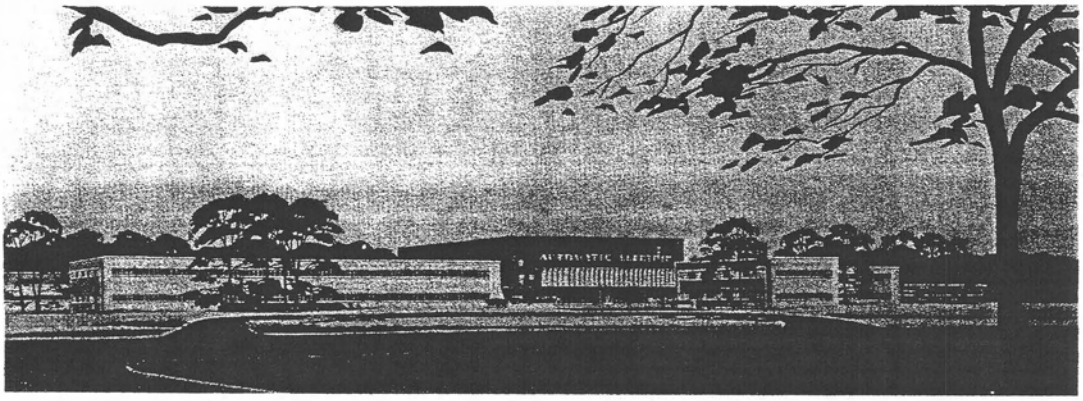
TEST TURRET TYPE 21

Technical bulletin 405

AUTOMATIC ELECTRIC

ORIGINATORS OF THE DIAL TELEPHONE



New factory, development laboratories, and general office at Northlake, Illinois, U.S.A.

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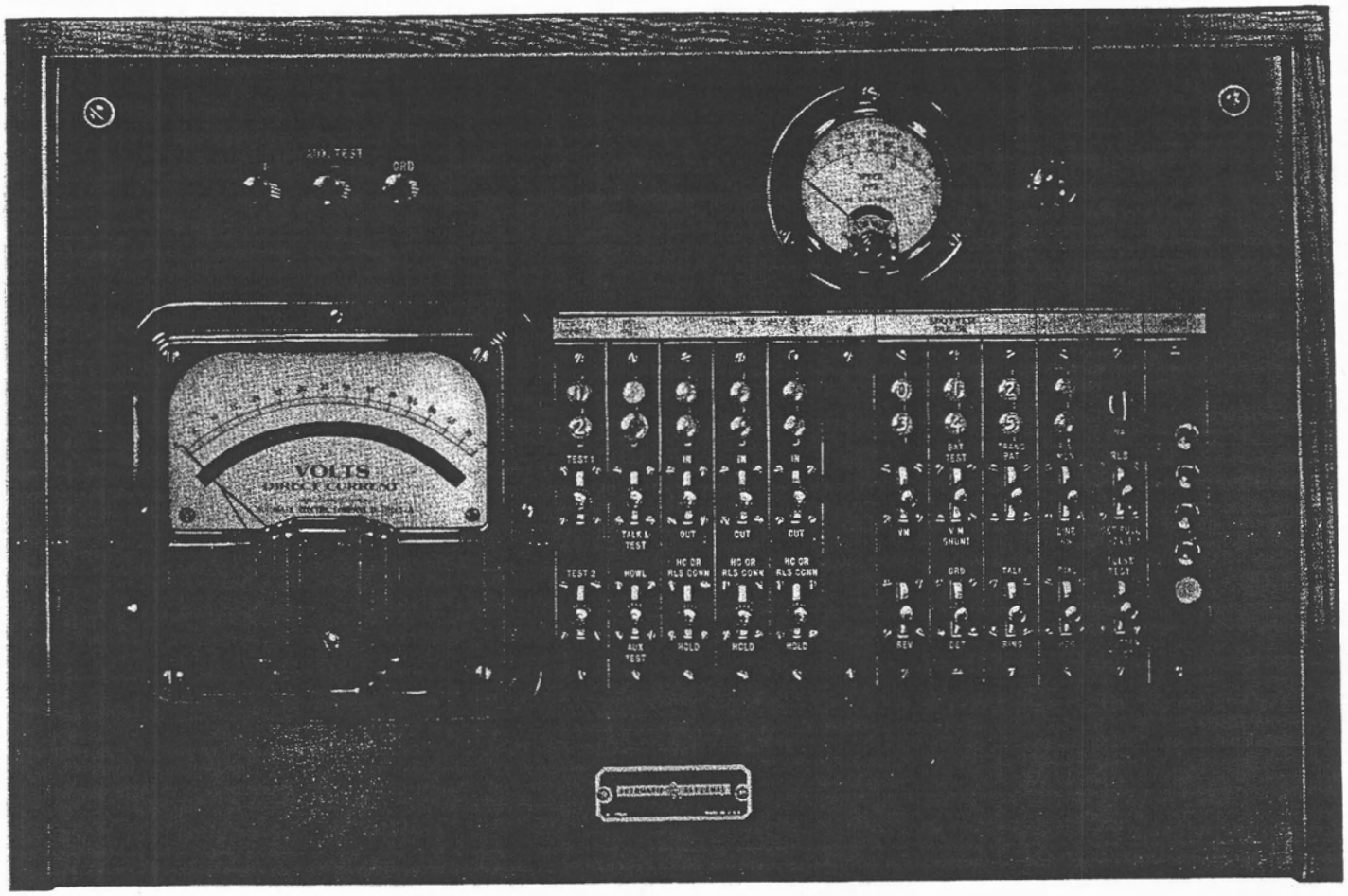

Type 21 Test Turret

TEST TURRET
TYPE 21

1. INTRODUCTION

The type 21 test turret is designed for making the tests required for maintaining small automatic exchanges. It is effectively used in exchanges of 1000 lines or less, or in P-A-Xs of any size.

The attendant's operations of the turret consist of operating panel controls and evaluating the results. Visual aids, such as supervisory lamps and meters, assist the attendant in making tests.

The manipulation of panel-controls and the explanation of electrical operation are included in this text. The tests that are normally used are described and the explanation of operation will enable the test attendant to improvise additional tests.

2. DESCRIPTION

2.1 General design. The type 21 test turret consists of a cabinet for housing the equipment, and a chassis containing the apparatus and wiring.

The cabinet is ordinarily made of mahogany with a dark finish, other woods and finishes can be furnished on special order. The cabinet size is 14-1/2'' high, 21-1/2'' long, and 14-5/8'' deep. It may be mounted on an office desk or table. It weighs 66 pounds.

The test turret components are assembled to provide easy access to the wiring and apparatus. The relays are mounted upon a swinging gate. With the gate swung open the rear wiring is accessible on either side and the rear of the front panel may be easily reached. External cable enters through a hole in the baseboard and passes to a terminal block where it will be connected to the test circuit.

2.2 Test facilities

2.2.1 Test cords. The test turret can be equipped for two trunks to a manual board. At the manual equipment, these trunks terminate at test cords or test jacks. These trunks are available for making various tests through the switchboard.

2.2.2 Selector level trunk (inspector's trunk). The turret is equipped with one inspector's trunk incoming from a selector level, which provides the means for inspectors, installers, and repairmen, to dial in and talk with the test attendant, and also provides the attendant

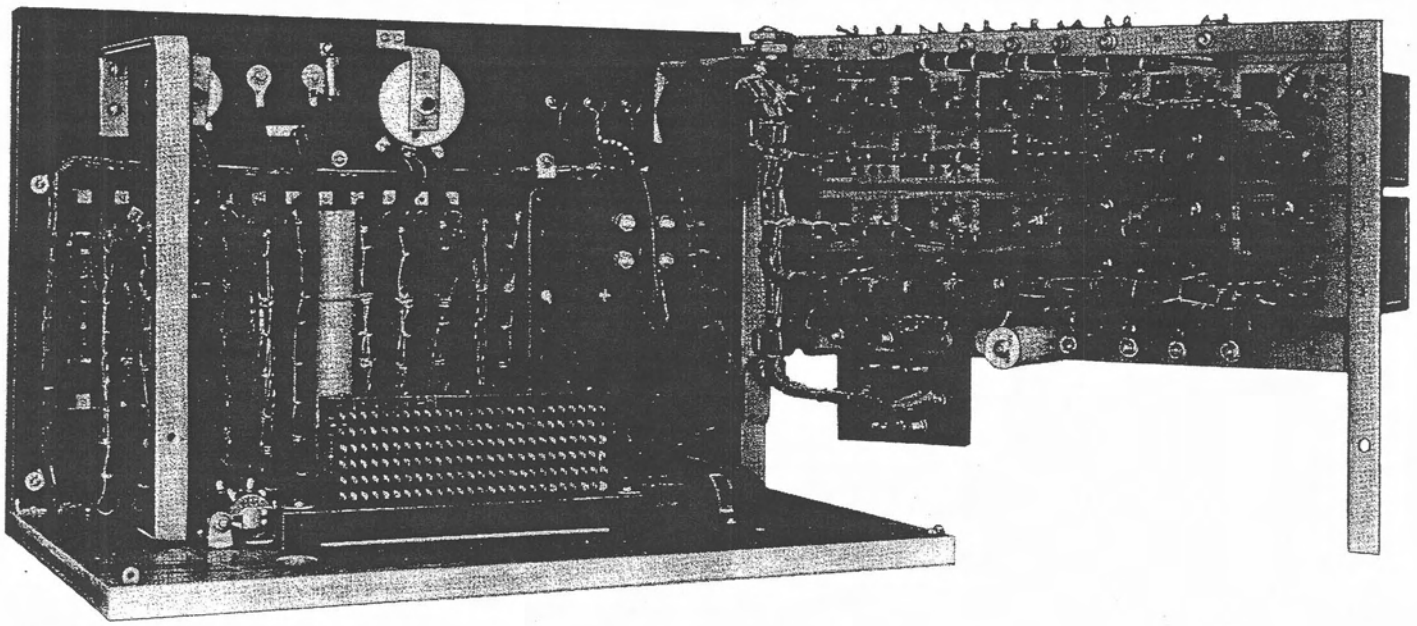

Figure 1. Turret wiring.

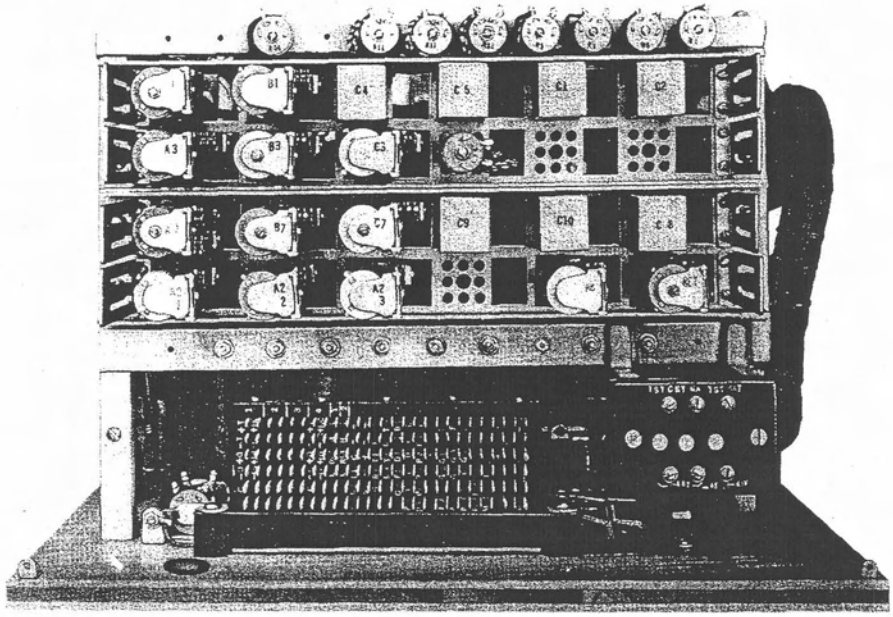

Figure 2. Type 21 test turret, rear view (cabinet removed).

with connections for test purposes. The trunk is cleared of attachments and is connected to the test circuit for making tests when the attendant answers.

2.2.3 Trunks to Main Distributing Frame or test distributor. The test turret is wired and may be equipped with facilities for four trunks to the M.D.F. and/or test distributors.

2.2.3.1 Trunks to Main Distributing Frame (figure 3). Ordinarily, it is desirable to have at least one trunk to the M.D.F., to establish connections which cannot be established via the test switch train, and for performing special or routine tests, without tying up the switch train. For example, test connections to trunk lines for making meter measurements, cannot be obtained through the test switch train, because the test connectors have access only to the line terminals. Connections to trunk lines, however, are easily made via the M.D.F. with a test shoe.

At the M.D.F. provision is made for connecting a test shoe to the trunk. The test shoe splits the inside plant from the outside plant, permitting tests to be made on either the inside or outside.

2.2.3.2 Trunks to test distributor. This trunk gives the testman access to the test switch train via the test distributor. By means of the test switch train the testman has access to and can test through the connector terminals of local lines.

2.2.4 Voltmeter. The test turret is equipped with a 0-75 volt direct current voltmeter of 100,000 ohms (Ω) internal resistance, for making tests on outside cable pairs.

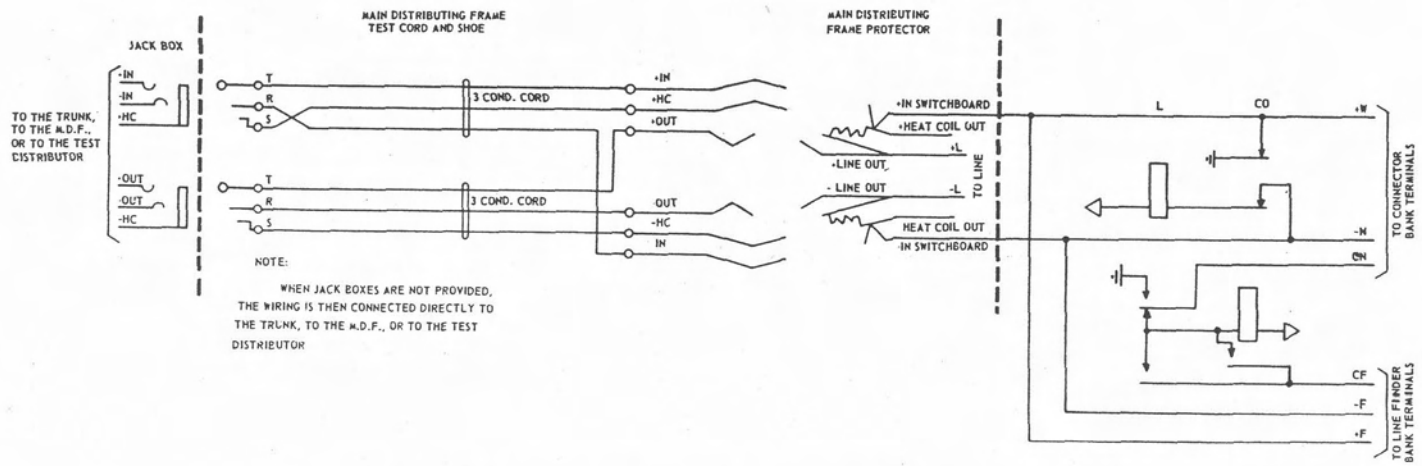

Figure 3. Connection of jackbox to Main Distributing Frame.

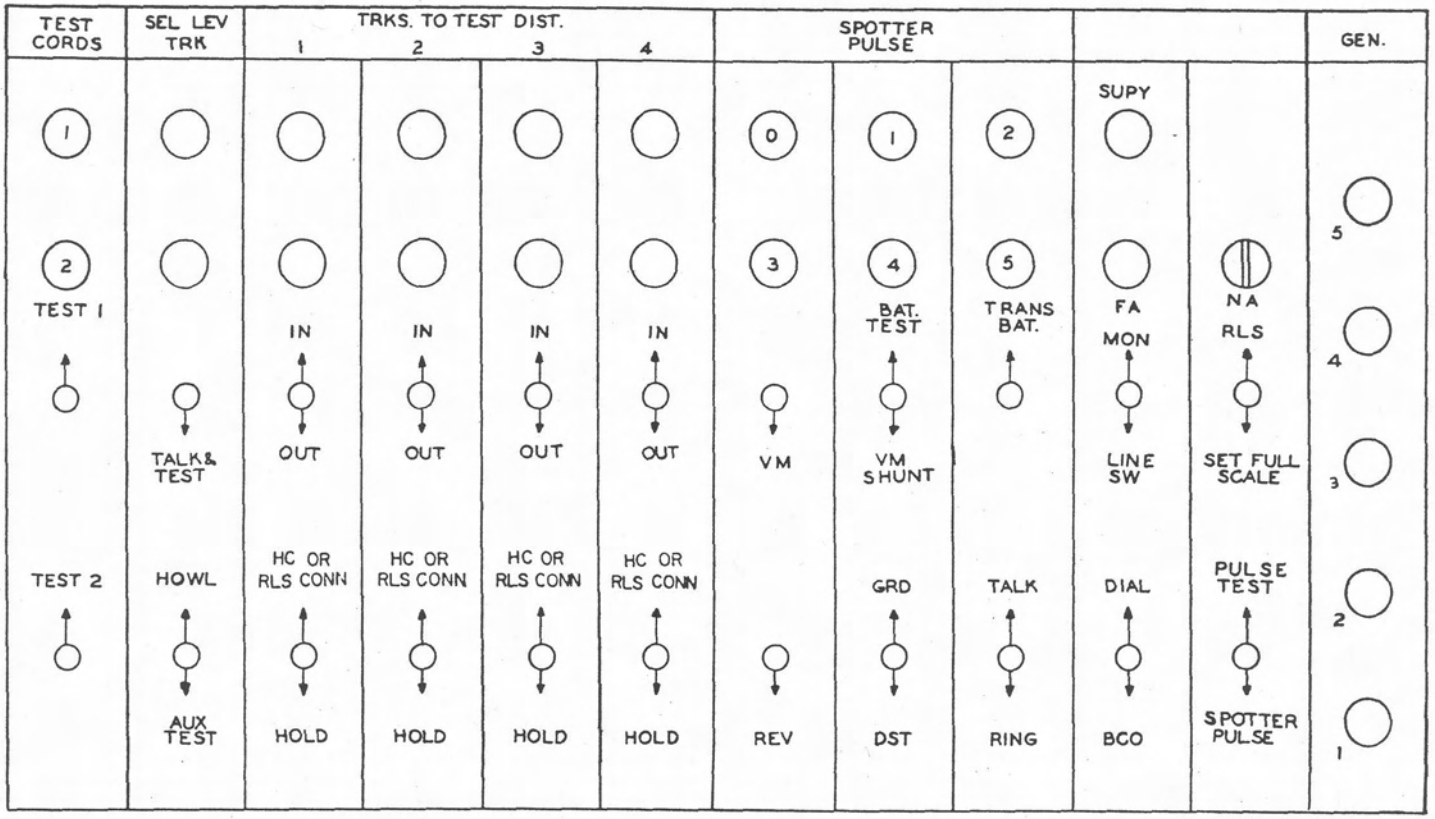

Figure 4. Key mounting and designations.

2.2.5 Auxiliary test. The AUX TEST key and AUX TEST binding post on the turret panel, provide for making voltmeter, dial speed, talking and ringing tests at the turret. Telephones and other apparatus may be tested, when brought to the turret location.

2.2.6 Dial test facilities. The test turret provides means for measuring dial pulse speed and percent make.

2.2.7 Testing of ringers. Five push-key switches are compactly mounted on one key escutcheon, for selecting the desired ringing frequency to be applied to the line for signaling.

2.3 Optional test equipment

2.3.1 Howler. The howler provides an effective means for attracting the attention of a subscriber, to a handset which was not returned to its cradle.

2.3.2 SATT. When Strowger Automatic Toll Ticketing dials are used, a spotter pulse test permits checking party identifying features.

2.4 Alarms

2.4.1 Night alarm. The night alarm is an audible signal provided with the test turret, that sounds when any of its lamps are lighted.

2.4.2 Fuse alarm. The fuse alarm provides supervision over the battery power supply.

2.5 Keys. All test circuits are key ended. Keys are assembled to flush-mounted escutcheons, located on the turret's panel. Each key is individually mounted, providing for its easy removal from the front of the turret when desired. For key positions on the test turret see figure 4.

NOTE: Key escutcheon identifications are purposely capitalized in the text discussions, as they appear on the turret panel. These items are treated in the order they appear on the panel, starting from top to bottom, and left to right.

2.5.1 TEST 1 and TEST 2. Supervisory lamps are associated with trunks to the manual switchboard. Such trunks are shown on the key panel designation strip as TEST CORDS, and marked TEST 1 and TEST 2 on the key escutcheon above the respective keys. The lighting of one of these supervisory lamps indicates that its cord is plugged into the jack of either a line, or a trunk at the switchboard. This lamp is extinguished when the corresponding test key is operated to connect the test circuit to the trunk. When the test attendant releases the connection first, the lamp relights, until the test cord is taken down by the switchboard operator.

2.5.2 TALK & TEST. When the TALK & TEST key is operated in response to a lighted trunk and answer lamp, it connects an inspector's trunk from a selector level, to the key panel for making tests.

2.5.3 HOWL. The operation of the HOWL key connects the test circuit to the "howler". The howler is not part of the turret; it is furnished only when ordered separately. A tone produced by the howler attracts the attention of a subscriber to a handset which was not returned to its cradle switch.

2.5.4 AUX TEST. Binding posts located on the upper left corner of the turret panel, marked AUX TEST, +, -, and G (ground), provide convenient terminals for connecting external equipment to the testing turret, such as an ohmmeter, transmission measuring set, Wheatstone bridge, etc. Whatever is connected to these binding posts, is connected in the testing circuit, when the AUX TEST (auxiliary test) key is operated.

2.5.5 IN. When the IN key is operated, it divides the line under test by separating the IN and OUT leads. The outside line is disconnected and the inside (switchboard end) circuit is extended to the key panel for the performance of tests.

2.5.6 OUT. When the OUT key is operated, it divides the line under test by separating the IN and OUT leads. The inside (or switchboard) end of the circuit is disconnected and shorted, and the outside line is extended to the key panel for the performance of tests.

2.5.7 HC or RLS CONN. When testing lines are plugged up at the M.D.F., the operation of the HC or RLS CONN (heat coil or release connector) key extends the heat coils to the key panel for the performance of tests for open heat coils.

When groups of subscriber's lines are tested via the test distributor and test connectors, the operation of this HC or RLS CONN key releases a test connector from one level of bank terminals, to permit the selection of another level which is under control of the test attendant's dial.

2.5.8 HOLD. When the HOLD key is operated, it enables the test attendant to hold a line that is connected to the test turret for testing. The attendant is then free to perform other duties, or make tests on other lines. This feature is desirable whenever time is required for an inspector to make other line tests or adjustments, until the held line is again ready to be tested at the turret. The inspector at a subscriber's station can flash the station attendant without losing the connection, when the HOLD key is operated.

2.5.9 VM. The voltmeter is normally without battery. Operation of the VM (voltmeter) key connects the meter across the + and - terminals.

2.5.10 REV. The REV key is used for reversing polarity (+ and -) of the connections from either line or trunk under test, to the key panel. This key is used when making voltmeter tests for foreign voltage on the Tip (or +) side of the line, capacitance across the line, divided ringing, or testing for ground.

2.5.11 BAT TEST. The operation of the BAT TEST (battery test) key permits the operator to check the battery voltage.

2.5.12 VM SHUNT. The operation of the VM SHUNT (voltmeter shunt) places a shunt across the voltmeter. The tables on pages 17 and 18 provide resistance values for the corresponding voltmeter deflections. TABLE I provides resistance values for meter needle deflections, without an external voltmeter shunt. TABLE II provides resistance values with the shunt connected across the voltmeter.

2.5.13 GRD. The operation of the GRD (ground) key, grounds the voltmeter testing circuit when checking faults.

2.5.14 DST. The DST (dial speed test) key is operated when testing dial speeds over lines under test.

2.5.15 TRANS BAT. When the TRANS BAT (transmission battery) key is operated, transmission battery is furnished to the telephone of an inspector, installer, or subscriber outside the exchange on connections which do not get battery from a switch train.

2.5.16 TALK. When the TALK key is operated, voice transmission battery is furnished to the test circuit telephone, and connects it through a capacitance bridge to the outside line or trunk. When both the TALK key and the MON key are operated, the test attendant may monitor the line.

2.5.17 RING. When the RING key is operated, ringing current is connected to a line or trunk, permitting the test attendant to signal a subscriber, recall an inspector, installer, etc.

2.5.18 MON. The operation of the MON key allows the test attendant to monitor a line under test, to verify whether the line is busy or idle, check subscriber dialing, and the quality of transmission, etc. When this MON key is used in conjunction with the TALK key, the transmission battery for the attendant's

telephone is disconnected during monitoring, to keep the background noise at a minimum.

2.5.19 LINE SW. The operation of the LINE SW (line switch) key connects the test attendant's telephone to the assigned line either for answering calls from the test position, or for originating outgoing calls from the test position through the regular exchange switch train. The LINE SW key remains normal during tests on lines and trunks.

2.5.20 DIAL. When the DIAL key is operated (OUT key also operated) it will connect a trunk to the test distributor through to the test telephone.

2.5.21 BCO. The operation of the BCO (bridge cut-off) key permits testing the operation of the line relay. With the BCO and TALK keys operated, the test attendant's telephone is connected to the line for dialing into the exchange.

2.5.22 NA. The NA (night alarm) turn-key is used to prepare an audible signal whenever a supervisory lamp is not visible to the test attendant.

2.5.23 RLS. The RLS (release) key has no application with ordinary dialing. This key is only used with SATT dials. This key has its momentary use in party identity tests.

2.5.24 SET FULL SCALE. Before using the milliammeter scale for speed and ratio tests, the meter scale should be set for full scale reading by operating the non-locking key marked SET FULL SCALE, and adjusting the rheostat designated SET FULL SCALE.

2.5.25 PULSE TEST. The PULSE TEST key is operated while making pulse ratio tests. The pulse is not the pulse ratio of the dial itself, but only as it is repeated over the telephone line.

2.5.26 SPOTTER PULSE. The SPOTTER PULSE key is provided when SATT dials are used. This key is then operated, when making dial speed and party identity tests.

2.6 Lamps

2.6.1 Test cord. A white supervisory lamp is associated with each of two trunks to the manual switchboard, designated TEST CORDS on the turret panel. The lighting of one of these lamps indicates that the plug of an associated test cord is plugged into the jack of a line or trunk at the switchboard. The lamp restores when the test attendant operates the associated TEST key, to connect the circuit to that trunk. When the test connection is released by the test attendant, the lamp relights and will remain lighted until the test cord is removed by the switchboard operator.

2.6.2 Selector level trunk. A white supervisory lamp is associated with the inspector's trunk from a selector level, marked SEL LEV TRK on the designation strip. This answering lamp indicates to the test attendant that a call has been made over this trunk. The lamp will flash on a recall signal to the test attendant and is under the control of the cradle switch at the calling station (TALK & TEST key restored).

2.6.3 Test switch train. A white supervisory lamp is common to the two or more trunks to the test switch train. The lamp lights when a busy test connector or a busy called line is found on an outgoing call, established by dialing through a test distributor, or when a busy line is encountered during routine testing of all lines of a test connector.

2.6.4 Hold. A green lamp is provided for each trunk to the M.D.F. or test switch train, designated TRKS. TO TEST DIST. on the key panel. When the test attendant operates the HOLD key of a test trunk, the associated "hold" lamp lights. This lamp also flashes on a recall to the test attendant under control of the telephone's cradle switch.

2.6.5 Busy lamp. A red lamp is provided for each trunk to the test switch train, when the test distributors or test connectors are multipled to other test positions. The lamp lights at all multipled positions, when the trunk to the test switch is busy.

2.6.6 Office fuse. A red fuse lamp lights when the office fuse blows.

2.6.7 SATT lamps. Numbered lamp caps for checking the party identifying feature of SATT dials, are treated in §4.9.3.

3. PROCEDURE OF OPERATION

3.1 Regular line equipment

3.1.1 Incoming (terminating call). When the test circuit number is dialed the extension ringer rings. The testman operates the LINE SW key and removes the handset of the test telephone. Conversation may now take place. To release the connection restore the LINE SW key and replace the handset.

3.1.2 Outgoing (originating). To make an outgoing call remove the handset and operate the LINE SW key. When dial tone is heard, proceed dialing as with a normal call. To release the connection, restore the LINE SW key and replace the handset.

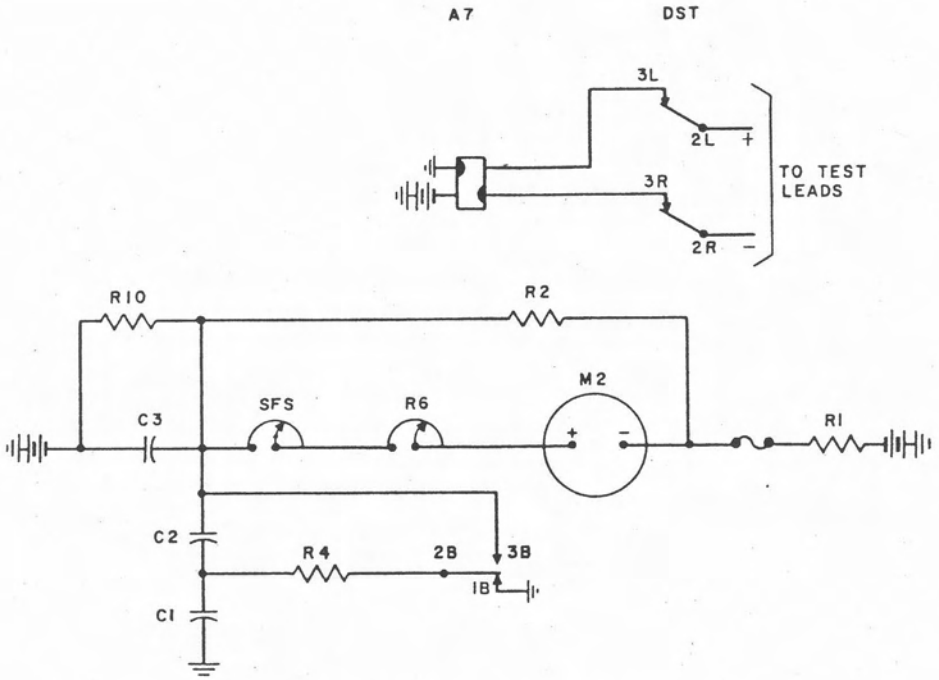

Figure 5. Dial speed test.

3.2 Inspector's trunk

3.2.1 Incoming call (terminating). *NOTE: It is impossible to call out.* When the test number has been dialed a white supervisory lamp will light over the proper TALK & TEST key. Operate this key, the TRANS BAT key and the TALK key. Remove the handset and conversation may now take place.

3.2.2 Re-ring (ringer test). Do not perform re-ring until the other party has hung up. Operate the RING key periodically. Ringing current is on the line at all times when the RING key is operated, making it necessary for the attendant to listen for the called party's answering during the silent period.

3.2.2.1 Frequency ringing (bridged 5 pty). Operate the proper ring push button designated 1, 2, 3, 4, or 5 under GEN on the turret panel and then operate the RING key periodically. Listen for the called party to answer.

3.2.2.2 Frequency ringing (bridged 10 pty, 1 & 2 ring). Differing from §3.2.2.1 in that the RING key may have to be manually operated to secure the proper code.

3.2.2.3 Frequency ringing (divided). As in normal frequency ringing except REV key may have to be operated to secure the proper side of the line.

3.2.2.4 Code ringing. Operate and restore the RING key manually, thus obtaining the proper code.

3.2.2.5 Superimposed ringing (bridged 1 & 2 pty). Operate the proper ring push button designated 1, 2, 3, 4, or 5 under GEN on the turret panel and then operate the RING key. Reoperate the TALK & TEST key.

3.2.2.6 Superimposed ringing (4 pty divided). Differing from §3.2.2.5 in that the REV key may have to be operated to obtain the proper side of the line.

3.2.3 Dial tests

3.2.3.1 Dial speed test. Refer to figure 5. Adjust the dial test set. Operate the SET FULL SCALE key and adjust the SET FULL SCALE rheostat. Restore the SET FULL SCALE key and operate the DST key. It is now possible to give instruction to the testman for dialing. Read the milliammeter and give the testman the results. Repeat the test as necessary.

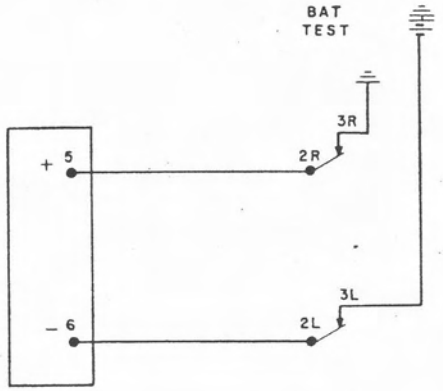

Figure 6. Exchange battery test.

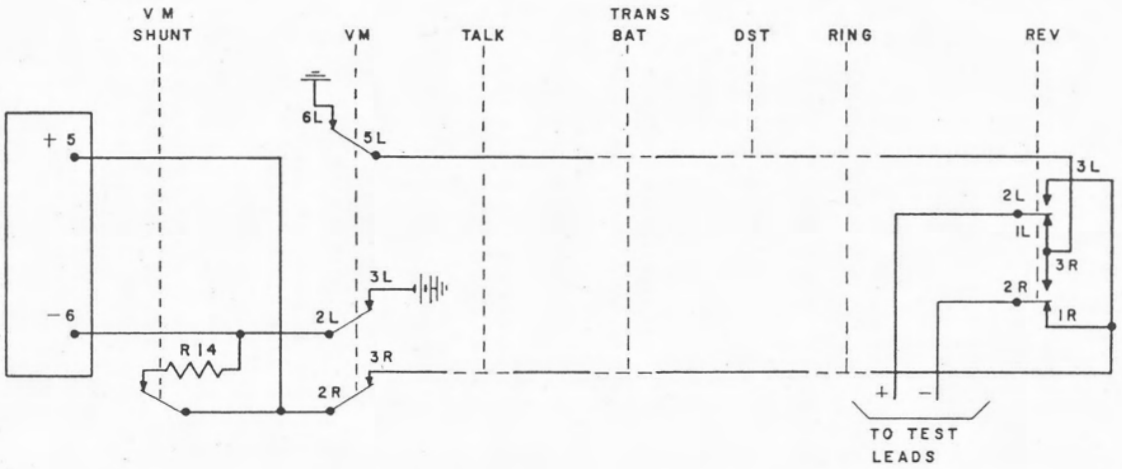

Figure 7. Test of loop resistance.

3.2.3.2 Pulse ratio test. The turret is set by the testman the same as for speed test except the PULSE TEST key is operated.

NOTE: This is a line condition test. If the dial is out of adjustment, replace it. To test the dial bring it to the test turret and use the auxiliary test circuit (connect to AUX TEST binding posts).

3.3. Test distributor. Check the white busy lamp, if this is not lighted, proceed. Operate the OUT key and operate the DIAL key. Remove the handset and dial the number of the line to be tested. Restore the DIAL key. If the called line is busy the SUPY lamp will light. Operate the MON key to monitor or operate the TALK key if operator wishes to talk to the testman.

3.4 Voltmeter tests. Make connection to the proper line to be tested and operate the OUT key. Read the meter or if the needle is deflected below zero operate the REV key to reverse the polarity, allowing a meter reading.

3.4.1 Checking polarity on line or trunk. Refer to figure 6. Measure the battery voltage by operating the BAT TEST key and reading the meter. Note the voltage and restore the BAT TEST key.

3.4.2 Checking loop resistance. Refer to figure 7. Operate the OUT key and the VM key. Note the voltage on the meter and find approximate resistance from table in rear. If less than 45,000, operate the VM SHUNT key and read the meter, noting the voltage. Find the resistance from TABLE II. If the battery voltage does not appear in the table, resistance may be calculated from the following formula: $X = R\ (E - V) / V$; where X is the resistance of the loop, E equals the test battery voltage, R equals the internal resistance of the voltmeter (100,000Ω) and V is the voltmeter reading. With the VM SHUNT key operated, the value of R will be 1000Ω.

3.4.3 Test for ground. Refer to figure 8. Operate the OUT key and the VM key. Then

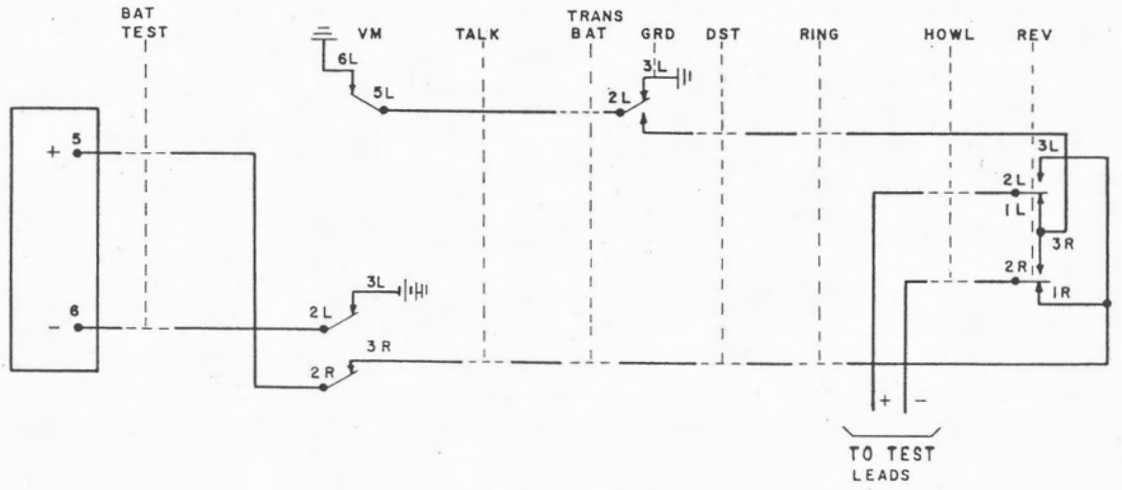

Figure 8. Test for ground (negative side of line).

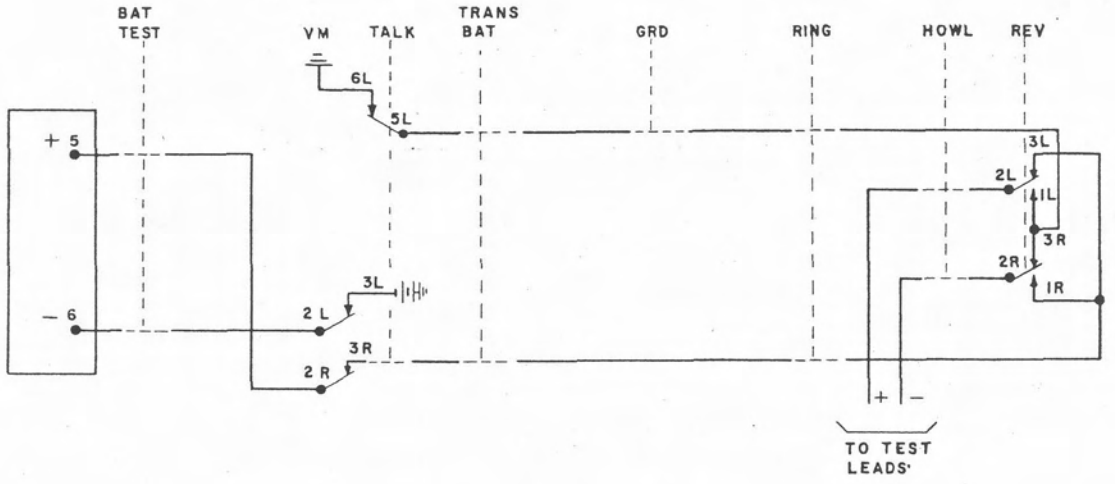

Figure 9. Test for open line.

operate the GRD key and observe the meter for deflection. To test positive side for ground, operate the REV key.

3.4.4 Test for open (using ringer capacitance). Refer to figure 9. Operate the OUT key and the VM key. Operate the REV key and observe the meter deflection. Restore the REV key and if the line is not open there should be a meter deflection.

3.4.5 Test for foreign potential. Refer to figure 10. To test on the negative side of the line operate the OUT key and the GRD key and observe the meter deflection. To test on the positive side of the line operate the OUT key, the GRD key, and the REV key. The voltmeter reading shows the presence of a foreign potential.

3.5 Testing line circuit over test lines

3.5.1 Through test distributor. Dial the line to be tested through the test switch train. Operate the BCO key and the TALK key. Dial tone should be heard.

3.5.2 Through M.D.F. trunks (jackbox). The OUT key is restored. Operate the IN, TALK, and BCO keys. Dial as on a normal call. To release, restore the TALK key.

3.5.3 Monitoring while the subscriber dials

3.5.3.1 Test distributor. Seize the test switch train. Operate the TALK and TRANS BAT keys. Ring and instruct the subscriber. Just before the subscriber dials, restore the TRANS BAT key to prevent interference with dialing and operate and then restore BCO key. The subscriber will dial.

3.5.3.2 M.D.F. Operate the OUT key, the TALK key, and the TRANS BAT key in that order. After instructions are given to the subscriber, restore the OUT and TRANS BAT keys and operate the HC or RLS CONN key. To release, restore the HC or RLS CONN key.

3.5.4 Test of heat coils. To test the heat coils operate the HC or RLS CONN key and the BCO key. Upon operating the TALK key

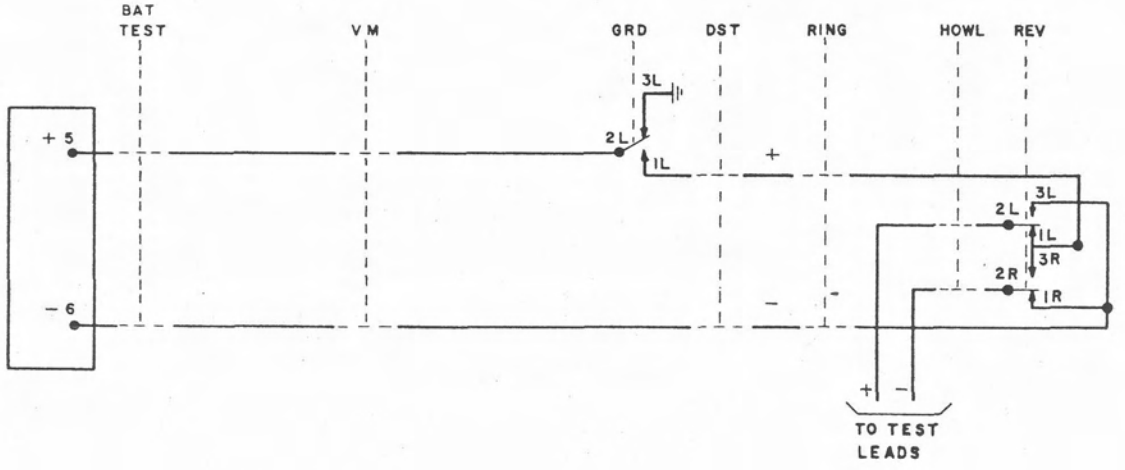

Figure 10. Test for negative foreign potential (negative side of line).

dial tone should be heard. If dial tone is not heard the heat coils are open.

3.5.5 Line test of a test connector. When all the lines of a test connector are to be tested, the operator dials the connector. Dialing 11 and then making his tests on 11, then dialing 1 and making tests on 12. Continue until through testing all lines on this level. When tests on one level have been completed, operate the HC or RLS CONN key and then restore it. Dial 21 and test all lines on this level and so on.

3.5.6 Permanent line release. Operate the OUT and DIAL keys, dial the directory number of the subscriber and monitor the line. If line is busy but is not being used, restore the DIAL key. Operate the BCO key. If supy lamp I 19 is not restored, the permanent line release circuit is not able to shunt down the operated relay and the equipment will have to be released manually.

3.6 Miscellaneous tests

3.6.1 Howler. First operate the OUT key, then operate the MON key to determine whether anyone is on the line. Operate the HOWL key to signal the subscriber to replace the handset.

3.6.2 Postpay paystations. The call will be received from the testman at the paystation over the inspector's trunk. Conversation takes place. Operate the REV key to reverse polarity and cause transmission block at the paystation. (For further details on testing paystations, see Automatic Electric Company's technical bulletin 702-82 or 702-86.)

3.6.3 Auxiliary spotter dial test. The turret is equipped with part of the equipment needed for performing SATT identity tests; however, to actually perform the tests, auxiliary test circuits are needed. For details on 5 spotter identification, see Automatic Electric drawing H-85295 and circuit explanation E-85295 or figure 13 of H-85275 with related explanation.

3.6.4 Loop compensator adjustment. The following test is for those telephones that are equipped with a variable loop compensator.

The testman will place his call on the inspector's trunk to the test attendant. Supy lamp I 3 will light. The test attendant will operate the TALK & TEST, TRANS BAT, and TALK keys. Conversation may now take place.

If the testman requests a line voltage measurement, the test attendant will connect the voltmeter across the loop that is held up by relay A3 in the inspector's trunk circuit. If the voltmeter needle is not deflected, the polarity is reversed to it. The REV key will have to be operated.

Read the voltage and recall the testman and inform him of the results.

If the testman requests a line resistance reading, the connection to the loop is the same. The OUT key is operated and the BAT TEST key is operated to find the exchange battery voltage. The VM SHUNT key is operated and the BAT TEST key is restored. Note the voltage and find the resistance from the table. If the resistance is not listed in the table, use the formula of §3.4.2.

NOTE: For more information on adjusting loop compensator, see Automatic Electric Company's installation handbooks on the type 80 series telephone.

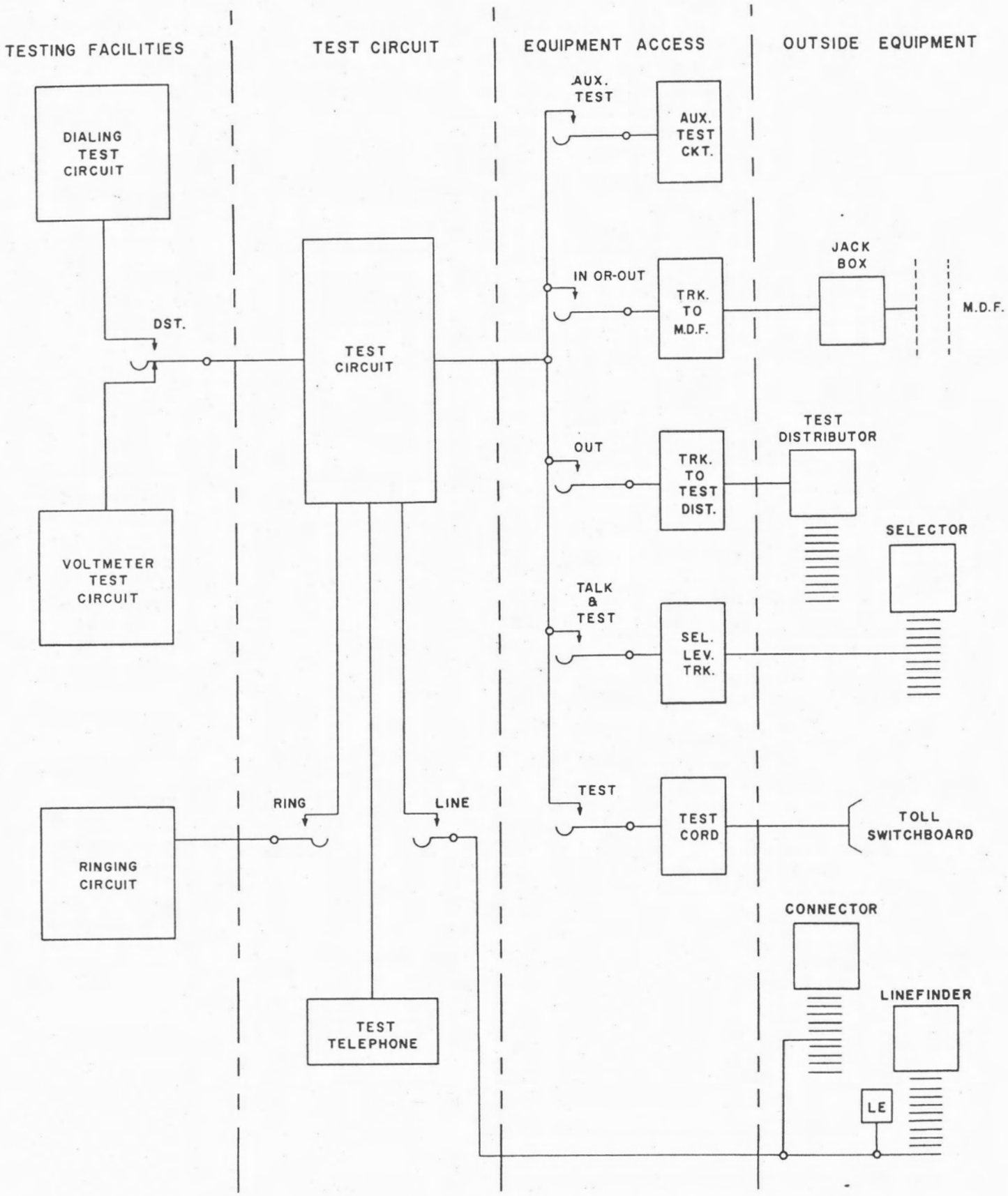

Figure 11. Block diagram of type 21 circuit arrangements.

4. EXPLANATION OF OPERATION

4.1 General. The block diagram (figure 11) shows the test turret divided into four sections.

The section labled "Testing facilities" is the section of the circuitry that sets up various conditions for the test that is to be performed and shows the results of the tests to the test attendant.

The "Test circuit" section, through the use of the keys associated with it, will enable the test attendant to control the condition of the test leads entering the testing facilities and also enable the testing facilities to reach outside equipment.

Regular line equipment has access to the test circuit making it possible for the test attendant to receive and make calls as a regular subscriber.

The "Equipment access" section, by the operation of the keys shown associated with each trunk, will both seize the outside equipment and connect the line or trunk to be tested through to the test circuit. All trunks are on a common lead to the test circuit, enabling each to have access not only to the test circuit but also to the auxiliary test circuit.

The "Outside equipment" section will complete the actual connection to the line or trunk to be tested.

Figure 14 is a schematic drawing of the type 21 test turret and is a reference for the following sections.

4.2 Trunk to M.D.F. (jackbox). The + and - OUT, + and - IN, and + and - HC leads connect to multiple jackboxes at the M.D.F. A six conductor cord with a plug on one end and a jack on the other will connect the jackbox with the desired line. The test shoe will be inserted into the protectors of the line (figure 3). This will remove the direct connection from the + and - lines through the heat coils and place it on the + and - lines on the "in" side of the protectors. The + and - HC leads will go directly through the heat coils. Without any keys operated the + and - IN leads will form a loop from the inside of the protectors to the trunk to the M.D.F. circuit and out the + and - OUT leads to return to the M.D.F. Inversely the + and - OUT leads will come from the "out" side of the protectors back to the circuit and out the + and - IN leads to return to the M.D.F.

4.2.1 Testing inside plant through a jackbox. The test shoe is placed in the desired line. The BCO key and TALK key are operated. The IN key is then operated and at make contacts 2R & 3R, and 2L & 3L will connect the + and - leads through make contacts of the TALK key, the make contacts of the BCO key, to the test telephone. When the test handset is removed the loop will be complete and will seize the regular line equipment associated with the subscriber's line. Dial tone should be heard. To release the line equipment, the IN key is restored, breaking the loop to the test telephone. The BCO key and TALK key are restored.

4.2.2 Testing the subscriber's line. The OUT key is operated, closing the + and - OUT lines to leads + and -. The + and - leads are extended to the test circuits via the contacts of the HOWL, REV, and RING keys. The following tests may be performed: the test for grounded lines (§4.7.4), the test for an open line or open ringer capacitor (§4.7.5), the test for foreign potential on the + and - lines (§4.7.6). These tests are described in the sections noted.

4.2.3 Monitoring while a subscriber dials. In order to gain the attention of the subscriber, ringing current is applied to the subscriber's line over the + and - OUT leads. The OUT key is still operated. The RING key is operated and connects the + and - lines through to the ringing circuit where the R (-) lead will pass through a buzzer and break contacts of the frequency push buttons 1 through 5 and go to the generator. When the ringing loop is complete the buzzer will sound. When the subscriber answers the RING key is restored.

To monitor while a subscriber dials, the OUT key, TALK key, and TRANS BAT key are operated. The OUT key, at contacts 2L & 3L, and 2R & 3R will connect the + and - lines through the TALK key make contacts, through the capacitors C4 and C5 to the test telephone. The line equipment will also be seized by closing a shorting loop across the + and - IN leads through contacts 8L & 9L of the OUT key. Transmission battery will be connected to the subscriber's line by the TRANS BAT key and extended through the break contacts of the DST, RING, REV, and HOWL keys, and the make contacts of the OUT key to the subscriber's telephone. The test attendant may now give instructions to the subscriber.

At this point several tests relating to the subscriber's station can be made: Battery voltage test (§4.7.2), Dial speed test (§4.8.1), and Pulse ratio test (§4.8.2). These routine tests are described in the denoted sections.

Restoring the TRANS BAT key and the OUT key connects the subscriber to the already seized line equipment and allows him to dial the number which the test attendant desired. By leaving the TALK key operated and operating

the HC or RLS CONN key the test telephone will be connected through capacitors C4 and C5, over the + and - HC leads, through the heat coils, to the subscriber's line. This allows the test attendant to monitor the call.

To remove his test telephone from the line, the test attendant restores the TALK key and the HC or RLS CONN key.

4.2.4 Testing heat coils. The HC or RLS CONN, BCO, and TALK keys are operated.

The HC or RLS CONN key will close a loop consisting of the + and - leads through make contacts of the TALK key and the BCO key to the test telephone. If the heat coils are not open the loop will seize regular line equipment through the heat coils and return dial tone.

4.2.5 Release. To release the connection from the jackbox, the six conductor patching cord is removed from the line at the M.D.F.

4.2.6 Hold. To hold a connection (in figure 12, the subscriber's loop holds the connection) through a jackbox all keys will be restored and the OUT and IN leads will complete a loop from the M.D.F. to the test turret to hold the connection. The switch train may be held by the test attendant by operating the HOLD key. This shorts the + and - leads which completes the loop to the switch train.

4.3 Trunk to test distributor

4.3.1 Outgoing call. The OUT key is operated. The OUT key operated will complete a loop consisting of the + and - OPER leads passing through the #1 winding of relay B1 and break contacts of the DIAL key to seize the test distributor. The OUT key will also place ground to the #2 winding of relay B1. Relay B1 will not operate because of opposing magnetic fields from its #1 and #2 windings. Operation of the DIAL key will extend the loop to the test telephone and place battery to the +OPER lead. If the test distributor is busy, the supy lamp I6 will be lighted from the grounded lead C.

The test distributor is associated with the test connectors to which the exchange telephones are connected. If the test connector dialed is busy, lead C will be grounded to the test distributor wiper causing the reversal of polarity of the + and - OPER leads to relay B1 in the test turret. Relay B1 will operate due to the reversed polarity and light the supy lamp I19. At break-make contacts 1, 2, and 3, relay B1 will remove battery from the +OPER lead and place it on the -OPER lead, to aid in holding B1 operated. When the connector becomes idle, the battery polarity on the +OPER and -OPER leads is again reversed, shunting relay B1. Relay B1 will then restore and extinguish the supy lamp.

The remaining digits are then dialed into the test connector. The connector places its wipers on the desired subscriber's line. If the subscriber's line is busy the same indications will be given as was given for the busy test connector. It is possible at this time to step the test connector off the busy contact by dialing a 1 into the test distributor.

When the line is not busy a ground from the test distributor will be extended over lead EC to the BCO relay of the subscriber's line equipment. This relay will operate and remove the line relay bridged across the + and - subscriber's lines and the + and - TEST lines. This clears the line of all attachments so that the following tests may be made: test for grounded lines (§4.7.4), test for an open line or open ringer capacitor (§4.7.5), test for foreign potential on the + and - lines (§4.7.6).

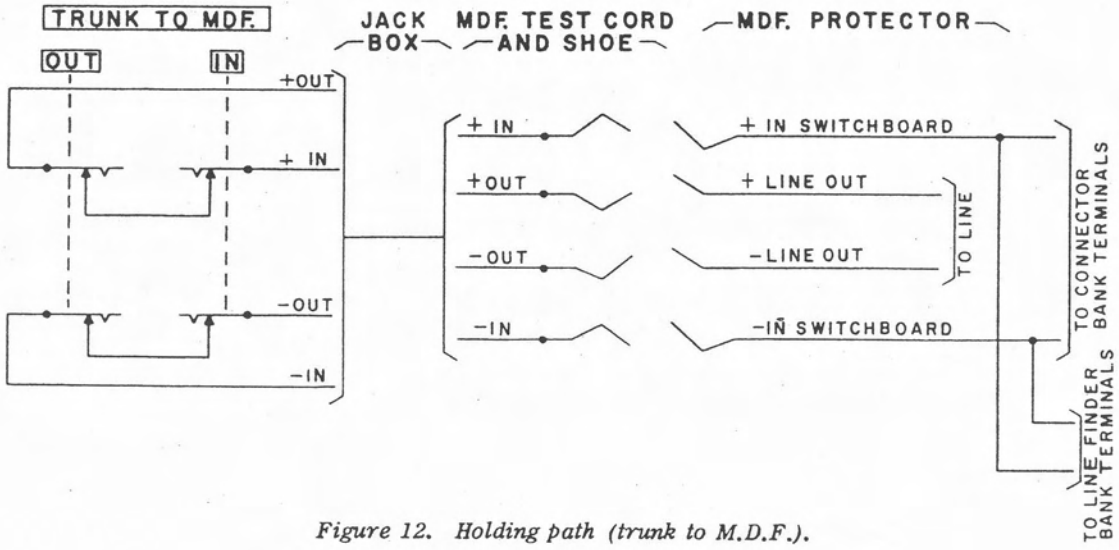

Figure 12. Holding path (trunk to M.D.F.).

By dialing a 1, the test connector wipers will be stepped to the next line so that the routine tests can be performed upon each line on that level. The OUT and DIAL keys are operated throughout this test.

4.3.2 Testing line circuit of the line under test. The test distributor is seized and connected to the subscriber's line in the manner explained in §4.3.1.

The OUT key is still operated. The DIAL key is restored and the BCO key is now operated (lower contacts of the same lever key, figure 4). It closes a ground through its contacts 4R & 5R to the + and - OPER leads to shunt a relay D in the test distributor. Relay D in restoring opens relay M which restores and removes ground from the battery connected BCO relay of the subscriber's line equipment. The BCO relay will restore and replace the line relay across the + and - TEST lines. The TALK key is now operated to place the test telephone across the + and - TEST lines, closing the line relay of the subscriber's line equipment. This line relay will connect the + and - TEST lines through to a linefinder in the regular switch train and dial tone should be heard. Restoration of the OUT key will release the connection.

4.3.3 Monitoring while a subscriber dials. After noting correct operation of the subscriber's line equipment by use of the test switch train, the plant man may desire the subscriber to dial into the exchange. By restoring the BCO key, which removes the line relay bridged across the subscriber's line, and operating the RING key (consequently restoring the TALK key on the opposite position of the lever key) the subscriber may be signaled. When the subscriber answers the TALK key is reoperated and the TRANS BAT key is operated to allow the plant man to converse with the party. The BCO key is momentarily reoperated and then restored in order to allow the subscriber to seize his line equipment and dial without any interference from the test telephone. The call can now be monitored over the + and - TEST lines, through the make contacts of the TALK key, capacitors C4 and C5 to the test telephone.

4.3.4 Releasing. To release the connection the OUT key is restored. This breaks the loop to the test switch train, which then restores.

4.3.5 Holding. Restore all other keys and leave the OUT key operated. The OUT key will complete a loop through the #1 winding of relay B1 over the +OPER and -OPER lines to hold the test distributor. If the line is busy relay B1 will operate and light the supy lamp.

4.3.6 Testing all lines of a test connector. The OUT key, operated, will seize the test distributor by making a loop from the + and - OPER leads through the #1 winding of relay B1. The DIAL key will extend this loop to the test telephone. The test attendant will dial 11 and the test connector will test the first rotary contact on the first vertical level. The test attendant will dial 1 continuously until all contacts on this level have been tested. When finished the HC or RLS CONN key will be operated momentarily to place battery on the + and - OPER leads. This battery on the +OPER lead will shunt down a relay in the test distributor which will cause the test connector to return to normal. The test attendant will then dial 2 and proceed to test the ten lines on this level. This procedure is followed for each of the ten test connector levels.

4.3.7 Permanent line release. The line will be dialed and monitored over the test distributor trunk. If the line is busy and no conversation is heard, it may be assumed that the line equipment is held due to a permanent short or ground. Relay B1 will operate from the reversed polarity of the test distributor and light the supy lamp I19. The BCO key will then be operated to place ground on the -OPER lead. This will activate the permanent line release circuit, not shown, through the shunting of one relay and the resultant operation of another. The permanent line release circuit will place direct ground and a low resistance battery connected relay across the faulty line. There will be a slight time lapse as the permanent line release relay shunts relay A in the selector being held by the fault. The selector will release if the value of the short or ground is not too low and remove ground from lead C. With the ground removed from lead C, the test distributor will again reverse the polarity to relay B1, thus shunting it down and restoring supy lamp I19.

4.4 Regular line equipment

4.4.1 Incoming. A call will be received from the connector switch banks on the + and - leads of the test circuit. The extension ringer, placed across the line, will ring. When the LINE SW key is operated it will connect the + and - lines through its make contacts 2L & 3L, and 2R & 3R, the break contacts of the BCO key, unoperated, the break contacts of the DIAL key to the L1 and L2 leads of the test telephone. When the handset is removed, the loop to the connector banks will be completed. Transmission battery will be supplied by the regular switch train.

4.4.2 Outgoing. To call out it is only necessary to operate the LINE SW key, thus seizing a linefinder via the loop described above.

4.5 Test cords (trunk to toll switchboard)

4.5.1 Incoming. Seizure of a trunk at the switchboard places ground on lead L to light the supy lamp I1. To answer the call the test attendant operates the TEST key. Operation of the TEST key will ground the RLY lead to operate a relay at the switchboard which will in turn remove ground from lead L and restore supy lamp I1. Operation of the TEST key will also ground the MST lead to operate the ringing equipment start relay, and connect the + and - TEST leads through to the test circuit and the test telephone. When the operator disconnects at the switchboard, the supy lamp I1 will relight, giving the attendant disconnect supervision. When the TEST key is restored the supy lamp will restore.

4.5.2 Outgoing. Operation of the TEST key places ground on the MST lead to operate the ringing equipment start relay, connects the + and - lines to the test circuit and test telephone and grounds the RLY lead. Ground on the RLY lead will operate the switchboard line relay, which will operate and light the switchboard line relay lamp and return a ground on lead L to light supy lamp I1. When the switchboard attendant answers, ground will be removed from lead L and the supy lamp I1 will restore. When the switchboard operator disconnects, the supy lamp will relight and remain lighted until the TEST key is restored.

4.6 Inspector's trunk circuit

4.6.1 Call to test attendant. If an inspector wishes to call the test attendant, the call will enter from the switch banks on the + and - leads of the inspector's trunk circuit through break contacts of relay C3, unoperated, to operate relay A3. Relay A3 operates and closes ground through contacts 3 & 4 to operate relay B3. At make contacts 1 & 2, relay A3 sends interrupted generator to the calling party and at make contacts 5 & 6 grounds and lights the supy lamp I3. Relay B3 operates and closes ground at make contacts 4 & 5 to activate the ringing relay on the MST lead and at contacts 2 & 3 returns a ground to busy the test station over lead C. When supy lamp I3 has lighted the attendant operates the TALK & TEST key. The TALK & TEST key at contacts 3L & 4L operates relay C3 and at make contacts 1L & 2L, and 1R & 2R connects the + and - leads through to the test circuit. Relay C3 in operating places a holding ground on relay B3 and at contacts 1 & 2; and 3 & 4 removes relay A3 from across the line. To complete the connection the TALK key is operated and at contacts 4R & 5R will send ground from relay A1 through break contacts of the MON key, break contacts of the LINE SW key, to the test telephone. Battery from relay A1 will go on the - lead to the test telephone. This will complete the circuit to the test telephone. The TRANS BAT key is operated and applies ground and battery over the trunk.

To release the connection the TALK & TEST key is restored to break the loop to the test telephone and removes transmission battery from the line.

4.6.2 Re-ring on inspector's trunk (ringing circuit). Circuitry of the ringing circuit applies whether the ringing is used on the inspector's trunk or elsewhere. Operation of the RING key will connect the + and - lines through to the ringing circuit where the R (-) lead will pass through a buzzer and break contacts of the frequency push buttons to the ringing supply circuit on the ALT lead. The T (+) lead will pass through break contacts of the frequency push buttons and go to the ringing generator. When the ringing loop is complete the buzzer will sound. Restoration of the RING key removes the + and - lines from the ringing circuit, removing ringing current from the line. When a divided ringing scheme is used the REV key (test circuit) may have to be operated. The REV key will change the polarity of the lines. The frequency push buttons enable the attendant to choose the proper ringing frequency.

4.7 Voltmeter tests

4.7.1 Incoming lines. Operation of the OUT key will bring the + and - leads into the test circuit, as explained in §4.2.2. Circuit explanations will begin with the + and - leads entering the test circuit.

4.7.2 Battery voltage test. Referring to figure 6, the BAT TEST key will be operated and at make contacts 2R & 3R will place positive battery at the + terminal of the voltmeter and at make contacts 2L & 3L will place negative battery to the - terminal of the voltmeter. The voltage will be noted upon the voltmeter.

4.7.3 Checking polarity of a line or trunk. It is understood that all tests concerning the voltmeter circuit will be performed with the OUT key operated, thus giving the test and voltmeter circuits access to the line or trunk to be tested. The first voltmeter test will be made with the VM key operated. The + and - lines will enter the test circuit through the break contacts of the HOWL key, go through break contacts of the REV, RING, and DST keys, unoperated, to the voltmeter circuit. The + line will enter the voltmeter circuit through break contacts of the GRD key, the TRANS BAT key, pass through make contacts 2R & 3R of the VM key to ground. The - line will pass through break contacts of the TRANS BAT key, out the #2 lead

through break contacts of the TALK key to return on the #1 lead and make contacts of the VM key 2L & 3L to the + terminal of the voltmeter. For a comparitive reading the VM SHUNT key is operated. The VM SHUNT key will place the resistor R14 across the + and - terminals of the voltmeter (the internal resistance of the voltmeter with the VM SHUNT key operated is 1000Ω).

4.7.4 Test for grounded lines

4.7.4.1 Negative side of the line. Refer to figure 8. Entering the test circuit through the break contacts of the HOWL key the + and - lines will pass through break contacts of the REV and RING keys, unoperated, the break contacts of the DST key, unoperated, to the voltmeter circuit. At the voltmeter circuit the + line will end at spring 1L of the GRD key, operated. The - line will continue through break contacts of the TRANS BAT key through contacts 2R & 3R of the VM key, operated, to the + terminal of the voltmeter. The GRD key operated, will send a ground from springs 2L & 3L through break contacts of the TRANS BAT key, make contacts 5L & 6L of the VM key to positive battery. The VM key will send battery to the - terminal of the voltmeter. If ground is present on the line, the voltmeter will be deflected.

4.7.4.2 Positive side of the line. The REV key, operated, at make contacts 2R & 3R, and 2L & 3L will change the polarity of the lines. The + line will now follow the circuit described above for the - line and go to the + terminal of the voltmeter. The - line will end at spring 1L of the GRD key.

4.7.5 Test for open (ringer capacitor or line). Figure 9 illustrates this test. The + and - lines will enter the circuit at break contacts of the HOWL key and go through make contacts 2L & 3L, and 2R & 3R, of the REV key, operated. The + line will go to the voltmeter circuit through make contacts of the VM key 2R & 3R, operated, to the + terminal of the voltmeter. The - line will pass through the test circuit to the voltmeter circuit and go through contacts 5L & 6L of the VM key to ground. The VM key, operated, will send battery to the - terminal of the voltmeter. The ringer capacitor will charge over the loop. When the REV key is restored the capacitor will discharge because of the reversal of the + and - lines. There should be a deflection of the voltmeter needle. If there is no deflection, the capacitor or line is open.

4.7.6 Test for negative foreign potential

4.7.6.1 Negative side of the line. Refer to figure 10. The + line will go through the test circuit and end at spring 1L of the GRD key, operated. The - line enters the voltmeter circuit through the break contacts of the TRANS BAT key, unoperated, to go through contacts 1L & 2L of the VM key, unoperated, to the - terminal of the voltmeter. The GRD key will send a ground to the + terminal of the voltmeter. A negative potential on the line will cause a voltmeter deflection.

4.7.6.2 Positive side of the line. The REV key will operate contacts 2L & 3L, and 2R & 3R, to change the polarity of the + and - lines. The + line will go to the - terminal of the voltmeter and the - line will end at spring 1L of the GRD key, operated. A negative potential on the line will cause a voltmeter deflection.

4.8 Dial tests

4.8.1 Dial speed test. Adjustment of the meter to show full scale readings is necessary. The SET FULL SCALE key is operated and sends a ground through resistor R3 and adjusted rheostat R7, the make contacts of the SET FULL SCALE key, the SET FULL SCALE rheostat, the meter and resistor to battery. When the meter has been adjusted by turning the SET FULL SCALE rheostat R8 to show full scale, the SET FULL SCALE key is restored.

Refer to figure 5. The DST key, operated, will connect the dialing loop through make contacts, 2R & 3R, and 2L & 3L, to the ground and battery connected windings of relay A7. Relay A7 in operating make contacts 2T & 3T will provide a path for ground from make springs 7L & 8L of the DST key to relay B7. Relay B7 in operating, will close contacts 2 & 3 to prepare a path for relay C7. When relay A7 restores by the subscriber's dial breaking the loop, relay C7 will operate contacts 5 & 6, and 7 & 8, removing the test telephone from the circuit and at contacts 2 & 3 will complete the circuit to the meter. Relay C7 and B7 remain operated during pulsing.

When relay A7 restores it completes a loop from battery, through the meter and resistors, contacts 1R & 2R of the SET FULL SCALE key, unoperated, the capacitor C2 and the resistor R4, break contacts of the PULSE TEST key, not operated. Capacitor C2 will charge across the loop. When relay A7 reoperates, capacitor C2 will discharge and capacitor C1 will charge from ground at springs 5R & 6R of the PULSE TEST key through capacitor C1, resistor R4, the break contacts of the PULSE TEST key, make contacts 2 & 3 of relay C7, break contacts of the SET FULL SCALE key, the resistors, and meter to negative battery. The frequency of operation of relay A7 governs the amount of current through the capacitors.

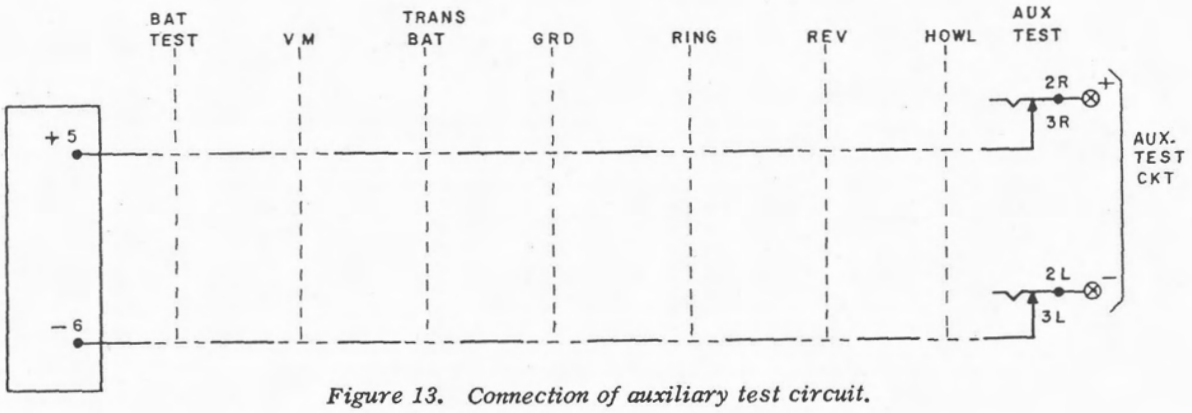

Figure 13. Connection of auxiliary test circuit.

This current flow is measured by the meter and indicates the dial speed. Resistor R4 is used for spark suppression when either capacitor discharges. Capacitor C3 is used to "damp" the meter and give a steady reading.

Circuitry will be the same with dials tested at the AUX TEST binding posts or the subscriber's telephone.

4.8.2 Pulse ratio test. Adjustment of the meter to show full scale readings is necessary. When the meter has been adjusted by turning the SET FULL SCALE rheostat R8 to show full scale as explained in §4.8.1, the SET FULL SCALE key is restored and the PULSE TEST key is operated.

The DIAL SPEED TEST key remains operated and the circuitry to relay A7 remains the same.

The PULSE TEST key, operated, will complete a loop through its 2L & 3L contacts from ground, through the resistor R3, the rheostat R7, make contacts 2L & 3L of the PULSE TEST key, make contacts 2B & 3B of relay A7, 2 & 3 make contacts of relay C7, break contacts 1L & 2L of the SET FULL SCALE key, through the resistor and meter to battery.

Relay A7 will at contacts 1B, 2B, and 3B break and restore the above circuit. The meter will average the current passing through, thus registering the percent make of relay A7's contacts, indicating the percent make of the dial being tested.

4.9 Miscellaneous circuit features

4.9.1 Auxiliary test circuit. Refer to figure 13. Operation of the AUX TEST key connects the auxiliary test binding posts through to the test circuit where the + and - lines are put under the control of the keys of the associated test circuit. The AUX TEST binding posts provide a place for the connection of a Wheatstone bridge, ohmmeter, etc.

4.9.2 Howler. Operation of the HOWL key returns a ground to the howler circuit to activate it and connects the howler signal to the + and - leads which are extended by the test distributor or jackbox to the subscriber's line.

4.9.3 Spotter dial. The spotter dial circuit has five lamps associated with it for SATT five party identification. The RLS and SPOTTER PULSE keys are also part of this circuit. This test circuit will be used with the "type A SATT system" providing for a minimum of five party identifications. To use the spotter dial circuit an auxiliary circuit is necessary. For more information, see Automatic Electric drawing H-85295 and operating explanation E-85295, or figure 13 of H-85275 and explanation E-85275.

4.9.4 Fuse circuit. The fuse circuit provides protection and alarm supervision for the test turret.

4.9.5 Night alarm circuit. The night alarm circuit provides for an audible alarm when any lamps associated with the test turret lights. The NA lead is common to the various lamps. When a lamp is lighted it lights in series with relay A8. Relay A8 in operating, closes a circuit to buzzer. If it is desired to have the buzzer sound when the lamp lights the NA key is restored to send a ground through the RET resistor to the buzzer.

RESISTANCE TABLE I

"VM SHUNT" KEY NORMAL (NO SHUNT)

Deflection of needle	Resistance								
	Test battery voltage								
	46	46.5	47	47.5	48	48.5	49	49.5	50
1	4,500,000	4,550,000	4,600,000	4,650,000	4,700,000	4,750,000	4,800,000	4,850,000	4,900,000
2	2,200,000	2,225,000	2,250,000	2,275,000	2,300,000	2,325,000	2,350,000	2,375,000	2,400,000
3	1,433,333	1,450,000	1,466,666	1,483,333	1,500,000	1,516,666	1,533,333	1,550,000	1,566,666
4	1,050,000	1,062,500	1,075,000	1,087,500	1,100,000	1,112,500	1,125,000	1,137,500	1,150,000
5	820,000	830,000	840,000	850,000	860,000	870,000	880,000	890,000	900,000
6	666,666	657,000	683,333	691,666	700,000	708,333	716,666	725,000	733,333
7	557,143	564,285	571,428	578,571	585,713	592,859	600,000	607,143	614,285
8	475,000	481,250	487,500	493,750	500,000	506,250	512,500	518,750	525,000
9	411,111	416,666	422,222	427,777	433,333	438,888	444,444	449,999	455,555
10	360,000	365,000	370,000	375,000	380,000	385,000	390,000	395,000	400,000
11	318,181	322,727	327,272	331,818	336,363	340,908	345,454	350,000	354,545
12	283,333	287,500	291,666	295,834	300,000	304,166	308,333	312,500	316,666
13	253,846	257,692	261,538	265,384	269,230	273,076	276,923	280,769	284,615
14	228,571	232,142	235,714	239,285	242,857	246,429	250,000	253,571	257,142
15	206,666	210,000	213,333	216,666	220,000	223,333	226,666	230,000	233,333
16	187,500	190,625	193,750	196,875	200,000	203,125	206,250	209,375	212,500
17	170,588	173,529	176,470	179,411	182,352	185,294	188,235	191,176	194,117
18	155,555	158,333	161,111	163,888	166,666	169,444	172,222	175,000	177,777
19	142,105	144,737	147,368	150,000	152,631	155,263	157,894	160,526	163,157
20	130,000	132,500	135,000	137,500	140,000	142,500	145,000	147,500	150,000
21	119,047	121,428	123,809	126,190	128,571	130,952	133,333	135,714	138,095
22	109,090	111,363	113,636	115,900	118,181	120,454	122,727	125,000	127,272
23	100,000	102,174	104,348	106,522	108,696	110,870	113,043	115,217	117,391
24	91,666	93,750	95,833	97,917	100,000	102,084	104,167	106,250	108,334
25	84,000	86,000	88,000	90,000	92,000	94,000	96,000	98,000	100,000
26	76,923	78,849	80,769	82,692	84,615	86,538	88,461	90,384	92,307
27	70,370	72,222	74,074	75,926	77,777	79,640	81,481	83,333	85,185
28	64,285	66,071	67,857	69,643	71,428	73,214	75,000	76,786	78,581
29	58,621	60,345	62,069	63,793	65,517	67,241	68,965	70,689	72,413
30	53,334	55,000	56,666	58,334	60,000	61,666	63,334	65,000	66,666
31	48,387	50,000	51,612	53,225	54,838	56,451	58,064	59,677	61,290
32	43,750	45,213	46,875	48,437	50,000	51,563	53,125	54,687	56,250
33	39,393	40,908	42,424	43,939	45,454	46,969	48,484	50,000	51,515
34	35,294	36,764	38,325	39,795	41,176	42,646	44,117	45,587	47,058
35	31,424	32,846	34,285	35,703	37,142	38,660	40,000	41,418	42,857
36	27,777	29,166	30,555	31,944	33,333	34,722	36,111	37,500	38,888
37	24,324	25,657	27,027	28,378	29,729	31,081	32,432	33,783	35,135
38	21,052	22,368	23,684	25,000	26,315	27,631	28,947	30,263	31,578
39	17,948	19,130	20,512	21,694	23,076	24,258	25,641	26,823	28,205
40	15,000	16,250	17,500	18,750	20,000	21,250	22,500	23,750	25,000
41	12,195	13,414	14,634	15,853	17,073	18,291	19,512	20,731	21,961
42	9,523	10,713	11,904	13,094	14,285	15,475	16,666	17,856	19,047
43	6,976	8,139	9,302	10,465	11,627	12,790	13,953	15,116	16,279
44	4,545	5,681	6,818	7,954	9,090	10,226	11,363	12,500	13,636
45	2,222	3,333	4,444	5,555	6,666	7,777	8,888	9,999	11,110
46	0	1,087	2,174	3,261	4,347	5,434	6,521	7,608	8,695
47		0	0	1,064	2,127	3,191	4,255	5,319	6,383
48				0	0	1,041	2,083	3,125	4,168
49						0	0	1,020	2,040
50								0	0

RESISTANCE TABLE II

"VM SHUNT" KEY OPERATED (VOLTMETER SHUNTED BY 1,010Ω)

Deflection of needle	Resistance								
	Test battery voltage								
	46	46.5	47	47.5	48	48.5	49	49.5	50
1	45,000	45,500	46,000	46,500	47,000	47,500	48,000	48,500	49,000
2	22,000	22,250	22,500	22,750	23,000	23,250	23,500	23,750	24,000
3	14,333	14,500	14,667	14,833	15,000	15,167	15,333	15,500	15,667
4	10,500	10,625	10,750	10,875	11,000	11,125	11,250	11,375	11,500
5	8,200	8,300	8,400	8,500	8,600	8,700	8,800	8,900	9,000
6	6,667	6,750	6,833	6,917	7,000	7,083	7,167	7,250	7,333
7	5,571	5,643	5,714	5,786	5,857	5,929	6,000	6,071	6,143
8	4,750	4,812	4,875	4,937	5,000	5,062	5,125	5,187	5,250
9	4,111	4,167	4,222	4,278	4,333	4,389	4,444	4,500	4,556
10	3,600	3,650	3,700	3,750	3,800	3,850	3,900	3,950	4,000
11	3,182	3,227	3,273	3,318	3,364	3,409	3,455	3,500	3,545
12	2,833	2,875	2,917	2,958	3,000	3,042	3,083	3,125	3,167
13	2,538	2,577	2,615	2,654	2,692	2,731	2,769	2,808	2,846
14	2,286	2,321	2,357	2,393	2,429	2,464	2,500	2,536	2,571
15	2,067	2,100	2,133	2,167	2,200	2,233	2,267	2,300	2,333
16	1,875	1,906	1,937	1,969	2,000	2,031	2,062	2,094	2,125
17	1,706	1,735	1,765	1,794	1,824	1,853	1,882	1,912	1,941
18	1,556	1,583	1,611	1,639	1,667	1,694	1,722	1,750	1,778
19	1,421	1,447	1,474	1,500	1,526	1,553	1,579	1,605	1,631
20	1,300	1,325	1,350	1,375	1,400	1,425	1,450	1,475	1,500
21	1,190	1,214	1,238	1,262	1,286	1,310	1,333	1,357	1,381
22	1,091	1,114	1,136	1,159	1,182	1,205	1,227	1,250	1,273
23	1,000	1,022	1,043	1,065	1,087	1,109	1,130	1,152	1,174
24	917	937	958	979	1,000	1,021	1,042	1,062	1,083
25	840	860	880	900	920	940	960	980	1,000
26	769	788	808	827	846	865	885	904	923
27	704	722	741	759	778	796	815	833	852
28	643	661	679	696	714	732	750	768	786
29	586	603	621	638	655	672	690	707	724
30	533	550	567	583	600	617	633	650	667
31	484	500	516	532	548	565	581	597	613
32	437	452	469	484	500	516	531	547	562
33	394	409	424	439	455	470	485	500	515
34	353	368	383	398	412	426	441	456	471
35	314	328	343	357	371	387	400	414	429
36	278	292	306	319	333	347	361	375	389
37	243	257	270	284	297	311	324	338	351
38	211	224	237	250	263	276	289	303	316
39	179	191	205	217	231	243	256	268	282
40	150	162	175	187	200	212	225	237	250
41	122	134	146	159	171	183	195	207	220
42	95	107	119	131	143	155	167	179	190
43	70	81	93	105	116	128	140	151	163
44	45	57	68	80	91	102	114	125	136
45	22	33	44	56	67	78	89	100	111
46	0	11	22	33	43	54	65	76	87
47		0	0	11	21	32	43	53	64
48				0	0	10	21	31	42
49						0	0	10	20
50								0	0

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