

## LOCAL TEST DESK—14-TYPE OPERATION AND TEST PROCEDURE

### 1. GENERAL

1.001 This addendum supplements Section 662-400-500, Issue 1.

1.002 This addendum is reissued to:

- (a) Add information on testing lines equipped with multichannel subscriber carrier.
- (b) Add Fig. 16.
- (c) Add information on testing lines equipped with the Range Extender with Gain (REG).
- (d) Add Fig. 17.
- (e) Add Table 15.

### 2. PRIMARY TEST CIRCUIT

2.21 (After 2.21 add the following unnumbered paragraph)

**Caution:** *When establishing a connection to a line which is already busy, do not operate the RCCI key. To do so could cause the +48-volt talking battery from the local office to meet the -48-volt battery from the local test desk. This could result in abnormally high current through the local office trunk circuit supervisory relay.*

2.38 (After 2.38 add the following unnumbered paragraph)

**The Unigauge Range Extension (REX) Key** (Fig. 1) controls the range extension feature of the LTD and when operated, performs the following:

- (1) Increases to 96 volts the talking and supervisory battery supplied to the line under test
- (2) Cuts in a voice frequency amplifier with a gain of about 5 dB in both directions
- (3) Limits the meter current to 480 mA

- (4) Increases to 72 volts the superimposed battery in the secondary ringing circuit.

### 5. TEST CONNECTIONS

5.19 (After 5.19 add the following unnumbered paragraph)

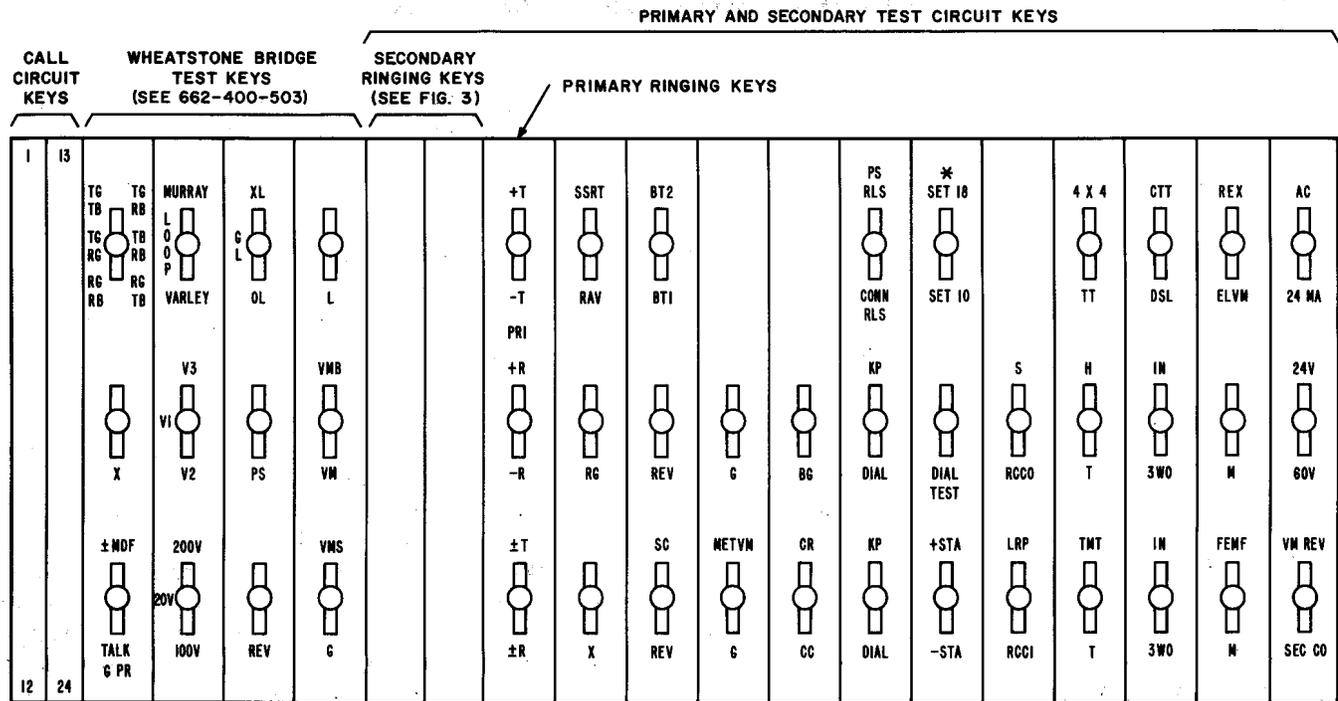
An interrupted permanent signal tone (60 ipm) identifies lines requiring unigauge range extension. In addition to the operation of the IN and 3WO keys, operate the REX key before regular ringing (SEC ringing keys) and talking over the line under test. When testing lines on plugging-up circuits, the line card must be consulted to determine whether the line is an extended unigauge range loop. Operate the REX key before regular ringing (SEC ringing keys) or talking if the line is extended loop.

5.21 (After 5.21 add the following unnumbered paragraph)

**Test Connection Through Switch Multiple (No. 5 Crossbar Offices Arranged for Unigauge):** When answering incoming calls on test trunks from the switch multiple in crossbar offices, a spurt of tone will be heard if the call is over a long loop unigauge line. (The calling party will also hear the tone). If the secondary cord and talk circuit are used to answer, operate REX and X keys (also T and RCCI keys of the primary circuit) in order to apply range extension features to the secondary cord. If the call is answered with the primary cord, operate only the REX key in addition to the T and RCCI keys.

### TEST TRUNKS WITHOUT LAMP SIGNALS

5.30 Consult the line card record to determine whether the line is an extended unigauge range loop. If so, operate REX key before ringing or talking on the line.



\* SEE FIG. 2

Fig. 1—Key Arrangement When Test Desk Is Equipped With Electronic Voltmeter, Keypulsing, Volt-milliammeter, Dial Speed Tester, Unigauge Testing, and Automatic Varley 3 Features

**6. METHOD OF PERFORMING TESTS, PRIMARY AND SECONDARY TEST CIRCUITS**

The following changes apply to Part 6 of this section:

- (a) 6.116 through 6.126—added
  - (b) Fig. 16—added
  - (c) 6.127 through 6.138—added
  - (d) Fig. 17—added
  - (e) Table 15—added
- 6.01** (After 6.01 add the following subtitle, VOLT-METER TESTING).
- 6.57** Revise table in 6.57 to read as shown.

## LINE IDENTIFICATION IN CROSSBAR OFFICES

TEST INDICATION	TYPE OF LINE	
	CROSSBAR NO. 1	CROSS BAR NO. 5
-48V on ring	Ring party, individual line, or last line of hunting group	Ring party or individual line
-24V on ring	—	Ring party of individual line (Unigauge)
-48V on tip	Tip party	Tip party
-24V on tip	—	Tip party (Unigauge)
Direct ground on ring	PBX line in terminal hunting group	PBX hunting line including last line of hunting group
1000 ohm ground on ring	—	PBX hunting line including last line of hunting group (Unigauge)

## COIN COLLECTOR RELAY TEST

**6.59** Use the primary test cord for coin collector relay tests. Request the person at the station to remove the coin collector housing, trip the coin trigger, and report the type of coin relay. The older type 60-volt relays are two-coil relays, while the newer type 50-volt relays have only one coil. The nonoperate and operate values are given in Table 13 and should be applied as described for the type of relay under test.

## A. Nonoperate Tests—All Type Relays

- (1) Operate the rheostat key, RHE, and adjust the rheostat to include maximum resistance.
- (2) Operate and hold the CR key while adjusting the current flow to the nonoperate value. Release and operate the CR key several times.

The milliammeter should show a deflection each time the key is operated. No deflection indicates that the coin relay has operated on the previous application of nonoperate current.

(3) Operate and hold the CC key. A milliammeter deflection of the nonoperate value should be obtained. Release and reoperate the CC key several times. The milliammeter should show a deflection each time the key is operated. No deflection indicates that the coin relay has operated on the previous application of nonoperate current.

## B. Operate Tests—60-Volt Relays

(1) Operate and hold the CC key while adjusting the current flow to the proper operate value, taking care that the operate value is not exceeded during adjustment. If the operate value should be exceeded, signal the station and request that the coin trigger be tripped, then repeat the adjustment. On long loops where the operate value cannot be obtained from the test desk, restore the rheostat key and repeat the test. Release and reoperate the CC key. If the relay is properly adjusted, no deflection will be obtained. Signal the station and ascertain that the relay operated properly. If it did, request the trigger be tripped again.

(2) Operate and hold the CR key. The milliammeter should indicate the same current flow as obtained in item (1). Release and reoperate the CR key. If the coin relay is properly adjusted, no deflection will be obtained on this test. Signal the station and ascertain that the relay operated properly.

## C. Operate Tests—50-Volt Relays

**Note:** The 50-volt coin relay is self-restoring and will result in the station ground being removed after the operate and slow-release holding period of the relay. Due to this feature, it will not be possible to obtain a steady reading of the operate current being applied.

**6.63** To test TOUCH-TONE dials on subscriber lines using the TOUCH-TONE frequency test applique circuit, establish connection to the customer line. Observe that the TOUCH-TONE group busy lamp associated with the test trunk is

TABLE 13

OPERATE VALUES OF COIN RELAYS

NUMBER STAMPED ON RELAY	NUMBER OF RELAY COILS	TYPE OF COIN COLLECTOR OR COIN TELEPHONE SET	CURRENT VALUE		REMARKS
			OPERATE	NONOPERATE	
P-10C117 P-10C725	Two	Multi-Slot 155-,166-, 174-, 176-Type, Etc.	60 ma	40 ma	Relay cannot be read-justed to perform reliably at lower values established for single-coil relays
P-10E786 P-13E961	One	Multi-Slot 200-, 1200-Type	48 ma	40 ma	Restoral spring diameter approximately 5/32-inch
P-15E687		Single-Slot 1A-, 2A- Type			
P-10E786* P-13E961*		Multi-Slot 200-, 1200-Type	41 ma	30 ma	Restoral spring diameter approximately 9/32-inch
1A* 1A (Note)		Single-Slot 1A-, 2A-, 1C-, 2C-, Type			

Note: Coin relays marked 1A without the asterisk symbol have bifurcated rather than solid contact spring.

not lighted, indicating that the TOUCH-TONE test circuit serving the test trunk is idle. Instruct the customer to wait for dial tone then to key a preliminary digit, if required as an indication to the TOUCH-TONE frequency test circuit of the number of digits to be dialed, as follows:

10 digits—No preliminary digit

12 digits—Preliminary digit 4

16 digits—Preliminary digit 5

The customer is requested to dial the preliminary digit, if required, and then to operate the dial buttons in order, left to right and top to bottom, ie, the top row of buttons is operated first in a left to right order; then the second row of buttons from the top is operated in the same order, etc. Operate the TT key in the test desk. The applique circuit transfers the customer line through a

TOUCH-TONE frequency test connector to an idle TOUCH-TONE frequency test circuit. A group busy lamp will light in all positions having multiple appearances indicating that the TOUCH-TONE frequency test circuit associated with that particular test trunk group of 4 trunks is busy. In the event that a TOUCH-TONE test receiver is unavailable when seizure is attempted over a test trunk, busy tone will be returned to the testing position but will not be audible to the customer. Dial tone remains audible during keying sequence. The test circuit examines the sequence and returns one of the following tone indications audible on both the customer line and the test desk position:

- (a) Two zips of high tone indicating an OK dial.
- (b) One zip of high tone indicating failure of one of the following conditions:
  - (1) Incorrect level of a digit

- (2) Incorrect frequency of a digit
- (3) Incorrect sequence of digits
- (4) Incomplete sequence of digits
- (5) Sequence not complete within a 15-second interval.

Additional frequency tests may be made on the customer line by restoring the TT key, instructing the customer to repeat the proper keying sequence, and reoperating the TT key. The dial test circuit is released by restoring the TT key.

- 6.65** (At the end of the paragraph, replace **CAUTION** with the following revised version)

**Caution:** *Howler tone, where still used, shall not be applied on trunks to a PBX due to the possibility of the attendant listening in during the tone cycle.*

#### TESTING SUBSCRIBER LINES EQUIPPED WITH POLE-MOUNTED MESSAGE AND SIGNAL REPEATERS (J98619A)

**6.94** Establish a test connection to the line in the normal manner through the line number or directory number. Apply positive coin potential (see **Note**) to the line under test for less than 10 seconds to operate the bypass circuit in the repeater. When two units are used in tandem, the positive coin potential must be applied sequentially to both units. After the bypass mode is established, the line may be tested for tip and ring continuity, grounds, shorts, and crosses. When testing in the bypass mode has been completed, application of a ringing signal to the line will restore the line to normal. A 3-minute timer is provided to restore the line to normal in the event a ringing signal is not applied to the line.

**Note:** Usually the CC key applies positive coin potential to the test circuit. In some central offices and test desks, the polarity of the coin potential is reversed; therefore, operation of the CR key will be required to apply positive coin potential.

#### TESTING SUBSCRIBER LINES EQUIPPED WITH UNIGAUGE RANGE EXTENDER CIRCUITS, NO. 5 CROSSBAR OFFICE

**6.95** Establish a test connection in the normal manner using the primary cord. Perform continuity and leakage tests in the usual manner. To ring a station, operate the X key and appropriate SEC ringing key. Also operate the RCCI and T keys. When the subscriber answers and the ringing is tripped, a high tone of 1/2-second duration will be heard in the receiver as an indication that the line under test is an extended unigauge range loop. Operate the REX and restore the X key to normal after hearing the tone. The range extension circuitry does not connect to the secondary cord for supplying talking battery.

**Note 1:** The 3W0 key may be used to verify an extended unigauge range line. Individual lines and the ring party of 2-party lines have -24 volts on the ring side; tip party lines have +24 volts on the tip side. PBX trunks have 1000 ohms to ground on the ring side.

**Note 2:** Monitoring a busy extended unigauge range line will register -72 volts on the position meter.

**Note 3:** To test IN toward the central office on an extended unigauge range line, the number called must be the balance test line or the milliwatt supply to prevent an unbalance (and subsequent possible repeater squeal) in the unigauge range extender.

#### TESTING SUBSCRIBER LINES EQUIPPED WITH U1 CARRIER SYSTEM

**6.96** A limited test is possible on *carrier-derived* lines. Establish a test connection to the carrier-derived line in the normal manner, using the primary cord. (Consult the line card record.) Continuity and leakage tests may be performed in the usual manner up to the *input* of the central office carrier equipment. (A 2-microfarad capacitor is bridged across the tip and ring of the line at input). Ring the station by operating the X key and the appropriate ringing key in the SEC test circuit. Normal talking tests may be made with the customer. The above tests are possible depending on the condition of the line. If physical line trouble is suspected, establish a test connection in the normal manner to the associated physical line. (Consult the line card record.) Test procedures

on the physical line are the same as those used on regular individual subscriber lines

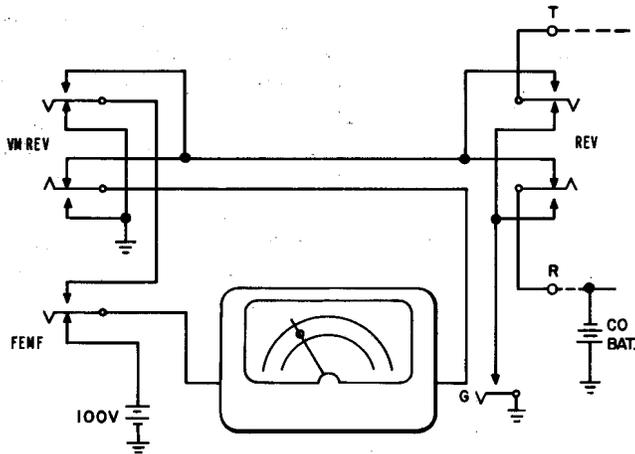


Fig. 6—Test for Cross With Central Office Battery Foreign Potential or Earth Potential

**TESTING SUBSCRIBER LINES EQUIPPED WITH 2A CIRCUIT PACK RANGE EXTENDER**

6.97 This range extender is a solid-state design of a dial long line circuit. It is used on subscriber lines over 30 kf from the central office, with as much as 1800-ohm conductor loop resistance. The LTD can make voltmeter tests on subscriber lines through the 2A circuit pack without having to use an MDF test trunk.

6.98 Establish a connection to the subscriber line in the normal manner. With the G key operated, a meter deflection of 37.5 to 42 volts should be measured on the 120V scale. Operate the 60V key, and with the G key still operated, a meter deflection of less than 4.0 volts should be measured on the 60V scale. A drop from about 40 volts to less than 4.0 volts when the 60V key is operated is an indication that a range extender is in series with the line. In addition, reasonably accurate tip to ring leakage measurements, as well as loop continuity tests, may be made with the 60V key operated. The station may be rung in the normal manner.

6.99 Further tests for correct operation of the range extender may be made when the station is off-hook or 1800 ohms is bridged across

the tip and ring of the cable pair at the MDF. Operate the RCCI, T, and REV keys. With each operation of the REV key there should be a meter deflection of approximately 30 mA for about 1/2 second, followed by a drop back to about 22 mA. Subsequent operations of the REV key should give the same deflections.

**TESTING COIN TELEPHONE SETS MODIFIED FOR DFT, MULTI-SLOT (200-TYPE) AND SINGLE-SLOT (1A- AND 1C-TYPE). (SEE FIG. 13 AND 14).**

6.100 Establish a connection to the line to be tested. Perform continuity and leakage tests in the usual manner. Note the absence of ground on the tip. Only normal leakage should be present.

6.101 Test the central office line relay to verify that it operates to provide DTF service. Procedure for testing the line relay of DTF lines is the same as the procedure for testing loop start lines described in 6.51 through 6.56 of this section.

6.102 Test for coin ground closure by ringing the station and requesting the station attendant to deposit coins equal to the initial rate. Disconnect talking battery and ground by restoring the RCCI and T keys. Operate the REV key. The test meter will indicate a coin ground on the tip with the station on-hook and on both tip and ring with the station off-hook. Operate the RCCI key. With RCCI and REV keys operated, -48-volt talking battery is connected to the tip through the test meter with the ring lead open. The test meter will indicate the tip ground. Restore RCCI and REV keys. Operate the CR key to return the coins. If coins cannot be returned while making any coin test, arrange for recovery of coins or reimbursement to attendant as covered by local procedures.

6.103 Single-slot sets and some multi-slot sets include a **ground removal relay**. This relay reduces noise by removing the unbalancing ground at the station during conversation. A modification of the LTD consists of, (a) applying + coin or - coin potential to the tip lead only, and, (b) grounding the ring lead through 1800 ohms when the G key is operated, (See Fig. 13). Test the ground removal relay as follows:

- (a) With the connection established, operate the RCCI and T keys to supply talking

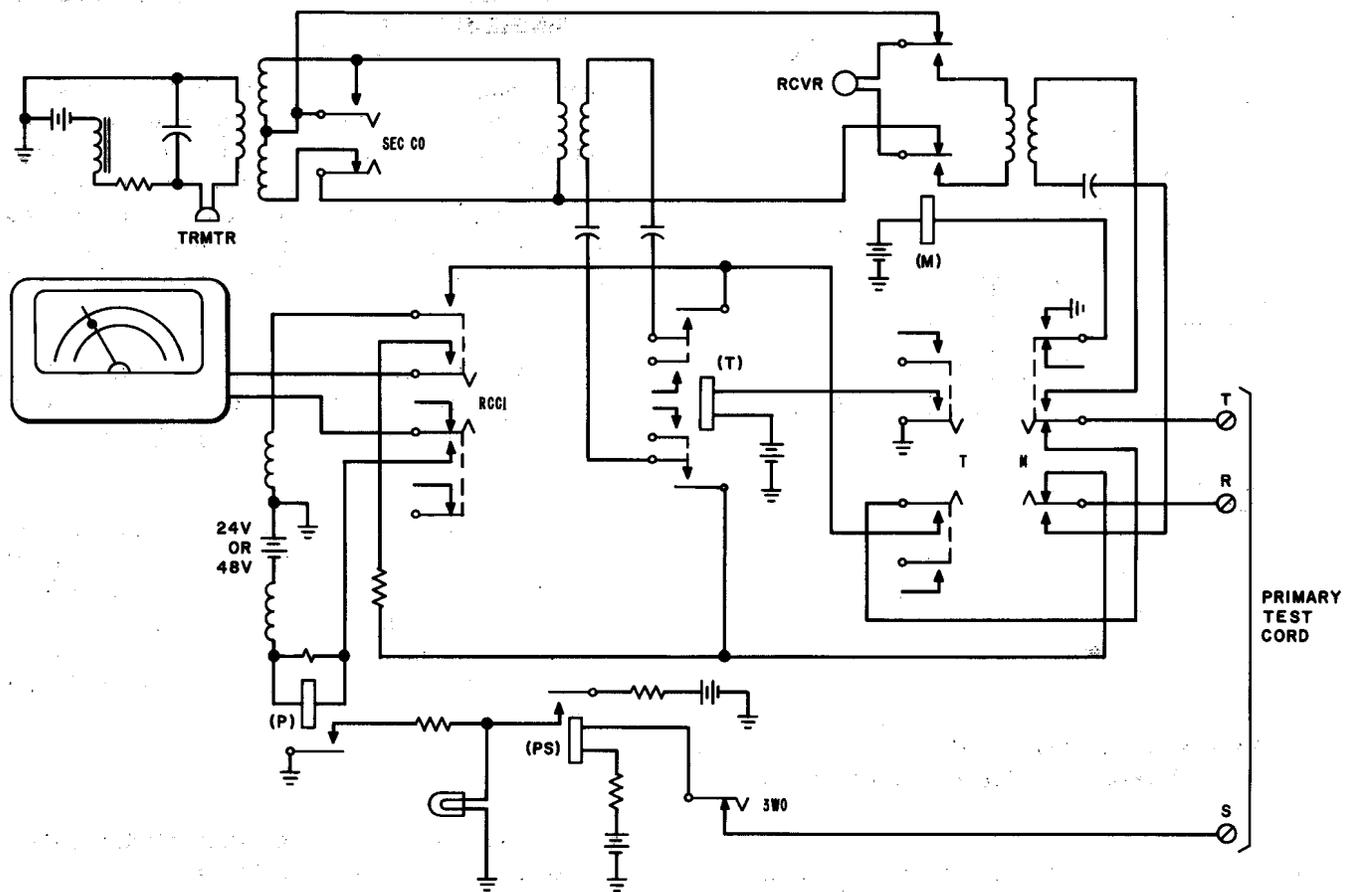


Fig. 9—Talking, Monitoring and Supplying Battery on Primary Test Circuit

battery and ground. Request attendant to deposit coins equal to the initial rate while remaining off-hook. Request attendant to delay a few seconds before depositing coins to permit testman to prepare for the test. During the pause, operate the CR and G keys. This connects coin return battery to the tip and grounds the ring through 1800 ohms.

(b) The ground removal relay (A) was operated over loop current when the talking connection with station attendant was established. Contacts of the A relay opened the coin relay ground path. Operation of the CR and G keys will apply coin return battery to the tip and resistance ground to the ring. The A relay will either hold, or release and then reoperate. Under these conditions, the test meter should read some value greater than 20 mA. With the coin relay ground

path open, there should be no change in meter reading when coins are deposited.

(c) Wait sufficient time for coins to be deposited, then verify their presence in the hopper by releasing the CR and G keys in that order and operating the REV key. Since the ground removal relay is in series with the ring lead, the relay releases and a coin ground is indicated on the tip. Return the coin in the normal manner.

**6.104 Failure of the ground removal relay to operate** as described in 6.103, will cause the test meter current to increase momentarily to some value over 45 mA when coins are deposited. With the ground path intact, the coin relay should operate to automatically return the coins. This will cause test meter current to return to the value greater than 20 mA. described in 6.103(b). If the

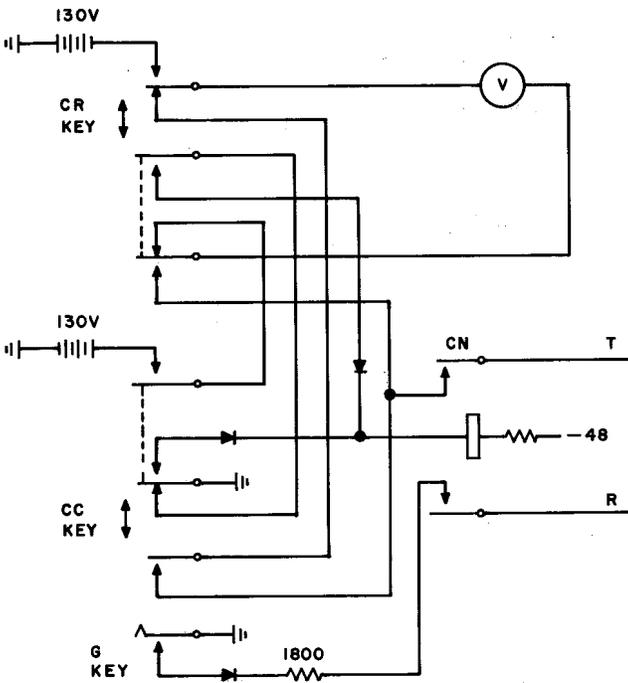


Fig. 13—CR, CC, and G Key Circuits for Testing Coin Telephone Sets Modified for Dial Tone First

loop is near maximum length, the coin relay may not operate, since it is in parallel with the station transmitter circuit. In this case, test meter current will remain near 45 mA. If this happens, request attendant to go on-hook so coins may be returned in the normal manner.

**A. TESTING THE CHUTE ELECTROMAGNET IN MULTI-SLOT SETS**

**6.105** When a multi-slot set is in the talking mode, a single nickel deposit is held in the chute. This is caused by conduction of a diode. The diode shunts the chute magnet and prevents it from operating. To test the diode and magnet, establish a connection and request attendant to deposit a single nickel. While still supplying talking battery and ground, operate the REV key. With battery potential reversed, the diode should not conduct. Loop current should operate the chute magnet to drop the coin in the hopper. Read the coin ground on the tip to verify proper action has occurred, and return the coin.

**B. TESTING THE TOTALIZER SHUNT DIODE IN SINGLE-SLOT SETS**

**6.106** Single-slot sets contain a diode which shunts the totalizer. This diode prevents the "readout" (coin identifying beep tone) of a single nickel deposit unless a positive potential of sufficient value is applied to the ring lead. Test the diode by establishing a connection and requesting the station attendant to deposit a single nickel while keeping the station off-hook.

- (a) With the RCCI and T keys operated, listen for a readout when the coin is deposited. If the diode is functioning properly, no readout will be heard.
- (b) Operate the CR key to return the coin and request the coin be redeposited. While keeping the RCCI key operated, operate the REV key. With battery at the diode reversed, the diode should become nonconducting and the readout should be heard. Restore REV key and return the coin.

**C. TESTING THE SILICON CONTROLLED RECTIFIER IN SINGLE-SLOT SETS. (SEE FIG. 14)**

**6.107** A silicon controlled rectifier (Q2) is in parallel with the totalizer initial rate contacts (T1). This arrangement permits the return of a single nickel deposit. A high negative voltage triggers the SCR (silicon controlled rectifier) causing it to conduct to close the coin relay ground path.

Test to verify that the SCR is triggered only by a high negative voltage.

- (a) Request station attendant to deposit a single nickel. After the coin is deposited, restore all operated keys and operate the REV key. A coin ground on the tip with the station on-hook and on both tip and ring with the station off-hook shows that at least one of the diodes, CR1 or VR2, is conducting.
- (b) Maintain the REV key operated and operate the RCCI key to apply -48 volts of talking battery to the tip with the ring open. No current reading above normal leakage should be obtained if the SCR does not trigger and if diodes CR1 and VR2 remain nonconducting.

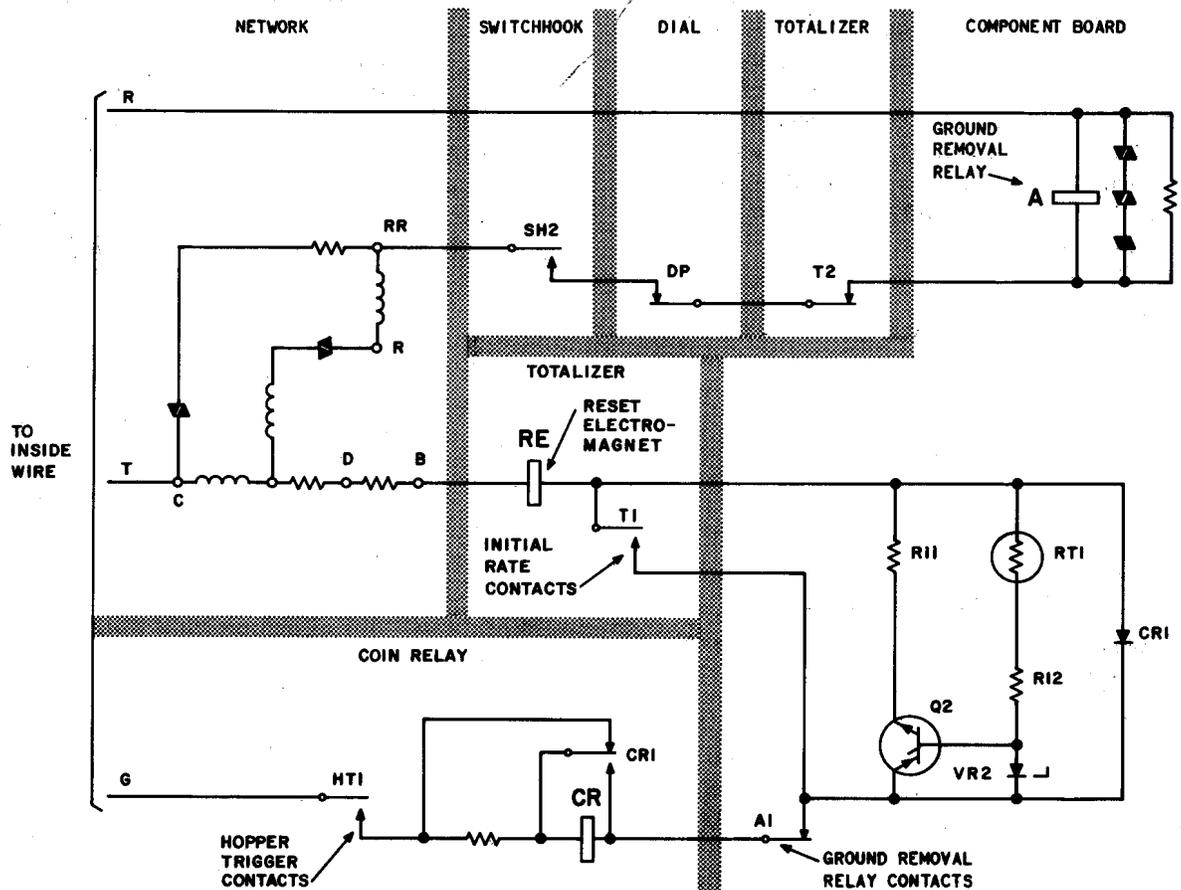


Fig. 14—Operating Paths of Ground Removal and Coin Relays in Single-Slot Coin Telephone Sets Modified for DTF

(c) Return the coin by operating the CR key to apply coin return potential to the tip to trigger the SCR. Failure to return the coin indicates a failure in the SCR or one or more of the circuit components paralleling the SCR. These items are shown on the component board, Fig. 14.

#### TESTING C PRESSURE TRANSDUCER

**6.108** The C Pressure Transducer is a bellows-actuated stepped switch arrangement which converts cable pressure in the range of 0 to 8 psi to resistance values ranging from 100,000 to 898,000 ohms respectively.

**6.109** Typically the C Pressure Transducer is installed on principal lateral or feeder cables at or near riser poles. At such locations its use

permits the following to be made from the test center.

- (a) A practical estimate of the pressure existing in the related UG cable at the manhole adjacent to the transducer location.
- (b) An approximate measurement of the cable pressure at the transducer and therefore provides a good indication of the effect, if any, of low pressure conditions elsewhere along the cable as evidenced by operating contactors.
- (c) Repeated tests, where indicated, to determine the speed of pressure drop where a low pressure condition has been observed. Such information can be helpful in estimating the real significance of a low pressure condition and the need for scheduling corrective action.

6.110 The resistance values are such that, when read from a 14-type test desk, a 50-volt reading on the 120-volt scale corresponds to zero pressure. Each 2.5-volt drop denotes a 0.5 psi pressure increase. The 14-type test desk arrangement is equivalent to a 100-volt dc voltmeter with 100,000 ohms internal shunt resistance placed in series with the transducer. The relation of cable pressure, transducer resistance, and voltmeter reading is shown in Table 14.

TABLE 14

RELATION OF CABLE PRESSURE, TRANSDUCER RESISTANCE, AND VOLTMETER READING

NOMINAL PRESSURE AT TRANSDUCER (PSI)	TRANSDUCER RESISTANCE (OHMS)	VOLTMETER READING* (120 VOLT SCALE)
0.0	100,000	50.0
0.5	110,000	47.5
1.0	122,000	45.0
1.5	135,000	42.5
2.0	150,000	40.0
2.5	166,000	37.5
3.0	186,000	35.0
3.5	208,000	32.5
4.0	232,000	30.0
4.5	265,000	27.5
5.0	301,000	25.0
5.5	344,000	22.5
6.0	400,000	20.0
6.5	468,000	17.5
7.0	568,000	15.0
7.5	698,000	12.5
8.0 and higher	898,000	10.0

\*Tolerance  $\pm 2.5$  volts for voltmeter reading associated with measured pressure at transducer. This tolerance is premised on 100-volt battery. Where the voltage at the test center is above or below 100 volts, the voltmeter reading should be adjusted accordingly. For example, with a 99-volt battery supply to the test position, each voltmeter reading in the above table should be reduced by 1 volt. Battery voltage is expected to be kept within the acceptable range of 99 to 101 volts.

TESTING POWER PAIR TO REMOTE REPEATER (FIG. 15)

6.111 The range of a customer loop can be extended by connecting a repeater in series with the loop. The repeater is located in a remote cabinet between the central office and the customer station and is powered from the central office over a separate cable pair. A remote cabinet has provision for two repeater panels, each panel capable of holding six repeaters. A separate power pair must be provided for each panel. A circuit on each panel constantly monitors the voltage on the associated power pair to insure that the voltage is adequate for repeater operation. Sufficient voltage on the power pair activates an oscillator, applying a 900 Hz tone on the power pair. If voltage drops below the required value, tone is removed from the pair, causing an alarm at the central office. When the circuit is unpowered, a power alarm and test circuit, associated with each repeater panel, shunts the series converters of the repeaters. This eliminates most of the loss normally added to the voice path by an unpowered E6 repeater. An unbalance detector in the power alarm circuit monitors the power pair to detect line unbalance, which may affect circuit operation.

6.112 A power pair can be tested by establishing a connection to the MDF appearance of the pair as described in 5.26 and performing a series of tests; *bridging*, testing *in* toward the central office, and testing *out* toward the customer station.

6.113 *Bridging Tests:* Connect to the power pair without opening it. This is accomplished with the primary cord by operating the 3W0 key. The secondary cord circuit may not have a 3W0 key, in which case the M key is used for bridging.

- (a) A tone (900 Hz) should be heard on the pair.
- (b) Voltage to ground on the tip and ring should be approximately +35 volts and -117 volts, respectively.

6.114 *Testing In:* Operate the IN key and restore the 3W0 (or M) key to open the pair toward the station and test in toward the central office.

- (a) Voltage readings to ground on tip and ring should be +48 volts  $\pm 4$  volts, and -130 volts  $\pm 5$  volts. The test meter can measure 120

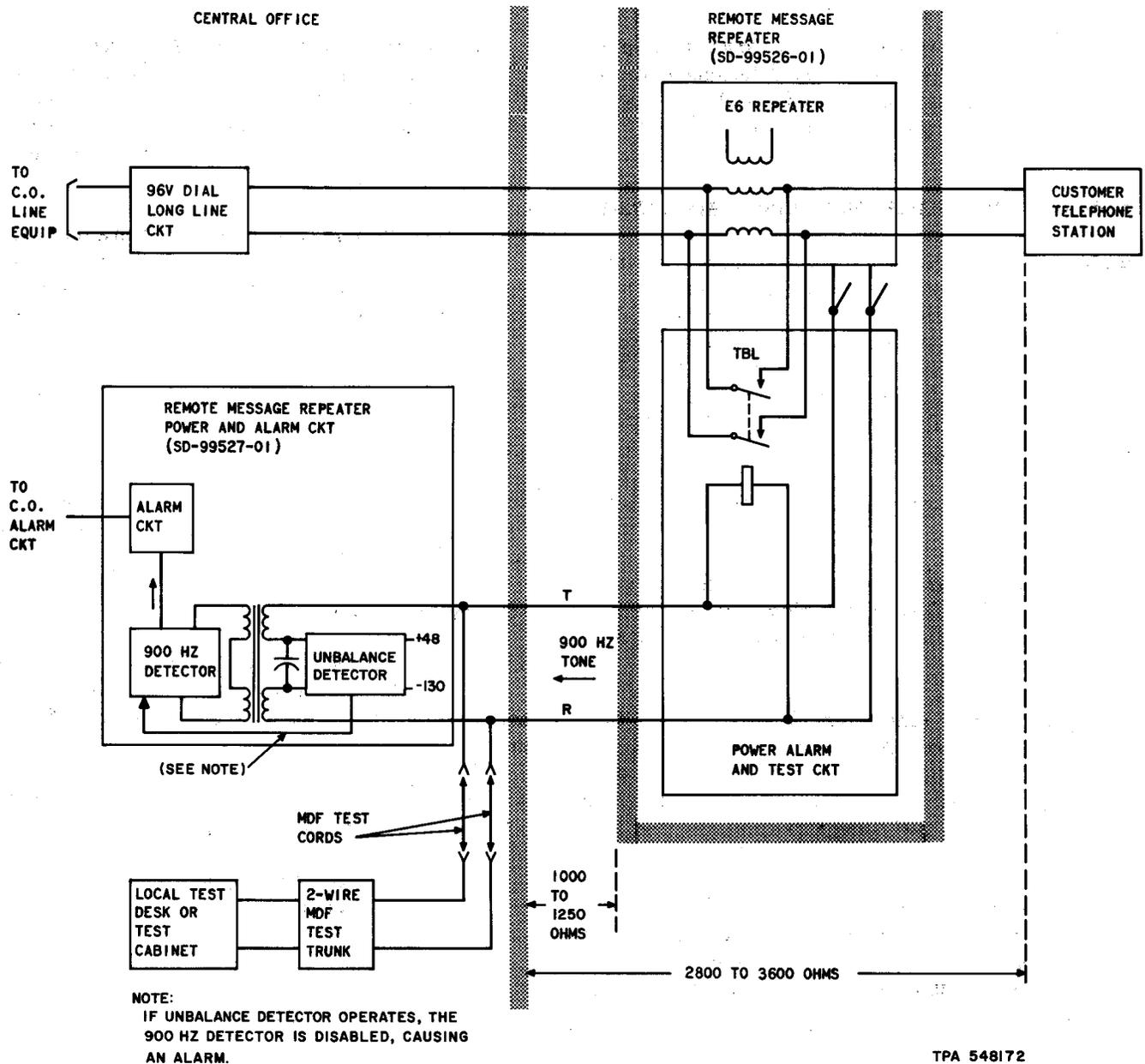


Fig. 15—Arrangement for Testing Power Pair for Remote Message Repeaters

volts, therefore, the meter needle will be off-scale when  $-130$  volts is applied.

**6.115 Testing Out:** Restore the IN key, and with 3W0 (or M) key restored, the connection is arranged to test out on the pair toward the customer station.

(a) There should be no foreign potential on the line.

(b) Leakage resistance measured ring to ground and tip to ground should be infinite. However, voltage at the repeater should be adequate with a 30,000-ohm leak.

(c) Line resistance measured ring to tip should measure approximately 1000 to 1500 ohms. The resistance measured tip to ring should be approximately 100 to 400 ohms greater than when measured ring to tip, depending on the number of repeaters plugged into the panel.

The measured resistance will vary with supply voltage, meter resistance (as determined by the particular meter scale used), and the circuit arrangement in the remote cabinet.

#### ▶THE KS-20988 MULTICHANNEL SUBSCRIBER CARRIER

**6.116** The KS-20988 multichannel carrier provides a maximum of six derived subscriber lines on a pair of exchange-grade nonloaded cable conductors. The physical cable conductors are only used for the carrier channels and may not be used for voice communication on other than the derived lines. The subscriber channels are numbered from one through six.

**6.117** A typical carrier system (Fig. 16) consists of:

- **A nonloaded cable pair**—Cable pair must be free of load coils, bridge lifters, building out capacitors, building out cable and loop extenders.
- **A central office terminal**—Equipped with one transceiver card for each of the six channels in service, one line driver card, one dc-to-dc converter and a ring detector card when party line service is provided.

**Note:** All cards are plug-in type and the central office terminal must be equipped with transceiver cards for channels 4, 5, 6, even if the associated subscriber terminals are not in service.

- **Repeaters**—A maximum of three repeaters, located at intervals of 35 dB at 112 KHz.
- **Subscriber terminals**—Two types of subscriber terminals are available. The terminals are classified according to their ringing ability feature. An SPS (single-party service) terminal provides two channels for two single-party service lines. An SPR (party line service) terminal provides one channel used for 2- and 4-party, full selective, superimposed ringing. The SPS terminal is equipped with two plug-in cards and the SPR terminal is equipped with ten plug-in cards. Each type of subscriber terminal contains a battery to supply ringing power.

- **Carrier line termination unit**—The terminating unit is an encapsulated network used to terminate the far end of cable conductors associated with the carrier system. The ends of all branch cables require terminating units.

- **Directional couplers**—Used when a subscriber receives service through a branch cable. The directional coupler is located where the branch cable taps into the main feed cable.

- **An ac isolation unit**—Used on carrier lines that have extremely high magnetic induction.

**6.118** Carrier system troubles are classified as either a total system failure, a partial system failure or a single channel failure. The type of trouble determines the proper procedure for handling the trouble report.

#### Total System Failure

**6.119** A total system failure is the case where all the channels of the system are out of service. Common causes of a total system failure are:

- Defective power supply unit or excessive drain on the power supply
- Defective common equipment in the central office terminal
- Cable trouble
- Defective repeaters.

#### Partial System Failure

**6.120** A partial system failure is the case when more than one, but not all channels are out of service. The common causes of a partial system failure are:

- Defective repeater
- Defective section of cable
- Defective line driver in central office terminal.

**6.121** A single channel failure is the case when one of the carrier system channels is out

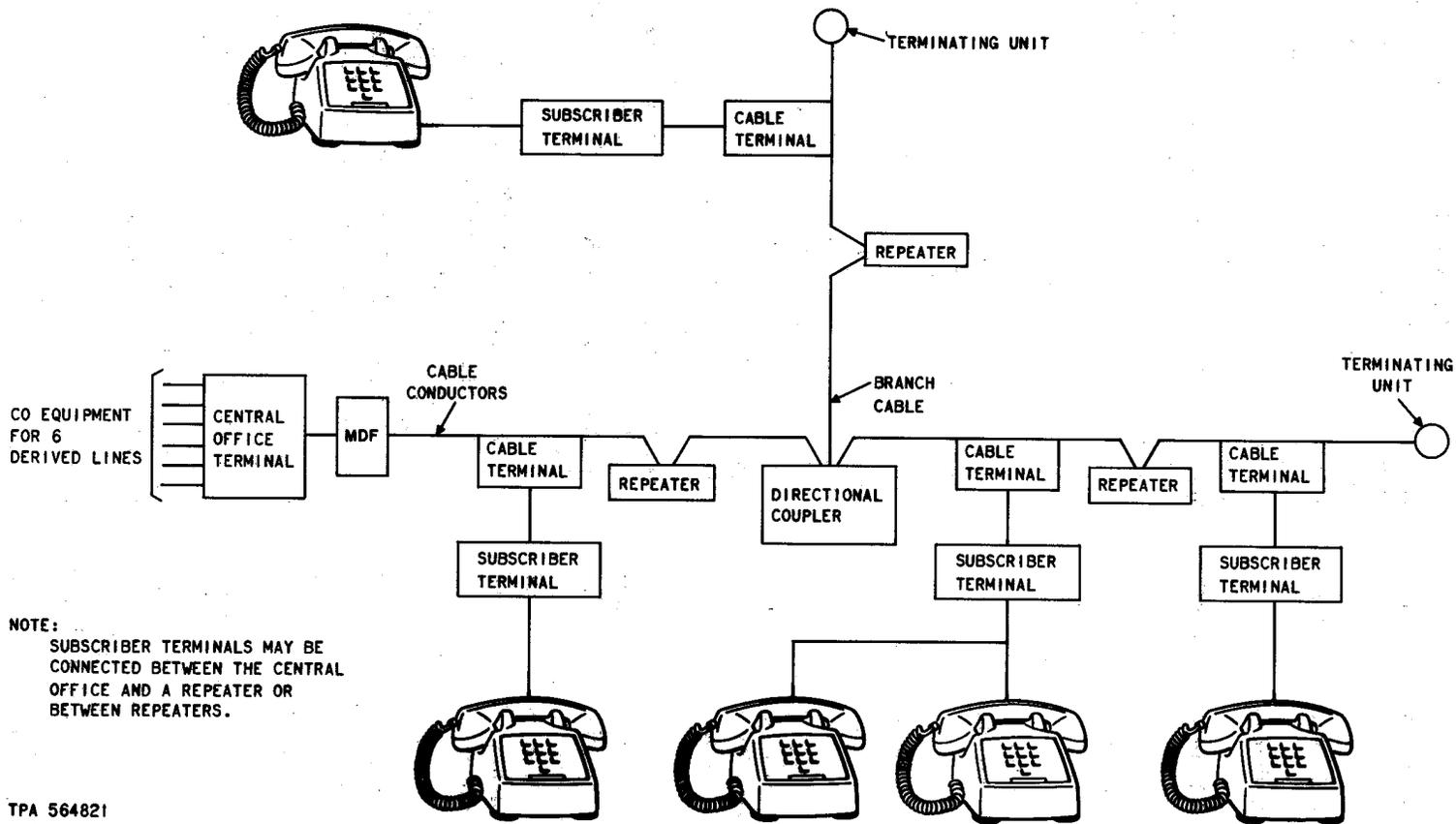


Fig. 16—Typical KS-20988 Multichannel Subscriber Carrier System.

of service. The common causes of a single channel failure are:

- Defective circuit pack (central office transceiver channel card)
- Defective subscriber terminal card or cards
- Defective battery in subscriber terminal.

**Testing Subscriber Lines Equipped With the KS-20988 Multichannel Subscriber Carrier.**

**6.122** Testing on carrier-derived lines is limited.

This limitation is due to the equipment used to interconnect the subscriber station and the central office equipment to the cable conductors. A total system failure can be determined by the following:

- Trouble reports from all subscribers on the carrier system.
- A power failure or irregularity at the central office terminal. This condition is usually indicated by an operated alarm light. An operated alarm always indicates a total system failure.
- Monitoring on each subscriber line. Connect to the subscriber line by dialing in the normal manner from the LTD (6.37 through 6.42). Operate the M (Monitor key). If conversation is detected on any of the derived lines, a total system failure may be ruled out.

**Note:** To talk to the subscriber from the LTD operate the T (Talk) key. Talk battery supplied by the carrier system makes it unnecessary to operate the RCCI key.

**6.123** A test may be made from the LTD through the central office switching train to the input of the carrier central office terminal. With the M key operated and using a no-test trunk, connect to each channel in turn by dialing a subscriber telephone number associated with the channel to be tested. As each channel is seized, restore the M key, operate the G key and then alternately operate and release the REV key as outlined in 6.03. The central office carrier terminal has a 1-microfarad capacitor and a ringing attenuator across the tip and ring at the input of each channel.

The capacitor simulates a ringer capacitor to the central office equipment to satisfy the office continuity test. The circuit for the ringing attenuator will register on the 120V scale of the meter as approximately 50V (100K ohm) ring to tip leak. Alternate operation and restoral of the REV key results in an increased meter deflection of about 20 volts greater than the 50 volts already registered on the meter. This deflection is similar to that obtained when testing for the presence of a bridged ringer. This test verifies that all input connections to the central office carrier terminal are in place and checks the path through the switching train to the terminal.

**6.124** The physical cable conductors may be tested from the LTD by having the central office line driver unit (L-18) removed from the central office carrier terminal and having in-and-out MDF test cords connected to the proper cable conductors at the distributing frame. The cable conductors must be tested with an MDF test trunk. The conductors are tested for capacity and leakage from tip to ground and ring to ground as described in 5.28, 6.04 (a) and (b), and 6.12 through 6.16. Repeaters are transparent in respect to testing on either conductor to ground.

***DO NOT OPERATE THE G (GROUND KEY OR APPLY VOLTAGE ACROSS THE CABLE CONDUCTORS WHILE TESTING ON THE LINE.***

***WARNING: POWER MUST BE REMOVED FROM THE SYSTEM BEFORE THE MDF TEST CORD IS CONNECTED TO THE DISTRIBUTION FRAME. DISCONNECT THE POWER BY REMOVING THE CENTRAL OFFICE LINE DRIVER UNIT.***

Removing the line driver unit (L-18) places all channels in the system out of service. Therefore, tests on the cable pair may not be performed until a total system failure is confirmed or until all other tests described in Sections 363-300-300 and 363-300-310 have failed to clear the trouble.

**6.125** All tests made with an MDF test cord must be made out on the cable conductors. The 3W0 and IN keys must be in the unoperated position to test out on the line when using test trunk SD-90070-01. No tests may be made from the LTD on an MDF test cord toward the central office equipment. A volt-ohm-milliammeter may

be used at the distribution frame as outlined in Section 363-300-310 to make a resistance check toward the central office equipment.

**CAUTION: CABLE BREAKDOWN TESTS SHOULD NOT BE USED TO LOCATE CABLE TROUBLE UNLESS ALL CARRIER EQUIPMENT IS REMOVED FROM THE CABLE PAIR.**

**6.126** Failure of more than one channel may indicate a repeater failure. Repeater failures may be isolated by comparing subscriber terminal locations to find a repeater common to the stations in trouble. No testing may be done on repeaters or subscriber carrier terminals from the LTD. Section 363-300-310 outlines the tests which may be performed from the repeater or subscriber carrier terminal locations. Also, the section provides information on testing the internal battery at the subscriber terminal when a subscriber station does not receive a ringing signal. Section 363-300-300 describes the general maintenance plan for the carrier system.

**WARNING: HIGH VOLTAGE IS PRESENT ON MULTICHANNEL SUBSCRIBER CARRIER LINES. A WARNING OF THIS NATURE SHOULD BE EXTENDED TO EMPLOYEES DISPATCHED TO SERVICE CARRIER EQUIPMENT.**

#### **▶ RANGE EXTENDER WITH VOICE FREQUENCY GAIN**

**6.127** The Range Extender with Voice Frequency Gain (REG) increases the resistance limit of the central office. The REG is designed to serve long subscriber loops having Plain Old Telephone Service (POTS), with finer gauge cable and less expensive equipment. The REG is of solid state design with both the signaling circuit and transmission circuit housed in a single plug-in unit. The REG units plug into a shelf which accommodates 12 units or a shelf which accommodates 9 units and a plug-in A71 power unit. Each power unit serves up to 165 REG units. Shelves are mounted on frame bays.

**6.128** The REG is located in the central office, between the subscriber line circuit and the main distributing frame. The REG is intended to be used for providing improved service to subscriber loops in the 1600- to 2800-ohm range.

**6.129** The functions of the REG are to:

- Add 4dB of voice frequency gain to loops between 1600 and 2000 ohms.
- Add 6dB of voice frequency gain to loops between 2000 and 2800 ohms.
- Extend limits of dial pulsing and supervision.
- Maintain transmitter output at a satisfactory level.
- Insure operations of line relay when subscriber goes off-hook.
- Provide a circuit for testing the subscriber loop from the test desk or line insulation test frame.
- Provide a circuit which bypasses the REG circuit when central office ringing signals are applied.
- Provide ring trip during ac-dc ringing or superimposed ringing.

**6.130** Fig. 17 shows how tip and ring are connected straight through the REG in the signaling mode when the transfer relay (TFR) is in its normal position. The voltage between tip and ring and the loop current are monitored by voltage and current detectors whose shunt resistance is very high. The two 100-ohm series resistors in the loop current detector represent a small fraction of the total loop resistance. These series resistors are used as part of both the loop current detector and the line build-out (LBO) network. The LBO network provides a means of extending the subscriber loop end-section by providing the proper impedance match for the repeater. The LBO settings are made on a prescription basis. This eliminates the need for a gain or return loss measurement on the transmission circuit.

**6.131** When the subscriber initiates a call:

- (1) The loop current detector is activated when the -48 volt central office battery causes current to pass through the two 100-ohm series resistors of the current detector.
- (2) The voltage developed across the current detector resistors operates the P relay.

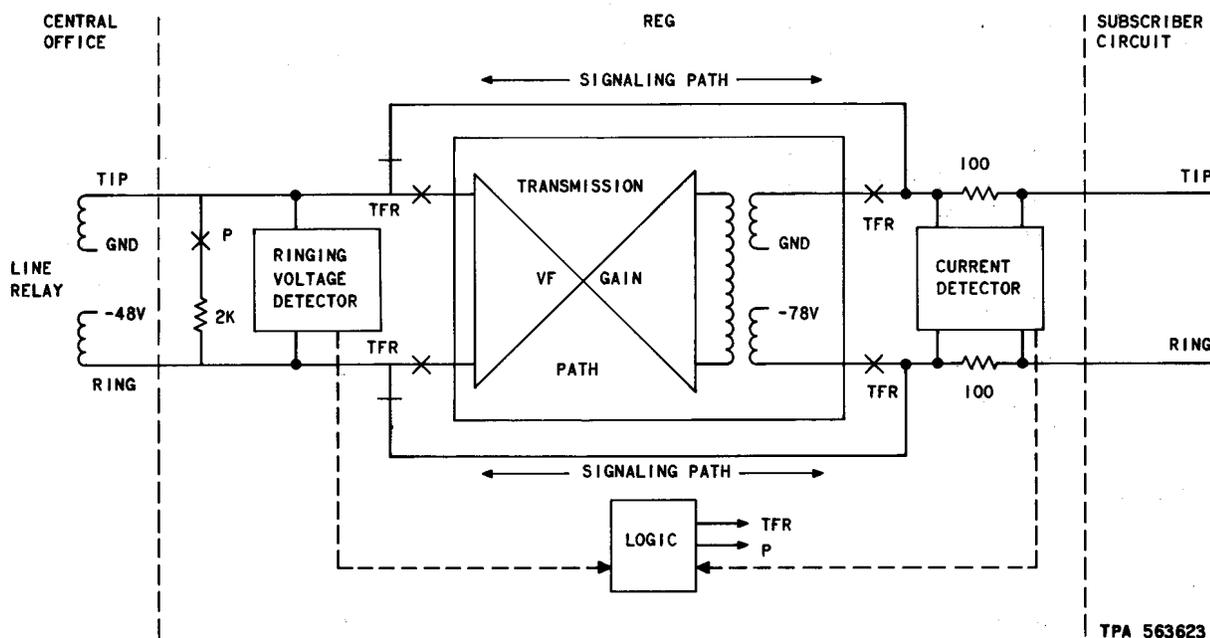


Fig. 17—Range Extender Circuit Showing Transmission and Signaling Paths

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Operating the P relay places a 2000-ohm shunt resistor across the line. The shunt resistor supplements the current drawn by the subscriber set.

- (3) The 2000-ohm resistor places the long loop electrically within the resistance range of the central office. This resistor causes the appropriate central office supervisory relays to operate.
- (4) Sixty-five milliseconds after the P relay operates, the TFR relay operates. When the TFR relay operates, the P relay releases and the 2000-ohm shunt is removed from the circuit.

**Note:** If the subscriber has a standard rotary dial telephone set, the P relay repeats the dial pulses. The operation of the P relay causes the appropriate central office relays to operate. When the P relay operates, the TFR relay releases, which in turn disconnects the repeater and added voltage from the circuit.

- (5) The operated TFR relay connects the repeater into the conductor loop. The repeater increases the loop voltage and brings the loop

current into the range required for proper transmitter, receiver, and TOUCH-TONE dial performance.

**6.132** When the subscriber receives a call:

- (1) The range of ringing signals is not increased by the REG (Fig. 17). To use the REG to its designed limit (2800 ohms), the 10A extender may be used to insure proper ringing operation.
- (2) Current passes through the loop when the subscriber goes off-hook. The P relay operates [6.131(2)]. The operated P relay provides ringing trip during either the silent or ringing interval and prepares the circuit for supervision on the call.
- (3) The voice frequency repeater is connected into the conductor loop [6.131(4 and 5)].
- (4) Current, initially drawn through the P relay and 2000-ohm resistor, now passes through the repeater and supervision is provided.
- (5) When the call terminates, the TFR relay releases, transferring the circuit back to the signaling path.

**6.133** In the transmission mode, the REG provides two-way voice frequency amplification by means of a negative impedance amplifier. Fig. 17 shows how the voice frequency gain unit is inserted in the loop when the TFR relay is operated. The gain unit remains in the loop during dialing and talking if the subscriber has a TOUCH-TONE dial. The voice frequency repeater is powered by the -48 volt talking battery in the central office during voice transmission. Each REG unit draws approximately 30mA from the -48 volt talking battery. To bring the subscriber loop current into the range specified to power the station transmitter, the REG is furnished with an additional -48 volt dc input. Each REG unit draws 10mA at idle and 30mA in operation from this second -48 volt supply. The additional voltage of the -48 volt dc input powers the REG logic and the supplemental power supply. The supplemental battery adds -30 volts to the -48 volts of the central office battery. This brings a total of -78 volts to the subscriber loop. The supplemental battery serves up to 165 REG units.

#### **Testing of Subscriber Lines Equipped With A Range Extender With Voice Frequency Gain**

**6.134** The REG does not hinder the Line Insulation Tests (LIT) on long loops. This is because of the higher leakage resistance (1 megohm) of the REG unit. The REG does not hinder 2-party Automatic Number Identification (ANI) tests. This is because the REG either stays in, or switches to the signaling mode when ANI tests are performed.

**6.135** There are two types of alarms associated with the REG unit—fuse alarms and power unit failure alarms. The operation of a fuse alarm indicates a failure either in the -48 volts necessary to power the logic circuitry or in the -78 volt talking voltage. As many as 12 subscriber lines are taken out of service when a fuse alarm operates. The REG power unit failure alarm indicates a failure in the REG power unit. Failure of the REG power unit causes the -78 volt talking voltage for as many as 165 REG units to be reduced to -48 volts. Subscriber loops with a resistance of 2000 ohms or greater experience degraded service

or loss of service in this event. All subscriber stations experience reduced transmitter output.

**6.136** To test subscriber lines from the LTD, a connection is established through a test trunk in the normal manner (5.02 through 5.05). An MDF test cord must be used to test out on the cable conductors when the relays in the REG are not operating properly and cable or station trouble is suspected as being the cause.

**6.137** After connection to the line is established, ringer impedances can be measured. Tests for leakage, false crosses and grounds, and foreign EMFs can be performed. These tests pass directly through the signaling path of the REG unit. By calling the subscriber, the transmission quality is determined and ringing verified. When the subscriber answers, the gain unit goes into operation. While the loss on the line or the gain of the gain unit cannot be measured at this point, it can be decided if the line is in satisfactory working order or in need of maintenance.

**6.138** Operation of the 24V key permits loop continuity tests and leakage tests. Test results to look for on subscriber circuits equipped with the REG are:

- (a) The minimum leakage resistance at any point on the long loop is 30,000 ohms for normal circuit operation. An effective leakage resistance of less than 30,000 ohms is considered a trouble condition.

**Note:** The +100 volts test battery from the LTD will break down the neon lamp in the REG. With the lamp ionized, the leakage resistance between the tip and ring will be approximately 200,000 ohms. This resistance is read on the 120-volt meter scale.

- (b) Loop balance tests conducted on a ballistic basis, under some conditions, show a maximum of 1-volt unbalance on the 120-volt scale.
- (c) The REG voltage detector bridges the line between tip and ring, modifying the ballistic tests as shown in Table 15.4

→TABLE 15←

TYPICAL BALLISTIC METER DEFLECTIONS WITH AND WITHOUT RANGE EXTENDER UNIT (REG)

CABLE LENGTH AND CONDUCTOR GAUGE (NOTE 1)	EQUIV. MILES OF CABLE	DC LOOP RESISTANCE (OHMS)	NUMBER OF STATIONS TERMINATED ON LINE (NOTE 4) (BRIDGED RINGER)	BALLISTIC DEFLECTION (READING TO GROUND NOTE 2)							
				LOOP ONLY				E/W RANGE EXTENDER			
				120 VOLT METER SCALE		60 VOLT METER SCALE		120 VOLT METER SCALE		60 VOLT METER SCALE	
				TIP	RING	TIP	RING	TIP	RING	TIP	RING
24000 FEET 26 GAUGE	4.5	2014	0	26.5	26.5	7.0	7.0	43.0	43.0	9.0	9.0
			1	47.0	47.0	14.0	14.0	55.0	55.0	15.0	15.0
			2	63.0	63.0	19.5	19.5	65.0	65.0	20.0	20.0
27000 FEET 26 GAUGE AND 21000 FEET 19 GAUGE	9.1	2655	0	45.5	45.5	13.0	13.0	54.0	54.0	14.5	14.5
			1	74.0	74.0	18.5	18.5	64.0	64.0	19.5	19.5
			2	74.5	74.5	23.5	23.5	72.0	72.0	24.0	24.0
9000 FEET 26 GAUGE AND 63000 FEET 19 GAUGE	13.6	1872	0	60.0	60.0	18.0	18.0	63.0	63.0	19.0	19.0
			1	72.5	72.5	23.0	23.0	71.0	71.0	23.5	23.5
			2	83.0	83.0	27.5	27.5	78.0	78.0	27.5	27.5
102,000 FEET 19 GAUGE	19.3	1803	0	72.0	72.0	22.5	22.5	70.5	70.5	23.0	23.0
			1	82.5	82.5	27.0	27.0	77.5	77.5	27.5	27.5
			2	91.0	91.0	31.0	31.0	84.0	84.0	31.0	31.0
132,000 FEET 19 GAUGE	25.0	2335	0	82.0	82.0	27.0	27.0	77.0	77.0	27.0	27.0
			1	90.0	90.0	30.5	30.5	83.0	83.0	30.5	30.5
			2	98.0	98.0	34.0	34.0	88.0	88.0	33.5	33.5
162,000 FEET 19 GAUGE	30.7	2867	0	90.0	90.0	30.5	30.5	83.0	83.0	30.5	30.5
			1	97.0	97.0	34.0	34.0	88.0	88.0	33.5	33.5
			2	105.0	105.0	37.0	37.0	93.0	93.0	36.5	36.5

1. H-88 loading used on cable conductors. Load coils are located 3000 ft. from central office, 3000 ft. from far end of cable, and 6000 ft. between load coils.
2. These tests were made with laboratory model equipment and simulated cable. The figures in this table are characteristic of the true values.
3. A neon lamp affects the tip to ring leakage resistance. The lamp is ionized by the 100-volt test battery but not by the 60-volt test battery. Tip to ring leakages are (a) 200K on 120-volt meter scale and (b) 950K on 60-volt meter scale.
4. 500-type telephone sets using C4A ringers (.45  $\mu$ f capacitance) were used.