## CHANGES

```
D. DESCRIPTION OF CIRCUIT CHANGES
D.1 A lead is added from the 7DG key of
    the main figure sheet 0ll to 4RT of
the (X-7DG) relay figure P sheet 016.
All other headings, no change.
```

BELL TELEPHONE LABORATORIES, INCORPORATED

PANEL SYSTEMS<br>AUTOMATIC TESTING CIRCUIT<br>FOR 3 DIGIT DECODERS<br>AND ASSOCIATED CONNECTORS

CHANGES

## A. CHANGED AND ADDED FUNCTIONS

A. 1 A feature is added to test decoder
circuits and decoder connector circuits associated with subscriber sender circuits that have been modified for use with the Auxiliary Sender Circuit
SD-96479-01.

## B. CHANGES IN APPARATUS

B. 1 Added

| (X-7DG) | Fig. R1557 relay |
| :---: | :---: |
| ( X -SK2 | R1557 " |
| (x-SK3 | R1557 |
| Y-7DG | E1508 |
| (Y-SK2 | R1508 |
| Y-SK3 | E1508 |
| Z-7DG | R354 |
| Z-SK2 | R354 |
| (z-SK3) | R354 |
| ( $\mathrm{X}-7 \mathrm{DG}$ ) | 2G lamp |
| ( x -SK2 | 2 G |
| x-SK3 | 2 G |
| (Y-7DG | 2 G |
| Y-SK2 | 2 G |
| Y-SK3 | 2 G |
| Z-7DG | 2 G |
| Z-SK2 | 2 G |
| (2-SK3) | 2 G |
| (SK2-SK3) | ClG key |

## D. DESCRIPTION OF CIRCUIT CHANGES

D. 1 Fig. O previously part of the main figure, shows a record where Fig. P is not equipped.
D. 2 Fig. $P$ is added to extend the existing
test facilities to include the 7DG, SK2 and SK3 leads through the decoder connector circuit, to the decoder circuit. $G$ option is indicated for the class keys and the leads through the test connector relays.
D. 3 Circuit Note 141 is added.
D. 4 One CLASS key, ElAM type, is designated 7DG.
D. 5 Thla ofrcuit is rated A\&M only.

All other headings under Changes, no change.

## 1. PURPOSE OF CIRCUIT

### 1.1 This circuit is for use in panel of-

fices which are equipped with threedigit decoders; it is arranged to test the decoder circuits and also the connector wiring and multicontact relays of the associated decoder connector circuits.
2. WORKING LIMITS

### 2.1 None.

## 3. FUNCTIONS

### 3.1 Decoder Testing

3.101 To connect to the start leads of two decoders so that these two decoders may be connected to the test circuit. To make use of one decoder as a "Master" so as to check other decoders against it.
3.102 When the "Master" decoder and the decoder to be tested have been connected to the test circuit to connect to the receiving and transmitting leads of both decoders, and when so connected (1) to hold the decoders busy, (2) to prevent the time alarms in each of the decoders from operating, and (3) to make the tests enumerated in the following items numbered 3.113 to 3.118 inclusive.
3.103 To test the ability of the decoder circuit to release a sender when any of the receiving leads are open or falsely grounded and to test the decoder (X1) ar (X2) relays for their ability to operate and lock.
3.104 To test the ability of the decoder circuit to route a pre-
Iiminary pulse indication (received by the decoder over the receiving leads) to an operator.
3.105 To test the abllity of the decoder to route calls to special service operator.
3.106 To test the ability of the decoder to route calls to permanent signal operator.
3.107 To test the ability of the decoder to translate all codes available to the senders and routie them according to the class of service to which the calling subscriber (or "A" operator) is entitled; the translated information from the decoder under test is compared with the translated information received from the "master" decoder.
3.108 To test the ability of the decoder under test to translate any particular code, matching the translated information with the required translation as manually recorded on keys in the test circuit.
3.109 To make the all codes test or a particular code test on each decoder in succession and to light an end of cycle lamp when all decoders have thus been tested.
3.110 To begin the decoder test on a particular decoder when the particular circuit key (PC) is operated, thereafter testing the remaining decoders in the same manner.
3.111 To make a test of the time alarm of each decoder circuit.
3.112 To record the number of decoder tests made (all code tests and particular code tests).
3.113 To release the master decoder whenever the test circuit falls to complete a test within the allowable time.
3.114 To advance to the next decoder or make a repeat test if the (REP) key is operated, when the (CA) key is operated after the test circuit becomes stuck.
3.115 To test the abillty of the decoder to hold itself busy for a short time after giving a trouble release signal.

### 3.2 Connector Testing

3.201 To connect to the start lead of the connector under test so that it may be connected to the test circuit.
3.202. To connect to the start lead of the decoder to which the connector 1 s
Lo be tested and to connect to this decoder
in similar manner to that mentioned in
1 tems 3.101 and 3.102.
3.203 To prevent the decoder time alarm from operating and to disconnect from each other all of the transmitting leads so that a false ground on one lead will be disconnected from the others.
3.204 To have the connector connected to . the test circuit, so as to connect ground to the TH lead of this connector so that the connector may be connected to the proper decoder circuit; when the connector, decoder and test circuits have been thus connected tests are made as enumerated in the following items number 3.205 and 3.211 inclusive.
3.205 To test the connector for continuity of all leads except the DBA and ST leads between the connector and decoder (these leads are tested when testing decoders).
3.206 To test the leads for false ground.
3.207 To test for crosses between leads.
3.208 To make a false battery test of those connector leads which do not normally have battery connected to them in the decoder.
3.209 To test the contacts of the multicontact relay, which connects the decoder to the test circuit, for crosses.
3.210 To test the contacts of the multicontact relay in the connector which connects the connector to the decoder circult and to test all leads through the connector but not extending to the decoder for false battery.
3.211 To test the contacts of the multicontact relay in the connector which connects the connector to the test circuit.
3.212 To make the tests enumerated on all decoders in succession for each connector in succession and to ilght an end of cycle lamp and sound an alarm when all connectors have been thus tested.
3.213 To make the connector tests to a particular decoder (particular path) when the (PPH) key is operated.
3.214 To begin tests on a particular connector when the particular circuit key (PC) is operated, thereafter testing the remaining connectors in the same manner.
3.215 To make a test of the time alarm of each connector circuit.
3.216 To record the number of connector tests made (all paths tests and particular paths tests).
3.217 To advance to the next connector, or make a repeat test if the (REP) key is operated, when the (CA) key is operated after the test circuit becomes stuck.

### 3.3 When testing either decoders or connectors.

3.301 To repeat any test or series of tests when the repeat key (REP) is operated.
3.302 To measure a time interval of from 5 to 12 seconds within which any single test should be completed and if not completed within that time to light a trouble lamp and operate a trouble message register (TBL).
3.303 To return to normal when the start key (ST) is restored to normal, or When the RN key is operated.

3 j, 44 To light lamps when the (LP) key is operated, indicating the group,
frame, channel and decoder under test.
3.305 To light lamps, when the proper keys are operated, indicating the connector leads which are in trouble when testing connectors and indicating any disagreement between the decoder under test and the "master" decoder (or matching keys) when testing decoders.
3.306 To check for operate of (PSI) and (Z) relays in the decoder over the "PSI" and "ZO" and closure of chain circuit for operating the (CK) relays when the decoder is designed to work with modified pulse machine type senders requiring "PSI" and "ZO" leads. These tests are made directly to the decoder and not through the decoder connector.

### 3.4 When connecting battery or ground to the DR, DST, DBA, T1A or T2A lead to any decoder, to block the test in case that lead is crossed with the corresponding lead to another decoder.

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$$
\begin{aligned}
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& \text { Apparatus } \\
& \text { Decoder. Tests } \\
& \text { All Codes test on all } \\
& \text { decoders }
\end{aligned}
$$5.

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| :---: | :---: | :---: |
| Advance to next connectorAdvance to next decoderAdvance to second groupof connectors anddecoders |  |  |
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10.
5. CONNECTING CIRCUITS
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5.3 Decoder test frame circuit.
5.4 Decoder frame circuit.
5.5 Decoder connector frame circuit.
5.6 Floor alarm board - Fuse and time alarm circuit.

## DESCRIPTION OF OPERATION

## 6. APPARATUS

The test circuit is wired for testing two groups of connectors and associated decoders; when the circuit is to be used for testing only one group the apparatus for the second group is omitted. The test necting each group and to a maximum of six decoders in each group. The apparatus provided and functions are listed in the following items numbered from 6.01 to 6.42 .
6.01 The "Orfice Code" sequence switches "A" "B" and "C" and (Ril) known as the control the code information which is transmitted to the "master" decoder and to the decoder under test. The positions indicates the code which is being or has
been transmitted to the decoder for translation by the decoder.

> 6.02 The connector test control switch (R12) controls the cycle of tests
$\downarrow$ made on each connector.
6.03 The decoder switches, (R8) for the first group of decoders and (R4) for the second group of decoders, control the connection of the test circuit to each decoder in succession.
6.04 The connector switches (R5), (R6) and (R7) for the first group of connectors and switches (R1), (R2) and (R3) for the second group of connectors control the connection of the test circuit to each connector in succession.
6.05 Start and Return to Normal Keys (ST) and (RN)

This key controls the start of both the decoder test and connector test and the return to normal of all switches and should be operated to the (RN) position before starting any tests. When normal, if testing connectors, the control switch R12, the decoder connector switches (R8) and (R4) and the A, B and C switches R9, RlO and Rll are restored to normal; if testing decoders the control A, B, C and connector test control sequence switches are restored to normal. If this key is operated to the "return to normal" position (RN) the R8, R4 and R5, R6, R7, R1, R2 and R3 switches are restored to normal. The key is not effective when operated to the (ST) position if the circuit key (CONN) - (DR) is normal or if the particular circult key (PC) is operated.

### 6.06 Circuit Keys (CONN) and (DR)

This is a two way locking key. When operated to the (CONN) position the circuit is prepared to test connectors; when operated to (DR) position the circuit is prepared to test decoders.

### 6.07 Particular Circuit Key (PC)

This key is usec when it is desired to pick a partioular circuit. The operation of this key, if the (CONN) key is operated, eriables a particular connector to be picked, as determined by the setting of the connector selection keys. If the (DR) key is operated the operation of the (PC) key permits the
selection of a particular decoder depending upon the setting of the decoder selection keys.

### 6.08 Particular Path Key (PPH)

This is a one way locking key. It is used only when testing connectors and enables the operator to select one of the several paths through the connectors to the decoders. Since there is one path from each connector for each decoder in the group of decoders with which the connector is associated this selection amounts to the picking of a particular decoder depending upon the setting of the Decoder Selection Keys. This key must remain operated during the test.

### 6.09 Special Code - Particular Code Keys (SCD) and (PCD)

This is a two way locking key. When the (SCD) key is operated the test set is prepared to make one of the following tests: Trouble release test, Preliminary Pulse and second trial test; Special Service Operator Route test, permanent si,: al route test or " 200 " code test when t'e (PCD) key is operated the test set is p "apared to test a particular code as determined by the setting of the $A, B$, and C code keys. When normal the test set is arranged to test all codes in succession.

### 6.10 Repeat Key (REP)

When testing connectors if this key is operated the circuit is prevented from advancing to the next connector and, if the ( PPH ) key is normal, the series of tests is repeated on all paths, 1.e., all decoders. If the (PPH) key is operated together with the (REP) key the circuit is arranged to repeat the series of tests on the same connector and the same path. When testing decoders if this key is operated, the test set is prevented from advancing to the next decoder and the test, as determined by the setting of the (SCD), (PCD) key, is repeated.

### 6.11 Time Alarm Key (TA)

The operation of this key prevents the functioning of the time alarm circuit and at the same time opens up the paths for advancing to the next connector or to the next decoder.

### 6.13 Lamp Key (LP)

If connectors are being tested the operation of this key lights lamps associated with connector tests. If testing decoders it lights lamps associated with decoder tests.

### 6.14 Lamp Key (LPI)

When testing connectors if any leads have false battery on them, are grounded or are crossed with other leads, the circuit will block. Operating the (LPI) key in conjunction with the (LP) key then causes the circuit to function to light lamps associated with the leads which are in trouble.

### 6.15 Alarm Test Key (ALT)

This key is used when making audible tests on the decoder and connector alarms.

### 6.16 Trouble Release Busy Ground Key (TRBG)

This key is used when testing the ability of a decoder to hold itself busy for a short time following a trouble release.

### 6.17 Frame and Connector Selection Keys

These are push button type keys arranged to select the particular connector which it is desired to test. The depression of one of the frame keys numbered 1 to 17 for Group (0) and the depression of one of the connector keys numbered A, B and C advances the Group (0) connector connecting sequence switches to the corresponding position in which that particular connector will be tested. These keys are effective only when testing connectors and then only if the (PC) key is operated.
6.18 Digit Keys (A, B and C)

B These keys are used to set the A, $B$ and C sequence switches for a particular code. They are effective only when the (PCD) key is operated.

### 6.19 Decoder Selection Keys

These are push button type keys used to position the decoder switches for a particular decoder. One set of keys is provided for two groups, with a maximum of 6 decoders per group. These keys
are eifective when testing connectors only 1f: the (PPH) key is operated and when lesting decoders only if the (PC) key is operated.

### 6.20 Class Selection Keys

These keys are used to select one of the classes of service which the decoder may be arranged to handle.

### 6.21 End of Cycle Key

This key when operated, prevents testing in the second group of decoders when any code or codes are arranged to transmit different information in the second group.

### 6.22 Matching Lamps

These lamps are designated in pairs corresponding to the transmitting leads from the decoder under test and from the master decoder or from the matching keys. The lamps associated with the relays controlled by the master decoder or matching keys indicate which leads should be grounded by the decoder under test. The other lamps indicate which leads were actually grounded by the decoder under test.

### 6.23 Check Lamps for Connector Leads 53 in Number

These lamps, one for each lead which is tested through the connector, indicate which leads are in trouble.

### 6.24 Group Lamps

These lamps are one for each group of connectors and decoders, indicates the group in which is included the circuit under test.

### 6.25 Decoder Lamps

These lamps with the ald of the Group Lampis, indicate which decoder (or which path through the connectors) is being tested.

### 6.26 Frame and Connector Lamps

These lamps with the ald of the Group Lamps indicate by frame and connector which connector is being tested.

### 6.27 Connector Busy Lamp (CNB) <br> This lamp remains lighted when testing connectors if the connector which it is desired to test is busy.

### 6.28 Decoder Busy Lamp (DB)

This lamp when testing connectors indicates that the decoder whose path through the connector it is desired to test is busy; when testing decoders it indicates that the decoder which it is desired to test is busy.
6.29 Master Decoder Busy Lamp (MDB)

This lamp when testing decoders on all "all codes" test indicates when the master decoder is busy.
6.30 End of Cycle Lamp (EC)

This lamp when lighted indicates that the cycle of tests has been completed on all connectors or all decoders.

### 6.31 Trouble Lamp (TBL)

This lamp lights when the time alarm operates indicating that the test set has remained stuck for the period of the time alarm.

### 6.32 Release Lamp (RL)

This lamp is used to indicate that the decoder has grounded the RL lead.

### 6.33 Cross Lamp (x)

This lamp is used to indicate a cross between one of several leads to a decoder and the corresponding lead to another decoder.
6.34 (X) Relay Test Lamp (XT)

This lamp lights during the time the test circuit checks the decoder (XI) and (x2) relays.
6.35 Decoder Connector Multi-Contact Relays (TA) and (TB)

These relays which are mounted on the decoder frame connect the decoders to the test set. They are shown on the decoder circuit.
6.36 Decoder Test Multi-Contant Relays $\left\{\begin{array}{l}\text { DTA } \\ M D A\end{array}\right)$ and (DFA $(M D B),(M A)$ as MB) and

These relays are required to connect the decoder under test and the master. decoder to that part of the test set used for testing decoders.

### 6.37 Connector Test Multi-Contact Relays (CA) and (CB)

This relay is required to connect the decoder to that part of the test set used for testing connectors.
5.38 Cross Test Multi-Contact Relay (XA) and (XB)

This relay is required in making for crosses between leads of the channel.

### 6.39 Connector Multi-Contact Relays (TF)

 and (TG)(One relay per connector used) -
these relays are located on the decoder connector frame and are shown on the decoder connector circuit SD-21187-01. They are used to connect the connector to the test circuit.

### 6.40 Decoders Tested Register (DRT)

Each time a decoder is tested either on single code or on all codes the (DT) register is operated once.
6.4 ${ }^{-}$Connectors Tested Register (CNT)

Each time a channel is tested either over a single path or over all paths this register is operated once.

### 6.42 Repeat Register (REP)

This register is operated each time a repeat test is made.

### 6.43 Trouble Register (TBL)

This register is operated each time a time alarm is given.

### 6.44 32A Test Set

The 32A test set consists of two buttons attached to a cord and plug and is for the purpose of giving remote control of the control-advance feature. The set is used in conjunction with Jacks which are multipled together at the decoder frames and at the decoder connector frames. This remote control is effective if the (REP) keys are operated. When making repeat test either on decoders or connectors the operation and release of the RED button key causes the test set to advance to normal and resume testing. The white key is not used.
6.45 Keys Associated with Codes That Require Auxiliary Sender Circuit 7DG, SK2 and SK3

To determine whether the decoder makes a correct translation of a particular code test for codes which require both the subscriber sender and an auxiliary sender for completion, the matching key which corresponds to the translated information should be operated. This matching key is in the "Class" group of keys. DDD codes which have either a or 1 in the $B$ dig: require the TAN PCI Class key to be oper ated. If the auxiliary sender is to complete a particular DDD code by skipping the first three digits of the ten digits that have been registered in it, the SK3 key is also operated.

The 7DG key is operated on sevendigit class calls that require the Auxiliary Sender for completion. The SK2 or SK3 when operated will signal the auxiliary sender through the subscriber sender that the first two or three digits are to be skipped.

## 7. TESTING DECODERS

The test circuit is arranged to make all codes tests on all decoders, in which case connection is made with two decoders in the same group; the "All Codes" test includes the test of Trouble Release, Preliminary pulse and Second trial, permanent signal and "Special Service" operator. The first decoder in the group is used as a "master" decoder with which all remaining decoders in the group are tested in succession. The test circuit connects the same conditions to the receiving leads of the two decoders and compares the translated information transmitted back by the decoder under test with that transmitted back to the test circuit by the master decoder. If the information checks; the test circuit proceeds with the next code and when all the codes have been tested on one decoder it advances to the next decoder until all decoders have been tested against the "master" decoder. The all codes test can be started on the 3rd, 4 th, 5 th or 6 th decoders instead of the second decoder if desired.

A particular code test may be made on any one or all of the decoders including the master decoder, in which case the translated information transmitted back
to the test circuit from the decoder under test is checked by the operation of matching keys instead of using the master decoder. Thus a trouble can be located in a particular decoder with only that decoder held out of service.

If the decoders to be tested serve subscribers who are entitled to different classes of service or the "A" operators are entitled to a different class of service than some or all subscribers, the decoders will require class of service information over the D1, D2, D3 and KS leads and one of the class keys corresponding to one of the classes of service must be depressed; with a given key depressed all of the tests made will be tests of calls as if made by that class of subscriber or operator.

### 7.1 All Codes Test on All Decoders

To insure that all switches are in normal position operate (RN) key, then restore to normal. Operate the (DR) key and with all other test keys normal operate the (ST) key.

### 7.11 Seizure of Master Decoder and of First Decoder to Be Tested

The operation of the (DR) and (ST) keys causes the operation of the (ST) relay, thereby operating in turn the (DR), (STD) and (STI) relays and connecting ground to the armature of the (TMT) interrupter. The operation of the (DR) relay also advances the decoder switches (R4) and (R8) to position 2. Battery is connected to the DBA leads of the master (first) and second decoders of group (0) so as to hold these decoders busy while connected thereto; battery is connected to the DST leads of these two decoders thus operating their (DST) relays respectively as soon as they become 1dle. The (DST) relays, which are shown on the decoder connector circuit, connect ground to leads DF operating the (TA) and (TB) relays in the two decoder circuits. W1th the (TA) and (TB) relays of the two decoders operated, ground in the test circuit over lead (TI) operates the CO relays in the decoder circuits, thereby preventing the operation of the decoder alarm circuit.
7.12 Trouble Release Test w1th "R" and "U" Wiring and Apparatus for Use with Decoders Which Cancel the Check of Receiving Leads on a Second Trial

W1th the (PCD) and (SCD) keys normal and (STD) relay operated, and with the $A$,
$B$ and $C$ sequence switches normal, the (CK) relay operates, thus connecting ground to all of the receiving leads of both decoders, connecting the winding of the (CKI) relay over the (CKI) lead to the decoder under test and the winding of the (СК2) relay over the (CK1) lead to the master decoder and opening the CK3 leads. The (CK1) and (CK2) relays in the test circuit operate to ground through the normal contacts of the (CKI) and (CK2) relays in the two decoder circuits, closing the TRL leads to the (CA2) and (CA3) relays in the test circuit. When the decoders have completed their timing, ground will be connected to the TRL leads, operating the (CA2) and (CA3) relays. The (CA2) and (CA3 relays lock under control of the (AI) and (AVI) relays and open the (DST) leads thus releasing the decoder multi-contact relays. With both of the (CA2) and (CA3) relays operated ground is connected to the (CA) interrupter; the (CA4) relay operates and locks when the " $B$ " contact closes and then the (CA5) relay operates and locks when the " $F^{\prime \prime}$ contact closes. This time interval is provided after releasing the decoders so as to allow sufficient time for the release of the (SR) relays in the de coders before making the next test when repeating the trouble release test. W1th the (CA5) relay operated, the (A) relay operates and locks in position 11 of the R9 sw1tch, causing the operation of the (AV), (AV1), (AV2) and (AV3) relays; thus disconnecting ground from the time measure interrupter. The (AV) relay locks under control of the (A) relay. The operation of the (AVI) relay releases the (CA2) and (CA3) relays thus reclosing the DST leads to both decoders and releasing the (CA4) and (CA5) relays. W1th the (CA5), (RL) and (RLI) relays normal, the (AI) relay operates and the R9 switch is advanced to position 12; the (A), (AV), (AV1), (AV2) and (AV3) relays release when the switch advances. If the test circuit should find some trouble in either of the decoders and fall to complete the test within the measured allowable time the time measure circuit operates as described in section 7.7. The release of the (CA5) relay reconnects ground to the time measure interrupter.
7.13 Trouble Release Test w1th "S" and "U" Wiring and Apparatus for Use with Decoders Which Check the Receiving eads on a Second Trial as on a First Trial

This test is to prove the ability of the decoder to send a trouble release

[^0]iest to the sender when it fails to make a proper translation. It is also to test the check of receiving leads, particularly that there is no false ground at any point In the receiving chains, which might cause the decoder to proceed with a translation w?nen there was a defect in the receiving leads.

With the (PCD) and (SCD) keys normal and (STD) relay operated, and with the $A$, $B$ and $C$ code sequence switches normal, relay (CK) operates. This grounds the A, PS, D and KS receiving leads to both decoders, disconnects the CKl leads from those leads, connects the CKl leads instead to the windings of relay (CKI) and (CK2) respectively, and breaks ground from the "CK3" leads. The B and C receiving leads are grounded over the CK2 leads, which are grounded in the decoders, and also by cam (09) in case one of the decoder grounds should be broken during the test. All the receiving relays operate, closing the checking chains in the decoders, but since the CK3 leads have no ground on them the check relays in the decoders cannot operate. The decoders therrfore time out and ground their TRL leari.. The (CKI) and (CK2) test circuit rei =ys are operated by ground on the CKl leads, and they connect the TRL leads to the (CA2) and (CA3) relay windings, so these last relays operate to the TRL lead grounds, thus proving the transmission of the trouble release signal from both decoders.

In case there is a false ground on either chain circuit in one of the decoders, its check relay will operate and through its locking contact will restore ground to the CK3 lead. Then the other two check relays in that decoder will operate, breaking ground from its CKl lead and thereby releasing relay (CKI) or (CK2) in the test circuit. Then the trouble release signal, if it comes, cannot operate its relay (CA2) or (CA3).

If trouble release signals from both decoders successfully operate both relays (CA2) and (CA3), those relays lock up, break the DST leads to release both decoders, and ground interrupter (CA). Successive back and front closures of the interrupter operate relays (CA4) and (CA5) and they lock. This time interval after releasing the decoders is provided to allow the ( $S R$ ) relays in the decoders to release before another test is made.

The operation of relay (CA5) is followed by the operation of relays (A)
and (AV), both locking, and then (AVI), (AV2) and (AV3) operate. (AV1) operating releases (CA2) and (CA3), whereupon (CA4) and (CA5) release. The release of (CA'5) with (A) still locked up operates (Al) and moves the A. code switch Rg out of its normal position 11 to position l'c for the next test. As the switch leaves 11 relay (A) releases, preventing its moving beyond 12 and releasing all the (AV) relays. The (DST) and other leads are now closed again for the next test.
7.14 Test of Decoder (X1) and (X2) Relays with "W" and "R" or "S" Wiring and Apparatus

This test is to check the ability of the decoder ( X 1 ) and (X2) relays to operate and lock.

On a trouble release test with either "R" or "S" wiring and apparatus the test circuit (CKI) and (CK2) relays are caused to operate and the (CK3) leads to the decoders are held open causing the decoders to time out and ground the TRL leads as previously described in connection with the trouble release test. The trouble release ground from the decoder under test is connected to and operates relay (XTI) through the contacts of the (CKI) relay. The operation of the (XTI) relay closes the trouble release lead from the decoder under test, previously out through by the (СК2) relay, to the (XT2) relay which operates. The (XTI) relay also applies a current flow test to the decoder (XI) relays and the (XT2) relay applies a current flow test to the decoder (X2) relays. The (XT2) relay operates the (XT3) relay which locks and releases the slow release (XTI), in turn releasing (XT2) and opening the circuit for operating the decoder (XI) and (X2) relays. The release of the (XT2) relay closes the iocking grounds from the windings of the decoder (X2) relays to relays (XT4) and (XT5) which operato and close the locking grounds from the decoder (XI) relays to the (CA2) and (CA3) relays which operate if the test is satisfactory. From this point the circuit operation continues as previously described in connection with the trouble. release test.
7.15 Preliminary Pulse and Second Trial Test with "R" Wiring and Apparatus for Use with Decoders Which Cancel the Check of Receiving Leads on a Second Trial
With the R9 switch in position 12 and the RlO and Rll switches normal
ground is connected over the Al leads to both decoders and battery through resistance is connected over the CK2 leads to both decoders. Ground is also connected to all of the B, C and D leads. Thus the (Al) relays and all (B), (C) and (D) relays in both decoders operate and the (CK2) relays in both decoders operate even though the other A register relays in the decoders are not operated thus the decoder is tested as to its ability to make a translation without checking the receiving leads when it is selzed and connected to a sender which is making a second trial, and also to route a call on which a preliminary pulse indication happens to be received in the decoder, as if zero has been dialed. Both decoders proceed to make translation and connect ground to certain of the transmitting leads, thereby operating the test circuit relays whose windings connect to the grounded leads. These relays have the same designation as the leads to which they connect, those which connect to leads from the master decoder having a prefix, "X", and those which connect to leads from the decoder under test having a prefix "Y". When the decoders send the release signal by connecting ground to the RL leads the (RL) and (RLI) relays operate; with the (RL) and (RLI) relays operated and if, for each test circuit relay with prefix $X$ which operates over a transmitting lead from the master decoder, the corresponding relay (with prefix Y) operates over a transmitting lead from the decoder under test, the (RL2) and (RL3) relays operate. With the (RL), (RLI), (RL2) and (RL3) relays operated, the (A) relay operates and locks in position 12 of the R9 switch. With the (A) relay operated the (AV), (AVI), (AV2) and (AV3) relays operate opening the CKI, CK2, and CK3 leads. The CK2 leads opened release the (СК2) relays in the two decoders, which release all relays in the two decoders which were operated from the receiving leads, resulting in the release of the test circuit " X " and " $Y$ " relays, and also opens the "RL" leads. When the decoder "RL" leads are opened, the (RL), (RL1), (RL2) and (RL3) relays release. The (AV) relay is locked in position 12 of the R9 switch thus holding the (AVI), (AV2) and (AV3) relays operated. The operation of the (AVI) relay also disconnects ground from the A, B, C and D leads to the two decoders. With the (CA5), (RL) and (RLI) relays normal the (AI) relay operates and the R9 switch is advanced to position 13; the (A), (AV), (AV1), (AV2) and (AV3) relays release when the switch advances. If the two decoders do not connect ground to the same transmitting
leads or the test is not completely satis: fied the trouble lamp (TBL) is lighted and the alarm circuit operated as described in section 7.7 .
7.16 Preliminary Pulse Test with "S" Wiring and Apparatus for Use with Decoders Which Check the Recefving Leads on a Second Trial as on a First Trial

This test is to prove the ability of the decoder, in case by any chance it receives a preliminary pulse indication, to route the call as if zero had been dialed. This is done by giving the indication to the decoder under test and also to the master decoder, and matching the translation returned. If these agree, it is assumed that both decoders have translated correctly. No special test is made of a second trial by a sender, since these decoders make no distinction between first and second trials.

With the (R9) switch in position 12 and the (R1O) and (R11) switches normal, the Al leads to both decoders are grounded directly by the test circuit, and all the other receiving leads are grounded by connection to the CKI and CK2 leads from their respective decoders.

Both decoders proceed to check their receiving leads, make translation, and ground certain of the transmitting leads, thereby operating the test circuit relays of the same designations as the grounded transmitting leads, with a prefix $X$ for those connecting with the master decoder, and a prefix $Y$ for those connecting with the decoder under test.

The decoders then send release signals by grounding their RL leads, and thus operate relays (RL) and (RLI). If the operated and non-operated ( $X$ ) relays correspond exactly with the operated and non-operated (Y) relays, showing that both decoders translated the same, then relays (RL2) and (RL3) operate after (RL) and (RLI). Other relays are then operated and the (R9) switch advanced to position 13 in the same manner as described for the next test in parigraph 7.16.

### 7.17 Operator Route Test

With the (OPR) key depressed, "LT" or "LU" wiring, the R9 switch in
position 13 and the R1O and Rll switches normal the CKl leads of the two decoders with "R" wiring, or the CK1 and CK2 leads with "S" wiring, are connected to all of hee $A, B, C, D, P S$ and KS leads of both decoders, thus temporarily operating all of the corresponding register relays in both decoders. When the decoders connect ground to the RL leads the (RL) and (RLI) relays in the test circuit operate and if the corresponding ( $X$ ) and (Y) relays are operated over the transmitting leads from the two decoders the (RL2) and (RL3) relays are also operated. The (A) relay operates and locks in position 13, and the (AV), (AV1), (AV2), and (AV3) relays operate opening the (CKI), (CK2) and (CK3) leads thus causing the release of the check relays in the two decoders; the decoders then open those transmitting leads which were grounded, releasing the "X" and "Y" relays which were operated and disconnect ground from the RL leads. The (RL), (RLI), (RL2) and (RL3) relays release, the release of (RL) and (RLI) causing the operation of the (Al) relay and the advance of the RI switch to position 14; the (A), (AV), (AV1), (AV2) and (AV3) relays release when the switch advances. The operatin: of the (AV) relay disconnects ground fre: the Time Measure Interrupter and its reif, ase reconnects ground thereto. If the test circuit should stick at any time during this test on account of trouble in either decoder the Time Measure Circuit functions as described in section 7.7 . "LU" wiring is used when testing decoders designed to work only with decoder type senders. "LT" wiring and apparatus is used when testing decoder circuits designed to work with both decoder type and modified pulse machine type senders.

### 7.17A After routine testing of decoders

 equipped with ( $Z$ ) relays to check (Z) relay chain circuit the (ZO) special test key should be operated. With the (Z0) key depressed, "LT" wiring, the test proceeds as for the (OPR) key depressed except as follows. The (ZO) relay operates opening the Al and Cl leads to the decoder under test and the $Z 0$ lead is grounded. The ZO lead is connected directly to the decoder and is not connected to the decoder connector.
### 7.18 Permanent Signal Route Test

With the (PS) key depressed, "LT" or "LU" wiring, the R9 switch in position 14 and the R1O and R1l switches normal test is made of the ability of the two decoders to make the same translation of a permanent signal code. The test is completed in the
same manner as the "Operator Route Test"; the test circuit directly connects ground over the PS leads only to both decoders. The decoders in turn connect ground to certain of the transmitting leads in accordance with the requirements of this route. The test having been completed and with the (RL) and (RLI) relays released the R9 switch is advanced to position 15. "Lu" wiring is used when testing decoders designed to work only with decoder type senders. "LT" wiring is used when testing decoders designed to work with both decoder type and modified pulse machine type senders.

### 7.18A After routine testing of decoders

 equipped with (PSI) relays, to check the (PSI) relay chain circuit the (PSI) special test key should be operated. With the (PSI) key depressed, "LT" wiring, the test proceeds as for the (PS) key depressed except as follows. The (PSI) relay operates opening the Al and Cl leads to the decoder under test and grounds the PSl lead. The PSI lead is connected directly to the decoder and is not connected to the decoder connector. Fig. B; the "PS" lead to the decoder is cut through relay (PSI) so that when relay (PSI) is operated the "PS" lead is connected to SS2-J9 instead of SS3-M9. This connects the (PS) relay in the decoder to the "CKI" lead and back contact on (CK3) relay which when operated will release the (PS) relay opening the operating circuit of relay (CKI), which releases, closing ground to complete the translation.
### 7.19 Code 200 Test

With the R9 switch in position 15 the R10 and Rll switches normal test is made of the ability of the decoders to translate zero when registered for either or both of the B and C digits as the letter "O" wihich zorresponds to the digit 6 if the decoders under test are arranged for this translation for the class of service being tested. This test is made of the route corresponding to numerical code 200. The test proceeds and is completed in the same manner as the "operator route test." The test circuit directly connects ground over the A2 leads only to both decoders. The decoders in turn then connect ground to sertain of the transmitting leads in accordance with the requirements of this routine. The test having been completed and with the (RL) and (RLl) relays released the R9 switch is advanced to position 2
(the positions 16 to 1 being pass-by positions).

### 7.20 Test of All Codes from 200 to 999 Inclusive

Following the special code tests described in sections 7.12 to 7.20 , the 3 digit codes are tested in a definite order by rotating the R9, R10 and Rll switches from code to code. The capacity of the decoders is 800 codes from 200 to 999 inclusive, and they all must be tested in case codes containing zeros for both the $B$ and C digits are used and the senders are arranged for 3 digit codes, exclusively. To test them all if Fig. T is used a class key is set to operate relays (KS) and (KSI) and if "L" wiring is furnished terminals TD2 to TD9 are all cross-connected to terminal TDO. When Fig. $U$ is furnished all codes are tested for all classes. If it is desired to skip the zero codes for either the B or the C digit optional wiring in Fig. T is used and the (KS) and (KSI) relays must be operated by a circuit through the (CL-S) keys.

To test any code the R9, RlO and Rll switches are set in positions corresponding in number to the $A, B$ and $C$ digits of the code, position 10 corresponding to zero in the B or C digit, and positions ll to 18 of R1O and Rll being passed by. In an all codes test, codes 211, 212, 213. 214, 215, 216, 217, 218, 219 and 220 are tested first, in that order, the R9 switch being held in position 2 and RlO in position 1 , while Rll moves one position after each code is tested, from position $l$ to position 10. Then R1O is advanced from 1 to 2 and Rll from 10 to 1 , and code 221 is tested. This continues, Rll advancing after each code and R1O after each tenth code, until code 200 finishes the first hundred codes. Then R9 is advanced to 3, RlO to l, and Rll to l, to test code 311, and the progression continues in this way until the entire 800 codes have been tested, finishing with 900. Each code is tested and the switches set for the next code as follows: After the special codes are tested F9 advances from 15 to 2 as described in section 7.18. This causes RlO and Rll to advance from normal 18 to 1 , by paths starting at SS2-F9. As long as any of the switches are moving, one or more of relays (Al), (Bl), and (Cl) operate to break the registration paths to the decoders. When they stop in position the registration for code 211 is set up in the decoders, and they function and operate eorresponding ( X ) and (Y) relays and the (RL) and (RLI) relays in the test circuit. If the ( $X$ ) and ( $Y$ )
relays check (RL2) and (RL3) operate and close a circuit to operate (C), which locks until Rll leaves position l: Then (AV) operates and is followed by (AV1), (AV2) and (AV3). (AV1) breaks the registration paths to the decoders, releasing the set up in them and thereby causing the release of relays (X), (Y), (RL) and (RLI), and consequently of (RL2) and (RL3). Switch Rll then starts to move. As it leaves position 1 relay (C) is unlocked and releases, so the switch stops in 2. The (AV) relays and (Cl) release and code 212 is set up in the decoders.

All codes are tested in this way and the Rll switch is advanced one position after each code except in the case of codes having zero for the C digit. After testing code 210 for example, with Rll in position 10 , relay (B) operates in parallel with (C). RlO advances from 1 to 2, releasing (B) as it leaves l. Rll advances from 10 to 1 , releasing ( $C$ ) as it leaves 17, and being passed through 18 by the same path from SS2-F9 which set it in 1 for testing the first code 211.

After testing code 200, with R10 and Rll both in position 10, relays (A), (B) and (C) all operate in parallel, R9' advances from 2 to 3, releasing (A) as it leaves 2. RlO and Ril both advance from 10 to 1 , releasing (B) and (C) respectively as they leave 17, and being passed through 18 by the same paths from SS2-F9 which set them in 1 for the first code 211.

Relay (AV) cannot operate until both (B) and (C) have, in the position when (B) operates; nor until (A), (B) and (C) have, in the position when (A) operates. (AV) locks until each of (A), (B) and (C) which has operated, releases. Circuits to the operating windings of (A), (B) and (C) are separated when (AV3) operates, to permit an inductive discharge from one of them, releasing first, from causing the premature release of another.

### 7.21 Passing by Certain Codes in the All Codes Test (Fig. T)

If no codes with zero for the B or C digit are employed, there is no need to test them. In that case a class key is set which does not operate relays (KS) and (KSI). Break contacts on (KSI) close circuits which cause relay ( $B$ ) to operate
in parallel with (C) when Rll is in position 9, and relay (A) to operate in parallel with (B) and (C) when RlO and Rll are both in position 9; also other circuits to lock (C) through positions 9 to 17 of Rll and (B) through positions 9 to 17 of RlO. The result is to skip over all codes containing zeros. If codes with zero for either the (B) or (C) digit are to be tested optional wiring in Fig. T is used and the (B) or (C) relay operating and locking paths are left open in the position in which the zero codes are checked.

If codes with certain $A$ or index digits are 2-digit codes, the senders are arranged to send such codes to the decoder as 3-digit codes with the second digit transferred to the third place, and a zero inserted in the second place. Thus codes 21, 22, 23, 24, 25, 26, 27, 28, 29 and 20 get to the decoder as 201, 202, 203, 204, 205, 206, 207, 208, 209 and 200. All other combinations of these digits beginning with 2 cannot by any possibility be sent by a sender to a decoder, so there is no need to test the decoders for them. Therefore, if there are any 2-digit codes the terminals TD2 to TD9 corresponding to ?-digit indexes are cross-connected to TD; and those corresponding to 3-digit 1!.iexes are cross-connected to TDO.

When the R9 switch moves to a position corresponding to a 3 -digit index, the Rlo switch is passed by position 18 to position 1 as in section 7.17, and the full set of 100 codes are tested.

When the R9 switch moves to a position corresponding to a 2 -digit index, the RlO switch is left in position 18, and If by any chance it moves out of 18 it is returned thereby the path through terminal TDl. In this position as in 10 it sends zero to the decoders for the B digit. When the Rll switch tests the code in position 10, or in 9 if (KSl) be not operated if Fig. T is used, relay (A) operates in parallel with (C), but (B) does not operate. Therefore after one revolution of the Ril switch the R9 is advanced to the next index digit, and the RlO switch either stays in 18 or moves to 1 , depending upon whether the next index is for 2-digit or 3-digit codes.

### 7.22 Advance to Next Decoder

When the (RL), (RL1), (RL2) and
(RL3) relays operate during test of code 900 the (A), (B), (C) and (DAI) relays operate. The (A) relay locks in positions $9 / 10$ of the R9 switch and the
(DAI) relay locks in position 2 of the R8 switch (position in which decoder 2 is tested). The (DRT) message register operates, thus recording the completion of the all codes test on one decoder and operating (AV) relay. The (AV) relay locks under control of the (A), (B), (C) and (DA1) relays and operates the (AVI): (AV2) and (AV3) relays. When the (RL) and (RLI) relays have released, the (AI), (BI) and (Cl) relays operate, the R9 switch is advanced to position 1l, the RiO switch to position 18, the Rll switch to position 18 . and the R8 switch to position 3; the (DAI), (A), (B), (C) and (AV); (AV1), (AV2) and (AV3) relays are released when all of these switches have advanced. The circuit is now in condition to make the cycle of tests described in the preceding sections ( 7.12 to 7.18 inclusive) on decoder number "3" and the inaster decoder. Similarly the R8 switch is advanced after each cycle of tests to the next decoder until all decoders in the first group have been tested. Then the test circuit begins test of decoder number " 2 " in the second group and the master decoder (number " 1 ") of that group and test of each decoder in the second group is completed in the same manner as the decoder of group (0).


#### Abstract

When the last equipped decoder has been tested, the release of the (RL) and (RLI) relays (with the (DAI) relay operated) causes the operation of the (EC) relay. The operation of the (EC) relay lights the end of the cycle lamp (EC), rings an AC bell, opens the start lead so as to release the two decoders, and advances the R4 switch from position 6 ; the (DAI) relay releases when the switch advances. The (EC) relay is locked and the (EC) lamp remains lighted until either the (DR) or (ST) key is restored to normal.


### 7.3 Particular Code and Special Code Test

with the (PCD) key operated and with one each of the "A", "B" and "C" code keys depressed, the (PC), (PCl), and (PC2) relays operate and the R9, R10 and Ril switches advance to the corresponding positions in which test is made of the code as registered on the code keys; with the (SCD) key operate $:$ and with one of the (SPL) code keys operated the (PCl), (PC2) and (PC3) relays advance the R9 switch alone to the corresponding position in which one of the special tests (such as trouble release, permanent
signal route, etc.) is made. The test thus set up is made on all decoders successively, connection being made to only one decoder at a time. The test is started by operating the start key (ST). The operation of the (PC2) relay connects the windings of the (RL) and (RLl) relays in parallel, likewise the windings of the (CA2) and (CA3) relays, and of the (CK1) and (CK2) relays and the (PC3) relay (W apparatus) connects the TRL leads together so that translation by only one decoder will satisfy the test circuit instead of the same translation by two decoders, as when testing all codes.

To determine whether the decoder makes a correct translation of a particular code test, those matching keys which correspond to the translated information should be operated; thus one each of the "Class", "Compensating Resistance", "District Brush", "District Group", "Office Brush", "Office Group", "Talking Selection" and "Station Delay" groups of keys should be operated, the "Trunk Test Resistance" key (TTR), the "Cancel Coin Test" key (CCT), and the (distant) "Two Wire Office" key (TWO) should either be operated or released. The operation of these keys causes the operation of the corresponding " $x$ " relays with which are compared the "Y" relays which are operated over the transmitting leads from the decoder under test. The keys to be operated depend greatly upon the "class of service" key operated as this governs the selections to be made in some cases on certain codes. When the decoder under test grounds the "RL" lead, the (RL) and (RLI) relays operate; and if the corresponding " $X$ " and " $Y$ " relays are operated, the (RL2) and (RL3) relays operate. With the "RL" relays operated the (DAI) relay operates, locks until the decoder switch (R8 or R4) is advanced to the next decoder, and operates the (DRT) register. The operation of the (DRT) register causes the operation of the (AV), (AVI), (AV2) and (AV3) relays; when the "RL" relays release, the decoder switch (R5 or R6) is advanced, releasing the (DAI) and (AV) relays. When the test of the last decoder is completed, the (EC) relay is operated and end of the cycle lamp (EC) is lighted; the (EC) relay advances the decoder switch.

If there are two groups of decoders and the test is completed in the first group, it will be started in the second group. Unless this particular code which is being tested transmits information hack to the test circuit over different
transmitting leads, in such cases, the (EC) key should be operated before the test is started and the (EC) relay will operate when the test is completed in the first group of decoders. The operation of the (EC) key is unnecessary if a particular code is being tested in the second group of decoders only.

The operation is similar if a special test is being made, except that for the "Trouble Release Test", the matching keys are not used; the satisfactory completion of the test is indicated by the operation of the (CK1), (CK2), (CA2) and (CA3) relays.

### 7.4 Selection of a Particular Decoder <br> The "all codes", "particular code" or

 "Special Code" test may be started on any one of the decoders by operating the particular circuit key (PC) and then depressing the decoder key which corresponds to the decoder circuit on which the test is to be started. The decoder switch (R8 or R4) is then advanced to the position in which this decoder is tested. The test cannot be started, even though the (ST) key is operated, until the (PC) key is restored to normal.
### 7.5 Repeat Tests

If the repeat key (REP) is operated in addition to the keys necessary for testing "All Codes", or a "Particular Code", the test is repeated on the same decoder. The operation of the "RL" relays when testing the last code of the "All codes test" causes the operation of the (A), (B) and (C) relays and the (REP) register. The operation of the (REP) register operates the (CA2), (CA3), (CA4) and (CA5) relays, thus operating the "AV" relays. The DST lead is opened and the decoders are released; when the "RL" relays release the (REP) register releases and the (R9), (R1O) and (R1l) switches are advanced to the "trouble release test" position to begin another cycle of "All Codes Test." The (Al), (BI) and (Cl) relays operate in parailel with the winding of the $R$ magnets so as to prevent starting a test before the switches are in the proper position.

If the test being made is the trouble release test, the operation of the (CK1) and (CK2) relays results in the operation of the (CA2), (CA3), (CA4) and
(CA5) relays. The (REP) register operates and the "AV" relays operate, thus opening the CKl, CK2 and CK3 leads. The CK1 and СК2 relays release followed by the release of the ( $\subset A 2$ ), (CA3) and (AV) relays. The test is then repeated on the same decoder.

### 7.6 Oneration When There Are Less Than 6 Decoders in a Group <br> If less than 6 decoders are installed in a group, the R8 and R4 switches are arranged to pass by the positions of the unequipped decoders. To this end crossconnecting terminals U1, U3, U4, U5 and U6 are provided for each of the two groups of decoders; terminal Ul is strapped to as many of the other terminals as correspond to unequipped decoders.

### 7.7 Provision for One or Two Groups of Decoders

If there is only one group of decoders to be tested, the R4 switch and (SG) relay are not furnished and leads are strapped as indicated in the circuit notes.

### 7.8 Operation of Time Alarm

At the same time that the circuit in which the (ST) relay operates is closed, ground is connected to the armature of the (TIMj interrupter. When the B contact closes, the (TM) relay operates and locks to the same ground; when the $F$ contact closes, the (TMI) relay operates and locks to this ground, lighting the trouble lamp (TBL), connecting ground over lead "TA" to the alarm circuit and operating the (BK) relay and (TBL) register. The (BK) relay locks and prevents the advance of the switches or completion of the test thereafter. The (TBL) register records the failure to complete the test within the measured allowable time (from 5 sec . min. to $12 \mathrm{sec} . \max$.$) and also operates the$ (DRI) relay thus causing the release of the master decoder; the (DRI) relay locks under control of the (ST) key.

If the single test is completed, and the (AV) relay operates before the (TMI) relay operates, the (TM) relay releases and the time measure circuit begins to measure another interval of time when ground is again connected to the armature of the (TM) interrupter by the release of the (CAS) relay on "Trouble Release" test or the (RL3) on other tests.

The pperation of the (TA) key removes ground from the (TA) lead when
the alarm is answered, and so stops the alarm.

A lamp is associated with each " X " and "Y" relay; the operation of the (LP) key lights the lamps which are associated with operated relays, thus indicating wherein the translation by the two decoders differed.

### 7.9 Return to Normal

When the (ST) key is released, the (RN) and (RN3) relays operate; operation of the (RN3) relay advances the R9, R10 and RIl switches to normal if the (PCD) and (SCD) keys are normal. The (RN3) relay cannot operate if the (PCD) or (SCD) keys are operated and the restoration of the start key in such a case releases the time alarm and prevents the test circuit from continuing with the test.

## 8. CONNECTOR TESTS

The test circuit is arranged to test all connectors through to all decoders or to a particular decoder; to advance to a particular connector testing that one and all remaining connectors and to repeat tests on the same connector.

### 8.1 Test of All Connectors to All Decoders

To insure that all switches are in their normal positions, operate the (ST-RN) key to the "RN" position; then restore to normal. Operate the (CN) key and with all other test keys normal operate the (ST) key.

### 8.11 Seizure of Connector

The operation of the (CiI) and (ST) keys operates ti. (ST), (STC) and (ST1) relays and connects ground to the armature of the (TM) interrupter. The operation of the ( $\left.\triangle H^{\prime \prime}\right)$ relay connects battery to the "DST" lead of the first decoder circuit resulting in the operation of the (TA) and (TB) relays of this decoder circuit. With the (TA) and (TB) relays operated, ground from the test circuit over the "TI" lead operates the decoder (CO) relay thus opening the decoder ti... alarm. Relays (TA) and (TB) also connect battery to the "ST" lead of the first comector: The operation of the (STC) rellay advances the R12 sWitch to posttion 2; the (STC) and (STl) relays lock to relay (ST) and also in positions $2 / 8$, of the R12 switch. The
operation of the decoder (TA) and (TB) relays operates the (CPI) relay which operates the test circuit relays (CTA) and (CTB). As soon as the first connector becomes idle, and there are no senders wait1ng to be served, the (TS) relay in the connector circuit operates the (TF) relay which operates the (TG) relay in the connector thereby connecting the connector leads to the test circuit and operating the (CP) relay in the test circuit over the "TG" lead. W1th the (CP) relay operated ground is connected over the "TH" lead to the first connector operating the (TH) relay. W1th the (TH) relay operated ground is connected through 55 ohms resistance over lead "DR1" operating the (DF) and (DG) relays in the connector which connect to the first decoder (which has already been se1zed by the test circu1t).

### 8.12 Test of Leads for Continuity, Grounds and Crosses

The operation of the (CPI) relay operates the (SRI) relay operating the (CTA) and (CTB) relays in the test circult. Ground is then connected over both the (T1) and (T2) leads to the decoder (ground was previously connected to the (T1) lead); ground over the (T2) lead operates the (CO1) and (CO2) relays in the decoder circuit causing the operation of the (C03) to (C09) relays. With the (C03) to (C09) relays in the decoder operated the СК1, СК2, СКЗ, TRL and all transmitting leads are disconnected from all other apparatus in the decoder circult. W1th the R12 switch in position 2 , the (TA) and (TB) relays of the decoder operated, the (TF) and (TG) relays of the connector operated and with the (DF) and (DG) relay (associated with the decoder) in the channel the 54 " 2 " relays in the test circuit operate, one for each connector lead except the "DB" and "ST" leads (these leads are tested when testing decoders.) The " Z " relays are designated the same as the lead to which its winding is connected and if any of the 54 connector leads are open the corresponding " 2 " relay falls to operate and the test circuit time alarm operates. Operation of the (LP) key lights lamps associated with all relays which have operated. W1th all " 2 " relays operated the (K) relay operates and locks in position $2 / 3$ of the Rl2 switch.

With the (K) relay operated, the
(XA) and (XB) relays operate thus releasing the (CRI), (CTA) and (CTB) relays; the (SR) relay is slow in releasing so.
that all leads will be closed by the (XA) and ( XB ) relays before they are opened by the (CTA) and (CTB) relays. With the (XA) and (XB) relays operated each of the " $Z$ " relays in the chain except the ( $Z-A l$ ) relay which holds through the back contact of the (CTR) relay; thus the last relay (Z-TRL) is locked under control of the next to last relay; the (CK3) relay locks under control of the (Z-CK2) and (Z-TRL) relays, etc. The release of the (CTA) and (CTB) relays advances the Ri2 switch to position 3; and (CP1) relay releases and if any of the contacts of the (XA) and (XB) relays fall to close, the corresponding "Z" relay and all other "Z" relays which are locked under control release, thus sticking the test circuit and operating the time alarm. If none of the 54 " 2 " relays release when the Rl2 switch enters position 3 the (CTR) relay operates and locks. The operation of the (CTR) relay opens the locking circuit for the ( $Z-A-1$ ) relay and if the "Al" connector lead is not grounded or crossed with any other lead the ( $\mathrm{Z}-\mathrm{A}-1$ ) relay releases. W1th the ( $Z-A l$ ) relay released, the locking circuit for the ( $Z-A 2$ ) relay is opened and if the "A-2" connector lead is not grounded or crossed w1th any other lead, the (Z-A2) relay releases. In turn each lead is thus tested for crosses and grounds and if all leads are clear, all of the " 2 " relays release. If any relay or relays fall to release, the test circuit sticks and the time alarm operates; the operation of the (LP1) key operates the (LP4) relay which locks in position 3, holds operated the first " $Z$ " relay in the chain which fa1led to release, and releases the (XA) and (XB) relays. All other " $Z$ " relays which were holding operated release when the (XA) and (XB) relays release, operation of the (LP) key lights the lamp associated with the relays which failed to release. If all leads are clear and all "Z" relays release, the (KI) relays operate, advancing the Rl2 switch to position 4; the (XA), (XB), (K) and (KI) relays release when the switch advances.

### 8.13 Test of Relay Connecting Decoder to Test C1rcuit

With the R12 swatich in position 4, the " 2 " relays are reonerated in the same manner as described $1 n^{\prime \prime}$ the preceding section; w1th all " $Z$ " relays operated, the (K) relay operates and locks. The operation of the (K) relay operates the (BT) relay, releasing the decoder relays (TA) and (TB). If any of the contacts on these relays fail to open, the
corresponding "Z" relays fail to release, in which case the test circuit sticks and the time alarm operates; the operation of the (LP) key lights the lamps associated with the relays which failed to release. If all relays release, the (KI) relay operates, advancing the kl2 switch to position 5; the (BT), (L) and (KI) relays jelease when the switch advances.

### 8.14 Test for False Battery on Connector Leads Which Are Not Normally Connected to Battery

With the R12 switch in position 5 the (TA) and (TB) relays in the decoder are reoperated. All the connector leads except the receiving leads and the "RL" lead are tested for false battery. The " Z " relays associated with the leads being tested operate when the (TA) and (TB) relays operate; with all of these "Z" relays operated the (SR) relay operates. The operation of the (SR) relay operates the (K) relay; the (K) relay locks in position 5 and operates the (BT) relay. The (BT) relay in operating releases the decoder (TA) and (TB) relays thus opening the ?eads which are being tested and the oby releasing the corresponding " $z$ " redays if none of these leads are crossed wich battery; the (SR) relay (which is a slow release relay) releases as soon as any of these " $Z$ " relays release. If any of the leads are crossed with battery the corresponding "Z" relays fail to release; and when the (SR) relay releases, the first of the relays which failed to release is locked through the hack contacts of the (Z-TRL) relay and (BL) resistance (unless the ( $Z-T R L$ ) relay has also failed to release); the operation of the (LP) key lights the lamps associated with the relays which have not feleased; the operation of the (LPI) key releases the locked relay if the false battery on this lead has been cleared. If all of the " $Z$ " relays release, the (KI) relay operates, advancing the Ri2 switch to position 6; the (K), (KI) and (BR) relays release when the switch advances.

### 8.15 Test of Relay Connecting Connector to Decoder and for False Battery on All Connector Leads

With the R12 switch in position 6, the (TA) and (TB) relays reoperate and all " 2 " relays operate. With all " 2 " relays operated the (SR) relay operates thus prorating the (K) relay. The operation of the (K) relay releases the ( TH ) relay in the connector thereby releasing the (DF) and (DG) relays associated with the
decoder to which the test circuit is connected. All " $Z$ " relays release except those whose corresponding leads are not opened by the release of the (DF) and (DG) relays or which are crossed with battery in the connector itself; the location of the trouble or the satisfactory completion of this test proceeds as described in the preceding section. If the test circuit is satisfied the operation of the (Kl) relay advances the Rl2 switch to position 7; the (K) and (Kl) relays release when the switch advances.

### 8.16 Test of Relay Connecting Connector to Test Circuit

With the Rl2 switch in position 7 the (TH) relay in the connector reoperates thus reoperating the (DF) and (DG) relays. All of the " $Z$ " relays operate, the (K) relay operates and the (BT) relay operates. The operation of the (BT) relay releases the (TF) and (TG) relays in the connector thus opening the connector leads. If any " 2 " relays fail to release, the test circuit sticks and the time alarm operates; the operation of the (LP) key lights the lamps associated with the leads which were not opened by the release of the (TF) and (TG) relays. With all "Z" relays released the (KI) relay operates advancing the Rl2 switch to position 9; when the switch advances the (K), (KI), (CTA) and (CTB) relays in the test circuit release, and the (TH), (DF) and (DG) relays in the connector release.

### 8.17 Advance to Next Connector

## When the Rl2 switch advances beyond

 position 8 the (STC) and (STI) relays release if the (ST) key has been restored to normal thus releasing the decoder circuit; but if the key remains in the "ST" position these relays remain operated and the doroder circuit is not released. With the Rl2 switch in position 9 and the (REP) key normal the (CN) relay operates, locks in position 1 of the R5 switch, and operates the (CNT) register. The operation. of the (CNT) register advances the R12 switch to normal in which position a circuit is closed which advances the R5 switch to position. 2; uhe (CN) relay and (CNT) register release when the R5 switch advances from position $i$. With the (CN) relay released and the (R5) switch in position 2, the Rl2 switch advances into position 2; thus beginning the cycle of tests described in section 8.12 to 8.16on the next connector (connector B of frame 1). Thus these tests are made successively on all connectors of group (0), on decoder 1 of group (0).

### 8.18 Advance to Next Decoder

When the Rid switch enters position 9 after testing the last connector of the first group to the last decoder of that group the (CN) relay operates, locks to position 17 of the R7 switch and operates the (CNT) register. The operation of the (CNT) register advances the R12 switch to normal thereby advancing the R7 switch to position 18; the (CN) relay and (CNT) register release when the (R7) switch advances. With the R5, R6 and R7 switches all in position 18 and the. R12 switch in position 1 the (CA) relay operates, locks in position 1 of the R8 switch, and advances the R5 switch to position l; with the R5 switch in position 1 the R6 switch advances to position 1; and with the R6 switch. in position 1 the R7 switch advances to position l. With the R5, R6 and R7 switches all in position 1 and with the (DA) relay operated, the R8 switch advances to position 2; the (DA) relay releases when the switch advances from position 1. With the (DA) relay released, the R12 switch advances to position 2 thus starting test of all channels of the first group with decoder 2 of that group. Test of all connectors with all decoders of the first group is completed in a similar manner.
8.19 Advance to Second Group of Connectors and Decoders and End of Cycle

When the Rl2 switch enters position 1 after testing the last connector in group (0) with the last decoder in that group, and with the R5, R6 and R7 switches in position 18, the (DA) relay operates and locks in position $6 / 8$ of the R8 switch; the R5, R6 and R7 switches advance to position 1 thus advancing the R8 switch to position 9. When the R8 switch enters position 7 of the (SG) relay operates and when it has advanced beyond position 8 the (DA) relay releases. With the (DA) relay released the R12 switch advances to position 2 thus beginning test of the first connector of the second group (connector A frame 1 of group 100); test of all connectors to all decoders of group (100) is completed in a similar manner to that in which all connectors of group (0) were tested, switches R4, R1, R2 and R3 being acivanced in a similar manner to that in which switches R8, R5, R6 and R7 were advanced.

When the Rl2 switch enters position 1
after testing the last connector of group (100) with the last decoder of that group, and with the R1, R2 and R3 switches in position 18 the (DA) relay operates and locks in position 6/8 of the R4 switch; the R1, R2 and R3 switches advance to position 1 thus operating the (EC) relay. The (EC) relay locks under control of the (ST) key, lights the (EC) lamp rings and AC bell, and advances the R4 switch to position 8; the (DA) relay releases when the switch advances beyond position 8 . When the (ST) key is restored to normal with the (ON) key operated the (RN2) relay operates advancing the R8 and R4 switches to normal.

### 8.2 Test of All Connectors to a <br> Particular Decoder

The operation of the (PPH) key arranges the circuit to test all connectors with a particular decoder. The particular decoder is selected by depressing the (PC) key and the corresponding one of the decoder keys, also a group key, thereby advancing the R8 and R4 switch or both switches to the proper position. After the test is completed on all connectors the (EC) relay operates stopping the test.

### 8.3 Selection of a Particular Connector

The operation of the (PC) key renders operation of the (ST) key ineffective and with one each of the connector frame and group keys depressed also causes the advance of the R1, R2, R3, R5, R6 and R7 switches to the position in which the test will be started on the particular connector corresponding to the keys depressed. When the (PC) key is restored to normal and with the (ST) key operated, test is made of the selected connector and of all remaining connectors on all decoders unless the (PPH) key is depressed in which case, the tests are made in connection with one decoder.

### 8.4 Repeat Tests

If the repeat key (REP) is operated in addition to the keys necessary for testing connectors, a particular connector is tested with all decoders, ther the test stops. If the (PPH) key is $e$ ? 50 operated a test is repeated indefinitely on one decoder and one connector.
8.5 Operation When There Are Less Than 51 Connectors per Group and When There Is Only One Group
If less than 51 connectons are in-
stalled in a group, the R5, Fit and R7
switches are arranged to pass by the positions of unequipped connectors. To this end cross-connecting terminals are provided, "L1" and "L5" to "Ll7" inclusive with switch R5, "M1" to "M17" inclusive with switch R6, "N1", to "N17" inclusive with switch R7, "R1", "R5" to "R17" inclusive with switch Rl, "Sl" to "Sl7" inclusive with switch R2 and "T1" to "T17" inclusive with switch R3. Terminal "L1" is strapped to the one of. "L5" to "L17" terminals which corresponds to the remaining unequipped connector positions on the R5 switch; the "M1", "N1", "R1", "S1" and "Tl" terminals are strapped in a similar manner as required. The first four connectors of each group are not arranged to be passed by, as they constitute the minimum equipment.

If an occasional connector is left unequipped, its "ST" and "TH" leads are strapped to those of another connector on the same frame, which is thereby tested twice.

If not more than 11 frames are equipped in group (0) the R7 switch is om rted or in group (100) the R3 switch is or icted; if not more than 6 frames are evilpped in group (0) the R6 and R7 switches are omitted or in group (100) the R2 and R3 switches are omitted,

If there is only one group of connectors and decoders to be tested, the R1, R2, R3, and R4 switches are omitted.

## 8,6 Time Alarm

At the same time that the circuit in which the (ST) relay operates is closed ground is connected to the armature of the (TMT) interrupter; if the cycle of tests is completed on the first connector (or any connector) before the (TMI) relay operates the advance of the Rl2 switch beyond position 9 disconnects ground from the interrupter thereby releasing the (TM) relay, if operated. If the test has not been completed within the measured allowable time the operation of the (TMI) relay closes the alarm circuit, lights the (TBL) lamp, operates the (TBL) register and operates the (BK) relay. The operation of the (BK) relay prevents the advance of the R12 switch.

If the test circuit sticks while testing connectors the operation and release of the (CA) key operates the (CA) and (CAI) relays thus releasing the (CPI) relay. The release of the (CPI) relay releases the (CTA) and (CTB) relays (or
prevents their reoperation) thus advancing the Rl2 switch to position 9. The test circuit then advances to test the next connector or proceeds to repeat the test if the (REP) key is operated.

### 8.7 Return to Normal

When the (ST) key is restored to normal the (RN) relay operates thus advancing the Rl2 switch to normal; with the (CONN) key operated and the (PPH) key normal the (RN2) relay also operates advancing the R8 and R4 switches to normal. The operation of the (RN) key operates the (RN1) relay if the (PPH) key is normal; operation of this relay advances the R1, R2, R3, R5, R6 and R7 switches to normal.

## 9. AUDIBLE TEST OF DECODER AND CONNECTOR ALARMS

### 9.1 Test of Decoder Time Alarm

The keys should be set for making a trouble release test on all decoders and the (SCD) key operated. The (ALT) key should also be operated which opens the (TI) and (TRL) leads to the decoder and the. time alarm circuit of the test set. The operation of the (ST) key causes the seizure of the first decoder as described above. Since the (TRL) lead is opened the test set will stick and since the Tl lead is opened the decoder time alarm will function and give an alarm. The operation of the (CA) key will advance the test set to the next decoder where the same test may be made. All decoders may be tested in this way.

### 9.2 Test of Decoder Ring Lead Alarm

A test of this trunk release busy ground is made as limited in section 10 , and 1. the keys are not restored the alarm should sound within one minute.

### 9.3 Test of Connector Alarms

The keys should be set for making a test on all connectors over a particular path, 1,e., the (PPH) key should be operated. The (ALT) key should also be operated'which opens ground from the back contact of the ( BK ) relay. The operation of the (ST) key causes the test set to proceed with the connector test until
position 3 of the control switch is reached where it will stick due to the above mentioned ground being open. The connector time alarm will advance and give an audible alarm. The operation of the (CA) key causes the test set to advance to the next connector where the same test may be made.

## 10. MANUAL TEST OF TROUBLE RELEASE BUSY GROUND

10.1. When it is desired to test the abillty of all the decoders or any particular decoder, to hold itself busy for a short time after giving a trouble release signal to:a sender so that the sender on its second trial will choose some other decoder if avallable, deooder switch (R8) or (R4) is set on the decoder to be tested, and all other switches normal. Then the (TRL) button in the (SPL. TESTS) key strip is pressed, and keys (DR), (SCD), (TRBG) and (ST) operated. If it is desired to make repeated tests on one decoder, the (REP) key is operated also.
100.2 Except for the (TRGB) key the setting is the same as for a special code test of the trouble release feature, described in paragraphs 7.12, 7.2, 7.3 and 7.4. The (TRBG) key opens the time alarm circuit of the test circuit, breaks the (TRL) lead to the decoder from its usual connection in the test circuit and connects it to the winding of relay (TRI), and operates relay (TR5) which locks to the DBA le'ad to the decoder.
10.3 The decoder will time out and ground the TRL lead as in a regular trouble yolease test. This operates relay (TRI) which locks through make contact of (STD) and break of (CA3). The operation of (TRI) breaks the start lead to the decoder, releasing it as a sender would release it upon receiving a trouble release signal. It aiso cuts off from the TDB lead the ground normally supplied by the test circuit to the decoder DB lead to hold the decoder busy while it is being tested, so that the only ground remaining upon the DB lead is that supplied for a short time by the decoder itself. It also connects the TDB lead through make contacts of relays (TR5) and (TR2) to the winding of (TR3), and connects ground to the winding of (TR2) and through a contact of (TR3) to the winding of (TR4).
10.4 The operation of (TRI) is therefore Sollowed by the operation of (TR2),
and then by the operation of (TR3) and (TR4) in turn, provided the decoder holds ground on the TDB lead for the requisite length of time to operate all those relays in turn. If so, (TR4) locks up and lights the (TRBG) lamp as a sign that the test was successful.
10.5 The moment the decoder ceases to hold ground on the TDB lead, relay (TR5) releases and allows the test circuit again to connect ground to the TDB lead, thereby holding the decoder busy to senders in case it may be desired to repeat the test on the same decoder.
10.6 The relays are released for a repeat test, or to advance to the next decoder to test that by operating the (CA) key.

## 11. DETECTION OF CROSSES BETWEEN DECODERS WITHIN THE TEST CIRCUIT

11.1 The apparatus shown in Fig. N is for the purpose of detecting crosses which may occur between two DR leads or two DST, TlA, T2A or DBA leads, which crosses are apt to occur at adjacent sequence switch springs and which might cause the test circuit when testing one decoder to interfere with the service operation of another.
11.2 The winding of cross relay (XI) is which the test circuit applies through cams (F8), (G8), (F4) and (G4) to the DR lead to connectors, to operate (DF) multicontact relays connecting decoders to connectors for connector tests. The normal current which passes through the winding of one (DF) relay is insufficient to operate relay (XI), but if two DR leads are crossed, the current through the windings of two (DF) relays will operate relay (XI). The contact of (XI) then closes a circuit to operate cross lock relay (XLI) and to hold (XI) and (XLI) locked up. (XII)
lights cross lamp (X) and immediately operates relay (TMI), which blocks the test and gives an alarm as previously described in connection with the time alarm. The ( $X$ ) lamp indicates the general nature of the trouble, and an inspection of the ( $x$ ) relays showing (XI) to be locked up discloses that two DR leads are crossed.

### 11.21 When "AE" and "AG" are: furnished

 the (XI) relay cannot operate and no cross detection test for the DR leads is made.```
11.3 Relay (X5) acts in a precisely
    similar mariner with respect to leads T2A operating pelays (COl) and (CO2) in decoders.
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```
11.4 Relays (X2) and (X3) act in a
```

11.4 Relays (X2) and (X3) act in a
similar manner with respect to leads
similar manner with respect to leads
DST operating (DST) relays in connectors,
DST operating (DST) relays in connectors,
with the followtne differences: two cross
with the followtne differences: two cross
relays are used lecause on an all codes
relays are used lecause on an all codes
test the DST Ieads of the first or master
test the DST Ieads of the first or master
decoder and one other are energized at the
decoder and one other are energized at the
same time; the test circuit applies battery
same time; the test circuit applies battery
to these leads instead of ground; the cross
to these leads instead of ground; the cross
relays operate (XL2) through its grounded
relays operate (XL2) through its grounded
secondary winding instead of (XLI). Relay
secondary winding instead of (XLI). Relay
(XL2) lights lamp (X) and operates relay
(XL2) lights lamp (X) and operates relay
(TMI) the same as (XII).

```
(TMI) the same as (XII).
```

11.5 Relays (X6) and (X7) act with respect to leads (DCA) operating relays
(TDB) in decoders in a manner precisely similar to (X2) and (X3).
11.6 The winding of relay ( x 4 ) is inserted in the lead "Tl" (to all decoders except \#l and \#lOl) in series with the ground which the test circuit applies to the TlA leads, through the (TB) relays, operating relay (CO) in decoders. If two TIA leads are crossed, (X4) operates and in
turn operates (XL2) b its primary winding. (XLÉ) lockz, lights lam (X) and operates relay (TMI). Relay (X4) cannot lock up, because, after relay ( CO ) in the decoder operates, the decoder grounds its TlA lead, shunting out the battery which operated (X4). The fact that lamp (X) lights and no (x) relay locks up indicates that there is a cross between two TlA leads.

## 12. FIG. E OPERATION

The (TVD) relays $X, X$ and $Z$ of $F i g$. D function the same as other $\mathrm{X}, \mathrm{Y}$ or Z relays for decoder transmitting leads. The (TVD-Z) relay is placed ahead of the (Al-Z) relay. The (TVD-X) and (TVD-Y) relays are placed between the (TW) and (OBI) relays. The (TDV) key has the same function as any of the other transmitting lead keys.

The (SG4) relay in Fig. $F$ or $G$ is added for use when there are two groups of decoder circuits, but only one group is equipped for diversion of restricted PBX traffic on extra charge calls. Fig.G is provided when Group 0 is equipped with the diversion feature, but Group 100 is not. Flg. $F$ is provided when Group 100 is equipped with the diversion feature, but Group 0 is not.

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