Western Electric Company, Inc.,
Equipment Engineering Branch,
Hawthorne.

Issue 1 - BT-52003-01.
July 16, 1923. (*)

This Method of Operation sheet made from ST-52003-01 Issue 5.

METHOD OF OPERATION

For Automatic - Routine Test of Final Selectors - Final Selector Test Frame - Panel Machine Switching System.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

1.1 This circuit is designed to test automatically final selector circuits in a full mechanical office. The circuit is arranged to test only adjacent groups of final circuits on an incoming bank. From one to four groups of selectors on the same bank may be tested when the incoming elevator is sent up. When non-adjacent groups of final selectors are to be tested, the incoming selector elevator is sent up as many times as there are groups to be tested. The cross connection of the (I) switch together with the associated terminal strip determines the number of times the elevator is sent up to complete the test on all groups in a frame.

2. WORKING LIMITS

2.1 This circuit is used when the voltage limit of the battery is from 24 to 25 volts and from 48.5 to 50 volts. The values of the several resistances incorporated in the circuit are such as to impose worse loop conditions upon the relays in the final selector circuit under test.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are as follows:

3.1 To make a particular selection in the final multiple, thereby using all the apparatus incorporated in the selector circuit and to return the final selector and sequence switch to normal, upon the successful conclusion of the test. Since the test will not proceed in the case of trouble in either the test circuit or the final selector circuit under test, the successful test of the final circuit is used as an O.K. signal to advance the test circuit to the next final selector.

3.2 This test circuit connects to local incoming selectors, (the elevators of which are controlled by the test circuit) to obtain access to the various final circuits to be tested. When they are not being used for test purposes, the incoming selectors are used in regular traffic. When used for test purposes, the incoming selector sequence switches do not move out of position 1, the elevators only being used. The movement of the elevator is controlled by the test circuit, causing it to test the proper group of final selector circuits.

3.3 The operation of the single key causes the circuit to test automatically all final selector circuits, even if they are not arranged in adjacent groups. The particular kind of test that is made is dependent upon the position of a sequence switch in the test circuit. The test circuit proceeds to test from frame to frame as required. The circuit is arranged to permit the elevator to pass over intermediate overflow terminals and only be returned to normal when the final overflow terminal of a series of groups has been reached. Should the test circuit find busy a particular incoming elevator, which it is to use, it waits until the elevator is restored to normal before proceeding with the test. If a final selector circuit is busy, the test circuit holds up the test for a reasonable length of time until the selector is restored to normal.

3.4 The circuit is equipped with an alarm which operates when insufficient time is left after a selector circuit has been discharged from routine service to complete a routine test upon a final circuit. An alarm is also operated, in case trouble arises either in the test circuit or in the final selector circuit.

3.5 The circuit is equipped with registers which count the number of single tests as well as the number of multiple tests, the number repeat tests made whether on a single test or multiple test basis, the number of busy terminals skipped by means of (MPB) or (APB) keys and the number of times trouble is found.

4. START KEY

The operation of this key start the automatic test which continues until all final selectors circuits have been tested. If other keys are operated, the operation of this key starts the particular circuit as determined by the keys operated. The release of the key at any time, stops the test.

5. TIME MEASURE RELEASE KEY (TMR)

The operation of this key causes the circuit to test the time measure release feature of a final circuit. When not operated, the test circuit skips this test and proceeds to the final selector circuit.

6. RETURN TO NORMAL KEY (RN)

The release of the (ST) key and the operation of this key causes all equipment to restore to normal.

7. CONTROL ADVANCE KEY (CA)

This key is operated when either the test circuit fails to complete a cycle due to a fault in itself or in the circuit under test. The operation of this key, advances the control circuit, but the circuit will not continue to resume its operation until the key is released. The key should not be restored until the control switch reaches position 16 and when the final circuit is to be made busy until the final has actually been made busy.

8. REPEAT KEY (REP)

The operation of the repeat key causes the test circuit to repeat on the final selector circuit under test until the key is released. A single repeat test is made by momentarily operating the key.

9. AUTOMATIC PASS-BY AND MANUAL PASS-BY KEY. (APB) AND (MPB)

The operation of the (APB) key causes the test circuit to automatically pass over the final terminals, testing busy. The operation of the (MPB) key steps the elevator from a busy final terminal to the next terminal which may or may not be busy. The test does not proceed until the key is restored to normal.

10. END OF CYCLE KEY (EC)

The operation of this key at the end of one completed cycle, causes the test circuit to start another cycle of tests.

11. PARTICULAR CIRCUIT (PC) KEY

The operation of this key in combination with other keys numerated below, causes the apparatus to make a test upon a particular group or groups of final circuits. However, the actual test does not proceed until the key is released.

12. MULTI-TEST KEY (MT)

The operation of this key causes seven or eight different tests to be made upon the final circuit. When normal, only one test is made on each final circuit. The one test made demands upon the position of the sequence switch in the test circuit. The switch is set manually to the position of the desired test when the (MT) key is normal.

13. This circuit is provided with special keys whic , when operated, causes the circuit to make an automatic test on the particular group or groups of final selectors, that is any group or series of groups of final selectors in any frame may be chosen at will. The test circuit is provided with units key (0 to 19 inclusive) and tens (T) key, ten to the particular (U) key depressed; twenty keys (TWA, TWB, TWC, etc.) each of which controls a particular incoming selector switch; group number (GN) keys to (0 to 3 inclusive) to guide the incoming elevator to the particular group to be tested; and overflow count (OC) keys, (0 to 3 inclusive) to determine the number of overflow terminals to be passed before the selector is restored to normal. As mentioned under paragraph 12 the type of test made on the final selector depends upon the position of the (R-3) switch in the test circuit. The following table shows the position of this sequence switch for any particular type of test, together with the number in the final frame to which the final selector is driven.

Position of (R-3) sequence switch.	Number to which is directed.	Conditions imposed on - line.
1	99	Individual line idle.
3	99	Individual line busy.
5	99	PBX Line Idle. (first of group)
7	97	Idle PBX Line (last of group)
9	97	Hunt Busy PBX Line (last of group)
11	97	Hunt Idle PBX Line (intermediate)
13	99	No test feature (individual line)
15	99	Time Measure release

14. CONNECTING CIRCUITS

This circuit functions with any standard local incoming selector circuit which in turn connects with a standard final selector circuit. Also ES-261092.

DESCRIPTION OF OPERATION

15. ROUTINE TEST

An automatic test is started upon all final selector circuits with the operation of the (ST) key. The (ST) key operated, closes a circuit from ground through the contacts of the key and upper contacts of the O cam associated with the connector switches to the (ST) relay, which operates. Should any connector be off normal, this circuit is open preventing the operation of the (ST) relay. The (ST) relay operated locks after the operation of the (CON) relay to ground on the (ST) key. The (ST) key operated, also closes a circuit from ground over the (STG) lead through the contacts of the (ST) relay, (EC) key (TW) keys, N terminal and brush (I-A1) of the (I-A) switch, break contact of the (TRA) relay, to battery through the break contact and winding of the 1-A selector magnet, energizing the magnet. Ground is also connected from the (ST) relay to the (T) relay, which however, does not operate on account of being shunted by ground through brush (I-A1) of the (I-A) switch. The energized selector magnet opens its operate circuit and release, stepping the brush of the (I-A) switch to terminal 1. When this terminal is wired for a final test, ground is not connected to it and the (T) relay operates through the battery through the (I-A) selector magnet. The selector magnet does not operate in series with the (T) relay on account of the high resistance. If terminal 1 of the (I-A1) switch is not wired for a test, ground is connected to that terminal, causing the associated selector magnet to energize and step the brush to a terminal to which no ground is connected. The operation of the (T) relay connects ground to the (CON) relay which operates and locks to the (ST) key, in turn operating the (RN) relay. The operation of the (RN) relay closes a circuit ground from the break contact of the (RN-1) relay make contact of the (RN) relay, (EC) key, brush and terminal 1 of the (I-A6) switch, cross connection of terminal strip 6, over lead 1, contact of cam P of the last connector switch in the equipment of the circuit, cam (B-1A), to the (R-1A) magnet, advancing the switch to position 2, and (E) operates the (RN) relay (See paragraph 50).

16. When more than one connector is required to test all the incoming circuits in an exchange, each succeeding connector cannot be moved out of normal until the preceding one used is restored to the normal position. For instance, it is assumed that the second connector shown in the schematic is the last of a series of connector units, connector 1 can only be moved out of position 1 or 10 after the last connector is restored to position 1 or 10. The circuit for restoring the last connector or any succeeding connector to the one required for the test, is from ground through the make contact of the (CON) relay, brush 6 and some terminal of an (I) switch, cross connection of the associated terminal strip 6, contacts of cam P of the last connector unit used to cam (C) of the connector.

then to the (R) magnet, advancing the connector unit to position 1 or 10. If one of the connector units is not returned to normal, the circuit ceases to function and an alarm operates as hereinafter described.

17. BUSY TEST OF INCOMING SELECTOR

With the (R-1A) switch in position 2, a circuit is closed through the 400 ohm winding of the T1 relay, contacts of cam (K-2), and (R-1A), cross connection of the terminal strip 5, terminal 1 and brush (I-A5), to battery on the (T) relay, operating the T1 relay. The operation of the T1 relay closes a circuit through cam C to the (R-2) magnet, advancing the sequence switch to position 2. With the (R-1A) and the (R-2) switches in position 2, the incoming selector assigned for test purposes is tested by the automatic test circuit to find whether it is busy on routine service. As long as the incoming selector circuit is busy, the T1 relay is held from battery on the contacts of the (T) relay, through brush 5 and terminal 1 of the (I-A) switch, cross connection of terminal strip 5, lead 1, cams (R-1A) and (K-2), 900 ohm winding and make contact of the T1 relay to ground at the incoming selector circuit over the (TK-1) lead. When the incoming selector circuit becomes idle and returned to normal, ground is removed from the (TK-1) lead. The (BIS) relay operates from battery on the (T) relay over the (TY-1) lead to ground on the Y commutator brush and segment to the incoming circuit. The operation of the (BIS) relay releases the T1 relay. The function of the (BIS) relay is to hold the T1 relay operated through its 400 ohm winding in case ground is removed from the (TK-1) lead due to an unguarded interval in a local incoming selector circuit after it has been released by the district and before the elevator is restored to normal. The release of the T1 relay under this condition, would cause the test selector to seize the selector before its return to normal, causing current to be applied to the (UP) magnet, by the test circuit at the same time current is supplied to the (DOWN) magnet by the local selector circuit. The operating circuit of the T1 relay through its 400 ohm winding is operated when the (R-2) switch advances out of position 1/1-1/2. The release of the T1 relay closes a circuit from ground on cam F, break contact of the relay to the (TK-1) lead, holding the incoming busy to other incoming busy selectors and also closes a circuit from ground through its break contact to cam (C-2), advancing the (R-2) switch to position 3.

18. SETTING INCOMING CONTROL SWITCH

With the (R-2) switch in position 3, ground on cam (E-2) is connected through the make contact of the (ST) key, break contact and winding of the 200-L selector magnet (IC), energizing the magnet. The operation of the magnet opens its energizing magnet, causing it to release and step the brush of the (IC) switch to terminal 1 or other odd-numbered terminals,

depending upon the cross connection of terminal strip 4.

19. With the scheme of cross connection shown on the drawing and with the brushes of the (I-A) switch resting on terminal 1, groups 0 to 3 inclusive in the first frame are tested. As determined by the cross connection of the (I-A) switch and terminal strip 4, the (IC) magnet is shunted when its brush assembly rests on terminal 1. This circuit is from ground through the contacts of the (PC) key, brush 4 and terminal 1 of the (I-2) switch, cross connection of terminal strip 4, over lead 4 to terminal 1 of the (IC) switch. The position of the (IC) switch determines the number of overflow terminals, the incoming elevator must pass by before it is restored to normal. On the setting just made, the incoming elevator returns to normal when the elevator brushes have stepped to the fourth set of overflow terminals.

20. Also with the (R-2) switch in position 3, a circuit is closed from cam (C-2) to the (TF) relay, which operates. The operation of the (TF) relay opens the operating path for the (TR) relay thereby holding the tip and ring open. The (R-2) switch is advanced to position 4 from ground on the break contact of the (O') relay to cam (D-2).

21. INCOMING BRUSH SELECTION

The incoming brush selection is determined by the cross connection of terminal strip 2. With the scheme used in the drawing, and with the (I-A) switch resting on terminal 1, the (O) brush of the first incoming elevator is selected. In position 4 of the (R-2) switch a circuit is closed from ground on cam H2 through cam (C-1A) to the (R-1A) magnet moving the switch to position 3. In position 3, connector 1 is connected through the cuttings of its cams to the incoming elevator which is held busy to other hunting incoming selectors by ground through the break contact of the (PG) relay. Also in position 3, a circuit is closed from ground through the break contact of the (O') relay, contact of cam (D) on (R-2), over lead (TU-1) to battery through the (UP) magnet in the incoming selector circuit. The incoming elevator moves upward under control of the ('P) magnet and ground is connected from the (A) commutator brush and segment over lead (TA-1), contacts of cam (N-2), brush 2 and terminal 1 of the (I-A) switch, cross connection with terminal strip 2, lead (O), thru the back contact of the (O^2) relay to the (O) relay which operates. The (O) relay connects its winding in series with the winding of the (O') and (O^2) relays, but the (O') and (O^2) relays do not operate as they are shunted at this time by ground. When the brush of the incoming elevator makes contact with an insulated segment of the "A" commutator bar, ground is removed from one side of the (O') and (O2) counting relays, allowing both to operate. The (O2) relay operated,

holds the (O) lead open. The (O') relay operated, closes a circuit through cam (C-2) to the (R-2) magnet, advancing the switch to position 5. The operation of the (O') relay disconnects ground from the (TU-1) lead, stopping the (UP) drive of the incoming selectors. When the (R-2) switch advances out of position 4½, the operating circuit for the (O2), (O') and (O) relays is opened at cam (R), releasing the relays. When the (R-2) switch advances out of position 4, the circuit over the (TU) lead is opened at cam (D-2) preventing the (UP) magnet in the incoming selector circuit from operating to ground on the break contact of the (O') relay. With the (R-2) switch in position 5, a circuit is closed from ground on cam (F-2), over the (TM-1) lead to battery through the (TRIP) magnet in the incoming circuit, energizing the magnet. Also a circuit is closed from ground on the break contact of the (O') relay to cam (B-2), advancing the (R-2) switch to position 6.

22. INCOMING GROUP SELECTION

With the (R-2) switch in position 6, a circuit is closed from the break contact of the (O') relay, over the (TU-1) lead, to battery through the (UP) magnet in the associated incoming circuit, moving the selector upward for group selection. As the district elevator is moved upward under control of the (UP) magnet, intermittent ground from the (B) commutator brush and segment in the circuit is connected over the (TB-1) lead through the contacts of cams (O), (L-IA) and (M-2) through the (PC) key, brush 3 and terminal 1 of the (I-A) switch, cross connection of terminal strip 3, over lead (O) to the (O) relay, operating the relay. The (O) relay operated, connects its winding in series with the windings of the (O') and (O2) relays which operate in parallel when the (B) brush of the incoming elevator makes contact with an insulated segment of the commutator, removing ground from one side of the (O') and (O^2) relays. The (O') and (O2) relays operated, (a) open the circuit through the (UP) magnet on the incoming selector circuit, stopping the upward movement of the selector, and (b) advances the (R-2) switch to position 7. As the switch advances the (R-2) switch to position 6, the operating circuit for the (O), (O') and (O^2) relays is opened at cam (I), releasing the relays.

23. BUSY TEST OF FINAL CIRCUIT.

When the (R-2) switch advances out of position 6, the operating circuit for the (TF) relay is opened at cam (G-2), releasing the relay if the final selector is idle. If the final selector circuit is busy, the (TF) relay is held operated from battery on the (I-2) cam in position

6¾/7, through its 800 ohm winding, the (MPB) and (APB) keys, contacts of the (TF) relay, contacts of the (CA) key, break contacts of the (TKR) and (NT) relays, (TS-1) lead to ground on the sleeve terminal of the busy final selector circuit. If the final circuit is idle or becomes idle, the holding circuit of the (TF) relay is opened, releasing the relay. The release of the (TF) relay operates the (TR) relay from ground on the (ST) key, through the break contact of the (ZC) relay, brush 6 and terminal 1 of the (IC) switch, through the contacts of the (TF) relay, to the winding of the (TR) relay. The operation of the (TR) relay connects the (TT-1) and (TR-1) leads through its make contacts to the sender portion of the test circuit, and also closes a circuit for advancing the (R-4) switch to position 2. The operation of the (TR) relay also closes a circuit from ground in the final over the (TR-1) lead, cams (I-4) and (L-4) to the (YT) relay, which operates. The (YT) relay operated, closes the tip side of the test circuit allowing the test to proceed. The final circuit is held busy to other hunting incoming selectors by ground in position 7 on cam (E-2) to the (TS-1) lead.

24. FINAL BRUSH SELECTION

In position 2 of the (R-2) switch, the particular final brush which is designated to test the final multiple for an auxiliary test line, is selected. The (STP) relay operates from battery through the winding of the (L) relay in the final circuit over the (TT-1) lead, contacts of the (TR) and (YT) relays, cam (K-4) and (BO') relays.

25. As the final elevator moves upward, intermittent ground is connected through the "A" commutator, brush and segment over the (TT-1), short-circuiting the (STP) relay, thus releasing and permitting its re-operation until the proper group has been selected. For test purposes brush 4 and group 4 will probably be assigned, requiring 5 and 10 pulses respectively to satisfy the sender portion of the test circuit. With the (R-2) switch in position 2, a circuit is closed from ground on cam (R-4), make contact of the (STP) relay, contacts of cam (S-4) and (Q-4) to the winding of counting relay 4, operating the relay. The operation of counting relay 4 connects its winding in series with counting relay 4 which operates when the (A) commutator brush of the final selector makes contact with a grounded segment of the (A) commutator. When this occurs, the (STP) relay releases, removing from one side of the counting relay 4, allowing it to operate and lock through the make contact of counting relay 4 to ground. The operation of the counting relay 4 transfers the pulsing circuit to the counting relay 3 through the make contact of counting relay 4'. The next pulse transmitted by the (A) commutator, brush and segment, operates counting relay 3' which locks to ground in a similar manner. The two sets of counting relays operate and lock on the third and fourth pulses respectively. When the (STP) relay releases on the fifth pulse, both the

(FO') and (BO') operate in parallel and in series with the (SO) relay and lock through the make contact of the (SO) relay. The operation of the (BO') relay opens the fundamental circuit, stopping the upward movement of the final selector. The operation of the (FO') relay closes a circuit for advancing the (R-4) switch to position 3. In position 3, all the counting relays release. The release of the (FO') relay advances the (R-4) switch to position 4.

26. FINAL TENS SELECTION

In position 4, tens group 9 is selected in a similar operation to final brush selection. With the (R-4) switch in position 4, a circuit is closed from ground on cam (S-4) through the contacts of the (STP) relay and cams (R-4) and (Q-4), break contact of counting relay 9' to the winding of counting relay 0 operating the relay. When the first pulse is transmitted by the (B) commutator, brush and segment of the final selection circuit, counting relay 9' operates and transfers the pulsing circuit through the winding of counting relay 8. With each successive pulse, a pair of counting relays are locked. When the (STP) releases on the tenth pulse, both the (FO') and (BO') relays operate in parallel and in series with the (SO) relay and lock to ground through the make contact of the (SO) relay. The operation of the (BO') relay opens the fundamental circuit, thus stopping the upward movement of the final selector. The operation of the (FO') relay advances the (R-4) switch to position 5. As the switch advances out of position 4 all the counting relays and the (FO') and (BO') relays release. The release of the (FO') relay advances the switch to position 6.

27. FINAL UNITS SELECTION

The final selector makes units selection in a manner similar to final tens selection while the test circuit waits in position 6 of the (R-4) switch. When units selection 7 or 9, depending upon the position of the (R-3) switch is made, the (FO') and (SO') relays operate, advancing the (R-4) switch to position 7. As the switch advances out of position 6, the incoming relays release. The release of the (FO') relay advances the (R-4) switch to position 8. The switch is moved to position 9 by ground on the (A) cam, as explained under "General Description". The type of test (1 to 8) made upon the final selector circuit depends upon the position of the (R-3) sequence switch if the (MT) key is not operated. When the (MT) key is operated, these tests are made automatically one after another upon a final selector.

28. MULTI-TEST OF FINAL SELECTOR CIRCUIT

The operation of the (MT) key closes a circuit, advancing the R3 switch from position 1 upon the completion of the first test.

29. TEST 1. INDIVIDUAL LINE IDLE

With the (R-3) switch in position 1 and the (R-4) switch in position 9, the brushes of the final selector are resting on the terminals of line 99.

Note: The terminals of the three test lines are represented in the time measure portion of the test circuit.

With the brushes of the final selector resting on the terminals of the test line, a circuit is closed from battery through the winding of the (TKR) relay through the contacts of cam (0-4), (H-3), (I-4), (TR) relay, over the (TR-1) lead, brush and test terminal of the final selector, cams (J-3), (V-4), compensating resistance, winding of the (SUB) relay, cam (I-3), (T) terminal and brush in the final selector (TT-1) lead, contacts of the (TR) relay, (YT) relay, cams (E-4) and (F-4) to ground, operating the (TKR) relay. A circuit is also closed when the brushes of the final selector rest on the terminals of the test line from battery in the final selector circuit over the (S) lead, contacts of cam (K-3), winding of the (SLV) relay to ground operating the (SLV) relay, which in turn operates the (SL-1) relay. The (TKR) relay operated, locks through its make contact and make contact of the (SL-1) relay to ground on (F-4) cam. The operation of the (TKR) relay opens the circuit over the (TS-1) lead, releasing the (TK) relay in the final selector circuit and advancing the selector to the next position. When the final selector circuit has advanced out of its talking position, the (SUB) operates in series with the (L) relay in the final circuit over the ringside of the final and test circuit, to ground on the tip side of the final circuits. The operation of the (SUB) relay in turn operates the (MT) relay which advances the (R-4) switch to position 10. With the (R-4) switch in position 10, the (MT) relay releases. The release of the (MT) relay closes a circuit from ground on cam (E-3), through the break contact of the relay to the (R-4) magnet, advancing the switch to position 11. With the switch in position 11, the (MT) relay reoperates over the same circuit as it previously operated, advancing the switch to position 12. In position 12, the (MT) relay is released, advancing the (R-4) switch to position 13. As the switch leaves position 12, the operating circuit for the (SUB) relay is opened at cam (V-4), releasing the (SUB) relay. The (L) relay in the final circuit should release through the release value which is connected to the ring side of the final circuit,

allowing the sequence switch and elevator in the final selector to restore to normal. In position 13, the (MT) relay reoperates to ground on cam (G-4), advancing the (R-4) switch to position 14. When the switch enters position 13, the (SUB) relay is again connected across the tip and ring sides of the final circuit to ascertain whether the line relay in the final circuit has released. If the line relay in the final circuit has released through its release value, the (SUB) relay does not reoperate and a circuit is closed to ground from cam (E-3), through contact of the (MT) relay, contacts of cam (U-4), (SUB) and (TMR) relays, cam (C-4), advancing the (R-4) switch to position 15. In position 15, the (MT) relay reoperates to ground on cam G4, advancing the switch to position 16. If the line relay in an incoming circuit or final circuit should not release through its release value, the (SUB) relay reoperates in position 14 of the (R-4) switch, preventing the sequence switch from advancing out of position 15. The circuit remains in this position, until the operation of the time alarm as hereinafter described.

30. In position 16 of the (R-4) switch, a circuit is closed from ground on cam (E-4), through the contacts of the (CA) and (MT) keys to cam (B) on (R-3), advancing the (R-3) switch to position 2. In position 2, of the (R-3) switch, a circuit is closed from ground on cam (C-3) through cam (B-4), advancing the (R-4) switch to position 17. The (R-4) switch advances to position 1 from ground on the (ST) key. In position 1 of the (R-4) switch, a circuit is closed from ground on cam (F-4), to (B-3) advancing the (R-3) switch to position 3.

31. TEST 2. INDIVIDUAL LINE BUSY

With the (R-3) switch in position 3, the final selector is redirected to line 99 and the condition imposed on the sleeve of the line is changed to battery through 220 ohms and thru the 675^{W} (SLV) relay to ground. The (R-4) switch is advanced to position 9 as previously described. This circuit is provided with a resistance through cams (G-3) and (K-3), (S) terminal and brush of the final elevator, causing the PBX and busy test relays in the final to operate, starting the sequence of events in the final circuit, which advances the sequence switch to its busy back position. In this position, intermittent ground is connected over the ring side of the final, (TR-1) lead, (TR) relay, cam (I-4), cam (H-3), to battery through the winding of the (BB) relay which operates and releases in unison. The (BB) relay operated, closes a circuit through its make contact (J, F and G) resistances, break contact of the (BO') relay to ground through the winding of the (STP) relay which follows the operation

of the (BB) relay. The operation of the (STP) relay closes a circuit through the break contact of counting relay 1' to the winding of counting relay 1, which operates and connects its winding in series with the winding of counting relay 1. When the (BB) relay releases in turn releasing the (STP) relay, the 1' counting relay operates in series with counting relay 1 and locks through the contacts of the latter relay, transferring a pulsing circuit to the (SO) relay. Upon the next operation of the (BB) relay, the (STP) relay reoperates, in turn operating the (SO) relay. Upon the release of the (STP) relay, the (FO') and (BO') relays are connected in parallel and operate in series with the (SO) relay. The operation of the (BO') relay opens the lead from the (BB) relay, through the (STP) relay, preventing its operation. The operation of the (FO') relay closes a circuit through cam B, advancing the (R-4) switch to position 10. As the switch advances out of position 9, the energizing circuit through the winding of the (BB) relay is opened at cam (I) and the counting relays release. In position 10, ground on cam (C-3), through cam (J-4), operates the (BB-1) relay which locks to ground on cam (G-4). The operation of the (BB-1) relay, closes circuits (a) from ground on cam (G-4) to battery through the winding of the (TKR) relay, which operates, thereby releasing the final circuit, restoring it to normal, and (b) from ground through the make contact of the (BB-1) relay to the (R-4) magnet, advancing the switch to position 16. In position 16, ground from cam (E-4), through the contacts of the (CA) and (MT) keys, cam (B-3), to the (R-3) magnet, advances the switch to position 4. In position 4, a circuit is closed from ground on cam (C-3) to cam (B-4), advancing the (R-4) magnet to position 17. The switch is advanced to position 1 by ground on the make contact of the (ST) key. With the (R-4) switch in position 1, the (R-3) switch is advanced to position 5, by ground on cam (S-4).

32. TEST 3. PBX LINE IDLE (FIRST OF GROUP)

With the (R-3) switch in position 5, the final is directed to line 99, test 1 is repeated except that the condition imposed upon the sleeve is such it represents and idle condition for the first line of a PBX group. The sleeve terminal of the final is now grounded through the 100 ohm winding of the (SLV) relay, instead of through its windings in series, and the relay therefore operates through its 100 ohm winding. The (R-4) switch is restored to normal in the same manner as described in test 1. At the successful conclusion of this test, the (R-3) sequence switch advances to position 7 in the same manner as it is advanced to position 3.

33. TEST 4. HUNT IDLE PBX LINE (LAST OF GROUP)

With the (R-3) switch in position 7, the final selector is sent up at line 97 where it finds 3,400 ohms connected to the (S) terminal. The busy test relay in the final circuit operates, but the PBX relay does not operate, owing to the high sleeve resistance and the final selector goes trunk hunting. The final selector passes by terminal 98 and reaches terminal 99 which represents and idle trunk to a PBX station. From this point, the test proceeds as explained under test 1. If the test on a final is successful, the (R-3) switch advances to position 9 and the (R-4) switch to position 1.

34. TEST 5. HUNT BUSY PBX LINE (LAST OF GROUP)

In position 9, the final is redirected to line 97, the sleeve condition of the line, causing the busy test relay in the final circuit to operate. When the elevator reaches line 99, it still finds condition on the sleeve, operating the PBX relay in the final, advancing the final to its busy position. From this point, the test circuit functions as described for test 2. If the test is successful, the (R-3) switch advances to position 11 and the (R-4) switch to position 1.

35. TEST 6. HUNT IDLE PBX LINE (INTERMEDIATE)

In position 11 of the (R-3) switch, the final selector is redirected to line 97, the condition of which represents a busy PBX trunk. The selector continues to move upward until terminals 99 are reached, which represents an idle PBX trunk, intermediate in the group. The test then proceeds as described for test 1. Upon the successful conclusion of this test, the (R-3) switch advances to position 13 and the (R-4) switch to position 1.

36. TEST 7. NO TEST FEATURE

In position 13 of the (R-3) switch, the final selector is redirected to line 99 and battery is connected to the test terminal through a low resistance (220 ohms) cam (G-3) and contacts of cam (K-3), causing the sender portion of the circuit to function and the line to test busy. The final, however, does not restore to normal when the (R-4) switch is advancing from position 6 to 8, and battery is connected through 200 ohms resistance and contacts of cam (L-3) and (I-4), and contact of the (TR) relay, to the ring side of the final, operating the busy test relay in the final. The operation of this relay prior to making the busy test, advances

the final selector switch to its talking position. In position 13 of the (R-3) switch, the holding circuit for the (YT) relay is transferred from the contacts of cam (L) to ground of cam (D). The (R-4) switch does not remain in position 8 but is carried to position 9 by ground on cam (A).

37. With the (R-4) switch in position 9, the (NT) relay operates over the tip side of the test line and final circuit through the contacts of the (TR) and (YT) relays, to ground on cam (E-4). The operation of the (NT) relay closes a circuit through cam (D-4), advancing the (R-4) sequence switch to position 16. In position 16, ground from cam (E-4) through the contacts of the (CA) and (REP) keys to the cam (B-3), advances the (R-3) switch to position 14. The (R-3) switch remains in position 14, until the (R-4) switch is returned to normal, if the (TMR) key is operated. When the (TMR) key is not operated, the same ground from cam (E-4) to the break contact of the (TMR) key to cam (B-3) advances the (R-3) switch to position 16, the (A) cam carrying it to position 18. In position 18, ground is connected from cam (D-3) through the contacts of the (MT) key, (REP) relay, to the (CT) register, operating the (CT) register. The (CT) register operated, connects ground through its make contact to the (P) winding of the (BOF) relay, which operates. The (BOF) relay operated, in turn operates the (RS-3) relay. The (RS-3) relay operated, connects ground through its make contact and cam (L-4) to the (R-4) switch, advancing it to position 17. The switch is carried to position 1 by ground on the (ST) key. With the switch in position 1, ground is connected from cam (F-4) to the magnet (R-3), advancing the switch to position 1. The operation of the (RS-3) relay causes a sequence of operations which are explained in detail under paragraph 39.

38. TEST 8, TIME MEASURE RELEASE

When it is desired to incorporate the time measure test in a multi-test of a final selector, the (TMR) key is operated, which closes a circuit from ground on cam (E-3), in position 14, through the contacts of the key, to cam (B-4), advancing the (R-4) switch to position 17 from which point it is restored to normal by ground on the (ST) key. The operation of the (TMR) key prevents the (R-3) magnet from moving out of position 14 by ground on cam (E-4). With the (R-4) switch in position 1, ground on cam (F-4) advances the (R-3) magnet to position 15. In position 15 of the (R-3) switch, the test circuits direct the final selector to the line 99 and bridge the (SUB) relay across the tip and ring of the line in a similar manner to test 1. When the (R-4) switch reaches position 9, the (TKR) and (SUB) relays are operated, closing a circuit from ground on the (TKR) relay through the (MT) and (SUB) relays, to battery on cam

(T-4), operating the (MT) relay. The (MT) relay performs no function at this time. A circuit is closed in position 15 of the (R-3) switch from cam (E-3) to the make contact of the (SUB) relay to cam (C-4) advancing the (R-4) switch to position 10. The (R-4) switch remains in position 10 and the (SUB) relay is bridged across the tip and ring side of the final selector until the time measure release apparatus has functioned, releasing the final selector. If the (L) relay in the final selector releases before the second interruption of the time measure release interrupter, the (SUB) relay releases in turn closing a circuit through the (TMR) relay to ground over the tip side of the test line. The (TMR) relay locks through its make contact to ground on cam (E-4) and prevents the test circuit from restoring to normal. If the test is successful, the (R-4) sequence switch moves to position 16 when the final selector (TK) relay has operated a second time to return it to normal, after releasing the (SUB) relay and the (SLV) relay in the testing circuit. The release of these relays closes a circuit from ground on cam (E-3) to cam (D-4), advancing the (R-4) magnet to position 16. With the (R-4) switch in position 16, ground from cam (E-4) to cam (B-3) advances the (R-3) switch to position 16, the A cam carrying it to position 18. In position 18, the operation of the circuit is the same as described in paragraph 37.

39. The operation of the (RS-3) relay closes a circuit through cam (L-4), to cam (B-4), advancing the (R-4) switch to position 17, from which point it advances to position 1 from ground on the (ST) key. With the (R-4) switch in position 1, the (R-3) switch is restored to normal. When the (R-3) switch leaves position 18½, the register releases and records a completed test. The operation of the (RS-3) relay closes a circuit through the (TF) relay from ground on cam G2, operating the (TF) relay, preparatory to advancing the incoming elevator.

40. SINGLE TEST ON FINAL CIRCUIT

When the (MT) key is not operated, the type of test made on a final circuit depends on the position of the (R-3) switch which may be set manually for any tests. The test circuit functions for any particular type of test the same as described for that type of test number under "Multi-test of final circuit" until position 16 of the (R-4) switch is reached. In position 16, the (CT) register operates through the contacts of the (REP) relay, break contacts of the (MT) and (CA) keys to ground on cam (E-4). The (CT) register operated, in turn operates the (RS-3) relay. The (RS-3) relay in turn advances the (R-4) switch to position 17 and then ground on the (ST) key advances it to position 1.

41. ADVANCING INCOMING SELECTOR

In order to test the next final selector in the incoming frame, the incoming elevator must step up one terminal. With the (R-4) switch in position 1, a circuit is closed from ground through the make contact of the (RS-3) relay, cam (L-4), break contact of the (RS-1) relay, through winding of the (CC) relay, winding of the (RS) relay operating the (RS) relay and (CC) relays in series. The (RS) relay operated, in turn operates the (RS-1) relay. The operation of the (RS) and (RS-1) relays, closes a circuit from ground through their make contacts to battery through the (UP) magnet in the incoming circuit, causing the elevator to move upward. As the incoming elevator moves upward, ground is supplied through the "C" commutator brush, and segment over the (TC-1) lead, through the make contacts of the (RS) relay, to battery through the winding of the (RS) relay, which shunts the (CC) relay causing it to release. The (CC) relay releasing, opens the locking circuit for the (RS) and (CC) relays.

42. When the "C" commutator brush moves to an insulated segment of the "C" commutator, ground is removed from the (TC-1) lead, releasing the (RS) relay, thus stopping the upward movement of the incoming selector. The (RS-1) relay does not release, being locked through the contacts of cam (L-4) to the armature of the (RS-3) relay. The release of the (RS) relay connects ground to the winding of the (RS-4) relay which operates. The operation of the (RS-4) relay opens the locking circuit of the (RS-3) relay which releases. The release of the (RS-3) relay in turn releases the (RS-1) relay. The release of the (RS-3) relay opens the circuit through the 1,000 winding of the (TF) relay, but the relay does not release if the final is busy. If the final is busy, ground is supplied over the (TS-1) lead to battery through the 800 ohm winding of the (TF) relay. The function of the (TF) relay is described under paragraph 23. The routine test of the second final trunk is exactly like the first trunk in the group, if the position of the (MT) key is unchanged. Upon the completion of the single or of a multi-test, the incoming elevator advances to the next trunk in the group. This procedure is repeated until the overflow terminals of the first group are reached by the incoming elevator.

43. OVERFLOW PASS-BY

As it is necessary to test the final trunk in the remaining group of the incoming frame, the incoming elevator must pass over the overflow terminal to the first trunk in the next group. With the incoming elevator brushes resting on the overflow terminal, a circuit is closed from ground through the (Z) commutator segment and brush over the (TA-1) lead, brush 4 and terminal 1 of the (IC) switch, outer contacts of cam (P-2) to the (ZC) relay which operates. The operation of the (ZC) relay

closes a circuit from ground on the interrupter, through contacts of the (BOF), (PB-1), and (ZC) relays, terminal 1 brush 3 of (IC) switch, cam (O) break contact and the winding of the (IC) selector switch magnet to battery, operating the magnet, which moves the brush assembly of the (IC) switch to terminal 2. With the (IC) brush assembly on terminal 2, the operating circuit for the (ZC) relay is opened, releasing the (ZC) relay. The (BOF) relay operates from ground through the contacts of cam (L), brush 1 and terminal 2 of the (IC) switch, to the (P) winding of the (BOF) relay. The (BOF) relay operated, in turn operates the (RS-3) relay. The operation of the (RS-3) relay in turn operates the (RS) and (CC) relays in series. The (RS) relay operated, in turn operates the (RS-1) relay. The operation of the (RS) and (RS-1) relays connects ground to the (UP) magnet in the incoming selector circuit, moving the incoming elevator to the first terminal of the next group in the same manner as the elevator was moved one terminal to another terminal in the same group. Upon the release of the (RS) relay as previously described, the (RS-4) relay operates, closing a circuit through its make contact from ground through brush 3 of the (IC) switch to (IC) selector magnet, moving the brush assembly of the (IC) switch to the next odd terminal.

44. All the trunks in the second group are tested in the same manner as the first trunk in the first group and when the incoming elevator is moved to the first terminal of the third group in the same manner as is just described. At this point, the (IC) brush assembly is resting on terminal 5. This procedure is repeated until all the trunks in the first to fourth groups have been tested. The brushes of the incoming elevator are then resting upon the overflow terminals of group 4 and the (IC) brush assembly is resting on terminal 7.

45. INCOMING ELEVATOR RETURNED TO NORMAL

With the (IC) switch on terminal 7, the (ZC) relay operates from ground on the (Z) commutator segment over the (TA-1) lead and advances the (IC) brush to terminal 8. With the (IC) switch on terminal 8, the (ZC) relay is released, and ground from the (L-2) cam through brush 1 and terminal 8 of the (IC) switch to battery through the (R-2) magnet, advances the (R-2) switch to position 8. In position 8, a circuit is closed from ground on cam (F-2) over the (TD-1) lead, to the DOWN magnet in the final selector circuit, energizing the magnet and restoring the incoming elevator to normal. When the incoming elevator reaches the bottom of the frame, a circuit is closed from ground through the (Y) commutator brush and segment, over the (TY-1) lead, cam (C-2) to the (R-2) magnet, advancing the switch to position 9. When the (R-2) switch is passing through position $8\frac{3}{4}$ to 9, a circuit is closed from ground through the contacts of the (ST) key, cam (S-2), break contact

of the (TRA) relay, to the (I-A) selector magnet, which operates and releases, moving the (I-A) switch to the next terminal. With the (R-2) switch in position 9, a circuit is closed from ground on the (L-2) cam, brush 1 and terminal 8 of the (IC) switch to the (R-2) magnet, advancing the switch to position 10 (normal). Also in position 9 a circuit is closed from ground on the contacts of cam (G-2), terminal 8 and brush 3 of the (IC) switch, to the (IC) selector magnet, advancing the switch to terminal 9, where the circuit through 200-L (IC) selector magnet, is reestablished through terminal 9 and brush 3 of the (IC) switch, stepping the switch to terminal 12 or normal. With the (R-2) switch in position 10, a circuit is closed from ground through the contacts of cam (G-2), to the (R-4) magnet, providing additional means for restoring the (R-4) switch to normal.

46. If the terminal upon which the brush assembly of the (I-A) switch rests is wired for a test, the circuit functions as described for the first terminal of the (I-A) switch until all the groups as determined by the cross scheme for this terminal have been tested, whereupon the (I-A) magnet is again energized, moving the brush assembly of the switch to the next terminal. When all the final circuits available to the first incoming elevator have been tested, the (R-IA) switch advances from position 3 to position 4, in which position a second incoming elevator is tested to determine whether it is being used in regular service.

47. SELECTION OF SECOND INCOMING ELEVATOR

Assuming that the second incoming elevator must be used when the brush assembly of the (I-A) switch rests on terminal 6, a circuit is closed from ground through the contacts of the (RN) and (RN-1) relay, (EC) key, brush 6 and terminals 6 of the (I-A) switch, cross connection of terminal strip 6, contacts of cam (B) on (R-IA) to the (R-IA) magnet, advancing the switch to position 4. As the switch enters position 3, the (PG) relay operates in a circuit from ground on cam (A-IA) through cam (S-IA) to battery. The operation of the (PG) relay removes ground from the (TK-1) lead, thereby permitting the intermediate use of the associated incoming elevator when necessary in regular traffic. In position 4, the second incoming elevator selector circuit is tested in the same manner similar to the first incoming selector circuit for a busy condition, except that lead (TK-2) is used instead of (TK-1). When the incoming elevator circuit becomes idle, the (R-1) switch advances to position 5. From this point the test circuit functions as described with the (R-1A) switch in position 3. When all the groups of the final selector circuit available to the second incoming elevator have been tested, the (R-1A) switch advances to position 6 where it tests a third incoming selector circuit for a busy condition, using the (TK-3) lead. Assuming that the third elevator must not be used when the (I-A) switch rests on terminal 10, a circuit is closed

from ground through the contact of the (RN) and (RN-1) relays, (EC) key, brush 6 and terminal 10 of the (I-A) switch, cross connection of terminal strip 6, to the (R-1A) magnet, advancing the switch to position 6. The switch is advanced to position 7 and connected with the third incoming elevator in the same manner as was connected to the first incoming elevator.

48. The test for the final selector trunks in the groups available to the third incoming elevator proceeds in the same manner as described for the first incoming elevator. If all final selector circuits have not been tested with the use of three incoming elevators, four or more incoming elevators must be used, thus necessitating the addition of a connector for every one to three additional incoming selectors required. Assuming that the fourth incoming elevator is required when the brush assembly of the (I-A) switch rests on terminal 15, a circuit is closed from ground through the (RN) and (RN-1) relays, (EC) key, brush 6 and terminal 15 of the (I-A) switch, cross connection of terminal 6 over lead 4, contacts of cam (P) and cam (C) on (R-1A) to the (R-1A) magnet, advancing the switch in position 8. The (A) cam carries the switch to position 10. In position 10, the same ground on the (CON) relay through the contacts of cam (P) on (R-1A) to cam (B) on (R-1B), advances the (R-1B) switch to position 2. In position 2, the fourth selector circuit is tested for a busy condition over lead (TK-4). From this point, the test circuit functions as described for the first incoming elevator.

49. If all the final circuits have not been tested by the time the (I-A) selector switch completes one revolution, a second switch (I-B) is required. When the brush assembly of the (I-A) switch rests on terminal 21, a circuit is closed from ground on the (RN-1) relay through make contact of the (RN) relay, through the (EC) key, brush 6 and terminal 21 of the (I-A) switch, to battery through the winding of the (TRA) relay, which operates. The (TRA) relay operated, closes a circuit from ground on the make contact of the relay through the (N) terminal and brush 1 of the (I-B) switch, terminal 21 and brush 1 of the (I-A) switch, make contact of the (TRA) relay, break contact and winding of the (I-B) selector magnet, to battery, moving the brush assembly of the (I-B) switch to terminal 1. From this point, the automatic test of the final selector circuit associated with the (I-B) switch unit is completed in a similar manner as described for the first (I) switch unit. When the brushes of the (I-B) switch rest on terminal 21, and there are more final selector circuits to be tested, a third switch (I-B), (not shown) is required. This switch is moved off normal in exactly the same manner as the (I-B) switch was stepped to terminal 1 by using a relay (TRA-1) (not shown).

50. CONCLUSION OF A ROUTINE TEST

After a test has been made on all the final selector circuits, ground is connected from the (RN-1) relay through the make contact of the (RN) relay, contacts of the (EC) key, brush 6 and terminal 21 of the last (I) switch unit in the equipment, to battery through the (EC) lamp, which lights. When only one connector switch is required in an equipment, this same ground advances the (R-1A) switch to normal through the contacts of cam (P), (C), and (R-1A). When normal, the (EC) lamp lights through the contacts of cam (P). This signal lamp indicates that the end of a complete routine test has been reached and if another cycle is not desired, the (RN) key is depressed, and the (ST) key released. The operation of the (RN) key closes a ground to the (RN-1) relay which operates and locks. The release of the (ST) key opens the holding circuit for the (CON) and (ST) relays, releasing them. The release of the (RN) key extinguishes the (EC) lamp and releases the (RN) and (TRA) relays, but the (RN-1) relay does not release being held in a circuit from the (PC) key through brush 4 and terminal 21 of the (I-A) switch and make contact of the relay. The release of the (TRA) relay also closes a circuit from ground on the (PC) key, brush 4 and terminal 21 of the (I-B) switch to the (I-B) selector magnet, stepping the brush assembly of the switch to the next or normal terminal. The (RN) key released, closes a circuit from ground through the break contact of the key, and make contact of the (RN-1) relay, terminal 21 and brush 1 of the (I-A) switch to the (I-A) selector magnet, moving the (I-A) switch to the normal terminal. With the (I-A) switch in the normal position, the holding circuit of the (RN-1) relay is opened, releasing the relay. This completes a single routine test of all final selector circuits in the full mechanical exchange.

51. TEST OF A PARTICULAR FINAL GROUP

In order to enable the test man to make a test upon a particular group of final selector circuits or particular final circuit, a chart is provided showing the groups for final trunks available to a brush on an incoming frame, and also it shows what keys to operate in connection with the (PC) key to cause an (I) switch to step to a terminal which permits the test of a particular group of trunks.

52. Assume that the group to be tested is reached by an incoming selector associated with the (I-B) switch and also requires the use of a third connector. Further assume that the cross connection scheme shown on the drawing applies to the (I-B) switch as well as the (I-A) switch. If it is desired to test a 2 group of trunks only appearing in the 8th incoming frame, the following keys must be depressed. In the units row; key 7;

in the second row, the tens (T) key and the (TWB) key; in the group number (GN) row, key 2; and in overflow count (OC) row, key 1; after which the (PC), and the (ST) keys are depressed. With these keys depressed, the brush assembly of the (I-B) switch steps to terminal 18, causing an elevator on the eight incoming frame to test the first trunk of group 2 in bank 3 of the frame. This will necessitate the use of connector 3 (not shown), which, however, is similar to connector 2. For clearness, the (T-5) lead of the second connector will be used to represent the (T-8) leads of the third connector. After testing the 8th frame, the incoming elevator returns to normal, upon stepping to the overflow terminal.

53. INCOMING SELECTION

The operation of the (ST) key closes a circuit operating the (ST) relay. The (ST) relay operated, closes a circuit from ground on the (STG) lead to the (TRA) relay through the contacts of the (ST) relay, (EC) key, (TWD) and (TEC) keys, make contact of the (TWB) key, over the (CC-1) lead, operating the (TRA) relay. The operation of the (TRA) relay closes a circuit ground through terminal (N) and brush 1 of the (I-B) switch, over lead (BA-1), contacts of the (TWB, TWC and TWD) keys, (N) terminal and brush 1 of the (I-A) switch, and break contact and winding of the (I-B) magnet, stepping the brush assembly of the (I-B) switch to terminal 1. With the (I-B) switch on terminal 1, ground on the (PC) key, through normal contacts of unit keys 0 to 6 inclusive, over leads 1 to 7, through the 1 to 7 contacts and brush 1 of the (I-B) switch, lead (BA-1) and contacts of the (TWB) key, break contacts of the (TWC) and (TWD) keys, (N) terminal and brush 1 of the (I-A) switch, to battery through the break contact and winding of the (I-B) magnet, moving the brush assembly of the (I-B) switch to position 8. The tens (T) key operated, closes a path to step by the unit terminal associated with the operated (U) key to step to the tens terminal associated with the (U) key. With the (I-B) switch resting on terminal 8, the energizing circuit of the (I-B) magnet is from ground on the (PC) key, through the contacts of the (T) key, make contacts of units key 7, over lead 8, brush 1 and terminal 8 of the (I-B) switch, contacts of the (TWB, TWC, and TWD) keys, make contact of the (TRA) relay, break contact and winding of the (I-B) magnet, to battery moving the (I-B) switch to terminal 9. Through terminals 9 to 17 inclusive, the (I-B) switch is connected over leads 9 to 17 inclusive, to ground through the associated units keys, thereby stepping the brush assembly of the (I-B) switch to terminal 18. When the (I-B) switch steps to terminal 18, the energizing circuit for the (I-B) magnet is opened over lead 18 at the contacts of units key 7, stopping the movement of the (I-B) switch. The removal of ground from terminal 18 of the (I-B) switch allows the (T) relay to operate from

ground through the contact of the (ST) relay to battery through the magnet. The (T) relay operated, in turn operates the (CON) relay. Since connector 2 and the (T-5) leads represent connector 3 in the (T-8) leads, the circuit operating the third connector may be traced over lead 5 from terminal strip 6, cam (B-1B), to the (R-1B) magnet. With the connector in position 4, the incoming selector assigned for test purpose is tested for a busy condition. When the incoming selector circuit becomes idle or if idle, the connector switch moves to position 5 in which position the circuit is connected to the incoming elevator.

54. INCOMING BRUSH AND GROUP SELECTION

With the sequence switch (R-2) in position 2, the incoming is tested for busy and the switch then advances to position 4, in the same manner as described under "Routine Test". In position 4, the incoming elevator is moved upward for incoming brush, selecting brush 3. Upon receipt of the fourth pulse transmitted by the "A" commutator brush and segment in the incoming, the (R-2) switch advances to position 5 and then to position 6 in the same manner as described under "Routine Test". The test circuit waits in this position until the (PC) key is released. In position 6, the incoming elevator moves upward for group selection. Intermittent ground is connected over the (TB) lead, through the contacts of cam (M-2), break contact of (GN) key 3, make contact of (GN) key 2, break contact of counting relay 2, winding of counting relay 2, to battery on cam (R), operating the counting relay 2. When ground is removed from the (TB) lead, counting relay 2' operates and locks. Upon receipt of the second pulse, counting relay 1' operates and locks through the make contact of counting relay 1. The operation of counting relay 1 transfers the pulsing circuit from the (SO, BO' and FO') relays, to the (O), (O^2) and (O') relays through cam (M-4). The third pulse is through the make contact of counting relay 1', cam (M-4), break contact of (O^2) relay, winding of counting relay (O') to battery on cam (R-2), operating the (O) relay. When the circuit through the (B) brush in the incoming elevator is opened, the (O') and (O^2) relays operate and lock. The operation of the (O') relay advances the (R-2) switch to position 7.

55. SETTING INCOMING CONTROL SWITCH

When the (R-2) switch enters position 3, the (IC) switch is stepped accordingly to the (OC) key operated. A circuit then is closed from ground through the contacts of cam (E-2), through the break contact of the (IC) selector magnet, successfully operating the selector magnet until it is shunted by one of the leads to arc 2 of the (IC) switch.

Having operated (OC) key 1, the (IC) switch steps until terminal 7 is reached. Ground through the make contact of the (OC) key 1, over lead 1, terminal 7 and brush 2 of the (IC) switch, contacts of cam (O), shunts the magnet, thereby preventing its operation. When the (R-2) switch advances out of position 6¼, ground is removed from both sides of the stepping magnet.

56. In position 7, the test on the particular group of final trunks proceeds in the same manner as described under "Routine Test", until the incoming elevator is stepped to the overflow terminals. Ground is then connected over the (TA) lead, brush 4 and terminal 7 of the (IC) switch contacts of cam (P), to the (ZC) relay which operates. Also in position 7, a circuit is closed from battery on cam (R), through the contacts of the 149-G interrupter, to ground through the winding of the key release magnet, releasing the (U), (GN), and (OC) keys. The operation of the (ZC) relay advances the (IC) switch to terminal 8 as described under paragraph 43. From this point of the incoming elevator, the (IC) switch and the (R-2) switch are restored to normal as also described under paragraph 43. When the switch (R-2) passes through position 8 to 9, a circuit is closed advancing the (I-B) switch to terminal 19. The circuit is restored to normal by operating the (RN), and releasing the (ST) key. The operation of the (RN) key operates the (RN-1) relay. The release of the (ST) key closes a circuit through the contacts of cam (B), to the (R-1C) magnet (not shown) on the third connector, which advances the switch to position 8, the (A) cam carrying it to position 10 (normal). The operation of the (RN) key connects ground through the contacts of cam (H) (R-2), (ST) and (RN) keys, normal contacts of the (U) keys, through all the terminals on arc 1 of the (I-B) switch advancing the switch to terminal 21. With the (I-B) switch on terminal 21, the (RN) key is released, closing a circuit from ground through the break contact and winding of the key release magnet associated with the (T) and (TWB) keys, operating the magnet and releasing the (T) and (TWB) keys. The release of the (TWB) key opens the holding circuit for the (TRA) relay which releases. The release of the (TRA) relay connects ground from the break contact of the (PC) key through brush 4 and terminal 21 of the (I-B) switch to the (I-B) stepping magnet, advancing the switch to normal. The release of the (RN) key releases the (RN) and (RN-1) relays, restoring the test circuit to normal.

TIME MEASURE ALARM

57. BUSY TIME ALARM.

Whenever the (ST) key is operated, a circuit is closed from ground

through the contacts of the key and break contacts of the (TR) relay and the (TA) key, brush 4 of the (BY) switch to the (BY) relay which operates and locks through its make contact over the same circuit. The operation of the (BY) relay connects ground through the contacts of the 152 interrupter, terminal 1 and break contact of the (Z) relay, winding of the (W) relay, to battery through the 450 ohm winding of the (Z) relay, operating the (W) relay. The (Z) relay does not receive enough current to operate under this condition. When the interrupter contacts break, ground is removed from one side of the 190 ohm winding of the (Z) relay which operates through its two windings in series with the winding of the (W) relay. Upon the next make of the interrupter contacts, ground is connected through the make contact of the (Z) relay (a) to the terminals on arc 3 of the (BY) switch, and winding of the (BY) selector magnet, which operates; and (b) holding the (Z) relay operated, through its 450 ohm winding, shunting the winding of the (W) relay, which releases. When the interrupter contacts break, ground is removed from both the (BY) magnet and the 450 ohm winding of the (Z) relay, releasing the magnet, which moves the brush assembly of the switch to the next terminal, and also releasing the (Z) relay. When the interrupter contacts make, the (W) relay reoperates, starting the above cycle anew. Should the selector be kept busy in regular traffic for a time sufficiently long to prevent a test being completed upon a final selector circuit, the (BY) switch advances to terminal 22. With the brush assembly on terminal 22, ground through the make contact of the (BY) relay, lights the (BY) lamp. The switch remains in this position until the operation of the (TA) key release the (BY) relay which closes a circuit through its break contact through arc 1 of the switch, to battery through the break contact and winding of the (BY) magnet, stepping the brush assembly of the switch to normal. With the switch normal, the (BY) relay reoperates and starts a new time measure. When a selector circuit becomes idle in sufficient time to allow the test upon a final selector circuit to be completed, the operation of the (TR) relay in conjunction with the routine test, releases the (BY) relay. The release of the (BY) relay connects ground to the terminals on arc 1, stepping the brush assembly of the switch to normal. So long as the (TR) relay is held operated by the test circuit, the (BY) relay does not reoperate. When the incoming elevator is advanced to test the next trunk the circuit of the (BY) relay reoperates, starting a new time measure feature.

58. TRUNK BUSY ALARM

Should trouble occur in the final selector circuit of the tost circuit before the (R-4) switch is moved out of position 2, a circuit is closed through the (TA) key and (TBL-1) relay, terminal and brush 4 of the (TBL) switch to battery through the (TBL) relay which operates. The (TBL) relay

operated, locks over the same circuit and closes a circuit from ground through its make contact, contacts of the 152 interrupter through terminal 1 and brush 3 of the (TBL) switch, to battery through the (TBL) magnet, which operates. When the interrupter contacts break, the magnet releases, moving the brush assembly of the switch to terminal 2. On the next make of the interrupter contacts, the magnet reoperates and releases, moving the brush assembly of the switch to terminal 3. On terminal 3, a circuit is closed from ground on the make contact of the (TBL) relay, to battery through the (TBL) register and (TBL) lamps, operating the register and lighting the lamp. The circuit remains in this position until the operation of the (TA) key. The operation of the (TA) key closes a circuit operating the (TBL-1) relay which locks through the contacts of cam (H-4). This in turn releases the (TBL) relay. The (TBL) relay connects ground to its break contact to terminals on arc 1 of the (TBL) switch, moving the brush assembly of the switch to a normal terminal. The operation of the (TBL-1) relay prevents the reoperation of the (TBL) relay until the trouble has been cleared. When the trouble has been cleared, the (RN) relay is operated, restoring the circuit to normal in turn releasing the (TBL-1) relay. This relay now reoperates through the contacts of cam (H), to ground on the (ST) key, starting a new trouble time measure.

59. END OF CYCLE (EC)

When one cycle of routine test has been completed upon all the final selector circuits, the (EC) lamp lights as previously described under paragraph 50. At this time, all the sequence switches are normal, and the brush assemblies of each switch are resting on the terminal 21 of each unit, awaiting the operation of the (RN) key. The (TRA, CON and RN) relays are operated and the (ST) keys depressed. If it is desired to start another cycle of routine test, the (EC) key is operated. The operation of the (EC) key extinguishes the (EC) lamp and releases the (TRA) relay. The release of the (TRA) relay closes a circuit from ground on the (PC) key through brush 1 and terminal 21 of the (I-B) switch to the (I-B) magnet, which operates and moves the brush assembly of the switch to normal. The circuit for restoring the (I-A) switch is from ground through the make contact of the (RN) and (RN-1) relays, contact of the (EC) key, terminal 21 and brush 1 of the (I-A) switch to battery through the break contact and winding of the (I-A) magnet. From this point, another automatic test of all the final selectors proceeds as described under "Routine Test".

60. CONTROL ADVANCE (CA) KEY

If trouble develops in either the test circuit itself or in the final selector circuit under test, the time alarm functions as described under "Trouble Time Measure Alarm". If the (TA) key is operated, and the test circuit does not continue to function, the (CA) key is operated. The operating of the (CA) key closes a circuit through cam (D-4), advancing the (R-4) switch to position 16. The circuit remains in position 16, as long as the (CA) key is operated. The final circuit during this interval is held busy from ground on cam (E-2), contact of the (TF) relay, (TKR) and (NT) relays, cam (D) to the (TS) lead. After the release of the (CA) key, the circuit either advances the incoming elevator to the next final in the group or repeats the test upon the troublesome final if the (REP) key is operated. If the (REP) key is not operated, the (R-3) switch advances through the restore contacts of the (CA) key to ground on cam (E-4). From this point, the (R-4) switch is restored to normal as described under paragraph 30.

61. REPEAT (REP) KEY

When it is desired to repeat the test upon a certain final selector circuit, the (REP) key is operated. The operation of this key closes a circuit operating the (REP) relay, which locks through its make contact to ground on cam (F-4) if the (REP) key is momentarily operated to make a single repeat test, or through the contacts of cam (D-3) if the (MT) key is operated. The operation of the (REP) relay closes a circuit from ground on cam (E-4) through the contacts of the (CA) and (MT) keys, (REP) relay to the (RST) register which operates. The operation of the (RST) register connects ground through its make contacts to cam (B-4) to the (R-4) magnet, advancing the switch to position 17. Ground on the (ST) key advances to position 1. The (BOF) relay does not operate as described under "Routine Test", with the switch in position 16, due to the operating circuit of the (CT) register being opened at the contacts of the (REP) key. In position 1, the second test upon final selector proceeds in exactly the same manner as the first test upon the circuit. This test is repeated until the release of the (REP) key which releases the (REP) relay, allowing the operation of the (CT) register at the conclusion of the test. From this point, the circuit functions and steps the incoming elevator to the next set of final selector terminals.

62. AUTOMATIC PASS-BY (APB) KEY

Whenever a final busy selector is encountered, the (BF) lamp lights from ground on the (TS) lead. The operation of the (APB) key causes the automatic test circuit to pass by all busy terminals and to stop the incoming elevator on the first idle incoming selector terminals. The operation of the key removes the short circuit from the winding of the (PB) relay, allowing it to operate in series with the 800 ohm winding of the (TF)

odd terminal. From this point, the circuit functions as described under paragraph 43, advancing the incoming elevator to the first terminal of the next group. When the overflow terminal happens to be the last in the series of groups to be tested, the incoming elevator is returned to normal in the same manner as described under paragraph 45. The test then proceeds on another incoming elevator which is used to continue the automatic test.

65. TO STOP THE AUTOMATIC TEST

The release of the (ST) key and operation of the (RN) key restores all apparatus to normal.