PANEL SYSTEMS
PORTABLE SELECTOR TEST CIRCUIT
FOR TESTING OFFICE INCOMING AND
FINAL SELECTORS

CHANGES

B. CHANGES IN APPARATUS

B.1

Superseded	Superseded By
Fig. H	Fig. J

B.2 Added in modifying Fig. H to Fig. J

1 - 479-BT (LGT) Key	1 - 19NU (BX) resistor
1 - 1.1M.F. (M) capacitor	1 - 18HB (BY) resistor
1 - 195D (BW) resistor	

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Fig. H, which was option "N, R" of Fig. D, is rated "Mfr. Disc." and is superseded by Fig. J to test repeating incoming selector with or without 280DG (L) relay.

D.2 Fig. G was option "S" in Fig. D.

D.3 Options AC and AD are added in Fig. J to permit using a "Mfr. Disc." retardation coils when modifying Fig. H to Fig. J.

D.4 Note 122 is added for record purposes.

D.5 Notes 120 and 121 were erroneously numbered 119 and 120, respectively, on the last issue.

D.6 Changes are added to the options used table.

All other headings under Changes, no change.

1. PURPOSE OF CIRCUIT

1.1 The purpose of this circuit is to test: Three-wire office selectors, three-wire local incoming selectors, two-wire inter-office, mechanical tandem, and repeating incoming selectors, two-wire inter-office and repeating key indicator incoming selectors, three-wire toll key indicator incoming selectors, two-wire toll key indicator incoming selectors, final selectors.

The O.K. Signal is given by a flashing or a steady lamp, according to the class of test.

This circuit is connected to the selector circuit under test by means patching cords. Repeat tests cannot be made.

2. WORKING LIMITS

2.1 None.

3. FUNCTIONS

3.01 This circuit will manually test three-wire office selectors, three-wire local incoming selectors, two-wire inter-office, mechanical tandem and repeating incoming selectors, two-wire inter-office and repeating key indicator incoming selectors, three-wire toll indicator incoming selectors, two-wire toll key indicator incoming selectors and final selectors.

3.02 (RM) stepper switch is used for controlling the progress of a test, position 1 is its normal position.

3.03 The numerical keys are of the locking type arranged so that only one key in each row will stay down at a time. They are used to direct a selector to a particular line or group.

3.04 The resistance keys are locking. They are operated individually or in combination for inserting compensating resistance in the fundament circuits.

3.05 The capacity keys are locking. They are operated individually or in combination for connecting grounded capacity to the fundamental circuit. The capacity keys (0.25 MF), (0.5 MF) and (1 MF) are provided, only with Fig. C. The key (M.F. 1.38) is provided only with Fig. D, which supersedes Fig. C.

3.06 (FCR) "Final Capacity and Resistance" key is locking. It may be operated alone to apply a lumped resistance and grounded capacity to the fundamental circuit. It is especially provided for testing final selectors, but may also be used for other selector tests. It is provided only with Fig. C.

3.07 (ST) "Start" key is non-locking. It is operated to start the test of a selector or to start a particular part of a test.

3.08 (A-ST) "Automatic Start" key is non-locking and a part of the same key unit as (ST) key; it is operated on tests of three-wire selectors not having combination test and make busy jacks, when the selector it is desired to test is busy and it is desired to have the test start automatically as soon as the selector becomes idle.

3.09 (STP) "Step-by-Step" key is locking. It is operated when it is desired to control a test in steps.

3.10 (DISC) "Disconnect" key is non-locking and a part of the same key unit as (STP) key. It is operated to restore the test circuit to normal.

3.11 (TKI-D) "Toll Key Indicator Disconnect" key is locking. It is operated to disconnect toll key indicator incoming selector, which requires battery and ground from the trunk for disconnection.

3.12 (LRF) "Long Range Final" key is locking, and is operated when testing final selectors arranged to operate over subscribers loops that extend to 1500 ohms.

3.13 (TEL) "Telephone" key is locking. It is operated to connect the operator's telephone set for testing ringing induction.

3.14 (BC) "Brush Continuity" key is locking and a part of the same key unit as (TEL) key. It is operated when making brush continuity tests of office and final selectors. It is provided where "V" wiring is used. See also (OBC), (IBC) and (FBC) keys.

3.15 (OBC) "Office Brush Continuity" key is locking. It is operated when making brush continuity tests of office selectors where "W" wiring is provided.

3.16 (IBC) "Incoming Brush Continuity" key is locking and a part of the same key unit as (OBC) key. It is operated when making brush continuity tests of incoming selectors where "W" wiring is provided.

3.17 (FBC) "Final Brush Continuity" key is locking and a part of the same key unit as (TEL) key. It is operated when making brush continuity tests of final selectors where "W" wiring is provided.

3.18 (GRD-SLV) "Ground Sleeve" key is non-locking. It is operated when making brush continuity and particular line idle tests of final selectors, but is not operated until the final under test has arrived in talking position.

3.19 (KI-350) "Key Indicator 350 Ohm" key is locking. Provided only in offices having two-wire inter-office key indicator incoming selectors having a 350 ohm resistance in series with the (A) relay. It is operated as well as (2W-IKI) key when testing this type of circuit.

3.20 (±) "Ringing" key is non-locking. It is operated to start the ringing in toll key indicator incomings by connecting direct ringing on the selector. Prior to Issue 5-D Key (±) formerly was designated (± KI).

3.21 (R±) "Resistance Ringing" is non-locking. It is operated to start the ringing in toll key indicator incomings by connecting 2300 ohms in both "A.C." and "Ring. G" leads.

3.22 (NT) "No Test" key is locking and a part of the same key unit as (±KI) or (±) key. It is operated to apply the "no test" condition to a final selector.

3.23 (LF-FB) "Line Finder, Final Busy" key is locking. It is operated when testing final selectors in line finder or line switch offices having (PBX) relays readjusted to operate on .024 and non-operate on .022 amps., when it is desired to simulate the condition of individual or last line of a P.B.X. group busy.

3.24 (LS-FB) "Line Switch, Final Busy" key is locking and a part of the same key unit as (LF-FB) key. It is operated when testing final selectors in line switch offices having (PBX) relays readjusted to operate on .021 and non-operate on .019 amps., when it is desired to simulate the condition of individual or last line of a P.B.X. group busy.

3.25 (OFF) "Office" key is locking. It is operated when three-wire office selectors are tested.

3.26 (FIN) "Final" key is locking and a part of the same key unit as (OFF) key. It is operated when Final Selectors are tested.

3.27 (2W-IKI) "Two-Wire Inter-office Key Indicator" key is locking. It is operated when two-wire inter-office or repeating key indicator incoming selectors are tested.

3.28 (2W-TKI) "Two-Wire Toll Key Indicator" key is locking and part of the same key unit as (2W-IKI) key. It is operated when testing two-wire toll key indicator incoming selectors.

3.29 (2WI) "Two-Wire Incoming" key is locking. It is operated when two-wire inter-office, mechanical tandem or repeating incoming selectors are tested.

3.30 (3WI) "Three-Wire Incoming" key is locking and a part of the same key unit as (2WI) key. It is operated when three-wire local incoming selectors and three-wire toll key indicator incoming selectors are tested.

3.31 (L-REL) "(L) Release" key is locking. It is operated when repeating incoming selectors are tested if it is desired to make a release test of the incoming (L) relay.

3.32 (L-HLD) "(L) Hold" key is locking and a part of the same key unit as (L-REL) key. It is operated when repeating incoming selectors are tested if it is desired to make a hold test of the incoming (L) relay.

3.33 (L-NO) "(L) Non-Operate" key is locking. It is operated when repeating incoming selectors are tested and when operated a non-operate test is made on the (L) relay; this test also checks for presence of the shunt around the incoming (L) relay in position 1. Failure of the incoming to move out of position 1 until this key is restored is the O.K. indication.

3.34 (LGT) Long Trunk key is locking. It is operated with the (L-NO) (L-REL) and (L-HLD) keys when testing repeating incomings with 280DG(L) relays.

3.35 (REV) "Reversing" key is locking and a part of the same key unit as (GRD-SLV) key. It is operated when making tests of toll K.I. incomings which supply battery on the tip and ground on the ring on trunk closure; also when making tests of office selectors by directing them to test lines which supply battery on the tip and ground on the ring.

3.36 (A) and (B) key is locking. It controls the loop for testing the trunk supervisory relays of two-wire inter-office, repeating, and mechanical tandem incoming selectors. When 24 V. battery is supplied on the trunk the key is left normal. When 48 V. battery is supplied on the trunk it is operated in direction (A) to simulate an external circuit loop of 6350 ohms and in direction (B) to simulate an external circuit loop of 7540 ohms. Designations (A) and (B) have been discontinued after Issue 2-D and replaced by designations (SL-48V) and (LL-48V) respectively.

3.37 (SL-48V) and (LL-48V) key is locking and replaced designations (A) and (B) respectively on Issue 3-D without change in circuit function.

3.38 The 32-A test set consists of two push button keys mounted at the end of a flexible cord. When the plug on the end of this cord is inserted in (EX-K) jack these keys may be used in place of (ST) and (DISC) keys, except as noted below the white button corresponding to the (ST) key and the red button corresponding to the (ST) key and the red button corresponding to (DISC) key. The regular (DISC) key must be used when restoring after making office selector brush continuity test, and when testing the hold value of the final selector (L) relay.

3.39 Key (TGO) "Tip Ground Open" and (PLB) "Particular Line Busy" provides means for testing final selectors on any particular subscriber's line. With key (TGO) and (PLB) normal, "idle" line tests are made on subscriber's lines. With key operated in direction (TGO) "Idle" line tests are made on coin lines or other lines where the tip ground is open in the line circuit. With key operated in direction (PLB) "busy" line tests are made on subscriber's lines.

3.40 "(BY) "Busy" lamp lights in the event a three-wire selector circuit, not equipped with combination test and make busy jacks, is busy. This lamp also lights when testing final selectors if the (L) relay fails to release on its release test.

3.41 (TST) "Test" lamp lights during the time the test circuit is off-normal.

3.42 (I-O OK) "Incoming and Office O.K." lamp gives a flashing signal to indicate the proper functioning of office and incoming selectors, except inter-office and repeating key indicator incoming selectors.

3.43 (FF-OK) "Final Free OK" lamp gives a flashing signal to indicate the proper functioning of a final selector in making the "line Free" test.

3.44 (FF-OK) "Final Busy O.K." lamp gives a flashing signal to indicate the proper functioning of a final selector in making the "line busy" test.

3.45 (OF) "Overflow" lamp gives an indication that the incoming selector has gone to overflow.

3.46 (KI) "Key Indicator" lamp gives a flashing signal to indicate the proper supervision on inter-office and repeating key indicator incoming selectors.

3.47 (BC-OK) "Brush Continuity OK" lamp lights steadily as an O.K. signal on brush continuity tests.

3.48 (SLV-X) "Sleeve Cross" lamp indicates a cross between the tip and sleeve of a final selector.

4. CONNECTING CIRCUITS

4.1 Three-wire office selector and office selector test line connecting interrupted battery to the tip and ground to the ring or battery to the ring and an interrupted closure between tip and sleeve.

4.2 Three-wire local incoming selector, two-wire inter-office, mechanical tandem, and repeating incoming selectors, two-wire inter-office and repeating key indicator incoming selectors, three-wire toll key indicator incoming selector, two-wire toll key indicator incoming selector, and their associated final multiple test lines.

4.3 Final selector and associated test lines and jack circuits.

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5. DESCRIPTION OF OPERATION

5.1 Start of Test

With the test circuit normal, (RM) stepper being in position 1, the proper keys are operated as later described in detail. The (B-GRD) jack on the test box is patched to the corresponding jack on the selector frame. The (TST) jack on the test box is patched to the test jack of the selector to be tested. When a working two-wire selector is tested, it must be made busy at its outgoing end. Where three-wire selector circuits are provided with combination test and make busy jacks, the tester should be sure that a circuit is normal, before plugging in to its jack, for plugging in while a call is in progress would restore the

circuit to normal and break down the connection. Where three-wire selector circuits are provided with separate test and make-busy jacks or with test jacks only, (T) relay operates on plugging in to the test jack of a busy selector, from ground on the sleeve. This lights the (BY) lamp and disconnects ground from (ST) key. Operating (ST) key will not advance the stepper under this condition, but if it is desired to start the test as soon as the selector becomes idle, (A-ST) key is depressed and released, this causes (ST) relay to operate and lock, closing a circuit through the (ST-1) relay, which does not operate as it is shunted by the ground through the make contact of (T) relay. When the trunk becomes idle (T) relay releases permitting (ST-1) relay to operate. Where the test of either a two or three-wire selector is started by the operation of (ST) key, (ST) relay will operate when (ST) key is operated. This closes a circuit through (ST-1) relay, which does not operate as it is shunted by the ground through the contact of (ST) key. When (ST) key is released (ST-1) relay connects ground to the sleeve of the (TST) jack and steps the switch to position 2. (ST) and (ST-1) relays remain locked up under control of (FO) relay. Ground is held on the sleeve of (TST) jack from (4) arc. Ground on (2) arc operates (LO) relay and lights the (TST) lamp, (LO) relay remaining operated and (TST) lamp remaining lighted until the completion of the test. When "K" wiring is used, ground on (1) arc steps the switch to position 3. When "L" wiring is used (FA) relay operates from ground on (3) arc, stepping the switch to position 3.

5.11 Compensating Resistance and Capacity

Where Fig. C is used, to simulate the worst fundamental circuit conditions, and allow for a margin of safety, compensating resistances may be cut in by operating one or a combination of the compensating resistance keys; by this means resistance may be added in steps of 100 or 200 ohms to a maximum of 2500 ohms. Grounded capacity may be connected to the tip side of the fundamental circuit by operating one or a combination of the capacity keys, by this means capacity may be introduced in steps of 1/4 to a maximum of 1 3/4 mf. The amount of compensating resistance and capacity should be based on the conditions that the circuit must work under, taking into account compensating resistance in selector circuit and in the case of inter-office trunks not provided with cut-off jacks, the capacity of cable conductors.

Where Fig. D and G is used, to simulate the worst fundamental circuit conditions, and allow for a margin of safety, compensating resistances may be cut in by operating one or a combination of the compensating resistance keys; by this means resistance may be added in steps of 100 ohms to a maximum of 2100 ohms. Capacity of 1.38 M.F. may be connected across tip and ring of the fundamental circuit by the operation of (M.F. 1.38) key. To determine the amount of compensating resistance to be added, and whether or not the (M.F. 1.38) key should be operated, consideration must be given to the conditions that this circuit must work under, taking into account compensating resistance in the selector circuits and in the case of inter-office trunks not provided with cut-off jacks, the capacity of cable conductors.

5.12 Test Networks for Repeating Incoming Selectors not Modified for 280DG Relay

Where Fig. D and H is used, there may be made, in addition to the test described above, release, hold, and non-operate tests on the (L) relay in repeating incoming selector circuits. With (L-REL) key operated the incoming selector is tested for ability of (L) relay to release quickly enough to avoid overstepping. With (L-HLD) key operated the incoming is tested for ability of (L) relay to hold during final selections over a trunk which imposes the worst circuit surge condition on the relay. If (L-NO) key is operated when either the release or hold test is to be made, a non-operate test is made on the (L) relay in position 1. If the relay is within its non-operate adjustment and if the shunt is properly connected around its primary winding, the incoming selector will not move out of position 1 until (L-NO) key released. When tests are being made of repeating incoming selectors, the 1:38 key and all compensating resistance keys must be normal.

5.13 Test Networks for Repeating Incoming Selectors with or Without 280DG(L) Relay.

Where Fig. D and J is used, the (LGT) key is provided to be operated when the repeating incoming selector has a 280DG(L) relay. The tests are as described in paragraphs 5.11 and 5.12

5.2 Three-Wire Office Selectors

5.21 Start of Test

(OFF) key and the proper keys in the second and third rows of numerical keys are operated. The (STP) key may be operated if desired. Compensating resistance and capacity keys are operated as described in paragraph 6.12. "REV" key should be operated when "W" wiring is used if the office test line supplies battery on the tip and ground on the ring. (BC) or (OBC) key, according as "V" or "W" wiring is used, may be operated for brush continuity test as later described. The circuit functions as described in paragraph 6.11 until position 3. Ground on (3) arc steps the switch

to position 5. Where "L" wiring is used, (FA) relay releases as the switch leaves position 2. Ground through the break contact of (SLO) relay steps the switch to position 6. Ground on (3) arc steps the switch to position 8. Ground through the break contact of (SLO) relay steps the switch to position 9. In position 9 (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 10.

5.22 Office Brush Selection

With the switch in position 10, the fundamental circuit for office brush selection is established. Fig. D: This circuit is from battery thru the office selector (L) relay, the tip of (TST) jack, make contact of (LO) relay, normal contact (L-REL) key if "R" wiring is used, compensating resistance, arc 5, windings of (OF) and (STP) relays, break contact of (BO) relay, normal contacts (L-REL), (L-HLD) and (L-NO) keys if "R" wiring is used, break contact of (FIN) key, make contact of (LO) relay, ring of (TST) jack to ground in the office circuit. Fig. C: With wiring per Fig. C the location of the compensating resistance and capacity in the fundamental circuit is different but with either wiring (STP) relay operates but (OF) relay being polarized, does not. (STP) relay operated, connects ground through the contacts of the operated numerical key in the second row, through the winding of the corresponding counting relay, operating the counting relay. Impulses from the office selector (A) commutator short circuit and releases (STP) relay, allowing the prime relay corresponding to the operating counting relay to operate. The operating of the prime relay transfers the pulsing lead from the numerical keys to the next counting relay. The impulses from the office selector continue until (O) counting relays operate. The operation of (BO) relay opens the fundamental circuit, causing the office selector to advance. The operation of (FO) relay releases (ST) and (ST-1) relays and steps the switch to position 11, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. If (STP) key is normal, ground through the break contact of (SLO) relay steps the switch to position 12. If (STP) key is operated, the switch remains in position 12 until (ST) key is operated and released the operation of (ST) key operating (ST) relay and the release of (ST) key removing the short circuit around (ST-1) relay, allowing it to operate and step the switch to position 12.

5.23 Office Group Selection

In position 12 (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 13. With the switch in position 13, the fundamental circuit for office group selection is established, operating (STP) relay. This connects ground through the contacts of the operated numerical key in the third row to operate the corresponding counting relay. As pulses are received, the successive counting relays operate; when (BO) and (FO) relays operate, the fundamental circuit is broken, advancing the office selector, (ST) and (ST-1) relays, if operated are released and the switch is stepped to position 14, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays.

5.24 Office OK Signal

In position 14, if (STP) key is normal, ground through the break contact of (SLO) relays steps the switch to position 15. If (STP) key is operated the advance out of position 14 is under control of (ST) key the same as in position 11. Ground through (3) arc and make contact of (OFF) key steps the switch from position 15 to position 17, and ground through the break contact of (SLO) relays steps the switch to position 18, ground through (3) arc stepping it to position 20. As the switch advances from position 19 to position 20, the direct ground on the sleeve of (TST) jack from (4) arc is replaced by ground through (L) 45 ohm resistance and the winding of (SLV) relay and battery through (K) 1200 ohm resistance and the winding of (SLV) relay, (SLV) relay operates from the direct ground on the sleeve in the office circuit if the office circuit has not advanced to its talking position, or operates in series with the locking winding of the office selector (L) relay if the office selector is in its talking position. In either case the office selector (L) relay holds operated in series with (SLV) relay to ground in the test circuit when the office selector reaches its talking position. (SLV) relay operated, in turn operates (SL-1) relay. (SL-1) relay operated lights (I-O OK) lamp and steps the switch to position 21. "V" wiring: in position 21 (SH) relay operates and (S1) relay, in series with the windings of the repeat coil is bridged across the tip and ring. The test line in the office multiple is connected to interrupted battery and ground, causing (S1) relay to operate and release regardless of polarity of the test line, flashing (I-O OK) lamp as a signal that the proper selections have been made. "W" wiring: in position 21 (S) relay is bridged across tip and ring. The test line is connected to interrupted battery and ground and with (REV) key in the proper position depending upon the polarity of the test line battery, (S) relay will operate and release, flashing (I-O OK) lamp as an indication that the proper selections have been made.

5.25 Office Selector Overflow

If during trunk hunting, all the trunks are busy, the office selector goes

to overflow. As the office selector advances it connects battery to the ring and ground to the tip. With "V" wiring, (S1) relay will operate, extinguishing (I-O OK) lamp. With "W" wiring, (S) relay will operate or not operate according as (REV) key is normal or operated; and (I-O OK) lamp will be extinguished or remain lighted, according as (S) relay operates or does not operate, respectively. The test circuit remains in position 21 until disconnection.

5.26 Office Selector Brush Continuity Test

"V" wiring: When it is desired to test the continuity of brushes on banks not having access to the regular test lines, the (BC) key is operated, operating (BC) relay and the office selector is directed to an incoming selector, or in banks where there are no incoming selectors, to an R.C.I. or operator's trunk. The office selector advances to its talking position. The test circuit advances to position 21: (CS) relay bridged across the tip and ring operates from the battery through the winding of the (L) relay and ground from the incoming selector or operator's trunk circuit, or from the battery through the winding of (A) relay and ground in the R.C.I. Trunk circuit. (CS) relays operated in turn operates (CS1) relay, which locks under control of (OFF) and (DISC) keys, lights (BC-OK) lamp, and operates (DIS) relay. (DIS) relay operated steps the switch to normal, releasing the office-selector circuit, allowing it to restore to normal, releasing (LO) relay and extinguishing the (TST) lamp. The incoming selector (L) relay does not operate as the resistance of the winding of (CS) relay is too high. The R.C.I. (A) relay may operate but as the test circuit immediately advances, the operation of (A) relay will only be momentary.

"W" wiring: When it is desired to test the continuity of brushes not having access to the regular test line, (OBC) key is operated, operating (BC) relay, and the office selector is directed to an incoming selector, or in banks where there are no incoming selectors, to an R.C.I. or operator's trunk. After finding an idle trunk the office selector advances to its talking position. The test circuit advances to position 21. (OBC) relay bridged across the tip and ring operates from battery on the tip thru the winding of the (L) relay and ground on the ring from the incoming selector or operator's trunk circuit, or from battery on the tip thru the winding of (A) relay and ground on the ring in the R.C.I. circuit. (OBC) relay operated operates (AV) relay which locks under control of (DISC) key, lights (BC-OK) lamp and operates (DIS) relay. (DIS) relay operated steps the switch to normal, releasing the office selector circuit, allowing it to restore to normal, releasing (LO) relay and extinguishing the (TST) lamp. If the office selector was directed to an incoming selector the (L) relay in the incoming selector should not operate on account of the high resistance of the bridge, and the incoming circuit should not move off normal. If the office selector was directed to an R.C.I. trunk, the (A) relay may operate, lighting the display lamp when (OBC) relay is bridged across the tip and ring but as (OBC) relay is held bridged only momentarily (A) relay will be released immediately, extinguishing the display lamp. (BC-OK) lamp lighting checks the continuity of the tip and ring brushes. If all the trunks in the group selected are busy the office circuit will advance to its overflow position and connect battery to the ring and ground to the tip. As the (OBC) relay is polarized it should not operate under this condition. Other conditions which will prevent the (OBC) relay from operating are: open tip or ring, crossed tip and ring, grounded tip and reversed tip and ring. Under any of these conditions where (OBC) relay does not operate, (RM) switch should remain in position 21 and there should be no lamp indication.

5.27 Office Disconnection

Removing the plug from the test jack allows the office circuit to advance to normal and releases (SLV) relay in turn releasing (SL1) relay, extinguishing (I-O OK) lamp and operating (DIS), relay provided the switch is in position 21. (DIS) relay locks through (2) arc, releasing (ST) and (ST-1) relays if operated, and steps the switch to normal. On reaching normal (DIS) and (LO) relays release and the (TST) lamp is extinguished. When it is not desired to remove the plug from the test jack, disconnection is accomplished by operating (DISC) key, this operates (DIS) relay, which locks and steps the switch to normal as above described. The advance of the switch removes ground from the sleeve of the test jack, allowing the office selector to restore to normal. After brush continuity test it is necessary to operate (DISC) key to restore the test circuit to normal, as (CS1) or (AV) relay is locked under control of (DISC) key.

5.3 Incoming Selectors

5.31 Start of Test

Four numerical keys, one in each row, corresponding to the number of a test line are operated. (STP) key is operated if it is desired to control the various steps of the test. Compensating resistance, capacity, and network keys are operated as described in paragraphs 5.12 and 5.13. (TEL) key is operated if the ringing induction is to be tested. The following keys are operated depending on the type of incoming selector to be tested:-

Three-wire local incoming selector and three-wire toll key indicator incoming selectors; (3WI) key.

Two-wire inter-office and mechanical tandem incoming selectors, (2WI) key, neither (SL-48V) nor (LL-48V) keys are operated if the incoming selector has 24 volt battery on the trunk, if the incoming selector has 48 V. battery on the trunk (SL-48V) key is operated for an external circuit loop of 6350 ohms and (LL-48V) key is operated for an external circuit loop of 7540 ohms.

Two-wire toll key indicator incoming selectors, (2W-TKI) key also operate (REV) key if the incoming is arranged to supply battery on the tip and ground on the ring in trunk closure.

Two-wire inter-office key indicator incoming selectors - (2W-IKI) key. Where the incoming circuit has a 350 ohm resistance in series with its (A) relay, (KI-350) key is operated as well as (2W-IKI) key.

Repeating incoming selectors - (L-REL) or (L-HLD) keys, also (L-NO) if desired. These keys appear only in circuits equipped with Figs. H or J. Fig. J, which superseded Fig. H, also includes an (LGT) key which is operated when testing repeating incomings with 280DG (L) relay. For function of these keys see paragraph 5.12 and 5.13. Also operate the same class key as for the corresponding non-repeating incoming.

When testing two-wire or three-wire toll key indicator incoming selectors, (±) jack is patched to the ringing supply jack in the jack box at the selector frame.

The test circuit functions as described in paragraph 6.11 until position 3. In position 3 (C) and (C1) relays operate from ground thru (3) arc, thru the break contact of (OFF) and (FIN) keys. This operates (SLO) relay, stepping the switch to position 4. Where "L" wiring is used (FA) relay releases as the switch leaves position 2.

5.32 Incoming Brush Selection

In position 4 the fundamental circuit for incoming brush selection is established.

Fig. D and G:

This circuit is from battery thru the incoming selector (L) relay, the tip of (TST) jack, make contact of (LO) relay, compensating resistance and compensating resistance keys, (5) arc, normal contact (FIN) key, normal contact (OFF) key, windings (OF) and (STP) relays, normal contacts (BO) relay, normal contact (FIN) key, make contacts (BO) relay, ring of (TST) jack to ground in the incoming circuit.

Fig. D and H:

This circuit is from battery thru the incoming selector (L) relay, the tip of (TST) jack, make contact of (LO) relay, contacts (L-REL) key, (L) relay release test network and contacts of (L-REL) key again if (L-REL) key is operated, thru compensating resistance keys (which should all be normal if (L-REL) or (L-HLD) keys are operated), (5) arc, normal contacts (FIN) and (OFF) keys, windings of (OF) and (STP) relays, back contact (BO) relay, contacts (L-REL) key, contacts (L-HLD) key, (L) relay hold test network if (L-HLD) key is operated, contacts of (L-NO) key if it is normal or thru non-operate test resistances instead if it is operated, normal contacts (FIN) key, make contact (LO) relay, ring of (TST) jack, to ground in the incoming selector circuit.

Fig. C:

This circuit is from battery thru the incoming selector (L) relay, the tip of test jack, make contact of (LO) relay, (5) arc, break contacts of (FIN) and (OFF) keys, compensating resistance and compensating resistance keys, windings (OF) and (STP) relays, back contacts (BO) relay, back contact (FIN) key, make contact of (LO) relay, ring of (TST) jack, to ground in the incoming circuit.

Fig. D and J:

This circuit is from battery thru the incoming selector (L) relay, tip of (TST) jack, keys (TKID), (±) and (R±) normal, make contacts of relay (LO), key (L-REL) operated, relay (L) release test network key (L-REL) operated, compensating resistance keys normal, 5 arc, key (OFF) normal, thru relays (CF) and (STP), break contact of relay (BO), keys (L-REL), (L-HLD) and (LGT) operated, relay (L) hold test network, key (L-NO) normal or, if (L-NO) is operated, key (LGT) operated, thru relay (L) non-operate test network, key (FIN) normal, make contact of relay (LO), key (R±), (±) and (TKID) normal, ring to (TST) jack, thru incoming selector (L) relay to ground.

Fig. J is used when some repeating incoming selectors are modified with the 280DG (L) relay, in which case, key (LGT) is operated. When key (LGT) is left normal, circuit is similar to Fig. D and H.

With any one of these wiring arrangements, (STP) relay operates but (OF) relay, being polarized, does not. (STP) relay operated, connects ground through the contacts of the operated numerical key in the first row, through the winding of the corresponding counting relay, operating the counting relay. Impulses from the incoming selector (A) commutator, short-circuit and

release (STP) relay, allowing the prime relay corresponding to the operated counting relay to operate. The operation of the prime relay transfers the pulsing lead from the numerical keys to the next counting relay. The impulses from the incoming selector circuit continues until (O) counting relay operates. When (STP) relay releases (BO) and (FO) relays operate. The operation of (BO) relay opens the fundamental circuit, causing the incoming selector circuit to advance. The operation of (FO) relay releases (ST) and (ST-1) relays and steps the switch to position 5, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. If (STP) key is normal ground through the break contact of (SLO) relay steps the switch to position 6. If (STP) key is operated the switch remains in position 5, until (ST) key is operated and released. The operation of (ST) key operating (ST) relay and the release of (ST) key removing the short circuit around (ST-1) relay permitting it to operate and step the switch to position 6.

5.33 Incoming Group Selection

In position 6, (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 7. With the switch in position 7, the fundamental circuit for incoming group selection is established, operating (STP) relay. This connects ground through the contacts of the operated numerical keys in the first and second rows to operate the counting relay corresponding to the group to be selected. As pulses are received the successive counting relays operate; when (BO) and (FO) relays operate, the fundamental circuit is broken advancing the incoming selector. (ST) and (ST1) relays if operated are released, and the switch is stepped to position 8, releasing (C) and (C1) relays in turn releasing (SLO) relay and the counting relays. If (STP) key is normal ground through the break contact of (SLO) relay steps the switch out of position 8 is under control of (ST) key the same as in position 5.

5.34 Final Selections

In position 9, (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 10. With the switch in position 10, the fundamental circuit for final brush selection is established. Selections are made in a manner similar to incoming selections: after final brush selection (BO) and (FO) relays operate, releasing (ST) and (ST1) relays, if operated, and stepping the switch to position 11, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. The switch advances to position 12 from the ground through the break contact of (SLO) relay or under control of (ST) key. (C) and (C1) relays operate in turn operating (SLO) relay stepping the switch to position 13. Final tens selection takes place in position 13. On completion (BO) and (FO) relays operate, releasing (ST) and (ST1) relays, if operated, and stepping the switch to position 14, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. The switch advances to position 15 from the ground through the break contact of (SLO) relay or under control of (ST) key. (C) and (C1) relays operate in turn operating (SLO) relay stepping the switch to position 16. Final units selection takes place in position 16, on completion (BO) and (FO) relays operate, releasing (ST) and (ST1) relays, if operated, and stepping the switch to position 17, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. Ground through the break contact of (SLO) relay steps the switch to position 18. In position 18, (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 19.

5.35 Reverse Battery

In position 19 after the incoming selector has advanced, it connects battery through the winding of its (L) relay to the ring of the test jack and ground to the tip. (STP) and (OF) relays in the fundamental circuit operate. (OF) relay locks and operates (OF1) relay, lighting (OF) lamp, operating (O) counting relay, and closing the circuit to (BO) and (FO) relays which remain unoperated until the incoming selector advances releasing (STP) relay, removing the short circuit around them. (FO) relay operated, steps the switch to position 20, extinguishing (OF) lamp, and releasing (C) and (C1) relays, in turn releasing (SLO), (O), (BO) and (FO) relays.

5.36 (SLV) Relay Operation

A. Three-Wire Incomings

As the switch steps from position 19 to position 20, the direct ground on the sleeve of (TST) jack from (4) arc is replaced by ground through (L) 45 ohm resistance and the winding of (SLV) relay and battery thru (K) 1200 ohm resistance and the winding of (SLV) relay. (SLV) relay will operate from direct ground on the sleeve of the incoming circuit. When the incoming selector (L) relay locks over the sleeve in series with (SLV) relay to ground in the test circuit. (SLV) relay operated in turn operates (SL1) relay. (SL1) relay operated, lights (I-O OK) lamp and steps the switch to position 21.

B. Two-Wire Incomings

In position 20, ground from (2) arc, through the make contact of (2 WI), (2W-LKI) or (2W-TKI) key, through (4) arc operates (SLV) relay in turn operating

(SL1) relay. (SL1) relay operated, lights (I-O OK) lamp and steps the switch to position 21.

5.37 Incoming Trunk Closure, Ringing, O.K. Flash, Disconnect

These functions are so different for each type of incoming selector circuit that they are described individually in the following paragraph.

5.371 Three-Wire Local Incoming

When the test circuit steps to position 21, (SH) relay operates and (S) relay in series with the repeat coil is bridged across the tip and ring. The incoming (L) relay will operate and it will advance to its ringing positions. (S) relay, being polarized, does not operate at this time. The line to which the final selector should connect is arranged to test automatically the ringing, tripping and supervision of the incoming circuit. If the (TEL) key is operated the tester can listen to the ringing induction, for with the switch in position 21 the repeat coil in series with (S) relay, is bridged across the tip and ring. (I-O OK) lamp remains lighted until the ringing is tripped. When the ringing is tripped the incoming selector advances to its talking position, and interrupter in the test line causes the line supervisory relay in the incoming selector circuit to flash, opening and closing the ground to the trunk, flashing (S) relay in the test circuit. (I-O OK) lamp, which lighted on the operation of (SL1) relay, flashes, as the operation of (S) relay extinguishes it. Removing the plug from the test jack allows the incoming selector to restore to normal and releases (SLV) relay in turn releasing (SL1) relay, extinguishing (I-O OK) lamp and, provided the switch is in position 21, operating (DIS) relay. (DIS) relay lock through (2) arc, and steps the switch to normal. On reaching normal (DIS) (LO) (OF) and (OF1) relays release and (TST) lamp is extinguished. When it is not desired to remove the plug from the test jack, disconnection is accomplished by operating (DISC) key. This operates (DIS) relay, which locks and steps the switch to normal as above described. The advance of the switch removes ground from the sleeve of the test jack, allowing the incoming selector under test to restore to normal.

5.372 Two-Wire Inter-Office, Mechanical Tandem and Repeating Incoming

When the test circuit steps to position 21, (SH) relay operates and (S) relay in series with the repeat coil and test resistance is bridged across the tip and ring. The amount of the test resistance is controlled by (SL-48V) - (LL-48V) key. With the key normal the resistance is such as to apply an operate test on incoming selector (A) relays supplied with 24 V. battery. When (SL-48V) key is operated the resistance is increased to apply an operate test on incoming selector (A) relays supplied with 48V. battery and designed for 6350 ohms external circuit loop. When (LL-48V) key is operated the resistance is increased to apply an operate test to incoming selector (A) relays supplied with 48V. battery and designed for 7540 ohms external circuit loop. This operates the trunk supervisory relay in the incoming selector, advancing it to its ringing positions. The direction of the circuit is such as not to operate (S) relay which is polarized, and (I-O OK) lamp remains lighted until the ringing is tripped. The line to which the final selector should connect is arranged to test automatically the ringing, tripping and supervision of the incoming circuit. If the (TEL) key is operated the tester can listen to the ringing induction. When the ringing is tripped, the incoming selector advances to its talking position. An interrupter in the test line circuit causes the line supervisory relay in the incoming circuit to flash, in turn operating and releasing a reversing relay, which reverses the direction of the current through (S) relay in the test circuit, permitting it to operate. (S) relay will thus flash in time with the interrupter in the test line. (I-O OK) lamp, which lighted on the operation of (SL1) relay, flashes, as the operation of (S) relay extinguishes it. The operation of (DISC) key operates (DIS) relay, which locks through (2) arc and steps the switch to normal. As the switch leaves position 21, the bridge across the tip and ring is opened, releasing the incoming trunk, supervisory relay, causing the incoming selector to restore to normal. On reaching the normal position (SLV) and (SL1) relays release extinguishing (I-O OK) lamp. (LO), (OF) and (OF1) relays release, and (TST) lamp is extinguished and, provided (DISC) key is normal, (DIS) relay releases. Removing the plug from the jack, without operating (DISC) key, restores the incoming selector to normal, but is is necessary to operate (DISC) key to restore the test circuit to normal.

5.373 Three-Wire Toll Key Indicator Incoming

After sending back reverse battery the incoming advances to its trunk closure position and its (L) relay will operate from ground on the sleeve advancing it to its ringing and talking position. Battery and ground through the incoming repeat coil are connected to the trunk operating (S) relay in the test circuit which is bridged across the tip and ring in series with the repeat coil. The operation of (S) relay extinguishes (I-O OK) lamp, indicating that the incoming circuit is ready for ringing. The tester operates key (± KI), where Fig. E is used or key (±) where Fig. F is used which disconnects relay (S). Relay (S) releasing causes lamp (I-OK) to light.

Where Fig. E is used the ringing current is sent out thru resistance (AG) 1000 ohms. Where Fig. F is used, the operation of key (±) permits ringing current to be sent out directly which applies an operate test of the ring up relay in the incoming selector circuit under maximum voltage conditions. By the operation of key (R±), (Fig. F), an operate test of the ring up relay is made thru 2300 ohms on both sides of the circuit which permits a test representing minimum voltage conditions. The operation of the ring up relay in the incoming selector circuit starts the ringing, which continues automatically. When the (± KI) key (Fig. E) or (R±) or (±) key, Fig. F is released (S) relay reoperates, extinguishing (I-O OK) lamp. The line to which the final selector should connect is arranged to test automatically the ringing, tripping and supervision of the incoming circuit. If the (TEL) key is operated the tester can listen to the ringing induction. (I-O OK) lamp remains extinguished until the ringing is tripped. When the ringing is tripped, an interrupter in the test line circuit causes the line supervisory relay in the incoming selector circuit to flash. This in turn causes the operation and release of a relay in the incoming circuit which by its operation, disconnects the battery and ground from the trunk causing (S) relay in the test circuit to flash, in turn flashing the (I-O OK) lamp. Removing the plug from the test jack allows the incoming selector to restore to normal and release (SLV) relay in turn releasing (SL1) relay, extinguishing (I-O OK) lamp and operating (DIS) relay provided the switch is in position 21. (DIS) relay locks through (2) arc and steps the switch to normal. On reaching normal (DIS), (LO), (OF) and (OF1) relays release and (TST) lamp is extinguished. When this is not desired to remove the plug from the test jack, dosconnection is accomplished by operating (DISC) key, this operates (DIS) relay, which locks and steps the switch to normal as described above. The advance of the switch removes ground from the sleeve of the test jack, allowing the incoming selector to restore to normal.

5.374 Two-Wire Toll Key Indicator Incoming

When the test circuit steps to position 21, (SH) relay operates and (S) relay in series with the repeat coil is bridged across the tip and ring. This operates the trunk supervisory relay in the two-wire toll key to indicator incoming selector circuit. (S) relay in the test circuit operates as the current is in the proper direction. The operation of (S) relay extinguishes (I-O OK) lamp, indicating that the incoming circuit is ready for ringing. The tester operates (± KI) key (Fig. E) or key (R±) or (±) (Fig. F) as described in the previous paragraph, disconnecting (S) relay and connecting ringing current to the circuit. (S) relay releases when the key is operated, lighting (I-O OK) lamp. The ringing current operates a ring up relay in the incoming selector circuit under the same conditions as described in the previous paragraph starting ringing, which continues automatically. When key (± KI) (Fig. E) or (R±) or (±) key, (Fig. F) is released (S) relay reoperates, extinguishing (I-O OK) lamp. The test line to which the final selector should connect is arranged to test automatically the ringing, tripping and supervision of the incoming circuit. If the (TEL) key is operated the tester can listen to the ringing induction. (I-O OK) lamp remains extinguished until the ringing is tripped. When the ringing is tripped, an interrupter in the test line circuit causes the line supervisory relay in the incoming selector circuit to flash. This in turn causes the operation and release of a relay in the incoming circuit which, by its operation, disconnects the battery and ground from the trunk causing (S) relay in the test circuit to flash, in turn flashing the (I-O OK) lamp. Except in the case of incoming selectors requiring battery and ground disconnect supervision as described later, disconnection may be accomplished by the operation of (DISC) key. This operates (DIS) relay which locks under control of the stepping switch and steps the switch to normal. As the switch leaves position 21 the (LO) relay releases opening the bridge across the tip and ring releasing the incomping selector supervisory relay, causing the incoming selector to restore to normal. When the stepping switch leaves position 21 the (SLV) and (SL1) relays release extinguishing the (I-O OK) lamp, (OF) and (OF1) relays release and the (TST) lamp is extinguished. Removing the plug from the (TST) jack, without operating the (DISC) key, will restore the incoming selector to normal, but it is necessary to operate the (DISC) key to restore the test circuit to normal.

To disconnect incoming selectors which require battery and ground disconnect supervision it is necessary first to open the bridge across the tip and ring. This may be accomplished by operating the (DISC) key. Operating the (DISC) key releases the test circuit as described in the preceding paragraph, opening the tip and ring allowing the incoming selector to advance to its awaiting release position. The (TKI D) key should then be operated connecting battery thru 6630 ohms to the tip and ground to the ring of the incoming selector, applying an operate test to the incoming supervisory relay, which should operate restoring the incoming selector to normal. Failure to restore to normal indicates that this relay is out of adjustment. This key should remain operated until the down drive starts. This key also operates the (DIS) relay which performs no function as it operated and

restored the test circuit to normal when the (DISC) key was operated. The (DIS) relay releases when the (TRI D) key is restored to normal.

5.375 Two-Wire Inter-Office and Repeating Key Indicator Incoming

When the test circuit steps to position 21, (SH) relay operates and (KI) relay operates from ground on (3) arc through the make contact of (2W-IKI) key. The operation of (KI) relay lights (KI) lamp, connects ground to the tip of the trunk through the winding of (KIS) relay, connects battery to the ring of the trunk through (Q) 260 ohm and (S) 370 ohm resistances and connects ground to the ring of the trunk thru (R) 180 ohm and (S) 370 ohm resistances. The purpose of this arrangement of battery and ground is to give the supervisory relay in the incoming circuit the proper amount of current through both its windings in series and through its low resistance winding alone. On incoming circuits of this type which have a 350 ohm resistance in series with the (A) relay, (KI-350) key is operated, short circuiting (S) 370 ohm resistance. At the time that (KI) relay operates, the high resistance winding of the trunk supervisory relay in the incoming circuit is not short-circuited. Under this condition it operates thru both its windings in series, but (KIS) relay will not receive enough current to operate. The incoming selector advances to its ringing positions. The line to which the final selector should connect is arranged to test automatically the ringing, tripping and supervision of the incoming circuit. If the (TEL) key is operated the tester can listen to the ringing induction. (KI) lamp remains lighted until the ringing is tripped. When the ringing is tripped, the incoming selector advances to its talking position. An interrupter in the test line circuit causes the line supervisory relay in the incoming circuit to flash in turn closing and opening the short circuit around the high resistance winding of the incoming trunk supervisory relay. When the high resistance winding is short-circuited (KIS) relay in the test circuit operates extinguishing (KI) lamp. Thus (KIS) relay flashes in turn flashing the (KI) lamp. (I-O OK) lamp remains lighted all through this test.

The operation of (DISC) key operates (DIS) relay, which locks through (2) arc and steps the switch to normal. As the switch leaves position 21, the battery and ground circuits are opened releasing the incoming trunk supervisory relay, causing the incoming selector to restore to normal.

On leaving position 21, (KI) relay releases extinguishing (KI) lamp. On reaching the normal position (SLV) and (SL1) relays release extinguishing (I-O OK) lamp, (LO), (OF), and (OF1) relays release, and the (TST) lamp is extinguished and, provided (DISC) key is normal, (DIS) relay releases. Removing the plug from the jack, without operating (DISC) key, restores the incoming selector to normal, but it is necessary to operate (DISC) key to restore the test circuit to normal.

5.38 Incoming Brush Continuity Test

The brushes on banks not having access to the final multiple test lines for testing incoming selectors may be tested in the following manner.

"V" Wiring:

The final selector test line, number 99 in the bank, on a final frame which is reached through the particular incoming brush it is desired to test, is made busy at the I.D.F. by means of a P.B.X. make busy cord. The incoming selector is directed to a final selector on this frame and the final selector is directed to this line. As the line is busy, busy back flashes, sent back by the final selector, cause the (I-O OK) lamp to flash.

"W" Wiring:

With "W" wiring it is not necessary to make a final test line busy. The brushes on banks not having access to the final multiple test lines for testing incoming selectors may be tested in the following manner. Operate (IBC) key which operates (IBC) relay and a key in (TH) and one in (OB-H) row according to the brush it is desired to test for continuity and the group it is desired to test in. No. 1 final brush should be tripped regardless of which key is operated in (OB-H) row. Keys in (OG-T) and (U) rows need not be operated. The test proceeds as for a regular test line call until the switch reaches final tens selection position. Here the fundamental circuit is open at the (IBC) relay. The switch advances out of this position from ground on the (IBC) key and into final units selection position in the regular manner. Here again the fundamental circuit is open at the (IBC) relay and the switch advances from ground on the (IBC) relay out of final units selection position and into position 19 in the regular manner. With the test switch in pos. 19 the final is driven to tell-tale on final tens selection, sending the incoming to its reverse battery position. Reverse battery is received from the incoming circuit and the test switch advances to pos. 20. Here (SLV) relay operates, operating (SL1) relay, which lights (BC-OK) lamp as an indication of satisfactory incoming brush continuity and steps the switch to pos. 21 where it remains with (BC-OK) lamp lighted until disconnection, which is

accomplished as in the case of a regular test line call. If the tip, ring, or sleeve brushes had been open, final brush selection would not have been made and the switch would have stuck in position 10.

5.39 Incoming Selector Overflow

If during trunk hunting, the incoming selector goes to overflow, due either to an all trunks busy condition or to an understep on group selection, when the test circuit reaches position 10, the fundamental circuit is closed for final brush selection, but the battery thru the winding of the incoming (L) relay is connected to the ring and ground is connected to the tip. The direction of the current is such that (OF) relay operates as well as (STP) relay. (OF) relay locks and operates (OF1) relay, lighting (OF) lamp, which continues lighted, as indication of overflow and the test circuit remains in position 10, until it is restored to normal.

5.4 Final Selectors

5.401 Start of Test

One numerical key in each row except the first is operated to direct the final selector to the particular line required as is later explained. (STP) key is operated if it is desired to control the various steps of the test.

Fig. C:

(FCR) key is operated if it is desired to simulate the maximum trunk condition as regards resistance and capacity. If (FCR) key is normal the compensating resistance and capacity keys should be operated as described in paragraph 5.12.

Fig. D and G, H or J:

A capacity of 1.38 M.F. and compensating resistance may be inserted in the fundamental circuit independently by the operation of (M.F. 1.38) key and the compensating resistance keys, respectively. See paragraph 5.12. (FIN) key is operated on all tests of the final selector circuit. For all tests except brush continuity tests and tests requiring P.B.X. hunting, the final selector is directed to the top test line, line 99 in the bank in which the three final test lines are located. When the P.B.X. hunting feature is to be tested, the final selector is directed to the bottom test line, line 97 in the bank. For the line free test no keys except as noted above are operated. To simulate the condition of individual or last line of a P.B.X. group busy (LF-FB) key is operated in line finder or line switch offices having (PBX) relays readjusted to operate on .024 and non-operate on .022 amperes. (LS-FB) key is operated in line switch offices having (PBX) relays readjusted to operate on .021 and non-operate on .019 amps. To make a "no test" call (NT) and (FB) keys are operated. (FT) jack is patched to the final test line jack in the jack box and (INT) jack is patched to the interrupter jack in the jack box. The test circuit functions as described in paragraph 5.11 until position 3, with the addition that when "L" wiring is used (FA) relay locks to ground on the ring of the final selector, and remains locked until the completion of final selections provided the ring conductor is continuous. Should the ring conductor be open or should the connection thru the 40 ohm resistance to ground in the final circuit be open (FA) relay will release as the switch leaves position 2, opening the fundamental circuit, preventing the final selector from moving off normal and blocking the test. Where "K" wiring is used (FA) relay operates locally and remains operated until the switch restores to normal. Ground on (3) arc through the make contact of (FIN) key steps the switch from position 3 to position 5. Ground through the break contact of (SLO) relay, steps the switch to position 6. Ground on (3) arc, through the make contact of (FIN) key steps the switch to position 8. Ground through the break contact of (SLO) relay steps the switch to position 9. In position 9, (C) and (C1) relays operate in turn operating (SLO) relay, stepping the switch to position 10.

5.402 Final Brush Selection

With the switch in position 10, the fundamental circuit for final brush selection is established.

Fig. C:

This circuit is from battery through the final (L) relay, the tip of (TST) jack, make contact of (LO) relay, (5) arc, compensating resistance winding of (OF) and (STP) relays, break contact of (BO) relay, make contact of (FIN) key to ground direct in the case of "K" wiring or to ground thru the make contact of (FA) relay in the case of "L" wiring.

Fig. D and G, H or J:

This circuit is from battery thru the final (L) relay, tip of (TST) jack, make contact of (LO) relay, back contacts (L-REL) key if Fig. H or J is used, compensating resistance, (S) arc, windings (OF) and (STP) relays, back contact (BO) relay, back contacts (L-REL), (L-HLD) and (L-NO) keys if Fig. H or J is used, make contacts (FIN) key, to direct ground in the case of "K" wiring or to ground thru the make contact of (FA) relay in the case of "L" wiring. With either figure (STP) relay operates but (OF) relay

being polarized does not. (STP) relay operated, connects ground through the contacts of the operated numerical key in the second row, through the winding of the corresponding counting relay, operating the counting relay. Impulses from the final selector (A) commutator short circuit and release (STP) relay, allowing the prime relay corresponding to the operated counting relay to operate. The operation of the prime relay transfers the pulsing lead from the numerical keys to the next counting relay. The impulses from the final selector circuit continue until (O) counting relay operates. When (STP) relay releases (BO) and (FO) relays operate. The operation of (BO) relay opens the fundamental circuit, causing the final selector circuit to advance. The operation of (FO) relay releases (ST) and (ST1) relays and steps the switch to position 11, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. If (STP) key is normal, ground through the break contact of (SLO) relay steps the switch to position 12. If (STP) key is operated, the switch remains in position 11 until (ST) key is operated and released, the operation of (ST) key operating (ST) relay and the release of (ST) key removing the short circuit around (ST1) relay, allowing it to operate and step the switch to position 12.

5.403 Final Tens Selection

In position 12, (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 13, the fundamental circuit for final tens selection is established, operating (STP) relay. This connects ground through the make contact of the operated numerical key in the third row, to operate the corresponding counting relay. As pulses are received, the successive counting relays operate. When (BO) and (FO) relays operate the fundamental circuit is broken advancing the final selector, (ST) and (ST1) relays, if operated, are released, and the switch is stepped to position 14, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. If (STP) key is normal, ground through the break contact of (SLO) relay steps the switch to position 15. If (STP) key is operated, the advance out of position 14 is under control of (ST) key the same as in position 11.

5.404 Final Units Selection

In position 15, (C) and (C1) relays operate, in turn operating (SLO) relay, stepping the switch to position 16. With the switch in position 16, the fundamental circuit for final units selection is established, operating (STP) relay. This connects ground through the make contact of the operated numerical key in the fourth row to operate the corresponding counting relay. As pulses are received, the successive counting relays operate. When (BO) and (FO) relays operate the fundamental circuit is broken advancing the final selector; (ST) and (ST1) relays, if operated, are released, and the switch is stepped to position 17, releasing (C) and (C1) relays, in turn releasing (SLO) relay and the counting relays. Ground through the break contact of (SLO) relay steps the switch to position 18.

5.405 Final Advance

"L" Wiring

When the final selector advances after units selection, ground through the winding of (PBX) relay is connected to the ring, this is in parallel with ground through the 40 ohm resistance which is connected to the ring. If (NT) key is normal (PBX) relay should not operate, as the resistance of (FA) relay and (AV) 360 ohm resistance is too high. If (NT) key is operated, (AV) 360 ohm resistance is short-circuited and (Z) 1170 ohm resistance or (N) 260 ohm resistance is connected in parallel with (FA) relay and (PBX) relay should operate as explained in paragraph 5.414. When the final selector advances the ground is removed from the ring releasing (FA) relay stepping the switch to position 20.

"K" Wiring

When the final selector advances after units selection, ground thru the winding of (T) relay is connected to the ring, this is in parallel with the ground thru a 220 ohm resistance. If (NT) key is normal, (T) relay should not operate, as the resistance of (BA) 500 ohm and (AZ) 360 ohm resistances is to high. If (NT) key is operated, (X) and (Y) 426 ohm resistance are connected in parallel with the series combination of (BA) and (AZ) resistances and sufficient current should flow to operate (T) relay as explained in paragraph 5.414. In position 18 (C) and (C1) relays operate from ground through (3) arc and the break contact of (OFF) key and (SLO) relay operates stepping the switch to position 19.

In position 19, the fundamental circuit is closed for final advance. (STP) relay operates, connecting ground through (6) arc and the make contact of (FA) relay, operating (O) counting relay. When the final selector advances (STP) relay releases. This removes the short circuit around (BO) and (FO) relays which operate in series with (O) counting relay. (BO) relay operated, breaks the fundamental circuit, (FO) operated steps the switch to position 20, releasing (C) and (C1) relays in turn releasing (SLO), (O), (BO) and (FO) relays.

5.406 Sleeve Relay Operation

As the switch steps from position 19 to position 20, the direct ground on the

sleeve of (TST) jack from (4) arc is replaced by ground through (L) 45 ohm resistance and the winding of (SLV) relay and battery thru (K) 1200 ohm resistance and the winding of (SLV) relay. (SLV) relay will operate in series with (TK) relay to battery in the final circuit. (SLV) relay operated, in turn operates (SL1) relay. (SL1) relay operated, steps the switch to position 21.

5.407 Individual Line Free Test

To make a line free test without P.B.X. hunting, the selector is directed to the top test line, line 99 in the bank, and neither (LS-FB) nor (LF-FB) keys are operated.

When the final (L) relay releases on leaving the test position, battery through 220 ohms is connected to the sleeve, thru the sleeve of (FT) jack, break contacts of (LS-FB), key, through both windings of (SLL) relay in series to ground, operating (SLL) relay. The operation of (SLL) relay closes a circuit from battery through (FF-OK) lamp, make contact of (LO) relay, ring of (TS) jack, ring conductor of final selector, ring of (FT) jack, break contact of (DISC) key, break contact of (T) relay, break contact of (NT) key, sleeve of (INT) jack, to ground through an interrupter flashing (FF-OK) lamp.

The operation of (SLL) relay also operates (CS) relay, in turn operating (CS1) relay. (CS1) relay operated connects battery to the winding of (CS) relay holding it operated in case (SLL) relay should release, it also connects ground to the tip of (TST) jack. If the tip and sleeve are crossed this ground would short-circuit (SLL) relay, permitting it to release. The release of (SLL) relay would light (SLV-X) lamp and (I-O OK) lamp and prevent (FF-OK) lamp from flashing.

5.408 Last Line of P.B.X. Group Free Test

To make a line free test with P.B.X. hunting, the selector is directed to the bottom test line, line 97 in the bank, and neither (LS-FB) nor (LF-FB) keys are operated. The selector will stop on line 97 on units selection. Battery thru a resistance is connected to this terminal, this will apply an operate test to the final (TB) relay when it advances to its testing position and (TB) relay should operate and P.B.X. hunting start. Battery through a resistance is connected to the sleeve of line 98. This will apply a non-operate speed test to the final (PBX) relay as the final selector hunts past this line. The final selector should hunt up to line 99 and as there is no battery connected to the sleeve of this line, the (TB) relay should not operate and the final selector should stop on this line and advance, connecting battery thru 220 ohms to the sleeve. From this point on the operation is the same as for "Individual Line Free Test."

5.409 Individual Line Busy Test

(LS-FB) key in line switch offices having (PBX) relays readjusted to operate on .021 and non-operate on .019 amps, or (LF-FB) key in line finder or line switch offices having (PBX) relays readjusted to operate on .024 and non-operate on .022 amps, is operated when the action of a final selector, directed to a busy line is to be tested. The operation of (LS-FB) key disconnects (SLL) relay from the sleeve of the test line and connects battery thru (M) 750 ohm resistance in its place. The operation of (LF-FB) key connects battery thru (U) 250 ohm and (V) 15 ohm resistances to the sleeve. (SLL) relay is left connected to the sleeve and will operate when (LO) relay operates, its operation however will perform no function as the circuits thru its front contacts are opened by (LF-FB) key and the circuit to (I-O OK) lamp thru its back contact is closed by (LF-FB) key. The function of (SLL) relay in the circuit at this time is to simulate the service condition encounted on a busy line. After units selection the final selector makes a busy test, connecting ground thru the winding of (PBX) and (TB) relays to the sleeve of the line, the circuit being completed thru the sleeve of (FT) jack thru the make contact of (LS-FB) or (LF-FB) key, test resistances to battery, (TB) and (PBX) relay should both operate, causing the final elevator to restore to normal and the final sequence switch to advance to its "busy back" position. When (SLV) relay operates in position 20, (BB) relay operates and locks through (2) arc and (SL1) relay operates, stepping the switch to position 21. The operation of (BB) relay lights (FB-OK) lamp. With the final selector circuit in its "busy back" position, interrupted ground is connected back over the ring from the final selector, flashing (BB-1) relay, in turn flashing (FB-OK) lamp. (I-O OK) lamp which lighted on the operation of (SL1) relay remains lighted during this test.

5.410 Last Line of P.B.X. Group Busy Test

When it is desired to test the action of a final selector when directed to a group of P.B.X. lines all of which are busy, the final selector is directed to the bottom test line, line 97 in the bank, and the busy keys are operated the same as for "Individual Line Busy Test". The operation is the same as "Last Line of P.B.X. Group Free Test" until the final selector reaches line 99, when the final (PBX) relay should operate and the test should proceed the same as for "Individual Line Busy Test."

5.411 Final Brush Continuity Test

The brushes on banks not having access to test lines may be tested in the following manner: Where "W" or "B" wiring is used, make the test final selector busy by inserting a make-busy plug in the (TMB) jack and

patch (D) jack of test set to (D) jack of test final selector, raise test final selector to the final terminal to which the selector under test is to be directed and trip the brush of the test final selector manually. With either "V" or "W" wiring (BC) or (FBC) keys respectively are operated, operating (BC) relay and the final selector is directed to any working terminal. If the line is a direct or last PBX line busy, the final selector will advance to its busy back position. No lamp indication is given of this but the tester can observe that the down drive has taken place. If the line is a busy intermediate PBX line, the final should hunt off it and the testman should check against this condition by observation before proceeding with the test. Where possible it is desirable to avoid final brush continuity testing on an intermediate PBX line. If the line is free, battery through 220 ohms will be connected to the sleeve of the line by the final selector, operating the (CO) relay in the line circuit and the final selector advances to its talking position. "V" wiring: The tester then connects ground to the sleeve terminal of any one of the multiple brushes.

"W" or "B" Wiring

The tester then operates (GRD-SLV) key. With either wiring, the (CO) relay in the line circuit will be short-circuited and released, in turn connecting ground to the tip and battery through the winding of the (L) relay to the ring. This causes (CS) relay which is bridged across the tip and ring to operate, but (L) relay will not operate, as the resistance of (CS) relay is too high. (CS) relay will only operate providing the tip and ring multiple brushes are making contact and their is no break in the tip and ring conductors. (CS) relay operated, operates (CS1) relay, lighting (BC-OK) lamp.

5.412 Test of Final Selectors to Particular Lines ("B" Wiring & Apparatus)

The particular line idle test is made as described for final brush continuity test in section 5.411. When making this test to lines having the tip ground open in the line circuit the (TGO) key should be operated. The (TGO) key operated closes a circuit to furnish ground thru 9000 ohms to the tip for operating the (CS) relay when the cut-off relay in the line circuit is shunted down by the operation of the (GRD-SLV) key. To make the particular line busy test the preliminary operations are made as when making the particular line idle test except the (PLB) key should be operated and it is not necessary to operate the (FBC) or (BC) key but may be left operated if so desired as it does not affect the test. The operation of the (PLB) key prepares a circuit for connecting battery thru 265 ohms to the sleeve of the (D) jack and closes a circuit for operating the (BB) relay when the (SLV) relay operates. The selector is directed to the terminals on which the test selector rests. The line should test busy and the final selector should restore to normal. With the stepping switch in position 20 the (SLV) relay operates operating the (SL1) and (BB) relays. The (SL1) relays operating advances the stepping switch to position 21 and lights the (I-O OK) lamp. The (BB) relay operating locks to ground thru the number 2 arc and closes a circuit from the ring of the test jack to the winding of the (BB1) relay. With the final selector in the busy back position interrupted ground is connected to the ring from the final selector. The (BB1) relay operates and releases from the interrupter ground in turn flashing the (FB OK) lamp. The (I-O OK) lamp which lighted on the operation of the (SL1) relay remains lighted during this test. Before the circuit is restored to normal after the particular line busy test the tester should observe the position of the final elevator to see that the final did not go to tell-tale.

5.413 Hold and Release Test of Final (L) Relay

The hold and release of the final (L) relay may be tested on disconnecting after a "line free" test. The operation of (DISC) key, operates (DIS) relay which locks thru (2) arc and steps the switch to normal. As the switch leaves position 21, ground is removed from the sleeve of (TST) jack permitting (TK) relay in the final circuit to release, advancing the final selector to its "awaiting called subscriber's release" position. The final selector connects ground to the incoming sleeve operating (T) relay in the test circuit lighting the (BY) lamp and connects battery thru the winding of (L) relay and a resistance in parallel to the ring of (FT) jack and ground to the tip of (FT) jack. With (DISC) key operated and the (LRF) key normal when "AB" apparatus is used, (AO) 340 ohm and (AP) 500 ohm resistances are bridged across the tip and ring of (FT) jack and when the (LRF) key is operated the (AO) and (AP) res. are replaced with (BT) and (BS) res. forming a holding path for the final selector (L) relay. (BY) lamp remaining lighted indicates that the final selector (L) relay is holding. When final selector circuits are tested which are arranged to function over subscriber loop ranges that extend to 1500 ohms, key (LRF) ("AB" apparatus) is operated. Key (LRF) operated bridges res. 1300 ohms and 362 ohms in series ("AB" apparatus) across the tip and ring of jack (FT) which forms the holding path for the final sel. (L) relay. When final selector circuits are tested which are arranged to function over subscriber loop ranges that extend to 750 ohms, key (LRF) is not operated. Under this condition resistances 500 ohms and 340 ohms in series are bridged

across the tip and ring for making the hold test of the final sel. (L) relay. On finals having a time measure release feature, it may be tested by holding (DISC) key operated until the final advances to normal under control of an interrupter, or its failure to advance will be noted if this feature is inoperative. The release of (DISC) key increases the resistance of the bridge across the tip and ring of (FT) jack as follows; when "AA" wiring is used or when "AB" apparatus is used leaving (LRF) key normal, by removing the short circuit around (AQ) 200 ohm (AR) 2000 ohm, and (AS) 2000 ohm resistances and around (AT) 1000 ohm and (AU) 2000 ohm resistances also when "K" wiring is used. When "AB" apparatus is used, operating (LRF) key, for long line operation, the short circuit is removed from (BU) and (BV) resistances. This tests the release of the final selector (L) relay. If it releases as it should, the final selector returns to normal, removing ground from the incoming sleeve releasing (T) relay and extinguishing (BY) lamp.

5.414 Final Disconnection

If it is not desired to test the hold and release of the final (L) relay, disconnection is accomplished either by operating the (DISC) key or provided the switch is in position 21, by removing the plug from the test jack. The operation of (DISC) key operates (DIS) relay which locks through 2 arc and steps the switch to normal. As the switch leaves position 21, ground through the winding of (SLV) relays is disconnected from the sleeve and the final selector advances, and (SLV) relay releases in turn releasing (SL1) relay. Removing the plug from the test jack, allows the final selector to restore to normal and releases (SLV) relay, in turn releasing (SL1) relay, operating (DIS) relay which locks through (2) arc and steps the switch to normal. The release of (SL1) relay extinguishes (FF-OK) lamp on "line free" tests and (I-O OK) lamp on "line busy" tests. When the switch leaves position 21, (LO) relay releases. (SLL) relay releases if not already released, (FA) relay releases where "K" wiring is used, and (B3) relay, if operated, releases, extinguishing (FB-OK) lamp. On reaching normal (DIS) relay releases, provided (DISC) key is normal, (TST) lamp is extinguished and the test circuit is normal.

5.415 Final Selector "No Test" Feature "L" Wiring

When it is desired to test the "No Test" feature, (NT) key as well as (LS-FB) or (LF-FB) key is operated, and the final selector is directed to the top test line, line 99 in the bank. The operation of (NT) key short-circuits (AV) 360 ohm resistance and shunts (FA) relay with (Z) 1170 ohm resistance or (N) 260 ohm resistance, according as "V" or "W" wiring, respectively, is used. This allows sufficient current to flow over the ring to operate the final selector (PBX) relay which is shunted by a 40 ohm resistance. The (PBX) relay should operate and cause the final selector to remain on the test line in spite of its busy condition. The operation of (NT) key also replaces the interrupted ground on the ring of (FT) jack by a steady ground. This causes the operation of (BB1) relay, extinguishing (FB-OK) lamp which lighted when (BB) relay operated.

"K" Wiring

When it is desired to test the "No Test" feature, (NT) key as well as (LS-FB) or (LF-FB) key is operated and the final selector is directed to the top test line, line 99 in the bank. The operation of (NT) key connects battery thru (I) and (Y) 426 ohm resistances in parallel with the circuit from battery thru (BA) and (AZ) resistances to the ring of (TST) jack. This should cause a relay in the final selector circuit to operate, causing the final selector to remain on the test line in spite of its busy condition. The operation of (NT) key also causes the switch to step from position 19 to position 20 and replaces the interrupter ground on the ring of (FT) jack by a steady ground. This causes the operating of (BB1) relay, extinguishing (FB-OK) lamp which lighted when (BB) relay operated.

5.5 Caution - All Types of Circuits

Care should be exercised when disconnecting the test circuit from a selector circuit to be sure that the selector circuit is restored to normal, as a selector circuit left in an off normal condition may cause a wrong connection or the loss of a call.