.ethod of Operation was Prepared from Issue 47 of Drawing T-501002.

METHOD OF OPERATION

Panel System - Sender, Recording Key and Testing Cord Circuit - Local Test Desk.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

This circuit is used at the local test desk for setting up connections and testing subscriber's lines and subscriber's and operator's dials.

2. WORKING LIMITS

2.1 Sleeve resistance of test lines to the special incoming test selector maximum 1102 ohms. Maximum 52 ohms for discharging the sender and connecting apparatus when selection is completed.

2.2 Sleeve resistance to zero operator toll switchboard and trouble desks maximum 52 ohms.

2.3 Sleeve resistance of test lines to main frame maximum 39 ohms.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are as follows:

3.01 Gives a visible signal, indicating which test cord is connected to the sender.

3.02 Gives a visible flashing signal while sender is connected to the test cord.

3.03 Gives a steady visible signal when selections are completed and sender sequence switch is returning to normal.

3.04 Selection of proper incoming brush.

3.05 Selection of proper incoming groups.

3.06 Selection of proper final brush.

3.07 Final tens selection.

3.08 Final units selection.

3.09 Gives a visible signal when the incoming selector goes to an overflow position.

3.1 Provides a visible signal for the testman as an indication to proceed testing.

3.2 Provision is made for testing the accuracy and speed of station and position dials.

3.3 Provision is made for testing 10-pulse and 20-pulse dials.

3.4 Testing line relays on coin prepayment lines.

3.5 The following keys are used for placing various tests on subscriber's lines.

PRIMARY TEST CIRCUIT

3.50001 A key marked (REV) which is used to reverse the tip and ring sides of the primary test circuit with respect to all apparatus connected back of the ringing keys.

3.50002 A key marked (G) used to connect ground to either side of the line under test.

3.50003 A repeating coil cut-in key marked (RCCI) to connect talking battery to test cord.

3.50004 A key marked (M) to connect the telephone circuit to the primary test circuit for monitoring purposes.

3.50005 A key marked (T) which is used to connect the wire chief's telephone set to the primary test circuit for talking purposes.

3.50006 A transmission test key marked (TMT) used to connect the telephone circuit to an artificial cable to the line under test to determine the degree of the transmission of the line.

3.50007 A key marked (FEMF) used to disconnect the volt-milliammeter from the testing battery and to connect it to ground to test for foreign potential.

3.50008 A key marked (VM-REV) used in conjunction with the (FEMF) key to reverse the leads from the voltmeter windings of the volt-milliammeter with respect to the tip and ring of the line under test.

3.50009 A key marked (20,000 ohms) used to disconnect the 100,000 ohm volt-milliammeter winding and the one hundred volt testing battery from the testing circuit and to connect the 20,000 ohm volt-milliammeter winding in series with the 20 volt testing battery to the testing circuit.

3.5001 A key marked (1000 ohms) used in a manner similar to that described above for the use of the 20,000 ohm scale changing key, but connecting the 1000 ohm winding of the voltmeter in series with the 20 volt battery to testing circuit.

3.5002 A key marked (RHE) used to disconnect a short-circuit from the windings of the rheostats.

3.5003 Two keys, one marked (CC) and the other (CR) used for testing coin collectors.

3.5004 A key marked (S.S.R.T.) used for supplying metallic ringing current to the line under test when testing the operation of the #98 type subscribers' sets.

3.5005 A key marked (3WO) used to test the sleeves of the circuits to which the plug of the test cord is connected and also to give the testman a regular "A" cord supervisory signal.

3.5006 A reversing key (REV) which is used in connection with the cord when it is desired to extend the grounded side of the battery to some point outside of the exchange to avoid earth potential while making loop measurements.

3.5007 A key marked (3WT) used to test the sleeves of the circuits to which the plug of the test cord is connected.

3.5008 A key marked (LRP) used to test the operation of line relays on coin prepayment lines.

SECONDARY TEST CIRCUIT

3.501 A howler key marked (H) and apparatus for applying a graduated howler tone to the line.

3.502 A dial test key "DT", with its associated "S" & "V" wiring is used when the secondary test circuit is to be connected directly to the 50-A dial tester circuit for testing 10 pulse dials. When the 51-A dial test circuit is used the "DT" key is omitted, also the "V" wiring and "S" and "U" wiring and apparatus is used to connect the secondary test circuit to the dial tester key circuit. The operation of the dial tester key circuit will connect the secondary test circuit directly to the 51-A dial test circuit for testing 10 or 20 pulse dials.

3.503 A key marked (REV) for reversing the tip and ring of the test cord with respect to the tip and ring of the secondary testing circuit.

3.504 A grounding key marked (G) used to connect ground to the tip of the line when the repeating coil ground is disconnected.

3.505 A monitoring key marked (M) used to connect telephone sets to the secondary test circuit for monitoring purposes.

3.506 A key marked (T) used for connecting the telephone set to the secondary test circuit.

3.507 A key marked (S) used for connecting the sounder cord to the ring and tip, respectively, of the secondary test circuit.

3.508 A key marked (X) used to interchange the testing equipment of the primary and secondary test cords, with the exception of the howler equipment, which can be used only with the secondary test cord.

3.509 A repeating coil cut-out key marked (RCCO) used to disconnect talking battery from the test cord.

3.510 Provides means for checking the speed of subscribers' dials.

3.511 Provides a sounder cord so that an audible signal will be given to the testman, should there by any grounds, or short-circuits on the line.

3.512 Provides regular "A" cord supervision when talking keys are operated.

3.513 Provides a means for the testman to release the test circuit at any time during the test.

3.514 Returns to normal.

4. CONNECTING CIRCUITS

4.1 This circuit functions with subscribers' lines through testing senders, lines, incomings and finals.

4.2 Telephone Circuit.

4.3 Dial tester circuit.

4.4 Wheatstone bridge circuit.

DESCRIPTION OF OPERATION

TRUNK TO INCOMING TEST SELECTOR
REGULAR LINE TEST-USING PRIMARY TEST CORD

5. The plug of the primary test cord is inserted in the jack of a test line, to incoming test selector, the proper numerical keys are depressed, and the "ST" key is operated. "When Al wiring is used", where the primary test cord is inserted in the jack of the test line, battery on the break contact of the (PCO) relay is closed thru the winding of the (PTC) relay, (El Wiring) or the (PS) relay (Fl wiring) to ground thru the sleeve relay in the test line circuit. The (PTC) relay (El wiring) or the (PS) relay (Fl wiring) does not operate at this time, however, due to the high resistance of the sleeve of the test line. The operation of any of the numerical keys closes a circuit from ground thru the common contact of the operated numerical key, to battery thru the winding of the (TH), (H), (T) or (U) relay, operating any or all relays depending upon which numerical keys are operated. The (TH), (H), (T) or (U) relays operated, closes a circuit from battery through the winding of the (L) relay in the incoming test selector, tip of the test line and cord, break contact of the (PTC) relay, winding of the (PCI) relay, cam J, breaking contact of the (SCO) relay, outer contacts of cam H, winding of the (STP) relay, A and B resistances, to ground on the armature of the (O') relay. The (PCI) relay operates, but the (L) relay in the incoming circuit and the (STP) relay do not operate due to the high resistance of the winding of the (PCI) relay. When "P" wiring is used on the "H" cam the (STP) is shunted out.

6. The (PCI) relay operated, (a) closes a circuit from battery through the lower inner and upper outer contacts of cam L, winding of the (PCO)

relay, in multiple with the A lamp, make contact of the (PCI) relay, make contact of the operated (TH), (H), (T) or (U) relay, make contact of the "ST" key, to ground on the lower contacts of cam C, lighting the A lamp and operating the (PCO) relay, (b) closes a circuit from battery, through one winding of the (ST) relay, which also operates to the same ground on cam C. The (PCO) relay operated, (a) locks to ground on its armature, (b) disconnects the tip and ring of the secondary test cord from the sender circuit, (this feature is provided so that if the plugs of both primary and secondary test cords are inserted in the jacks of test lines before the ST key is operated, and the sender switch has moved off normal, the primary test cord only is connected to the sender), (c) disconnects ground from an armature of the (SCO) relay, (d) opens the circuit from battery through the winding of the (PTC) relay, (E1 wiring) or the (PS) relay (F1 wiring) and (e) closes a circuit from battery through the winding of the (PD) relay, which operates in the sleeve circuit. The (PD) relay operated, prevents the operation of the (D) relay, the function of which is described under "OVERFLOW".

7. The (ST) relay operated, advances the switch to position 2. In position 2, a circuit is closed from battery through the contact of the 149 type interrupter, make contact of the (ST) relay and sender pilot lamp to ground on the lower inner contact of cam E, causing the lamp to flash. In position 2 the winding of the (PCI) relay is short circuited through the outer contacts of cam J releasing the (PCI) relay. The (PCI) relay released, reduces the resistance of the fundamental circuit sufficiently to operate the (L) relay in the incoming selector and the stepping relay in the sender circuit. The sender is now ready for selection beyond.

INCOMING BRUSH SELECTION

8. Assuming thousands key 6 to be operated, four impulses will be required to satisfy the sender, therefore the pulsing path is closed to the 3 counting relay. This circuit (M wiring) is traced from battery through the winding of the (3) counting relay, break contact of the (3') relay, lead 3, contact of the thousands key 6, upper outer and lower inner contacts of cam G, make contact of the (STP) relay, lower outer contact cam E to ground on the lower inner contact of cam D, operating the (3) counting relay. With "N" wiring the circuit is traced from battery thru the winding of the (3) counting relay, break contact of the (3') counting relay, lead "3", contact of the "6" thousands key depressed, upper outer and lower inner contacts of cam G, make contact of (STP) relay to ground. "M" wiring provides for reversing direction of current thru contacts of the (STP) relay whereas "N" wiring does not provide for this reversal of current. During brush selection intermittent ground is connected to the tip side of the fundamental circuit by means of the A commutator in the

incoming selector circuit, alternately short-circuiting the (STP) relay thus releasing it and permitting its re-operation. When the (STP) relay releases, the short circuit around the winding of the (3') counting relay is removed allowing it to operate in series with the (3) counting relay. The (3) and (3') counting relays lock in series, to ground on cam D. The 2, 1, and 0 sets of counting relays are similarly operated by the second, third and fourth impulses from the incoming A commutator. The operation of the number (0') counting relay closes a circuit from ground on its armature, upper outer contact of cam B, to battery through the winding of the R magnet, advancing the switch to position 3, the A cam advancing the switch to position 4. In position 4 the fundamental is closed operating the (STP) relay for incoming group selection.

9. INCOMING GROUP SELECTION

Assuming hundreds key 7 to be operated, two impulses will be required to satisfy the sender for incoming group selection, the first impulse operating 1 set of counting relays. The operating circuit ("M" wiring) is from battery, through the winding of the (1) counting relay, break contact of the (1') counting relay, right outer contact of the 6 thousand key depressed, contacts of the 7 hundreds key, upper outer and lower inner contacts of cam F, make contacts of the (STP) relay, upper outer contact of cam E, to ground on the lower inner contact of cam D, operating the (1) counting relay. With "N" wiring the circuit is from battery thru the winding of the (1) counting relay, break contact of the (1') counting relay, right outer contact of the "6" thousands key depressed, contacts of the "7" hundreds key depressed, upper outer and lower inner contacts of cam "F". Make contacts of the (STP) relay to ground. The tip side of the fundamental circuit is intermittently short-circuited by impulses from the incoming B commutator, thus the (STP) relay successively releases and re-operates. The release of the (STP) relay, removes the short circuit from the winding of the (1') counting relay, which operates. The zero counting relays are similarly operated by the second impulse applied to the fundamental circuit. The (0') counting relay operated, advances the switch to position 5, the cam A advancing the switch to position 6. As the switch advances from position 4 all operated counting relays release .

10. FINAL BRUSH SELECTION

In position 6 the fundamental circuit is again closed operating the (STP) relay for final brush selection. Final brush selection is made similar to incoming brush selection. When sufficient impulses have been sent back to satisfy the sender, the (0') counting relay operates,

advancing the switch to position 7, the cam A, advancing the switch to position 8. As the switch leaves position 6 all operated counting relays release.

11. TENS SELECTION

In position 8 the fundamental circuit is again established operating the (STP) relay for final tens selection. Final tens selection is made similar to incoming brush selection. The required counting relays being operated, the fundamental circuit is opened and the switch is advanced to position 10 for units selection.

12. UNITS SELECTION

Units selection is made in a manner similar to incoming brush selection. Impulses from the final U commutator actuating the (STP) relay. When sufficient impulses have been sent back to satisfy the sender the (O') relay operates advancing the switch to position 11.

13. DISCHARGING THE SENDER

In position 11 a circuit is closed from battery through the line relay in the incoming selection over the ring of the cord, "X" key normal the (PTC), (SCO), (NT), and (ADV) relays normal through the winding of the (ADV) relay, the (PD) relay operated, cam E, to ground on cam D operating the (ADV) relay. The (ADV) relay operated, locks to battery on cam L and closes a circuit from battery through the inner contacts of cam L, operating the (ADV-1) relay. The operation of the (ADV) relay opens the ring of the circuit thus releasing the line relay in the incoming, which advances to its talking position. The (ADV-1) relay operated, also locks to battery on cam L, and closes a circuit from ground on its armature, cam B, to battery through the winding of the R magnet, advancing the switch to position 12, the A cam advancing it to position 18. As the switch passes through positions 12 to 17 the (ADV) and (ADV-1) relays release and a circuit is closed from battery on cam I, to ground through the windings of the key release magnets which operate, releasing all operated keys. The release of the keys release the (U), (T), (H) and (TH) relays. As the sender switch advances from position 17, the circuit through the winding of the (PCO) relay is opened at cam L, releasing the relay. The (PCO) relay released, releases the (ST) relay. The (ST) relay released, lights the sender pilot lamp steadily, to ground on cam E, and advances the switch from position 18 to normal. The lighted pilot lamp is an indication that selection is completed and the sender switch is returning to normal. The (PCO) relay released also extinguishes the "A" lamp, connects the sender to the secondary test cord and maintains battery on the sleeve of the test cord through its continuity contacts and the winding of the (PTC) relay. (E1 wiring) or the winding of the (PS) relay (F1 wiring).

14. LINE TRANSFERRED TO TEST CIRCUIT

14.1 (El Wiring)

The sleeve of the test line is grounded through a maximu resistance of 998 ohms until after the incoming test selector switch advances to position 1-3/4, (which occurs after the winding of the (PCI) relay is short circuited). As the incoming advances a relay in the test line circuit operates, reducing the sleeve resistance to a maximum of 52 ohms, causing the (PTC) relay "Al wiring" to operate. The (PTC) relay operated, disconnects the tip and ring of the primary test cord from the sender and connects them to the testing equipment. The (PTC) relay operated, also closes a circuit from ground on its armature, lighting the primary supervisory lamp as an indication that the test man may proceed with the tests.

14.2 (Fl Wiring)

The sleeve of the test line is grounded thru a minimum resistance of 900 ohms until after the incoming test selector switch advances to position 2 (which occurs after the winding of the (PCI) relay is short circuited), reducing the sleeve resistance to a maximum of 52 ohms, causing the (PS) relay to operate. The (PS) relay operated, operates the (PTC) relay which disconnects the tip and ring of the primary test cord from the sender and connects them to the testing equipment. The (PTC) relay operated, also closes a circuit from ground on its armature lighting the primary supervisory lamp as an indication that the tester may proceed with the test.

15. LINE TEST - NO TEST BASIS - PRIMARY CORD

To select a line on a no test basis, the operation is the same as that described under "Regular line test - Using Primary test cord", except that the no test key (NT) of the sender circuit and the M key of the associated primary test circuit are operated, instead of the "ST" key. The operation of the M key, (a) closes in part the operating circuit of the (PCO) relay, (b) disconnects the repeating coil and battery from the test set and (c) connects the monitoring circuit, to the test cord. Therefore, the (PCO) relay operates to ground on cam C through the contacts of the "NT" and "M" keys. This is to prevent the interference with the transmission of a subscriber's line, should the R.C.C.I. key of the test circuit be operated when a busy line is selected.

16. After final tens selection in position 8, the (O') relay operates and closes a circuit from ground on its armature, upper contacts of cam C, contacts of the NT key, to battery through the windings of the (NT) relay which operates. The (NT) relay operated, locks through the break contacts of the (SCO) and (PTC) relays, ring of the test cord, test line, and incoming selector, to ground on the ring of the final selector. As the final selector, upon the completion of final units selection, advances through its "no test", position, battery through the windings of the (NT) relay, in parallel with the battery through the 1200 ohm winding of the (L) relay in the incoming, operates the P.B.X. relay in the final selector, allowing the final selector to rest on a busy terminal. As the final selector advances the (NT) relay releases. When "A" wiring and apparatus is used, the "D" and "D-1" resistances serve to increase the current flow thru the (PBX) relay in the final circuit. This increase of current is necessary to compensate for the decrease time available for operating the (PBX) relay due to a change in the final sequence switch.

17. OVERFLOW

Should the special incoming test selector go to overflow during selection, a circuit is closed from battery on the ring of the incoming, ring of the test line, and test cord, break contact of the (PTC), (SCO) and (NT) relay, to ground through the winding of the (ADV) relay which operates. The (ADV) relay operated, closes a circuit from battery through the inner contacts of cam L, make contacts of the (ADV) relay to ground through the winding of the (ADV-1) relay which operates. The (ADV-1) relay operated, locks to battery on cam L, and closes a circuit from battery through the 149 interrupter, OFL pilot lamp, to ground through the inner contacts of cam D, and also opens the fundamental circuit to keep the incoming from returning to normal. The OFL pilot lamp flashes until the plug of the test cord is momentarily withdrawn from the jack of the test line, or the disconnect key in the associated test line circuit is operated, releasing the (PD) relay. The (PD) relay released closes a circuit from ground on cam D, upper inner contact of cam E, break contacts of the (PD) and (SD) relays, to battery through the winding of the (D) relay which operates. The (D) relay operated, locks to ground on cam D and also closes a circuit from the same ground to battery through the winding of the R magnet, advancing the switch to position 17. The A cam advances the switch to position 18. The switch advances to normal from ground on the armature and break contact of the (ST) relay. The key release magnets and the (TH), (H), (T) and (U) relays release, as described in paragraph 13, returning the circuit to normal.

Manual Line Test Using Primary Test Cord

When the plug of the primary test cord is inserted in the jack of a manual test line the (PS) relay operates and operates the (PTC) relay. The (PTC) relay operated, disconnects the tip and ring of the test cord from the sender and recorder circuit and connects them to the test circuit and lights the primary cord supervisory lamp.

Secondary Test Cord

The circuit functions the same for the secondary test cord as for the primary test cord, except that the secondary cord relays operate instead of the primary cord relays and the (B) lamp lights in place of the (A) lamp.

18. TALKING OVER PRIMARY AND SECONDARY TEST CORDS

The telephone set is normally disconnected from the testing line. To talk over a line which is connected to the primary testing circuit, operate the primary talking key "T" and "R.C.C.I." keys the operation of which connects the telephone set to the line and supplies talking battery. To talk over a line connected to the secondary test cord circuit, the secondary talking key (T) is operated. In both cases, regular "A" cord supervision is obtained.

19. TESTS FOR GROUNDS - PRIMARY TEST CIRCUIT

To test for grounds on the ring of the line, no keys need be operated. Normally the 100 volt testing battery is connected to the ring, in series with the 100,000 ohm winding of the volt-milliammeter. If the line is clear the voltmeter should show no deflection or at most a very small one, except, in the case of a party line with the receiver off the switchhook at a "ring" station. If a ground is indicated the resistance may be determined as explained later under "Tests for Short Circuits". If the deflection is in excess of that which the testing battery can produce, there is an indication that the line is crossed with a foreign source of current. To test a ground on the tip of the line, reversing key "REV" is operated.

20. To measure a high resistance ground the 100 volt testing battery is used. On account of the high resistance in series with the 100 volts of the volt-milliammeter and the needle shows a greater deflection than would be the case if the 20 volt testing battery were used, thereby giving a chance for greater accuracy. In measuring small resistances the 20 volt battery is used.

21. To test with the milliammeter the repeating coil cut in key "R.C.C. I" is operated. This connects one winding of the volt-milliammeter to the ring of the circuit in series with the central office battery. If the line is clear no deflection will occur. This test is made on the tip by operating the reversing key "REV" also.

22. TESTS FOR GROUNDS - SECONDARY TEST CIRCUIT.

When the voltmeter indicates a swinging ground, of apparently high resistance it is desirable to supplement the foregoing tests by a test with the (SR) relay. This test is made with all keys in their normal positions, except the relay key "S". The operation of this key connects ground to the tip and 24 volt battery through to the winding of the (SR) relay to the ring of the testing circuit. The (SR) relay operates, if there is ground on the ring or across on the line, if turn operating the sounder (S). A test is made on the tip by operating the reversing key "REV" in addition to the operation of the "S" key.

23. If the optional wiring "To Buzzer Test Circuit", is furnished the operation is the same except that a relay with a make and break spring combination replaces the (SR) relay and a buzzer replaces the sounder S.

24. TESTS FOR SHORT CIRCUITS

Tests for crossed lines are made by operating the ground key (G). If the line is crossed the voltmeter needle shows a deflection which is unchanged when the REV. key is operated. The smaller the resistance of the short circuit in the line, the greater is the deflection. In all cases, the voltmeter reading bears the same ratio to the voltmeter resistance, as the difference between this reading and the testing battery voltage bears to the external resistance. The line resistance is calculated by dividing the difference between the testing battery voltage and the voltmeter reading by the voltmeter reading and multiplying this quotient by the resistance of the voltmeter coil. For example, if the voltmeter coil has a resistance of 100,000 ohms, the testing battery has a potential of 100 volts and a reading of 40 volts is obtained in the line, the resistance of the line is 100 minus 40, then divided by 40 and multipled by 100,000 or 150,000 ohms. For measuring lower resistances the lower scale and lower voltages are used.

25. To test with the milliammeter, operate the R.C.C.I. and G keys. The deflection of the milliammeter results if the line is crossed. The milliammeter needle returns to zero when the R.C.C.I. key is restored to normal.

26. CONTINUITY TEST - PRIMARY TEST CIRCUIT

Continuity tests are made in the same manner as tests for crosses. On lines equipped with standard common battery sub-station sets which have a condenser in series with the ringer, no deflection occurs unless the receiver is removed from the switchhook at the sub-station, or the line is crossed. If it is not convenient to have the receiver removed, a very satisfactory test of continuity can be made by operating the REV key several times. This results in momentary deflection of the voltmeter needle, due to the discharge of the station condenser, if the line is continuous. A test for continuity should always be preceded by a test for ground.

27. TESTS FOR CROSSES WITH LINES CARRYING CURRENT - PRIMARY TEST CIRCUIT

To test a line for foreign battery, the battery cut-off key "FEMF" is operated. This connects the voltmeter to the ring of the test circuit, with ground. The external potential causes a negative reading of the voltmeter, the "MM-REV" key is then also operated, thereby reversing the voltmeter connection with respect to the line. To test the tip side of the line the regular "REV" is operated.

28. TESTS FOR CROSSES WITH OTHER LINES - PRIMARY AND SECONDARY TEST CIRCUITS IN CONJUNCTION WITH EACH OTHER

To test for a cross between two lines, one of them is connected to the primary testing circuit and the other to the secondary testing circuit. The tip and ring of the secondary testing circuit is connected to ground by the operation of the secondary "G" and "REV" keys and testing the line connected to the primary testing position for ground as described under "Test for grounds".

29. BALLISTIC CAPACITY TESTS - PRIMARY TESTING CIRCUIT

These tests are made to determine approximately the value of the capacity of the line in locating an open or the capacity of the attached condensers. The circuit is arranged for a grounded capacity test only, unless the Wheatstone bridge circuit is equipped, in which case tests for mutual capacity are made by operating the Wheatstone bridge key which disconnects ground from the testing battery. To test a line for grounded capacity, the "G" key is operated, when the reversing key "REV" is quickly operated and released several times. This causes a deflection proportional to the capacity on the ring, when the reversing key returns to normal and proportional to the capacity on the tip when the reversing key "REV" is operated. If an extension bell is connected in series with the ringer of the subscriber's main set a slight reduction in the deflection of the needle results.

30. BREAKDOWN TEST - PRIMARY TEST CORD

When the breakdown test key is operated, the following sequence of operation occurs:- (a) the springs of the impulse wheel "A" close, operating the (BT), (CR) and (CC) relays. The (BT) relay operated, connects the ring of the test circuit direct to ground, and prepares for a closure of the high voltage battery when the (CR) and (CC) relays operate, connect the tip of the test circuit to ground through 96,000 ohms, under control of the "B" cam of the impulse wheel, (b) the springs of the impulse wheel "B" operate, removing ground through the 96,000 ohm resistance from the tip of the test circuit and connecting the 200 volt break down potential through the 96,000 ohm resistance, make contacts of the (BT) and (CR) relays, the ammeter winding of the volt-milliammeter and the tip of the test circuit, the ring of the cord remaining connected to ground, (c) the springs of the impulse wheel "C" operate short circuiting the 96,000 ohm resistance and connecting the breakdown potential through the resistance lamps and make contact of the (BT) and (CR) relays, through the milliammeter winding of the volt-milliammeter to the tip of the test circuit. By gradually charging the line condensers in this manner, bell taps are avoided, (d) the springs of the impulse wheel "C" release again impressing the 200 volt potential on the tip of the test circuit through 96,000 ohms (e) the springs of the impulse wheel "B" release disconnecting the 200 volt battery and connecting ground to the tip of the test circuit, (f) the springs of the impulse wheel "A" release, causing the (BT), (CR) and (CC) relays to release, restoring the circuit to normal. To make the breakdown test on the ring of the line, the REV key is operated, together with the insulation breakdown key.

31. TRANSMISSION TEST - PRIMARY TEST CORD

These tests are made for testing the degree of transmission on the line. The operation of the transmission test key "TMT" and the repeating coil cut in key "RCCI" connect the line to the telephone circuit. The rheostat key "RHE" is then operated, and the current through the transmitter varied by adjusting the rheostat.

32. COIN COLLECT AND RETURN - PRIMARY AND TERTIARY

To test the operation of the coin boxes on the subscriber's line, the CC or CR key is operated. The operation of the CC coin collect key operates the (D) and (CC) relays. The operation of these relays connect 110 volt positive direct current to the tip side of the test circuit through the milliammeter winding of the volt-milliammeter. When the key is restored, the relays release. The operation of the coin

return key "CR" operates the (CR) and (CC) relays connecting the 110 volts negative direct current to the tip side of the test circuit through the milliammeter winding of the volt-milliammeter. The current through the coin collector may be regulated by operating the special rheostat key and then adjusting the rheostat. In any case when a coin is deposited in a coin box of a pre-payment line to which the primary test circuit is connected, the deflection of the volt-milliammeter needle indicates what disposition has been made of the coin.

33. APPLICATION OF THE HOWLER - SECONDARY TEST CIRCUIT

If there is a cross of sufficiently low resistance on a line to which the secondary test circuit is connected the (SS) relay operates, connecting the winding of the (A) relay across the secondary test circuit supervisory lamp, operating the relay to ground on the armature of the (STC) or (TS-3) relay preventing the lamp from lighting. When the howler key H is operated, a circuit is closed from ground on the H key, C brush of the 200-R selector, make contact of the (A) relay, to battery through the winding of the (H-1) relay, which operates. The (H-1) relay operated, (a) locks to ground on its armature under control of the H key, and connects the winding of the (H-2) relay, to the break contact of the (A) relay, (b) closes a circuit from the howler source, break contact of the (H-2) relay, make contact of the (H-1) relay, break contact of the (SR-2) relay, primary winding of the 49-A repeating coil, back to the howler source, and (c) closes a circuit from ground through the 149 interrupter, break contact of the (SR-2) relay, S brush and normal contact of the 200-R selector, to battery through the winding of the selector magnet which operates, moving the selector to the off-normal position. With the selector switch in its off-normal position, a circuit is closed from ground through the 149 interrupter, break contact of the (SR-2) relay, S brush of the selector, off-normal contact of the selector, to battery through the winding of the stepping magnet, which operates and steps the brush assembly to the next terminal. The operation of the interrupter continues to step the selector through one revolution.

34. The C brush of the selector in the off-normal position connects section A-B of the secondary circuit of the 49-A repeating coil in series with the 5-6 and 1-2 windings of the 25-A repeating coil of the secondary test circuit, causing a minimum howler tone to be induced through to the line under test. As the selector switch advances, additional sections of the secondary of the 49-A repeating coil are added to the circuit until maximum howler tone is reached, at a half revolution of the selector. At the next step of the selector, the tone is again reduced to a minimum and is built up to a maximum at

the step previous to the return to normal. At this point, a circuit is closed from ground on the SR brush of the selector, break contact of the (SR-1) relay, to battery through the winding of the (SR) relay, which operates. The (SR) and (SR-1) relays lock to ground on the make contact of the (H-1) relay, when the SR arm of the selector switch leaves the last contact. The (SR-1) relay operated, closes in part a circuit from battery through the winding of the (SR-2) relay, make contacts of the (SR-1) relay, to the last contact of the SR arc.

35. The selector moves through the second revolution in the same manner as it does through the first, but when the SR arm reaches the last terminal, a circuit is closed from ground on the SR arm, last contact of the SR arc, make contact of the (SR-1) relay, to battery through the winding of the (SR-2) relay which operates. The (SR-2) relay operated, opens the circuit through the stepping magnet, stopping the selector. The (SR-2) relay operated, also locks to ground on the armature of the (H-1) relay and opens the circuit through the primary windings of the 49-A repeating coil, disconnecting the howler tone. To repeat the operation, the H key must be again operated, opening the circuit in which the (H-1) relay is locked, releasing the relay. The (H-1) relay released, releases the (SR), (SR-1) and (SR-2) relays restoring the circuit to normal.

36. Should the plug be removed from the line at any time while the howler is being applied, the (SS) relay releases, releasing the (A) relay. The (A) relay released, closes a circuit from ground on the armature of the (H-1) relay, to battery through the winding of the (H-2) relay which operates. The (H-2) relay operated locks to ground on the armature of the (H-1) relay under control of the H key and opens a circuit to the primary of the 49-A repeating coil, disconnecting the howler tone from the line. The howler tone will not be reconnected even though the line again becomes crossed and the (SS) and (A) relays re-operate.

37. The selector completes its two revolutions and returns to normal as described above. When the H key is restored to normal, the (H-1), (H-2), and (SR), (SR-1) and (SR-2) relays release. Should the H key be released at any time before the selector has completed its second revolution, the (H-1) relay releases, closing a circuit from ground on its armature, RN brush of the selector, to battery through the winding of the stepping magnet restoring the switch to normal. The (H-1) relay released, also opens a circuit through the primary winding of the 49-A repeating coil disconnecting the howler tone. With the H key reoperated immediately, the howler will not be applied until the RN brush has caused the selector to return to normal as the circuit in which the (H-1) relay operates is opened at the C brush of the selector. This assures a graduated application to the howler tone.

38. The howler can be applied only by means of the secondary test cord as the operation of the howler key (H) disconnects the primary and secondary test cords from the howler circuits.

39. The key marked "X" is used to interchange the primary and secondary test cords with respect to the primary and secondary testing circuits. When the key is in the normal position, the primary test cord is connected to the primary testing circuit and the secondary cord is connected to the secondary test circuit. The operation of the key makes it possible to apply all primary and secondary tests except the third wire test over the secondary cord and all secondary tests except the howler test, over the primary cord.

40. TESTING LINE RELAYS ON COIN PREPAYMENT LINES - "E" WIRING

With the (LRP) key normal, the operation of (3WO) key bridges a 750 ohm retardation coil across the tip and ring of the test cord to operate the line relay, and opens the sleeve lead, preventing operation of the line cut-off relay. When the (LRP) key is then operated, the tip side of the line is opened and a 47-Y retardation coil (2000 ohms) is connected to the ring side of the line, to test the operation of the line relay and coin prepayment line.

41. DIAL TESTER

When it is desired to test only 10 pulse dials, the 50-A dial tester and "V" wiring are used. The (DT) key is operated, disconnecting the tip and ring of the line from the 25-A repeating coil and connecting them to the 50-A dial tester.

42. "U" AND "C1" WIRING

When it is desired to test both 10 and 20 pulse dials, the 51-A dial tester is used. When the dial testing key (DIAL TEST) is operated, (a) ground is connected to the ST lead, operating the start relay in the 51-A dial testing circuit, (b) battery is connected to the HTG lead which causes the dial tester circuit to find this particular position, (c) prepares the circuit for operating the (DT) relay, (d) connects telephone circuit leads "C" and "D" to the tip and ring of the secondary test circuit through to the test keys 10-A, 10-T, 20-A and 20-T, and (e) holds the dial test circuit connected to this particular position. When a dial tester becomes associated with this circuit, ground is connected to the HLD lead, operating the (DT) relay. The (DT) relay operated, disconnects ground and battery from the ST and HTG leads respectively thereby stopping the dial tester circuit from further hunting. The

operation of the 10-T key connects the station loop and secondary test cord through to the dial tester. Operation of the 10-A key performs the same functions as the 10-T key and in addition, it connects battery to the "RJ" lead for the purpose of arranging the dial test circuit for a readjust test. Operation of the 20-T key performs the same function as the 10-T key. In addition it connects ground to the "SP" lead of the dial tester circuit for the purpose of arranging the dial tester to test a 20 pulse dial. Operation of the 20-A key performs the same functions as the 20-T key. It also arranges the dial test circuit for a readjust test of the 20 pulse dial. When the dial test circuit reaches position 4, the operation of a relay in that circuit operates the (M) relay over the HTG lead. The (M) relay operated, closes the monitoring bridge and when the dial tester is in position 5 dial tone is connected to the line. When the dial is operated, the first open will cause the relay in the dial test circuit to release. The (M) relay releases and the monitoring bridge is opened, while the pulses go through. When the dial test circuit reaches position 15, the (M) relay is reoperated in the manner described above and the test tone is heard by the operator at the test desk. If the operator at the test desk desires to talk to the outside station between tests, the test key is restored and the talking key in the secondary test circuit is operated. When the dial test key is released, the circuit is restored to normal.

43. DIAL TESTER "M" WIRING

43.1 Seizure by Dial Tester

When it is desired to associate a 51-A dial tester circuit with the secondary test circuit of a position at the local test desk, the (DIAL TEST) key is operated. The operation of this key connects battery through (HG) 150 ohm resistance to (HG) lead; then connects ground to (ST) lead and ground through the winding of the (DT) relay to (TD) lead. The (DIAL TEST) key is so constructed that battery is connected to (HG) lead before ground is connected to (ST) lead, this is in case a 51-A dial tester circuit is resting on the terminals of the selector associated with this position in order not to move this dial tester off this terminal. Ground on (ST) lead causes the idle 51-A dial tester circuits to hunt for battery through 150 ohms on (HG) lead. When this circuit is found by a dial tester, the selector of the dial tester circuit will stop on the associated terminals and battery from the dial tester circuit over (TD) lead will operate (DT) relay. The operation of (DT) relay opens (ST) and (HG) leads causing other 51-A dial tester circuits to stop hunting, and releasing the hunting relays of the associated dial tester circuit.

43.2 Class of Test - "X1" or "Y1" Wiring

One of the four test keys (LT), (LA), (HT) or (HA), will be operated depending upon the type of test it is desired to make as follows:

43.21 Low Speed Dial Test

When it is desired to test a low speed dial within its test limits, (LT) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "X1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. Both (SP) and (RJ) leads will be open under this condition. When "Y1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead will be open.

43.22 Low Speed Dial Readjust

When it is desired to test a low speed dial within its readjust limits, (LA) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "X1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. (SP) lead will be open and (RJ) lead will be grounded under this condition. When "Y1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead is connected to ground through 5,000 ohms resistance.

43.23 High Speed Dial Test

When it is desired to test a high speed dial within its test limits, (HT) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "X1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. (SP) lead will be grounded and (RJ) lead will be open under this condition. When "Y1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead is connected to 48 volt battery.

43.24 High Speed Dial Readjust

When it is desired to test a high speed dial within its readjust limits, (HA) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "X1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. Both (SP) and (RJ) leads will be grounded under this condition. When "Y1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead is grounded.

43.3 Dial Tone

When the 51-A dial tester circuit is ready to make a dial test, the regular dial tone will be sent out over the ring of the line where "X1" wiring is used or the tip of the line where "Y1" wiring is used and battery will be connected to (HL) lead operating (M) relay closing the monitoring circuit through (DIAL TEST) key and leads (d) and (e) to the telephone circuit at the local test desk. The dial tone is audible at the station under test and at the local test desk. With the circuit in this condition, the maintenance man or subscriber at the station under test may talk to the attendant at the local test desk, but the attendant cannot be heard at the station under test. When the dial tone is heard zero should be dialed. When the (L) relay in the 51-A dial tester circuit releases on the first pulse the battery is disconnected from (HL) lead releasing (M) relay opening the monitoring circuit. The purpose of this is to prevent dial clicks in the attendant's ear and to remove the capacity bridge which might interfere with pulsing.

43.4 Dial Testers Busy Lamp "Z1" Wiring

If all the dial tester circuits are busy, a chain circuit is closed through contacts of relays in the dial tester circuits which lights the (DT-BY) lamps which are multipled to all the positions of the test desk arranged to use the 51 type dial tester.

44. DIAL TESTER "U" & "D1" WIRING

SEIZURE BY DIAL TESTER

When it is desired to associate a 51 type dial tester circuit with the secondary test circuit of a position at the local test desk, the

(DIAL TEST) key is operated. The operation of this key connects battery through (HG) 150 ohm resistance to (HTG) lead; then connects ground to (ST) lead and ground through the winding of (DT) relay to (TD) lead. The (DIAL TEST) key is so constructed that battery is connected to (HTG) lead before ground is connected to (ST) lead, this is in case a 51 type dial tester circuit is resting on the terminals of the selector associated with this position in order not to move this dial tester off this terminal. Ground on (ST) lead causes the idle 51 type dial tester circuits to hunt for battery through 150 ohms on (HTG) lead. When this circuit is found by a dial tester, the selector of the dial tester circuit will stop on the associated terminals and battery from the dial tester circuit over (TD) lead will operate (DT) relay. The operation of (DT) relay opens (ST) and (HTG) leads causing other 51 type dial tester circuits to stop hunting, and releasing the hunting relays of the associated dial tester circuit.

44.1 Class of Test - "C1" or "D1" Wiring

One of the four test keys (LT), (LA), (HT), or (HA), will be operated depending upon the type of test it is desired to make as follows:

44.11 Low Speed Dial Test

When it is desired to test a low speed dial within its test limits, (LT) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "C1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. Both (SP) and (RJ) leads will be open under this condition. When "D1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead will be open.

44.12 Low Speed Dial Readjust

When it is desired to test a low speed dial within its readjust limits, (LA) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "C1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. (SP) lead will be open and (RJ) lead will be grounded under this condition. When "D1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead is connected to ground through 5,000 ohms resistance.

44.13 High Speed Dial Test

When it is desired to test a high speed dial within its test limits, (HT) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "C1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. (SP) lead will be grounded and (RJ) lead will be open under this condition. When "D1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead is connected to 48 volt battery.

44.14 High Speed Dial Readjust

When it is desired to test a high speed dial within its readjust limits, (HA) key is operated. The (f) lead is grounded operating a relay in the telephone circuit to close the secondary of the monitoring circuit. When "C1" wiring is used the ring conductor is cut through to the selector of the dial tester circuit and the tip conductor is grounded at the dial tester circuit. Both (SP) and (RJ) leads will be grounded under this condition. When "D1" wiring is used the tip and ring conductors are cut through to the dial tester circuit and the (SP) lead is grounded.

44.2 Dial Tone

When the 51 type dial tester circuit is ready to make a dial test, the regular dial tone will be sent out over the ring of the line where "C1" wiring is used or the tip of the line where "D1" wiring is used and battery will be connected to (HL) lead, operating (M) relay, closing the monitoring circuit through (DIAL TEST) key and leads (d) and (e) to the telephone circuit at the local test desk. The dial tone is audible at the station under test and at the local test desk. With the circuit in this condition, the maintenance man or subscriber at the station under test may talk to the attendant at the local test desk, but the attendant cannot be heard at the station under test. When the dial tone is heard zero should be dialed. When the (L) relay in the 51 type dial tester circuit releases on the first pulse the battery is disconnected from (HL) lead releasing (M) relay opening the monitoring circuit. The purpose of this is to prevent dial clicks in the attendant's ear and to remove the capacity bridge which might interfere with pulsing.

44.3 All Dial Testers Busy Lamp

If all the dial tester circuits are busy, a chain circuit is closed through contacts of relays in the dial tester circuits which lights the (DT-BY) lamps which are multipled to all the positions of the test desk arranged to use the 51 type dial tester.

45. TEST TONE

At the completion of the tenth pulse a tone is connected to the line and (HL) and battery will be connected to (HL) lead operating (M) relay, again closing the monitoring circuit through (DIAL TEST) key and leads (d) and (e) to the telephone circuit at the local test desk. Distinctive tones indicating a too fast, O.K. or too slow condition will be audible at the station under test and at the local test desk. With the circuit in this condition, the maintenance man or subscriber at the station under test may talk to the attendant at the local test desk, but the attendant cannot be heard at the station under test.

46. REPEAT TESTS

When the distinctive tone indicating the speed condition of the dial is audible, the 51-A dial tester circuit will be restored to normal by the station under test disconnecting or by restoring the operated test key (LT), (LA), (HT) or (HA). On restoring to normal the tone is disconnected and battery is removed from (HL) lead, releasing (M) relay, in turn opening the monitoring circuit at the local test desk. Provided (DIAL TEST) key is not restored to normal, the 51-A dial tester circuit will remain associated with the position of the local test desk. If, after sufficient time for the relays in the 51-A Dial Tester Circuit to release, the station under test is again bridged across the line or if, in the case where the station remained bridged across the line, a test key is operated, the 51-A Dial Tester Circuit will prepare to make another test, and when ready will connect the regular dial tone to the ring and close the monitoring circuit in the same manner as for the first test.

47. TALKING TO TEST DESK ATTENDANT

With all the test keys (LT), (LA), (HT) and (HA) normal, a talking circuit may be established between the local test desk and the station under test. This feature permits the attendant at the local test desk to talk with the station between tests.

48. DISCONNECTION

When the (DIAL TEST) key is restored to normal the circuit over (TD) lead is broken. The associated 51-A Dial Tester Circuit will not be disassociated, however, even with this key normal unless all the test keys are normal or the station under test has disconnected. With the test keys normal or with the station under test disconnected the Dial Tester Circuit will be released when (DIAL TEST) key is restored to normal.

49. TESTING THRU TOLL SWITCHBOARDS #3 "B1 WIRING"

When testing thru a #3 toll switchboard, the "PRI TOLL 3" key or the "SEC. TOLL 3" key is operated depending on whether the primary or secondary test cord is used. With the key operated, the cord sleeve will be connected to the (TP-3) or (TS-3) relay which will operate over a rated resistance of 1800 ohms. When the (TP3) or (TS3) relay operates, a 100 ohm ground is connected to the (PTC) or (STC) relay, which operates and cuts the tip and ring thru for testing.