COMMON SYSTEMS
COIN STATION TEST LINE CIRCUIT
FOR USE WITH
SXS NO. 1 CROSSBAR NO. 5 CROSSBAR
PANEL, ESS NO. 1 AND ESS NO. 2 SYSTEMS

B. Changes in Apparatus

B.1 Added

ETT resistor, KS20289,L6C, 5.11kΩ, APP FIG 1, FS4
R87, 41.2kΩ, APP FIG 1, FS5

B.2 Superseded / Superseded By

Superseded	Superseded By
Resistor LFP, KS-20289,L6C, 681Ω, Option YW, APP FIG 3, FS6	Resistor LFP, KS-20289,L6C, 1.47kΩ, Option YX, APP FIG 3, FS6

D. Description of Changes

D.1 Added Option YX, rated STD, to insure proper operation of the ETT relay. The previous wiring was designated Option YW and rated MFR DISC.

D.2 Updated the Option and Apparatus Indexes.

D.3 Changed FS4 through FS7, and APP FIGS 1 and 3.

D.4 Note 104 updated.

D.5 Note 126 added.

AT&T BELL LABORATORIES

DEPT 59324-JDQ-GGAB

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 The coin station test line allows one person to test the operation of a coin station. Testing is done by calling the test line from the coin station. With the aid of the test person at the coin station, the operational status of the coin station is determined.

1.02 Several tests can be performed before the test line is dialed. First, the test line should be dialed with no coin present in the coin station. In step-by-step offices equipped for dial tone first (DTF), the code for the test line will be a free code. Therefore, to perform the following tests, the number of the coin station can be used as a charge number. Because this is not a free call, the call should not complete. If it does complete, a malfunction of the totalizer or a grounded loop is indicated. The same call should be attempted again with only a nickel present. Again the call should not complete. If it does complete, a malfunction of a diode in the totalizer circuit or of the totalizer itself is indicated. Further testing of the totalizer can be performed by depositing various coins and listening to the tone responses present on the tip and the ring. If these tests pass, then the test line should be called using coins equal to or greater than the initial rate.

1.03 When the test line is seized, it tests to see that a coin is present. If a coin is not present, C tone (interrupted high and low tone) is sent requesting that a coin be deposited. When a coin is detected, a test is made to determine if the ground removal relay (if the station is DTF) will operate. The results of this are presented to the test person in terms of a coded tone, which is given three times for clarity. For the ground isolation test the answers are as follows:

CONDITION	ANSWER
Relay A operates and ground is removed (for DTF)	1 beep
Ground not removed (either station is CF or a relay has malfunctioned)	2 beeps

1.04 Upon completion of the answer, the test person receives interrupted dial tone. This indicates that a selection of one of the five available test sequences is to be made. Selection is made by dialing the digit representing the desired test. If an invalid digit is dialed, interrupted dial tone continues to be present. This indicates that the digit is invalid and another attempt should be made to dial a valid digit. TOUCH-TONE dialing is optional. If no further testing is desired, the receiver may be placed on-hook while the interrupted dial tone is present and the test line will disconnect. During disconnect an attempt is made to return any coins that may be in the coin hopper. A discussion of the five test sequences follows.

FEMF TEST - DIAL 0 (OPTION ZK)

1.05 To initiate the FEMF test sequence, the test person dials digit 0. If the station is wired for COIN FIRST service, the T1 contacts in the coin station must be operated before dialing is possible. This requires that a single coin whose value is equal to or greater than the initial rate must be deposited, unless this is the first test after seizure. For a DTF station, after the digit 0 is dialed, a coin-present test is made and if no coin has been deposited or the hopper trigger switch has not been operated, the coin tone will be heard indicating a coin must be deposited. If no coin has been deposited within about 60 seconds, the test line disconnects. When a coin is detected, the ground path dc FEMF test sequence begins by monitoring the voltage between tip and ground at the test line. Any series potential greater than ±3.0 volts (±6 volts with option YT) results in a failure. After this test, an attempt is made to return the coin. If the coin is not returned, the test line disconnects in 60 seconds. If the coin return is successful, an answer for the ground FEMF test result is heard three times as follows:

CONDITION	ANSWER
Ground FEMF too high	1 beep
Ground FEMF within limits	3 beeps

1.06 After the answer is received, a steady high tone is heard to notify the test person to hang up the handset. If this command is not fulfilled within 60 seconds, disconnect occurs. When the handset is placed on-hook, the sequence to test for FEMF between the loop conductors and ground begins. This test detects any dc FEMF between tip and ground, ring and ground, or tip and ring greater than ±3.0 volts (±6 volts with option YT) with a series leakage resistance greater than 100 kilohms. If lower leakage (higher value of resistance) is present, a larger FEMF is required before test failure is indicated. Upon completion of the loop FEMF tests, one of the following answers is heard three times for clarity.

CONDITION	ANSWER
Loop FEMF OK	3 rings
Loop FEMF too high	2 rings

If the receiver is lifted off the switch hook before all answers have finished, the remaining rings will be heard as beeps. After the answer is completed, an interrupted dial tone is heard requesting a new test digit. If the handset is not removed from the switch hook before the

answer has finished, the test line disconnects.

RESISTANCE TESTS - DIAL 2

1.07 Dialing the digit 2 selects the ground check and loop resistance test sequence. This sequence is intended to determine (a) if the coin station's coin ground is operationally acceptable, and (b) if the loop resistance is within preselected limits. Once the digit 2 is dialed, a coin-present test is made. If no coin is present, a tone will be heard indicating that a coin is required. If no coin is deposited within 60 seconds, a disconnect is initiated. If a coin is detected, the ground check sequence is initiated. This ground check sequence is a screening test for the ground resistance. A failure of the ground check means that the ohmic value of the tip to ground coin station resistance plus the ground resistance is greater than 1300 ohms, representing the tip to ground coin station resistance plus 50 ohms for a total of 1350 ohms. A pass indication means a ground resistance of less than 50 ohms. If a failure is indicated, the grounding requirement practice, BSP Section 508-100-100, should definitely be performed. A coin station that passes the ground check indicates that the coin station's coin relay will perform reliably and not that the ground meets the requirement of BSP Section 508-100-100. The following elements in a particular coin phone determine the value of ground resistance at which the ground check failure will occur: the coin relay resistance, reset magnet resistance, and whether the station is coin first or DTF. After the ground resistance detection interval, an attempt will be made to return the coin. If the coin does not return, disconnect occurs after 60 seconds. If the coin does return, then the loop resistance is measured. Following this measurement the results of the tests are given by a coded tone repeated three times. This coded answer is as follows:

CONDITION	ANSWER
Loop and ground within limits	3 beeps
Loop resistance marginal	4 beeps
Loop resistance too high	2 beeps
Ground resistance too high	1 beep

1.08 Upon completion of the answer, steady high tone is heard requesting that the receiver be placed on-hook. If the receiver is not hung up within 60 seconds, a disconnect occurs. When the receiver is on-hook, the leakage measurements are made. The leakage test is designed to detect leakage less than 100 kilohms. This allows early detection of leaky loops before they cause circuit failure. When the tests are complete, the answer is given as coded ringing with the answer repeated three times. The code is as follows:

CONDITION	ANSWER
Loop OK	1 ring
Loop leaky or grounded	2 rings

1.09 Coded ringing is used to indicate that the receiver is to be removed from the on-hook state. Also, the operation of the ringer is tested. If the receiver is lifted before completion of the coded answer, the answer is completed as coded tone. When the answer is completed, interrupted dial tone is heard indicating that a new test digit is desired. If the receiver is not lifted prior to completion of the answer, a disconnect results.

COLLECT TEST - DIAL 3

1.10 Dialing the digit 3 selects the collect test sequence. This sequence is identical to the return sequence except that collect battery is applied. The return test may be applied with coins. The collect test is intended primarily to provide collect attempts for the bias measurement. Since it is not desirable to collect the coin during this test, the following procedures are recommended:

(a) For prepay type-1A station (for 200-type, perform only steps 4, 3, 5, and 6 in this order):

(1) Block the coin chute between the totalizer and the coin relay with a card.

(2) Deposit a single coin greater than or equal to the initial rate.

(3) Dial the digit 3.

(4) Trip the hopper trigger to simulate coin ground. (This should cause coin tone to be discontinued.)

(5) Insert bias margin gauge.

(6) Hang up the receiver and the collect attempt will be made.

(b) For DTF station perform the following steps:

(1) Dial the digit 3.

(2) Trip the hopper trigger; this should cause the coin tone to cease. If it does not cease, then the diode that shunts the totalizer contacts in the ground path is faulty and the chassis should be replaced.

(3) Place the receiver on-hook and the collect attempt will be made.

1.11 In each of the above cases, up to three attempts are made to operate the coin relay. Coded ringing will be

returned indicating the number of attempts made. The results are:

ATTEMPTS TO COLLECT	ANSWER
1	1 ring
2	2 rings
3 or not collected	3 rings

In each of the above cases, up to three attempts are made to operate the coin relay. With option Z0 added, the first attempt is made with about 200 ohms inserted in series with the tip conductor of the loop. The second and third attempts are made without the series resistor. Coded ringing will be returned indicating the attempts required to dispose the coin. If only one attempt was required, no problem to collect coins should be experienced even if the loop resistance increases by 200 ohms or the coin-collect voltage drops by 15%. However, if two attempts are required, a marginal collect condition is indicated that may cause problems with circuit parameter changes. Three attempts should warrant additional checking of loop, ground path, and coin relay.

1.12 Since the receiver is on-hook, coded ringing is supplied. If the receiver is lifted during the answer, the coded ringing is replaced by coded tone. The receiver should be lifted before completion of the answer, because a disconnect will result if the answer is completed and the receiver is still on-hook.

RETURN TEST - DIAL 4

1.13 Dialing the digit 4 selects the return test sequence. This sequence is intended to test the ability of the coin station to return coins, and is intended to be used in conjunction with a bias margin gauge. A nickel should be used to make this test in the DTF coin station and should be deposited before the digit is dialed. This allows the test to perform an additional function. A test will be made to determine if the nickel is in the coin hopper, verifying the ability to determine that the presence of a nickel can be detected in the coin station. If this test is satisfactory, the test continues. If not, C tone is received indicating that the coin is not detected, and appropriate maintenance should be performed to remedy the trouble.

1.14 Following detection of a coin, a continuous high tone is heard in the receiver. This indicates that the receiver is to be placed on-hook. If the receiver is not placed on-hook within 60 seconds, disconnect results. Once the receiver is on-hook, as many as three attempts are made to return the coin. As in Paragraph 1.11, if option Z0 is used, the first attempt is made with a 200 ohm-resistor in series with the tip conductor. The second and third attempts are made with the resistor out of the circuit. If only one attempt is required for coin return, plenty of margin is indicated. However, if two or three attempts are required, a marginal condition exists which should be pursued.

1.15 Ringing is used to answer because the receiver is on-hook. It serves two purposes. First, it tests the operation of the ringer and second, it indicates that the receiver is to be lifted off-hook for testing to continue. If the receiver is lifted before the coded answer is complete, the answer is completed as coded tone. Once the coded answer is complete, interrupted dial tone will be heard indicating that a test digit is again desired. If the receiver is not lifted before completion of the answer, disconnect occurs.

1.16 The return test can provide return signals for the bias test. To make this test, the bias margin gauge is inserted and the hopper trip switch is operated with an "orange" stick. The digit 4 is then dialed.

1.17 In prepay phones the totalizer also has to be set to the initial rate so that the dial is enabled. This can be done by depositing a single coin equal to or greater than the initial rate. Because the trip switch is operated, coin ground is detected as soon as the digit is dialed. High tone is transmitted and the switch hook should be operated. Following operation of the switch hook, the return attempt is made. The test line will then supply a coded ringing answer as indicated above.

COIN RELAY TIME TEST - DIAL 5

1.18 Dialing the digit 5 selects the coin relay time test. This sequence is intended to determine the operating time of the coin relay in the coin station. For optimum operation of the station the operate time should be 450 $\pm$ 25 ms.

1.19 The test sequence first checks to determine if a coin is present in the coin station. If a coin is not present, C tone is sent requesting a coin. If a coin is not deposited within 60 seconds, a disconnect is initiated. Once a coin is detected a return attempt is initiated and the operate time of the coin relay measured. This operate time is then reported to the test person as coded tones with the answer given three times for clarity. The code will be as follows:

OPERATE TIME	ANSWER
<400 ms	1 beep
400-425 ms	2 beeps
425-475 ms (ideal)	Steady tone

475-500 ms	3 beeps
>500 ms	4 beeps

1.20 Upon completion of the tone bursts, C tone returns requesting a coin to repeat the measurement. If the relay is not within operating limits, adjustment should be applied and a coin deposited to repeat the test. If the relay is within operating limits, then the switch hook should be flashed for 1 second. This returns interrupted dial tone to the test person, allowing another test selection to be made by dialing a new digit. If the switch hook is not flashed before receiver hang-up, the test line will not disconnect for 60 seconds. If a fault is on the tip conductor, the coin relay may or may not operate. No answer will be heard and the coin station will be immediately disconnected if the F or YA option is provided. When the YA option is provided, the coin station will also disconnect if the coin relay operate time is greater than 525 ms. In this case, the coin relay must be adjusted faster and the test repeated.

CALIBRATION DIAGNOSTICS TESTS - DIAL 8 AND DIAL 9, (OPTION ZO)

1.21 Option ZO provides an expedient procedure to check the calibration settings for the Dial 2 resistance tests. These checks can be performed from any coin station served from the central office in which the CSTL is located. If digit 8 is dialed, the dial 2 sequence of paragraph 1.07 will be followed except that an additional relay will be operated that disconnects the loop from the test circuit during the test state and connects a standard resistor whose value is just below the test "fail" threshold for that particular test and office. As a result, if the calibration settings are correct, the dial 8 sequence will produce all test "OK" answers.

1.22 Then Digit 9 is dialed which results in the identical dial-2 sequence except this time a different additional relay operates which connects standard resistors just above the threshold for a particular test and office. Thus, dial 9 should produce all "FAIL" answers for the dial-2 sequence if the calibration is correct. The tester will know which test requires adjusting, and in which direction, from the answers received.

DISCONNECT

1.23 Normal disconnect is achieved by placing the receiver on-hook while the interrupted dial tone is present. Disconnect is also produced by operation of a 60-second timer that is enabled when requests are made to perform an operation at the coin station. Disconnect will also be produced if the coin fails to return during the resistance tests, or if a 60-Hz power failure prevents completion of the time test.

2. GENERAL DESCRIPTION OF OPERATION

2.01 The coin station test line contains sequential tests that are chosen by dialing a digit at the coin station. Since the tests require that the test line have the ability to collect and return coins, it is necessary that the switching network, to which the line is connected, be arranged to provide a metallic connection from the coin station to the test line.

2.02 All tests are preceded by a coin-present test. This test consists entirely of wire spring and mercury relays, with the mercury relays used to determine the conditions on the tip and the ring. Upon initial seizure, the circuit not only determines whether or not a coin is present, but also determines if the ground removal relay (if present in the coin station) is functioning. If no coin is present when the coin test is made, a coin is requested by a coded tone. If this request is satisfied the sequence continues.

2.03 There are 10 test selections available; however, it is recommended that the digit 1 not be used unless absolutely necessary, since noise or false opens may result in the selection of the test associated with the digit. The following digits are connected and provide the following test sequences.

DIGITS

2.04 Dialing digit 0 (ZK OPTION) selects the ground path FEMF and loop FEMF tests. Wire spring relays are used for the logic sequence that connects the electronic detector to the loop conductors at the proper times to determine if FEMFs exceeding the ±3.0 volt (±6 volts with option YT) are present. The sequence is as follows:

(a) Check for a coin in the hopper.

(b) If a coin is present, connect the detector between tip and ground for 2.5 seconds. (RT, GRT, FEMF relays operated.) If ground FEMF exceeds ±3.0 or ±6 with option YT Vdc, ANS-1 operates.

(c) Return the coin (RC operated). If the coin does not return, the circuit will lock up and disconnect in 60 seconds.

(d) Answer sequence for ground FEMF test results:

(1) FEMF within limits - three beeps

(2) FEMF out of limits - one beep

(e) Request hang-up with hang-up tone (relays ADS and SUPV operated).

(f) After the handset hang-up, connect the threshold detector between tip and ground for 2.5 seconds. (Relays LLT, AUX-3 and LFP operated.) AUX5 operates for about 60 ms to discharge the loop capacitance. Then connect the threshold detector between ring and ground and connect tip to ground for 2.0 seconds. (Relays TMR-2, and ELT operated and TMR-1 operates at end of 2.0 seconds)

(g) Loop FEMF answer sequence with coded ringing while the handset is on-hook or coded beeps when the handset is lifted. (Relays LFP, ELT, and AUX-3 operated.) ANS-2 operates if the test failed. Answers are as follows:

(1) FEMF OK - three rings

(2) FEMF too high - two rings

(h) Return to interrupted dial tone. (Relays FEMF, LFP, AUX-3, and ELT released.)

2.05 Dialing the digit 2 selects the resistance and leakage tests. These tests are performed by a sequence that consists entirely of wire spring relays. These relays connect the electronic circuits to the line at the proper times to determine the resistance of the loop and the leakage of the loop. The following sequence is followed:

(a) Check for a coin.

(b) With the coin present, check the ground resistance (RT and GRT relays operated).

(c) Return the coin (RC operated); if the coin does not return, the circuit locks up and a 60-second timer initiates disconnect.

(d) Measure the loop resistance (relay LRT operated and RT operated).

(e) Return answer (LRT relay operated, relay RT released) as follows:

(1) Loop and ground OK - three beeps

(2) Ground resistance too high - one beep

(3) Loop resistance too high - two beeps

(4) Loop resistance marginal - four beeps.

(f) Request hang-up (relay ADS operated) and relay SUPV operated).

(g) Measure the leakage (LLT operated). During this time TMR2 operates, ELT operates, and TMR1 operates.

(h) Return answer as ringing (ELT operated and LLT released):

(1) Loop OK - one ring

(2) Loop leaky - two rings

(i) Return to interrupted dial tone.

2.06 Resistance tests are made by a threshold detector and a current source, while leakage measurements are made with a threshold circuit employing a neon lamp.

2.07 Dialing the digit 3 selects the collect test. This, following completion of the coin-present test, causes a supervisory relay to be placed on the loop and a hang-up signal (continuous high tone) is generated until the receiver is placed on-hook. When the receiver is on-hook, a 200-ms collect pulse is generated. The pulse duration is determined by a timer. Following the pulse, a mercury relay is connected to the tip to determine if the coin ground is still present. If it is present, another attempt will be initiated. Each attempt is counted in a wire spring relay counter consisting of ATC 1 through 3. If the coin is collected or if the counter counts three attempts, the collect sequence initiates an answer to the coin station. The answer is generated by the beep circuit and consists of coded ringing generated by switching superimposed ringing onto the line during selected states of a wire spring counter. If the receiver is lifted during the answer, the ringing is replaced by tone. During this answer, the clock for the counter is provided by the 60-i/m office interrupter. Upon completion of the coded answer, interrupted dial tone is returned indicating that a new test selection is desired.

2.08 Dialing the digit 4 selects the return test. This test operates in the same fashion as the collect test except that return battery is applied instead of collect battery. Sequencing utilizes the same circuitry except for one relay. This relay is the RET relay which is operated in place of the COL relay in this sequence.

2.09 Dialing the digit 5 enables the coin-relay time test. This test employs an integrated circuit timer using 60-Hz alternating current as its clock source to determine the operating time of the coin relay in the coin station. Wire spring relays are driven by latching transistors to provide the interface with the remainder of the test line. Upon completion of the time measurement, the results are returned to the coin station by means of a beep circuit, which consists of a wire spring relay counter and associated

wire spring relays necessary to place the coded signals on the tip and ring. Again, the interface between the state of the integrated circuit timer and the answer circuit consists of latching transistors.

2.10 Dialing the digit 8 operates the CAL1 relay which disconnects the tip and ring connections to the loop and connects standard resistors whose values are just below the test-fail thresholds for each test in the Dial-2 series.

2.11 Dialing the digit 9 operates the CAL2 relay which disconnects the tip and ring connections to the loop and connects standard resistors whose values are just above the fail thresholds for each test in the Dial 2 tests.

DIGIT RECEPTION

2.12 The interrupted dial tone is sent whenever the digits are to be dialed. The dial pulse receiving and registering circuits are taken from the No. 5 crossbar originating register. Some modification is done to permit holding the digit so that a ground can be generated for the desired test. The circuit consists of one mercury relay and a number of wire spring relays. Sequencing is also provided so that if any digit that does not represent an existing test is dialed, the digit is ignored. Also, circuitry is provided to enable a disconnect to be obtained if the receiver placed on-hook during the presence of interrupted dial tone.

2.13 With options ZE, ZN and ZV provided, message register counts of individual test digits dialed can be recorded. This option provides ground closure leads for each of the five test digits.

SECTION II - DETAILED DESCRIPTION

1. SEIZURE (FS 1, SC 1)

1.01 In a step-by-step, No. 1 crossbar, or panel office, the switching machine will see a potential on the tip and ring. If option M is supplied, the battery is on the ring and the ground is on the tip. If option N is supplied, the battery is on the tip and the ground is on the ring. The potentials are supplied through the winding on the SUPV relay. Seizure is initiated when the switching machine places a short across the tip and the ring. This operates the SUPV relay (FS 5), which in turn operates the off-hook (OH) relay. The OH relay locks up through DISC released and its own contacts and places a ground on the sleeve leads to hold the connection. OH also removes the SUPV relay from the tip and ring.

1.02 In an ESS No. 1 or No. 2 office, the -48 volt idle state is on the ring, and ground is on the tip (option M). With option F supplied, the operation of the SUPV and OH relays is the same as described in 1.01.

1.03 In a No. 5 crossbar office, the marker places battery on the BT lead and ground on the F lead. This operates the F relay, which operates the OH relay. The OH relay disconnects the F relay, removes the SUPV relay from the tip and ring, and grounds the sleeve leads.

1.04 When the OH relay operates, timer TM2 is enabled. Since relay PS is released, timer counts 2.5 seconds and then operates relay TMR2. Relay TMR2 operating will operate relay CPT. This 2.5-second interval allows the seizing circuit time to complete necessary tests before a reversal is generated on the loop indicating answer (see 2.02).

1.05 In a 5ESS office the coin craftperson activates an outgoing trunk that places a current-detector bridge across the sleeve and sleeve-return leads. The resulting current flow causes relay ST to operate, which applies -48V on the ring lead through the SUPV relay primary coil, and grounds the tip lead through the SUPV secondary coil. The 5ESS trunk circuit tip and ring path is bridged by a voltage detector causing tip/ring current flow to operate relay SUPV. Relay OH operates after a 400-millisecond delay through relay SUPV-8 make and thermistor RT1, releasing relay SUPV. The 400-millisecond delay allows the application of -48V to the ring lead of the trunk circuit for a minimum of 200 milliseconds prior to connecting the CSTL to the coin phone to be tested. The 5ESS switch requires a seven-second interval prior to CSTL seizure to perform FEMF compensation that cancels GDX leakage current. The connection is maintained as long as low sleeve current flows through resistor RL, DISC-6 break, and the ST relay coil.

2. COIN-PRESENT TEST (FS 2, SC 1)

2.01 The coin-present test operates in two modes. When applied immediately following seizure, it performs a ground isolation test to check operation of the ground removal relay in a DTF telephone. In all other operations it serves only to determine if a coin is present in the phone and, if not, to request that a coin be inserted. A coin equal to or greater than initial rate is required in the phone before each test is dialed in non-DTF stations. This is required because the dial is shunted until the initial rate requirement is satisfied. If a coin is requested by the presence of coin tone and the switch hook is flashed, the test currently selected is released and the interrupted dial tone is returned requesting a new test selection. The test functions are described below.

2.02 Operation With PS Released: First consider the combination coin-present test and ground-isolation test (for this case the PS relay is released). When the CPT relay operates, timer TM1 (800 ms) starts. If option N is supplied, the SN relay will be operated. During the timing period, battery and ground are placed on the tip and the ring through the SN 2 and SN 3 contacts in such a way as to be a reversal of the battery and ground found on the tip and ring during the time when the test line was idle. This reversal indicates to the step-by-step, panel, and No. 1 crossbar switch machines that the trunk has been seized. Also, the SHF relay operates and capacitor C1 charges. This capacitor delays the release of SHF by about 5 ms to prevent false operation from line hits and circuit transfers in the test line. When timer TM1 times out, relay TMR1 operates and connects relay SHF to the ring and relay CG to the tip. If a coin is present and the loop is closed, relay SHF remains operated and relay CG operates. If no coin is present, relay CG will not operate, but relay SHF remains operated through diode CR2 around the CG relay. The condition CG released and TMR1 operated places C tone on the tip and ring in the following manner. The C-tone ground operates the CT relay, which bridges the primary and secondary of transformer TN with a capacitor. It also connects the alternately interrupted high and low tone (produced by 120-i/m INTR relay) to the third winding. This produces C tone.

2.03 If C tone is generated, a coin or coins must be deposited. When a coin is detected by relay CG, operation of the ground isolation test is initiated. Note that during this test the release of SHF will not advance the circuit to the test selection state (indicated by interrupted dial tone) since relay PS is released. The ground isolation test begins when relay CG operates, which operates relay CGA, which in turn, locks up. Relay CGA operated starts timer TMR3 (FS 6), which counts for 100 ms. Also, relay CGA operated connects

the 20 mA current source to the ring through the CGA-8 make-contacts, the PS-1 break-contacts, CPT-2-make-contact, and RTT-8-break-contact. This should operate the ground removal relay. If the ground is removed, the CG relay releases. If the ground remains, the CG relay remains operated. When TMR3 operates it operates the RTN relay and the BP relay via the GO lead. During the operate time of TMR3, the continuity path provided by the No. 3 transfer contact interrogates the state of the CG relay. If relay CG is operated, a ground causes latching transistor Q1 to operate and latch; otherwise, latching transistor Q1 remains unoperated. When BP operates, it transmits either one beep or two beeps depending upon whether the BP1 or both the BP1 and BP2 leads are connected to -48 volts. The BP relay, upon completion of the one-or-two-beep answer, releases and operates relay ON, which releases relay CPT. The ON relay operated will operate the PS relay, which locks up and remains operated for the remainder of the tests. When relay ON is operated, the circuit is prepared to accept dialed digits.

2.04 Operation With PS Operated (No Ground Isolation Test): When relay CPT operates, timer TM1 starts timing for 800 ms, and -48 volts is connected to the tip to drop a single nickel if present. The ring is connected to ground during this time. At the end of 800 ms, relay TMR1 operates. If a coin is not present, relay CG remains released and C tone is transmitted as outlined above. During this time, it is possible to operate the ON relay by flashing the switch hook. This releases the CPT relay and returns interrupted dial tone, indicating that a new test is to be selected by dialing a digit. This occurs as follows. Relay SHF is connected to the line by operation of TMR1 and remains operated. If the tip and the ring are open for greater than 20 ms, relay SHF releases and operates relay AUX3. When the switch hook is released, SHF reoperates and, through the AUX3 make-contact, operates relay ON, which releases relay CPT. This removes C tone and sends interrupted dial tone, requesting a new digit.

2.05 With C tone present, no attempt is made to drop a single nickel; therefore a sufficient amount of coins must be deposited to result in coins in the hopper. When the coin ground is detected, the CG relay operates relay CGA. Relay CGA locks up through contact 1 of relay AUX1. Since relay PS is operated, relay RTT is operated when relay CGA operates. Relay RTT enables timer TM2, which begins to time for 2.5 seconds. This time is obtained by having an RTT break-contact remove the timing resistors TM2A and TM2B, thus leaving only resistor TM2, which provides the 2.5-second time. Also, an RTT break-contact releases timer TM1 and relay TMR1. When timer TM2 times out, it will re-enable timer TM1, which times for 800 ms. During these time intervals, RTT remains operated and connects battery and ground to the ring and tip respectively. This provides battery to the totalizer, thus enabling it to return to its normal position. When timer TM1 times out, it operates relay TMR1. This releases the CPT relay.

3. DIGIT RECEPTION (FS 3, SC 2)

3.01 This portion of the circuit is enabled by the operation of the ON relay. This initially occurs at the completion of the coin present test employing the ground isolation test. The circuit will accept either TOUCH-TONE digits or dialed digits.

DIALED DIGITS

3.02 Upon operation of the ON relay, the ground is removed from the DIN relay. If the DIN relay was operated it will slow release. Since the AUX2 relay is released, the grounds holding the P1 through 5 relays operated will be removed during the time DIN relay is releasing. Thus, the P1 through 5 relays all release. DIN relay is released on the first operation of the ON relay, but the P1 through 5 relays have previously been released by removal of ground from the off-hook ground (OHG) lead. The first operation of the ON relay also operates the PS relay, which is operated for the remainder of the tests and until DISC relay operates.

3.03 When the DIN relay releases, the L relay is connected to the tip and ring through the TA and RA leads respectively. Interrupted dial tone is supplied to transformer TN through the ON-7 make-contact and the INTR-4 make-contact. The L relay is operated and remains operated when connected to the tip and ring of the test line. Because L is operated, the SR relay also operates. This relay detects receiver on-hook while awaiting a digit for test selection. This is the only legitimate state in which a disconnect can be initiated by simply hanging up the coin station receiver.

3.04 Dialing a digit causes the L relay to operate and release following the dial pulses. The SR relay remains operated because it is a slow release relay. The first time the L relay releases, the RA relay operates. The RA relay stays operated until the completion of the digit, because the secondary winding is shorted. This makes the RA relay slow in releasing; thus it will not release between dial pulses. The digit is counted in relays P1 through 5.

3.05 Operation of the RA relay causes the AUX2 relay to operate and to lock up because relay DIN is released. Upon completion of the digit, the L relay remains operated and the RA relay releases. With relay AUX2 operated and relay SR operated, the release of relay RA causes the STP relay to operate and to lock. This

in turn operates the DIN relay. Depending upon the digit received, one of two events (3.06 or 3.07) will occur.

3.06 If the digit is a legal digit (one which initiates a valid test), the ON relay releases. Because relays STP and DIN are operated, the CPT relay (FS 2) is operated by the OCPT lead. The AUX2 make-contacts hold the ground to the P1 through 5 relays, thus holding the digit in the counter until the ON relay releases to provide the holding ground. Relay DIN operated removes the ground from AUX2, allowing it to release. Since relay AUX2 is a slow release relay, it does not release until about 75 ms after the removal of the ground. Relay AUX2 releasing will release relay STP and leave relay DIN operated because relay ON is released. Upon completion of the coin-present test (indicated by the release of CPT) a ground is placed on the D0, D2 through D5, D8 or D9 leads corresponding to the test digit dialed.

3.07 If an illegal digit is dialed, the ON relay is held operated through the ILLEGAL NO. GATING tree. Relay DIN operated releases relay AUX2, but this time when relay AUX2 releases, it releases both relays STP and DIN because relay ON is still operated. Relay DIN is a second slow release relay; therefore, it will not release immediately after relay AUX2 removes the operate ground. Since relay AUX2 is released and relays DIN and ON are operated, the ground to the P1 through 5 relays is removed and the digit is released. As soon as relay DIN releases, the circuit is reset and awaits a legal digit. A new digit and test can be incorporated merely by removing the digit from the ILLEGAL NO. GATING tree and connecting the new test to the desired D-lead.

3.08 If the receiver is placed on-hook, the L relay releases and the RA relay operates, but since the L relay does not reoperate, the SR relay releases. This places an operate ground on the disconnect relay and causes the test line circuit to disconnect.

PEG COUNT REGISTRATION OF EACH TEST DIALED (OPTION ZE, ZN, or ZV)

3.09 When message register counts of each dialed test digit are desired, this option provides the necessary ground closure leads. These leads are labeled MD0, MD2 through MD5, M8, and M9, and correspond to the test digits D0, D2 through D5, D8, and D9 respectively. During the coin-present test, the ground is closed through to a second legal number gating tree made up of the dial pulse receiver relays P1 through P5, and the ground appears on the corresponding MD lead.

TOUCH-TONE DIGITS

3.10 TOUCH-TONE digits are received by an optional TOUCH-TONE receiver and eight optional reed relays. Initially, the ON relay operates and releases the DIN relay if operated as before. If the DIN relay is operated, the release period will be the time allowed for the digit held in relays P1 through 5 to release (see dialed digits). Relay ON places interrupted dial tone on the tip and ring through transformer TN. Also, relay ON connects the TT receiver to the line and places battery on the receiver (via contact 1 make in FS 1). The dialed digit is translated from the 2-out-of-8 code to the proper code for the P1 through 5 relays by relays LG1 through 4 and HG1 through 3. Also, the STR relay operates, causing relay AUX2 to operate. Because relay RA is released, relay STP will immediately operate and this action in turn operates relay DIN. Relay STR operated places battery on the ring, through a resistor, to operate the TT pad in the coin station when the DIN relay operates. When option YO is employed to extend the loop resistance range beyond 1300 ohms, the placing of battery on this ring lead is delayed through relay DIN-1 make-contact.

3.11 If a legal digit is dialed, relay ON releases when relay STR releases. This causes relay CPT to operate through the ON 12 break-contact. Relay STR releasing also removes the ground from relay AUX2, which allows it to slow release. Relay AUX2 provides a path to hold the P1 through 5 relays operated, while relay ON releases. When relay AUX2 releases, it releases relay STP, but relay DIN remains operated because relay ON has released. A ground will then be provided on the appropriate D- lead when the coin-present test is completed (indicated by release of relay CPT).

3.12 If an illegal digit is dialed, the ILLEGAL NO. GATING tree provides a ground to the ON relay which prevents it from releasing when the DIN relay operates. Relay DIN is operated as follows. Upon reception of the TOUCH-TONE digit, the STP relay operates. This operates relay AUX2, and because relay RA is released, relays STP and DIN also operate. when relay STR releases, relay AUX2 slow releases, because relay DIN is operating. When relay AUX2 releases, relay STP releases immediately and relay DIN slow releases. Since relay ON is operated and relay AUX2 is released, the release time of relay DIN provides a time during which the ground to the P1 through 5 relays is open. During this time the P1 through 5 relays release. When relay DIN releases, the circuit is prepared to receive another digit.

3.13 If the receiver is placed on-hook while awaiting a digit (indicated by

presence of interrupted dial tone) disconnect is initiated in the same manner as outlined under dialed digits. A disconnect is also initiated if the ON relay remains operated for greater than 60 seconds. This interval is provided by timer DISC, which operates relay DISC.

4. GROUND PATH AND LOOP FEMF TESTS - DIAL 0 (OPTION ZK,FS 6,SC8)

4.01 After the coin-present test is completed and CPT has released, D10 leads are connected to ground with the operation of P3 and P5 for DIAL 0 registration. FEMF operates through released CPT contact 12. FEMF contact 2 connects the D2 lead to the D10 lead. Both are grounded and the DIAL 2 logic sequence follows except where altered by relays AUX3, AUX5, FEMF, and LFP. AUX1 relay releases when CPT releases. However, AUX1 has a 45 ms delay, so RT does not operate immediately. ADS, LRT, LLT, and ELT are all released so GRT operates through these relay release contacts in addition to the RT contact. After the 45 ms delay, RT also operates. GRT is held by TMR1. Contacts of RT, GRT, and FEMF now have the absolute value detector connected between TA lead and ground A. AUX3, No. 5 make-contact connects terminals 24 and 21 together to set the detector gain required for ground path FEMF. Terminals 23 and 24 are strapped to increase the FEMF limit from 3 to 6 volts (Option YT).

4.02 The absolute value threshold detector appears on A1246B. With FEMF operated, the signal is steered to terminal 4 of A1246B where it is amplified by AMP1, whose gain is set by AUX3 through terminals 24, 23, and 21 of A1246B. AMP2 and AMP3 constitute an absolute value amplifier whose output has a specific polarity regardless of the input polarity. If the output at AMP3 exceeds the threshold of Zener diode CR14, a signal appears at the base of Q1 which causes Q1 to turn on. This causes Q4 to conduct, and trigger latching transistor (SCR) Q5 on, connecting -V to terminal 0 of A1246B, which operates ANS1 because GRT is operated. Latching transistor Q5 continues to conduct until its output circuit opens. This occurs when GRT releases.

4.03 When GRT releases, RC operates and places a ground on the RET relay (FS 5), and coin return potential on the loop. RC also operates AUX4 to release TMR1. AUX4 starts timer TM2, which operates after 200 ms and releases RET. Therefore the return signal has a 200 ms duration. RC also connects ICGD (FS 5) to the loop conductors. ICGD operates through the HT switch of the coin station. TMR2 operated activates TM1 which times an additional 800 ms allowing time for the coin to be returned.

4.04 ICGD relay remains operated as long as the coin ground is present. CGD (FS 4) operates and releases with ICGD. After the 800 ms time interval, TMR1 operates, which provides a path for LRT to operate if CGD is released (coin disposed). If the coin was not returned, the circuit locks up in this state with RC operated. The 60-second DISC timer is activated by RC and disconnects the test line at the end of the 60-second interval. When LRT operates, RC releases and LRT starts timer TM3, which times for 2 seconds before TMR3 operates and releases RT. This time interval serves no function for the DIAL 0 sequence.

4.05 When RT releases, it places a ground on the GO lead, causing RTN to operate when INTR releases, which in turn operates BP. BP operated introduces the answer sequence (see 4.08) which is as follows:

(a) Ground path FEMF too high - one beep

(b) Ground path FEMF OK - three beeps.

These answers are the result of ANS1 and ANS2 relay states. If ANS1 operates because of FEMF as described in 4.01, -48 volts appear on the BP1 lead. If neither ANS1 nor ANS2 is operated with LRT operated, the -48 volts is on the BP3 lead.

4.06 After the answer sequence has finished, a 70 ms time interval (during which RTN is released but BP is still operated) provides a ground path through LRT, RTN, and BP to operate ADS, which holds through its own make-contact. ADS break-contact 9 removes ground from the GO lead and activates TM3 timer for 500 ms. ADS operated also connects SUPV across tip and ring (FS 5). When TMR3 operates (500 ms after ADS operates) the RHU and CT relays operate (causing hang-up tone to be heard) unless and until the receiver is placed on hook, which releases SUPV (see hang-up tone). SUPV released not only releases CT and RHU, but closes the ground path (D10) for LLT and LFP to operate. LLT operating releases ADS, disconnecting SUPV from tip and ring. LLT also pulses AUX4 operated (FS 5) by charging capacitors C13, C14, and C15 through the AUX4 coil. AUX4 in turn pulses AUX5 operated, but AUX5 is slow release, and remains operated for about 60 ms. While AUX5 is operated, it connects tip and ring to ground through 200 ohms, discharging any voltage stored in the line capacitance and station ringer.

4.07 LFP operated holds through its own contact and operates AUX3, which, along with LFP, connects the threshold detector, A1246, between tip and ground. To allow time for AUX5 to discharge the line before the detector is connected, LFP is delayed from operating by LFP capacitor and resistor in its coil circuit. LLT operated also sets timer TM2 for a 2-second period during which the detector is connected between tip and ground.

4.08 The detector A1246, operation is the same as described in 4.02. If an FEMF above ±9.0 volts in series with 100

kilohms of leakage resistance is present between tip and ground, latching transistor Q5 turns on and operates ANS2 through LFP. Option YT increases the 9 volts to 18 volts.

4.09 At the end of the 2.5-second period, TMR2 operates providing a ground path for ELT to operate and hold by its own contact. ELT sets timer TM1 for a 2-second timing period. TMR2 operating also connects tip to ground, and ring to the detector A1246 input. Simultaneously, TMR2 pulses AUX4 operated by providing a path to charge capacitors C16, C17, and C18 through AUX4 coil. AUX4 operating will operate AUX5, which stays operated for about 60 ms because it is slow release. AUX5 contacts discharge the ring conductor to ground. During the 2-second interval, the detector is connected between ring and ground with tip grounded. Any FEMF above ±9.0 volts with a series leakage of 100 kilohms or less between ring and ground or tip and ring is detected and operates ANS2 as in 4.08. If ANS2 was already operated, nothing more will happen.

4.10 At the end of the 2-second interval, TMR1 operates and releases LLT. LLT operating connects the RNG1 lead (FS 7) to ground, operating RHU, RTN, and then BP to initiate an answer sequence (SC5). While the handset is on-hook, the coded answer is heard as rings through RHU contacts to the ring lead, rather than beeps (see CODED RINGING 8.11). RHU also connects INTR to 60 IPM rather than 120 IPM to slow the coding for ringing. The coded answer returned will be:

(a) Loop FEMF too high - two rings

(b) Loop FEMF OK - three rings.

The answer is stored by AUX3, ANS2, and ANS1 relay contacts, which connect -48 volts to BP3 or BP2 leads depending on the operation of ANS2.

4.11 If the receiver is lifted off the switch hook during the answer, the ringing is tripped and the remainder of the answer is heard as beeps. Upon completion of the answer, a ground pulse is placed on the ON relay through BP, RTN, and ELT (FS 7) to operate ON (FS 3). This releases the D10 ground, releasing FEMF, LFP, ELT, AUX3, and ANS2 if operated, to set up for the next test selection.

5. LOOP RESISTANCE AND LEAKAGE TESTS - DIAL 2 (FS 6, SC4)

5.01 Completion of the coin-present test by the release of CPT places a ground on the D2 lead if the digit 2 was dialed. Since relays LRT, LTT, ELT, and ADS are released, relay GRT operates. Relay AUX1 operates with relay CPT, but because it is slow release, it does not release until at least 45 ms after CPT. Therefore, relay RT will not operate until relay AUX1 releases. Relay RT, operating in conjunction with relay GRT operated, connects the voltage detector between the ring and ground (the voltage detector consists of transistors Q1 through Q5 A1246B as discussed below), and connects the constant current source to the tip (this consists of transistors Q2 and Q1 [A962] and associated components, which are discussed below). Also, because relay AUX4 is released, relay RT operating enables timer TM1. This timer times for 2 seconds because shunting resistor TM1A is removed. The ground check is then made as follows. The current fed into the tip by the constant current source Q1 and Q2 (A962) is determined by R2 and R3 (A962) because relay GRT is operated. Q2 (A962) is determined by R2 and R3 (A962) because relay GRT is operated. This current is set so that, for the maximum tip-to-ground resistance, the voltage developed (due to the constant current) is equal to the threshold of the voltage detector

$$E_t = I_c R_{MAX}$$

5.02 The threshold is determined by zener diode CR9 and the drop across the base-emitter junction of Q1 A1246B. If the ring-to-ground resistance is lower than R_{MAX}, then the sensed voltage is less than E_t and transistor Q1 remains off. If the resistance is greater than R(MAX), then the sensed voltage is greater than E_c if the current I_c is held constant. This causes Q1 (A965) to turn on and Q2 (A965) to turn off. Zener diode CR10 (A965) will then bias the base of transistor Q3 (A965) so that it turns off. This turns on transistor Q4 (A965), which operates latching transistor Q5 (A965) operating the ANS1 relay. Thus, if the tip-to-ground resistance is too great, ANS1 operates. The ground resistance test is completed when TM1 times out. This operates relay TMR1, which releases relay GRT. For test lines having the ZK FEMF option, A1246(B) replaces A965 and the operation is the same except that Q2 and Q3 are eliminated.

5.03 Relay GRT releasing operates relay RC because relay LRT is released. This places a ground on the RET relay (FS 5), thus placing return battery on the loop. The ground from the RC relay also activates the TM2 timer through the AUX4 relay. The AUX4 relay operated releases relay TMR1 and allows timer TM1 to be re-enabled. The TM2 timer times the 200-ms return signal. Relay RC also connects the 1CGD relay (FS 5) to the tip. Upon time-out of timer TM2, the TMR2 relay (FS 5) operates. This activates the TM1 timer (FS 2), which times for an additional 800 ms. Since relay AUX4 is operated, shunting resistor TM1A is reinserted in timer TM1 to allow 800 ms for the coin to return. Relay TMR2 operating also allows the RET relay to release. This removes the return potential.

5.04 The 1CGD relay operates and remains operated as long as the coin ground is present. At the end of the 800 ms TM1 time interval, the TMR1 relay operates. If

the coin has returned and the CGD relay (FS 5) has released, the LRT relay operates. If the coin did not return, the circuit locks with relay RC operated. This activates the 60-second DISC timer and if it times out, the circuit disconnects.

5.05 When the LRT (loop resistance test) relay operates, it connects R4 and R5 (A962) to the constant current source. This produces a different constant current I_c so that the following equation is satisfied:

$$E_t = I_c' R_{LOOP}$$

When the LRT relay operates, it also enables timer TM3 and the release of relay RC. Timer TM3 times for 2 seconds (relay RT operated removes shunting resistors TM3A and TM3B).

5.06 When TM3 times out, relay TMR3 operates. This releases relay RT. During the time relay RC is released and relay RT is operated, the loop resistance test is made. During this time, the threshold detector is connected to the tip, and because relay LRT is operated, the ring is connected to ground. When relay GRT releases, the operate path of relay ANS1 is transferred to a lock path through relay ANS1 and relay LLT. Thus, if relay ANS1 is operated, it remains operated. With relay LRT operated, ANS2 is connected to the output of latching transistor Q5 (A965). Because the ring is connected to ground and the tip is connected to the constant current source with current $I sub c sup '$ the voltage at the threshold detector is given by $I sub c sup '$ $ R sub {LOOP} $. If the loop resistance is less than the maximum allowed, the threshold detector will not operate ANS2.

With option ZX, marginal loop resistance test answer, an additional detector is added consisting of Q6, 7, and 8 (A1246B). Both detectors turn on Q5 and Q8 latching transistors when the maximum loop resistance is exceeded. The output on terminal 10 of the A1246B operates ANS2. Since an ANS2 11 break-contact is in the Q5 terminal 0 path, a voltage does not appear on BP4 lead. Therefore, the answer will be a two-beep answer. When the loop resistance is near (within 100 ohms) the maximum loop resistance, a test voltage at the input to the detectors is sufficient to operate Q5, but not Q8. Therefore, ANS2 does not operate, but a voltage at the output of Q5 appears on the BP4 lead to develop a 4-beep answer. Q5 is kept on by connecting its output through 1800 ohms to terminal 20 and then to ground via relay LRT, 3 make-contact. When LRT releases, Q5 returns to its off state.

5.07 If the resistance is greater than the maximum allowed, then the threshold detector operates the latching transistor as outlined above. This operates the ANS2 relay. Thus, if the loop resistance is acceptable, the ANS2 relay is released. When the RT relay releases, it places a ground on the GO lead that operates the BP relay in the beep circuit. Also, RT releasing will release relay TMR3. This causes the answer from the resistance tests to be transmitted. The answer will be as follows:

(a) Bad ground - one beep

(b) Bad loop - two beeps

(c) Loop and ground OK - three beeps

(d) Loop resistance marginal - four beeps.

5.08 Upon completion of the ground and resistance test answers, the beep circuit places a ground pulse on the return lead. This ground operates the ADS relay (FS 5), which locks up through the LLT break-contact. The ADS relay operating removes the ground on the GO lead and activates timer TM3, which times for 500 ms. (This time is selected by having the ADS relay remove shunting resistor TM3A from timer TM3.) Relay ADS also connects the SUPV relay (FS 5) to the tip and ring. When TM3 times out, relay TMR3 operates. If the SUPV relay is operated, indicating that the receiver is off-hook, the RHU and CT relays are operated. This places steady high tone on the line indicating that the receiver should be hung up. If the receiver is not hung up in 60 seconds, the CT relay operates the DISC relay through the DISC timer and the circuit disconnects. If the receiver is hung up, the SUPV relay releases causing the RHU and CT relays to release.

5.09 The SUPV relay releasing also operates the LLT relay, which initiates the leakage tests. The LLT relay operating releases the ADS relay and pulses the AUX4 relay (FS 5) by allowing capacitors C13, C14, and C15 to charge through the coil of AUX4. During the time relay AUX4 is operated with relay LLT operated, the collect battery is connected to the line. This will precharge the line. When AUX4 releases, the ring is open and the tip is connected to the leakage detector.

5.10 If the resistance between the tip and ground is greater than 100 kilohms, the voltage, as divided across resistors R5 and R6 (A963), and the loop, allows the voltage across neon lamp DS2 (A963) to remain above the sustaining voltage. Neon lamp DS1 (A963) serves as a source of illumination for lamp DS2 (A963). This keeps some of the neon gas in lamp DS2 ionized so that it ignites at the proper voltage. Transistor Q1 (A963) stays turned on and nothing else happens. If the

resistance is less than 100 kilohms, the voltage across the lamp is reduced to less than the sustaining voltage and the lamp is extinguished. If the lamp is extinguished, Q1 (A963) turns off. This turns off Q2 and Q3 (A963), respectively. Q2 (A963) turning off turns on Q4 (A963), holding R13 (A963) to ground. This also keeps Q5 (A963) turned off. Since the time constant of C1 and R10 (A963) is shorter than the timer constant of R11 and C2 (A963), Q2 (A963) turns on before Q3 (A963). When Q2 (A963) turns on, Q4 (A963) turns off. Since Q3 (A963) is off, Q5 (A963) turns on. This operates latching transistor Q6 (A963). Thus, lamp DS2 (A963) must be extinguished for at least the time required to operate Q2 (A963) before the signal is applied to the latching transistor. This provides a guard in case noise pulses exist on the line. Once the latching transistor operates, it stays operated until the circuit is reset by removal of the D2 ground upon completion of the resistance tests. Only two answers are produced by the state of latching transistor Q6 (A963). This is because, from the test, it is impossible to know exactly how the line is shorted. There are only two answers, either leaky or not leaky.

5.11 The completion of the first portion of the leakage test is signified by the timeout of timer TM2, which was enabled by the LLT relay operating. Since LLT is operated, TM2 times for 800 ms, because LLT removes shunting resistor TM2B. When option ZK is incorporated, TM2 times for 2.5 seconds. Timer TM2 operates relay TMR2, which transfers the leakage test circuit to the ring and connects the tip to ground. This transfer allows detection of either a ground on the tip or a ground on the ring, as well as a short between the tip and the ring. Relay TMR2 operating again pulses relay AUX4 (FS 5) to charge the line. This time, the relay charges capacitors C16, C17, and C18. Again, if lamp DS2 (A963) is extinguished, the loop is leaky, and latching transistor Q6 (A963) operates. When TMR2 is operated, it operates ELT and enables timer TM1. Timer TM1 times for 800 ms and upon timing out, operates relay TMR1. When option ZK is incorporated, TM1 times for 2 seconds. When relay TMR1 operates, it releases relay LLT. Since relay LLT is a slow release relay, the leakage test takes place during the TM1 timing interval and while LLT is releasing. When LLT releases, a GO ground is enabled that operates the BP relay in the beep circuit. Since the receiver is on-hook, the reply should be ringing. Therefore, RNG2 operates the RHU relay in the beep counter, which places ringing on the line. The answer returned will be as follows:

(a) Line OK - one ring

(b) Line leaky - two rings.

5.12 Upon completion, the beep circuit generates a return ground pulse that operates the ON relay in the dial pulse receiver through the ELT relay. This releases the D2 ground, releasing the ELT relay and preparing the line circuit for the next test selection.

OPERATION OF THE CONSTANT CURRENT SOURCE

5.13 Transistor Q1 and Q2 (A962) form the active elements of the current source. Transistors Q1 (A962) is connected as an emitter-follower with the base voltage fixed by zener diode CR1 (A962). This fixes the voltage drop across the base-emitter junction and the emitter resistor, which is selected by the current desired. Since the base-emitter drop is nearly constant, the voltage on the emitter resistor (either R1 or R2-R3 [A962] or R5-R4 [A962] depending on the current value desired) is also nearly constant. The emitter current is given by:

$$\frac{V_Z - V_{BE}}{R} = I_E,$$

where V_Z is the zener voltage = 10V,

V_{BE} is the base-to-emitter drop for Q1 (A962), and

R is the emitter resistance.

If the gain of Q1 (A962) is sufficiently large, I_E equals I_C. Therefore, the current is constant as long as the transistor is operating in the active region.

5.14 Zener diode CR74 serves to limit the maximum available supply voltage to about 100 volts. This voltage still exceeds the breakdown voltage of Q1 (A962) so that if its collector were connected to ground, it would break down. To remedy this condition, Q2, R7, and R6 (A962) are added. Q2 (A962) again operates as an emitter-follower with Q1 (A962) serving as its emitter resistor. R7 and R6 (A962) divide the voltage between the current source output and the emitter of Q1 (A962) in half. Thus, the base of Q2 (A962) is at the midpoint of the voltage drop across transistors Q2 and Q1 (A962). This places half of the voltage across Q1 (A962) since the base-emitter drop of Q2 (A962) is limited to less than a volt. The remainder of the voltage is across Q2 (A962). These transistors should not break down; however, note that if Q2 or Q1 (A962) fails, both transistors can be destroyed since the breakdown voltage of either may be exceeded. TN1 and TN2 serve as protection to prevent burned relay contacts should a ground pick be accidentally applied to a contact on which the +CC supply is present.

5.15 A new A962C circuit pack (option YU) substitutes a single 147D transistor in place of Q1 and Q2 which has a higher breakdown potential and provides the same

function as the combination of Q1, Q2, R6, and R7.

6. RETURN AND COLLECT TEST - DIAL 4 RETURN, DIAL 3 COLLECT (FS 5, SC3)

6.01 Upon completion of the coin-present test (indicated by release of the CPT relay) a ground will be placed on the D3 or D4 lead if digit 3 or 4 was dialed. The D4 ground initiates the return test, while the D3 ground initiates the collect test. Both tests are sequenced identically except that the return test operates the RET relay, which applies return potential to the tip and ring. The collect test operates the COL relay, which applies collect potential to the tip and ring. Note that both the return and collect relays isolate the tip and ring from the rest of the test line circuit when they operate.

OPERATION OF RETURN TEST

6.02 Relay CPT releasing places a ground on the D4 lead. AUX1 is a slow release relay, which is operated by the CPT relay. Since it is slow release, it does not release until at least 45 ms after relay CPT releases. During the time relay AUX1 is releasing, the D4 ground operates the ADS relay through the relay TMR1 break-contact, the TST break-contact, and the TC break-contact. The ADS relay places the SUPV relay across the tip and ring. Operation of the SUPV relay cuts the D4 ground through to the RHU and CT relays, causing them both to operate. With both of these relays operated, the high tone is placed steadily on the line and this indicates that the receiver is to be placed on-hook. When the coin station receiver is placed on-hook, the SUPV relay releases, allowing the test to proceed. If the receiver is not placed on-hook within 60 seconds, the DISC timer times out and a disconnect is generated.

6.03 Releasing the SUPV relay releases the CT and RHU relays. With relay AUX1 released, the D4 ground is cut through to the RET relay which operates, placing return potential on the tip. The D4 ground also operates relay AUX4, which enables TM2. TM2 times out 200 ms later, operating relay TMR2. When relay TMR2 operates, the battery is removed from the RET relay, allowing it to release. Thus, the 200-ms return pulse is generated. Relay TMR2 operating enables timer TM1 (FS 2). This timer times for 800 ms to allow the coin to be returned. Upon time-out, relay TMR1 (FS 2) operates. This releases the ADS relay and operates the TST relay. When the TST relay operates, the 1CGD relay is placed on the tip. This relay is connected to the +48 volt supply and is operated if a coin ground is present. If the coin ground is present, 1CGD operates, operating CGD. Also when TMR1 operates, AUX1 operates. This releases relay TMR2, which releases relay TMR 1, which inturn releases relay AUX1. Since AUX1 is a slow release relay, it will take at least 45 ms for this process to occur. It is during this time that the 1CGD relay, if it operated (indicating the coin was not returned), will operate the CGD relay. If the CGD relay operates, it releases the TST relay since relay TMR1 has released.

6.04 To count each attempt, an attempt counter, consisting of relays ATC1 through 3, is advanced by each operation of the RET or COL relay. (See D sheet for counter states.) If the coin ground is not detected, the TST relay remains operated. Thus, when the AUX1 relay releases, the TC relay operates through the TST make-contacts. If the TST relay is released, AUX1 releasing reoperates the RET relay and the whole sequence is repeated. Three attempts will be made. If during any attempt the coin is returned, the TC relay operates. This blocks any further attempts to return the coin and also generates a ground that operates the BP relay in the beep circuit. Since the receiver is on-hook, the TC relay operates the RHU relay, which causes the answer to be coded ringing. The answer consists of one through three rings given three times and is produced by the state of the attempt counter as shown below.

COIN RETURNED	ANSWER
First attempt	1 ring or beep
Second attempt	2 rings or beeps
Third attempt or not at all	3 rings or beeps

The circuit is stopped on the third attempt if the coin is not returned by the advancing of the attempt counter. When it advances to the state ATC2 release (with ATC1 and ATC3 operated), battery is cut through to the TC relay causing it to operate. Upon completion of the transmission of the answer, the D4 ground is removed by resetting the dial pulse registration relays P1 through P5. This is done by operating the ON relay through a TC make-contact by a ground pulse generated by the beep circuit. When option ZO is used, relay CRM and resistors COL (196 ohms) and RET (196 ohms) are added as shown in FS 5. Resistors COL and RET are connected in series with the T conductor for collect and return test, respectively. Relay CRM is operated by ATC2-12 make-contact when ATC2 operates at the end of the first attempt. CRM locks with its CRM-8 make-contact and COL and RET resistors are shorted by CRM-10 and 11 make-contacts, respectively, removing the resistors for the second and third attempts. CRM releases at the end of the collect or return tests. Thus, the 196-ohm series resistor added to the loop resistance provides a marginal test on the first attempt.

COLLECT TEST

6.05 The collect test operates in the same fashion as the return test except that the ground is supplied by the D3 lead. This allows the COL relay to operate rather than the RET relay. The COL relay places collect battery on the tip rather than return battery, thus the coin will be collected instead of returned. For option S, collect and return potentials are applied to both tip and ring.

7. COIN RELAY TIME TEST - DIAL 5 (FS 4, SC7)

7.01 Following satisfaction of the coin present test (indicated by release of CPT relay) a ground is supplied on the D5 lead if the digit 5 was dialed. This ground operates the TT relay through the ETT break-contact. The TT relay 8 make-contact places a ground on the CR relay, causing it to operate. This initiates the coin return attempt by operating the AUX4 and RET relay (FS 5). The RET relay in operating places return potential on the loop and places IC+ on the set lead of IC1A. To time the length of the return attempt, the AUX4 relay enables timer TM2, which times for 200 ms (since both the RTT and LTT relays are released). At the end of the 200 ms interval, timer TM2 operates relay TMR2. Relay TMR2 removes the battery from the RET relay, which releases, removing the return battery from the tip. The tip is then connected to the coin ground detection relay 1CGD. TMR2 operating also initiates timing of timer TM3 which times for 100 ms. Upon time-out of TM3, relay TMR3 operates. Relay TMR3 operating allows the detection relay 1CGD to stop the integrated circuit timer when the coin ground is removed in the coin station.

7.02 During the return period, the IC timer is timing since the IC1A flip-flop on CPA973 is set. This enables clock pulses that are generated by Q1 and Q2 on CPA973 to be fed to the toggle lead of IC3B through gate IC2C and IC2D which are CPA973. The two IC3 flip-flops divide the 120 p/s clock by 3 providing a 40 p/s clock. This 40 p/s clock has a period of 25 ms and will be counted in flip-flops IC1B, IC5A, IC5B, IC6A, and IC6B (located on CPA973). The 40 p/s clock is enabled to this counter by gates IC4B and IC4C on CPA973. When the seventeenth 25 ms input pulse is generated, the counter reaches the state 00001. This state is detected by gates IC4A and IC4D and when it occurs the output of these gates goes high (+4 volts above -36 volt reference supply). (The -36 volt supply prevents noise on the -48 volt battery from reaching the counter.) This output prevents the counter from receiving any further clock pulses, thus leaving it in the state 00001. Instead the clock pulses are routed through gates IC7D (enabled by IC7C) and IC10A to the T leads of the 5-bit serial shift registers IC8, IC9, and IC11. This register has a high input on the D lead of the first flip-flop IC8A. As the 25 ms input pulses occur, the register shifts through the following states: 00000, 10000, 11000,11100, 11110, and 11111. Thus on the seventeenth 25 ms pulse (which occurs at 400 ms), the shift register advances from 00000 to 10000. Each 25 ms pulse after this causes the serial counter to advance one state (until 500 ms), at which time the state of the counter will be 11111. Thus these states can be used to indicate 25 ms time intervals between 400 and 500 ms. The intervals 400 through 425, 425 through 475, 475 through 500, and 500 are decoded by gates IC12C, IC12D, IC12B, and IC12A, respectively. If the time interval is less than 400 ms, none of the above gates is enabled. This is detected by IC7A and IC7B. The outputs of these time interval gates are held low by the STB lead. This lead is pulsed at the end of the time interval measurement to allow encoding of the answer.

7.03 Following the release of the RET relay, the 1CGD relay is connected to the tip through the CR and TMR2 make-contacts. Since the coin should still be present, immediately following the return attempt the coin ground should cause the 1CGD relay to operate. The CGD relay operates through the zener diode CR6 on CPA1246(B). This diode drops about 6.2 volts of the -36 volts with the remainder being across the CGD coil. Thus, capacitor C2 on CPA1246(B) charges to 6 volts above the -36 volt office battery. When the coin is returned, the 1CGD relay releases. If relay TMR3 has been operated, capacitor C2 on CPA1246(B) discharges through resistor R1 and the clear lead of flip-flop IC1A. This clears the flip-flop. When this flip-flop is cleared, the 120 p/s clock is removed from the divide-by-3 counter and the timing is stopped. Also, when IC1A is reset, the Q lead goes to -36 volts. This pulls down capacitors C6 and C7 on CPA973 which enables gate IC10B producing the STB pulse. The duration of the pulse is given by the time constant C6, C7, and R8. It is during this time that the answer is gated to the latching transistors Q1.1 through 1.4 on CPA964. One of these transistors will operate and remain on, placing -36 volts on the appropriate answer lead. Note that if the coin is not returned within 500 ms, the >500 lead will clear IC3 through 10 and operate the ETT relay in case the coin does not return at all. If the CGD is removed before the operation of TMR3 (i.e., time is less then 300 ms), then relay TRM3 blocks the clear pulse and the timer is stopped by the >500 lead. This prevents the inductive kick from the coin relay in the coin station from falsely stopping the timer if the coin relay fails to operate.

7.04 When the F or YA option is furnished, if 1CGD and CGD fail to release as a result of the coin not returning, or the presence of a tip-ground fault on the line,

the DISC relay is operated through CGD, 3 make and ETT, 4 make-contacts and the CSTL will disconnect from the station. This action is required to prevent an ambiguous answer from being heard and to prevent lockup of the test line to the station. If the coin relay time is greater than 525 ms, the test line disconnects.

7.05 When IC1A is cleared, it also operates latching transistor Q2.5 on CPA964. Since relay CR is operated, relay ETT operates and locks up through its own make-contact. Relay ETT releases the TT relay, which also releases the CR relay. This releases relay AUX4. The ETT relay also operates the BP relay in the beep circuit (FS 7). This initiates the transmission of the coded tone, the answer indicating the time interval measured. The beep circuit will be explained in detail later.

7.06 When the beep circuit has completed the answer, it operates CPT relay through an ETT make-contact. This initiates the coin present test and removes the ground on D5, releasing ETT. When the coin present test is satisfied (indicated by release of relay CPT), the D5 ground is returned and the time test repeats. The time test continues to repeat until the switch hook is flashed while awaiting a coin, or if coin tone is present for 60 seconds. If the switch hook is flashed for about 1 second, the circuit operates the ON relay and looks for a new test selection (dialed digit). If coin tone is present for 60 seconds, the DISC relay operates and the circuit disconnects. The latching transistors are released by operation of the TT relay when the test is repeated. Following completion of the test, removal of the D5 ground prevents accidental operation of the latching transistors.

INTEGRATED CIRCUIT POWER SUPPLY AND 120-HZ CLOCK

7.07 The power supply is a series regulated supply with transistors Q1 and Q2 on CPA966 connected in a Darlington configuration. Zener diode CR6 on CPA966 provides a 6.2-volt reference which is divided across potentiometer R2 (on A966). The output voltage from the wiper is the reference to which the supply regulates. This should be set so that the output voltage IC is +4.0 volts above the -36 volt reference supply consisting of zener diodes CR21 and CR22 and of capacitor C22 and resistor R66. This supply is provided to prevent any noise which might exist on the -48 volt battery from appearing in the IC counter. Diode CR5 on CPA966 isolates the filter capacitor C6 (A and B sections) from the bridge rectifier (diodes CR1 through 4 on CPA966). This allows the unfiltered output of the bridge to serve as an input for the clock circuit which consists of Q1 and Q2 on CPA973. Q1 and Q2 operate very similarly to a latching transistor. When the voltage on the emitter of Q1 exceeds the voltage at the base of Q1, Q1 turns on. This generates an avalanche effect, also turning on Q2. Capacitors C1 and C11 are thus discharged through resistor R4. This generates a very narrow pulse which drives the IC counter. Q1 and Q2 remain on until the input voltages go to zero. This prevents generation of more than one clock pulse for each half sine wave input.

8. RESISTANCE TESTS CALIBRATION
DIAGNOSTICS - DIAL 8 AND 9 (FS 6, SC4)

8.01 When digits 8 or 9 are dialed, ground is applied on D8 or D9, respectively, through the registration (P) relays. With relay CPT released, the application of ground operates relay CAL1 for Dial 8 and relay CAL2 for Dial 9. The CAL1-1 and CAL2-12 make-contacts connect D2 to ground through the released CPT-9 break-contact. This starts the logic sequence for Dial2 (paragraph). However, the CAL1 contacts now disconnect leads TA and RA from the constant current test source and the CPA965 [1246(Option ZK)] detector. Test current then flows through relay make-contacts RT-11 and CAL1-2, and through resistor STB to ground for the ground path check. The detector is connected across the STB resistor through resistor STS and relays CAL1-3 make, GRT-1 make, and LFP-11 break. The value of STB is 1350 ohms which is just under the allowable maximum total resistance of the tip to ground resistance of the coin station plus the earth resistance between the coin station and the CO. With Dial 9 ground path test, CAL2 is operated rather than CAL1 and the 50 ohm STD resistor is added in series with STB1, which should cause the voltage drop due to the test current flowing through STD + STB to exceed the test threshold and result in operation of ANS1 relay.

8.02 During the loop resistance diagnostics (dial 8) test, the test current flows through relay make-contacts RT-11, CAL1-2, LRT-11 and through resistors STE and R86 to ground. The detector is connected across the loop standard resistors STE and R86. The combined total resistance equals the office loop requirement plus 300 ohms, which represents the coin station tip to ring resistance. Again with dial 9, CAL2 is operated rather than CAL1 and the test current flow through resistor STD (50 ohms) in addition to resistors STE plus R86. This total resistance is equal to the maximum loop resistance plus station tip-ring resistance and allows for 50 ohms of switch and intra-office resistance. If the switch and intra-office resistance is more or less than 50 ohms, R86 can be increased or decreased accordingly.

8.03 During the loop leakage test calibration sequence, the path to the loop conductors is opened by break-relays CAL1-4 or CAL2-9 for RA and CAL1-5 or CAL2-8 for TA. With CAL1 operated, the test voltage from CPA963(B), TER.27 is applied across the series combination of resistors STF (10K) and STG(100K) for a

total of 110K through operated make-relay LLT-7, released break-relays TMR2-6 and CAL2-8, operated make-relay CAL1-5, and released break-relays AUX4-10 and AUX3-3 (Option ZK). Since 110K leakage is below the threshold for leakage, Q6 of CPA963(B) does not fire and only a single ring answer is obtained. With digit 9 dialed (CAL2 operated) the test voltage is applied directly across STG(100K) resistor, which should extinguish DS2 on CPA963(B) and fire Q6 to obtain a double ring (Test Fail) answer.

8.04 Operation of TMR2 initiates the second leakage test by connecting tip to ground and the test voltage between ring and ground. However, CAL1 operated connects the test voltage across resistors STJ and STH in series for a total of 110K ohms leakage, which should result in a test OK. For the Dail 9 test (CAL2 operated), only STH (100K) is connected, which again should trigger the detector on CPA963(B) and cause Q6 to trigger, putting a signal on the BP2 lead to obtain a double ring (FAIL) answer. If a test OK for Dial 8 or test fail for Dial 9 is not obtained for paragraphs 8.03 or 8.04, R5 of CPA963(B) must be adjusted to get the proper results.

9. BEEP CIRCUIT (FS 7, SC5)

9.01 The purpose of the beep circuit is to generate the signaling which is returned to the coin station. This signaling consists of:

(a) C tone (coin tone)

(b) Interrupted dial tone

(c) Hang-up tone

(d) Answers consisting of either coded rings or coded tones repeated three times. These answers are:

(1) One beep or ring

(2) Two beeps or rings

(3) Three beeps or rings

(4) Four beeps or rings

(5) Continuous beep or ring.

9.02 The coded answers are controlled by the office interrupter. For the beeps, the 120 i/m interrupter is controlling; for rings, the 60 i/m interrupter is controlling.

SIGNALING TONES

A. C Tone

9.03 C tone is supplied whenever a coin is desired in the coin hopper and none is detected. This tone is produced by operating only the CT relay. When the OH relay (FS 1) operates as the test line is seized, it connects the 120 i/m interrupter ground through to the INTR relay. Thus, the INTR relay is pulsing at 120 i/m. All tones are placed on the line through the TN transformer. When the CT relay operates, it places a shunting capacitor across the primary and secondary winding of the transformer. The CT relay also cuts the tones on to the third winding on the coil. The tones are switched by the interrupter, which is operating at 120 i/m. Thus, the coin tone consists of alternate application of high tone (HT) and dial tone. This continues until the CT relay is released.

B. Interrupted Dial Tone

9.04 This tone is supplied when the test line is anticipating a digit requesting a new test. The tone is initiated when the ON relay is operated. The ON make-contact cuts through the dial tone, which is interrupted by the 120 i/m interrupter. This interrupted dial tone is used instead of steady dial tone; therefore, if the test line is disconnected and the office dial tone is applied to the coin station, a difference is noted.

C. Hang-Up Tone

9.05 Hang-up tone consists of steady high tone. This signal is generated whenever it is desired to have the receiver placed on-hook and continues until the receiver is on-hook. The signal is produced by simultaneously operating the RHU and CT relays. Again, as with C tone, the CT relay places a capacitor across the primary and the secondary winding of the transformer. The CT relay also cuts through the tones and, if the interrupter (INTR) relay was operating, C tone would be produced. But since the RHU and the CT relays are operated, no ground can be supplied to the INTR relay and thus the INTR relay remains released. This causes only the high tone to be placed on the test line, which is the desired signal for hang-up tone.

9.06 When the RHU relay is operated without the CT relay being operated, it is used to indicate that ringing is desired. For this reason, the CT9 break-contact is placed in the operate path of the TR relay. This prevents the TR relay from operating when the CT relay is operated, and thus prevents ringing from being applied.

D. Test Answers

9.07 The test answers are initiated by the operation of the BP relay. This relay is operated by a ground from the circuit desiring transmission of an answer. The ground is presented to the BP relay in the following way. To cause the correct number of signals to be sent, the BP relay is allowed to operate only when the INTR relay is released. To provide the correct sequencing, the ground cut through the INTR relay operates the RTN relay, which operates the BP relay. When the BP relay

operates it locks up and remains up until the sequence is completed. To provide an additional delay, allowing the totalizer in the coin station to reset, relay TRT operates on the operation of the INTR relay (which follows the operation of the BP relay). Only when both the BP and TRT relays are operated will ground pulses be enabled to the beep counter.

ANSWER BY CODED TONE

9.08 If the RHU relay is not operated, the answer is in coded tone. Because the RHU relay is released, the INTR relay is pulsing at 120 i/m. Since relay TRT operated while INTR was operated, the beep counter is enabled before the INTR relay is released. The first release of the INTR relay causes the counter to advance by one. The counter will then count in the pattern shown on the D sheet in the schematic drawing. During the counting period, the states of the BCA, BCB, BCC, and BCD relays are used to enable BPR relay through the INTR 1 break-contact. Every time the BPR relay is allowed to operate, it places HT1 onto the transformer. The BP relay, in operating, places battery and ground on the TN transformer, thus enabling the tone to be placed on the tip and ring. The number of times the BPR relay is operated is determined by the battery signal placed on the BP1 through BP4 leads.

9.09 Diodes CR58 through CR63 create a set of OR gates. These enable the circuit to work as follows. If no OR gating were used, each lead BP1 through BP4 would cause the single beeps to be generated with a space of five periods in between. Each single beep is staggered in time from the other. This is shown also in the drawing on the D sheet. The OR gates cause not only the selected beep to be generated but also cause all beeps of lower order to be generated by steering the battery to these inputs. For example, battery is placed on the BP3 lead. Diode CR61 places battery on the BP2 lead and diode CR62 places battery on the BP1 lead. Note that a maximum code of only four beeps be generated and three codes are produced by each selection. Thus the answers will be as follows:

Battery ON

```
BP1 _ B _ _ _ _ B _ _ _ _ B _ _
BP2 B B _ _ _ B B _ _ _ B B _ _
BP3 B B B _ _ B B B _ _ B B B _
BP4 B B B B _ B B B B _ B B B B
```

where B indicates tone and _ indicates silence. While counting, the counter reaches the state where only relay BCF is operated when the INTR relay is operated. Thus, the operate path for the BP relay is removed and the BP, TRT, and RTN relays release. Since the BP relay is a slow release relay, there is a period determined by the release time of BP during which the BP relay is operated and the RTN relay is is released. This combination causes a ground to be generated that is switched through appropriate relays to cause the test line to advance to the next state in testing. The BP10 make-contact, in series with the RTN break-contact, holds the interrupter operated during the release of BP to prevent the INTR relay from changing state during this period, and thus re-enabling the counter.

9.10 To generate a steady tone, the counter is allowed to count through the entire sequence and the BPR relay is held operated by the steady signal. Thus, during the entire cycle while the BP relay is operated, the tone is applied to the line.

CODED RINGING

9.11 Coded ringing is generated in the same fashion as coded tone except that the RHU relay is operated. This produces two differences. First, the INTR relay is connected to the 60 i/m interrupter instead of the 120 i/m interrupter. Thus, the coding rate is slowed to allow time for the ringing to be recognized. Second, the RHU relay causes the ringing signal to be switched to the tip and ring through the BPR relay. Again, the BPR relay switches on and off the ringing signal. Ringing supervision is added by placing the TRA relay in the ground path. This permits the test person to remove the receiver without getting the 20-Hz ringing signal applied to the receiver. Instead, the circuit continues to respond by applying the coded tones. However, the 60 i/m interrupter will still be used as the clock. Ringing is tripped by having the TRA relay operate when the receiver is lifted. This removes the lock path on the TR (trip ring) relay, which releases and removes the ringing signal from the tip and ring. Releasing the TR relay also provides a connection back to the TN transformer, which supplies the coded tone until the answer is completed.

10. DISCONNECT (FS 1, SC5)

10.01 Disconnect is achieved by operation of the DISC relay. It can be operated directly through a ground on the OG lead. It can also be operated with a ground on the DISC lead when option F or YA is provided. This ground is produced when the receiver is returned on-hook during the digit-waiting period indicated by the presence of interrupted dial tone at the receiver. Disconnect otherwise is originated by timeout of the 60-second DISC timer. The signals for this timer are all indications of failure to satisfy the signals sent by the circuit or to prevent a lockup of the circuit. These conditions are listed below.

DISCONNECT DUE TO	REASON
CT Relay Operated	Requested coin for 60 seconds and none deposited or requested hang-up of receiver for 60 seconds and none occurred.
RC Relay Operated	Attempted to return coin in resistance test and coin did not return.
ON Relay Operated	Requested dialed digit for 60 seconds and no response.
TT Relay Operated	Failure of the IC counter due to loss of 110V, 60-Hz ac supply.

10.02 Once the DISC relay operates, the disconnect sequence is started and continues until the sequence is completed. The sequence operates in two separate modes depending upon whether the PS relay is operated or released. This is done to ensure proper sequencing so that the DISC relay is always the last relay to drop. If the PS relay is operated, a return attempt is initiated during any disconnect attempt in case a coin is present. If the PS relay is released, no coin return attempt is made. This is because the only time such a disconnect would occur is during the time when a coin is being requested upon initial seizure, and thus there is no coin to return. Sequencing is as follows.

RELAY PS RELEASED - NO RETURN ATTEMPT

10.03 When the DISC relay operates, the OH relay releases. This removes the ground holding the CPT relay operated, and thus the CPT relay releases. This releases the CT and TMR1 relays, which release the DISC relay. The DISC relay releasing, removes the grounds on the sleeve leads and releases the test line.

RELAY PS OPERATED - RETURN ATTEMPT

10.04 When the DISC relay operates, (Y or Z options) the OH relay releases. The OH relay releasing, releases the ground to the circuit that operated DISC; thus, the DISC relay must be held up. The PS 9 make-contact serves this function. Since PS is operated, the DISC relay operating places a ground on the RET and AUX4 relays causing them to operate. When the RET relay is operated, the return attempt is initiated. AUX4 operating enables timer TM2. This timer operates relay TMR2 at the end of 200 ms. When TMR2 operates the RET relay releases. TMR2 operating also enables timer TM1. The timer times for 500 ms to allow the return attempt to complete. When TMR1 times out it operates relay TMR1. Relay TMR1 operating releases relay PS and bridges the hold path for the DISC relay so that it will not release. When the PS relay releases it releases the AUX4 relay, which releases the TMR2 relay. When relay TMR2 releases, relay TMR1 releases, allowing the DISC relay to release. Thus the DISC relay is the last relay to release with all other relays normal. This guarantees that the test line cannot be seized with any relay off-normal unless a trouble condition exists. Relay DISC releasing removes the sleeve ground allowing the test line to release the loop.

10.05 In 1ESS switch and 2ESS switch offices (F option), test couplers are used to interconnect the Coin Station Test Line and the switching network. A short across leads E and EG for F option energizes a scan point in the coupler circuit to maintain the connection between the line circuit and the CSTL through the switching network. When OH relay is operated and DISC is not operated, or when relay PS is operated, the short across the E and EG leads is prevalent.

10.06 With relay PS operated, (F option) and when DISC operates, OH releases, but PS 9 make-contact maintains the scan point energized. When DISC operates, TMR3 is released if operated, and its 5B contact holds DISC operated through DISC 4 make-contact. However, the TM3 timer is not yet activated because the PS relay is operated. With DISC and PS operated, relay RET operates for 200 ms to return any coins in the hopper. TMR2 operates at the end of the 200 ms time interval which initiates an additional 800 ms interval after which TMR1 operates. When both TMR2 and TMR1 are operated, the PS relay releases, the TM3 timer is activated, and the coupler scan point across leads E and EG is opened. At this time, the switching network and coupler begin their disconnect sequence. TM3 has a 2.5 second interval to allow ample time for the line circuit to disconnect from the switching network before TMR3 operates to release DISC relay. This in turn releases TMR3 to terminate the disconnect procedure. If ample time is not allowed for the switching network to disconnect before DISC relay is released and an Off Hook condition exists on the station connected, OH relay will reoperate when DISC releases to re-energize the scan point and the line circuit will not be disconnected from the CSTL.

10.07 When the PS relay is not operated and The F option is furnished (1ESS switch and 2ESS switch offices), operation of DISC relay immediately opens the E and EG scan point leads. The TM3 timer is activated to provide a 2.5 second interval which allows the switching network time to disconnect with PS released; no coins will be in the hopper, so operation of RET relay to apply coin return voltage is unnecessary. DISC will be kept operated by the TMR3 5 break-contact until TMR3 relay operates at the end of 2.5 seconds. When DISC releases, TMR3 also releases.

10.08 In SC7, the coin-relay time test, when relay ETT operates and ICGD is

still operated due to a tip-ground short or the hopper trigger not operating, a false answer for the coin relay would be forthcoming. At that point, DISC relay is operated through the disconnect sequence. A disconnect at this point is also necessary to prevent a lock up of the CSTL to the station connected because the coin relay test would continue to cycle endlessly with the tester powerless to interrupt the operation. A disconnect also occurs during the DIAL 5 time test if the coin relay time is >525 ms.

10.09 In the 5ESS switch office, relay DISC operation provides high sleeve current, thru resistor RH, DISC 6M contact, and the ST relay coil, which signals the test trunk circuit to disconnect the test connection. During CSTL operation, low sleeve current is provided through resistor RL.

11. TEST CURRENT SENSING AND INTERLOCK CIRCUIT (OPTION ZK, FS 7)

11.01 The coded beep and ring answers for the FEMF and LOOP RESISTANCE, LOOP LEAKAGE AND GROUND check tests depend on applying test currents and/or detecting test voltages with a constant current electronic circuit and several voltage detection circuits mounted on circuit packs plugged into connectors. To obtain a "test fail" answer, the threshold voltage detectors operate wire spring relays or latching transistors (SCRs). When these devices are not operated, "test OK" answers are indicated. For certain tests the TEST CURRENT SENSING and INTERLOCK CIRCUIT prevents all test answers from being heard if a certain amount of test current is not applied to the test, or, if the constant current circuit pack or voltage detector circuit packs are not connected.

11.02 The interlock circuit (FS 7) is in series with BPR relay. CPA963B has a jumper connected between terminals 17 and 19 and on CPA1246, terminals 11 and 9 are connected together by relay ITL contacts when LRT is operated and by LRT break-contacts when LRT is not operated. ITL requires about 10 milliamperes through its coil to operate. Therefore, if CPA963B, A1246, and A962 are all seated in their connectors and if the constant current (test current) source is operating, the BPR relay is connected to its circuit and for the Ground Check, Loop Resistance and Ground Path FEMF tests, test answers should be heard. However, if any one of these conditions is lacking, the circuit to BPR opens and no beeps are heard during these tests. For the Leakage Resistance and Loop FEMF tests, the ITL relay contacts are shunted by the LRT break-contacts so that, even though the constant current source or CPA1246 are missing, test answers are heard. If CPA963B is not in the circuit, no coded ringing or beeps are heard on any test.

12. POWER AND TONE UNIT (OPTION YL, FS 9)

12.01 The CSTL requires several test voltages and signals which are normally provided by the central office power and tone plants. The 5ESS switch does not provide any voltages other than -48 Vdc office battery. The power and tone unit provides the necessary signals, fusing, and alarms as follows:

FUNCTION	OUTPUT	AVG LEVEL	FUSING AMPS
Coin Collect	+145 Vdc	100 mA	1/4
Coin Return	-145 Vdc	100 mA	1/4
Gnd Det Pot	+50 Vdc	100mA	1/4
Ringing	92 Vac, 20 Hz	100mA	1 1/3
Input Power	115 Vac, 60 Hz	<200 mA	1 1/3
Relay Driver	60 IPM	40 mA	None
Relay Driver	120 IPM	40 mA	None
Dial Tone	DT	-1dBm	None
High Tone	HT	-2dBm	None
5ESS ALARM	ALM1	Normally Open Contact	None
Aisle Alarm	ALM2	Normally Open Contact	None

COIN COLLECT AND RETURN VOLTAGES

12.02 The 5ESS switch provides coin phone operation over 1500-ohm loops, this is a 200-ohm increase over other ESS central offices. This is accomplished by increasing the coin potentials to 140 Vdc. The CSTL power supply using 145 Vdc through the 450 ohms of the MSU test path, provides the 140 Vdc potential.

12.03 The SF20 circuit pack provides +145 Vdc, -145 Vdc, and +50 Vdc supplies using full-wave bridge rectifiers and series regulators. Overcurrent protection is provided with 1/4 ampere fusing.

RINGING GENERATOR

12.04 The SF21 circuit pack provides a 92 Vac, 20 Hz potential with a -48 Vdc battery superimposed on it for trip ringing. The -48 Vdc input is on T1-6 with the output on T1-2. Feedback resistor R13 controls the output voltage level.

CSTL TONE, ALARM, AND INTERRUPTER GENERATOR

12.05 The SF22 circuit pack provides dial tone and high tone outputs at about -2 dBm by using IC5, IC6, and IC7 (star-filter- oscillator chips). Dial tone is provided by mixing the 350-Hz and 440-Hz

oscillator outputs in a resistor-summing voltage divider circuit (R7, R8, and R9). This combination of frequencies is called precision dial tone. High tone is the CW output of IC7 (480 Hz, voltage divided down to -2 dBm into a 1K ohm load).

12.06 The 60- and 120-IPM relay-control signals are provided by a binary countdown of the 480-Hz oscillator in IC1 and relay driver IC2.

12.07 The alarm circuit is provided by monitoring the output of the fuses that feed the CSTL with +145, -145, SUP-ringing and +50 Vdc. The voltages provide current through limiting resistors (R18, R19, R20, R21), which feed opto-isolators with output transistors connected in series supplying alarm relays' AL1 and AL2. The relay break-contact is used to supply the CO alarm system. One AL1 make-contact supplies alarm information to the 5ESS switch, and the AL2 make-contact supplies an aisle alarm circuit when available.

12.08 The ED-7C607-30 Power and Fuse Panel provides circuit protection through fusing, power ON/OFF switching, and alarm disable switching.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 This circuit operates with any local coin loop that does not require dial long lines circuits. However, it will test through a 8A REG (COIN REG) circuit but the ground lift test (2.03) should be ignored.

2. FUNCTIONAL DESIGNATIONS

2.01 Relays

Designation	Meaning
ADS	Add Supervision
ANS1, ANS2	Answer 1, 2
ATC1-3	Attempt Counter 1-3
AUX1, AUX2, AUX3, AUX4, AUX5	Auxiliary 1, 2, 3, 4, 5
BCA-F	Beep Counter A through F
BP	Beep
BPR	Beep Producer
CAL1, CAL2	Calibration 1,2
CG	Coin Ground
CGA	Coin Ground Auxiliary
CGD	Coin Ground Detector
CRM	Coin Relay Margin
COL	Collect
CPT	Coin Present Test
CR	Coin Return
CT	Coin Tone
DIN	Digit Inserted
DISC	Disconnect
ELT	End Leakage Test
ETT	End Time Test
FEMF	Foreign EMF
GRT	Ground Resistance Test
HG1-3	High Group 1 through 3 (TOUCH-TONE only)
ICGD	Auxiliary to Coin Ground Detector
ITL	Interlock
INTR	Interrupter
L	Line Relay (Dial Pulse Receiver)
LFP	Loop Foreign Potential
LG1-4	Low Group 1 through 4 (TOUCH-TONE only)
LLT	Loop Leakage Test
LRT	Loop Resistance Test
MD2-5,0,8,9,	Message Register Leads for Individual Test Digits 2 through 5 and 0, 8, and 9
OH	Off-Hook
ON	Off-Normal (dial Pulse Receiver)
P1-5	Pulse Relay 1 through 5
PS	Pretest Start
RA	Received All of Digit
RC	Return Coin
RET	Return
RHU	Ring or Hang-Up
RT	Resistance Test
RTN	Return to Next State
RTT	Reset Totalizer Time
SHF	Switch Hook Flash
SR	Slow Release
STP	Stop (Dial Pulse Receiver)
STR	Store Digit (TOUCH-TONE only)
SUPV	Supervision
TC	Test Complete
TMR1, TMR2, TMR3	Timer 1, 2, 3
TR	Trip Ringing
TRA	Trip Ringing Auxiliary
TRT	Totalizer Reset Time
TST	Test
TT	Time Test

2.02 Jack

Designation	Meaning
TJ	Test Jack

2.03 Switch

Designation	Meaning
MB	Make Busy (No. 5 Crossbar Only)

2.04 Leads

Designation	Meaning
BP1	1 Beep or Ring
BP2	2 Beeps or Rings
BP3	3 Beeps or Rings
BP4	4 Beeps or Rings

Designation	Meaning
E	Sleeve Lead in ESS No. 1 and No. 2 Offices
EG	Sleeve Ground in ESS No. 1 and No. 2 Offices
CLK	Clock
CLR	Clear
CT	Coin Tone
D-	Digit-
DISC	Disconnect
GO	Operate BP
ITL	Interlock
R	Ring
RA, RB	Ring A, B
ST_	Standard_
STB	Strobe
T	Tip
TA, TB	Tip A, B
>500	Greater Than 500 ms

3. FUNCTIONS

3.01 Provides a means of determining the operating status of a coin station by providing the following:

(a) Coin present test

(b) Ground removal relay operation test

(c) Dial pulse or TOUCH-TONE receiver

(d) Coin relay time test

(e) Collect and return test

(f) Loop and leakage resistance test

(g) Ground path and loop FEMF.

4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a keysheet, the connecting information thereon is to be followed.

(a) Step-by-Step:

(1) 3- 4-wire selector - SD-32077-01

(2) Miscellaneous Interrupter Circuit - SD-31606-01

(b) Panel:

(1) District or Office Selector - SD-21630-01

(2) Miscellaneous Circuit - SD-21666-01 or SD-21667-01

(c) No. 1 Crossbar:

(1) Office Link and Connector Circuit - SD-25033-01

(2) Interrupter Frame Circuit or Signal Supply - SD-25062-01.

(d) No. 5 Crossbar:

(1) Trunk Link and Connector Circuit - SD-26032-01.

(2) PRTD Circuit - SD-25599-01 or SD-27860-01.

(3) Miscellaneous Circuit - SD-25574-01.

(4) Miscellaneous Circuit - SD-25574-01.

(e) No. 1 ESS:

(1) No. 1 ESS Test Line Coupler Circuit - SD-1A303-01.

(2) No. 1 ESS Ringing and Tone Plant Circuit - SD-81605-01 or SD-81652-01.

(f) No. 2 ESS:

(1) No. 2 ESS Test Line Coupler Circuit - SD-2H159-01.

(2) No. 2 ESS Ringing and Tone Plant Circuit - SD-81870-01.

(g) 5ESS Switch:

(1) No. 5ESS Trunk Unit Circuit - SD-5D300-01.

(2) SN107 Circuit Pack, Test Trunk Circuit - CPS-SN107

(3) 5ESS Switching Equipment Cross Connecting Information - ED-5D500-13

(4) TN220 Circuit Pack - MSU Scan-Pack Circuit - SD-5D130-01

(h) Miscellaneous:

(1) Traffic Register Circuit - SD-25892-01, SD-30896-01, SD-31976-01

(2) Traffic Usage Recorder Circuit - SD-95738-01.

(3) TOUCH-TONE Calling Receiving Circuit Type A3 - SD-98148-01.

4.02 For additional information, see Circuit Note 105 of the SD.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 Manufacturing testing requirements are covered in X-78256.

6. TAKING EQUIPMENT OUT OF SERVICE

6.01 Make sure that the circuit is not busy by noting that neither the OH nor DISC relay is operated. Then for:

(a) No. 5 Crossbar, operate MB switch.

(b) All others, insert dummy plug in jack TJ (eitner 258C, D, or E).

SECTION IV - REASONS FOR REISSUE

CHANGES

A. Changed and Added Functions

A.1 The following new signals are provided as an option YL: +145 coin collect, -145V coin return, +48 Vdc, 92 Vac 20 Hz ringing, 60 IPM, 120 IPM, DT (dial tone), HT (high tone) and office alarm contacts for power failure or blown fuse indication.

A.2 This circuit can now interface with the 5ESS test-trunk circuit (option YM).

B. Changes in Apparatus

B.1 Added

FS9, APP FIG 6 (option YL)

APP FIG 5 (option YM)

R86 resistor (option YM),
KS-20289, L6C, 750
FS6, APP FIG 4

LFP2 capacitor (option YS)
596G, 1.0
FS6, APP FIG 3

D. Description of Changes

D.1 FS9, APP FIG 6 is added an option YL to provide the aforementioned new signals.

D.2 APP FIG 5 and CAD 8 are added as an option YM to show the equipment necessary for interface with the No. 5ESS test-trunk circuit (CP SN107).

D.3 A new value for resistor R86 is added to APP FIG 4 as option YM.

D.4 Option YN is added to FS1 as the previous wiring configuration of option YM.

D.5 Option YO is added to FS3 to allow touch-tone operation over loop resistances above the previously used 1300-ohm limit (necessary for 5ESS switches). The previous wiring configuration is designed option YP and is MANUFACTURE DISCONTINUED.

D.6 Option YR is added to FS3 as the previous wiring configuration of option YL.

D.7 Option YS is added to FS6, APP FIG 3 to ease FEMF testing.

D.8 Option YT is added to FS 6 to provide an additional 6V FEMF threshold.

D.9 Option YU is added to allow the introduction of a redesigned circuit pack, CPS A962C. The previous circuit pack configuration is designated option YV.

D.10 On FS1 and FS8, the -48V (d) talk battery is changed from -48V (a) signal battery. In addition, on FS8, T1 and R1 leads are added. The touch-tone calling receiving circuit is modified to improve circuit noise immunity.

D.11 Diode CR19 is added to CPS-A1246 to correct the drawing.

D.12 As a result of the above changes, circuit notes 119 through 125 are added.

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