SEMI-AUTOMATIC TESTING AND ADJUSTING CIRCUITS

LOW SHUNT TYPE PER SD-62140-01 OR SD-62140-02 AND SD-62136-01

HIGH IMPEDANCE CORD CIRCUITS

No. 1 TOLL SWITCHBOARD

1. GENERAL

1.01 This section describes the semi-automatic test circuits per SD-62140-01 or SD-62140-02 and adjusting circuit SD-62136-01 for testing and adjusting certain high impedance cord circuits in No. 1 toll offices.

1.02 This section has been revised to modify the time intervals covered in Figs. 3 and 4 and to cover minor changes.

1.03 The circuits are arranged to test through, through and terminating, and terminating cord circuits equipped with B43 or No. 190F d-c. supervisory relays and Nos. 190E or 196A a-c. supervisory relays.

1.04 These facilities, which have been developed for use principally in the larger No. 1 toll offices, have been made as fully automatic in operation as practicable. In so doing, and through the use of a motor-driven interrupter the sequence and timing margins may be more closely adhered to than would be possible if the same operations were to be simulated manually.

2. EQUIPMENT FEATURES

2.01 The circuits have been designed so that the proper currents, both alternating current and direct current can be set up at a control cabinet. Keys are provided at the cabinet for setting up the particular test desired.

2.02 The semi-automatic maintenance arrangements may be subdivided into three main parts; the equipment for controlling the general functions of the test and adjusting circuits located in a control cabinet, the test circuit which is extended to jacks appearing in the switchboard multiple and the adjusting circuit which is extended to jacks mounted in the rear of the switchboard sections. The automatic features of these circuits are controlled by pulses from a 163-type motor-driven interrupter.

2.03 The control cabinet consists essentially of a test box 2' 2-5/8" long, 1' 5-7/8" high and 8-7/16" deep, which is usually located in the operating room at a point convenient to the tester at the switchboard.

2.04 The control cabinet contains meters for indicating the d-c. and a-c. current values set up for the test and adjusting circuits, and devices for regulating these currents. Various keys and switches, the operation of which determines the type of test to be applied by the circuits, are located in this cabinet.

2.05 The test circuit is extended to jacks located in the switchboard multiple for making the various tests of the cord circuits. These jacks are designated and used as follows:

TRK - For testing d-c. relays.

TOLL - For testing a-c. relays.

TOLL - 1 - For testing a-c. relays when more than one type relay is installed, or when the same type relay is installed but some relays have windings in parallel and some have windings in series.

Note: The TRK and TOLL (or TOLL-1) jacks are also used for a-c. continuity tests and ringing key tests.

REC - For connecting portable control box (potentiometer and receiver) for a-c. continuity tests and for connecting the pad control feature test set for the pad control feature test.

B-G - For connecting battery and ground to the pad control feature test set.

Note: As an aid in making tests and for trouble analysis purposes the REC and B-G jacks may be located at the relay rack and the REC jack at the rear of the switchboard. When the REC jack is used in the rear of the switchboard the POS jack of the adjusting circuit can be utilized for the same purpose as the B-G jack.

2.06 The adjusting circuit is extended to jacks located in the rear of the switchboard positions. Connection may be made between these jacks and the individual

cord circuit terminals on the cord shelf at the rear of the switchboard through the use of a cord terminal connecting tool. Functioning of the adjusting circuit is under direct control of an adjusting control box, which also is arranged to be connected to the jacks at the rear of the switchboard positions. These jacks are designated and used as follows:

POS -)
CONN-) For adjusting supervisory re-
ADJ -) lays.

DIAL - For timing the application of current to the a-c. relay.

2.07 In the testing circuits, direct current values are indicated by a d-c. milammeter associated with the circuits. By operating the proper keys and setting sliders on 54-type resistances, the values of direct current which it is desired to apply to the cord circuits for testing and for readjusting may be established.

2.08 For both the testing and adjusting circuits, alternating current values are indicated on an a-c. milammeter, which is permanently connected in the low-shunt testing circuit. The proper setting of the sliders results in the same a-c. testing current value being applied to the supervisory relay in each case.

2.09 A portable control box (potentiometer and receiver) J64703A is used for conducting a-c. continuity tests. This box is connected to the REC jack in the switchboard multiple.

2.10 A portable control adjusting set J64715A consisting of 4 keys, four resistances, a lamp, dial, and three jacks mounted in a standard size A (hand-size) box, is used at the rear of the switchboard to control the current values set up in the adjusting circuit SD-62136-01 when adjusting a-c. supervisory relays and for timing the application of current to the a-c. relays. The ADJ, DIAL and POS jacks of the adjusting control set are connected to the ADJ, DIAL and POS multiple jacks, respectively, at the rear of the switchboard. The dial is provided for controlling a timed application of ringing current of the a-c. relay chain when making adjustments.

Note: In some installations an adjusting control set X-63173E consisting of 4 keys, two resistances, a lamp and two cords and plugs is used at the rear of the switchboard to control the current values set up in the adjusting circuit SD-62136-01 when adjusting a-c. relays.

2.11 A pad control feature test set per D-97037 is used with SD-62140-02 for conducting the pad control feature test. This set consists of a spring-driven key (60-type selector key) mounted in a 60-type selector key case, approximately 2-1/2" x 3" x 4". An arm is attached to the shaft of the key in such a manner as to sweep above a plate drilled with holes numbered 1 to 6 and with the use of a stop pin the travel of the spring-driven key can be stopped at any one of the six positions. A W5A cord equipped with two No. 110 plugs with red and black shells is provided for connection to the REC and B-G jacks of the test circuit and is sufficiently long to permit the test set, when connected to the multiple jacks to be extended beneath the keyshelf and through the switchboard from front to rear, if desired.

2.12 A motor-driven interrupter (163 type) is employed for controlling the d-c. and a-c. supervisory relay tests. The interrupter is usually located in the terminal room. A locking type key designated INT is mounted in the control cabinet and the interrupter is started by operating this key. A lamp mounted in the cabinet and associated with the INT key flashes at the rate of 120 I.P.M. while the interrupter motor is running.

2.13 A vibrating interrupter (169 type) is furnished for supplying 425-cycle tone in a-c. continuity test. This interrupter is usually mounted with the associated testing equipment on a relay rack in the terminal room.

3. OPERATING FEATURES

A-C. and D-C. Test on Supervisory Relays

3.01 After the testing circuit has been made ready for operation and the proper testing current values have been established at the cabinet, a series of tests may be automatically applied to a cord circuit by connecting the cord to the testing jack of the switchboard multiple. Fig. 1 shows in schematic form a series of such tests which are applied when making a test of the d-c. supervisory relay. The sequence of operation as well as the period of time during which the current is applied to the d-c. relay under test is automatically controlled by means of the motor-driven interrupter (163 type).

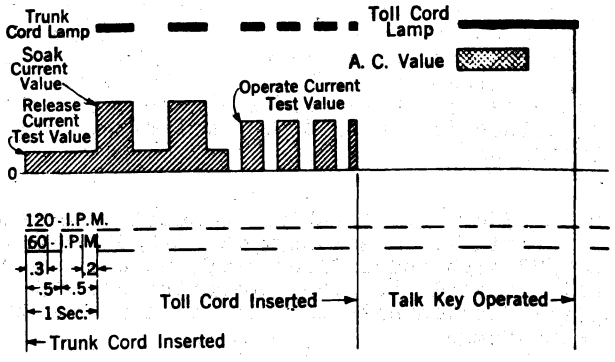

Fig. 1.

3.02 With the operations performed as described in detail in Division A200 and after the trunk cord of the cord pair has been inserted into the trunk test jack TRK, the testing circuit functions automatically, applying "soak" current to the d-c. relay under test for two intervals with the "release" current applied between these intervals. At the end of the two cycles of "soak" and "release" current, "operate" current is periodically applied with open circuit between the "operate" current intervals.

3.03 The cycles described above have been arranged to simulate conditions somewhat more severe than those expected in service. The application of the "operate" current, after the application of the "soak" and "release" currents, simulates a condition that is encountered in service after alternating ringing current is caused to flow in the cord circuits and broken, particularly at or near the negative peak of the wave, and immediately thereafter the d-c. supervisory relay is required to meet busy-back, reorder or switchhook flashing.

3.04 In service, the point of the a-c. wave at which the path is broken sometimes causes the d-c. relay to take a temporary magnetic set, causing sluggish operation of the relay, unless the relay has been adjusted to counteract this effect. Consequently, if the relay is in proper condition, it should follow the flash of "soak" and "operate" current pulses in the sequence given in Fig. 1. If the relay meets this test requirement, it should function properly in service.

3.05 Interrupted "operate" current is supplied to the d-c. supervisory relay until the toll cord is inserted into the TOLL jack. The trunk cord supervisory lamp flashes in accordance with the operation of the supervisory relay.

3.06 Fig. 1 also shows in schematic form the functioning of the testing circuit when making a current flow test on the a-c. supervisory relay. The motor-driven interrupter regulates the period of time during which alternating current is applied to the a-c. supervisory relay.

3.07 After the insertion of the toll cord in the TOLL jack, alternating current is applied to the a-c. relay for a period of one second. If the a-c. relay and its associated relays are in proper condition, the toll cord supervisory lamp will light, indicating satisfactory operation. The supervisory lamp will be extinguished by operating the cord circuit talking key.

3.08 Fig. 2 shows the method in schematic circuit form of applying the alternating current to the a-c. supervisory relay. The test circuit utilizes an arrangement whereby a resistance (S) of a relatively low value is bridged across the circuit. This is known as the "low shunt" method.

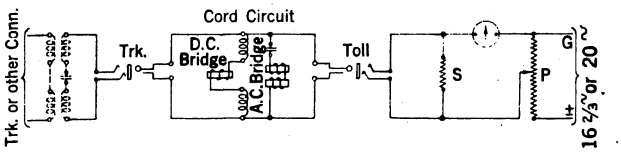

Fig. 2.

3.09 This method materially reduces the effect of the normal shunts encountered across the a-c. relay such as the d-c. supervisory relay shunt which ranges from 1500 to 5000 ohms impedance at 20 cycles in the case of cord circuits on a terminating cord condition, to infinity on a through cord condition when the d-c. shunt is removed.

Ringing Key Test

3.10 With all keys normal the testing circuit is arranged for testing the proper closure of ringing key springs in cord circuits by inserting the trunk and toll cords into the TRK and TOLL jacks of the test circuit and operating the trunk cord and then the toll cord ringing keys. The ringing current from the ringing key passes through the test circuit to the cord circuit and lights the cord supervisory lamp. A shunt resistance is connected across the T and R leads of the test circuit to reduce the amount of current applied to the a-c. supervisory relay.

3.11 Cord circuit ringing keys may be tested following the d-c. and a-c. supervisory relay tests without removing the cords from the test jacks, if the NT key in the cabinet has been left normal at the start of the supervisory relay tests; or, the test may be conducted as a separate test by having all test circuit keys normal.

Pad Control Feature Test

3.12 The pad control feature may be tested following the a-c. and d-c. supervisory relay tests without removing cords from the test jacks provided the TST-PC key has been operated, and the pad control feature test set has been connected to the REC and B-G jacks of the test circuit; or the test may be conducted as an individual test by operating the TST-PCO key.

3.13 To check the functioning of the pad control features, it is necessary to determine first, that the marginal relay in each of the two sleeve circuits of a cord pair remains unoperated on a trunk sleeve condition of approximately 500 ohms, that these relays operate on the toll line sleeve circuit condition of approximately 60 ohms, and that they release when this sleeve resistance value is again increased from the toll circuit sleeve value to the trunk sleeve resistance value; second, that the cord circuit relay chain which is controlled by the simultaneous operation of trunk and toll cord marginal and non-marginal sleeve circuit relays, operates and

releases properly to cut in or out the added resistances inserted by it in the cord sleeve circuits; and third, that these resistances are not open or short-circuited.

3.14 By operating the spring-driven key of the pad control feature set, a complete series of conditions necessary to test the pad control features is applied to the cord circuit. The indications of the response of the cord circuit relays to this series of tests, applied over a period of approximately 7 seconds, which is the time required for the operated cam key to return to normal, are obtained through the flashing of the cord circuit supervisory lamps.

3.15 In addition to the distinctive toll and trunk cord lamp indication which is obtained when the operation of the cord circuit relays and the values of the inserted sleeve resistances are satisfactory, a number of different and characteristic combinations of toll and trunk cord lamp flashes are obtained which indicate certain trouble conditions which may exist in the cord circuit under test as covered in 3.21.

Method and Sequence of Test Conditions

3.16 Fig. 3 shows graphically the conditions which obtain simultaneously in the cord circuit and test circuit during the time that the pad control feature test is being applied under the control of the spring-driven cam key of the pad control feature test set.

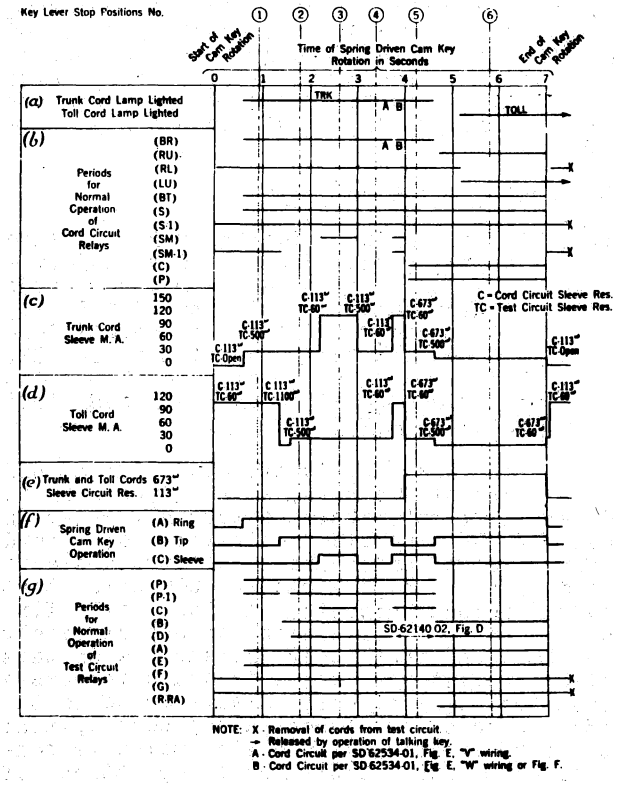

Fig. 3.

3.17 The upper section (a) of Fig. 3 indicates the normal operation of the cord circuit lamps in response to the application of the tests. Section (b) of Fig. 3 indicates the operation of the relays of a typical cord circuit in normal condition, during the application of the test. Sections (c) and (d) of Fig. 3 indicate, respectively, the nominal value of current flowing through the cord sleeve circuits during the progress of the test. For each change in the current value, the figure carries notations which indicate the cord circuit and test circuit sleeve resistances as these resistances are changed. Section (e) of Fig. 3 indicates the toll cord and the trunk cord sleeve circuit resistances. The operation of the cam contacts of the pad control feature test set is shown in Section (f) of Fig. 3.

3.18 Section (g) of Fig. 3 shows the operation of test circuit relays as the test progresses. Briefly, the conditions applied to the cord circuits are as follows:

(1) Open sleeve is applied to the trunk cord while a 60-ohm sleeve is applied to the toll cord.

(2) The 500-ohm sleeve condition is applied to the trunk cord, the toll cord sleeve condition remaining 60 ohms.

(3) With the trunk cord condition remaining at 500 ohms, the resistance connected to the toll cord is increased to 1100 ohms.

(4) With the trunk cord condition remaining at 500 ohms, the resistance connected to the toll cord is changed to 500 ohms.

(5) The condition on the trunk cord sleeve is changed to 60 ohms with the 500-ohm sleeve resistance remaining on the toll cord.

(6) The resistance connected to the trunk cord is increased to 500 ohms, with a 500-ohm resistance remaining connected to the toll cord sleeve.

(7) A 60-ohm sleeve condition is applied to both the trunk and the toll cord.

(8) A 500-ohm sleeve condition is applied simultaneously to both cord sleeves.

(9) Concluding the test, the trunk cord sleeve is opened and a 60-ohm resistance is applied to the toll cord.

(10) At certain points in the above tests, battery and ground are applied to the trunk cord to light the trunk supervisory lamp and ringing current is applied to the toll cord to light its associated supervisory relay.

(11) After restoring the toll cord lamp through operation of the talking key, the circuit is prepared for retest, if desired.

3.19 The conditions in 3.18 are applied to the cord circuit under the control of a spring-driven cam key which is connected to the REC jack of the testing circuit. This key is shown schematically on Drawing SD-62140-02 and is operated manually, released and automatically allowed to return to normal. Proper functioning of the toll cord circuit relays and normal pad control resistance values in the cord circuit are indicated by the lighting of the trunk lamp for a period of about three seconds. Then it is extinguished, and after an interval of approximately one second the toll cord lamp is lighted, as indicated in the upper section of Figs. 3 and 4.

3.20 The automatic return of the spring-driven key to normal occupies a period of approximately 7 seconds. The manner in which the trunk and toll cord lamps light is shown in graph form on Fig. 4. When improper operation of cord circuit relays is encountered during this test, or when the cord circuit resistances R or R1 are found to be either short-circuited or open, the trunk and toll cord supervisory lamps will not flash in the normal manner described above and shown at the top of Fig. 4. The trouble conditions will result in a sufficiently different flashing of the cord circuit lamps as to be easily recognized as trouble conditions. With the use of a small stop pin furnished with the pad control feature test set the operation of the test set may be stopped at any one of the 6 points shown in Fig. 4 in its swing-back to the normal position, thus providing when desired, a step-by-step progressive sequence of operations as an effective aid in localizing trouble conditions.

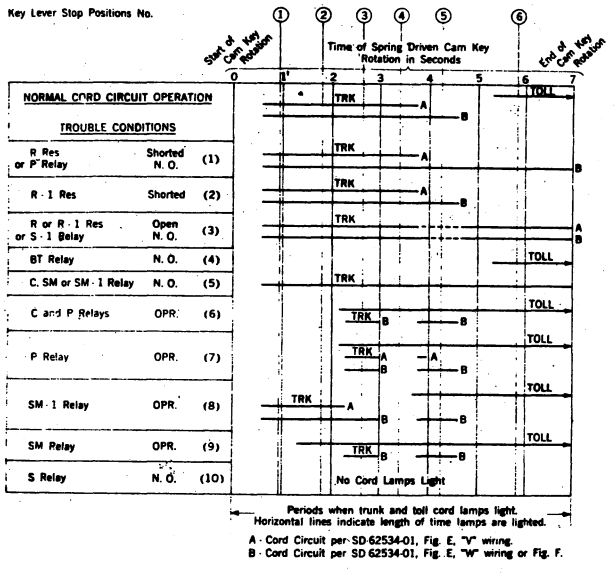

Fig. 4.

3.21 While the tester may wish only to determine whether the flashes of the cord circuit supervisory lamp are normal or otherwise, it may be of advantage to the maintenance man clearing trouble conditions to have some clue as to the type of trouble existing in the cord circuit. Accordingly, the remainder of the lamp indications listed on Fig. 4 have been listed to show the approximate time and duration of lamp flashes during the travel of the test key cams which are obtained for the types of trouble listed in the following. The parenthetical numbers in the list refer to corresponding numbers in Fig. 4.

R cord circuit resistance short-circuited. (1)

R1 cord circuit resistance short-circuited. (2)

R or R1 cord circuit resistance open. (3)

Busy test relay BT fails to operate. (4)

C relay fails to operate. (5)

C and P relay operated falsely. (6)

P relay fails to operate. (1)

P relay operated falsely. (7)

SM1 relay fails to operate. (5)

SM1 relay operated falsely. (8)

SM relay fails to operate. (5)

SM relay operated falsely. (9)

S1 relay fails to operate. (3)

S relay fails to operate. (10)

Function of the Test Conditions Applied to the Cord Sleeve Circuits

3.22 Referring to 3.18, various sleeve conditions are applied to the cord circuit trunk and toll sleeves. These conditions are also shown on Fig. 3, in terms of the relative amounts of current supplied to the sleeve relays of the trunk and toll cords. The purpose of these conditions is as follows:

(1) Initial connection, no test condition.

(2) Marginal relay in toll sleeve should operate; marginal relay in trunk sleeve should not operate.

(3) Marginal relay in toll sleeve should release.

(4) Preliminary step to test of (5).

(5) Trunk marginal relay should operate; marginal relay in toll cord should not operate.

(6) Preliminary step to test of (7).

(7) Both cord sleeve marginal relays should operate, thereby increasing each cord circuit sleeve resistance to 673 ohms. The cord relay C should lock up at this point and extinguish the cord lamp. With normal operation of the cord circuit relays the trunk lamp will remain lighted during conditions (2) to (6), inclusive, and until (7) is applied.

(8) This resistance, plus the 673 ohms in the cord circuit sleeves, allows the P and P1 relays in the test circuit to release and cause ringing current to be applied to the cord circuit, to light the toll lamp. Should the cord circuit pad control resistance of either sleeve, or the 420-ohm unit of either of these resistances be short-circuited, the P and P1 relays will not be permitted to release, and the ringing current will not be applied to the cord to light the toll lamp. Should either R or R1 resistance be open, the toll cord relay C will not remain locked up following condition (7) since the sleeve relay releases on the open sleeve circuit, and test circuit conditions will be such that ringing current will not be applied to the toll cord. The toll lamp therefore does not light and the trunk lamp flashes until the sleeve resistance is increased and the trunk lamp lights steadily until the end of the cam key travel.

(9) Conclusion of test. No test condition is provided other than to open the trunk sleeve at the end of the cam key travel and to retain a sleeve connection on the toll cord in order that the toll supervisory lamp will remain locked in until restored by operating the listening key, or by disconnecting the toll cord from the test jack.

3.23 The ringing current applied to the toll cord, while of test value, is not to be considered as a test of the toll cord supervisory relay. It is assumed that before the application of the pad control test, the cord circuit supervisory relays are in normal adjustment.

A-C. Continuity Test

3.24 As shown in Fig. 5, the continuity testing arrangement consists of essentially an a-c. Wheatstone bridge circuit, utilizing a 425-cycle tone. It has been found by experiments with various frequencies that apparently a frequency of about 425 cycles is most effective in detecting troubles that may be encountered in service.

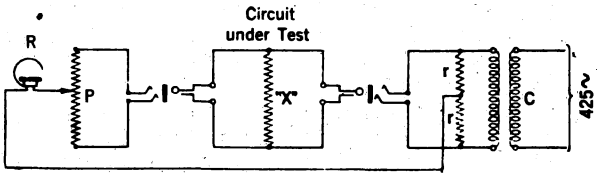

Fig. 5.

3.25 A potentiometer is provided for use with the continuity test circuit in order that settings may be obtained so that no tone or practically no tone is heard in the receiver. If unbalances are present in the circuit under test, tone will result with the potentiometer set at zero. The extent of unbalance will be indicated by the setting of the potentiometer necessary to obtain minimum tone.

3.26 The a-c. continuity test may be conducted immediately following the supervisory relay tests of a cord circuit (the ringing key test being omitted) provided the NT key has been operated at the start of the tests or the a-c. continuity test may be conducted individually by operating the NTO key in the cabinet with all other test circuit keys normal.

3.27 A continuity test of cords and worn jacks in the toll line multiple may be made by using the a-c. continuity testing feature of the test circuit. The a-c. continuity test circuit features for jack tests are similar to those used for cord circuit tests.

Adjusting Circuit A-C. Timing Test

3.28 To time the application of the a-c. test current, the dial in the adjusting control test set (J64715A) is operated to the number of digits required, each digit corresponding to an approximate time of .1 second of the closing of the off-normal contact after the dial has started to return to normal. For example if the digit 6 is dialed ringing current will be applied to the a-c. supervisory relays for approximately six-tenths of a second.

3.29 When the pulsing contact opens in sending the first pulse it operates certain relays in the adjusting circuit to supply the a-c. operate value of current to the toll cord circuit a-c. supervisory relay. When the dial has returned to normal the off-normal contact opens causing the release of certain relays which disconnects the operate value of current to the a-c. relay.

4. CIRCUIT FEATURES AND CIRCUIT DESCRIPTIONS

4.01 Drawings SD-62136-01, SD-62140-01 and SD-62140-02 show the circuit arrangements of the adjusting circuit, test circuit not arranged for testing pad control features and test circuit which include pad control feature, respectively. Detail circuit descriptions will be found in the associated CD sheets for the respective drawings.