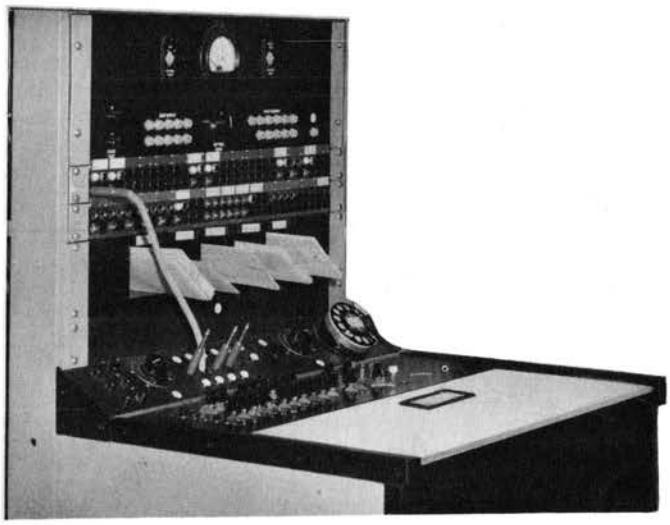
TYPE 180L LOCAL TEST PANEL



Technical bulletin 100-604

AUTOMATIC ELECTRIC
GENERAL SYSTEM
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

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

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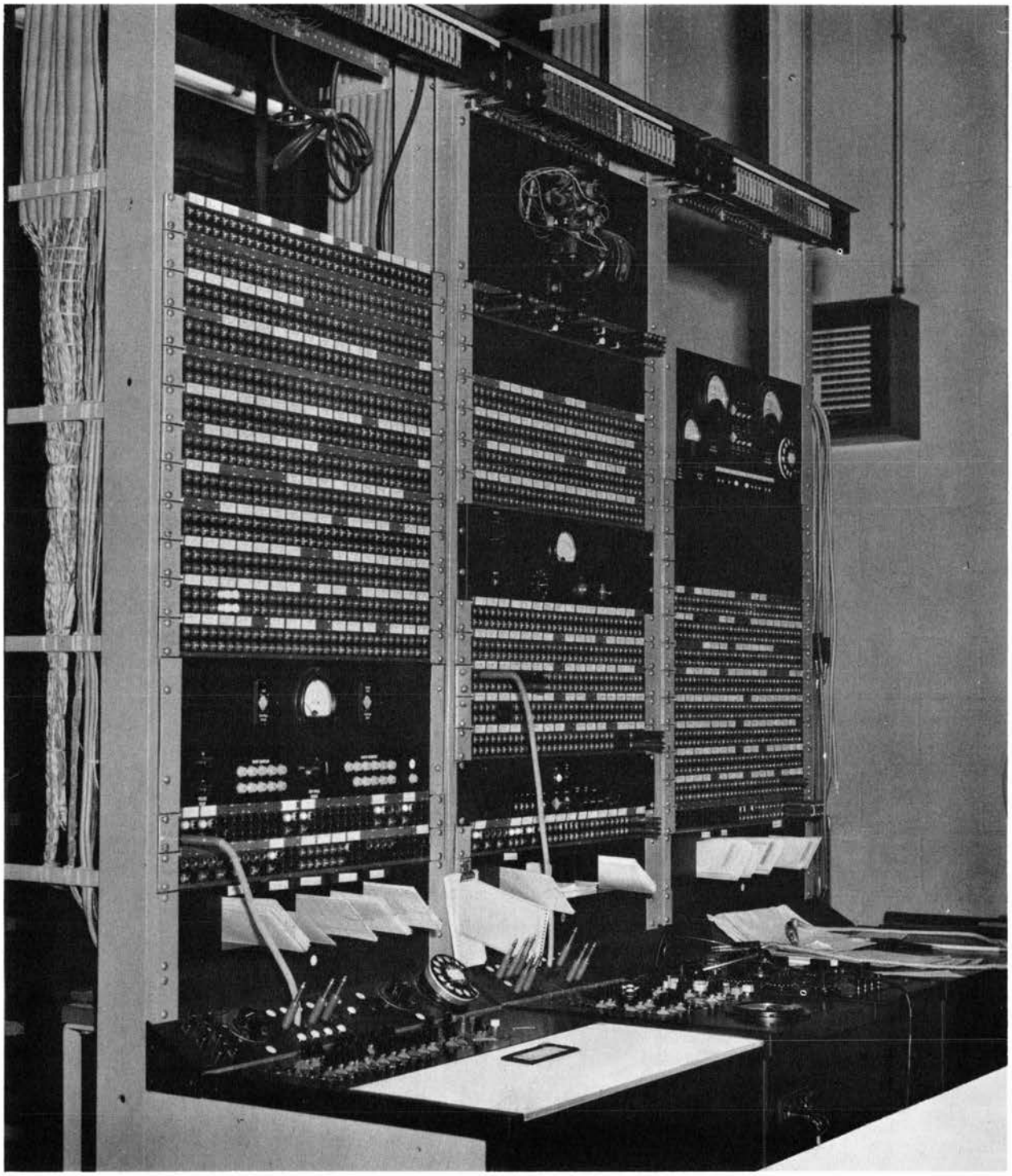

Figure 1. Typical Type 180L Local Test Panel.

TYPE 180L
LOCAL TEST PANEL

1. INTRODUCTION

1.1 Scope

This Technical Bulletin is intended to familiarize the prospective user of the Type 180L Local Test Panel with its testing features and field application. Only such circuit information and circuit diagrams of the test panel are presented as is necessary to illustrate the testing examples given. The test panel arrangements shown are the latest standards and may or may not agree with any particular installation. Where the exact wiring or equipment arrangements of the test panel at a given office are required, reference should be made to the diagrams covering the installation involved.

1.2 Purpose

The primary purpose of the Type 180L Local Test Panel (figure 1) is the testing of lines and trunks on which trouble has been reported. It is also used to routine test customer lines, a form of preventive maintenance that enables the testman to discover line trouble before it becomes serious.

1.3 General Operation

Testing connections to customer lines can be made over automatic (dialing) trunks terminated on jacks at the test panel. Testing connections can also be established from customer lines to the test panel over automatic trunks, also jack ended. A description of these trunks and others available is given in section 4. The test attendant, after establishing a connection to a line with a test cord, can make a variety of tests by operating various keys and noting the resulting meter readings.

2. DESCRIPTION

2.1 General

The Type 180L Local Test Panel is a relay rack-mounted local test facility (figure 1), consisting of a lower unit, a jackfield, and optional test components.

2.2 Physical Description

The Type 180L Local Test Panel is a test panel built up of standard components. Each test panel has a test attendant console (lower unit) and a jackfield mounted on a section of relay rack. In addition, the test panel may be equipped with optional test components mounted above the jackfield. The lower unit, jackfield, and optional test components mount on sections of relay rack 24-3/8'' wide and 9' 0'' or 11' 8'' high. The lower unit mounts on the face of the relay rack such that its keyshelf is 40'' above the floor. The over-all physical appearance of the test panel will vary from office to office depending upon optional test equipment supplied and number and arrangement of trunks and lines on the jackfield. Figure 1 shows a typical Type 180L Local Test Panel.

2.2.1 Lower unit.

The lower unit, or attendant's console (figure 2), consists of a metal cabinet with a gray enamel finish. The top of the console is fitted with a plugshelf and keyshelf (figure 3) made of wood and covered with black phenolic fibre. The keyshelf mounts test keys and a volt-ohm-milliammeter. The plugshelf mounts test plugs and supervisory lamps of the primary, auxiliary, and sounder cord circuits, and plugs and supervisory lamps for the single-ended cord circuits (one or two circuits optional). Also mounted on the plugshelf are two rheostats associated with the volt-ohm-milliammeter, a dial, a night alarm key, a howler lamp, and two sets of binding posts. The testing circuit relay equipment mounts on the frame of the lower unit below the level of the keyshelf (figure 2). A door at the front of the console provides access to the relay equipment. Headset jacks are provided in duplicate and are located on the left side of the keyshelf front panel (figure 2).

a. Keyshelf. The keyshelf of the lower unit (figure 3) is 15-7/8'' deep. The top portion mounts the test keys and lamps; the bottom portion mounts the volt-ohm-milliammeter. The designation and function of each key and lamp is described in section 3.3. The

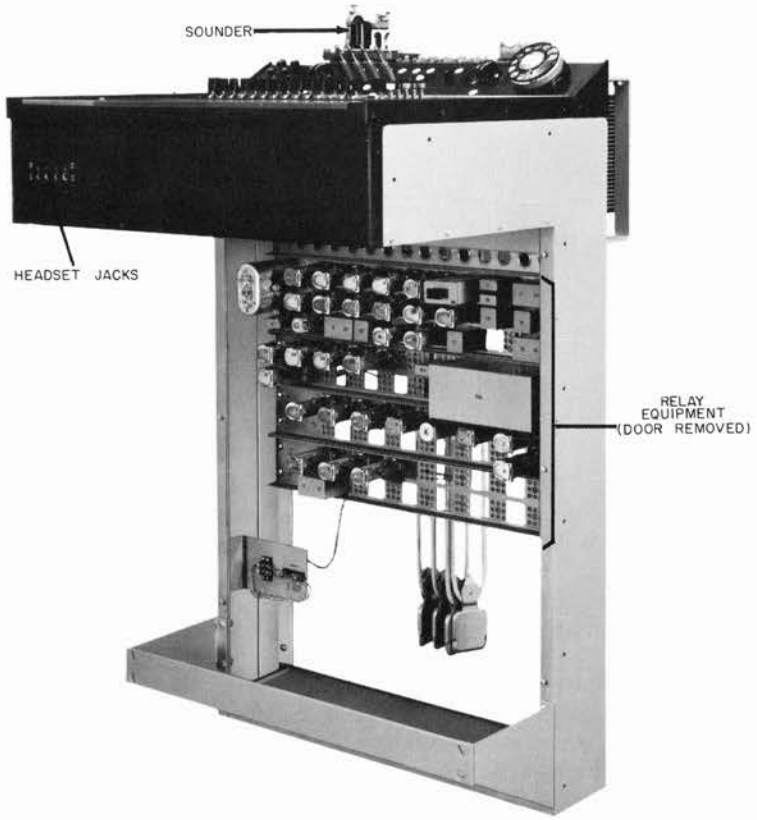

Figure 2. Type 180L Local Test Panel lower unit.

volt-ohm-milliammeter (figure 4) is used in conjunction with the primary test cord, test keys, and 150-volt and 15-volt battery or battery eliminator to determine the cause of trouble on a line or trunk. The volt-ohm-milliammeter (herein after called the meter) has the following scales:

Range	Scale
0-750	Volts
0-150	Volts
0-15	Volts (Read on 0-150 Scale Multiplied by .1)
0-750	Milliamperes
0-150	Milliamperes
500 Ohms Mid-Scale	Ohms (Using Lower Half of Scale)
5,000 Ohms Mid-Scale	Ohms (Multiply 0-500 Scale by 10)
50,000 Ohms Mid-Scale	Ohms (Multiply 0-500 Scale by 100)

A clear plastic bulletin holder extends across the bottom of the keyshelf. The keyshelf is hinged at its junction with the plugshelf providing easy access to the key and meter wiring.

b. Plugshelf. The plugshelf (figure 3) is inclined 30° above the plane of the keyshelf to aid in identifying the equipment mounted on it. Starting from the left the plugshelf contains two vertical rows of binding posts, the first row designated T and R, and the second row designated T, R, and G; rheostat VM ADJ (voltmeter adjustment); cord and lamp PRIM (primary test); cord and lamp AUX (auxiliary test); cord and lamp SDR (sounder test); cords and lamps CORD 1 and CORD 2; howler lamp HLR; night alarm turn key NA; rheostat RH and the dial. The function of each plugshelf component is described in section 3.2.

2.2.2 Jackfield.

The jackfield of a typical Type 180L Local Test Panel consists of two miscellaneous jack strips (upper and lower) and a number of blank strips which in some cases can be used for overflow jacks from a Type 180 Toll Test Panel installation. The jack strips have a capacity of two rows of 32 jacks each.

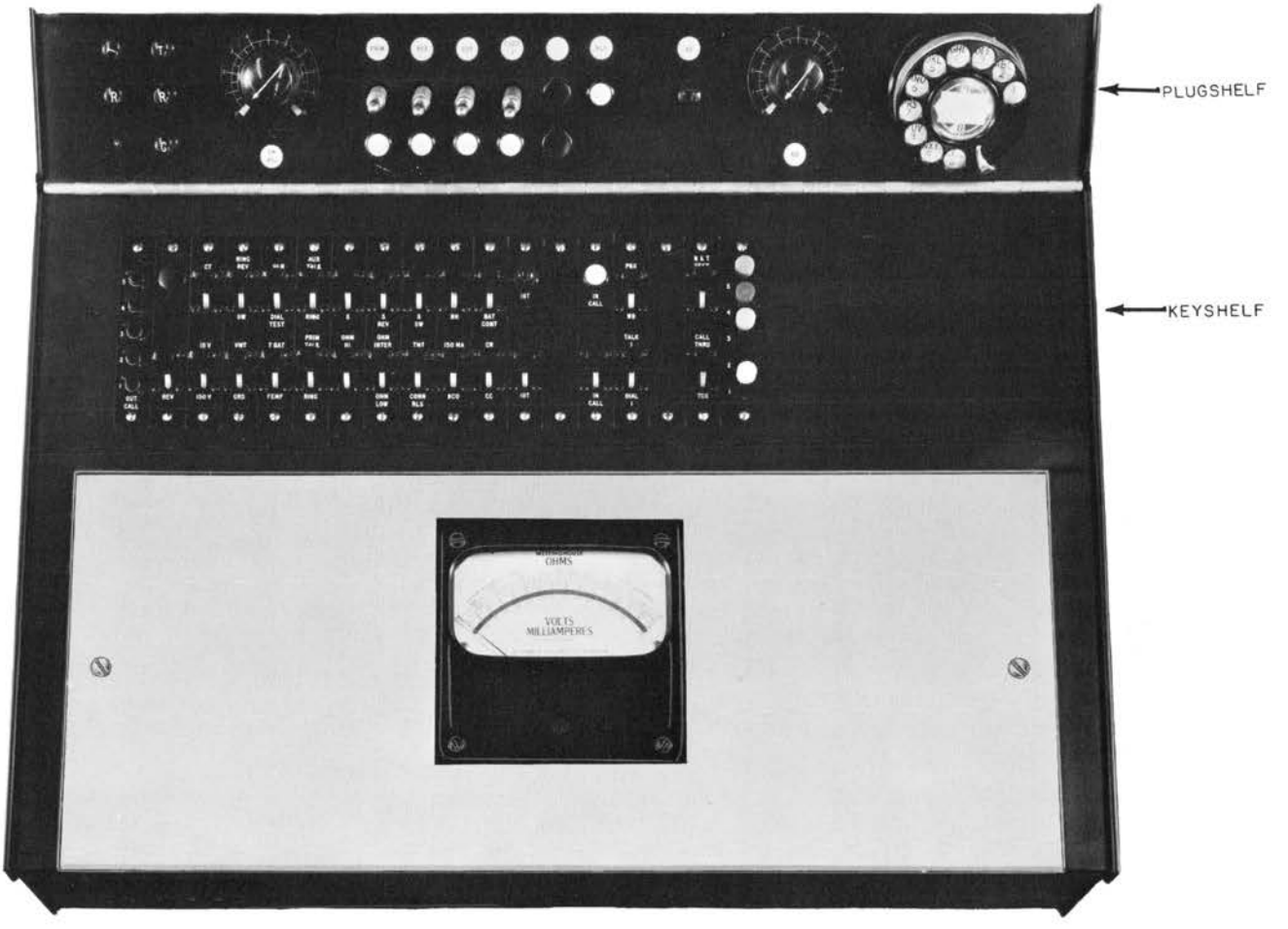

Figure 3. View of keyshelf and plugshelf of Type 180L Local Test Panel.

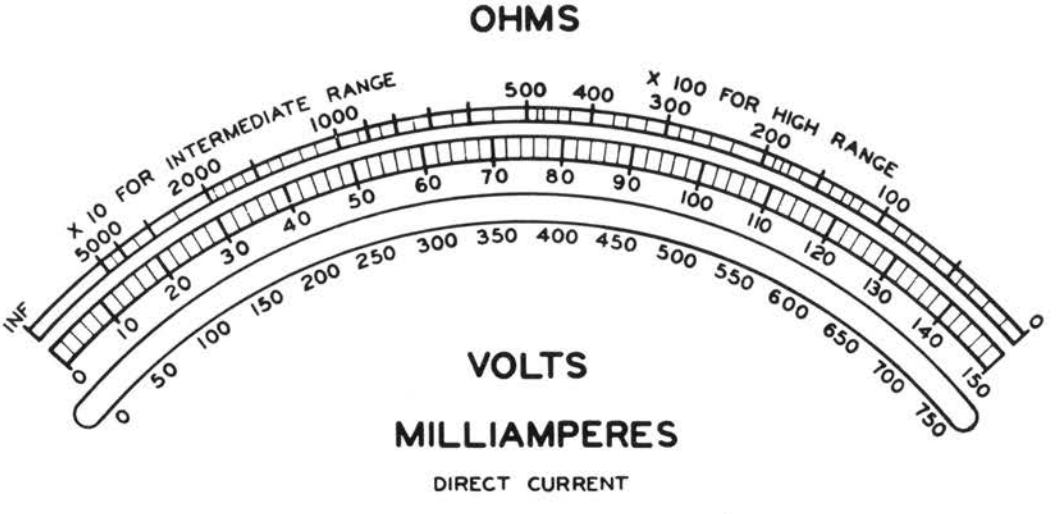

Figure 4. Volt-ohm-milliammeter scales.

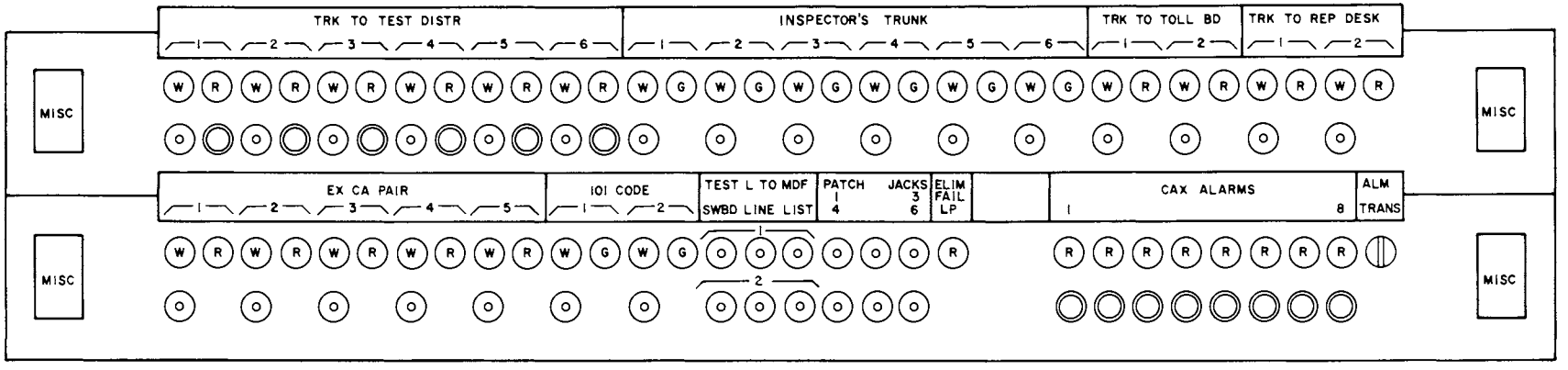

Figure 5. MISC jack strips of a typical Type 180L Local Test Panel.

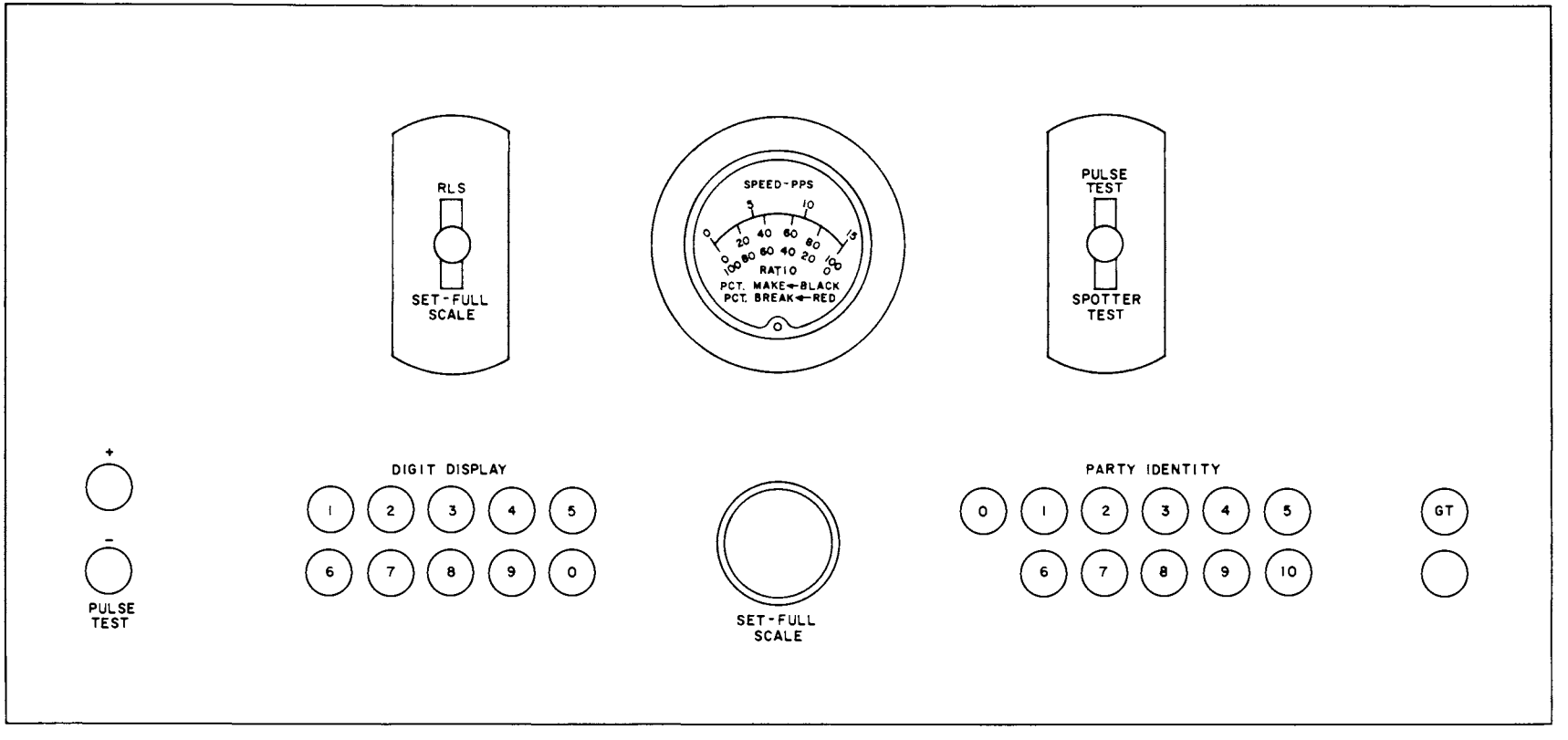

Figure 6. Dial speed test panel.

The miscellaneous jack strips mount single jacks, push keys and lamp equipment. Lamp equipment is mounted in the top row and associated jack equipment in the bottom row. The push keys are also mounted in the bottom row. The test function of each jack on the miscellaneous jack strips is shown by a designation above the jack on a bristol board designation strip. The designation strip consists of 16 individual increments, each increment serving two jacks, in this way designations can readily be changed without changing the entire strip. In addition the miscellaneous jack strips are identified by number plates designated MISC and located at each end of the strips. Figure 5 illustrates the MISC (upper and lower) jack strips of a typical Type 180L Local Test Panel. The function of the lines and trunks available is described in section 4.

2.2.3 Auxiliary test components.

a. Dial Speed Test Panel. The Dial Speed Test Panel (figure 6) provides dial testing facilities for regular and SATT installations. When used as a regular dial testing facility, the DIGIT DISPLAY, PARTY IDENTITY, and GT (ground test) lamps and keys RLS and SPOTTER TEST are wired but not used. The Dial Speed Test Panel mounts within the jackfield (figure 7). The function of the Dial Speed Test Panel lamps and keys is described in section 3.4.

b. Howler. The howler is an optional component used to place howler tone on a line to attract the attention of a customer who has failed to return the handset to its cradle. The howler is mounted on the relay rack directly above the test battery (figure 7) or battery eliminator (see paragraph 2.2.4).

2.2.4 Test battery and battery eliminator.

The Type 180L Local Test Panel mounts a test battery or battery eliminator for a test voltage source of 150-volt and 15-volt dc. The battery or battery eliminator mounts on a battery tray located on the relay rack above the jackfield (figure 7).

The 200-volt dry battery required for insulation breakdown testing is located on a battery tray in the base of the lower unit, and is accessible by removing the door at the front of the lower unit.

2.2.5 Card file.

The Type 180L Local Test Panel can be equipped with a trouble ticket card file. This card compartment mounts below the jackfield as shown in figure 7.

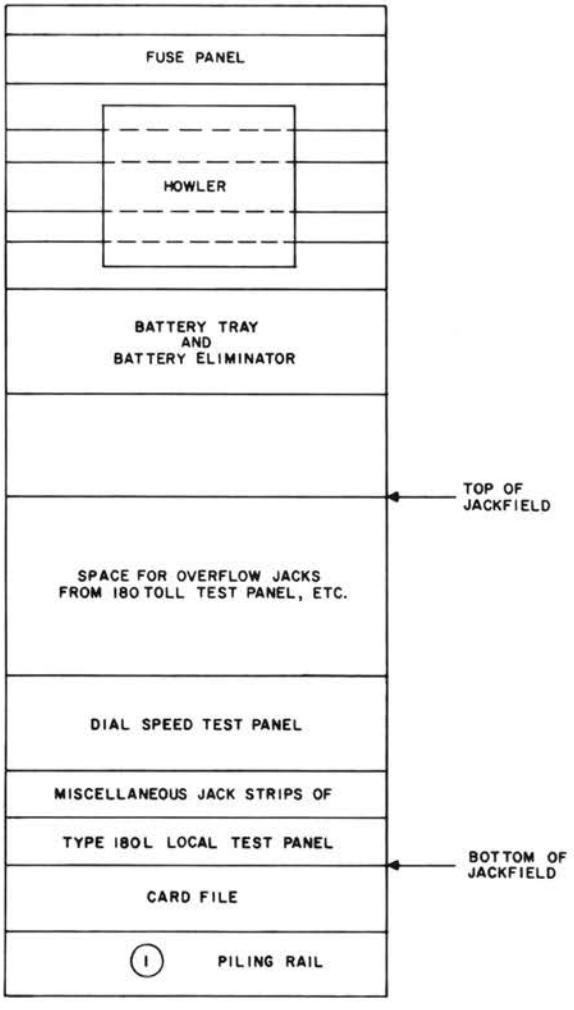

Figure 7. Typical layout of equipment mounted on the relay rack.

3. FUNCTION OF TEST PANEL KEYS, LAMPS, CORDS, AND CONTROLS

3.1 General

Controls used in testing operations at the test panel consist of keys, lamps, and cords of the plugshelf and keyshelf of the lower unit; and keys and controls associated with the Dial Speed Test Panel.

3.2 Function of Keys, Lamps, Cords, and Controls Located on the Plugshelf

The following sections provide information on the function of binding posts, rheostats, lamps, keys, and cords located on the plugshelf (figure 8) of the Type 180L Local Test Panel.

3.2.1 Binding posts T, R and T, R, G.

a. The first row of binding posts, designated T and R, is used to connect a portable Wheatstone bridge to the test panel. Operation of key PBX/WB, on the keyshelf,

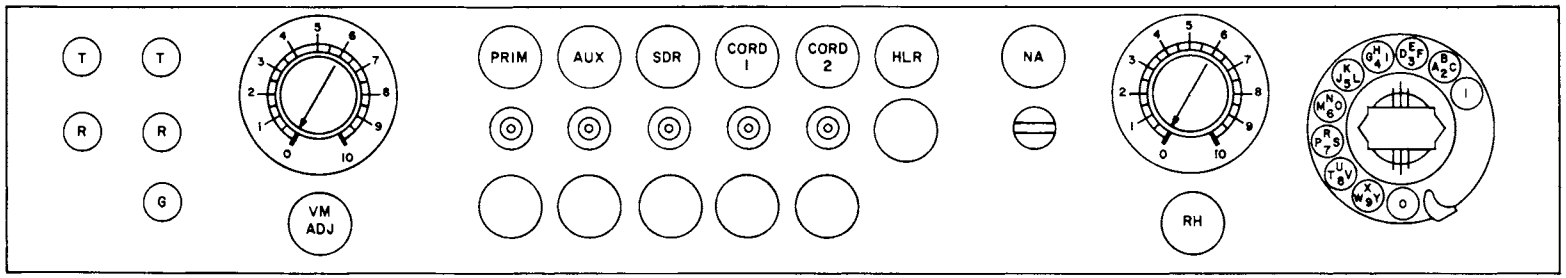

Figure 8. Arrangement of components on plugshelf.

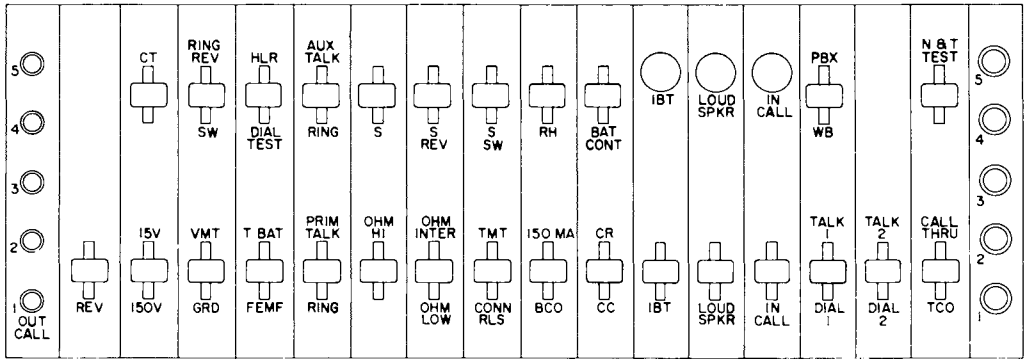

Figure 9. Arrangement of keys and lamps on keyshelf.

to the WB position connects the portable Wheatstone bridge to the primary test cord circuit. With a Wheatstone bridge, high-resistance faults may be located quickly and accurately with Varley or Murray loop tests.

b. The second row of binding posts, designated T, R, and G, is used to connect a transmission test set to the test panel. Operation of key N & T TEST on the keyshelf connects the transmission test set to the primary test cord circuit.

3.2.2 Rheostat VM ADJ.

Rheostat VM ADJ (voltmeter adjustment) is used in conjunction with key VMT/GRD operated to the VMT position to "zero" the meter to insure an accurate reading.

3.2.3 Primary test cord circuit (PRIM).

The primary (PRIM) test cord circuit is provided for making tests in conjunction with the meter and is also arranged so that the line or trunk under test can be connected to a portable Wheatstone bridge or a transmission test set. Using this cord circuit also allows the test attendant to dial (without operating a key) over Test Distributor Trunks to reach customer lines. The primary test cord circuit is arranged for the following operations:

a. Customer line testing or routining through Trunks to Test Distributor.

(1) Dialing (no keys operated) to reach a customer's line.

(2) Monitoring busy lines.

(3) Releasing permanent if any (see test distributor explanation for particular exchange).

(4) Testing customers' lines (see tests in section 5.2).

(5) Releasing customer's cut-off relay and seizing the line relay for in (switchboard) testing.

(6) Stepping test connector one rotary step at a time by dialing digit "1".

(7) Releasing the test connector (operate the TMT/CONN RLS key to the CONN RLS position) before dialing it up to the next level.

NOTE: The connection to a busy or idle line is held with the cord removed until it is released by operating the associated TRK TO TEST DISTRIBUTOR release key (located on the miscellaneous jack strip, figure 5).

b. Line and trunk testing through Test Lines to MDF.

(1) Monitoring through LIST jack (miscellaneous jack strip, figure 5).

(2) Testing heat coil continuity by measuring line relay voltage through the LIST jack.

(3) Testing the line side (outside equipment) through LINE jack (miscellaneous jack strip, figure 5).

(4) Testing switchboard side (inside equipment) through SWBD jack (located on miscellaneous jack strip, figure 5).

c. Incoming calls over Inspector's Trunks.

(1) Answering with PRIM TALK/RING and T BAT/FEMF keys operated to the PRIM TALK and T BAT positions to supply talking battery to the repairman.

(2) Holding the connection if the repairman disconnects.

NOTE: The repairman holds the connection if the primary cord (PRIM) is removed.

(3) Testing (see tests in section 5.2).

3.2.4 Auxiliary test cord circuit (AUX).

The auxiliary test cord circuit is provided for making tests which do not involve the use of the meter, Wheatstone bridge or transmission test set. Tests such as howler, dial speed, and sounder, require considerable time, and are made with the auxiliary test cord; thus enabling the test attendant to use the primary test cord circuit for other testing duties.

A test cord interchange key (designated SW) is provided on the keyshelf to allow the primary and auxiliary testing circuits to be interchanged with respect to their cords and therefore permits rapid testing during cut-over and rush periods. The auxiliary test cord circuit is arranged for the following operations.

a. Connects howler tone to a customer's line (through Trunk to Test Distributor or Test Line to MDF).

(1) Dialing (RING REV/SW key operated to the SW position) to reach a customer line.

(2) Monitoring for conversation.

(3) Releasing permanent, if any (see test distributor explanation for particular exchange).

(4) Testing with ohmmeter, etc., to determine whether the handset is actually off its cardle (RING REV/SW key in the SW position for testing).

(5) Placing howler tone on a line by operating the HLR/DIAL TEST key to the HLR position.

b. Dial speed testing (through Inspector's Trunks, Trunks to Test Distributor, or Test Line to MDF).

(1) Answering (AUX TALK/RING key operated to the AUX TALK position).

(2) Dial Speed Testing (operate HLR/DIAL TEST key to DIAL TEST position).

(3) Detecting party identity of ten-party SATT dials.

(4) Digit counting circuit to allow test attendant to verify that the digit "0" is dialed when checking party identity.

(5) Check that dial impulse springs do not open falsely when dial is rotated off-normal.

c. Serves as an auxiliary sounder cord circuit by operation of the S (sounder) key.

3.2.5 Sounder cord circuit (SDR).

The Type 180L Local Test Panel lower unit contains a sounder (figure 2) which may be energized by an outside repairman to signal the test attendant over a line connected to the sounder circuit. Exchange dial tone is associated with this circuit as an outgoing signal to a repairman who may need the tone to help him locate a particular pair, etc. A key designated S (sounder) is provided on the keyshelf to allow the sounder test circuit to be connected to the auxiliary test cord. A separate cord for the sounder is provided for those cases where the use of key S would tie up the auxiliary testing circuit.

The sounder cord circuit is arranged for the following operations after a connection to a line has been made (with the sounder cord or with the auxiliary cord and key S operated).

a. With the line shorted (or grounded on the ring), the SDR cord supervisory lamp lights, the sounder clicks to signal the test attendant and dial tone is sent to the repairman over the line.

b. Variations on item a. (see paragraph 5.3.2).

c. When key S SW (sounder switch) is operated, dial tone is placed on a pair to help the repairman find it.

d. Permits the repairman to short the line to signal the test attendant by operating the sounder and lighting the SDR lamp.

3.2.6 Single-ended cord circuit (CORD 1 and CORD 2).

Either one or two single-ended cord circuits may be supplied with the test panel. The single-ended cord circuit is used by the test attendant to make outgoing calls to a customer or another switchboard, and to extend an incoming call from a repairman to a customer over the regular switchtrain. The circuit is connected to either regular line equipment or to a selector.

3.2.7 NA (night alarm) key.

A turn-key used to prepare a circuit to a buzzer. When the test attendant is away from the test panel (and key NA is operated) and a call comes in, the buzzer will give an audible signal to the test attendant.

3.2.8 RH rheostat.

The RH rheostat is used in conjunction with key RH to insert 0-3000 ohms into the circuit to adjust to the correct current when making transmission tests, and when adjusting coin-box relays.

3.2.9 Dial.

The dial is associated with the test attendant's telephone circuit, and is used to originate or extend calls to a customer for talking, or to seize the customer line for testing purposes.

3.2.10 Lamps PRIM, AUX, SDR, CORD 1 and CORD 2, and HLR.

Lamps PRIM, AUX, SDR, and CORD 1 and CORD 2, are supervisory lamps associated with the cord circuits of the same designation. Lamp HLR (howler) is associated with the HLR key and howler circuit.

a. PRIM lamp - a white supervisory lamp associated with the primary test cord circuit. When the T BAT/FEMF key is operated to the T BAT position the PRIM lamp lights.

b. AUX lamp - a white supervisory lamp associated with the auxiliary test cord circuit. Key HLR/DIAL TEST is operated to the HLR position to send howler tone to a customer's telephone which has been left off-hook; this lamp will light when the customer replaces the handset. This gives the test attendant disconnect supervision and he may restore the HLR/DIAL TEST key to normal.

c. SDR lamp - a white supervisory lamp associated with the sounder circuit. This lamp lights as an indication of a ground on the ring side of the line, or as an indication that a fault has been cleared, depending on which keys (associated with the sounder test circuit) have been operated.

d. CORD 1 and CORD 2 lamps - white supervisory lamps associated with single-ended cord circuits CORD 1 and CORD 2. These lamps provide answer or disconnect supervision as described in section 5.4.

e. HLR (howler busy) lamp - a white lamp which lights to indicate that the howler is being used.

3.3 Function of Keys and Lamps Located on the Keyshelf

The following sections provide information on the function of keys and lamps located on the keyshelf of the Type 180L Local Test Panel. Figure 9 shows the location and designation of each key and lamp.

3.3.1 OUT CALL push keys (1, 2, 3, 4, 5).

The five OUT CALL push keys are used to connect the test attendant's telephone circuit to other desks or to another position of the Type 180L Local Test Panel.

3.3.2 REV key.

REV (reverse) key - a locking key used to reverse the tip and ring connections of a line or trunk under test. This key is used when making meter tests as follows: tests for negative potential on tip side of the line; resistance to ground on the tip side of the line; tests for capacitance; test for positive potential on the tip side of the line; resistance to a ground on the tip side of the line; insulation breakdown testing; testing coin box polarized relays; and for tip side party-line ringing.

3.3.3 CT key.

CT (capacitance test) - a locking key used when determining capacitance bridged across the line; capacitance between the ring side of the line and ground; and capacitance between the tip side of the line and ground.

3.3.4 15V/150V key.

15V (15-volt) - a locking key position used to check the voltage of the 15-volt test battery or battery eliminator. This key position is also operated when making a loop test with battery for measuring insulation resistance between wires of a two-wire line.

150V (150-volt) - a locking key position used to check the voltage of the 150-volt test battery or battery eliminator. This position is also used when making loop tests with battery; tests for resistance to a ground on the tip or ring side of the line; and tests for capacitance.

3.3.5 RING REV/SW key.

RING REV (ringing reverse) - a locking key position used to ring a party on the tip side of the line.

SW (switch) - a locking key position providing a means to interchange the connections to the auxiliary and primary cords. That is, the primary cord is connected to the auxiliary test circuit, and the auxiliary cord is connected to the primary test circuit. This eliminates the need for switching cords.

3.3.6 VMT/GRD key.

VMT (voltmeter test) - a nonlocking key position used when measuring the voltage of the 15- or 150-volt test battery or battery eliminator.

GRD (ground) - a nonlocking key position used to connect ground to the positive terminal of the meter when making tests for foreign negative potential on ring or tip side of the line. The GRD position is also used to connect ground to the positive terminal of the test battery when making the following tests: tests for ground on the tip or ring side of the line; and tests for capacitance on the tip or ring side of the line. This key is also used when making tests for foreign positive potential on the tip or ring side of the line.

3.3.7 HLR/DIAL TEST key.

HLR (howler) - a locking key position used to extend howler tone to a line when a receiver has been left off-hook.

DIAL TEST - a locking key position which connects the line under test to the Dial Speed Test Circuit.

3.3.8 T BAT/FEMF key.

T BAT (transmission battery) - a locking key position which furnishes battery and ground as talking battery, when the primary cord circuit is used, to the telephone of a customer or repairman outside the exchange.

FEMF (foreign electromotive force) - a locking key position used in conjunction with the VMT/GRD key in the GRD position to connect a ground on the negative terminal of the meter when making tests for positive potential on tip or ring side of the line.

3.3.9 AUX TALK/RING key.

AUX TALK (auxiliary talk) - a locking key position used to furnish talking battery to test attendant's telephone and customer's or repairman's telephone when the auxiliary test circuit is used.

RING - a nonlocking key position for connecting ringing current to a line when the auxiliary test circuit is used.

3.3.10 PRIM TALK/RING key.

PRIM TALK (primary talk) - a locking key position used in conjunction with the T BAT/FEMF key in the T BAT position to supply talking battery to a customer or repairman when the primary test circuit is used. This key position (PRIM TALK) is also used in conjunction with key CALL THRU/TCO in the TCO position when monitoring a line.

RING - a nonlocking key position for connecting ringing current to a line when the primary test circuit is used.

3.3.11 S key.

S (sounder) - a locking key position used to connect the auxiliary test cord to the sounder test circuit.

3.3.12 OHM HI key.

OHM HI (ohm high) - a locking key used alone to give resistance readings directly in ohms on the meter scale 50,000 ohms mid-scale (multiply 0-500 ohm scale by 100). The OHM HI key is also used in conjunction with other keys when making tests for resistance on the ring or tip side of the line.

3.3.13 S REV key.

S REV (sounder reverse) - a locking key used with the sounder test cord (or auxiliary test cord if sounder key S is operated) to test for a shorted line or ground on the tip side of the line.

3.3.14 OHM INTER/OHM LOW key.

OHM INTER (ohm intermediate) - a locking key position used alone when making loop tests without battery using the 0-150 volt scale of the meter. This key is also used in conjunction with other keys when making tests for negative foreign potential on the tip or ring side of the line using the 0-150 volt scale of the meter; tests for positive foreign potential on ring or tip side of the line using the 0-150 volt scale of the meter; testing loop resistance using the 5,000 ohms mid-scale (multiply 0-500 ohm scale by 10) scale of the meter; and tests for resistance to ground on the tip or ring side of the line measured directly in ohms on the 5,000 ohms mid-scale (multiply 0-500 ohm scale by 10) scale of the meter.

OHM LOW - a locking key position used alone when making loop tests without battery using the 0-150 volt (multiplied by .1) scale of the meter. This key is also used in conjunction with other keys when making tests for negative foreign potential on the tip or ring side of the line using the 0-150 volt (multiplied by .1) scale of the meter; tests for positive foreign potential on ring or tip side of the line using the 0-150 volt (multiplied by .1) scale of the meter; testing loop resistance using the 500-ohm mid-scale (read direct) scale of the meter; and tests for resistance to ground on the tip or ring side of the line measured directly in ohms on the 500-ohm mid-scale (read direct) scale of the meter.

3.3.15 S SW key.

S SW (sounder switch) - a locking key used to reverse the operation of the sounder circuit. The sounder circuit will remain inoperative while a fault is present; when the fault is cleared, the sounder circuit will operate.

3.3.16 TMT/CONN RLS key.

TMT (transmission test) - a locking key position used in conjunction with other keys when making transmission tests and when testing coin box polarized relays.

CONN RLS (connector release) - a nonlocking key position used when making routine tests on customer's lines via Trunk to Test Distributor. Operation of this key releases the test connector but holds the other switches in the switchtrain.

3.3.17 RH key.

RH (rheostat) - a locking key used to connect a 0-3000 ohm rheostat into the circuit.

3.3.18 150 MA/BCO key.

150 MA (150 milliampere) - a locking key position used when meter readings in milliamperes on the 0-150 scale are desired. This key (150 MA) is operated in conjunction with other keys when making transmission tests and tests for checking and adjusting coin box relays.

BCO (bridge cut-off) - a locking key position which permits testing the operation of the line relay. This key is also operated to the BCO position when monitoring customer dialing.

3.3.19 BAT CONT key.

BAT CONT (battery control) - a locking key used when making transmission tests to short-circuit two resistors in series with the battery-feed coil to increase the customer's transmitter current, if necessary.

3.3.20 CR/CC key.

CR (coin return) - a locking key position used to check that the coin control relay of a paystation is refunding coins properly. The CR/CC key is also operated to the CR position along with key RH to furnish variable current for adjustment of the coin control relay.

CC (coin collect) - a locking key position used to check that the coin control relay of a paystation is collecting coins properly. Also operate this key to the CC position along with key RH to furnish variable current for adjustment of the coin control relay.

3.3.21 IBT key.

IBT (insulation breakdown test) - a locking key used to determine if line insulation breaks down under the high potential of ringing or coin-control currents.

3.3.22 LOUD SPKR key.

LOUD SPKR (loud speaker) - a locking key which allows the test attendant to talk over a loudspeaking system to framemen located at the main frame.

3.3.23 IN CALL key.

IN CALL - a locking key operated when its corresponding IN CALL lamp lights in response to an OUT CALL key depressed by a distant operator, thereby establishing a talking circuit.

3.3.24 PBX/WB key.

PBX (private branch exchange) - a nonlocking key position used in conjunction with the 150 MA/BCO and CALL THRU/TCO keys in the BCO and CALL THRU positions respectively to seize a P-B-X line that has ground normally disconnected from the positive side of the line.

WB (Wheatstone bridge) - a locking key position used to connect the primary test circuit to a Wheatstone bridge testing circuit.

3.3.25 TALK/DIAL key (one or two optional).

TALK - a locking key position used in conjunction with its associated single-ended cord circuit to connect the test attendant's telephone circuit to the calling or called line for conversation.

DIAL - a locking key position used in conjunction with its associated single-ended cord circuit to allow the test attendant to dial through regular exchange switching equipment.

3.3.26 N & T TEST key.

N & T TEST (noise and transmission test) - a locking key position used to connect the line or trunk under test to a portable transmission test set.

3.3.27 CALL THRU/TCO key.

CALL THRU - a nonlocking key position used in conjunction with the 150 MA/BCO key operated to the BCO position to disconnect the primary test cord from the testing circuit and connect it to the test attendant's telephone and dialing circuit.

TCO (transmitter cut-off) - a nonlocking key position used when monitoring a line or trunk; the PRIM TALK/RING key must also be operated to the PRIM TALK position.

3.3.28 Ringing keys 1, 2, 3, 4, and 5.

1, 2, 3, 4, and 5 (ringing keys) - locking push keys used in conjunction with the PRIM TEST/RING or AUX TEST/RING keys operated to the RING position when harmonic party-line ringing is used. The operation of a harmonic ringing key furnishes ringing current of a particular frequency to ring a station ringer connected to the ring side of the line. The RING REV/SW key is operated to the RING REV position when ringing a party connected to the tip side of the line.

When superimposed ringing is required, push keys 1 and 2 are wired to (-) generator and push keys 3 and 4 are wired to (+) generator.

3.3.29 IBT lamp.

IBT (insulation breakdown test) - a green supervisory lamp which flashes when the IBT key is operated to make insulation breakdown tests.

3.3.30 IN CALL lamp.

IN CALL - a white lamp to signal the test attendant to answer a call on the in call circuit. The test attendant answers the call by operating the IN CALL key.

3.3.31 LOUD SPKR lamp.

LOUD SPKR - a red lamp which lights to signal the test attendant to answer a call on

the loudspeaker circuit. The test attendant answers by operating key LOUD SPKR.

3.4 Function of Keys and Controls Located on the Dial Speed Test Panel

The following sections provide information on the function of keys, lamps, and controls located on the Dial Speed Test Panel (figure 6).

3.4.1 Binding posts (PULSE TEST + and -).

Binding posts used to connect a dial directly to the test circuit for performing tests.

3.4.2 DIGIT DISPLAY lamps (1-0).

These lamps are used in a SATT installation as a digit counting circuit to allow the test attendant to verify that the digit "0" is dialed when checking party identity of SATT dials.

3.4.3 PARTY IDENTITY lamps (0-10).

These lamps are used when testing the party identification feature of ten-party SATT dials. One of these lamps lights to indicate the party identity of the dial under test.

3.4.4 GT (ground test) lamp.

This lamp lights, when checking the party identification feature of ten-party SATT dials, if a false ground exists on the tip side of the line.

3.4.5 SET FULL SCALE rheostat.

Rheostat SET FULL SCALE is adjusted (key RLS/SET FULL SCALE also operated to the SET FULL SCALE position) to give a full scale meter deflection to compensate for variations in the exchange voltage.

3.4.6 RLS/SET FULL SCALE key.

RLS (release) - a nonlocking key position used in a SATT installation to prepare the circuit for further tests.

SET FULL SCALE - a nonlocking key position operated in conjunction with the SET FULL SCALE rheostat to adjust the meter for a full scale deflection.

3.4.7 PULSE TEST/SPOTTER TEST key.

PULSE TEST - a locking key position that checks the adjustment of the dial impulse springs to insure they do not open when the dial is rotated off-normal.

SPOTTER TEST - a locking key position used when checking the party identifying feature of ten-party SATT dials.

4. FUNCTION OF LINES, TRUNKS, KEYS, AND LAMPS LOCATED IN THE MISC JACK STRIPS

4.1 General

Figure 5 is a line drawing of the MISC jack strips of a typical Type 180L Local Test Panel. The following sections provide information on the function of jacks, lamps, and keys located in the MISC jack strip.

4.1.1 Upper MISC jack strip.

a. TRK TO TEST DIST (trunk to test distributor). The upper MISC jack strip is equipped with six trunks to test distributors. Associated with each trunk is a white supervisory lamp, a red busy lamp, a jack, and a release key (push key).

   A trunk to test distributor permits the test attendant to reach any customer in a 10,000-line group by dialing through the test switchtrain. A typical test switchtrain (figure 10) consists of a test distributor trunk circuit, a test distributor, and a test connector (either a 100-line or 200-line type) for each connector group, although sometimes a test distributor selector may be ahead of the test distributor.

   The primary test cord is plugged into the test distributor trunk jack in order to establish a connection. The red busy lamp lights to indicate the trunk is busy. This lamp also flashes to indicate a busy switch or a busy line. To hold a connection the plug is removed; thus lighting the white supervisory lamp. This lamp will go out should the repairman hang up, or will flash if the repairman alternately presses and releases the hookswitch. If the lamp flashes, the test attendant re-inserts the plug and talks to the repairman. Should the lamp go out the test attendant presses the release key, associated with the trunk, to release the switchtrain.

b. INSPECTOR'S TRUNK. The upper MISC jack strip is equipped with six inspector's trunks (incoming trunks from selector levels). Associated with each trunk is a white answer lamp, a green hold lamp, and a jack.

   Inspector's trunks are provided in order that inspectors, installers, etc., may access the Type 180L Local Test Panel from a customer's station. The connection is established by dialing the code assigned for this service. When the code number is dialed, a white answer lamp lights. The test attendant answers by plugging a cord into the jack associated with the lit

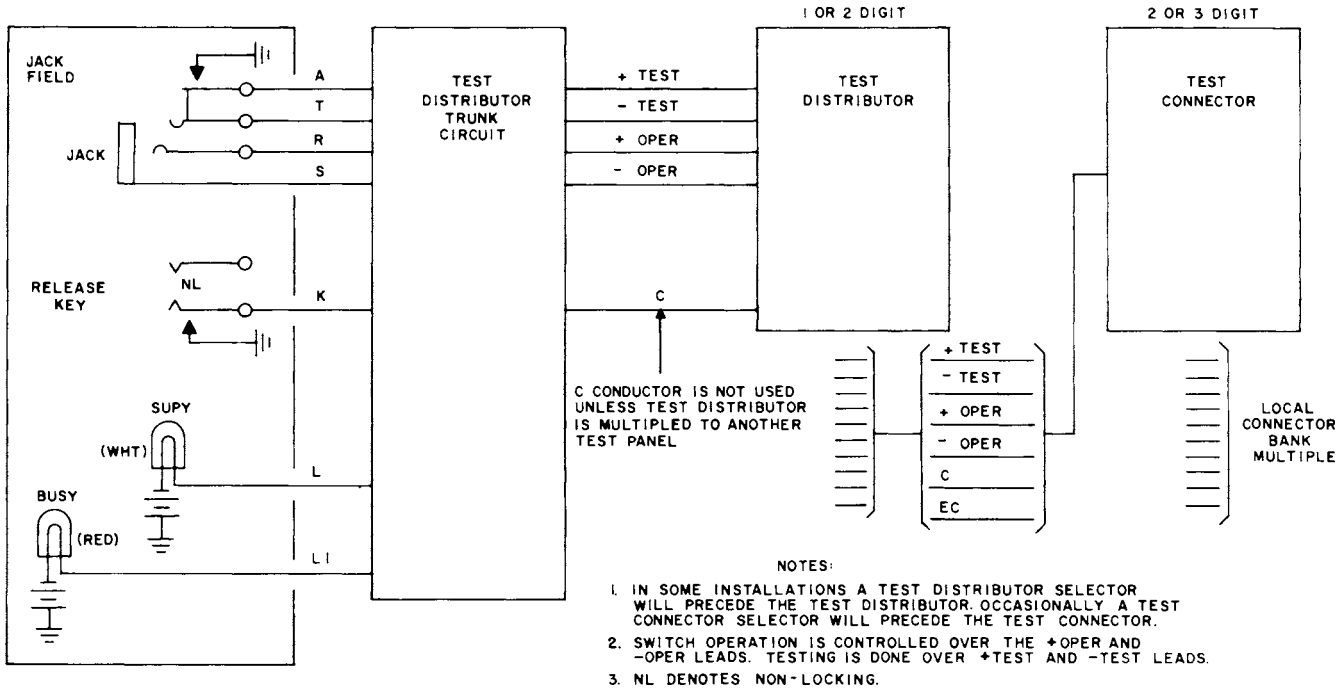

Figure 10. Typical test switchtrain.

answer lamp, extinguishing the lamp. The green hold lamp lights if the plug is removed from the jack, indicating that the calling party is still on the line. If the calling party alternately presses and releases the hookswitch the lamp flashes, thus signaling the test attendant that he is wanted on the line. If the calling party hangs up, the lamp goes out and the circuit is at normal.

c. TRK TO TOLL BD (trunk to toll board). Two trunks to toll board are located on the upper MISC jack strip. Associated with each trunk is a white answer lamp, a red busy lamp, and a jack.

The trunks to toll board are two-way trunks between the Type 180L Local Test Panel and the toll switchboard which allows the test attendant at the test panel and an operator at the toll switchboard to call each other.

d. TRK TO REP DESK (trunk to repair desk). The upper MISC jack strip is equipped with two trunks to repair desk. Associated with each trunk is a white answer lamp, a red busy lamp, and a jack.

The trunks to repair desk are two-way trunks between the Type 180L Local Test Panel and a repair clerk's desk, which allow the test attendant and repair clerk to call each other.

A white answer lamp associated with one of the trunks, lights to indicate a call from the repair clerk. The red busy lamp lights when the test attendant plugs into the jack associated with the lit answer lamp.

4.1.2 Lower MISC jack strip.

a. EX CA PAIR (extra cable pair). Five extra cable pair lines are located in the lower MISC jack strip. Associated with each line is a white line lamp, a red busy lamp, and a jack.

The extra cable pair line is a common battery line circuit utilizing a spare cable pair. It provides emergency service for plant members or may be used for an inside line for direct access to the Type 180L Local Test Panel. Tests can be made over this line since it is free of bridges and attachments.

The test attendant is signaled by a lighted line lamp. To answer, one of the cord circuit plugs is inserted into the jack associated with the lit line lamp. This extinguishes the line lamp and lights the busy lamp.

b. 101 CODE. The lower MISC jack strip is equipped with two one-way 101 code trunks. Associated with each trunk is a white answer lamp, a green supervisory lamp, and a jack.

101 code trunk jacks usually appear at the toll test panel. They are used to answer incoming 101 code calls from distant test personnel. When one test attendant must

divide his attention between both the Type 180L Local Test Panel and a toll test panel these trunk jacks are provided (to answer incoming 101 code calls) at both the Type 180L Local Test Panel and the toll test panel.

A lit white answer lamp indicates an incoming 101 code call. The test attendant plugs into the jack associated with the lit answer lamp thus extinguishing the lamp. The green supervisory lamp flashes on re-call by the distant operator. The test attendant may also re-call the distant operator.

c. TEST L TO MDF (test lines to main distributing frame). The lower MISC jack strip is equipped with two test lines to MDF. Associated with each line are three jacks; SWBD (switchboard), LINE, and LIST (listen).

The test lines to MDF provide means for making tests on lines and trunks connected to the MDF (Main Distributing Frame). At the MDF, a test shoe is provided for establishing a connection between the protector and the Type 180L Local Test Panel. This circuit terminates at the test panel, in a bridging jack for listening, and in two cut-off jacks so that the "line" (outside plant) side of the line or trunk may be tested independently of the "switchboard" (inside equipment) side and vice versa. The bridging jack is designated LIST and the cut-off jacks are designated SWBD and LINE.

d. PATCH JACKS (patching jacks). The lower MISC jack strip is equipped with six patching jacks. These jacks are associated with identical jacks located in the toll test panel jackfield. By use of these jacks, the test attendant may make use of precision test equipment associated with the toll test panel (such as the Wheatstone bridge) for testing local lines and trunks.

e. ELIM FAIL LP (eliminator failure lamp). The red eliminator failure lamp lights to indicate that the battery eliminator is not working.

f. CAX ALARMS (community automatic exchange alarms). The lower MISC jack strip is equipped with eight CAX alarm lamps (red) and eight CAX alarm release keys (push-button).

When a CAX alarm lamp lights and the CAX alarm buzzer operates, it indicates that trouble exists at the CAX associated with the lamp. The test attendant may extinguish the lamp by pressing the associated alarm release key.

g. ALM TRANS (Alarm Transfer). The lower MISC jack strip is equipped with an ALM TRANS key (turn-key) which allows the test attendant to transfer the CAX alarm receiving circuit to another desk or to the toll board.

5. TEST OPERATION

5.1 General

Test operations at the Type 180L Local Test Panel consist of tests using the primary, auxiliary, and sounder cord circuits. To initiate test operations at the test panel, connect an attendant's headset to the headset jacks in the upper left-hand corner of the lower unit (figure 2).

5.2 Primary Cord Circuit Test Instructions

Make a connection between the test panel and the line or trunk to be tested via Test Distributor Trunks, Test Lines to MDF, or another trunk or line arranged for testing, as described in section 4. Tests should not be started until the meter needle comes to rest.

Check the voltage of the 150-volt and 15-volt battery or battery eliminator before making any tests (see paragraph 5.2.1). Then make the next five tests (paragraphs 5.2.2 to 5.2.6) to make certain that there is no foreign potential on the line. If these tests show an absence of foreign potential, it is safe to proceed with the other tests.

Associated with each test section is a figure showing circuit conditions after the named keys have been operated.

5.2.1 Checking the voltage of the 150-volt and 15-volt battery or battery eliminator.

a. To check the voltage of the 150-volt battery or battery eliminator operate keys 15V/150V and VMT/GRD to the 150V and VMT positions. Read the test battery voltage on the 0-150 volt scale of the meter.

b. To check the voltage of the 15-volt battery or battery eliminator operate keys 15V/150V and VMT/GRD to the 15V and VMT positions. Read the test battery voltage on the 0-150 volt scale (multiplied by .1) of the meter.

5.2.2 Loop test with no battery on the meter (figure 11).

With all keys normal the meter is arranged for reading voltage on the 0-750 volt scale (figure 11A). A deflection of the meter needle

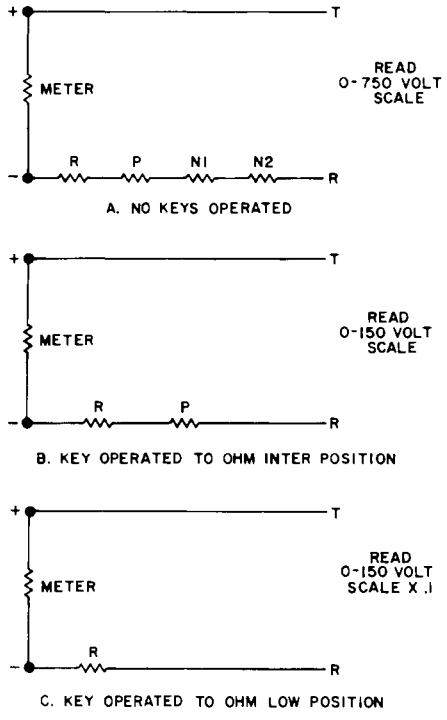

Figure 11. Loop test - no battery.

indicates that the line under test has d-c potential on it. A voltage reading of the distant battery may be taken in the same manner.

If the meter reading is below 150 volts on the 0-750 volt scale, operate the OHM INTER/OHM LOW key to the OHM INTER position for a more accurate reading on the 0-150 volt scale (figure 11B). If the meter reading is below 15 volts on the 0-750 volt scale operate the OHM INTER/OHM LOW key to the OHM LOW position for a more accurate reading on the 0-150 volt scale (multiplied by .1, figure 11C).

When testing the voltage of battery connected to a line or trunk, should the meter needle deflect off-scale, operate the REV key for the proper reading.

5.2.3 Test for foreign negative potential on ring (figure 12).

If the previous loop test with no battery indicated that some source of foreign potential is crossed with the line, make this test and those described in paragraphs 5.2.4, 5.2.5, and 5.2.6 to determine its location.

To test for foreign negative potential on the ring side of the line operate key VMT/GRD to the GRD position. A deflection of the meter needle indicates the presence of foreign negative potential on the ring.

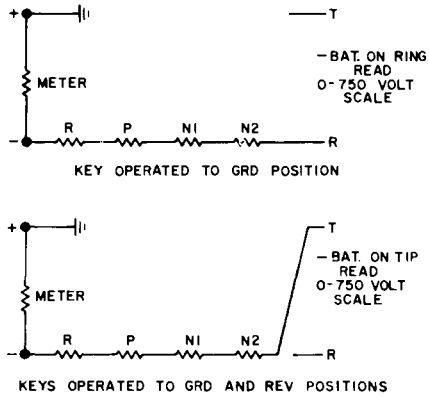

Figure 12. Test for foreign negative potential on ring or tip.

5.2.4 Test for foreign positive potential on ring (figure 13).

If in the preceding test for foreign negative potential on the ring side of the line, the meter needle deflects off scale, operate keys T BAT/FEMF and VMT/GRD to the FEMF and GRD positions. A deflection of the meter needle indicates the presence of foreign positive potential on the ring.

5.2.5 Test for foreign negative potential on the tip (figure 12).

To test for foreign negative potential on the tip side of the line, operate key VMT/GRD to the GRD position and the REV key. A deflection of the meter needle indicates the presence of a foreign negative potential on the tip.

5.2.6 Test for foreign positive potential on the tip (figure 13).

If in the preceding test for foreign negative potential on the tip side of the line, the meter

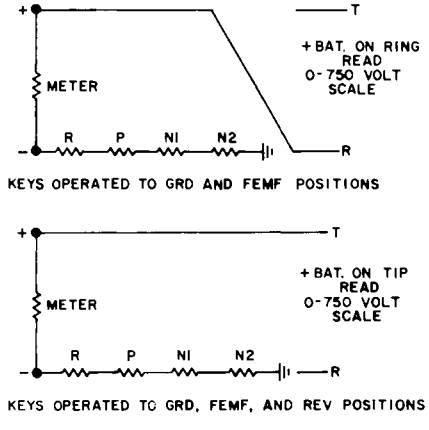

Figure 13. Test for foreign positive potential on ring or tip.

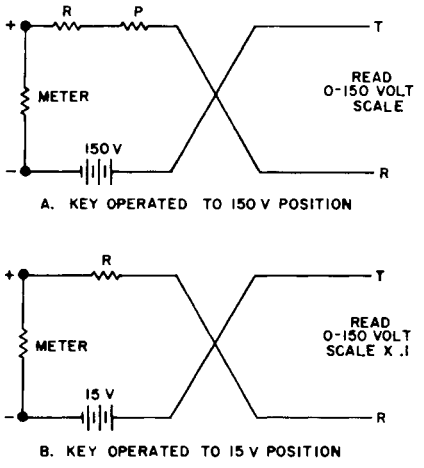

Figure 14. Loop test with battery in series with meter and line.

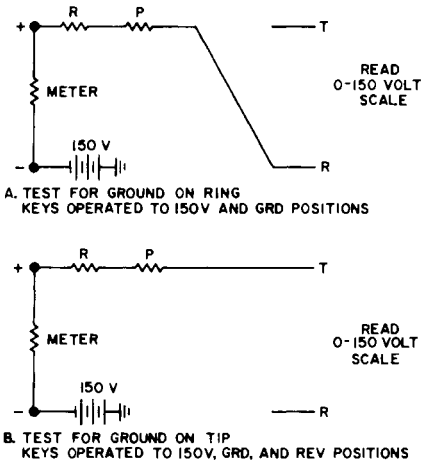

Figure 15. Test for ground on ring and tip.

needle deflects off scale, operate keys VMT/GRD and T BAT/FEMF to the GRD and FEMF positions and the REV key. A deflection of the meter needle indicates the presence of a foreign positive potential on the tip.

5.2.7 Loop test with 150-volt test battery in series with the meter and the line (figure 14).

To make a test for insulation resistance operate key 15V/150V to the 150V position (figure 14A). If the meter needle deflects and then returns to normal (on the 0-150 volt scale) the line insulation resistance is infinite and the line capacitors are being charged. A full deflection to 150 volts indicates a short circuit. If the meter needle deflects to 100 volts or under it indicates line insulation resistance over 50,000 ohms. Tables 1A and 1B may be used to convert the voltage reading to ohms or megohms. For example: if the meter reads 50 volts and a check of the test battery or battery eliminator voltage (paragraph 5.2.1) indicates 150 volts, reference to Table 1A shows insulation resistance of .200 megohms (200,000 ohms). This resistance may also be calculated by the following formula:

$$\text{Insulation Resistance (Ohms)} = \frac{V-S}{S} \times (100{,}000)$$

V is the voltage of the test battery and S is the meter reading in volts.

If the meter reading on the 0-150 volt scale is 15 volts or less operate key 15V/150V to the 15V position for a more accurate reading (on the 0-150 volt scale multiplied by .1, figure 14B).

If the meter reads more than 100 volts, the resistance can be measured more conveniently on the ohmmeter scale (refer to paragraph 5.2.11 for information on making ohmmeter tests).

5.2.8 Test for ground on ring (figure 15A).

To test for ground on the ring side of the line operate keys 15V/150V and VMT/GRD to the 150V and GRD positions. A deflection of the needle is an indication of ground on the ring side of the line.

5.2.9 Test for ground on tip (figure 15B).

To test for ground on the tip side of the line operate keys 15V/150V and VMT/GRD to the 150V and GRD positions and the REV key. A deflection of the meter needle indicates a ground on the tip side of the line.

5.2.10 Capacitance tests (figure 16).

To determine the capacitance bridged across a line, between the ring side of the line and ground, and between the tip side of the line and ground, proceed as follows:

a. Capacitance across the line. To test the capacitance between wires with ringer capacitors bridged across the line, first operate key 15V/150V to the 150V position. Then operate key CT. The operation of key CT starts an interrupter circuit which sends intermittent ground pulses to a capacitance test relay. When this relay is operated, the capacitors are charged to a certain polarity; when the relay restores, the capacitors are charged to the opposite polarity. This cycle is timed at such a rate that the deflection of the meter needle is

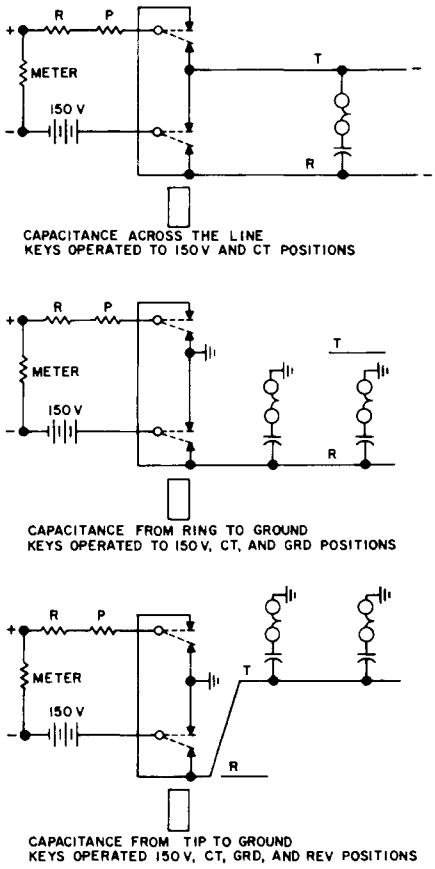

Figure 16. Capacitance test.

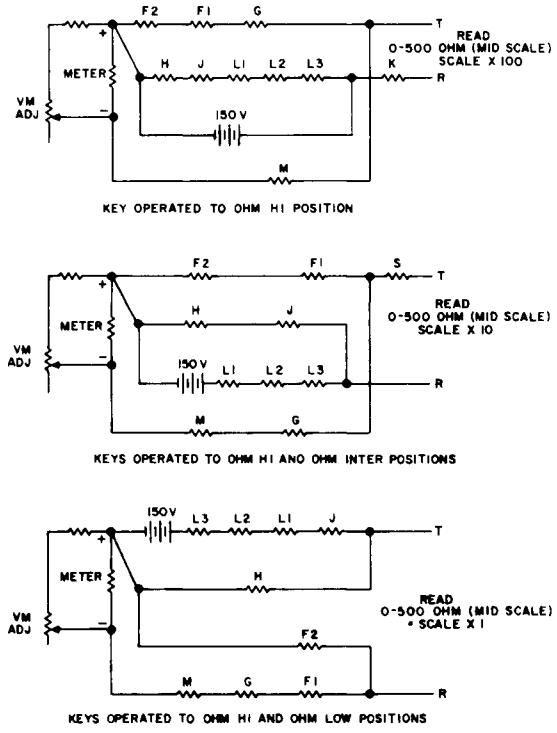

Figure 17. Loop resistance measurement.

held reasonably constant. The extent of the deflection indicates the relative capacitance across the line. The test will continue as long as the keys remain operated.

b. Capacitance between ring side of the line and ground. To test the capacitance of party lines which have the ringers connected between the ring side of the line and ground, first operate key 15V/150V to the 150V position. Then operate key CT and key VMT/GRD to the GRD position. The meter needle is deflected as described in item a. above. The extent of meter needle deflection indicates the relative capacitance between the ring side of the line and ground.

c. Capacitance between tip side of the line and ground. To test the capacitance of party lines which have the ringers connected between the tip side of the line and ground, first operate key 15V/150V to the 150V position. Then operate key CT and key VMT/GRD to the GRD position. Also operate key REV. The meter needle is deflected as described in item a. above. The extent of meter needle deflection indicates the relative capacitance between the tip side of the line and ground.

5.2.11 Loop resistance measurement (figure 17).

If the meter reading of the loop test with battery (paragraph 5.2.7) indicates a short circuit, or to measure the loop resistance of a good line (arrange to short-circuit the good line at its station) make the following test.

Operate key OHM HI; then operate key VMT/GRD to the VMT position, and adjust rheostat VM to "zero" the meter. Restore key VMT. Read the ohmmeter scale and multiply by 100. If the meter reading is over 500 ohms, leave key OHM HI operated and operate key OHM INTER/OHM LOW to the OHM INTER position. Re-zero the meter as stated above and read the ohmmeter and multiply by 10. If the meter reading is over 500 ohms, leave key OHM HI operated and restore the OHM INTER position of key OHM INTER/OHM LOW and operate it to the OHM LOW position. Re-zero the meter as stated above and read the ohmmeter scale directly.

5.2.12 Measurement of resistance to ground on ring.

To measure resistance to ground on the ring side of the line make tests in paragraph 5.2.11 with the VMT/GRD key operated to the GRD position. The operation of this key to the GRD position places a ground on the ring side of the line.

5.2.13 Measurement of resistance to ground on tip.

To measure resistance to ground on the tip side of the line make tests in paragraph 5.2.11 with key VMT/GRD operated to the GRD position, and key REV operated. The operation of key REV removes ground from the ring and puts it on the tip side of the line.

5.2.14 Ringing.

Operate PRIM TALK/RING (or AUX TALK/RING) key to RING position to connect the toll ringing supply (usually insulated from ground) to the customer's line, and ring a bridged straight-line ringer.

For party line code ringing on the tip side of the line, operate the RING REV/SW key to the RING REV position.

Then operate the PRIM TALK/RING (or AUX TALK/RING) key to the RING position, as required, for the code. With all ringing keys (1, 2, 3, 4, and 5) normal, only insulated toll ringing current is available. For divided ringing operate ringing key 1, 2, 3, 4, or 5 to get ground-connected generator.

For party-line harmonic ringing operate one of the ringing keys 1, 2, 3, 4, or 5 to select ground-connected ringing current of the required frequency. If the called station is to be rung over the tip side of the line, operate the RING REV/SW key to the RING REV position in conjunction with one of the ringing keys, then operate the PRIM TALK/RING or (AUX TALK/RING) key to the RING position.

For party-line superimposed ringing operate one of the ringing keys 1, 2, 3, or 4 to select ringing current of the desired polarity and for the desired side of the line. Then operate the PRIM TALK/RING (or AUX TALK/RING) key to the RING position.

The ringing current comes through a lamp and an 80-ohm polarized buzzer. If the test attendant rings on a low-impedance or short-circuited line, a 120V 25W lamp protects the ringing generator from the short circuit, and also prevents the short circuit from diverting all ringing current away from other test panel positions and from connectors, etc.

The buzzer loudness is an indication of the ringer load, line impedance, etc. An 800-ohm resistor bridged around the buzzer lowers the impedance so that the ringing current fed from the test panel (through the 120V 25W lamp, buzzer, and buzzer 800-ohm shunt) looks the same to the called station as does ringing current fed through a connector ringing cut-off relay. Thus an installer or inspector can adjust a station ringer under its normal operating condition.

5.2.15 Transmission tests.

Make transmission tests on new installations and for transmission complaints.

a. Transmission test using an artificial line. An artificial line (figure 18) is connected in the circuit between the line under test and the test attendant's telephone circuit. A repeating coil separates the customer's line from the testing circuit. The transmission battery feed is through repeating-coil windings 1-2 and 5-6. The artificial line is connected to repeating-coil windings 3-4 and 7-8. With the artificial line, the transmission equivalent of the testing

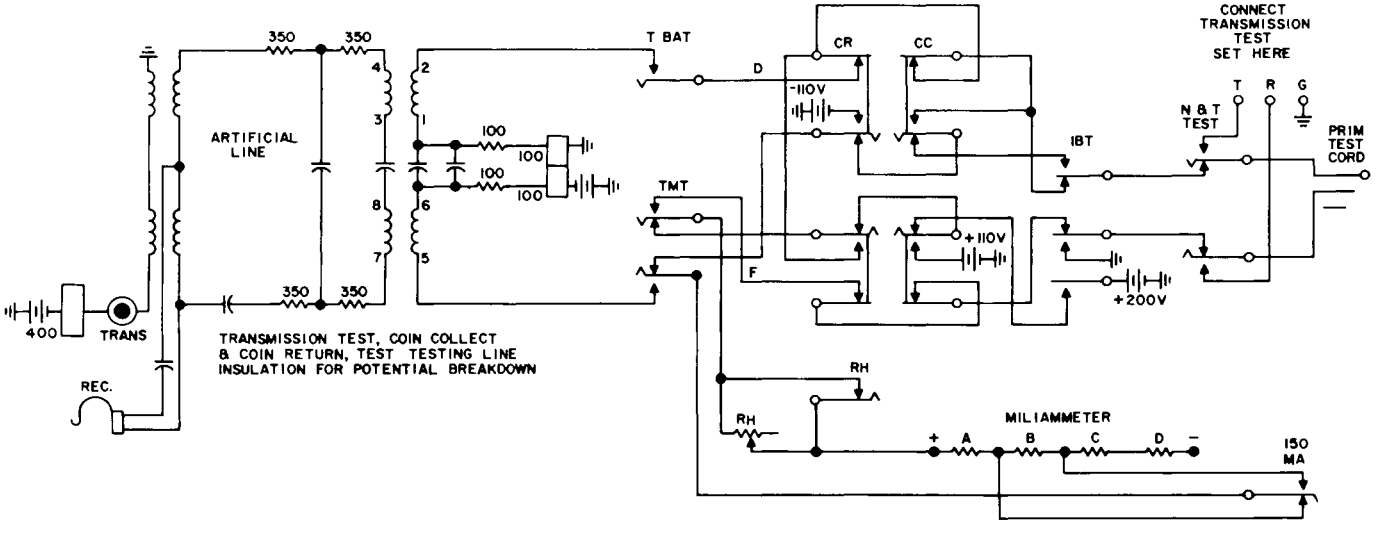

Figure 18. Milliammeter tests.

circuit approximates the minimum grade of transmission permissible on a toll connection. In addition, it is the general experience that small differences in volume can be detected more readily at this level.

A talking test is made between the test attendant and the installer at the customer's station. In order that a proper comparison may be made between the transmission obtained on one loop and the transmission obtained on another loop, either on the same or different days, it is essential that the testers use care always to talk in the same manner and with their lips always in the same relative position with respect to the transmitter.

Key RH at normal, short-circuits a 0-3000 ohm rheostat (designated RH on the plug shelf, figure 8). When key RH is operated, rheostat RH is cut in, and can be adjusted to insert 0-3000 ohms to adjust transmitter current to 40 milliamperes.

Make tests uniformly with 40 milliamperes supplied to the line loop. To do this, operate keys T BAT/FEMF, TMT/CONN RLS, and 150 MA/BCO to the T BAT, TMT, and 150 MA positions, respectively. Also operate key RH to cut in rheostat RH. Adjust rheostat knob RH until the milliammeter reads 40 milliamperes. This is equivalent to a subscriber loop of 500 ohms.

Key BAT CONT, when operated, short-circuits two 100-ohm resistors in series with the battery-feed coil, to increase the customer's transmitter current if necessary.

b. Loop-compensator adjustment for manually adjusted Type 80 or 90 telephones. The best performance of a Type 80 or 90 telephone is obtained when the line current through the transmitter is not over 60 milliamperes. A rheostat accessible from the bottom of the Type 80, or from the interior of the Type 90 (housing removed), has index numbers around the slotted end. As the slot is turned counterclockwise with a small screwdriver from 0-4, 0-400 ohms resistance is inserted in series with the line.

   To test for line-current measurement through usual 200 ohm + 200 ohm battery feed, operate keys T BAT/FEMF, TMT/CONN RLS, and 150 MA/BCO to the T BAT, TMT, and 150 MA positions, respectively. Have the installer vary the loop compensator until the current averages 60 milliamperes.

   If the telephone is on a long loop and the reading is less than 60 milliamperes, have installer set the loop compensator at "0".

   On party lines do not mix manually-adjusted Type 80 or 90 telephones with other types. Where it is absolutely necessary that one or more telephones lacking a loop compensator be mixed with Type 80 or 90 manually adjusted telephones, set the loop compensator of each such equipped telephone at "0".

c. Transmission test with a portable test set. If a portable transmission test set is available, the line or trunk under test may be connected to it by operation of the N & T TEST key. Connect the test set to the second row of binding posts on the plugshelf of the test panel (figure 8).

5.2.16 Wheatstone bridge test.

To make resistance measurements using a portable Wheatstone bridge, operate key PBX/WB to the WB position. Connect the Wheatstone bridge to the first row of binding posts on the plugshelf of the test panel (figure 8). Refer to the directions supplied with the bridge when making specific tests.

5.2.17 Testing line insulation for breakdown.

Prior to making tests for line insulation breakdown, the previous tests described in paragraphs 5.2.7 and 5.2.11 should be made to determine the insulation resistance of the line. The following tests for line insulation breakdown may be made to determine if the line insulation breaks down under the high potentials of ringing, or coin-control current.

To test the tip side of the line for insulation breakdown, operate key IBT. The green IBT lamp flashes during the test. A deflection of the meter needle (0-750 milliampere scale) in excess of 20 milliamperes indicates trouble.

To test the ring side of the line, operate the IBT key and the REV key. Read the meter as stated above. To return the circuit to normal restore the IBT key and REV key (if operated).

5.2.18 Paystation relay tests.

Prepay and semi-postpay paystations use polarized relays which can be adjusted by an installer or inspector working with the test attendant. The relays should be tested with the upper housing in place.

If the following tests show that the coin relay is not properly adjusted, have the installer or inspector adjust it until the relay operates satisfactorily. To talk with the inspector, operate keys PRIM TALK/RING and T BAT/FEMF to the PRIM TALK and T BAT positions. The inspector may signal the test attendant by alternately pressing and releasing the hookswitch.

a. Testing prepay paystation coin relays (figure 18). Key CR/CC (coin return and coil collect) connects coin control battery of positive and negative potential respectively to the tip side of the primary test circuit through the meter in series with rheostat RH. The key is so wired that the current flow through the meter is always in the same direction with either positive or negative potential on the line. After establishing a connection with the paystation under test, the following coin collect and coin return tests may be made. The coin relays should be adjusted to operate on a certain specified current in order that the proper operation will be assumed and that ground potentials may not interfere.

To test a prepay paystation for coin collection, have the inspector drop a coin (or trip the coin-relay trigger by hand) to connect the coin relay to the line. Turn rheostat RH counterclockwise as far as it will go to insert maximum resistance in the circuit. Operate key CR/CC to the CC position and key RH. This connects positive coin control battery (+110 volts) through a resistance lamp, the meter, and rheostat RH to the tip. Turn rheostat RH clockwise until the meter (0-750 ma scale) reads the coin relay 58.8 milliampere (58.8 ma is equivalent to 60 volts applied directly to the terminals of the 1020 ohm coin relay) "operate" current. The coin relay should operate and collect the coin. Restore the CC/CR key and reoperate it to the CC position; the meter should read "0" to show the coin relay has disconnected.

To test for coin return operate key RH and key CC/CR to the CR position (after the inspector has deposited a coin). Negative coin battery (-110 volts) is connected through a resistance lamp, the meter, and rheostat RH to the tip. Adjust rheostat RH clockwise until the meter reads the coin relay 58.8 milliampere "operate" current. The relay should operate and refund the coin. Restore key CR/CC and then re-operate it to the CR position; the meter should read "0" to show that the coin relay has disconnected.

Repeat the above operations with coin relay "nonoperate" current ("nonoperate" current of 39.2 milliamperes is equivalent to 40 volts applied directly to the terminals of the 1020 ohm coin relay). The coin relay should not operate.

b. Testing semi-postpay paystation coin relay. The inspector must lift the handset to connect the coin relay to the semi-postpay paystation line. Then the test attendant operates keys T BAT/FEMF and TMT/CONN RLS to the T BAT and TMT positions and key RH. The operation of these keys connects exchange battery and ground through the meter (0-750 ma scale) and the rheostat RH to the tip and ring sides of the line. Turn rheostat RH until the meter reads the coin relay 83-ohm winding "operate" current (usually 26 milliamperes). Then operate key REV. Reverse battery operates the coin relay and locks out the paystation transmitter until the inspector trips the coin-trigger with a coin. (Where ten cents is required for a local call, the meter may read over 30 milliamperes; this is normally due to short-circuiting of some paystation apparatus.) Operate key PRIM TALK/RING to the PRIM TALK position and have the inspector hang up. Then restore key PRIM TALK/RING. Turn rheostat RH counterclockwise until the meter reads the coin relay 2900-ohm winding "operate" current of 9 milliamperes (9 milliamperes is equivalent to 50 volts in a 5460-ohm circuit). Then restore key REV to reset the coin relay; if it resets properly, the meter will read "0".

5.2.19 Routine testing of customer's lines via Trunk to Test Distributor.

It is often desirable to make routine tests on the entire group of lines to which a test connector has access. The test attendant establishes a connection via a test distributor trunk to a test connector (see paragraph 5.5.1).

To test lines accessed by a 100 line test connector, establish connection to line 11 by dialing "11". After routine tests have been made on this line, step the connector one line at a time by dialing digit 1 for each step until tests have been made in succession on lines 12 through 10.

Momentarily operate key TMT/CONN RLS to the CONN RLS position; this releases the test connector but holds the other switches in the train. Next, dial 21 and repeat the above sequence until line 20 is tested. Momentarily reoperate key TMT/CONN RLS to the CONN RLS position. Repeat the above operations on each remaining level until all lines in the particular hundred group have been routined.

To test lines accessed by a 200 line type test connector, the hundred group-selecting-digit (usually "1" for the first hundred and "6" for the second hundred group) must be dialed either ahead or in back of the two (line-selecting) digits depending upon the circuit requirements of the particular switch. Otherwise, the method of operation is the same as described for testing with the 100 line type

test connector (except that the group-selecting digit must be repeated each time a new level is dialed).

If the test attendant wants to continue with routine tests in other connector groups served by the same Trunk to Test Distributor, momentarily operate the associated release key (figure 5). Repeat the above dialing operation for each connector group accessed from the test distributor bank levels until all lines (or any particular portion of lines) have been tested. Remove the plug from the jack and operate the associated release key. This frees the test switchtrain.

When there are other Trunks to Test Distributors in the central office, or to nearby exchanges, select the proper trunk or trunks, and continue the tests in the above manner.

5.2.20 Monitoring while a customer dials.

If a customer reports that he is unable to dial a certain number, and tests fail to reveal any trouble, it is often desirable to monitor at the test panel while the customer attempts to dial the number.

Connect to the customer's line over the test distributor switchtrain. Ring the customer and operate keys T BAT/FEMF and PRIM TALK/RING to the T BAT and PRIM TALK positions. Then instruct the customer to dial (on hearing dial tone) the number. Restore the T BAT/FEMF key to normal and operate key 150 MA/BCO momentarily to the BCO position. This releases the line equipment cut-off relay and permits the line relay to operate. If the line equipment is functioning properly, dial tone will be returned to the customer and test attendant. Thus, with the PRIM TALK/RING key operated to the PRIM TALK position the test attendant may monitor the call without interference with the customer's dialing.

5.2.21 Testing line equipment of line under test.

After establishing connection with a line, operate key 150 MA/BCO to the BCO position. A deflection of the meter needle indicates that the line circuit is prepared for seizure. Operate key CALL THRU/TCO to the CALL THRU position momentarily, to connect the test attendant's telephone and dialing circuit across the line under test. Upon hearing dial tone, dial the desired number. When dialing is completed, restore key 150 MA/BCO to normal.

To seize a P-B-X line that has ground normally disconnected from the tip side of the line, operate key PBX/WB to the PBX position in addition to keys 150 MA/BCO and CALL THRU/TCO in the BCO and CALL THRU positions.

5.3 Auxiliary Cord Circuit Test Instructions

The following tests may be made with the auxiliary test cord circuit in conjunction with the dial speed testing circuit, the sounder cord circuit, and the howler circuit.

To talk over the auxiliary test cord circuit, operate key AUX TALK/RING to the AUX TALK position. This connects the test attendant's telephone circuit and transmission battery to the line.

5.3.1 Dial tests.

The dial speed test circuit, associated with the auxiliary test cord circuit, is used to measure dial speed, to check dial pulse springs for normal operation, to check party identity of ten-party SATT dials, and to verify that the digit "0" is dialed by counting digits when checking party identity. Figure 6 shows the dial speed test panel used for regular and SATT installations.

Dial tests may be made over Inspector's Trunks (incoming trunks from selector levels). Connection with the customer's line for these tests can also be made via a Trunk to Test Distributor or Test Line to MDF.

Before making any dial tests adjust the meter for a full scale deflection. To do this, operate key RLS/SET FULL SCALE to the SET FULL SCALE position; rotate rheostat SET FULL SCALE to obtain a full scale meter reading (to compensate for variations in exchange voltage). Then release the RLS/SET FULL SCALE key. Operate key HLR/DIAL TEST to the DIAL TEST position (located on the key shelf of the lower unit). The circuit is now ready to make the following dial tests:

a. Test for false opening of dial impulse springs. This test is made to determine whether the dial impulse springs open falsely when the dial is rotated off-normal. This test should be made first, before proceeding to the dial speed and digit counting or the spotter test.

   Operate dial speed test circuit key PULSE TEST/SPOTTER TEST to the PULSE TEST position. Ask the distant repairman to rotate the dial off-normal and hold it momentarily. The dial speed meter should continue to read full scale. If the dial impulse springs open when the dial is rotated off-normal, the meter circuit opens and the meter needle falls to zero to indicate the open loop.

b. Dial speed test without SATT party identity - to check dial speed of the standard dials, instruct the distant serviceman to dial "0" (all dial speed test circuit keys at normal). Since the meter was originally calibrated to read "10" on the meter scale at a pulse scale of 10 pulses per second (pps) at any other speed the meter deflection will vary proportionately.

c. Dial speed and digit counting test. This test on SATT dials is the same as in b. above except that a DIGIT DISPLAY lamp corresponding to the digit dialed lights. When the digit "0" is dialed DIGIT DISPLAY lamp "0" should light. If DIGIT DISPLAY lamp "1" lights when digit "0" is dialed, or if a lamp numbered one higher than the digit dialed lights when any other digit is dialed, the adjustment of the impulse shorting arm on the dial should be checked to make certain that its action occurs soon enough to blank out the last pulse as the dial returns to normal. The serviceman could then correct the condition by consulting standard adjustment sheets.

   To extinguish the lamp for other tests operate key RLS/SET FULL SCALE to the RLS position. Successive dial speed readings can be made without operating the RLS key, but the digit counting feature will be inoperative for successive readings.

d. Dial speed, digit counting, and party identity test - this test is used to check the party identification feature of a SATT dial. Operate key PULSE TEST/SPOTTER PULSE to the SPOTTER PULSE position. Instruct the serviceman to dial the digit "0". After the digit is dialed, the PARTY IDENTITY lamp lights showing which dial on a party line is used.

   Dial speed and digit counting tests can be made at the same time by dialing the digit "0".

   If PARTY IDENTITY lamp "0" lights, it indicates a private line telephone or that the spotter pulse is not being detected.

   If a ground fault is detected on the tip side of the line, lamp GT will light.

   To re-check the identity of a party's dial or to prepare for further tests, momentarily operate key RLS/SET FULL SCALE to the RLS position.

5.3.2 Sounder and tone tests.

The sounder test circuit may be connected to the auxiliary test cord at any time by operating key S. A separate sounder cord is provided for those cases where use of key S would tie up the auxiliary test circuit.

To test for a shorted line or ground on the ring side of the line insert the sounder cord (or auxiliary cord with key S operated) into the proper trunk or line jack. Ground on the ring side of the line or a shorted circuit operates the sounder, lights the white sounder cord supervisory lamp, and places dial tone on the line until the trouble is cleared.

If the ring side of the line is free of trouble, operate key S REV. In case ground is on the tip side of the line or the line is shorted, the sounder circuit will operate as described above.

If the line is shorted or grounded and the test attendant wants to be signaled when the line is clear, operate key S SW. This reverses the operation and the sounder circuit will remain inoperative while the fault is present. When the fault is cleared, the sounder circuit operates. Restore key S SW to remove the signal.

Whenever dial tone is on the line, it may be used by the serviceman to identify the wire (or pair) under test. Likewise, the serviceman signals the test attendant automatically when the fault is corrected. The serviceman may also insert his test telephone across the line and by alternately pressing and releasing the hookswitch he can attract the test attendant's attention.

5.3.3 Howler test.

Howler tone is connected to a line to attract the attention of a customer who has left his handset off-hook.

To connect howler tone to the line under observation or test, plug the auxiliary test cord into the proper line jack and operate key HLR/DIAL TEST to the HLR position. This starts the howler and lights the HLR lamp on the plugshelf. Howler tone is applied to the customer's line and continues howling until the customer replaces the handset. When the customer replaces the handset, the howler is stopped and supervisory lamp AUX lights to give the test attendant disconnect supervision. The test attendant then restores key HLR/DIAL TEST to normal, thus extinguishing supervisory lamp AUX and lamp HLR, marking the howler idle.

It is possible for another test panel to camp on a busy howler circuit without any affect to the circuit. After the test attendant restores key HLR/DIAL TEST, the other test panel will seize the howler circuit.

5.4 Single-Ended Cord Circuit

The test attendant may use the single-ended cord circuit to make outgoing calls to a customer or another switchboard, to answer an incoming call, and to extend an incoming call from a repairman to a customer over the regular switchtrain.

To make an outgoing call, operate the TALK/DIAL key associated with one of the single-ended cord circuits to the DIAL position. The supervisory lamp, associated with this cord circuit, lights and the desired number may be dialed. Restore the TALK/DIAL key to normal. When the called party answers, the supervisory lamp goes out. Operate the TALK/DIAL key to the TALK position to converse with called party. When conversation is over and the called party hangs up, the supervisory lamp lights. To release the switchtrain restore the TALK/DIAL key to normal. If the call is unanswered, momentarily operate the TALK/DIAL key to the TALK position to release the switchtrain.

To answer an incoming call, operate the TALK/DIAL key to the TALK position and insert the plug of the associated single-ended cord circuit (CORD 1 or CORD 2) into the incoming trunk jack. If the incoming call is from a repairman who wishes to be extended to a customer, restore the TALK/DIAL key then reoperate it to the DIAL position. Dial the desired number and restore the TALK/DIAL key. When the called party answers, the cord supervisory lamp goes out, giving the test attendant answer supervision. If the test attendant desires to take part in the conversation, he operates the key to the TALK position. When the parties hang up, the supervisory lamp lights to give disconnect supervision. The test attendant restores the TALK/DIAL key (if operated) and removes the plug to release the connection.

5.5 Making Outgoing Test Calls

The following sections provide information on making outgoing test calls via the various lines and trunks available.

5.5.1 Establishing a connection via Trunk to Test Distributor.

To establish a connection with a line in the automatic exchange via a Trunk to Test Distributor, insert the plug of the primary test cord into a jack of a test distributor trunk. The red busy lamp lights to mark the trunk busy. Dial the customer's number without operating any keys. The number of digits dialed depends upon the number of switches ahead of the test connector and also upon the number of digits each switch requires. If a busy switch is met while dialing in the train, the busy lamp will flash when the busy condition is reached. The test attendant may stay on the line until the busy lamp stops flashing; remove the plug and do other functions until the busy lamp stops flashing; or release connection by pushing the associated release key, and try later.

If the busy lamp flashes after dialing is completed, the line is busy. The test attendant may monitor the line to determine if the line is actually busy or held by "permanents" (faulty line conditions or line on which the handset has been left off-hook), by operating keys CALL THRU/TCO and PRIM TALK/RING to the TCO and PRIM TALK positions.

Whenever an idle line is seized, the line cut-off relay operates and frees the line of attachments, and the dialed line is ready for testing.

5.5.2 Establishing a connection via Trunk to Toll Board.

To call the toll board, insert the plug of either the primary or auxiliary test cord, or the single-ended cord into a jack associated with the two-way trunk to toll board. This lights the answer lamp associated with the trunk on the toll board. The red busy lamp at the test panel also lights. To talk to the toll board operator, operate keys PRIM TALK/RING and T BAT/FEMF to the PRIM TALK and T BAT positions when the primary test cord is used; key AUX TALK/RING to the AUX TALK position if the auxiliary test cord is used; or key TALK/DIAL in the TALK position if a single-ended cord is used.

Testing over these trunks is not required as they are used only for conversation between the local test panel and the toll board.

5.5.3 Establishing a connection via Trunk to Repair Desk.

To call the repair desk, insert the plug of either the primary or auxiliary test cord, or the single-ended cord into a jack associated with the two-way trunk to repair desk. The answer lamp associated with this trunk at the repair desk, lights. The red busy lamp at the test panel also lights. To talk to the repair desk clerk operate the proper key(s) corresponding to the cord used (as described in paragraph 5.5.2 above).

Testing over these trunks is not required as they are used only for conversation between the local test panel and the repair desk.

5.5.4 Establishing a connection via Extra Cable Pair line.

To call a plant member whose telephone is connected to an Extra Cable Pair line, insert

the plug of either the primary or auxiliary test cord into the associated trunk jack and operate either key AUX TALK/RING or PRIM TALK/RING to the RING position depending upon which cord is used. To talk, operate the above keys to either the AUX TALK or PRIM TALK positions (also operate key T BAT/FEMF to the T BAT position if the primary test cord is used).

Tests can be made over this line as it is free of all bridges and attachments.

5.5.5 Establishing a connection via Test Lines to MDF.

To extend a line or trunk from the MDF to the test panel insert a test shoe into the protector associated with the line or trunk to be tested. This operation loops the line through the cut-off (SWBD and LINE, figure 5) jacks at the test panel and also extends the heat coil side of the line through to the LIST jack at the test panel.

To monitor or listen on the line or trunk before testing without interrupting conversation or splitting the circuit, insert the plug of the primary test cord into jack LIST (figure 5). This connects the line or trunk in series with the protector heat coils, through the primary cord circuit (figure 19A). To monitor, hold key CALL THRU/TCO in the TCO position and operate the PRIM TALK/RING key to the PRIM TALK position.

To test the heat coils, make voltmeter tests described in paragraph 5.2.2 with the primary test cord plugged into the LIST jack. The line relay may be seized through the heat coils by operating key 150 MA/BCO to the BCO position and then key CALL THRU/TCO to the CALL THRU position momentarily (figure 19A).

For testing the line side of the line or trunk, plug the primary test cord into the LINE jack. This disconnects the switchboard side of the line and extends the line side to the primary test cord circuit (figure 19C).

To test the switchboard side of the line or trunk, plug the primary test cord into the SWBD jack. This disconnects the line side of the line and extends the switchboard side to the primary test cord circuit (figure 19B).

5.5.6 Establishing a connection via the Out Call Wire keys.

To call another desk or position of the test panel, push the Out Call Wire key associated with that desk. The test attendant's telephone circuit is connected across the line and a lamp lights at the called desk or position.

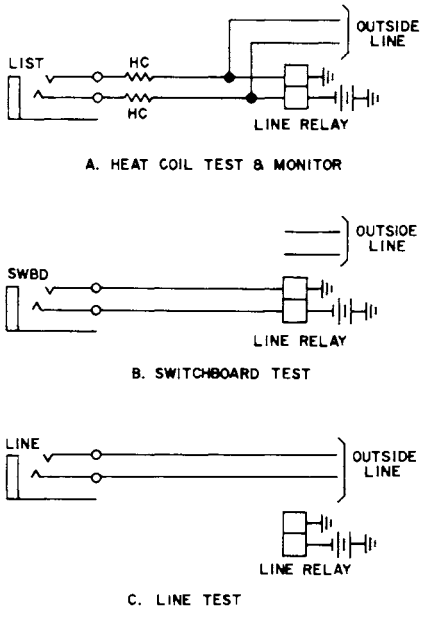

Figure 19. Test line to MDF.

5.5.7 Establishing a connection via Loudspeaker Trunk to MDF.

The loudspeaker trunk is provided for direct communication between the test attendant and men working on the Main Distributing Frame.

The test panel end of this circuit terminates on key LOUD SPKR located on the keyshelf (figure 9). The main frame end terminates on control equipment (generally on relay racks). Associated loudspeakers are located above the frame.

Operation of key LOUD SPKR enables the test attendant to talk to framemen over the loudspeaking system. The framemen are signaled by the test attendant's voice and by lighted MDF answer lamps located at as many as six locations.

To answer, the frameman momentarily operates a key at an MDF position, and then speaks into a talk-back transmitter associated with the key. Busy lamps light at the MDF positions and the answer lamps are extinguished. To talk to the test attendant from another location along the main frame, the frameman momentarily operates the key at that location. This cuts off the first talk-back transmitter from the circuit.

5.6 Handling Incoming Calls to the Test Panel

The following sections provide information on handling incoming calls at the Type 180L Local Test Panel.

5.6.1 Receiving a call via an Inspector's Trunk.

When the code assigned for this service is dialed by an inspector or installer, the test attendant is signaled by a lighted white answer lamp associated with the Inspector's Trunk seized. The test attendant answers by inserting the primary or auxiliary cord plug into the trunk jack associated with the lit answer lamp. If the primary and auxiliary cords are in use, a single-ended cord may be used. This extinguishes the answer lamp and removes ringback tone from the calling line. To talk to the inspector operate key AUX TALK/RING or PRIM TALK/RING to the AUX TALK or PRIM TALK position (if the primary cord is used also operate key T BAT/FEMF to the T BAT position). If a single-ended cord is used operate key TALK/DIAL to the TALK position. The inspector or repairman may have completed an installation or cleared a case of trouble and require tests to be made to check his work. The trunk is arranged so that any required tests can be made. The inspector may hang up to permit certain tests to be made (the testing circuit holds the connection as long as the test cord is left in the trunk jack).

The green hold lamp associated with the Inspector's Trunk lights when the answering cord is removed from the trunk jack (provided the calling party is still on the line). If the calling party hangs up, the hold lamp is extinguished. If, during the interval this trunk is in the hold condition, the calling party wishes the services of the test attendant, he can flash the hold lamp by alternately depressing and releasing the hookswitch. Care should be excercised when flashing since slow flashing may release the switchtrain.

5.6.2 Receiving a call from the local toll board via Trunk to Toll Board.

When the white answer lamp associated with a trunk to toll board lights, the test attendant answers by inserting the plug of the primary, auxiliary, or single-ended cord circuit into the associated trunk jack. To talk to the toll operator, operate the proper key(s) associated with the cord being used (as described in paragraph 5.6.1 above).

5.6.3 Receiving a call from the repair desk via Trunks to Repair Desk.

When the white answer lamp associated with a trunk to repair desk lights, the test attendant answers by inserting the plug of the primary, auxiliary, or single-ended cord circuit into the associated trunk jack. To talk to the repair clerk, operate the proper key(s) associated with the cord being used (as described in paragraph 5.6.1 above).

5.6.4 Receiving a call via Extra Cable Pair lines.

The test attendant is signaled by a lit line lamp (white) when a telephone is bridged across the line. Answer the call by inserting the plug associated with either the primary, auxiliary, or single-ended cord circuit into the associated trunk jack. This extinguishes the line lamp and removes the line relay from the line. To talk with the calling party, operate the proper key(s) associated with the cord being used (as described in paragraph 5.6.1 above).

5.6.5 Receiving a 101 Code call.

When a 101 code call from distant test personnel comes into the test panel, the white answer lamp lights. Answer the call by inserting the plug associated with either the primary, auxiliary, or single-ended cord circuit into the associated trunk jack. To talk with the calling distant test operator, operate the proper key(s) associated with the cord being used (as described in paragraph 5.6.1).

5.6.6 Receiving a call via the In Call Wire.

The In Call Wire (one per position) provides a means of direct communication between the Type 180L Local Test Panel and one or more other desks in the office, or between test panel positions. The calling end of the In Call Wire is connected to an Out Call Wire in one or more desks or other positions of the test panel.

An incoming call is indicated by lighting of the IN CALL lamp (located on the keyshelf, figure 9). To answer, operate key IN CALL. This connects the test attendant's telephone circuit across the line.

5.6.7 Receiving a call via Loudspeaker Trunk.

An incoming call on the loudspeaker trunk is indicated by the lighting of the LOUD SPKR lamp (located on the keyshelf, figure 9). To answer, operate key LOUD SPKR. The test attendant is now able to converse with the frameman.

TABLE 1A

INSULATION RESISTANCE

(VOLTMETER READING CONVERTED TO MEGOHMS)

READING (Volts)	TESTING BATTERY								
	138.0 V	139.5 V	141.0 V	142.5 V	144.0 V	145.5 V	147.0 V	148.5 V	150.0 V
1	13.7	13.8	14.0	14.2	14.3	14.5	14.6	14.8	14.9
2	6.80	6.89	6.95	7.04	7.10	7.19	7.25	7.34	7.40
3	4.49	4.55	4.61	4.64	4.70	4.76	4.79	4.85	4.90
4	3.17	3.18	3.44	3.47	3.50	3.53	3.59	3.62	3.65
5	2.66	2.69	2.72	2.75	2.78	2.81	2.84	2.87	2.90
6	2.20	2.23	2.25	2.28	2.30	2.32	2.35	2.38	2.40
7	1.87	1.89	1.91	1.94	1.96	1.98	2.00	2.02	2.04
8	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.76	1.78
9	1.43	1.45	1.47	1.48	1.50	1.52	1.53	1.55	1.57
10	1.28	1.30	1.31	1.32	1.34	1.36	1.37	1.38	1.40
11	1.15	1.17	1.18	1.20	1.21	1.22	1.24	1.25	1.26
12	1.05	1.05	1.08	1.09	1.10	1.11	1.12	1.13	1.15
13	.962	.974	.986	.995	1.01	1.02	1.03	1.04	1.06
14	.887	.896	.908	.917	.929	.938	.950	.962	.971
15	.821	.830	.839	.851	.860	.869	.881	.890	.899
16	.764	.773	.782	.791	.800	.809	.818	.827	.836
17	.713	.722	.728	.737	.746	.755	.764	.773	.782
18	.668	.674	.683	.692	.700	.707	.716	.725	.734
19	.626	.635	.641	.650	.658	.665	.674	.680	.689
20	.590	.596	.605	.614	.620	.626	.635	.644	.650
21	.557	.563	.572	.578	.584	.593	.599	.608	.614
22	.527	.533	.542	.551	.554	.560	.569	.575	.581
23	.500	.506	.512	.521	.527	.533	.539	.545	.551
24	.476	.482	.488	.494	.500	.506	.512	.518	.524
25	.452	.458	.464	.470	.476	.482	.488	.494	.500
26	.431	.437	.443	.449	.454	.460	.464	.470	.477
27	.411	.417	.423	.428	.433	.440	.445	.450	.455
28	.393	.398	.404	.409	.414	.420	.425	.431	.436
29	.376	.381	.386	.392	.397	.402	.407	.413	.417
30	.360	.365	.370	.375	.380	.385	.390	.395	.400
31	.345	.350	.355	.357	.364	.369	.374	.379	.384
32	.332	.336	.341	.345	.350	.354	.359	.364	.368
33	.318	.323	.327	.332	.336	.341	.346	.350	.354
34	.306	.310	.315	.319	.324	.328	.332	.337	.341
35	.294	.298	.303	.307	.311	.316	.320	.324	.328
36	.283	.289	.291	.297	.300	.306	.308	.314	.317
37	.273	.277	.281	.285	.289	.290	.297	.301	.305
38	.263	.267	.271	.275	.279	.283	.287	.291	.295
39	.254	.257	.261	.265	.269	.272	.277	.280	.285
40	.245	.249	.252	.259	.260	.263	.267	.271	.275
41	.236	.240	.244	.247	.251	.255	.258	.262	.266
42	.228	.232	.236	.239	.242	.246	.250	.253	.257
43	.221	.224	.228	.231	.235	.238	.242	.245	.249
44	.214	.217	.220	.224	.227	.231	.234	.237	.241
45	.207	.210	.213	.217	.220	.223	.227	.230	.233
46	.200	.203	.206	.210	.213	.216	.219	.223	.226
47	.193	.197	.200	.203	.206	.209	.213	.216	.219
48	.187	.191	.194	.197	.200	.203	.206	.209	.213
49	.182	.185	.187	.191	.194	.197	.200	.203	.206
50	.176	.179	.182	.185	.188	.191	.194	.198	.200

TABLE 1B

INSULATION RESISTANCE
(VOLTMETER READING CONVERTED TO OHMS)

READING (Volts)	TESTING BATTERY								
	138.0 V	139.5 V	141.0 V	142.5 V	144.0 V	145.5 V	147.0 V	148.5 V	150.0 V
51	171,000	173,000	177,000	179,000	183,000	185,000	188,000	191,000	194,116
52	165,000	168,000	171,000	174,000	177,000	180,000	183,000	185,000	189,000
53	161,000	163,000	166,000	169,000	172,000	175,000	177,000	180,000	183,000
54	155,000	158,000	161,000	164,000	167,000	169,000	172,000	175,000	179,000
55	151,000	153,000	156,000	159,000	162,000	165,000	167,000	170,000	173,000
56	147,000	149,000	152,000	155,000	157,000	160,000	163,000	165,000	168,000
57	142,000	145,000	147,000	150,000	153,000	155,000	158,000	160,000	163,000
58	138,000	140,000	143,000	145,000	148,000	151,000	153,000	156,000	159,000
59	134,000	136,000	139,000	141,000	144,000	147,000	149,000	151,000	154,000
60	130,000	133,000	135,000	137,000	140,000	143,000	145,000	147,000	150,000
61	127,000	129,000	131,000	134,000	136,000	139,000	141,000	143,000	146,000
62	123,000	125,000	127,000	130,000	132,000	135,000	137,000	139,000	142,000
63	119,000	121,000	123,000	126,000	129,000	131,000	133,000	135,000	138,000
64	115,000	118,000	121,000	123,000	125,000	127,000	129,000	132,000	134,000
65	113,000	115,000	117,000	119,000	121,000	124,000	126,000	128,000	131,000
66	109,000	111,000	114,000	116,000	118,000	121,000	123,000	125,000	127,000
67	106,000	108,000	111,000	113,000	115,000	117,000	119,000	121,000	124,000
68	103,000	105,000	107,000	109,000	112,000	114,000	116,000	118,000	120,000
69	100,000	102,000	105,000	107,000	109,000	111,000	113,000	115,000	118,000
70	97,500	99,500	101,000	103,000	105,000	108,000	110,000	112,000	114,000
71	94,500	96,500	98,500	100,000	103,000	105,000	107,000	109,000	111,000
72	91,500	93,500	96,000	97,500	100,000	102,000	104,000	106,000	108,000
73	89,000	91,000	93,500	95,500	99,700	99,500	101,000	103,000	106,000
74	86,500	88,500	90,500	92,500	94,500	96,500	98,500	101,000	103,000
75	84,000	86,000	88,000	90,000	92,000	94,000	96,000	98,000	100,000
76	81,500	83,500	85,500	87,500	89,500	91,500	93,500	95,500	97,000
77	79,500	81,000	83,500	85,000	87,000	89,000	91,000	92,500	95,000
78	77,000	78,500	81,000	82,500	84,500	86,500	88,500	90,500	92,000
79	74,500	76,500	78,500	80,000	82,500	84,500	86,000	88,000	90,000
80	72,500	74,500	76,500	78,500	80,000	82,000	84,000	85,500	88,000
81	70,500	72,000	74,000	76,000	77,500	80,000	81,500	83,000	85,000
82	68,500	70,000	72,000	73,500	75,500	77,500	79,500	81,000	83,000
83	66,500	68,000	70,000	71,500	73,500	75,500	77,000	79,000	81,000
84	64,500	66,000	68,000	70,000	71,500	73,000	75,000	76,500	79,000
85	62,500	64,000	66,000	67,500	69,500	71,000	73,500	74,500	77,000
86	60,500	62,000	64,000	65,500	67,500	69,000	71,000	72,500	74,500
87	58,500	60,000	62,500	64,000	65,500	67,500	69,000	70,500	72,000
88	56,500	58,500	60,500	62,000	63,500	65,500	67,000	68,500	70,000
89	55,000	56,500	58,500	60,000	62,000	63,500	65,000	67,000	69,000
90	53,500	55,000	56,500	58,500	60,000	61,500	63,000	65,000	67,000
91	51,500	53,500	55,000	56,500	58,500	60,000	61,500	63,000	65,000
92	50,000	51,500	53,500	55,000	56,500	58,500	60,000	61,500	63,000
93		50,000	51,500	53,500	55,000	56,500	58,000	60,000	61,500
94			50,000	51,500	53,500	54,500	56,500	58,000	60,000
95				50,000	51,500	53,500	54,500	56,500	58,000
96					50,000	51,500	53,000	54,500	56,000
97						50,000	51,500	53,000	55,000
98							50,000	51,500	53,000
99								50,000	51,000
100									50,000

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