO 1 2 4 U7
CDLCNAC AC AHA AFA		TO 1 2 4 T7 UO 1 2 4 U7		0 1 2 4 7 0 1 2 4 7		
DIM RD		TO 1 T2 UO 1 2 4 U7		0 1 2 4 7 TO TI UO 1 2 4 U7		TO TI UO 1 2 4 U7
CC CR RR FOF FMB FRO FST		PCR NPCR		HN TN UN HO 1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7		
MB RO PRO FOF FMB FRO FST HLD		MLCT CLCT ODG 4DG 5DG NDG		HO 1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7		
M DC MF SXD LPD XDD XSG DLC SXR 2OC		ODG 4DG 5DG		NSK SK3 SK6 IC OC FA FB FC FD FE FF FG FH		
CKG HTK SMI SMC CK3 CCK CBK NCT NC		VCR COP1 COP2 ARST CAK HBA SMC O TID TBY DBS RHC R6D TCK 6DK IT TC RCRR ME RCD RCA HBI				
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RL		CHK		CKG RCK TCK TBK GCK TKS SCT ATB TB SG OCK ICK OFK IFK SK		
AK BK CK CHS A C HMG CCT TR TIRI CONI MT		B OSC MRL RL		CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT		

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

FIG. 6 B

30	35	40	45	50	55	59
DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT		
CA REC IK CRK 6DT TRB CF TRL DRL RL		WT FTD MD T8D		TMC TMI TM2 TM3		
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS		TR TRL STRMRL TIF TOF				
TC TO 1 T2		TB TBMS		MS		
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		
TC TO 1 T2		TC MS		MS		
UO 1 2 3 4 5 6 7 8 9 U9		20 21 22 23 24 25 26 27 28 29		30 31 32 33 34 35 36 37 38 39		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		20 21 22 23 24 25 26 27 28 29		
30 31 32 33 34 35 36 37 38 39		INC. FR. OUT. FR. T.B. CONN. OUT. CONN. INC. CONN.		CONN. PREF. CONTROL		JUNCTOR WALKING
E O E O E O E O		CNO CNE TCB OCB ICB		CHB RTA RTB RTC RTD		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19		LO 1 2 3 4 5 6 7 8 L9		
0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17		JPN RO 1 2 3 4 5 6 7 8 R9		
LPD CLI2		NCF CHK MSK XPS SMG SMB				
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		LK. FR.-TENS LK. FR.-UNITS
A B C D E F 0		1 2 3 4 5		1 2 3 4 5 0 1 2		7 0 1 2 7
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		SDRTYPE
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		AO AI BO BI		DP MFP OS
PREFERENCE		SEC. SW. LEVEL		DU DL		
A B C D E		0 1 2 3 4				
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM		GX PX SX HX		CLX A B C SR AR NF TR		

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FIG. 6 - TROUBLE RECORDER CARDS - CONTROLLER TROUBLE NO. 2

0	5	10	15	20	25	29
SOURCE OF RECORD			DECODER			
D M DT MT TV CT	TRI TR2	TRI TR2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17			
TYPE OF RECORD			MARKER-IT OR COMB			MARKER-TC
FIF MFT CFR DSTIMSTI RTRF TST SDT	OGT	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9		
RO PRO	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 0 1 2			
TRANSLATOR ENGAGED			DECODER CONNECTOR			
H EM TO TI UO	1 2 3 4 5 6 7 8 9	UO	TO TI T2 UO	1 2 3 4 5 6 7 8 9	UO	CO 1 C2
DECODER INPUT CODE			CODE BARS			
A0 1 2 4 A7 B0	1 2 4 B7 CO	1 2 4 C7 DO	1 2 4 D7 EO	1 2 4 E7 FO	1 2 4 F7	
DECODER INPUT			LATCH MAGNETS			CARD GROUP
3D 6D 6DA VO NVO	NRO CKI CFM PF	TSA TSB TSC 5BD	LI L2 L3 L4	VO NVO CGO	1 2 CG4	CSI CS2
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE			
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO	GI G2 G3 GB RLS MB	RO ROIT ROTC	RSI RS3 OF MBR ROR			
OGT APP TS TP			6D TRANSLATOR			CLASS
NCA CA4 CA5 CA6	IT TC ITC	0 1 2 TPC	0 1 2 H TO TI UO	1 2 4 7 TO TI	UO	1 2 4 U7
ALTERNATE ROUTE			ROUTING INST.			CDC
CDL NAC AC AHA AFA	TO 1 2 4 T7 UO	1 2 4 U7	0 1 2 4 7 0 1 2 4 7			
TRUNK BLOCK CONNECTOR			TRUNK BLOCK			GROUP START
DIM RD	TO 1 T2 UO	1 2 4 U7	0 1 2 4 7	TO TI UO	1 2 4 U7	TO TI UO 1 2 4 U7
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION			
CC CR RR FOF FMB FRO FST	PCR NPCR	HN TN UN HO	1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7	
MARKER REGISTRATION			MKR-SDR TRANSMITTED CODE CONVERSION			
MB RO PRO FOF FMB FRO FST HLD	MLCT CLCT ODG 4DG 5DG NDG	HO 1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7		
TRANSMITTED-MARKER TO SENDER			FRAME IDENTIFICATION			
M DC MF SXD LPD XDD XSG DLC SXR 20C	ODG 4DG 5DG	NSK SK3 SK6	IC OC FA FB FC FD FE FF FG FH			
DECODER PROGRESS			MARKER PROGRESS			
CKG HTK SMI SMC CK3 CCK CBK NCT NC	VCR COP1 COP2 ARST CAK HBA SMCOTID TBY DBS RHC R6D TCK 6DK IT	TC RCRR ME	RCD RCA	HBI		
DECODER PROGRESS			MARKER PROGRESS			
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT	CHK	CKG RCK TCK TBK GCK TKS SCT ATB TB	SG OCK ICK OFK IFK SK			
MARKER PROGRESS			MKR-SDR TRANSMITTING			
AK BK CK CHS A C HMG CCT TR	TIRI CONI MT	B OSC MRL RL	CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA	R6DT		

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

30	35	40	45	50	55	59
DECODER CROSS (X-)			DECODER TIME-OUT			MARKER TIME-OUT
CA REC IK CRK 6DT TRB CF	TRL DRL RLT	WT FTD MD TBD			TMC TMI TM2 TM3	
MARKER CROSS (X-)			TR TRL STR MRL TIF TOF			
X IS IPS TB ST MS K O I	JP ILS OLS JS SM SMI SMO TL RCK TKS					
TC TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	MS			
TC TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	MS			
UO 1 2 3 4 5 6 7 8 9	UO 20 21 22 23 24 25 26 27 28 29	30 31 32 33 34 35 36 37 38 39				
INCOMING FRAME GROUP			INC. SWITCH			
SELECT MAGNET			SELECT MAGNET			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	20 21 22 23 24 25 26 27 28 29					
30 31 32 33 34 35 36 37 38 39	INC. FR. E 0 E 0 E 0 E 0	OUT. FR. E 0 E 0 E 0 E 0	T.B. CONN. OUT. CONN. INC. CONN.	CONN. PREF. CONTROL		JUNCTOR WALKING
OUTGOING FRAME GROUP			OUT. SWITCH			
JUNCTOR CONTROL			CHANNEL			
JUNCTOR PATTERN			CHANNEL			
DECODER-MARKER TEST			DECODER-MARKER TEST			
LPD CLI2	NCF CHK MSK XPS SMG SMB					
CONT. GROUP			CONTROLLER			CONTROLLER CONNECTOR
A B C D E F 0	1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
TRUNK GROUP			TRUNK LEVEL			SEC. SW.
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	AO AI	BO BI	DP MP OS	
PREFERENCE			SEC. SW. LEVEL			
A B C D E	0 1 2 3 4					DU DL
CONTROLLER PROGRESS			CROSS			CONTROLLER TEST
TT FR GR CLO CLI OT PC	PC PC PC PC PC	PB SA SB SC HO HM	GX PX	HX	CLX A B C SR AR NF TR	

FIG. 7A

0	5	10	15	20	25	29
SOURCE OF RECORD			DECODER			
D M DT MT TV CT	TRI TR2	TRI TR2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17			
TYPE OF RECORD			MARKER-IT OR COMB			MARKER-TC
FIF MFT CFR DSTIMSTI RTRF TST SDT	OGT	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9		
RO PRO	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 0 1 2			
TRANSLATOR ENGAGED			DECODER CONNECTOR			
H EM TO TI UO	1 2 3 4 5 6 7 8 9	UO	TO TI T2 UO	1 2 3 4 5 6 7 8 9	UO	CO 1 C2
DECODER INPUT CODE			CODE BARS			
A0 1 2 4 A7 B0	1 2 4 B7 CO	1 2 4 C7 DO	1 2 4 D7 EO	1 2 4 E7 FO	1 2 4 F7	
DECODER INPUT			LATCH MAGNETS			CARD GROUP
3D 6D 6DA VO NVO	NRO CKI CFM PF	TSA TSB TSC 5BD	LI L2 L3 L4	VO NVO CGO	1 2 CG4	CSI CS2
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE			
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO	GI G2 G3 GB RLS MB	RO ROIT ROTC	RSI RS3 OF MBR ROR			
OGT APP TS TP			6D TRANSLATOR			CLASS
NCA CA4 CA5 CA6	IT TC ITC	0 1 2 TPC	0 1 2 H TO TI UO	1 2 4 7 TO TI	UO	1 2 4 U7
ALTERNATE ROUTE			ROUTING INST.			CDC
CDL NAC AC AHA AFA	TO 1 2 4 T7 UO	1 2 4 U7	0 1 2 4 7 0 1 2 4 7			
TRUNK BLOCK CONNECTOR			TRUNK BLOCK			GROUP START
DIM RD	TO 1 T2 UO	1 2 4 U7	0 1 2 4 7	TO TI UO	1 2 4 U7	TO TI UO 1 2 4 U7
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION			
CC CR RR FOF FMB FRO FST	PCR NPCR	HN TN UN HO	1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7	
MARKER REGISTRATION			MKR-SDR TRANSMITTED CODE CONVERSION			
MB RO PRO FOF FMB FRO FST HLD	MLCT CLCT ODG 4DG 5DG NDG	HO 1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7		
TRANSMITTED-MARKER TO SENDER			FRAME IDENTIFICATION			
M DC MF SXD LPD XDD XSG DLC SXR 20C	ODG 4DG 5DG	NSK SK3 SK6	IC OC FA FB FC FD FE FF FG FH			
DECODER PROGRESS			MARKER PROGRESS			
CKG HTK SMI SMC CK3 CCK CBK NCT NC	VCR COP1 COP2 ARST CAK HBA SMCOTID TBY DBS RHC R6D TCK 6DK IT	TC RCRR ME	RCD RCA	HBI		
DECODER PROGRESS			MARKER PROGRESS			
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT	CHK	CKG RCK TCK TBK GCK TKS SCT ATB TB	SG OCK ICK OFK IFK SK			
MARKER PROGRESS			MKR-SDR TRANSMITTING			
AK BK CK CHS A C HMG CCT TR	TIRI CONI MT	B OSC MRL RL	CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA	R6DT		

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

30	35	40	45	50	55	59
DECODER CROSS (X-)			DECODER TIME-OUT			MARKER TIME-OUT
CA REC IK CRK 6DT TRB CF	TRL DRL RLT	WT FTD MD TBD			TMC TMI TM2 TM3	
MARKER CROSS (X-)			TR TRL STR MRL TIF TOF			
X IS IPS TB ST MS K O I	JP ILS OLS JS SM SMI SMO TL RCK TKS					
TC TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	MS			
TC TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	MS			
UO 1 2 3 4 5 6 7 8 9	UO 20 21 22 23 24 25 26 27 28 29	30 31 32 33 34 35 36 37 38 39				
INCOMING FRAME GROUP			INC. SWITCH			
SELECT MAGNET			SELECT MAGNET			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	20 21 22 23 24 25 26 27 28 29					
30 31 32 33 34 35 36 37 38 39	INC. FR. E 0 E 0 E 0 E 0	OUT. FR. E 0 E 0 E 0 E 0	T.B. CONN. OUT. CONN. INC. CONN.	CONN. PREF. CONTROL		JUNCTOR WALKING
OUTGOING FRAME GROUP			OUT. SWITCH			
JUNCTOR CONTROL			CHANNEL			
JUNCTOR PATTERN			CHANNEL			
DECODER-MARKER TEST			DECODER-MARKER TEST			
LPD CLI2	NCF CHK MSK XPS SMG SMB					
CONT. GROUP			CONTROLLER			CONTROLLER CONNECTOR
A B C D E F 0	1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
TRUNK GROUP			TRUNK LEVEL			SEC. SW.
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	AO AI	BO BI	DP MP OS	
PREFERENCE			SEC. SW. LEVEL			
A B C D E	0 1 2 3 4					DU DL
CONTROLLER PROGRESS			CROSS			CONTROLLER TEST
TT FR GR CLO CLI OT PC	PC PC PC PC PC	PB SA SB SC HO HM	GX PX	HX	CLX A B C SR AR NF TR	

FIG. 7B

FIG. 7 - TROUBLE RECORDER CARDS - CONTROLLER TROUBLE NO. 3

0	5	10	15	20	25	29
SOURCE OF RECORD		D M		DECODER		
DT MT TV CT		TRI TR2		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		
TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC		
FIF MFT CFR DSTIMSTI RTNF TST SDT		OGT		0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9		
TYPE OF RECORD		SDR FR TENS		SDR FR UNITS		DP SDR MFP SDR
RO PRO		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9 0 1 2 0 1 2		
H EM TO TI UO		1 2 3 4 5 6 7 8 9		U9 TO TI T2 UO		1 2 3 4 5 6 7 8 9 U9 CO 1 C2
DECODER INPUT CODE		CODE BARS		DECODER CONNECTOR		
A0 1 2 4 A7 B0		1 2 4 B7 CO		1 2 4 C7 DO		1 2 4 D7 EO 1 2 4 E7 FO 1 2 4 F7
A0 1 2 4 A7 B0		1 2 4 B7 CO		1 2 4 C7 DO		1 2 4 D7 EO 1 2 4 E7 FO 1 2 4 F7
DECODER INPUT		LATCH MAGNETS		CARD GROUP		
3D 6D 6DA VO NVO		NRO CKI CFM PF		TSA TSB TSC 5BD		LI L2 L3 L4 VO NVO CGO 1 2 CG4 CSI CS2
DECODER ROUTE ADVANCE		MKR ROUTE ADVANCE				
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO		GI G2 G3 GB RLS MB		RO ROIT ROTC		RSI RS3 OF MBR ROR
NCA CA4 CA5 CA6		IT TC ITC		0 1 2 TPC		0 1 2 H TO TI UO 1 2 4 7 TO TI UO 1 2 4 U7
ALTERNATE ROUTE		ROUTING INST.		CDC		
CDL NAC AC AHA AFA		TO 1 2 4 T7 UO		1 2 4 U7		0 1 2 4 7 0 1 2 4 7
NSK SK3 SK6		HN TN UN HO		1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7
TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START		GROUP END
DIM RD		TO 1 T2 UO		1 2 4 U7		0 1 2 4 7 TO TI UO 1 2 4 U7 TO TI UO 1 2 4 U7
DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION				
CC CR RR FOF FMB FRO FST		PCR NPCR		HN TN UN HO		1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7
MARKER REGISTRATION		MKR-SDR TRANSMITTED CODE CONVERSION				
MB RO PRO FOF FMB FRO FST HLD		MLCT CLCT ODG 4DG 5DG NDG		HO 1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7
TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION				
M DC MF SXD LPD XDD XSG DLC SXR 20C		ODG 4DG 5DG		NSK SK3 SK6		IC OC FA FB FC FD FE FF FG FH
DECODER PROGRESS		MARKER PROGRESS				
CKG HTK SMI SMC CK3 CCK CBK NCT NC		VCR COP1 COP2 ARST CAK HBA SMC O TID TBY		DBS RHC R6D TCK 6DK IT		TC RCRR ME RCD RCA HBI
DECODER PROGRESS		MARKER PROGRESS				
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT		CHK		CKG RCK TCK TBK GCK TKS SCT ATB TB		SG OCK ICK OFK IFK SK
MARKER PROGRESS		MKR-SDR TRANSMITTING				
AK BK CK CHS A C HMG CCT TR TIRI CONI MT		B OSC MRL RL		CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT		

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

FIG. 10 - TROUBLE RECORDER CARD - CONTROLLER TROUBLE NO. 6

0	5	10	15	20	25	29
SOURCE OF RECORD		D M		DECODER		
DT MT TV CT		TRI TR2		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		
TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC		
FIF MFT CFR DSTIMSTI RTNF TST SDT		OGT		0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9		
TYPE OF RECORD		SDR FR TENS		SDR FR UNITS		DP SDR MFP SDR
RO PRO		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9 0 1 2 0 1 2		
H EM TO TI UO		1 2 3 4 5 6 7 8 9		U9 TO TI T2 UO		1 2 3 4 5 6 7 8 9 U9 CO 1 C2
DECODER INPUT CODE		CODE BARS		DECODER CONNECTOR		
A0 1 2 4 A7 B0		1 2 4 B7 CO		1 2 4 C7 DO		1 2 4 D7 EO 1 2 4 E7 FO 1 2 4 F7
A0 1 2 4 A7 B0		1 2 4 B7 CO		1 2 4 C7 DO		1 2 4 D7 EO 1 2 4 E7 FO 1 2 4 F7
DECODER INPUT		LATCH MAGNETS		CARD GROUP		
3D 6D 6DA VO NVO		NRO CKI CFM PF		TSA TSB TSC 5BD		LI L2 L3 L4 VO NVO CGO 1 2 CG4 CSI CS2
DECODER ROUTE ADVANCE		MKR ROUTE ADVANCE				
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO		GI G2 G3 GB RLS MB		RO ROIT ROTC		RSI RS3 OF MBR ROR
NCA CA4 CA5 CA6		IT TC ITC		0 1 2 TPC		0 1 2 H TO TI UO 1 2 4 7 TO TI UO 1 2 4 U7
ALTERNATE ROUTE		ROUTING INST.		CDC		
CDL NAC AC AHA AFA		TO 1 2 4 T7 UO		1 2 4 U7		0 1 2 4 7 0 1 2 4 7
NSK SK3 SK6		HN TN UN HO		1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7
TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START		GROUP END
DIM RD		TO 1 T2 UO		1 2 4 U7		0 1 2 4 7 TO TI UO 1 2 4 U7 TO TI UO 1 2 4 U7
DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION				
CC CR RR FOF FMB FRO FST		PCR NPCR		HN TN UN HO		1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7
MARKER REGISTRATION		MKR-SDR TRANSMITTED CODE CONVERSION				
MB RO PRO FOF FMB FRO FST HLD		MLCT CLCT ODG 4DG 5DG NDG		HO 1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7
TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION				
M DC MF SXD LPD XDD XSG DLC SXR 20C		ODG 4DG 5DG		NSK SK3 SK6		IC OC FA FB FC FD FE FF FG FH
DECODER PROGRESS		MARKER PROGRESS				
CKG HTK SMI SMC CK3 CCK CBK NCT NC		VCR COP1 COP2 ARST CAK HBA SMC O TID TBY		DBS RHC R6D TCK 6DK IT		TC RCRR ME RCD RCA HBI
DECODER PROGRESS		MARKER PROGRESS				
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT		CHK		CKG RCK TCK TBK GCK TKS SCT ATB TB		SG OCK ICK OFK IFK SK
MARKER PROGRESS		MKR-SDR TRANSMITTING				
AK BK CK CHS A C HMG CCT TR TIRI CONI MT		B OSC MRL RL		CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT		

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

FIG. 11 - TROUBLE RECORDER CARD - CONTROLLER TROUBLE NO. 7

30	35	40	45	50	55	59
DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT		
CA REC IK CRK 6DT TRB CF TRL DRL RLT		WT FTD MD TBD		TMC TMI TM2 TM3		
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS		TR TRL STR MRL TIF TOF				
TC		TB		TC		MS
TO 1 T2		0 1 2 4 7		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		MS
TC		TC		TC		MS
UO 1 2 3 4 5 6 7 8 9		U9		20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39		MS
INCOMING FRAME GROUP		INC. SWITCH				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9				
SELECT MAGNET						
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		20 21 22 23 24 25 26 27 28 29				
SELECT MAGNET		INC. FR.		OUT. FR.		T.B. CONN. OUT. CONN. INC. CONN.
30 31 32 33 34 35 36 37 38 39		E 0		E 0 E 0 E 0 E 0		CONN. PREF. CONTROL JUNCTOR WALKING
OUTGOING FRAME GROUP		OUT. SWITCH				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9				
JUNCTOR CONTROL		CHANNEL				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		LO 1 2 3 4 5 6 7 8 9				
JUNCTOR PATTERN		CHANNEL				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		JPN RO 1 2 3 4 5 6 7 8 9				
DECODER-MARKER TEST						
LPD CL12		NCF CHKMSK XPS SMG SMB				
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		LK. FR.-TENS LK. FR.-UNITS
A B C D E F 0		1 2 3 4 5		0 1 2 3 4 5 0 1 2 7 0 2 7		
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		SDR TYPE
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		AO AI BO BI DP MPP OS		
PREFERENCE		SEC. SW. LEVEL		DU DL		
A B C D E		0 1 2 4				
CONTROLLER PROGRESS		CROSS		CONTROLLER TEST		
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM		GX PX SX HX		CLX A B C SR AR NF TR		

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0	5	10	15	20	25	29
S8	SOURCE OF RECORD		D		M	
S7	TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC	
S6	TYPE OF RECORD		SDR. FR. TENS		SDR. FR. UNITS	
S5	TRANSLATOR ENGAGED		DECODER CONNECTOR		DECODER INPUT CODE	
S4	CODE BARS		LATCH MAGNETS		CARD GROUP	
S3	DECODER INPUT		DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE	
S2	OGT APP		6D TRANSLATOR		CLASS	
S1	ALTERNATE ROUTE		ROUTING INST.		CDC	
S0	CODE CONVERSION		TRUNK BLOCK CONNECTOR		TRUNK BLOCK	
R8	DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION		MARKER REGISTRATION-CODE CONVERSION	
R7	MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION		FRAME IDENTIFICATION	
R6	DECODER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	
R5	MARKER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	
R4	MARKER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	
R3	MARKER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	
R2	MARKER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	
R1	MARKER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	
R0	MARKER PROGRESS		MARKER PROGRESS		MARKER PROGRESS	

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

30	35	40	45	50	55	59
S8	DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT	
S7	MARKER CROSS (X-)		WT FTD MD TBD		TMC TMI TM2 TM3	
S6	MARKER CROSS (X-)		TR TRL STR MRL TIF TOF		MS	
S5	TC		TC		MS	
S4	INCOMING FRAME GROUP		INC. SWITCH		MS	
S3	SELECT MAGNET		SELECT MAGNET		MS	
S2	INC. FR.		OUT. FR.		CONN. INC. CONN.	
S1	OUTGOING FRAME GROUP		OUT. SWITCH		MS	
S0	JUNCTOR CONTROL		CHANNEL		MS	
R8	JUNCTOR PATTERN		CHANNEL		MS	
R7	DECODER-MARKER TEST		NCF CHKMSK XPS SMG SMB		MS	
R6	CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR	
R5	TRUNK GROUP		TRUNK LEVEL		SEC. SW.	
R4	REFERENCE		SEC. SW. LEVEL		SDR TYPE	
R3	CONTROLLER PROGRESS		CROSS		CONTROLLER TEST	
R2	CONTROLLER PROGRESS		CONTROLLER TEST		CONTROLLER TEST	
R1	CONTROLLER PROGRESS		CONTROLLER TEST		CONTROLLER TEST	
R0	CONTROLLER PROGRESS		CONTROLLER TEST		CONTROLLER TEST	

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TIME

FIG. 14 - TROUBLE RECORDER CARD - CONTROLLER TROUBLE NO. 10

0	5	10	15	20	25	29
SOURCE OF RECORD			DECODER			
D	M	C	DT	MT	TV	CT
TYPE OF RECORD			MARKER-IT OR COMB.			
F	I	F	M	F	T	S
TYPE OF RECORD			MARKER-TC			
R	O	P	R	O	P	R
TRANSLATOR ENGAGED			DECODER CONNECTOR			
H	E	M	T	O	T	I
DECODER INPUT			CODE BARS			
A	O	I	2	4	A	7
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE			
R	A	R	A	I	R	A
ALTERNATE ROUTE			ROUTING INST.			
C	D	L	C	A	C	A
TRUNK BLOCK CONNECTOR			GROUP START			
D	I	M	R	D	T	O
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION			
C	C	R	R	F	O	F
MARKER REGISTRATION			MKR.-SDR. TRANSMITTED CODE CONVERSION			
M	B	R	O	P	R	O
DECODER PROGRESS			MARKER PROGRESS			
C	K	G	H	T	K	S
DECODER PROGRESS			MKR.-SDR. TRANSMITTING			
D	C	B	D	C	B	2
A	K	B	K	C	H	S

TOLL SWITCHING SYSTEM
NO 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

30	35	40	45	50	55	59
DECODER CROSS (X-)			DECODER TIME-OUT			
C	A	R	E	C	A	R
MARKER CROSS (X-)			MARKER TIME-OUT			
X	I	S	I	P	S	T
INCOMING FRAME GROUP			INC. SWITCH			
0	1	2	3	4	5	6
SELECT MAGNET			JUNCTOR WALKING			
3	0	3	1	3	2	3
OUTGOING FRAME GROUP			OUT. SWITCH			
0	1	2	3	4	5	6
JUNCTOR CONTROL			CHANNEL			
0	1	2	3	4	5	6
JUNCTOR PATTERN			CHANNEL			
0	1	2	3	4	5	6
CONT. GROUP			CONTROLLER			
A	B	C	D	E	F	G
TRUNK LEVEL			SEC. SW.			
0	1	2	3	4	5	6
PREFERENCE			SEC. SW. LEVEL			
A	B	C	D	E	F	G
CONTROLLER PROGRESS			CROSS			
T	T	F	R	G	R	C

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TIME

FIG. 15A

0	5	10	15	20	25	29
SOURCE OF RECORD			DECODER			
D	M	C	DT	MT	TV	CT
TYPE OF RECORD			MARKER-IT OR COMB.			
F	I	F	M	F	T	S
TYPE OF RECORD			MARKER-TC			
R	O	P	R	O	P	R
TRANSLATOR ENGAGED			DECODER CONNECTOR			
H	E	M	T	O	T	I
DECODER INPUT			CODE BARS			
A	O	I	2	4	A	7
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE			
R	A	R	A	I	R	A
ALTERNATE ROUTE			ROUTING INST.			
C	D	L	C	A	C	A
TRUNK BLOCK CONNECTOR			GROUP START			
D	I	M	R	D	T	O
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION			
C	C	R	R	F	O	F
MARKER REGISTRATION			MKR.-SDR. TRANSMITTED CODE CONVERSION			
M	B	R	O	P	R	O
DECODER PROGRESS			MARKER PROGRESS			
C	K	G	H	T	K	S
DECODER PROGRESS			MKR.-SDR. TRANSMITTING			
D	C	B	D	C	B	2
A	K	B	K	C	H	S

TOLL SWITCHING SYSTEM
NO 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

30	35	40	45	50	55	59
DECODER CROSS (X-)			DECODER TIME-OUT			
C	A	R	E	C	A	R
MARKER CROSS (X-)			MARKER TIME-OUT			
X	I	S	I	P	S	T
INCOMING FRAME GROUP			INC. SWITCH			
0	1	2	3	4	5	6
SELECT MAGNET			JUNCTOR WALKING			
3	0	3	1	3	2	3
OUTGOING FRAME GROUP			OUT. SWITCH			
0	1	2	3	4	5	6
JUNCTOR CONTROL			CHANNEL			
0	1	2	3	4	5	6
JUNCTOR PATTERN			CHANNEL			
0	1	2	3	4	5	6
CONT. GROUP			CONTROLLER			
A	B	C	D	E	F	G
TRUNK LEVEL			SEC. SW.			
0	1	2	3	4	5	6
PREFERENCE			SEC. SW. LEVEL			
A	B	C	D	E	F	G
CONTROLLER PROGRESS			CROSS			
T	T	F	R	G	R	C

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FIG. 15B

FIG. 15 - TROUBLE RECORDER CARDS - TROUBLE NO. 1

0	5	10	15	20	25	29	
SOURCE OF RECORD		D M C DT MT TV CT		DECODER			
TYPE OF RECORD		TRI TR2		MARKER-IT OR COMB.		MARKER-TC	
FIF MFT CFR DSTIMSTI RTRF TST SDT		OGT		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9	
TYPE OF RECORD		SDR. FR. TENS		SDR. FR. UNITS		DP SDR. MFP SDR.	
RO PRO		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		0 1 2 0 1 2	
TRANSLATOR ENGAGED		DECODER CONNECTOR					
H EM TO TI UO		1 2 3 4 5 6 7 8 9		TO TI T2 UO		1 2 3 4 5 6 7 8 9 U9 CO 1 C2	
DECODER INPUT CODE							
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0		1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7	
CODE BARS							
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0		1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7	
DECODER INPUT		LATCH MAGNETS		CARD GROUP			
3D 6D 6DA VO NVO		NRO CKI CFM PF		TSA TSB TSC 5BD		LI L2 L3 L4 VO NVO CGO 1 2 CG4 CSI CS2	
DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE					
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO		GI G2 G3 GB RLS MB RO ROIT ROTC		RSI RS3 OF MBR ROR			
OCTAPP TS		TP		6D TRANSLATOR		CLASS	
NCA CA4 CA5 CA6		IT TC ITC		0 1 2 TPC 0 1 2 H TO TI UO		1 2 4 7 TO TI UO 1 2 4 U7	
ALTERNATE ROUTE		ROUTING INST.		CDC			
CDLCNAC AC AHA AFA		TO 1 2 4 T7 UO		1 2 4 U7		0 1 2 4 7 0 1 2 4 7	
CODE CONVERSION							
NSK SK3 SK6		HN TN UN HO		1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7	
TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START		GROUP END	
DIM RD		TO 1 T2 UO		1 2 4 U7		0 1 2 4 7 TO TI UO 1 2 4 U7	
DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION					
CC CR RR FOF FMB FRO FST		PCR NPCR		HN TN UN HO		1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7	
MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION					
MB RO PRO FOF FMB FRO FST HLD		MCT CLCT ODG 4DG 5DG NDG		HO 1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7	
TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION					
M DC MF SXD LPD XDD XSG DLC SXR 20C		ODG 4DG 5DG		NSK SK3 SK6		IC OC FA FB FC FD FE FF FG FH	
DECODER PROGRESS							
CKG HTK SMI SMC CK3 CCK CBK NCT NC		VCR COP1 COP2 ARST CAK HBA SMC0 TID TBY		DBS RHC R6D TCK 6DK IT		TC RCRR ME RCD RCA HBI	
DECODER PROGRESS		MARKER PROGRESS					
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT		CHK		CKG RCK TCK TBK GCK TKS SET ATB TB		SG OCK ICK OFK IFK SK	
MARKER PROGRESS		MKR.-SDR. TRANSMITTING					
AK BK CK CHS A C HMG GCT TR TIRI CONI MT		B OSC MRL RL		CLA CLB CLC CDA SKA HA HB TA TB UA UB		TSA DGA R6DT	

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

FIG. 16A

0	5	10	15	20	25	29	
SOURCE OF RECORD		D M C DT MT TV CT		DECODER			
TYPE OF RECORD		TRI TR2		MARKER-IT OR COMB.		MARKER-TC	
FIF MFT CFR DSTIMSTI RTRF TST SDT		OGT		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9	
TYPE OF RECORD		SDR. FR. TENS		SDR. FR. UNITS		DP SDR. MFP SDR.	
RO PRO		0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		0 1 2 0 1 2	
TRANSLATOR ENGAGED		DECODER CONNECTOR					
H EM TO TI UO		1 2 3 4 5 6 7 8 9		TO TI T2 UO		1 2 3 4 5 6 7 8 9 U9 CO 1 C2	
DECODER INPUT CODE							
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0		1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7	
CODE BARS							
A0 1 2 4 A7 B0		1 2 4 B7 C0		1 2 4 C7 D0		1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7	
DECODER INPUT		LATCH MAGNETS		CARD GROUP			
3D 6D 6DA VO NVO		NRO CKI CFM PF		TSA TSB TSC 5BD		LI L2 L3 L4 VO NVO CGO 1 2 CG4 CSI CS2	
DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE					
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO		GI G2 G3 GB RLS MB RO ROIT ROTC		RSI RS3 OF MBR ROR			
OCTAPP TS		TP		6D TRANSLATOR		CLASS	
NCA CA4 CA5 CA6		IT TC ITC		0 1 2 TPC 0 1 2 H TO TI UO		1 2 4 7 TO TI UO 1 2 4 U7	
ALTERNATE ROUTE		ROUTING INST.		CDC			
CDLCNAC AC AHA AFA		TO 1 2 4 T7 UO		1 2 4 U7		0 1 2 4 7 0 1 2 4 7	
CODE CONVERSION							
NSK SK3 SK6		HN TN UN HO		1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7	
TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START		GROUP END	
DIM RD		TO 1 T2 UO		1 2 4 U7		0 1 2 4 7 TO TI UO 1 2 4 U7	
DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION					
CC CR RR FOF FMB FRO FST		PCR NPCR		HN TN UN HO		1 2 4 H7 TO 1 2 4 T7 UO 1 2 4 U7	
MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION					
MB RO PRO FOF FMB FRO FST HLD		MCT CLCT ODG 4DG 5DG NDG		HO 1 2 4 H7 TO		1 2 4 T7 UO 1 2 4 U7	
TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION					
M DC MF SXD LPD XDD XSG DLC SXR 20C		ODG 4DG 5DG		NSK SK3 SK6		IC OC FA FB FC FD FE FF FG FH	
DECODER PROGRESS							
CKG HTK SMI SMC CK3 CCK CBK NCT NC		VCR COP1 COP2 ARST CAK HBA SMC0 TID TBY		DBS RHC R6D TCK 6DK IT		TC RCRR ME RCD RCA HBI	
DECODER PROGRESS		MARKER PROGRESS					
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT		CHK		CKG RCK TCK TBK GCK TKS SET ATB TB		SG OCK ICK OFK IFK SK	
MARKER PROGRESS		MKR.-SDR. TRANSMITTING					
AK BK CK CHS A C HMG GCT TR TIRI CONI MT		B OSC MRL RL		CLA CLB CLC CDA SKA HA HB TA TB UA UB		TSA DGA R6DT	

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

FIG. 16B

FIG. 16 - TROUBLE RECORDER CARDS - TROUBLE NO. 2

30	35	40	45	50	55	59
DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT		
CA REC IK CRK 6DT TRB CF TRL DRL RLT		WT FTD MD TBD		TMC TM1 TM2 TM3		
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS		TR TRL STR MRL TIF TOF				
TC		TB		TC		MS
TO 1 T2		0 1 2 4 7		0 1 2 3 4 5 6 7 8 9		10 11 12 13 14 15 16 17 18 19
TC		TC		TC		MS
UO 1 2 3 4 5 6 7 8 9		20 21 22 23 24 25 26 27 28 29		30 31 32 33 34 35 36 37 38 39		
INCOMING FRAME GROUP		INC. SWITCH				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9				
SELECT MAGNET		SELECT MAGNET				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		20 21 22 23 24 25 26 27 28 29				
30 31 32 33 34 35 36 37 38 39		INC. FR. OUT. FR. T.B. CONN. OUT. CONN. INC. CONN.		CONN. PREF. CONTROL		JUNCTOR WALKING
E. O. E. O. E. O.		E. O. E. O.		CNO CNE TCB OCB ICB		CHB RTA RTB RTC RTD
OUTGOING FRAME GROUP		OUT. SWITCH				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		0 1 2 3 4 5 6 7 8 9				
JUNCTOR CONTROL		CHANNEL				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		LO 1 2 3 4 5 6 7 8 9				
JUNCTOR PATTERN		CHANNEL				
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		JPN RO 1 2 3 4 5 6 7 8 9				
DECODER-MARKER TEST						
LPD CL12		NCF CHKMSK XPS SMG SMB				
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		LK. FR.-TENS LK. FR.-UNITS
A B C D E F		0 1 2 3 4 5		0 1 2 3 4 5 0 1 2 4 7 0 1 2 4 7		
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		SDR. TYPE
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		AO AI BO BI		DP MFP OS
PREFERENCE		SEC. SW. LEVEL				
A B C D E		0 1 2 3 4		DU DL		
CONTROLLER PROGRESS		CROSS		CONTROLLER TEST		
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM		GX PX SX HX		CLX A B C SR AR NF TR		

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0	5	10	15	20	25	29
SOURCE OF RECORD		DECODER				
D M C DT MT TV CT	TRI TR2	TRI TR2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17			
TYPE OF RECORD		MARKER - IT OR COMB.		MARKER - TC		
FIF MFT CFR DSTIMSTI RTRF TST SDT	OGT	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9			
RO PRO	SDR. FR. TENS	SDR. FR. UNITS	DP SDR.	MFP SDR.		
H EM TO TI UO	1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 0 1 2			
TRANSLATOR ENGAGED		DECODER CONNECTOR				
A0 1 2 4 A7 B0 1 2 4 B7 C0 1 2 4 C7 D0 1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7						
DECODER INPUT		LATCH MAGNETS		CARD GROUP		
3D 6D 6DA VO NVO	NRO CKI CFM PF	TSA TSB TSC 5BD	LI L2 L3 L4	VO NVO CGO 1 2 CG4	CSI CS2	
DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE				
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO	GI G2 G3 GB RLS MB RO ROIT ROTC	RSI RS3 OF MBR ROR				
DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE				
NCA CA4 CA5 CA6	IT TC ITC	0 1 2 TPC	0 1 2 H TO TI UO	1 2 4 7	TO TI UO 1 2 4 U7	
ALTERNATE ROUTE		ROUTING INST.		CDC		
CDL NAC AC AHA AFA	TO 1 2 4 T7 UO	1 2 4 U7	0 1 2 4 7	0 1 2 4 7		
TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START		
DIM RD	TO 1 T2 UO	1 2 4 U7	0 1 2 4 7	TO TI UO	1 2 4 U7	
DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION				
CC CR RR FOF FMB FRO FST	PCR NPCR	HN TN UN HO	1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7	
MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION				
MB RO PRO FOF FMB FRO FST HLD	MCT CLCT ODG 4DG 5DG NDG	HO 1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7		
TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION				
M DC MF SXD LPD XDD XSG DLC SXR 20C	ODG 4DG 5DG	NSK SK3 SK6	IC OC FA FB FC FD FE FF FG FH			
DECODER PROGRESS		MARKER PROGRESS				
CKG HTK SMI SMC CK3 CCK CBK NCT NC	VCR COP1 COP2 ARST CAK HBA SMC0 TID TBY DBS RHC R6D TCK 6DK IT TC RCRR ME RCD RCA HBI					
DECODER PROGRESS		MARKER PROGRESS				
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT	CHK	CKG RCK TCK TBK CK TKS SCT ATB TB	SG OCK ICK OFK IFK SK			
MARKER PROGRESS		MKR.-SDR. TRANSMITTING				
AK BK CK CHS A C HMG CCT TR TIRI CONI MT	B OSC MRL RL	CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT				

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

30	35	40	45	50	55	59
DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT		
CA REC IK CRK 6DT TRB CF TRL DRL RLT	WT FTD MD TBD	TMC TMI TM2 TM3				
MARKER CROSS (X-)		INC. SWITCH		OUT. SWITCH		
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS	TR TRL STR MRL TIF TOF					
TC	TC	TC	TC	TC	TC	MS
TO 1 T2	0 1 2 4 7	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19
TC	TC	TC	TC	TC	TC	MS
UO 1 2 3 4 5 6 7 8 9	20 21 22 23 24 25 26 27 28 29	30 31 32 33 34 35 36 37 38 39				
INCOMING FRAME GROUP		SELECT MAGNET		INC. SWITCH		
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	20 21 22 23 24 25 26 27 28 29				
OUTGOING FRAME GROUP		SELECT MAGNET		INC. SWITCH		
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	20 21 22 23 24 25 26 27 28 29				
JUNCTOR CONTROL		JUNCTOR WALKING		CHANNEL		
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17 18 19	LO 1 2 3 4 5 6 7 8 9				
JUNCTOR PATTERN		CHANNEL		CHANNEL		
0 1 2 3 4 5 6 7 8 9	10 11 12 13 14 15 16 17	JPN RO 1 2 3 4 5 6 7 8 9				
DECODER-MARKER TEST		CONT. GROUP		CONTROLLER		
LPD CLI2	NCF CHK MSK XPS SMG SMB					
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		
A B C D E F	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 4 7	0 1 2 4 7	
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	AO AI	BO BI	DP MFP OS	SDR. TYPE	
PREFERENCE		SEC. SW. LEVEL		DU DL		
A B C D E	0 1 2 3 4					
CONTROLLER PROGRESS		CROSS		CONTROLLER TEST		
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM	GX PX SX HX	CLX A B C SR AR NF TR				

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FIG. 17A

0	5	10	15	20	25	29
SOURCE OF RECORD		DECODER				
D M C DT MT TV CT	TRI TR2	TRI TR2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17			
TYPE OF RECORD		MARKER - IT OR COMB.		MARKER - TC		
FIF MFT CFR DSTIMSTI RTRF TST SDT	OGT	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9			
RO PRO	SDR. FR. TENS	SDR. FR. UNITS	DP SDR.	MFP SDR.		
H EM TO TI UO	1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 0 1 2			
TRANSLATOR ENGAGED		DECODER CONNECTOR				
A0 1 2 4 A7 B0 1 2 4 B7 C0 1 2 4 C7 D0 1 2 4 D7 E0 1 2 4 E7 F0 1 2 4 F7						
DECODER INPUT		LATCH MAGNETS		CARD GROUP		
3D 6D 6DA VO NVO	NRO CKI CFM PF	TSA TSB TSC 5BD	LI L2 L3 L4	VO NVO CGO 1 2 CG4	CSI CS2	
DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE				
RA RAI RA2 RA3 GSO GSI GS2 GS3 GS4 GS5 GO	GI G2 G3 GB RLS MB RO ROIT ROTC	RSI RS3 OF MBR ROR				
DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE				
NCA CA4 CA5 CA6	IT TC ITC	0 1 2 TPC	0 1 2 H TO TI UO	1 2 4 7	TO TI UO 1 2 4 U7	
ALTERNATE ROUTE		ROUTING INST.		CDC		
CDL NAC AC AHA AFA	TO 1 2 4 T7 UO	1 2 4 U7	0 1 2 4 7	0 1 2 4 7		
TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START		
DIM RD	TO 1 T2 UO	1 2 4 U7	0 1 2 4 7	TO TI UO	1 2 4 U7	
DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION				
CC CR RR FOF FMB FRO FST	PCR NPCR	HN TN UN HO	1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7	
MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION				
MB RO PRO FOF FMB FRO FST HLD	MCT CLCT ODG 4DG 5DG NDG	HO 1 2 4 H7 TO	1 2 4 T7 UO	1 2 4 U7		
TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION				
M DC MF SXD LPD XDD XSG DLC SXR 20C	ODG 4DG 5DG	NSK SK3 SK6	IC OC FA FB FC FD FE FF FG FH			
DECODER PROGRESS		MARKER PROGRESS				
CKG HTK SMI SMC CK3 CCK CBK NCT NC	VCR COP1 COP2 ARST CAK HBA SMC0 TID TBY DBS RHC R6D TCK 6DK IT TC RCRR ME RCD RCA HBI					
DECODER PROGRESS		MARKER PROGRESS				
DCB DCB2 ATB GPL ARS TCD TKS RDRL DRL RLT	CHK	CKG RCK TCK TBK CK TKS SCT ATB TB	SG OCK ICK OFK IFK SK			
MARKER PROGRESS		MKR.-SDR. TRANSMITTING				
AK BK CK CHS A C HMG CCT TR TIRI CONI MT	B OSC MRL RL	CLA CLB CLC CDA SKA HA HB TA TB UA UB TSA DGA R6DT				

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

FIG. 17B

FIG. 17 - TROUBLE RECORDER CARDS - TROUBLE NO. 3

0	5	10	15	20	25	29																							
SOURCE OF RECORD			DECODER																										
D	M	C	DT	MT	TV	CT																							
TYPE OF RECORD			MARKER-IT OR COMB.			MARKER-TC																							
F	I	F	M	F	T	S	T	I	M	S	T	S	D	T															
SDR. FR. TENS			SDR. FR. UNITS			DP SDR.			MFP SDR.																				
RO	PRO	0	1	2	3	4	5	6	7	8	9	0	1	2	0	1	2												
TRANSLATOR ENGAGED			DECODER CONNECTOR																										
H	EM	TO	TI	UO	1	2	3	4	5	6	7	8	U9	TO	TI	T2	UO	1	2	3	4	5	6	7	8	U9	CO	1	C2
DECODER INPUT CODE			CODE BARS																										
A0	1	2	4	A7	B0	1	2	4	B7	CO	1	2	4	D0	1	2	4	D7	E0	1	2	4	E7	F0	1	2	4	F7	
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE																										
RA	RA1	RA2	RA3	GS0	GS1	GS2	GS3	GS4	GS5	GO	GI	G2	G3	GB	RLS	MB	RO	ROIT	ROTC	RS1	RS3	OF	MBR	ROR					
ALTERNATE ROUTE			ROUTING INST.			CDC																							
CDLC	NAC	AC	AHA	AFA	TO	1	2	4	T7	UO	1	2	4	U7	0	1	2	7	0	1	2	4	7						
TRUNK BLOCK CONNECTOR			TRUNK BLOCK			GROUP START			GROUP END																				
DIM	RD	TO	1	2	4	U7	0	1	2	4	7	TO	TI	UO	1	2	4	U7	TO	TI	UO	1	2	4	U7				
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION																										
CC	CR	RR	FOF	FMB	FRO	FST	HL	MLCT	CLCT	ODG	4DG	5DG	NDG	HO	1	2	4	H7	TO	1	2	4	T7	UO	1	2	4	U7	
MARKER REGISTRATION			MKR.-SDR. TRANSMITTED CODE CONVERSION																										
M	DC	MF	SXD	LPD	XDD	XSG	DLC	SXR	ZOC	ODG	4DG	5DG	NSK	SK3	SK6	IC	OC	FA	FB	FC	FD	FE	FF	FG	FH				
DECODER PROGRESS			MARKER PROGRESS																										
CKG	HTK	SMI	SMC	CK3	CKK	CBK	NCT	NC	VCR	COP1	COP2	ARST	CAK	HBA	SMO	TID	TBY	DBS	RHC	R6D	TCK	6DK	IT	TC	RCRR	ME	RCD	RCA	HBI
DECODER PROGRESS			MARKER PROGRESS																										
DCB	DCB2	ATB	GPL	ARS	TCD	TKS	RDRL	DRL	RLT	CHK	CKG	RCK	TCK	TBK	GCK	TKS	SCT	ATB	TB	SG	OCK	ICK	OFK	IFK	SK				
MARKER PROGRESS			MKR.-SDR. TRANSMITTING																										
AK	BK	CK	CHS	A	C	HMG	GCT	TR	TIRI	CONI	MT	B	OSCMRL	RL	CLA	CLB	CLC	CDA	SKA	HA	HB	TA	TB	UA	UB	TSA	DGA	R6DT	

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

FIG. 20 A

0	5	10	15	20	25	29																							
SOURCE OF RECORD			DECODER																										
D	M	C	DT	MT	TV	CT																							
TYPE OF RECORD			MARKER-IT OR COMB.			MARKER-TC																							
F	I	F	M	F	T	S	T	I	M	S	T	S	D	T															
SDR. FR. TENS			SDR. FR. UNITS			DP SDR.			MFP SDR.																				
RO	PRO	0	1	2	3	4	5	6	7	8	9	0	1	2	0	1	2												
TRANSLATOR ENGAGED			DECODER CONNECTOR																										
H	EM	TO	TI	UO	1	2	3	4	5	6	7	8	U9	TO	TI	T2	UO	1	2	3	4	5	6	7	8	U9	CO	1	C2
DECODER INPUT CODE			CODE BARS																										
A0	1	2	4	A7	B0	1	2	4	B7	CO	1	2	4	D0	1	2	4	D7	E0	1	2	4	E7	F0	1	2	4	F7	
DECODER ROUTE ADVANCE			MKR. ROUTE ADVANCE																										
RA	RA1	RA2	RA3	GS0	GS1	GS2	GS3	GS4	GS5	GO	GI	G2	G3	GB	RLS	MB	RO	ROIT	ROTC	RS1	RS3	OF	MBR	ROR					
ALTERNATE ROUTE			ROUTING INST.			CDC																							
CDLC	NAC	AC	AHA	AFA	TO	1	2	4	T7	UO	1	2	4	U7	0	1	2	7	0	1	2	4	7						
TRUNK BLOCK CONNECTOR			TRUNK BLOCK			GROUP START			GROUP END																				
DIM	RD	TO	1	2	4	U7	0	1	2	4	7	TO	TI	UO	1	2	4	U7	TO	TI	UO	1	2	4	U7				
DECODER ROUTING INSTRUCTIONS			MARKER REGISTRATION-CODE CONVERSION																										
CC	CR	RR	FOF	FMB	FRO	FST	HL	MLCT	CLCT	ODG	4DG	5DG	NDG	HO	1	2	4	H7	TO	1	2	4	T7	UO	1	2	4	U7	
MARKER REGISTRATION			MKR.-SDR. TRANSMITTED CODE CONVERSION																										
M	DC	MF	SXD	LPD	XDD	XSG	DLC	SXR	ZOC	ODG	4DG	5DG	NSK	SK3	SK6	IC	OC	FA	FB	FC	FD	FE	FF	FG	FH				
DECODER PROGRESS			MARKER PROGRESS																										
CKG	HTK	SMI	SMC	CK3	CKK	CBK	NCT	NC	VCR	COP1	COP2	ARST	CAK	HBA	SMO	TID	TBY	DBS	RHC	R6D	TCK	6DK	IT	TC	RCRR	ME	RCD	RCA	HBI
DECODER PROGRESS			MARKER PROGRESS																										
DCB	DCB2	ATB	GPL	ARS	TCD	TKS	RDRL	DRL	RLT	CHK	CKG	RCK	TCK	TBK	GCK	TKS	SCT	ATB	TB	SG	OCK	ICK	OFK	IFK	SK				
MARKER PROGRESS			MKR.-SDR. TRANSMITTING																										
AK	BK	CK	CHS	A	C	HMG	GCT	TR	TIRI	CONI	MT	B	OSCMRL	RL	CLA	CLB	CLC	CDA	SKA	HA	HB	TA	TB	UA	UB	TSA	DGA	R6DT	

TOLL SWITCHING SYSTEM
NO. 4A
TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

FIG. 20 B

30	35	40	45	50	55	59																										
DECODER CROSS (X-)			DECODER TIME-OUT			MARKER TIME-OUT																										
CA	REC	IK	CRK	6DT	TRB	CF	TRL	DRL	RLT	FTD	MD	TBD	TMC	TMI	TM2	TM3																
MARKER CROSS (X-)																																
X	IS	IPS	TB	ST	MS	K	O	I	JP	ILS	OLS	JS	SM	SMI	SMO	TL	RCK	TKS	TR	TRL	STR	MRL	TIF	TOF								
TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC							
TO	1	T2	0	1	2	4	7	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19					
TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC	TC					
UO	1	2	3	4	5	6	7	8	U9	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39			
INCOMING FRAME GROUP			SELECT MAGNET			INC. FR.			OUT. FR.			T.B. CONN. OUT. CONN. INC. CONN.			CONN. PREF. CONTROL			JUNCTOR WALKING														
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29			
30	31	32	33	34	35	36	37	38	39	E	O	E	O	E	O	E	O	E	O	CNO	CNE	TCB	OCB	ICB	CHB	RTA	RTB	RTC	RTD			
OUTGOING FRAME GROUP			JUNCTOR CONTROL			JUNCTOR PATTERN			OUT. SWITCH			CHANNEL			CHANNEL																	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	LO	1	2	3	4	5	6	7	8	9			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	LO	1	2	3	4	5	6	7	8	9			
DECODER-MARKER TEST			NCF			CHK			MSK			XPS			SMG			SMB														
LPD	CLI2																															
CONT. GROUP			CONTROLLER			CONTROLLER CONNECTOR			LK. FR.-TENS			LK. FR.-UNITS																				
A	B	C	D	E	F	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	4	7	0	1	2	4	7					
TRUNK GROUP			TRUNK LEVEL			SEC. SW.			SDR. TYPE																							
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	AO	AI	BO	BI	DF	MFP	OS						
PREFERENCE			SEC. SW. LEVEL			DU			DL																							
A	B	C	D	E																												
CONTROLLER PROGRESS			CROSS			CONTROLLER TEST																										
TT	FR	GR	CLO	CL	OT	PC	DTC	OTC	PA	PB	SA	SB	SC	HO	HM	GX	PX	SX	HX	CLX	A	B	C	SR	AR	NF	TR					

OFFICE
DATE

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TIME

R7

R6

R5

R4

R3

R2

R1

RO

OFFICE
DATE

000

TIME

R7

R6

R5

R4

R3

R2

R1

RO

0	5	10	15	20	25	29
S8	SOURCE OF RECORD		DECODER			
S7	TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC	
S6	SDR. FR. TENS		SDR. FR. UNITS		DP SDR. MFP SDR.	
S5	TRANSLATOR ENGAGED		DECODER CONNECTOR			
S4	DECODER INPUT CODE					
S3	CODE BARS					
S2	DECODER INPUT		LATCH MAGNETS		CARD GROUP	
S1	DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE			
S0	OGT APP. TS		ED TRANSLATOR		CLASS	
R8	ALTERNATE ROUTE		ROUTING INST.		CDC	
R7	NSK SK3 SK6		HN TN UN HO		I 2 4 H7 TO I 2 4 T7 UO I 2 4 U7	
R6	TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START GROUP END	
R5	DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION			
R4	MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION			
R3	TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION			
R2	DECODER PROGRESS					
R1	MARKER PROGRESS		MARKER PROGRESS			
R0	MARKER PROGRESS		MKR.-SDR. TRANSMITTING			

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

30	35	40	45	50	55	59	
DECODER CROSS (X-)		DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT	
CA REC IK CRK 6DT TRB CF TRL DRL RLT		MARKER CROSS (X-)		WT FTD MD TBD		TMC TMI TM2 TM3	
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS		TR TRL STR MRL TIF TOF					
TC		TB		TC		MS	
TO I T2		U 1 2 4 7		O 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		MS	
UO I 2 3 4 5 6 7 8 9 U9		20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39					
INCOMING FRAME GROUP		SELECT MAGNET		INC. SWITCH			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		20 21 22 23 24 25 26 27 28 29		0 1 2 3 4 5 6 7 8 9			
OUTGOING FRAME GROUP		INC. FR.		OUT. FR.		T.B. CONN. OUT. CONN. INC. CONN.	
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		E		E		E	
JUNCTOR CONTROL		CONN. PREF. CONTROL		JUNCTOR WALKING			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		CNO CNE TCB OCB ICB		CHB RTA RTB RTC RTD			
JUNCTOR PATTERN		OUT. SWITCH		CHANNEL			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		JPN RO I 2 3 4 5 6 7 8 R9		CHANNEL			
DECODER-MARKER TEST							
LPD CLI2		NCF CHKMSK XPS SMG SMB					
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		LK. FR.-TENS	
A B C D E F		0 1 2 3 4 5		0 1 2 3 4 5		0 1 2 4 7 0 1 2 4 7	
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		SDR. TYPE	
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		AO AI BO BI		DP MFP OS	
PREFERENCE		SEC. SW. LEVEL		DU DL			
A B C D E		0 1 2 3 4					
CONTROLLER PROGRESS		CROSS		CONTROLLER TEST			
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM		GX PX SX HX CLX A B C SR AR NF TR					

OFFICE DATE

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TIME

R7

R6

R5

R4

R3

R2

R1

R0

FIG. 21A

0	5	10	15	20	25	29
S8	SOURCE OF RECORD		DECODER			
S7	TYPE OF RECORD		MARKER-IT OR COMB.		MARKER-TC	
S6	SDR. FR. TENS		SDR. FR. UNITS		DP SDR. MFP SDR.	
S5	TRANSLATOR ENGAGED		DECODER CONNECTOR			
S4	DECODER INPUT CODE					
S3	CODE BARS					
S2	DECODER INPUT		LATCH MAGNETS		CARD GROUP	
S1	DECODER ROUTE ADVANCE		MKR. ROUTE ADVANCE			
S0	OGT APP. TS		ED TRANSLATOR		CLASS	
R8	ALTERNATE ROUTE		ROUTING INST.		CDC	
R7	NSK SK3 SK6		HN TN UN HO		I 2 4 H7 TO I 2 4 T7 UO I 2 4 U7	
R6	TRUNK BLOCK CONNECTOR		TRUNK BLOCK		GROUP START GROUP END	
R5	DECODER ROUTING INSTRUCTIONS		MARKER REGISTRATION-CODE CONVERSION			
R4	MARKER REGISTRATION		MKR.-SDR. TRANSMITTED CODE CONVERSION			
R3	TRANSMITTED-MARKER TO SENDER		FRAME IDENTIFICATION			
R2	DECODER PROGRESS					
R1	MARKER PROGRESS		MARKER PROGRESS			
R0	MARKER PROGRESS		MKR.-SDR. TRANSMITTING			

TOLL SWITCHING SYSTEM NO. 4A TROUBLE RECORDER CARD

TROUBLE FOUND OR ACTION TAKEN

30	35	40	45	50	55	59	
DECODER CROSS (X-)		DECODER CROSS (X-)		DECODER TIME-OUT		MARKER TIME-OUT	
CA REC IK CRK 6DT TRB CF TRL DRL RLT		MARKER CROSS (X-)		WT FTD MD TBD		TMC TMI TM2 TM3	
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS		TR TRL STR MRL TIF TOF					
TC		TB		TC		MS	
TO I T2		U 1 2 4 7		O 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		MS	
UO I 2 3 4 5 6 7 8 9 U9		20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39					
INCOMING FRAME GROUP		SELECT MAGNET		INC. SWITCH			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		20 21 22 23 24 25 26 27 28 29		0 1 2 3 4 5 6 7 8 9			
OUTGOING FRAME GROUP		INC. FR.		OUT. FR.		T.B. CONN. OUT. CONN. INC. CONN.	
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		E		E		E	
JUNCTOR CONTROL		CONN. PREF. CONTROL		JUNCTOR WALKING			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		CNO CNE TCB OCB ICB		CHB RTA RTB RTC RTD			
JUNCTOR PATTERN		OUT. SWITCH		CHANNEL			
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		JPN RO I 2 3 4 5 6 7 8 R9		CHANNEL			
DECODER-MARKER TEST							
LPD CLI2		NCF CHKMSK XPS SMG SMB					
CONT. GROUP		CONTROLLER		CONTROLLER CONNECTOR		LK. FR.-TENS	
A B C D E F		0 1 2 3 4 5		0 1 2 3 4 5		0 1 2 4 7 0 1 2 4 7	
TRUNK GROUP		TRUNK LEVEL		SEC. SW.		SDR. TYPE	
0 1 2 3 4 5 6 7 8 9		0 1 2 3 4 5 6 7 8 9		AO AI BO BI		DP MFP OS	
PREFERENCE		SEC. SW. LEVEL		DU DL			
A B C D E		0 1 2 3 4					
CONTROLLER PROGRESS		CROSS		CONTROLLER TEST			
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM		GX PX SX HX CLX A B C SR AR NF TR					

OFFICE DATE

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TIME

R7

R6

R5

R4

R3

R2

R1

R0

FIG. 21B

FIG. 21 - TROUBLE RECORDER CARDS - TROUBLE NO. 7

0	5	10	15	20	25	29
SOURCE OF RECORD						
D	M	C	DT	MT	TV	CT
TYPE OF RECORD						
FIF	MFT	CFR	DSTM	STI	RTRF	TST
SDT						
OGT						
MARKER-IT OR COMB						
MARKER-TC						
SDR. FR. TENS						
SDR. FR. UNITS						
DP SDR.						
MFP SDR.						
TRANSLATOR ENGAGED						
DECODER CONNECTOR						
DECODER INPUT CODE						
CODE BARS						
DECODER INPUT						
LATCH MAGNETS						
CARD GROUP						
DECODER ROUTE ADVANCE						
MKR. ROUTE ADVANCE						
RSI RS3 OF MBR ROR						
OCTAPP						
TS						
TP						
SD TRANSLATOR						
CLASS						
ALTERNATE ROUTE						
ROUTING INST.						
CDC						
CODE CONVERSION						
TRUNK BLOCK CONNECTOR						
TRUNK BLOCK						
GROUP START						
GROUP END						
DECODER ROUTING INSTRUCTIONS						
MARKER REGISTRATION-CODE CONVERSION						
MCR-SDR TRANSMITTED CODE CONVERSION						
MARKER REGISTRATION						
MCR-SDR TRANSMITTED CODE CONVERSION						
TRANSMITTED-MARKER TO SENDER						
FRAME IDENTIFICATION						
DECODER PROGRESS						
MARKER PROGRESS						
MCR-SDR TRANSMITTING						

TOLL SWITCHING SYSTEM
NO 4A
TROUBLE RECORDER CARD

FIG. 22 - TROUBLE RECORDER CARD - TROUBLE NO. 8

30	35	40	45	50	55	59
DECODER CROSS (X-)						
DECODER TIME-OUT						
MARKER TIME-OUT						
CA REC IK CRK 6DT TRB CF TRL DRL RLT						
MARKER CROSS (X-)						
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS						
TR TRL STR MRL TIF TOF						
TC						
T2						
TC MS						
UO						
INCOMING FRAME GROUP						
INC. SWITCH						
SELECT MAGNET						
SELECT MAGNET						
INC. FR.						
OUT. FR.						
T.B. COMM. OUT. COMM. INC. COMM.						
COMM. PREF. CONTROL						
JUNCTOR WALKING						
OUTGOING FRAME GROUP						
OUT. SWITCH						
JUNCTOR CONTROL						
CHANNEL						
JUNCTOR PATTERN						
CHANNEL						
DECODER-MARKER TEST						
LPD CL12						
NCF CHK MSK XPS SMG SMB						
CONT. GROUP						
CONTROLLER						
CONTROLLER CONNECTOR						
LK. FR.-TENS						
LK. FR.-UNITS						
TRUNK GROUP						
TRUNK LEVEL						
SEC. SW.						
SDR TYPE						
PREFERENCE						
SEC. SW. LEVEL						
CONTROLLER PROGRESS						
CROSS						
CONTROLLER TEST						
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM						
GX PX SX HX CLX A B C SR AR NF TR						

OFFICE
DATE

TIME

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OFFICE
DATE

TIME

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0	5	10	15	20	25	29
SOURCE OF RECORD						
D	M	C	DT	MT	TV	CT
TYPE OF RECORD						
FIF	MFT	CFR	DSTM	STI	RTRF	TST
SDT						
OGT						
MARKER-IT OR COMB						
MARKER-TC						
SDR. FR. TENS						
SDR. FR. UNITS						
DP SDR.						
MFP SDR.						
TRANSLATOR ENGAGED						
DECODER CONNECTOR						
DECODER INPUT CODE						
CODE BARS						
DECODER INPUT						
LATCH MAGNETS						
CARD GROUP						
DECODER ROUTE ADVANCE						
MKR. ROUTE ADVANCE						
RSI RS3 OF MBR ROR						
OCTAPP						
TS						
TP						
SD TRANSLATOR						
CLASS						
ALTERNATE ROUTE						
ROUTING INST.						
CDC						
CODE CONVERSION						
TRUNK BLOCK CONNECTOR						
TRUNK BLOCK						
GROUP START						
GROUP END						
DECODER ROUTING INSTRUCTIONS						
MARKER REGISTRATION-CODE CONVERSION						
MCR-SDR TRANSMITTED CODE CONVERSION						
MARKER REGISTRATION						
MCR-SDR TRANSMITTED CODE CONVERSION						
TRANSMITTED-MARKER TO SENDER						
FRAME IDENTIFICATION						
DECODER PROGRESS						
MARKER PROGRESS						
MCR-SDR TRANSMITTING						

TOLL SWITCHING SYSTEM
NO 4A
TROUBLE RECORDER CARD

FIG. 23 - TROUBLE RECORDER CARD - TROUBLE NO. 9

30	35	40	45	50	55	59
DECODER CROSS (X-)						
DECODER TIME-OUT						
MARKER TIME-OUT						
CA REC IK CRK 6DT TRB CF TRL DRL RLT						
MARKER CROSS (X-)						
X IS IPS TB ST MS K O I JP ILS OLS JS SM SMI SMO TL RCK TKS						
TR TRL STR MRL TIF TOF						
TC						
T2						
TC MS						
UO						
INCOMING FRAME GROUP						
INC. SWITCH						
SELECT MAGNET						
SELECT MAGNET						
INC. FR.						
OUT. FR.						
T.B. COMM. OUT. COMM. INC. COMM.						
COMM. PREF. CONTROL						
JUNCTOR WALKING						
OUTGOING FRAME GROUP						
OUT. SWITCH						
JUNCTOR CONTROL						
CHANNEL						
JUNCTOR PATTERN						
CHANNEL						
DECODER-MARKER TEST						
LPD CL12						
NCF CHK MSK XPS SMG SMB						
CONT. GROUP						
CONTROLLER						
CONTROLLER CONNECTOR						
LK. FR.-TENS						
LK. FR.-UNITS						
TRUNK GROUP						
TRUNK LEVEL						
SEC. SW.						
SDR TYPE						
PREFERENCE						
SEC. SW. LEVEL						
CONTROLLER PROGRESS						
CROSS						
CONTROLLER TEST						
TT FR GR CLO CLI OT PC DTC OTC PA PB SA SB SC HO HM						
GX PX SX HX CLX A B C SR AR NF TR						