

CIRCUIT DESCRIPTION  
SYSTEMS DEVELOPMENT DEPARTMENT  
PRINTED IN U.S.A.

CD-239844  
Issue 24-D  
February 14, 1939  
Supplementing  
CD-239844, Issue 23-D  
Dated 3/31/37  
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PANEL SYSTEM  
SELECTOR TEST CIRCUIT  
FOR TESTING OFFICE INCOMING AND  
FINAL SELECTORS

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

- D.1 The code of the (L0) relay in Figure G is changed from  
E1979 to R1979.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 332

EBS)  
FJS)FF

PANEL SYSTEM  
SELECTOR TEST CIRCUIT  
FOR TESTING OFFICE INCOMING AND  
FINAL SELECTORS

CHANGES

A. CHANGED AND ADDED FUNCTIONS

- A.1 This circuit was changed to provide operation in areas where subscribers loop ranges extend to 1300 ohms.

B. CHANGES IN APPARATUS

B.1 Added

1 Res. 18BK - 1300 $\omega$   
1 Res. 19MB - 362 $\omega$  - 362 $\omega$   
1 Key 92B - (LRF)

D. DESCRIPTION OF CIRCUIT CHANGES

- D.1 In order to provide operation in areas where subscribers loop ranges extend to 1300 ohms "AB" wiring and apparatus were added replacing "AA" wiring. Note 24 was added covering this change.

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 interoffice and mechanical tandem incoming selectors, two-wire interoffice key indicator incoming selectors, three-wire toll key indicator incoming selectors, two-wire toll key indicator incoming selectors, repeating incoming selectors, final selectors.

- 1.2 The O.K. signals for the various classes of test are given by appropriate lamp signals.
- 1.3 This circuit is connected to the selector circuit under test by means of patching cords.

## 2. WORKING LIMITS

- 2.1 None.

## 3. FUNCTIONS

- 3.1 To make manual test of:

Three-wire office selectors, three-wire local incoming selectors, two-wire interoffice and mechanical tandem incoming selectors, two-wire interoffice key indicator incoming selectors, three-wire toll key indicator incoming selectors, two-wire toll key indicator incoming selectors, repeating incoming selectors, final selectors.

- 3.2 Test conditions imposed on the (L) relays are made to simulate service conditions by the addition of compensating resistance and bridged capacity to the fundamental circuit, or (in the case of repeating incoming selectors) by the use of special networks.
- 3.3 The hold value of the final selector (L) relay is tested.
- 3.4 The operate value of the final selector (PBX) relay is tested.
- 3.5 The incoming selectors are connected through to final multiple test lines which test the ringing, tripping and supervision.
- 3.6 The PBX hunting feature of final selectors is tested.

#### 4. CONNECTING CIRCUITS

- 4.1 Three-wire office selector and office selector test line connecting interrupted battery to the tip or ring.
- 4.2 Three-wire local incoming selector, two-wire inter-office and mechanical tandem incoming selectors, two-wire interoffice key indicator incoming selector, three-wire toll key indicator incoming selector, two-wire toll key indicator incoming selector, repeating incoming selector, and their associated final multiple test lines.
- 4.3 Final selector and associated test lines and jack circuits.

#### DESCRIPTION OF OPERATION

#### 5. APPARATUS AND FUNCTIONS

- 5.01 (RM) stepper switch is used for controlling the progress of a test, position 1 is its normal position.
- 5.02 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.
- 5.03 The resistance keys are locking. When thrown in one direction resistance only is inserted in the fundamental circuit. When thrown in the opposite direction capacity is bridged as well as resistance. These keys may be used individually or in combination.
- 5.04 (FCR) "Final Capacity and Resistance" key is locking. It is provided where fig. E is used. It may be used 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 testing incoming selectors which have no internal compensating resistance and from which the trunk conductors are disconnected.

- 5.05 (1.38-MF) key is locking. It is provided where fig. F is used. It is used in conjunction with the resistance keys when testing final selectors and incoming selectors when the trunk conductors are disconnected.
- 5.06 (ST) "Start" key is non-locking. It is used to start the test of a selector or to start a particular part of a test.
- 5.07 (A-ST) "Automatic Start" key is non-locking and a part of the same key unit as (ST) key, it is used 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.
- 5.08 (STP) "Step-by-Step" key is locking. It is used when it is desired to control a test in steps.
- 5.09 (DISC) "Disconnect" key is non-locking if a C1 type and locking if a 479 type, it is a part of the same key unit as (STP) key. It is used in restoring the test circuit to normal.
- 5.10 (TKI-D) "Toll Key Indicator-Disconnect" key is locking. It is used in disconnecting the toll key indicator incoming selectors, which require battery and ground from the trunk for disconnection.
- 5.11 (TEL) "Telephone" key is locking. It is used to connect the operator's telephone set for testing ringing induction.
- 5.12 (OBC) "Office Brush Continuity" key is locking and is part of the same key unit as (2KI) key. It is used in making brush continuity tests of office selectors. It is provided where "W" wiring is used.
- 5.13 (IBC) "Incoming Brush Continuity" key is locking. It is used in making brush continuity tests of incoming selectors. It is provided where "W" wiring is used.

- 5.14 (FBC) "Final Brush Continuity" key is locking and a part of the same key unit as (TEL) key. It is used in making brush continuity tests of final selectors. It is provided where "W" wiring is used.
- 5.15 (BC) "Brush Continuity" key is locking and a part of the same key unit as (TEL) key. It is used in making brush continuity tests of office and final selectors where "V" wiring is used. See also (OBC), (IBC), and (FBC) keys.
- 5.16 ( $\pm$ KI) "Key Indicator Ringing" key is non-locking. It is used to start the ringing in toll key indicator incomings.
- 5.17 (NT) "No Test" key is locking and a part of the same key unit as ( $\pm$ KI) key. It is used to apply the "no test" condition to a final selector.
- 5.18 (FB) "Final Busy" key is locking. It is used when testing final selectors when it is desired to simulate the condition of individual or last line of a PBX group busy.
- 5.19 (IXFF) "First P.B.X. Final Free" key is locking and a part of the same key unit as (FB) key. It is used for testing for a cross between the tip and sleeve of a final selector and imposes a condition on the sleeve of the test line making it resemble the free condition of the first or intermediate line of a PBX group.
- 5.20 (OFF) "Office" key is locking. It is used when three-wire office selectors are tested.
- 5.21 (FF) "Final" key is locking and a part of the same key unit as (OFF) key. It is used when Final Selectors are tested.
- 5.22 (2KI) "Two-Wire Key Indicator" key is locking. It is used when two-wire interoffice key indicator incoming selectors are tested.
- 5.23 (3KI) "Three-Wire Key Indicator" key is locking, and a part of the same key unit as (2KI) key. It is provided where "V" wiring is used but is never used as there are no local three-wire key indicator incomings.

- 5.24 (2WI) "Two-Wire Incoming" key is locking. It is used when two-wire interoffice or mechanical tandem incoming selectors and two-wire toll key indicator incoming selectors are tested.
- 5.25 (3WI) "Three-Wire Incoming" key is locking and a part of the same key unit as (2WI) key. It is used when three-wire local incoming selectors and three-wire toll key indicator incoming selectors are tested.
- 5.26 (L-REL) "(L) Relay Release" test key is locking. It is provided where "R" wiring is specified and operated when tests are made on repeating incoming selectors to check that the (L) relay releases quickly enough to avoid overstepping.
- 5.27 (L-HLD) "(L) Relay Hold" test key is locking. It is provided where "R" wiring is specified and operated when tests are made on repeating incoming selectors to check for ability of (L) relay to hold over worst surge.
- 5.28 (L-NO) "(L) Relay Non-Operate" key is locking. It is provided where "R" wiring is specified and operated when testing repeating incoming selectors and applies a non-operate test to the (L) relay in pos. 1, thus checking against weak (L) relay and for presence of shunt around primary winding of the (L) relay.
- 5.29 (GRD-SLV) "Ground Sleeve" key is non-locking. It is operated when making brush continuity tests of final selectors and after the final under test has arrived in talking position. It short-circuits and releases the (CO) relay, thus applying battery and ground through the line circuit (L) relay to the tip and ring for brush continuity test.
- 5.30 (REV) "Reverse" key is locking. It is operated when testing toll K.I. incomings which supply battery on the tip and ground on the ring on trunk closure; also when testing office selectors directed to test lines supplying battery on the tip and ground on the ring.
- 5.31 The 32-A test set consists of two non-locking 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 (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.

- 5.32 The (TGO) key is locking and is operated when making final selector tests to particular lines having the tip ground normally open at the cut off relay.
- 5.33 The (PLB) key is locking and is operated when making final selector tests to particular lines for busy condition.
- 5.34 Key (LRF) is locking and is operated when testing final selectors arranged to operate over subscribers loops that extend to 1300 ohms.
- 5.35 (BY) "Busy" lamp has a white cap. When testing three-wire selector circuits not equipped with combination test and make busy jacks, this lamp will light if the selector it is desired to test is busy.
- 5.36 (TST) "Test" lamp has a white cap. It is lighted all the time the test circuit is off normal.
- 5.37 (I-O OK) "Incoming and Office O.K." lamp has a white cap and gives a flashing signal indicating the proper functioning of office and incoming selectors, except interoffice key indicator incoming selectors.
- 5.38 (FF-OK) "Final Free OK" lamp has a white cap and gives a flashing signal indicating the proper functioning of a final selector in making the "line free" test.
- 5.39 (FB-OK) "Final Busy OK" lamp has a white cap and gives a flashing signal indicating the proper functioning of a final selector in making the "line busy" test.
- 5.40 (OF) "Overflow" lamp has a white cap and is used to indicate that the incoming selector has gone to overflow.
- 5.41 (KI) "Key Indicator" lamp has a white cap and gives a flashing signal indicating the proper supervision of interoffice key indicator incoming selectors.
- 5.42 (BC-OK) "Brush Continuity OK" lamp has a white cap, it lights steadily as an O.K. signal on brush continuity tests.
- 5.43 (SLV-X) "Sleeve Cross" lamp has a white cap. Its lighting indicates a cross between the tip and sleeve of a final selector.

6. CIRCUIT OPERATION

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6.5 Caution - All Types of Circuits.

6.1 General - All Types of Circuits

- 6.11 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 into 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 into 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 (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 operates. The operation of (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 (D) arc. Ground on (B) arc operates (LO) relay and lights the (TST) lamp. (LO) relay remains operated and (TST) lamp remains lighted until the completion of the test. Ground on (A) arc steps the switch to position 3.

- 6.12 Compensating Resistance and Capacity - To simulate the worst circuit conditions, and allow for a margin of safety, compensating resistance may be cut in the fundamental circuit by the operation of one or a combination of compensating resistance keys. When thrown in one direction, resistance only is inserted; when thrown in the opposite direction, capacity is bridged as well as resistance. The amount of compensating resistance and capacity should be based on the conditions that the circuit must work under, taking into account compensating resistances in the selector circuits and in the case of interoffice trunks not provided with cut-off jacks, the capacity of the cable conductors. The (FCR) key provided where fig. E is used, is primarily intended to insert a lumped resistance and capacity in the fundamental circuit when testing final selectors, when it is operated the other compensating resistance keys should be normal. Where fig. F is used, (1.38-MF) key is operated in conjunction with the resistance keys when it is desired to simulate the maximum trunk condition when testing final selectors and incoming selectors equipped with cut-off jacks or from which the trunk conductors have been disconnected. When testing final selectors when (1.38 MF) key is operated, 1300 ohms should be inserted in the fundamental circuit by means of the resistance keys. When testing incoming selectors when (1.38 MF) key is operated, the sum of the compensating resistance in the incoming and the resistance inserted by

means of the resistance keys should be 1300 ohms.

- 6.13 **Test Networks for Repeating Incoming Selectors.** Where "R" wiring and apparatus are specified, repeating incoming selectors may be tested. With (L-RKL) key operated, the incoming 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 over maximum surge. When either of these keys is operated, all compensating resistance and capacity keys should be normal. If, in addition to one of the above keys, (L-NO) key is operated, a non-operate test will be applied to the repeating incoming (L) relay, and the incoming should not advance to position 2 until (L-NO) key is released. If the incoming does advance before (L-NO) key is restored, it indicates a weak (L) relay or else an (L) relay with no shunt.

## 6.2 Three-Wire Office Selectors

- 6.21 **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. When "W" wiring and apparatus is used (REV) key should be operated if the office selector is to be directed to a test line having battery on the tip and ground on the ring. Otherwise it should be left normal. Compensating resistance keys are operated as described in paragraph 6.12. (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 through the break contact of (SLO) relay steps the switch to position 6. Ground on (C) 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) relay operates, in turn operating (SLO) relay, stepping the switch to position 10.

## 6.22 Office Brush Selection

With the switch in position 10, the fundamental circuit for office brush selection is established. This circuit is from battery through the office selector (L) relay, the tip of (TST) jack, make contact of (LO) relay; back contact (RI) relay if "R" wiring is used, compensating resistance

keys, (E) arc, windings of (OF) and (STP) relays, break contact of (BO) relay, break contact of (T) relay if "V" wiring is used, back contact (TEL) key if "Y" wiring is used, compensating resistance keys, back contact (RI) relay, (L-HLD) and (L-NO) keys if "R" wiring is used, break contact of "FF" key, make contact of (LO) relay, ring of (TST) jack to ground in the office circuit. (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 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 office selector continue until (O) counting relay operates. When (STP) relay releases (FO) and (BO) 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) relay, 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 (ST-1) relay, allowing it to operate and step the switch to position 12.

- 6.23 Office Group Selection In position 12 (C) relay operates, 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) relay, in turn releasing (SLO) relay and the counting relays.

- 6.24 Office OK Signal. In position 14, 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. Ground through (C) arc and make contact of (OFF) key steps the switch from position 15 to position 17, and ground through the break contact of (SLO) relay steps the switch to position 18, ground through (C) arc stepping it to position 19. As the switch advances from position 18 to position 19 the direct ground on the sleeve of (TST) jack from (D) arc is replaced by ground through the 45 ohm resistance and the winding of (SLV) relay and battery thru the 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 20, (I-O OK) lamp remains lighted until the office circuit has completed trunk hunting and advances to its talking position. In position 20 (S) relay, in series with the compensating resistance is bridged across the tip and ring.

"V" Wiring - The (S) relay is polarized so that it should operate if the office test line supplies battery on the tip and ground on the ring. Since the battery is interrupted, the (S) relay should operate and release, flashing (I-O OK) lamp as a signal that the proper selections have been made.

"W" Wiring - The (S) relay is polarized so that with (REV) key normal it should operate if the office test line supplies battery on the ring and ground on the tip. If (REV) key is operated and the test line supplies battery on the tip and ground on the ring, (S) relay should also operate. In either case, the operation and release of (S) relay under control of the test line interrupter should cause (I-0 OK) lamp to flash as a signal that the proper selections have been made.

6.25 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.

"V" Wiring - (S) relay will not operate and (I-0 OK) lamp remains lighted in position 20 until disconnection.

"W" Wiring - When (REV) key is normal (S) relay will operate and (I-0 OK) lamp will not be lighted. When (REV) key is operated (S) relay will not operate and (I-0 OK) lamp will remain lighted in position 20 until disconnection.

6.26 Office Selector Brush Continuity Test

"V" Wiring - When it is desired to test the continuity of brushes 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 20. (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) relay operated in turn operates (CS-1) relay, which locks under control of (OFF) and (DISC) keys, lights (BC-OK) lamp, and operates (DISC) relay. (DISC) 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 20. (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 (DISC) relay. (DISC) 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 immediately released, 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 20 and there should be no lamp indication.

6.27 Office Disconnection. Removing the plug from the test jack allows the office circuit to advance to normal and releases (SLV) relay in turn releasing (SL-1) relay, extinguishing (I-0 OK) lamp and operating (DISC) relay provided the switch is in position 20. (DISC) relay locks through (B) arc, releasing (ST) and (ST-1) relays if operated, and steps the switch to normal. On reaching normal (DISC) 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 (DISC) 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 (CS-1) or (AV) relay is locked under control of (DISC) key.

### 6.3 Incoming Selectors

6.31 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 keys are operated as described in paragraph 6.12. (IBC) key is operated where "W" wiring is used if it is desired to make an incoming brush continuity test on a brush not having access to a final multiple test line. The following keys are operated depending on the type of incoming selector to be tested:-

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

Two-wire interoffice and mechanical tandem incoming selectors, (2WI) key.

Two-wire toll key indicator incoming selectors, (2WI) 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 interoffice key indicator incoming selectors - (2KI) key.

Repeating incoming selectors - (L-REL) or (L-HLD) keys, also (L-NO) if desired. These keys appear only in circuits equipped with "R" wiring and apparatus. For function of these keys see paragraph 6.13. 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 ( $\pm$ ) 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) relay operated from ground through (C) arc, through the break contact of (OFF) and (FF) keys. This operates (SLO) relay; stepping the switch to position 4.

#### 6.32 Incoming Brush Selection

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

"S" Wiring - This circuit is from battery thru the incoming selector (L) relay, the tip of (TST) jack, make contact of (LO) relay, compensating resistance keys, (E) arc, break contacts of (FF) and (OFF) keys, windings of (OF) and (STP) relays, break contact of (BO) relay, break contact of (T) relay where "V" wiring is used, compensating resistance keys, break contact of (FF) key, make contact of (LO) relay, ring of (TST) jack to ground in the incoming circuit.

"R" Wiring - This circuit is from battery thru the incoming selector (L) relay, the tip of test jack, make contact of (LO) relay, contacts (RI) relay, thru repeating incoming (L) relay release test network if (L-REL) key is operated, thru compensating resistance keys (which should all be normal if (L-REL) or (L-HLD) keys are operated, (E) arc, break contacts of (FF) and (OFF) keys, windings of (OF) and (STP) relays, break contact of (BO) relay, compensating

resistance keys (which should all be normal if (L-REL) or (L-HLD) keys are operated), contacts (RI) relay, contacts (L-HLD) key, thru repeating incoming (L) relay hold test network if (L-HLD) key is operated, thru repeating incoming (L) relay non-operate test resistances if (L-NO) key is operated, contacts of (L-NO) key is normal, break contact (FF) key, make contact of (LO) relay, ring of (TST) jack to ground in the incoming circuit.

"R" or "S" Wiring - (STP) relay operates, but (OF) relay, being polarized, does not. (STP) relay operated, connects ground through 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 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 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) relay, 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.

### 6.33 Incoming Group Selection

In position 6, (C) relay operates, 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 (ST-1) relays if operated are released, and the switch is stepped to position 8, releasing (C) relay 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 9. If (STP) key is operated, the advance of the switch out of position 8 is under control of (ST) key the same as in position 5.

#### 6.34 Final Selections

In position 9, (C) relay operates, 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 selection; after final brush selection (FO) and (BO) relays operate, releasing (ST) and (ST-1) relays, if operated, and stepping the switch to position 11, releasing (C) relay, 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) relay operates 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 (ST-1) relays, if operated, and stepping the switch to position 14, releasing (C) relay, 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) relay operates, 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 (ST-1) relays, if operated,

and stepping the switch to position 17, releasing (C) relay, 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) relay operates in turn operating (SLO) relay.

### 6.35 Reverse Battery

In position 18 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 (OF-1) 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 19, extinguishing (OF) lamp, and releasing (C) relay, in turn releasing (SLO), (O), (BO) and (FO) relays.

### 6.36 (SLV) Relay Operation

- A. **Three-Wire Incomings:** As the switch steps from position 18 to position 19, the direct ground on the sleeve of (TST) jack from (D) arc is replaced by ground through the 45 ohm resistance and the winding of (SLV) relay and battery thru the 1200 ohm resistance and the winding of (SLV) relay. (SLV) relay will operate from the direct ground on the sleeve, of the incoming circuit. When the incoming selector (L) relay operates, the incoming selector advances, removing the direct ground from the sleeve and (L) relay locks over the sleeve in series with (SLV) relay to ground in the test circuit. (SLV) relay operated in turn operates (SL-1) relay. (SL-1) relay operated, lights (I-0 OK) lamp and steps the switch to position 20.
- B. **Two-Wire Incomings:** In position 19, ground from (B) arc, through the make contact of (2-WI) or (2-KI) key, through (D) arc operates (SLV) relay in turn operating (SL-1) relay. (SL-1) relay operated, lights (I-0 OK) lamp and steps the switch to position 20.

## 6.37 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 paragraphs.

- 6.371 Three-Wire Local Incoming "V" Wiring: Ground through the make contact of (3-WI) key steps the switch from position 20 to position 21. In position 21, (T) relay operates from ground on (C) arc. (S) relay in series with the compensating resistance is bridged across the tip and ring. "W" wiring: (S) relay in series with compensating resistance is bridged across the tip and ring in position 20. In either case the incoming (L) relay will operate and it will advance to its ringing positions. (S) relay does not operate at this time as its circuit is open. The line to which the final selector should connect is arranged to test automatically the ringing, tripping and supervision of the incoming circuit. By operating (TEL) key, the tester can listen to the ringing induction. (I-O OK) 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 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 operating (DISC) relay provided the switch is in position 20 or 21. (DISC) relay locks through (B) arc, and steps the switch to normal. (T) relay (operated where "V" wiring is used) releases on leaving position 21. On reaching normal (DISC), (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 (DISC) 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.

### 6.372 Two-Wire Interoffice and Mechanical Tandem Incoming "V" Wiring

Ground through the make contact of (2 WI) key steps the switch from position 20 to position 21. In position 21, (T) relay operates from ground on (C) arc. "W" wiring: The switch remains in position 20. With either wiring the (S) relay in series with the compensating resistance is bridged across the tip and ring. This operates the trunk supervisory relay in the incoming selector, advancing it to its ringing positions. The direction of the current 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. By operating (TEL) key 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 (DISC) relay, which locks through (B) arc and steps the switch to normal. (T) relay (operated where "V" wiring is used) releases on leaving position 21. As the switch leaves the supervisory test position, 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 (OFL) relays release, and (TST) lamp is extinguished and, provided (DISC) key is normal (DISC) 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 re-

store the test circuit to normal.

### 6.373 Three-Wire Toll Key Indicator Incoming "V" Wiring

Ground on the make contact of (3WI) key steps the switch from position 20 to position 21. In position 21 (T) relay operates from ground on (C) arc. "W" wiring: The switch remains in position 20. With either wiring, 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 bridging across the tip and ring in series with the compensating resistances. The operation of (S) relay extinguishes (I-O OK) lamp, indicating that the incoming circuit is ready for ringing. The tester operates ( $\pm$  KI) key, disconnecting (S) relay from the trunk and connecting ringing current to the trunk. (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, starting the ringing, which continues automatically. When the ( $\pm$  KI) key 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. By operating (TEL) key 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 releases (SLV) relay in turn releasing (SL1) relay, extinguishing (I-O OK) lamp and operating (DISC) relay provided

the switch is in position 20 or 21. (DISC) relay locks through (B) arc and steps the switch to normal. (T) relay (operated where "V" wiring is used) releases on leaving position 21. On reaching normal (DISC), (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 (DISC) 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 to restore to normal.

#### 6.374 Two-Wire Toll Key Indicator Incoming "V" Wiring

Ground on the make contact of (2WI) key steps the switch from position 20 to position 21. In position 21, (T) relay operates from ground on (C) arc. "W" wiring: The switch remains in position 20. With either wiring, the (S) relay in series with the compensating resistance is bridged across the tip and ring. This operates the trunk supervisory relay in the two-wire toll key 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 ( $\pm$  KI) key, disconnecting (S) relay from the trunk and connecting ringing current to it. (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, starting ringing, which continues automatically. When ( $\pm$  KI) key 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. By operating (TEL) key 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. Before removing the plug from the test jack on disconnection, disconnect supervision must be given to the two-wire toll key indicator incoming selector by the operation of (TKI-D) key. This causes the incoming to advance to its awaiting release position and connects battery to the tip side of the trunk through a resistance and ground to the ring side of the trunk, operating the trunk supervisory relay, restoring the incoming circuit to normal. This key should be held operated until the down drive starts. The operation of this key also operates the (DISC) relay which locks through (B) arc and steps the switch to normal. (T) relay (operated where "V" wiring is used) releases on leaving position 21. 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 (TKI-D) key is normal (DISC) relay releases.

6.375 Two-Wire Interoffice Key Indicator Incoming. When the test circuit steps to position 20, (KI) relay operates from ground on (C) arc through the make contact of (2KI) key. The operation of (KI) relay lights (KI) lamp, connects ground through resistances to the tip of the trunk and connects battery to the ring of the trunk through the winding of (KIS) relay. 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 through 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. (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 (DISC) relay, which locks through (B) arc and steps the switch to normal. As the switch leaves position 20, (KI) relay releases, extinguishing (KI) lamp and releasing (KIS) relay and the incoming trunk supervisory relay, causing the incoming selector to restore to normal. When the test switch reaches the normal position (SLV) and (SLI) 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, (DISC) 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.

- 6.376 Repeating Incoming Selectors - The test of these circuits in trunk closure position and beyond is the same as for the corresponding non-repeating incomings.
- 6.38 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) or (KI) 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 and a key in (THOUS) and one in (HUND) row to direct the selector to the bank and group that it is desired to test. No. 1 final brush should be tripped regardless of which key is operated in (HUND) row. Keys in (OFF. GR.) and (FINAL UNITS) 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 and the final will get no closure for tens selection at this time. 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 to position 17 and from position 17 in the regular manner to position 18, where the fundamental circuit is closed but with no counting relay operated. The final should ride to tell-tale in tens selection position and send the incoming to its reverse battery position. When the test circuit receives reverse battery, (OF) and (OF1) relays operate, operating (O), (BO), and (FO) relays, stepping the switch to position 19, where (BC-OK) lamp lights as an indication of satisfactory incoming brush continuity. The switch advances to position 20 from ground on the front contact of (SL1) relay, and remains there 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.

- 6.39 Incoming Selector Overflow - If during trunk hunting, all the trunks are busy, or if the selector has understepped on group selection, the incoming selector goes to overflow. When the test circuit reaches position 10, the fundamental circuit is closed for final brush selection, but 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 an indication of overflow and the test circuit remains in position 10 until it is restored to normal.

## 6.4 Final Selectors

6.401 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.

If it is desired to simulate the maximum trunk condition as regards resistance and capacity, where fig. E is used (FCR) key should be operated with all the resistance keys normal and where fig. F is used (1.38 M.F.) key should be operated and resistance keys should be operated to insert 1300 ohms in the fundamental circuit. When it is desired to make tests without capacity, the resistance keys only should be operated.

(FF) 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 (FB) key is operated. To make a "no test" call (NT) and (FB) keys are operated. To test for a cross between the tip and sleeve (IXFF) key is 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. When making final brush continuity tests where "W" wiring is used, patch (D) jack of the test set to (D) jack of the test final selector and operate (FBC) key; where "V" wiring is used, operate (BC) key. The test circuit functions as described in paragraph 6.11 until position 3.

Ground on (C) arc through the make contact of (FF) 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 (C) arc, through the make contact of (FF) 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) relay operates, in turn operating (SLO) relay, stepping the switch to position 10.

6.402 Final Brush Selection. With the switch in position 10, the fundamental circuit for final brush selection is established. This circuit is from battery through the final (L) relay, the tip of (TST) jack, make contact of (LO) relay, compensating resistance keys, arc (E), winding of (OF) and (STP) relays, break contact of (BO) relay, break contact of (T) relay where "V" wiring is used, compensating resistance keys, make contact of (FF) key to ground. (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) relay, 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.

- 6.403 Final Tens Selection. In position 12, (C) relay operates, in turn operating (SLO) relay, stepping the switch to position 13. With the switch in 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) relay, 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.
- 6.404 Final Units Selection. In position 15, (C) relay operates, 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) relay, in turn releasing (SLO) relay and the counting relays. Ground through the break contact of (SLO) relay steps the switch to position 18. The fundamental circuit is closed in position 18, in order to advance the Kansas City final selectors. Ground through (C) arc steps the switch to position 19.
- 6.405 Sleeve Relay Operation. As the switch steps from position 18 to position 19, the direct ground on the sleeve of (TST) jack from (D) arc is replaced by ground through the 45 ohm resistance

and the winding of (SLV) relay and battery thru the 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 (SLL) relay. (SLL) relay operated, steps the switch to position 20.

#### 6.406 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 (FB) key is not operated.

When the final (L) relay releases on leaving the testing position, battery through 220 ohms is connected to the sleeve, through the sleeve of (FT) jack, break contacts of (FB) and (IXFF) keys, 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 (TST) jack, ring conductor of final selector, ring of (FT) jack, break contact of (DISC) key, sleeve of (INT) jack, to ground through an interrupter, flashing (FF-OK) lamp.

#### 6.407 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 (FB) key is not operated. The selector will stop on line 97 on units selection. Battery through 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 its sequence switch should advance, connecting battery through 220 ohms to the sleeve. From this point on the operation is the same as for "Individual Line Free Test".

#### 6.408 Individual Line Busy Test

(FB) key is operated when the action of a final selector, directed to a busy line is to be tested. The operation of (FB) key disconnects (SLL) relay from the sleeve of the test line and connects battery through a resistance in its place.

After units selection the final selector makes a busy test, connecting ground through the winding of (PBX) and (TB) relays to the sleeve of the line, the circuit being completed through the sleeve of (FT) jack through the make contact of (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 19, (BB) relay operates and locks through (B) arc, and (SLI) relay operates, stepping the switch to position 20. 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 (BBI) relay, in turn flashing (FB-OK) lamp. (I-O OK) lamp which lighted on the operation of (SLI) relay remains lighted during this test.

#### 6.409 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 (FB) key is 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".

#### 6.410 Final Brush Continuity Test

The brushes on banks not having access to test lines may be tested in the following manner: Where "W" 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 elevator 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 P.B.X. 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 P.B.X. line, the final should hunt off it and the test man 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 P.B.X. 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" wiring: The tester then operates (GRD-SLV) key. In either case, this will short-circuit and release (CO) relay in the line circuit, 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 not operate providing the tip and ring multiple brushes are making contact and there is no break in the tip and ring conductors. (CS) relay operated, operates (CS1) relay, lighting (BC-OK) lamp.

With "K" wiring the operation is the same as above except that the advance of the switch from position 18 to position 19 is controlled by the operation of (FO) relay. When the final selector advances after units selection, the fundamental circuit is again closed for final advance; this operates (STP) relay in turn operating (O) counting relay through the make contact of (BC) relay. When the final advances and opens the fundamental circuit (STP) relay releases, removing the short circuit around (BO) and (FO) relays which operate. (BO) relay operated, opens the fundamental circuit and (FO) relay operated steps the switch from position 18 to position 19.

6.411 Test of Final Selectors to Particular Lines. ("X", "Y" and "W" Wiring, "X" Apparatus and Fig. G)

The particular line idle test is made as described for final brush continuity test. 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 (FBC) key should be normal. 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 19 the (SLV) relay operates operating the (SL1) and (BB) relays. The (SL1) relay operating advances the stepping switch to position 20 and lights the (I-O OK) lamp. The (BB) relay operating locks to ground from the (B) arc of the (RM) selector 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.

#### 6.412 Hold Test of Final (L) Relay

The hold of the final (L) relay may be tested on disconnecting after a "line free" test. The operation of (DISC) key, operates (DISC) relay, which locks through (B) 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 resistances are bridged across the tip and ring of (FT) jack forming a holding path for the final selector (L) relay. (BY) lamp remaining lighted indicates that the final selector (L) relay is holding.

Where final selector circuits are tested which are arranged to function over subscriber loop ranges that extend to 1300 ohms, key (LRF) ("AB" apparatus) is operated. Key (LRF) operated bridges resistances 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 selector (L) relay.

Where 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 selector (L) relay.

On finals having a time measure release feature, the (L) relay 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 opens the holding circuit permitting the final (L) relay to release, restoring the final selector to normal, removing ground from the incoming sleeve releasing (T) relay and extinguishing (BY) lamp.

#### 6.413 Final Disconnection

If it is not desired to test the hold of the final (L) relay, disconnection is accomplished either by operating the (DISC) key or provided the switch is in position 20, by removing the plug from the test jack. The operation of (DISC) key operates (DISC) relay which locks through (B) arc and steps the switch to normal. As the switch leaves position 21, ground through the winding of (SLV) relay 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 releasing (SLL) relay if operated and releases (SLV) relay, in turn releasing (SL1) relay, operating (DISC) relay which locks through (B) 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" test. When the switch leaves position 21, (LO) relay releases, the (BB) relay, if operated, releases, extinguishes (FB-OK) lamp. On reaching normal (DISC) relay releases, provided (DISC) key is normal, (TST) lamp is extinguished and the test circuit is normal.

#### 6.414 Final Selector "No Test" Feature

When it is desired to test the "No Test" feature, (NT) key as well as (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 to the ring through a 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.

#### 6.415 Tip Sleeve Cross Test

When it is desired to test to determine whether the tip and sleeve are crossed, (IXFF) key is operated and the final selector is directed to the test line.

The operation of (IXFF) key also connects ground through the 100 ohm winding of (SLL) relay to the sleeve of (FT) jack instead of ground through both windings in series. Battery through 220 ohms in the final selector operates (SLL) relay, causing (CS) relay to operate, 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.

### 6.5 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.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 332

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