PANEL SYSTEMS
TRUNK TEST CORD
TROUBLE DESK

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit is used at the trouble desk in a mechanical office to test trunks outgoing to direct mechanical offices, distant office selector, direct RCI offices, manual tandem offices, mechanical tandem offices, step-by-step offices, and crossbar tandem offices.

SECTION II - DETAILED DESCRIPTION

1. DIRECT MECHANICAL TRUNK TEST

PRELIMINARY FUNCTIONS

1.01 To test a direct mechanical trunk (a) the DM key is operated, (b) the proper compensating resistance key is operated, (c) the plug of the cord is inserted in the test jack of the trunk, and (d) the start key ST is operated. The DM key operated operates relay DM.

A. Busy Test - Fig. J

1.02 The ST key operated operates relay BY. Relay BY operated prepares a path for lighting lamp BUSY and locks in series with relay BY1 under control of key DISC and sender cam D. If the trunk is found busy, the primary winding of relay BY1 will be shunted by ground on the trunk S lead, preventing its operation. When the ST key is released, the BUSY lamp will light, from ground at the ST key and through relay BY operated and relay BY1 released, as a trunk busy indication. If the trunk is idle, relay BY1 operates in series with relay BY. Relay BY1 operated closes a path to the ST lead to operate relay ST for connecting the tip and ring circuit to the sender. The circuit for operating relay ST is traced through the ST relay winding, the make contact of the operated DM key, the operated COMP key, lead ST, the BY1 relay make contact, and relay BY operated to ground at the ST key released. Relay ST operated also causes the sender lamp to flash and advances the sender switch to position 2. Where E wiring is used, the path for moving the switch is direct from ground at the ST relay; where D wiring is used, the path is grounded from the ST relay through leads F and V and break contact of the SXS key in the telephone circuit. It will be noted that if the test circuit is left connected when a trunk is found busy and the ST key has been operated, when the trunk becomes idle relay BY1 will operate and cause the circuit to function as described for an idle trunk.

B. Busy Test - Fig. K

1.03 If the trunk under test is found busy, relay BY1 will operate by a circuit through its primary winding and the ON1 relay break contact to ground on the sleeve of the trunk. Relay BY1 operated lights lamp BUSY as a trunk busy indication. If the trunk is found idle, relay BY1 will not operate and lamp BUSY will not light. After the test cord has been connected to the trunk, the ST key is operated. The ST key operated operates relay BY. If the trunk is found busy or becomes busy before the BY relay operates, the operation of relay BY will have no effect on the circuit due to the operation of relay BY1. If the trunk is found idle, relay SL1 will operate from a circuit through its winding, the ON1 relay break contact, the BY1 relay break contact, the BY relay make contact, and the DISC key break contact to ground. Relay SL1 operated operates relay SL2. Relay SL2 operated operates relay BY1 by a circuit through the BY1 relay secondary winding to ground through the SL1 relay make contact. Relay SL2 also operates relay ON1. Relay BY1 in operating opens the operating circuit of relay SL1 which is slow in releasing. Relay BY1 operated also connects its primary winding to the sleeve of the trunk. When relay SL1 releases, the operating circuit to relay BY1 is opened. If the trunk becomes busy before this circuit is opened, relay BY1 will remain operated by a circuit through its primary winding and make contact to ground on the sleeve of the trunk and will light lamp BUSY indicating a busy trunk. Relay SL2 and ON1 will release. If the trunk is still idle, relay BY1 will release when the circuit through its secondary winding is opened and will immediately close a holding circuit for relay ON1, which is held operated by slow-releasing relay SL2 until relay SL2 releases. Relay BY1 in releasing makes the trunk busy by connecting ground to the sleeve through its break contact and the ON1 relay make contact. The holding circuit for relay ON1 after relay SL2 releases is through the ON1 relay winding and make contact, the BY1 relay break contact, the BY relay make contact, and key DISC to ground. Relay ON1 operated lights off-normal lamp ON1. With relay ON1 operated and relays BY1 and SL2 released, a circuit is closed to the lead ST for operating relay ST for connecting the tip and ring circuit to the sender. The circuit for operating ST is traced through the ST relay winding, the make contact of key DM, the make contact of a COMP key, lead ST to the SL2 relay break contact, the ON1 relay make contact, the BY1 relay break contact, the relay BY make contact, and key DISC to ground. Relay ST operated causes the sender lamp to flash and advances the sender switch to position 2. Where E wiring is used, the path for moving the switch is direct from ground at the ST relay; where D wiring is used, the path is grounded from the ST relay through leads F and V and the break contact of the SXS key in the telephone circuit. It will be noted that if the BY relay is operated and the test cord left connected when a trunk is found busy, when the trunk becomes idle relay BY1 will release and cause the circuit to function as described above for an idle trunk before connecting a busy ground to the sleeve. The purpose of this is to allow time for the releasing of any relays held operated over the sleeve on a previous connection.

FUNDAMENTAL CIRCUIT CLOSURE

1.04 As the switch enters position 2, a circuit is completed from battery at the distant end of the trunk over the tip of the trunk through contacts of relays VM, ST, and FP; contacts of key DM; resistor TG; the winding of relay TG; cam M; contacts of the DM key; contacts of relay FP; compensating resistors; contacts of relays ST and VM; and out over the ring of the trunk to ground in the incoming circuit, operating relay TG. Relay TG operated operates relay TG-1. Relay TG-1 operated advances the sender switch to position 3. As the switch leaves position 2, relay TG releases, in turn releasing relay TG-1. Relay TG-1, released in position 3, closes the fundamental circuit through relays STP and OFL. The direction of the current is such that polarized relay OFL will not operate. The foregoing description covers the operation of the circuit when M wiring of Sheet 2 is used. When N wiring of Sheet 2 is used, the operation of the circuit is the same as above except that the SUP lamp lights during the time that relay TG-1 is operated.

SELECTION - NOTE

1.05 The selection made depends upon the cross-connection between the terminals IB, IG, FB, FT, and FU and the counting relay terminals, 1, 2, 3, 4, etc. The cross-connections are made as desired by the telephone company. Assume the line-busy test number to be 1111. To reach this number it is necessary that the incoming select brush 0 and group 2 and the final select brush 1, tens 1, and units 1. On reaching the line-busy test number, the final selector will move to its busyback position, where a line-busy signal is sent over the trunk under control of an interrupter. This signal may be busyback flash and tone or busyback tone only.

A. Brush Selection

1.06 Relay STP operated operates counting relay 0. As the selector at the incoming end of the trunk moves upward, the commutator brush and segment short-circuit relay STP, releasing it. Relay STP released opens the circuit through counting relay 0, but relay 0 locks in series with relays FO' and BO' in parallel, operating relays FO' and BO'. Relay BO' operated opens the circuit through relay STP, thus preventing its operation when the short circuit in the incoming circuit is removed, thereby releasing the line relay in the incoming circuit and stopping the updrive. Relay FO' operated advances the sender switch to position 4, and cam A advances the switch to position 5. As the switch advances out of position 3, relays BO', FO', and 0 release.

B. Group Selection

1.07 As the switch enters position 5, the fundamental circuit is again closed for group selection, operating relay STP. Relay STP operated operates counting relay 2. As the incoming selector moves upward, the commutator brush and segment short-circuits relay STP when the tripped brush enters the zero group, releasing relay STP. Relay STP released opens the circuit. Relay 2 locks to ground on cam D in series with counting relay 2', which operates. Counting relay 2' operated transfers the counting circuit to counting relay 1. Relay STP re-operates when the short circuit is removed, and counting relays 1 and 1' function in a similar manner. When the brush enters group 1, the STP relay is again short-circuited and the counting relay circuit is transferred to relay 0. As the brush enters group 2, relay STP is again short-circuited and counting relay 0 locks in series with relay BO' and FO' in parallel, which operate. The BO' relay operated opens the fundamental circuit, releasing the line relay in the incoming circuit. Relay FO' operated advances the sender switch to position 6, the A cam advancing the switch to position 7. As the switch leaves position 5, the operated counting relays release.

C. Final Selection

1.08 After an idle trunk in group 2 has been selected at the incoming circuit, the fundamental circuit is again closed for final brush selection. As the final selector moves upward for brush selection, the A commutator brush and segment short-circuit relay STP as the selector reaches the position to trip the zero brush. The counting circuit is completed through counting relay 1, which functions with counting relay 1', transferring the circuit to counting relay 0. As the selector reaches the position to trip brush 1, the STP relay is again short-circuited and releases. Relays BO' and FO' function as previously described, opening the fundamental circuit and advancing the switch to position 9, releasing the counting relays. As the switch enters position 9, the fundamental circuit is closed for tens selection. As the circuit is closed through counting relay 1 and sender cam H, the circuit functions as previously described for brush selection. As the brush enters the second group of ten lines in the bank selected, the fundamental circuit is opened and the sender switch is advanced to position 11. As the switch enters position 11, the fundamental circuit is closed for units selection. The counting circuit is again closed through counting relay 1. The circuit functions as previously described for brush selection. As the brush seizes the terminals of the second line in that group, relays BO' and FO' operate, opening the fundamental circuit and advancing the switch to position 12. When sequence switch D-86862 is used, cam A advances the switch to position 13.

OPERATION OF SUPERVISORY SIGNAL - USING M WIRING OF SHEET 2

1.09 With the switch in position 12 when sequence switch D-22832 or D-85384 is used or in position 13 when sequence switch D-86862 is used, the fundamental circuit is closed through relay SUP and the transformer to advance the incoming and final switches. The direction of current flow is such that the polarized relay SUP remains nonoperated. The particular set of terminals at the final selector is made permanently busy and the busyback interrupter causes the supervisory relays in the incoming circuit to operate and release intermittently. The supervisory relay operated reverses the direction of the current. The reversal of the current causes relay SUP to operate over the circuit previously described. The SUP relay operated closes a circuit through the SUP lamp, which lights. The SUP lamp flashes in synchronism with the busyback interrupter. The SENDER lamp ceases to flash and burns steadily from direct battery on cam F until the switch is returned to normal.

OPERATION OF SUPERVISORY SIGNAL - USING N WIRING OF SHEET 2

1.10 When N wiring is used, the supervisory feature is the same as for M wiring with the exception of the following. The SUP lamp lights from ground on the back contact of the SUP relay as soon as the sender switch moves into position 12 when sequence switch D-22832 or D-85384 is used or into position 13 when sequence switch D-86862 is used. When relay SUP operates, the SUP lamp is extinguished. When relay SUP operates and releases intermittently, the SUP lamp flashes.

DISCONNECTION - FIG. J

1.11 When key DISC is depressed, the circuit through relays BY and BY-1 is opened releasing the relays. Relay BY-1 released releases relay ST. Relay ST released advances the sender switch to position 1, thereby restoring the circuit to normal.

DISCONNECTION - FIG. K

1.12 When key DISC is operated, the circuit through relays BY and ON1 is opened, releasing the relays. Relay ON1 released releases relay ST. Relay ST released advances the sender switch to position 1, thereby restoring the circuit to normal.

DISTANT OFFICE TRUNK TEST

1.13 To test a distant office trunk, the proper compensating resistance key is depressed, and the plug of the cord is inserted in the test jack of the trunk. The class and start keys are operated, causing the circuit to function as previously described, but relay DO operates when key DO is operated. Relay DO operated connects the counting relays for offices brush and office group selection. The selections for office brush and office group are completed the same as the incoming brush and incoming group selections previously described in 1.05 to 1.08. The office brush selection can be any number from zero to four and the group selection can be any number from zero to nine. The cross-connections between the terminals OB and OG and the counting relays are made as desired by the telephone company. When the office group selection is completed, the R magnet is energized through the make contact of relay FO', advancing the switch to position 6, the A cam advancing the switch to position 7. As the switch enters position 7, the fundamental circuit is again closed, operating relay STP. Relay STP operated operates relay ADV. Relay ADV operated locks to ground on cam D and advances the switch to position 11. As the switch advances out of position 10, relay ADV releases. Relay ADV released advances the sender switch to position 12. When sequence switch D-86862 is used, the A cam advances the switch to position 13. From this point the circuit functions as described in 1.09 to 1.12.

2. DIRECT RCI TRUNK TEST

PRELIMINARY FUNCTIONS

2.01 To test a direct RCI trunk, the proper compensating resistance key is depressed and the plug of the cord is inserted in the test jack of the trunk. If the group of trunks is made busy by the operation of the make-busy key on the call indicator position at the manual office, the no test (NT) key must be operated in order to send the call over a busy trunk. The no test key may be left operated while testing the entire group of busy trunks. The RCI class and start keys are operated, advancing the sender switch to position 2 as previously described.

SIGNAL TO DISTANT OFFICE - USING M WIRING OF SHEET 2

2.02 As the sender switch enters position 2, the fundamental circuit is closed, operating relay TG and causing the assignment lamp to light at the distant office. Relay TG operated closes a circuit through relay TG-1 which operates. Relay TG-1 operated advances the sender switch to position 3 and short-circuits the inner contacts of cam M thus preventing relay TG from releasing when the switch advances from position 2.

SIGNAL TO DISTANT OFFICE - USING N WIRING OF SHEET 2

2.03 The operating of the circuit is the same as above except that relay TG-1 lights the SUP lamp, thus notifying the testman that trunk test has been made. This lamp remains lighted until the operator depresses the assignment key, releasing relay TG.

PULSING

2.04 When the assignment key at the distant office is depressed, the circuit through relay TG is opened, allowing it to release. Relay TG released releases relay TG-1. Relay TG-1 released operates relay FP. Relay FP operated (a) connects the tip and ring of the trunk to the impulser circuit, (b) locks to ground on impulser cam D, and (c)operates relay FP-1. Relay FP-1 operated operates the impulser R magnet, advancing the switch to position 2, the A cam advancing the switch to position 8. Relay FP-1 is slow operating in order to delay the operation of the impulser switch so as to give a complete first pulse. When the switch reaches position 8, relay FP-1 operated advances the impulser switch to position 9, the A cam advancing it to position 1. While the impulser switch is advancing through one revolution, positive and negative impulses are sent over either the tip or ring side of the trunk to the distant office, causing certain relays to operate and lock, displaying the test call at the RCI position. As the switch enters position 10, relay ADV operates. Relay ADV operated advances the sender switch to position 11. When the impulser switch advances out of position 20-1/4, the circuits through relays ADV and FP are opened, releasing the relays. Relay ADV released advances the sender switch to position 12. When sequence switch D-86862 is used, the A cam advances the switch to position 13. Relay FP released connects the tip and ring of the trunk to the "flashing or talking" circuit and releases relay FP-1. When the plug of the trunk cord is inserted in the busy jack at the RCI office, the supervisory lamp flashes as described in 1.10. The circuit is restored to normal by depressing the disconnect key, causing the circuit to function as described in 1.11 and 1.12.

FINAL HEAVY + PULSE FEATURE

A. Direct RCI Z Wiring

2.05 When the RCI key is operated and relay HP-2 operates, after the TG test has been made, relays FP, HP-1, and FP-1 are operated. The impulser switch advances as described in 2.04. As the impulser switch enters position 11, counting relay 9 operates, and when the switch passes out of position 12, relay 9' operates and both relays lock. As the switch enters position 18, relay HP operates and locks to impulser cam U. With relay HP operated, the remaining RCI pulses are sent through the V and W cams, the end of the last pulse being sent at position 20-1/4. As the switch passes out of position 20-1/4, relays FP, FP-1, and HP-1 release. The impulser switch goes through a second revolution due to relay HP remaining operated. In position 20-3/4 of the V cam, a short circuit is placed across the tip and ring for the purpose of discharging the loop before sending the final heavy + pulse. When the switch leaves position 1, the short circuit is removed and the tip and ring are opened until position 4/5, when the final heavy + pulse is sent. As the impulser switch passes out of position 10 on the second revolution, relay HP releases and the switch returns to normal.

B. Tandem RCI

2.06 The operation for sending a tandem RCI call is similar to the one described in 2.05 except that one of the tandem keys is operated instead of the RCI key, and the switch goes through two revolutions to send the RCI pulses. Relays 9 and 9' operate in positions 18 and 19 for the first revolution. The operation of relays HP occurs in positions 18/19 of the second revolution, relay HP-2 being normal. The heavy + pulse is sent at positions 4/5 of the third revolution of the switch.

3. MANUAL TANDEM TRUNK TEST

PRELIMINARY FUNCTIONS

3.01 To test a manual tandem trunk, the proper compensating resistance key is operated and the plug of the cord is inserted in the testing jack of the trunk. The MAN. T class key is operated, and the start key is momentarily depressed. The manual tandem class key operated energizes the impulser R magnet, advancing the impulser switch to position 2, the A cam advancing it to position 8. Relays TG and TG-1 operate, and the sender switch is advanced to position 3 as described in 2.02.

OFFICE CODE PULSING

3.02 When the assignment key at the incoming office is depressed, relay TG releases. Relay TG released releases relay TG-1. Relay TG-1 released operates relay TAN. Relay TAN operated locks to ground on impulser cam D and operates relay FP. Relay FP operated locks to ground on impulser cam D, connecting the tip and ring of the trunk to the impulser circuit, and operates relay FP-1. Relay FP-1 operated operates the impulser R magnet, advancing the switch to position 9, the A cam advancing the switch to position 1. As the impulser switch advances from position 8 to 1, impulses for the tandem office code are sent over the trunk go to the RCI position.

FLASHING OR TALKING CIRCUIT

3.03 Relay ADV operates as the impulser switch enters position 10. Relay ADV operated advances the sender switch to position 11. When the impulser switch advances out of position 20-1/4 and the sender switch has advanced out of position 10, relay ADV releases. Relay ADV released energizes the sender R magnet, advancing the sender switch to position 12. When sequence switch D-86862 is used, the A cam advances the switch to position 13. The "flashing or talking circuit" is not completed, however, until relay FP releases.

STATION AND NUMERICAL DIGIT PULSING

3.04 As the impulser switch advances out of position 20-1/4, the locking circuit of relay FP is opened, but the circuit through the relay is maintained through the make contacts of relay TAN. As the impulser switch advances to position 1, relay FP is locked and in turn holds relay FP-1, advancing the switch to position 2, the A cam advancing it to position 8. As the switch enters position 2, relay FP again locks to ground on cam D. As the switch leaves position 2 (second revolution), relay TAN releases. As the switch enters position 8, relay FP-1 again energizes the impulser magnet and the A cam advances the impulser switch to position 1 or normal. During the second revolution of the impulser switch, the impulses for the stations and numerical digits are created. The circuit functions the same as described in 2. and is restored to normal as described in 1.11 and 1.12.

MECHANICAL TANDEM TRUNK TEST

3.05 If the tandem code number is the same for manual and mechanical tandem trunks, the circuit functions the same for both, relays T-1 and T-2 being omitted. If the tandem code number is different, X wiring and relays T-1 and T-2 are used. Relays T-1 and T-2 operate in series under control of the mechanical tandem class (MECH T) key. Relays T-1 and T-2 operated change the cross-connection between the 1, 2, 3, and 4 terminals and the contacts of cams G and H, thus changing the code number transmitted. The tandem, station, and numerical code numbers are transmitted to the RCI station as previously described in 3.02 to 3.04. The relays and other apparatus in the mechanical tandem points respond to the impulses and cause the number to appear on the cordless board. When the numerical and start keys at the cordless board are depressed, the associated district or office selector selects the terminals of a flashing circuit, causing the supervisory lamp to flash. The circuit is restored to normal as previously described in 1.11 and 1.12.

TEST FOR MOMENTARY OPENS ON T AND R LEADS

3.06 When the heavy positive pulse is sent, the P relay operates operating the MO-2 relay. This relay opens the short circuits around the windings of the TWS relay, which operates from current over the tip and ring when the HP relay releases. The MO relay then operates and locks. If for any reason the TWS relay should release falsely, the MO-1 relay will operate releasing the MO-2 relay and the TWS relay cannot reoperate. The operation of the MO-1 will cause the busy lamp to flash as an indication that the trunk being tested will not properly function when operating in conjunction with 2-wire office circuits.

WHEN USED IN 2-DIGIT OFFICES

3.07 When used for a 2-digit office where tandem pulses are required, relay TAN-1 and the X cam are added. The TAN and TAN-1 operate together. Relay TAN-1 operated grounds the tip and ring while the pulsing switch passes through the tandem hundreds cam cuttings. After the tandem ten and tandem unit RCI pulses are sent, the switch moves out of position 4, thereby releasing relays TAN and TAN-1. Relay TAN-1 released removes the ground from the tip and ring when the numerical hundred pulses are being transmitted during the second revolution.

STEP-BY-STEP TRUNK TEST

3.08 When this circuit is specified for testing trunks to step-by-step offices, D wiring is used. To test a step-by-step trunk (a) the proper compensating resistance key is depressed, (b) the step-by-step class key SXS in the telephone circuit is operated, and (c) the plug of the test cord is inserted in the test jack of the trunk. The operation of key SXS prepares the test cord and telephone circuits for step-by-step testing and operates relay SS which in turn operates relay SS1 for transferring the dial to the test cord circuit. The ST key is operated and busy is made as described for test of direct mechanical trunks. The path for the operation of relay ST is from ground on the ST lead through the make contact of the compensating resistance key, leads Y and X and make contact of relay SS1 in the telephone circuit to the winding of relay ST. Relay ST operated closes the tip and ring of the test cord in series with leads A, B, K, and L, relay RV and the dial in the telephone circuit and relay TG. Relay ST operated also connects a holding ground to lead F for relays TG-2 and RV-1. The operation of relay ST does not move the sequence switch out of position 1 since the moving of the switch is not required for this class of call.

3.09 Battery and ground received over the trunk from the selector circuit at the distant office operated relay TG which in turn operated relay TG1. Relay TG1 operated connects ground to lead E and operates relay TG2 in the telephone circuit. Relay TG2 operated (a) locks through its make contact to ground at relay ST, (b) lights the SUP lamp over leads I and J, (c) short-circuits leads G and H causing sender lamp to light steadily, and (d) short-circuits relay TG which releases. The releasing of relay TG releases relay TG1 which opens the operating path of TG2.

3.10 The lighting of the SUP lamp is a signal that the circuit is in condition for dialing. When dialing is completed, the talking (TALK) key is operated for connecting the telephone circuit to one side of the transformer and for closing leads O and W for operating relay RV1 which in turn operates relay CT. Relays RV1 and CT lock through the make contact at relay RV1. Relay CT operated transfers the tip and ring from the dial and relay RV to the transformer, completing the talking circuit. Should the call be answered before the TALK key is operated, polarized relay RV will operate from reversed battery and ground received from the trunk and in turn operate relays RV1 and CT. With relay CT operated and the call answered, reversed battery and ground from the trunk operates polarized relay SUP and extinguishes the SUP lamp.

3.11 Tests can be repeated by operating the DISC key, which causes relays ST, TG2, RV1, and CT and the operated busy test relays to release, and then operating ST key, dial, and TALK key in the order already described.

3.12 The circuit is returned to normal by removing the plug from the trunk jack, depressing the DISC key, then restoring the SXS and TALK keys to their normal position.

OVERFLOW

3.13 If the incoming or office selector should travel to overflow with the sender switch in position 7, the direction of the current is reversed in the fundamental circuit and relay OFL operates. Relay OFL operated operates relay OFL-1. Relay OFL-1 operated locks to ground through cams E and D and advances the sender switch to position 16, lighting the OFL lamp in a local circuit.

VOLTMETER TEST

3.14 When the test cord is inserted in the jack of an OGT and the TEST key in voltmeter test cord circuit is operated, relay VM operates. Relay VM operated transfers the tip and ring of the OGT to the voltmeter test cord circuit. When the key is restored to normal, relay VM releases.

RETURN TO NORMAL

3.15 The circuit is restored to normal as described in 1.11 and 1.12.

RELEASE OF OFL RELAY

3.16 While the sender switch is returning to normal, a circuit is closed in position 17 through relay OFL, permitting a current to flow through this relay in its nonoperating direction. This causes relay OFL, if operated, to release, thereby preventing a false overflow indication in a subsequent test.

CHECK OF REMOTE CONTROL CHARGING

3.17 If a charge call is set up and remote control registration pulses are returned, the V tube will operate, operating relay SX, and the REG lamp will illuminate as an indication of the register pulses returned.

4. TESTING MULTIFREQUENCY PULSING TRUNKS

WINK START PULSING SIGNAL

4.01 A wink start pulsing signal is given when a trunk is seized with on-hook (battery on tip, ground on ring) supervision. The polarity of the trunk is changed to off-hook (ground on tip, battery on ring) supervision when the terminating sender is seized and changed back to on-hook supervision when the sender is ready to receive multifrequency pulses.

A. Preparation

4.02 The number to be called is written up on the numerical register keys on the associated recording key circuit. Operate the required A RLY COMP RES key to compensate up to the operate value of the trunk A relay and the MF key. If a crossbar outgoing trunk is to be tested, operate XB key.

4.03 The test circuit is then patched to the trunk test jack and a busy test is made as described for direct mechanical trunks except that when the trunk is idle, the ground connected to the ST lead operates relay MF through MF key operated. Relay MF operated operates relay PON. Relay PON operated (a) operates relay MFC through relay MF operated, (b) operates relay MFA through relay RO normal and relay PS normal, (c) applies ground to relay PF to prepare it for pulse operating, (d) operates relay KPS through the steering relays normal, (e) closes a ground for locking relays RO, SU1, and RB, (f) closes a ground to the sending key circuit, (g) with Fig. G and either ZL option or the XB key is normal, operates relay PNL, (h) with Fig. H and either ZL option or the XB key is normal, operates relays PNL-1, PNL-2, and PNL in cascade. Relay MFC operated operates relays MFC1-5 cutting through the recording key numerical control leads.

4.04 Relay MFA operated (a) removes 600-ohm ground from the MF1 capacitor and connects the MF1 capacitor in parallel with the PG capacitor, (b) closes through the operate path of relay PGA to contacts of relay PG1. Relay KPS operated (a) removes the short circuit from around the 2700-ohm AM resistor to increase the time of the KP pulse, (b) closes through its operating ground to a path to operate the next steering relay whose register key is operated, (c) prepares operate path of relay KPS1.

B. Trunk Polarity Test

4.05 When relay MF operates, the tip and ring from the test plug is cut through as follows: from tip of test plug; through relay VM normal, relay MF operated, relay MFS normal, MF transformer, A RLY COMP RES keys, relay DPL normal, polar supervisory relays SU and SUR, relay DPL normal, MF transformer, relay MFS normal, relay MF operated, and relay VM normal; to ring of test plug.

4.06 The polar relays SU and SUR are the reverse of each other. When these relays are connected across the tip and ring of the trunk, and should the trunk be poled for off-hook supervision (ground tip, battery ring), relay SUR will operate as an indication the trunk is reversed. Relay SUR operated will operate relay RO through normal contacts of relay SU1. Relay RO operated (a) lights OFL lamp, (b) closes a ground from relay PON to midpoint of pulse generator to prevent it from pulsing, and (c) locks to relay PON.

C. Trunk Test and Start of Pulsing

4.07 When the polar supervisory relays SU and SUR are connected across the tip and ring of a trunk poled on-hook, relay SU operates, operating relay SU1. Relay SU1 operated (a) closes path from relay SUR for operating relay RB, (b) opens operate path for relay RO, and (c) closes in part the path for operating relay SG. When the terminating circuits have functioned and a sender is picked, the polarity of the trunk is reversed to off-hook. This polarity will release relay SU and operate relay SUR which operates relay RB. Relay RB operated (a) locks to ground on relay PON, (b) opens operate path of relay SU1, (c) closes in part the path for operating the steering relays. When the MF receiver is ready to receive MF pulses in the terminating office it signals the terminating sender which in turn reverses the polarity to on-hook as a signal to the originating end to send MF pulses. This reversal to on-hook releases relay SUR and reoperates relay SU. Relay SU operated passes a ground through contacts of relay DPL normal, relays SU1 and RB operated, and relay PS normal to operate relay SG.

D. Pulsing and Steering

4.08 The steering relays TAN H, TAN T, TAN U, TH, H, T, V, and STA control the steering of the pulses for each digit. Steering relay KPS controls the sending of the KP pulse; relay SST controls the sending of the ST pulse. The pulse stop relay PS operates at the end of a train of pulses to stop the pulse generator. The pulse generator consists of a timing relay PG and a pulsing relay PG1. Relay PG is a nonbiased polarized relay, and the winding of relay PG1 is connected in series with the primary winding of relay PG. The PR potentiometer forms a voltage divider with its intermediate point (lug 3) being connected through the operated contacts of relay MFA, through the winding of relay PG1, to the primary winding of relay PG. Relay PON operated closes a ground through contacts of relay SG normal to the primary and secondary windings of relay PG and to shunt the 300-ohm battery. It also closes ground to the armature of relay PG. When relay MFA operates, current flows through relay PG to cause it to move to its back contact and through relay PG1 to cause it to move to its front contact. When ground is removed by the operation of relay SG, allowing the 300-ohm battery to become effective, the current in the primary winding is reversed and tends to operate relay PG towards its front contact. Capacitors PG and MF1 will start to charge when the ground is removed from the primary and secondary windings of relay PG. Initially the charging current through the secondary winding is more powerful and tends to hold the armature on its back contact. But as the capacitors are charged, the current diminishes and the primary winding becomes more effective, operating relay PG towards its front contact. This causes the ground on the armature to be connected to the primary and secondary windings of relay PG and shunt the 300-ohm battery. The current in both windings again reverses to cause the armature to move to its back contact after a delay due to the capacitor discharge through the secondary winding. The action of the pulse generator continues as long as the present battery and ground condition exists. Relay PG1 follows relay PG primary winding reversals thus generating pulses. The pulse generator generates approximately 60-msec pulses except the KP pulse, which is about 100 msec due to a 2700-ohm resistance connected in series with the PR potentiometer when relay KPS is operated.

4.09 As previously explained, when relay SU operates the second time for the wink start pulsing signal, it operates relay SG. Relay SG operated removes the ground from the midpoint of the pulse generator relay PG, and relay PG starts to time pulses and closes a path to light the SDR lamp. When relay PG1 goes to its back contact, a path is closed through to operate relay PGA, which in turn operates relay KPS1 to send a KP pulse to the terminating sender at the same time operating the next steering relay TAN H. The operating path for relay TAN H is ground from relay PON operated through contacts of all steering relay normal through the locking contact of relay KPS, through relays RB, PGA, KPS, and SKTH operated to relay TAN H winding.

4.10 When the pulse generator cycles, relay PG1 moves to its front contact, releasing relay PGA which in turn releases relays KPS and KPS1. Relay KPS1 released removes the KP signal to the terminating office MF receiver.

4.11 As the pulse generator continues to cycle, relay PG1 will move to its back contact reoperating relay PGA which now operates a pulse control relay C0 to C9, depending upon the register key depressed, and the succeeding steering relay. The pulse relay, C0 to C9, operated closes through the required frequencies for the number that is multifrequency-outpulsed. Relay PGA continues to operate and release, following the pulse operator, operating the proper pulse control relay for each key depressed and advancing the steering circuit until relay SST is operated when the ST pulse is to be outpulsed. When the ST pulse has been sent and relay PS operates, a ground will be placed at the midpoint of relay PG to stop pulsing. Relay PS operated operates relay MFS.

4.12 Relay MFS operated (a) opens the trunk loop and switches the tip and ring to relay PNL, (b) closes a path for the SUP lamp to respond to flashing, (c) closes 24-volt battery to SENDER lamp to causes it to light steady, (d) releases relay PON, and (e) locks to ground from relay MF.

4.13 Relay PON released (a) with Fig. G releases slow-release relay PNL if it is operated and (b) with Fig. H releases slow-release relays PNL-1, PNL-2, and PNL if they are operated. Relay PNL released recloses the trunk loop to the talk transformer. The delay in trunk reclosure provides the momentary trunk loop open necessary to satisfy the tandem sender on panel MF calls to tandem operator CAMA. With Fig. H the loop open time is increased to test the operation of the outgoing trunk circuits that are used with panel MF non-AMA trunks.

4.14 The SKTH, SKTT, SKTU, and SKST relays are used to skip or omit MF outpulsing of the TAN H, TAN T, TAN U, or STA digits. This allows outpulsing of four to eight digits. If a particular digit is not outpulsed, for example the stations digit, none of the STA keys in the recording key circuit would be depressed, and relay SKST would be normal preventing the operation of relay STA thereby causing the ST pulse to be outpulsed after the units digit.

The MF pulses are as follows:

Freq	Digits										Signals	
	0	1	2	3	4	5	6	7	8	9	KP	ST
700		X	X		X			X				
900		X		X		X			X			
1100			X	X			X			X	X	
1300	X				X	X	X					
1500	X							X	X	X		X
1700											X	X

E. Reorder During MF Pulsing

4.15 Should the terminating sender go to reorder before outpulsing is completed, it will reverse the polarity of the trunk. This reversal of tip and ring will release relay SU and operate relay SUR. Relay SUR operated operates relay RO. Relay RO operated (a) closes a ground from relay PON to the midpoint of the pulse generator to stop pulsing, (b) applies ground to light OFL lamp, (c) releases relay MFA, and (d) opens relay SG locking path.

F. Operation of Supervisory Signal

4.16 Relay PS operated operates relay MFS. Relay MFS operated (a) locks to relay MF, (b) releases relay PON, (c) switches tip and ring leads to supervisory transformer, (d) closes a path to permit SUP lamp to respond to flashing, and (e) closes 24-volt battery to SENDER lamp to cause it to light steady. Relay PON released permits all relays associated with the MF call to release except relays MF and MFS. The circuit is now ready to supervise signals as described in 1.09 and 1.10.

G. Disconnection

4.17 When the DISC key is operated, relays BY and BY1 release. Relay BY1 released, releases relay MF which in turn releases relay MFS thereby restoring the circuit to normal.

DELAY DIAL START SIGNAL

4.18 When the delay dial signal is used, the trunk is picked with off-hook normal supervision. The trunk circuit functions to cause the terminating circuits to pick a terminating sender which awaits a signal from the MF receiver that it is ready to receive pulses. The sender then reverses the battery and ground to the originating end as an on-hook signal to start pulsing.

A. Preparation

4.19 The preparation for testing MF pulsing trunks arranged for delay dial start pulsing signals is the same as described in 4.03 except that the MFD key instead of the MF key is operated.

B. Trunk Polarity Test

4.20 The polarity test is made as described in 4.05. With delay dial start pulsing signal, however, the operation of the MFD key arranges the circuit to operate relay DPL. Relay DPL operated causes relay SUR to operate when the trunk is poled on-hook when picked. Relay SUR operated performs the same functions as described in 4.06.

C. Trunk Test and Start of Pulsing

4.21 When the polar supervisory relays SU and SUR are connected across the tip and ring of the trunk and the trunk is poled off-hook with relay DPL operated for delay dial start signaling, relay SU will operate, operating relay SU1. When the terminating office is ready to receive MF pulses, the polarity of the trunk is reversed, releasing relay SU and operating relay SUR. Relay SUR operated operates relay RB which (a) locks through its make before break contacts, (b) opens the operate path for relay RO, (c) closes the operate path for relay SG, (d) opens the operate path of relay SU1, (e) closes in part the path to operate the steering relays.

D. Pulsing and Steering

4.22 Same as described in 4.08 with the exception that relay SUR operates relay SG to start pulsing.

E. Reorder During MF Pulsing

4.23 Should the MF terminating sender go to reorder before the U steering relay operates during pulsing, it will reverse the polarity of the trunk and release relay SUR and operate relay SU. Relay SU operated closes a ground to operate relay RO through contacts of relay DPL operated. The functions of relay RO are the same as described in 4.15.

TRANSMISSION TEST OF ANI OUTGOING TRUNK CIRCUITS, MF PULSING TO 4A TOLL, AND DIAL ZERO TRUNKS TO CROSSBAR TANDEM TSP

A. Preparation

4.24 A 12-type or similar transmission measuring test circuit is patched in between the trunk test circuit and trunk leads to the district or office multiple at the trunk test jack. Operate key ANI. The test call is then made as described in 4., and, in addition, key ANI being operated, provision is also made for district selector cut-through signal and calling line identification.

B. Where Connection to More Than One ANI Test Number Network Is Required - Fig. N and Option ZP

4.25 Where the OGT board is required to test trunks in more than one ANI group or to test separate groups of trunks in the same ANI group where the separate trunk groups serve customers with different office codes, it is necessary to connect the test circuit to a particular test number network for each trunk group condition. A patching arrangement (Fig. M and ZP option) is provided for establishing this connection: patch the test circuit ANI jack to the correct number network jack NN- for the trunk under test.

C. District Selector Cut-Through Signal

4.26 With PS relay operated and relay SST released (see 4.11), a path is closed through key ANI operated to operate relay ANI. Relay ANI operated (a) holds to the MFS relay locking ground and (b) removes ground from and connects battery to the test cord sleeve to operate the ANI-trunk CT relay as the district selector cut-through signal. Key ANI and relay ANI operated provide continuity of the sleeve circuit to the VIDF for connecting to a directory number for calling line identification.

5. REPEAT TEST

5.01 When it is desired to repeat "busy line" and "test line" tests, operate the proper keys for the trunk under test, insert the plug of the test cord into the test jack of the trunk, and operate the REP key.

5.02 The REP key operated closes a path to operate relay BY and, if the trunk is not busy, ground is connected to the ST lead. The test circuit functions as previously described until the operation of relay SUP in response to the supervisory signal. The first operation of SUP causes relays SUPV and REP to operate. Relay REP operated locks to the start ground, closes ground to the odd and even counting relays, and prepares an operate path for relay REP1.

5.03 Relay SUPV follows the operate and release of relay SUP, flashing the SUP lamp and applying ground pulses to the armature of counting relay 3', counting down four flashes until relay FO' operates. Relay FO' operated operates relay REP1 through relay REP operated. Relay REP1 operated locks to register RST and opens up the disconnect ground releasing relays BY and BY1 which in turn open up the start ground restoring the circuit to normal. Relay REP1 also connects interrupter to operate relays REPW and REPZ and then to shunt down relay REPW. With relay REPW normal and REPZ operated, message register RST operates, scoring the register and releasing relay REP1. Relay REP1 released causes the test circuit to start a new call.

5.04 Each time a new test is made the message register is scored.

6. COIN ZONE DIAL TRUNKS

6.01 When testing coin zone dial trunks, the operation of the TN key will cause a distinctive tone to be applied to the trunk to indicate to an operator that the call is a test call. She will then allow the call to complete without further challenge.

7. OPERATION WITH THE TONE DETECTOR CIRCUIT - FIG. N AND OPTION ZO OR ZP

GENERAL

7.01 With Fig. N, the test circuit functions as described to recognize busyback flashes and in addition the Tone Detector Circuit is called in for recognition of busyback tone. Option ZP is furnished where the test circuit and a Test Termination Circuit are served by the same tone detector. Option ZP locks out usage of the tone detector by the test circuit while key DET of the associated Test Termination Circuit is operated and lights guard lamp DBY at the test circuit to indicate key DET operated.

CONNECTION TO THE TONE DETECTOR CIRCUIT

7.02 When the sender sequence switch is advanced to the flash or talk position (position 12 when switch D-22832 or D-85384 is used or position 13 when switch D-86832 is used), a path is closed from ground at cam E to operate relay TDC. With option ZO this path is direct to the TDC relay winding, and with option ZP the path is through the break contacts of key DET of the associated Test Termination Circuit. When testing multifrequency pulsing trunks, the sender switch is not used; in this case, relay TDC is operated at the completion of MF pulsing by ground from relay PS operated, through option ZO or ZP, and is locked to ground at relay MF operated. Relay TDC operated closes through leads T,R, and BY to the Tone Detector Circuit and connects ground to leads ST and ON to operate the tone detector ST and ON relays. Relay ST operated connects leads T and R of this circuit into the tone detector. Relay ON operated connects -48 volts to the tone detector power supply to activate the Tone Detector Circuit.

RECOGNITION OF BUSYBACK TONE

7.03 When the busyback signal (pulses of reversed battery and 60-ipm tone) is received, the reversed battery causes the polarized relay SUP to operate and function as described in 1.09 and 1.10. If the accompanying tone pulse is at least -30 dbm and 100 msec long, it will cause the tone detector to ground lead TF and start timing the tone-pulse interval. The ground on lead TF performs no function at this time as relay BYT is normal. At the end of the pulse, relay SUP releases and the tone detector removes ground from lead TF. The next busyback pulse reoperates relay SUP and, if this second pulse is received within an interval of 450 to 700 msec after the first, the tone detector will again ground lead TF for the duration of the tone pulse and, in addition, will apply a steady ground to lead BY. The BY lead ground operates relays BTF and BYT. Relay BYT operated transfers the operate path of relay BTF from lead BY to lead TF and transfers the control of lamp SUP operation from relay SUP to relay BTF by removing ground from the armature of relay SUP and connecting the optional wiring furnished, M or N of Sheet 2, to contacts of relay BTF. Pulses of ground from the tone detector over lead TF will cause relay BTF to operate and release, flashing lamp SUP in synchronism with the pulses of busyback tone.

7.04 When only pulses of tone are received as the busyback signal, the circuit functions as described for tone and flash, except that the polarized relay SUP is not operated, and as a result, lamp SUP is not flashed until the tone detector has determined that the tone received is busyback tone and operates relays BYT and BTF.

OPERATION WITH THE REPEAT SINGLE TEST FEATURE - FIG. A

7.05 The repeat tests are made as described in 5.01 to 5.04, except that in 5.02 the operate path for relays REP and SUPV is now from ground at relay BTF through relays BYT and TDC operated, and in 5.03 relay SUPV now follows the operate and release of relay BTF as it responds to the pulses of ground from the tone detector over lead TF (see 7.03).

TONE DETECTOR RELEASE

7.06 The Tone Detector Circuit is released and restored to normal by the release of relay TDC (Fig. N). Relay TDC releases when the sender sequence switch is advanced from the flash or talk position, as described in 1.11, 1.12, and 5.03, or by the release of relay MF, as described in 4.17 and 5.03. Relay TDC released opens leads T, R, BY, TF, ST, and ON to the tone detector. The opening of leads BY and TF releases relays BYT and BTF in Fig. N if they are operated, and the opening of leads ST and ON releases the tone detector relays ST and ON, restoring the Tone Detector Circuit to normal.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 When testing direct mechanical circuits, the maximum external circuit loop for trunk test, selections and supervision is 2520 ohms with a minimum insulation resistance of 30,000 ohms.

1.02 When testing RCI trunks, the maximum external loop for trunk test and supervision is 5790 ohms with a minimum insulation resistance of 30,000 ohms.

1.03 (SU) (SUR) 280B Relays

Max Ext Loop	10,000 ohms
Min Ins Res	30,000 ohms

2. FUNCTIONAL DESIGNATIONS

None.

3. FUNCTIONS

GENERAL

3.01 Flashes sender lamp when trunk to be tested is not busy.

3.02 Lights busy lamp if trunk to be tested is busy.

3.03 Gives a visual signal on overflow.

3.04 Insures a release of OFL relay after each test.

3.05 Provides REG lamp to indicate that message register current is received from remote control charging trunks.

3.06 Makes repeat tests on "busy line" and "test line" tests.

3.07 Applies tone when testing coin zone dial trunks.

3.08 Functions with the Tone Detector Circuit to recognize and count spurts of busyback tone.

3.09 Lights lamp DBY to indicate that use of the Tone Detector Circuit is locked out by the operated key DET of the Test Termination Circuit.

DIRECT MECHANICAL TRUNK TEST

3.10 Selects proper incoming brush and group.

3.11 Selects proper final brush, group and units.

3.12 Holds trunk busy to other selectors.

3.13 Gives a visible flashing supervisory signal.

3.14 Returns to normal.

DISTANT OFFICE TRUNK TEST

3.15 Selects proper office brush and group.

3.16 Holds trunk busy to other selectors.

3.17 Gives a visible flashing supervisory signal.

3.18 Returns to normal.

DIRECT RCI TRUNK TEST

3.19 Lights assignment lamp at the distant office.

3.20 Originates pulses for distant RCI position.

3.21 Establishes the "flashing or talking" connection.

3.22 Gives a visible flashing supervisory signal.

3.23 Gives a flashing busy lamp on failure due to momentary opens on the T and R leads.

3.24 Returns to normal.

MECHANICAL OR MANUAL TANDEM TRUNK TEST

3.25 Originates impulses for distant tandem office.

3.26 Establishes the "flashing or talking" connection.

3.27 Gives a visible flashing supervisory signal.

3.28 Gives a flashing busy lamp on failure due to momentary opens on T and R leads.

3.29 Returns to normal.

STEP-BY-STEP TRUNK TEST

3.30 Originates impulses for distant step-by-step office.

3.31 Establishes the "flashing or talking" connection.

3.32 Gives a visible flashing supervisory signal.

3.33 Returns to normal.

MULTIFREQUENCY TRUNK TESTS

3.34 Checks wink and delay dial start signals.

3.35 Provides a visual indication if the trunk A relay fails.

3.36 Originates MF pulses for distant office.

3.37 Checks polarity of trunk before and during outpulsing, lighting the OFL lamp if the trunk is reversed.

3.38 Establishes the "flashing or talking" connection.

3.39 Gives a visible flashing supervisory signal.

3.40 Provides a momentary trunk loop open to test panel MF trunks to tandem operator CAMA.

3.41 Key XB operated eliminates the momentary trunk loop open to test crossbar outgoing trunks.

3.42 Key ANI operated arranges the test circuit for the transmission testing of ANI MF outgoing trunks to 4A toll, and dial-zero trunks to crossbar tandem TSP.

3.43 A patching arrangement provides for connection to the proper ANI test number network for testing a particular ANI trunk group.

3.44 Provides a feature to test panel MF non-AMA trunks for false abandonment signals.

3.45 Returns to normal.

4. CONNECTING CIRCUITS

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

(a) Test and Make Busy Jack Circuit - ES-261052.

(b) Recording Key Circuit - ES-261223.

(c) Telephone Circuit - ES-226560.

(d) Voltmeter Circuit - ES-207571.

(e) Multifrequency Signal Generator - SD-95867-01.

(f) Multifrequency Current Supply and Distribution Circuit - SD-93591-01.

(g) Miscellaneous Tones and Interrupters - ES-20255-01.

(h) Tone Detector Circuit - SD-94800-01.

(i) Test Termination Circuit - SD-96540-01.

5. MANUFACTURING TESTING REQUIREMENTS

INTERMEDIATE REQUIREMENTS

5.01 None.

END REQUIREMENTS

5.02 This circuit shall be capable of performing all the functions specified in 3. FUNCTIONS and meeting all the requirements of the Circuit Requirements Tables and also be capable of functioning under the test conditions listed below.

5.03 All tests shall be performed with the test voltage between -45 and -50 volts.

SECTION IV - REASONS FOR REISSUE

D. Description of Changes

D.1 Fig. 2 has been revised to show the addition of ZR option. Wiring formerly not designated has been designated ZQ and is rated Mfr Disc. Circuit Note 104 is changed and Circuit Note 113 is added to cover the use of ZR option. ZR option provides a longer ST pulse required when testing multifrequency pulsing outgoing trunks to ESS or TSPS.

D.2 Manufacturing Testing Requirements are added to Section III.

BELL TELEPHONE LABORATORIES, INCORPORATED

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