Western Electric Co., Incorporated,
Equipment Engineering Branch, Hawthorne.

(23 Pages, Page 1)
Issue 2 BT 502625
July 5, 1923. (*)
Replacing all previous issues.

This M. of O. sheet was prepared from issue 14 of T-502625.

METHOD OF OPERATION
AUTOMATIC ROUTINE TEST OF OFFICE SELECTORS
3 Digit Line Finder Offices - Automatic Routine Test Frame - Panel Machine Switching System.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

This circuit is designed to test automatically three wire office selector circuits. The circuit is arranged to test adjacent groups of office selector circuits. When non-adjacent groups of selector circuits in the district panel are to be tested, the district elevator must be sent up as many times as there are groups to be tested. The cross connection of the terminal strip determines the number of times the elevator must be sent up to complete the tests of all groups in the panel. In order to test all the selector circuits in the given office, it is usually necessary to use one district elevator in each panel in the exchange.

2. WORKING LIMITS

This circuit is designed to operate when the voltage limits of the battery are from 24 to 25 and from 48 to 50 volts, only. The values of the several resistances incorporated in the circuit are such as to place a worst circuit loop condition upon the relays in the office selector circuit under test.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are as follows:

3.1 To make a particular selection using all the apparatus incorporated in the office selector circuit, and returning the office elevator and sequence switch to normal upon the successful conclusion of the test.

3.2 This circuit seizes a line finder type district selector circuit which it uses as means of access to connect to the office selector circuit. When not being used for test purposes, the district selector circuit performs its usual functions. When

used for test purposes, the district selector switch does not move out of position 1, the elevator only being used. The movement of the elevator is controlled by the test circuit causing it to test the proper groups of office circuits.

3.3 The operation of a single key causes the test circuit to automatically test all selector circuits, even though not arranged in adjacent groups. The test circuit proceeds from panel to panel as may be required. The circuit is arranged to permit the district elevator to pass by an intermediate overflow terminal and return to normal only when the final overflow terminal in series of groups has been reached.

3.4 The test circuit is arranged to distinguish between busy district selector circuits and busy office selector circuits. Should the district selector circuit to be used be busy, the test circuit waits until the elevator restores to normal before proceeding with the test. In the case of a busy office selector circuit, the test circuit holds up the test for a reasonable length of time until the office selector is restored to normal, unless the MPB or APB key is operated.

3.5 The test circuit is provided with alarms which operate should not the office selector circuit or district selector circuit be returned to normal within a reasonable length of time. An alarm is also operated in case trouble is discovered either in the test or in the office selector circuit. An alarm may also operate in case insufficient time is left after the district elevator circuit has been seized to complete the routine test.

3.6 The test circuit is provided with registers which record the actual number of routine tests made as well as the number of times the time alarm and the trouble alarm operates.

3.7 The circuit is provided with keys which when operated, cause the selector to select or make an automatic test on a particular group of office selectors, that is, any group or series of office selector circuits on any panel may be chosen at will.

4. START KEY (ST)

The operation of this key alone starts the automatic test which continues until all office selector circuits have been tested. If other keys are operated, the operation of this key starts a special

test as determined by the keys operated. The release of the ST key at any time stops the test.

5. RETURN TO NORMAL KEY (RN)

The operation of this key causes the district selector switches, (B-A, B-B, ETC.) to return to normal but it is not effective unless the ST key has been restored to normal and the test has gone to a point where the circuit under test will not be left off-normal.

6. CONTROL ADVANCE KEY (CA)

This key is operated when either the test circuit fails to complete its cycle due to a fault in itself or in the circuit under test. The operation of the key advances the test control circuit and the district elevator, unless the REP key is operated. The circuit does not resume the test until the key is restored to normal.

7. TIME ALARM KEY (TA)

The operation of this key resets the timing period whenever the alarm bell has rung and testing is in progress.

8. REPEAT KEY (REP)

The operation of this key causes the test circuit to repeat the test upon an unsuccessfully tested selector. 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 pass all terminals that are busy. The operation of the MPB key steps the district elevator from a busy 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 test.

11. PARTICULAR CIRCUIT KEY (PTC)

The operation of this key in combination with the other keys is

numerated below and causes the apparatus to make a test upon the particular group of office circuits. The particular test does not proceed until the key is released. For the purpose of testing the particular group or groups, this circuit is provided with a UNITS (U) keys, 0 to 9 inclusive; a TENS (T) key which adds tens to particular U key depressed; one or more TWENTY (TWA, TWB, TWC, TWD, ETC.) keys, each of which controls a particular district selector switch; GROUP NUMBER (GN) keys, 0 to 9 inclusive, to guide the district elevator to the number of the particular group to be tested and OVERFLOW COUNT (OC) keys 0 to 9 inclusive, which determine the number of overflow terminals to be passed before the district elevator is restored to normal.

12. CONNECTING CIRCUITS

This circuit is arranged for use with line finder district selectors, which in turn connect to the office selector circuits to be tested.

DESCRIPTION OF OPERATION

ROUTINE TEST

13. An automatic test is started on all office selector circuits by the operation of the ST key. The ST key operated; (a) operates the (TA) relay; (b) connects ground through the V cams of all the connectors to the (ST) relay, which operates; and (c) provides a locking path from the (ST) relay, and an operating path for the (T) relay, after the operation of the DA switch. The operation of the (ST) relay closes a circuit through its make contact, contacts of the (TWD) and "TWC" keys, N terminal and brush of the D-A switch, break contact of the (TRA) relay (when required) to the 200-M (D-a) selector magnet, energizing the magnet. Ground is also connected through the make contact of the ST key to the other side of the (T) relay, preventing the operation of the (T) relay. The energized selector magnet opens its operating circuit and releases moving the brush assembly of the D-A switch to terminal 1. If this terminal is wired for an office test, ground is removed from one side of the winding of the (T) relay, allowing it to operate. The selector magnet does not operate in series with the (T) relay on account of its high resistance. When a terminal of a "D" switch is not wired for office test, ground is connected to that terminal, on arc 1, causing the associated 200-M selector magnet to energize and move the brush assembly to the next terminal. The operation of the (T) relay in turn operates the (CON) relay which locks under control of the (ST) relay. The operation of the (CON) relay closes a circuit

through its contacts, contact of the EC key, brush and terminal 1 of the D-A switch, cross connection of terminal strip 6, to cam W on the 1st connector switch in the equipment of the circuit to cam B, on R-1 A, advancing the connector switch to terminal 2. The (CON) relay operated also operates the (RN) relay.

NOTE: When more than one connector is required to test all the office selector circuits in an exchange, each succeeding connector cannot be moved out of normal, until the succeeding connector used has been restored to its normal position. For instance, if it is assumed that the second connector shown on the schematic is the last of a series of connector units, connector 1 can only be moved out of positions 1 or 10 after connector 2 is restored to positions 1 or 10. The circuit for restoring the last connector or any preceding connector to the one required for the test, is from ground through the make contacts of the (CON) relay (EC) key, brushes and terminal on a "D" switch unit, cross connection of the associated terminal strip 6, inner and upper outer contacts of cam W, on the last connector used, to battery through the R magnet, advancing the connector unit to position 1 or 10. If one of the connector units does not return to normal, the circuit ceases to function and operates the alarm as hereinafter described.

BUSY TEST OF LINE SWITCH DISTRICT SELECTOR

14. As the sequence switch of connector 1 is advancing from position 1 to position 2, the (PG) relay operates in parallel with the R-1A magnet. The (PG) relay operated, in turn operates the (TD-1) relay. The (TD-1) relay is slow to release and with the R-1A switch in position 2, locks through its make contact and the CON relay. With the release of the (PG) relay in position 1 1/2, a circuit is closed operating the (SLO) relay. The (SLO) relay operated in turn operates the (TLF) relay. The operation of the (TLF) relay advances the R-2 switch to position 2. With the R-1A and the R-2 switches in position 2, the district selector assigned for test purposes is tested to find if it is busy on routine service.

15. If the district selector circuit is being used in regular traffic, the TJ and TK leads must be kept closed to prevent the district from being unguarded prior to the completion of the regular service call. When the R-1A switch is in its normal position, the closure between the TJ-1 and TK-1 lead is through the contacts of cam P. As the R-1A switch enters position 1 3/4, the closure between the TJ-1

and TK-1 leads is through the contacts cam R on R-2. With both the R-1A and R-2 switches in position 2, ground is connected to the TJ-1 lead through the break contact of the (Pg) relay and battery is connected to the TK-1 lead through the secondary winding of the (TLF) relay, holding the (TLF) relay operated, as long as the district is busy. When the district selector circuit becomes idle, or if idle when tested, ground is removed from the TK-1 lead in the district circuit, releasing the (TLF) relay. The operating circuit for the (TLF) relay is opened by the release of the SLO relay after position 1 1/2 of the R-2 switch. The release of the (TLF) relay advances the R-2 switch to position 3.

DISTRICT CONTROL SWITCH SET

16. The R-1A switch is advanced to position 3 through the C cam on R-2. With the R-2 switch in position 3, the DC stepping magnet operates and advances the DC switch brush assembly to terminal 1, or other odd numbered terminal, depending upon the cross connection of terminal strip 5. With the scheme of cross connection shown on the drawing and with the assembly of the D-A switch resting on terminal 1, groups 0 to 8 inclusive in the first bank are tested. The 200-L (DC) selector continues to step until the winding of the DC magnet is short circuited by ground over one of the leads connected arc B of the DC switch. As determined by the cross connection of the D-A switch and terminal strip 6, the DC selector magnet is short circuited when its brush assembly rests on terminal 3. The position of the DC switch determines the number of the overflow terminals the district elevator must pass by before it is restored to normal. With the setting just made, the district elevator returns to normal when the elevator brushes have stepped to the overflow terminals above group 8. Also in position 3, the (RS-2) relay operates to ground on cam G, closing a circuit operating the (TO) relay and advancing the R-2 switch to position 4. The operation of the (TO) relay in turn operates the (TO-1) relay to ground on the break contact of the (ZC) relay. The (TO) and (TO-1) relays operated, perform no useful function at this time.

DISTRICT BRUSH SELECTION

17. The district brush selection is determined by the cross connection of terminal 3. With the scheme used in the drawing and with the D-A switch resting on terminal 1, the 0 brush of the first district elevator is selected. In position 3, of R-1A

connector is connected through the cuttings of the cams to the district selector elevator which is held busy by ground through the break contact of the (PC) relay, over the TJ-1 lead; also in position 3 of the connector switch, ground is connected from the break contact of the (O') relay, through cam D on R-2 over the TU-1 lead, to battery through the up drive magnet in the district selector circuit. As the district elevator moves upward under control of the UP drive magnet, ground is connected through the A brush and commutator segment in the district circuit, over lead TA, through brush 3 of terminal 1 of the DA switch, cross connection of terminal strip 3, winding of counting relay O to battery, operating the (O) relay. The operation of the (O) relay connects its winding in series with the winding of relay (O'). This relay does not operate on account of being short circuited by ground. When the A brush on the district elevator makes contact with an insulated segment on the "A" commutator bar, ground is removed from one side of relay (O') allowing it to operate. The (O') relay operated, advances the R-2 switch to position 5 and disconnects ground from the TU-1 lead, stopping the upward drive of the district selector. With the R-2 switch in position 5, the operating circuit for the (O') and (O) relays is opened, releasing the relays. In this position, the TU-1 lead is opened at the contacts of cam D, preventing the up drive magnet of the district selector from operating to ground on the break contacts of the (O') relay. Ground, however, is closed through the contacts of cam F on R-2 over the TN-1 lead, to battery, through the TRIP magnet in the district circuit, energizing the magnet. With the switch in position 5 and with the (O') relay released, the R-2 switch advances to position 6 in the same manner as it advances to position 4.

DISTRICT GROUP SELECTION

18. In position 6, the circuit from ground from the break contact of the (O') relay through cam D, to the TU lead is re-established. As the district elevator moves upward under control of the up drive magnet, intermittent ground is connected to the TB-1 lead through the cross connection of terminal 4, winding of the (O) relay to battery, operating the relay. The (O) relay operated, connects its winding in series with the (O') relay which operates when the brush of the district elevator makes contact with an insulated segment of the commutator bar. The (O') relay operated, (a) opens the circuit through the up drive in the selector circuit, stopping the upward movement of the elevator and (b) advances the R-2 switch to position 7. As the switch leaves position 6 1/2,

the holding circuit for relays (O) and (O') is operated at cam U, releasing the relays.

OFFICE BUSY TEST

19. When the R-2 switch leaves position 6, the (RS-2) and (T) relays release. The release of the (T) relay transfers the holding circuit of the (CON), relay from the make contact of the (T) relay to ground on the ST key. The release of the (RS-2) relay transfers the holding circuit of the (TO) relay from its 1,000 ohm winding to its 800 ohm winding for the purpose of testing the office circuit. When the office selector circuit is busy, the (TO) relay is held operated through the break contacts of the MPB and APB keys and the (REP) relay over the TS-1 lead to ground in the busy office selector circuit. The same ground lights the BO lamp. With the (TO) relay held operated, the (TO-1) relay is held operated to ground on the break contact of the (ZC) relay. If the office circuit is idle or becomes idle, the holding circuit for the (TO) relay is opened, releasing the (TO) relay. The (TO-1) relay is held operated through its make contact to ground on cam G. The release of the (TO) relay operates the (TR) relay to ground on the break contact of the (ZC) relay.

20. The operation of the (TR) relay connects the TT and TR leads through its make contacts to the test circuit, and closes a circuit advancing the R-3 switch to position 2. The office selector is held busy to other hunting district selectors by ground on cam E or R-2 to the TS-1 lead.

OFFICE BRUSH AND GROUP SELECTIONS

21. In position 2 of the R-3 switch, the particular office brush which is designated to test the office multiple for the particular set of terminals which send back the O.K. pulses to the test set is selected. For test purposes, brush O and group 8 have been assigned, requiring one and nine pulses each to satisfy the sender portion of the test circuit. A circuit is closed from ground over the ringside of the office selector circuit under test, over the TR-1 lead, two 18-AF resistances, cross connection of terminal strip 2, terminal and brush of the D-A switch, winding of the (STP) relay to battery over the TT-1 lead and winding of the (L) relay in the office selector circuit. The (L) relay and (STP) relays operate. The operation of the (STP) relay connects ground to the winding of counting relay (SO), which operates. The (L) relay operated, advances the office selector circuit to its brush selection

position, which allows the office elevator to move upward under control of the up drive magnet. As the A commutator brush moves the A commutator segment, ground is connected to the tip side of the office selector over the TT-1 lead, shunting the (STP) relay, which releases. The release of the (STP) relay allows the (BO) and (BO') relays to operate in parallel in series with the (SO) relay. The operation of the (BO') relay opens the fundamental circuit. The operation of the (FO') relay advances the R-3 switch to position 3. With the switch in position 3, the (FO'), (BO') and (SO) relays release. The release of the (FO') relay advances the switch to position 4.

22. In position 4, office group 8 is selected in a similar manner to office selection. When the first pulse is transmitted by the B commutator brush and segment in the office selector circuit, counting relay (8) and (8') operate and lock in series to ground transferring the pulsing circuit to the winding of counting relay (7). Upon the receipt of the last pulse, the (BO') and (FO') relays operate. The operation of the (BO') relay opens the fundamental pulsing loop and releases the (L) relay in the office selector circuit. The operation of the (FO') relay advances the R-3 switch to position 5. As the switch leaves position 4 1/4, the (BO'), (FO') and counting relays release. The release of the (FO') relay advances the switch to position 6, the A cam carrying it to position 7. With the R-3 switch in position 7, the test circuit awaits the O.K. pulses(3 in number) before proceeding with the test.

23. As the office selector starts trunk hunting it passes over the first two trunks in the test group, they being made busy, and stops on the third trunk since the S terminal of this trunk is open. As soon as the office elevator is properly centered on the trunk terminal, a circuit is closed from ground over the ringside of the office circuit and test circuit, compensating resistance, cross connection of terminal strip 2, terminal 1 and brush 2 of the D-A switch, winding of the (STP) relay to battery through an interrupter on the T terminal of the selector bank. The (STP) relay operates and releases following the make and break of the interrupter contacts. With the (STP) relay operated, a circuit is closed through the winding of counting relay 2, which operates. Upon the break of the interrupter contact, the (STP) relay releases, removing ground from one side of the winding of counting relay 2' which operates and locks in series with the winding of counting relay (2) and transfers the energizing circuit to the break contact of counting relay (1').

On the second pulse of the interrupter, counting relays (1) and (1') operate and lock in series. On the next pulse of the interrupter, the (SO), (BO') and (FO') relays operate. The operation of the (BO') relay opens the pulsing circuit, preventing further operation of the (STP) relay. The operation of the (FO') relay connects ground to the winding of the (RS-3) relay, which operates.

24. The operation of the (RS-3) relay which locks (a) opens the holding circuit through the (TO-1) relay, which releases; (b) operates the (RS-2) relay; and (c) advances the (R-3) switch to position 8. The operation of the (RS-2) relay in turn operates the (TO) relay, which in turn closes a circuit operating the (TO-1) relay. The function of this relay as previously explained under paragraph 19, is to test the office trunk for a busy condition. With the R-3 switch in position 8, ground is connected through the make contact of the ST key and cam B to the R-3 magnet, advancing the switch to position 10, awaiting the test of a second office trunk circuit.

ADVANCE DISTRICT SELECTOR

25. In order to test the next trunk in the district group, the district elevator must advance one terminal. With the R-3 switch in position 10, a circuit is closed from ground on the make contact of the (ES-3) relay cam K on R-3, winding of the (RS) relay and outer winding of the (RS-1) relay to battery, operating the (RS) relay. The (RS-1) relay does not receive sufficient current to operate. The operation of the (RS) relay connects ground through cam Q to the TU-1 lead, which energizes the UP drive magnet in the district circuit, moving the elevator upward. As the district elevator moves upward, ground from the C commutator brush and segment in the district circuit over lead TC-1 to battery through the inner winding of the (RS-1) relay and outer winding of the (RS) relay, operates the (RS-1) relay and holds the (RS) relay operated. The (RS-1) relay locks through its outer winding to ground on the contacts of the (RS-3) relay.

26. The UP drive of the district elevator carries the C brush, beyond the C commutator segment and ground is removed from the TC-1 lead, releasing the (RS) relay, thus stopping the upward movement of the selector, and operating the (RS-4) relay. The operation of the (RS-4) relay opens the locking circuit for the (ES-3) relay which releases. The release of the (RS-3) relay in turn releases the (RS-4), (RS-2) and (RS-1) relays. The release of the

RS-2 relay opens the circuit through the 1,000 ohm winding of the (TO) relay and a busy test is made through its 800 ohm winding. If the office selector circuit is busy, ground is supplied over the TS-1 lead, holding the relay operated. The function of the (TO) and (TO-1) relays is the same as previously described under paragraph 19. The routine test of the second office group in the trunk is made exactly as the test for the first trunk in any group. Upon receipt of the three O.K. pulses, the district elevator advances to the next group. This procedure is repeated until the overflow terminals of the first group are reached by the district elevator.

OVERFLOW PASS BY

27. When it is necessary to test the office trunks, in the next group of the district frame, the district elevator must pass over the overflow terminals of the first group to the first trunk in the next group. With the district elevator brushes resting upon the overflow terminal, a circuit is closed from ground over the TA-1 lead to the (ZC) relay, which operates. The operation of the (ZC) relay closes a circuit through the brush and terminal of arc 3 on the DC switch to the DC magnet, energizing the magnet which moves the brush assembly of the DC switch to terminal 4. The (TO-1) relay does not release while the district elevator is stepped over the overflow terminal. It is held through the brush and an even numbered terminal of arc 5 on the DC switch. With the DC switch assembly on terminal 4, the operating circuit of the (ZC) relay is opened, releasing the relay which closes a circuit through the winding of the (RS-3) relay, which operates and locks. The operation of the (RS-3) relay in turn operates the (RS-2) relay and closes a circuit for operating the (RS) relay. The operation of the (RS) and (RS-2) relays energizes the up drive magnet of the district selector circuit, moving the district elevator to the first terminal in the next group, in the same manner as the elevator is moved from one terminal to another in the same group. Upon the operation of the (RS-1) relay and the release of the (RS) relay as previously described under paragraph 26, the (RS-4) relay operates, closing a circuit through the even numbered terminal and brush of arc 3 of the DC switch to the DC magnet, moving the brush assembly of the DC switch to terminal 5.

28. All the trunks in group 1 are tested in exactly the same manner as group 0 and when the district elevator brushes rest upon

the overflow terminals of group 1, the elevator is moved to the first terminal of the group 2 in the same manner as just described. When the elevator has moved to the first terminal of group 2, the DC brush assembly is resting on terminal 7. This procedure is repeated until all the trunks in the nine consecutive groups have been tested. The brushes of the district elevator are then resting upon the overflow terminals of group 8 and the DC brush assembly is resting on terminal 19.

DISTRICT ELEVATOR RETURNED TO NORMAL

29. With the DC switch on terminal 19, the (ZC) relay operates from ground on the Z commutator brush and segment and advances the DC brush to terminal 20. With the DC switch on terminal 20, the (ZC) relay is released, closing a circuit through the R-2 magnet which advances the switch to position 8. As the switch leaves position 7, the (TR) relay releases. In position 8 of the R-2 switch, a circuit is closed over the TD-1 lead to battery through the DOWN magnet in the district selector circuit, energizing the magnet and restoring the district elevator to normal. When the district 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, to battery through the R-2 magnet, advancing the switch to position 9. While the sequence switch is passing through position 8 3/4 to 9, a circuit is closed through the make contact of the ST key and D-A selector magnet, energizing the magnet, which moves the D-A switch to the next terminal. In position 9, a circuit is closed from ground on cam G to terminal 20 and brush 3 of the DC switch to the DC selector magnet, moving the switch to terminal 21, and then to normal. With the DC switch normal, a circuit is closed from ground through the break contact of the relay to battery through the R-2 magnet, advancing the switch to position 10. With the R-2 switch in position 10, ground from cam G to battery through the R-3 magnet provided an additional means of restoring the R-3 switch to normal. If the terminal upon which the brush assembly of the D-A switch rests is wired for a test, the circuit functions as described for the first terminal of the D-A switch until all groups as determined by the cross connection scheme have been tested, whereupon the D-A magnet is again energized, moving the brush assembly of the D-A switch to the next terminal. When all the district selector circuits available to the first district elevator have been tested, the R-1A switch advances to position 4 in which position a second district elevator is tested to determine whether it is being used in regular service.

SELECTION OF SECOND DISTRICT ELEVATOR

30. Assume that the second district elevator must be used when the brush

assembly of the D-A switch rests on terminal 6. A circuit is closed from ground on the break contact of the (RN-1) relay, through contacts of the EC and ST key brush and terminal on arc 6 of the D-A switch, cross connections of terminal strip 6, to battery through the R-1A magnet, advancing the switch to position 4. As the switch leaves position 2 1/4, ground is removed from the TJ-1 lead. The TJ-1 and TK leads are closed through cam P after the switch reaches position 3 1/2 thereby permitting the associated district selector to be used when necessary to handle traffic at once. In position 4, the second district elevator is tested in a similar manner as the first district elevator selector circuit for a busy condition, except that the TJ-2 and TK-2 leads are used. When the district selector becomes idle, or if idle, the R-1A switch advances to position 5. From this point, the testing circuit functions the same as described with the R-1A switch in position 3. When all the groups of office selector circuits available to the second district elevator have been tested, the R-1A switch advances to position 6, where it tests a third district selector circuit for busy, using leads TJ-3 and TK-3. Assuming that a third district elevator must be used when the brush assembly of the D-A switch rests on terminal 12, a circuit is closed from ground on the break contact of the (RN-1) relay, through contacts of the EC and ST key the brush and terminal of the D-A switch, cross connection of terminal strip 6 to the R-1A magnet, advancing the R-1A switch to position 6. The switch is advanced to position 7 and connects to the district elevator in the same manner as connecting to the first district elevator.

31. The test of the office selector trunks in the groups available to the third district elevator proceeds the same as described for the first district elevator. If all the office selector trunks have been tested with the use of three district elevators, four or more district elevators must be used, thus necessitating the addition of a connector for every one to three additional district selectors required. Assuming that the fourth district elevator is required when the brush assembly of the D-A switch rests on terminal 13, a circuit is closed from cam C to battery through the R-1A magnet, advancing the switch to position 9. The A cam carries the switch to position 10. In position 10, the same ground on the (CON.) relay, cam B on R-1B, advances the second connector switch to position 2. In position 2, the fourth selector circuit is tested for a busy condition over the TJ-4 and TK-4 leads. From this point on, the test circuit functions as described for the first district elevator.

32. If all the office selectors have not been tested by the time the D-A switch completes one revolution, a second switch (D-B) is required. When the brush assembly of the D-A switch rests on terminal 21, a circuit is

closed from ground on the break contact of the (RN-1) relay and the make contact of the (RN) relay through the brush and terminal 21 of arc 6 of the D-A switch, to battery through the winding of the (TRA) relay, which operates. The (TRA) relay operated closes a circuit from ground on its own make contact through the N terminal and brush 1 of the D-B switch and the D-B selector magnet, moving the brush assembly of the D-B switch to terminal 1. From this point, the automatic test of the office selector circuits associated with the D-B switch is completed in a similar manner as described for the D-A lead. When the brush of the D-B switch rests on terminal 21 and there are further office selector circuits to be tested, a third (D-C) switch and (TRA) relay (not shown) are required. The switch is moved off normal, exactly the same as the D-B switch moved to terminal 1.

CONCLUSION OF A ROUTINE TEST.

33. After the test has been made upon all of the office selector circuits, ground is connected through both the make contacts of the (CON.) and (RN) relays to terminal 21 and brush of arc 6 of the last "D" switch unit in equipment, to 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 V and cam R-1A. When normal, the EC lamp lights through the contacts of cam V. This signal indicates that the end of a complete routine test has been reached. If another cycle is not desired, the RN key is depressed and the ST key released. The operation of the RN key in turn operates the (RN-1) relay which locks through its make contact to ground on the make contact of the (RN) relay. The operation of the (RN-1) relay, releases the (TRA) relay. The release of the ST key opens the holding circuit for the (ST) relay, which releases in turn releasing the (CON.) relay. The release of the (CON.) relay, extinguishes the EC lamp, and releases the (RN) relay.

34. The release of the (TRA) relay connects ground to the winding of the D-B selector magnet, moving the brush assembly of the D-B switch to the next or normal terminal. The RN key is now restored to normal, opening the next operating circuit through the (RN-1) relay, but the relay is still held by ground on the PC key. The release of the RN key connects ground through its break contact to the winding of the D-A selector magnet, moving the D-A switch to the normal position. With the D-A switch in its normal position, the holding circuit through the (RN-1) relay through terminal 21 and brush 5 is opened, releasing the relay. This completes the single routine test of all office selector circuits in a full mechanical exchange. When the RN

key is operated and the ST key is released prior to the completion of the cycle of tests, the test on the office circuit is completed and the district elevator steps to the next set of terminals in the usual manner. The release of the (RS) relay after the district elevator advances, closes a circuit through the contacts of the ST and RN keys and all U keys to the terminals of any "D" switch that is off normal. These grounded terminals cause the associated 200-M magnet to stop the brush assembly of the switch to terminal 21. The release of the ST key advances the R-3 switch to position 18, through cam C. In position 18, the same ground is connected to the R-2 magnet, advancing the R-2 switch to position 8. In the position 8, the district is restored to normal as described under paragraph 29, and ground on the Y commutator over the TY lead and cam C advances the R-2 switch to position 9. In position 9 ground is connected to the odd numbered terminals of arc 3 of the DC switch and ground from cam C is connected to even numbered contacts on arc 3; these two circuits alternately operate the DC magnet, stepping the DC switch to normal. As the DC switch steps to terminal 20, ground through the break contact of the (ZC) relay advances the R-2 magnet switch to normal.

TEST OF A PARTICULAR OFFICE GROUP

35. To enable the test man to make a test upon a particular group of office selector circuits, a chart is provided showing the groups of office trunks available to a brush on a district frame and also shows which keys to operate in conjunction with the PC key to cause a "D" switch to step to a terminal which permits the test of a particular group of trunks.

36. Assume that the group to be tested is reached by district selectors associated with the D-B switch and also requires the use of a third connector. Further assume that the cross connection scheme shown on the schematic applies to the D-B switch as well as the D-A switch. If it is desired to test group 7 associated with terminal 18 of the D-B switch, the following keys are depressed. In the units row key 7; in the second row, the tens (T) key and the TWB key; in the group number row (GN) key 7; and in overflow count, (OC) row, key 1; after which the PC and ST keys are depressed. With these keys depressed, the brush assembly of the D-B switch steps to terminal 18, causing the 8th elevator to test group 7 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 leads of connector 2 will be used to represent the T-8 leads of connector 3. After testing the district elevator returns to normal upon stepping to the overflow terminal.

DISTRICT SELECTION

37. The operation of the ST key closes a circuit operating the (ST) relay. The (ST) relay operated, closes a circuit through the make contact of the TWB key and the break contacts of the TWC and the TWD keys to the (TRA) relay which operates. The operation of the (TRA) relay closes a circuit through the N terminal and brush 1 of the D-B switch to the D-B magnet, which steps the brush assembly of the D-B switch to terminal 1. With the brush assembly of the switch on terminal 1, ground through the make contact of the PC key, normal contacts of the unit keys 0 to 6 inclusive over leads 1 to 7, to the contacts 1 to 7 on arc 1 of the D-B switch, energizing the D-B magnet which moves the brush assembly of the switch to terminal 8. The tens (T) key operated, closes a path permitting the D-B switch to step ten additional terminals and reach terminal 18. With the D-B switch resting on terminal 8, the circuit for stepping the switch to terminals 18 is from the PC key, T key, contacts of the units key 7, over lead 8, terminal 8 and brush 1 of the D-B switch, contact of the TWB, TWC and TWD keys, through the D-A switch and (TRA) relay of the D-B magnet. Terminals 9 to 17 inclusive are connected to ground through the unit keys 8 to 6 inclusive, thereby stepping the brush assembly of the switch to terminal 18. When the D-B switch brush assembly rests on terminal 18 the energizing circuit of the D-B switch magnet is opened at the contacts of units key 7. The removal of ground from terminal 18 at the D-B switch allows the relay to operate. The (T) relay operated, in turn operates the (CON.) relay.

38. With the switch on terminal 18 and the (CON.) relay operated, the (RN) relay operates and ground is connected through brush 6 of the switch, cross connection of terminal strip 6, to the magnet of the 3rd connector advancing the connector to position 4. (Use connector 2) as the R-1B switch is advancing through position 1 1/2 to 4, the (PG) relay is operated to ground on cams B and A of the switch. The (PG) relay is thus prevented from releasing in position 1 1/2 to 3 1/4, grounding an undesired district selector circuit. With the connector in position 4, the district selector assigned for test purposes is tested for a busy condition. When the selector becomes idle, or if idle, the selector moves to position 5, in which position the test circuit is connected to the district elevator. The circuit waits in this position until the release of the PC key.

DISTRICT BRUSH AND GROUP SELECTION

39. The sequence switch R-2 advances to position 2 and enters position 4 in the same manner as described under "ROUTINE TEST". In position 4, the district elevator is moved upward for brush selection, selecting

district group 4. Upon receipt of a fifth pulse transmitted by the "A" commutator brush and segment in the district, the R-2 switch advances to position 5 and then to position 6 in the same manner as described under "ROUTINE TEST". In position 6, the district elevator moves upward for group selection. Intermittent ground is connected over the TB lead through the normal contacts of GN keys 9 and 8, make contact of GN key 7, to counting relay (7,) which operates. When ground isremoved from the TB leads, counting relay (7') operates and locks through the make contact of counting relay (7.). Upon receipt of the eighth pulse, the (8O) relay operates, connecting its winding in series with the windings of the (BO') and (FO') relays. When the B brush in the district elevator breaks contact with the 8th segment, the (BO') and (FO') relays operate and lock. The operation of the (FO') relay advances the R-3 switch to position 7. In position 7, a circuit is closed from ground through the make contact of the 149-C interrupter, windings of the key release magnet, releasing the U, GN and OC keys.

SETTING DISTRICT CONTROL SWITCH

40. When the R-2 switch enters position 3, the DC switch is stepped according to the OC key operated. A circuit is then closed from the ground on cam E through the DC selector magnet successively operating the selector magnet until it is short circuited by ground over the one of leads to arc 2 of the DC switch. Having operated OC key 1, the DC switch steps to terminal 19; ground through the make contact of the OC key, terminal 19 and brush 2 of the DC switch, to battery through the 44-A resistance, short circuits the winding of the magnet, thus preventing its operation. When the R-2 switch leaves position 6-1/4, ground is removed from both sides of the stepping magnet.

41. In position 7, the test of the particular group of office trunks proceeds after the PC key is released in the regular manner as described under "ROUTINE TEST". As soon as the district elevator is stepped to the overflow terminals, ground is connected to the TA lead, through brush 4 and terminal 19 of DC switch to the (ZC) relay, which operates. The operation of the (ZC) relay performs the same function as described under paragraph 29, restoring the district elevator to normal and advancing the DC switch to terminal 20. From this point, the DC switch and the R-2 switch are returned to normal as described under paragraph 29. When the sequence switch R-2 passes through position 8 3/4 to 9, a circuit is closed advancing the DC switch to terminal 19. The circuit is restored to normal by operating the RN key and releasing the ST key. The operation of the RN key closes a circuit operating the RN-1

relay. The release of the ST key closes a circuit through the R-1B magnet, advancing the switch to position 8, the A cam carrying it to position 10. The operation of the RN key also connects ground from cam H to all terminals on arc 1 of the D-B switch, advancing the switch to terminal 21. The D-B switch rests on terminal 21 until the RN key is released, which closes a circuit through the magnet associated with the T and TWB keys, which operates and releases the keys. The release of the TWB key opens the holding circuit for the (TRA) relay which releases, in turn advancing the D-B switch to normal. The release of the (TRA) relay also opens the holding circuit for the (RN) relay, which releases. The release of the (RN) relay opens the holding circuit of the (RN-1) relay, which releases in turn restoring the circuit to normal.

TIMING FEATURE

42. Whenever the ST key is operated, ground is connected through the make contact of the key through terminal 1 and brush 4 of the time alarm switch to the (TA) relay which operates. If trouble develops in the test circuit before the sequence switch R-2 reaches position 7 or should the district selector be kept busy in regular traffic for a time sufficiently long to prevent an office selector circuit from being tested completely before the time switch makes on revolution, a circuit is closed operating a message register and lighting the TA alarm lamp. The operation of the (TA) relay closes a circuit through the contacts of the 152 type interrupter, break contact of the (Z) relay ("Y" wiring) to battery through the winding of the (W) relay and 250 ohm winding of the (Z) relay in series, operating the (W) relay. The (Z) relay does not receive sufficient current to operate. At the break of the interrupter contacts, the 190 ohm winding of the (Z) relay is connected in series with the 450 ohm winding of the relay, operating the relay through the make contact of the (W) relay to ground on the make contact of the ST key. At the next break of the interrupter contacts the windings of the (W) relay and 190 ohm winding of the (Z) relay are short circuited by ground, releasing the (W) relay. The (Z) relay is held operated through the contacts of the interrupter and its 450 ohm winding. A circuit is now closed through the contacts of the interrupter, make contact of the (TA) and (Z) relays, terminal 1 on arc 3 of the time alarm switch, energizing the TA magnet.

43. On the second break of the interrupter, the holding circuit for the (Z) relay and the energizing circuit for the TA magnet is opened,

releasing the relay and the magnet, and stepping the brush assembly of the time alarm switch to the next terminal. Upon the third make of the interrupter, the (W) relay reoperates and starts the above described cycle. If either the district elevator or the office elevator is kept busy on routine traffic sufficiently long to prevent the completion of the office test as the interval as determined by the Telephone Company, the time alarm switch is advanced to terminal 22. With the brush assembly of the switch resting on terminal 22, a circuit is closed through brush 2 of the time alarm switch, to battery in the alarm circuit, operating the message and lighting the signal lamp located in the test desk. The switch brushes remain on terminal 22 until the TA key is operated. The operation of the TA key releases the (TA) relay closing a circuit from ground through terminal 22 on arc 1 of the time alarm switch to the TA magnet, which moves the time alarm switch to normal. The (TA) relay reoperates with the time alarm switch normal over the same circuit as is originally operated and locks, starting another timing interval. When the test on an office selector is completed before the time alarm switch completes the revolution, the holding circuit for the (TA) relay is opened when the sequence switch R-3 advances from position 9, releasing the (TA) relay. The release of the (TA) relay advances the time alarm switch to normal from ground on its break contact, and contacts of arc 1 of the time alarm switch to battery through the break contact and winding of the

44. Separate trouble and busy time alarm FIG. 2. When a separate busy time alarm is used the operation of the ST key operates the (BY) relay which locks through its make contact. The (BY) relay operated connects ground through the 152 interrupter contacts to the TBL selector magnet stepping the selector one step with each make and break of the interrupter contacts. When the switch reaches the terminal corresponding to the time limit set by the telephone company the BY lamp lights. When the R-3 switch is advanced out of position 9 the (BY) relay releases and the BY lamp is extinguished. The (BY) relay released connects ground to the BY selector magnet through the BY-1 arc restoring the switch to normal.

45. When a separate trouble alarm is used the operation of the ST key operates the (TBL) relay which locks. With the (TBL) relay operated the TBL selector magnet operates under the influence of the 152 interrupter as described above. After the selector magnet steps the switch three terminals the 2G trouble lamp lights and the TBL message register operates. The operation of the TA key operates the (TBL-1) relay which locks and releases the (TBL) relay. The release of the (TBL) relay restores the selector magnet to its next normal position.

END OF CYCLE (EC) KEY

46. When one cycle of routine test has been completed, on all office selector circuits, the EC lamp lights as described under paragraph 33. At this time, all sequence switches are normal and the brush assemblies of the "B" switches are resting on terminals 21, awaiting the operation of the RN key; the (TRA), (CON), and (RN) relays operated and the ST key depressed. If it is desired to start another cycle of routine test, the EC key is momentarily operated. The operation of the key opens the holding circuit through the (TRA) relay, releasing it. From this point, the D-B and successive switches are restored to normal in a similar manner to that described under paragraph 33. With the D-B switch normal and the EC key operated, a circuit is closed, restoring the D-A switch to normal. The operation of the EC key operates the key release magnets restoring the keys in the second row. When the D-A switch is returned to normal, a circuit is closed through the contacts of the ST, EC and "TW" keys, through the D-A switch and the D-A magnet, moving the D-A switch to terminal 1. From this point, another automatic test of all office selections is repeated in the same manner as described under "ROUTINE TEST".

CONTROL ADVANCE (CA) KEY

47. If trouble develops either in the test circuit itself or in the trunk circuit under test, the time alarm lamp lights as described under paragraph 42. If after the TA key is operated, the test circuit does not continue to operate the CA key is operated. The operation of the CA key opens the circuit through the (FO') relay and closes a circuit through its contacts to cam C on R-3, advancing the R-3 switch to position 7. In position 7 a circuit is closed from ground through the contacts of the CA key, through the windings of the (SO) and (BO') relays, which operate. The relays operated, lock to ground through the make contact of the (SO) relay. The circuit remains in this position until the CA key is released. After the release of the CA key, the (FO') relay operates. The operation of the (BO') relay performs no useful function at this time. When it is not desired to repeat a test upon the same district selector, the REP. key is not operated and the operation of the (FO') relay closes a circuit through the winding of the (RS-3) relay, which operates. The (RS-3) relay operated, locks and closes a circuit through cam B on R-3 advancing the switch to position 8, and starts the ("ES") relay operating. The switch is carried to position 10, by ground on the contact of the ST key. The operation of the (RS) relay advances the district elevator to the next terminal as described under paragraph 25.

REPEAT (REP). KEY

48. If it is desired to repeat the test upon the unsuccessfully tested office selector circuit, the REP. key is operated before the CA key is released. The operation of the REP. key operates the (REP.) relay which locks to ground on cam F. With the release of the CA key, the (FO') relay operates as described in paragraph 45, closing a circuit through cam B of the R-3 switch, advancing the switch to position 8. The switch is carried to position 10 by ground on the ST key. With the R-3 switch in position 10, the repeat test is made upon the office selector circuit. If the second test is satisfactory, the district selector is advanced as described under paragraph 25. In repeat tests, with the (REP.) relay operated, the TS lead is opened at cam O between 16 1/2 and 18 of the R-3 switch for the purpose of restoring the office circuit to normal before attempting to repeat the test. If the repeat key is operated to repeat a test upon a successfully tested office selector circuit, the circuit functions as described below. After the receipt of the O.K. pulses, the (FO') relay operates, in turn advancing the sequence switch R-3 to position 8. The switch is advanced to position 8 by ground on the ST key. The operation of the (FO') relay does not operate the (RN-3) relay as described under "ROUTINE TEST" due to the energizing circuit of the RN-3 being opened at the contacts of the REP. key, in position 8 and 9, a circuit is closed through the 1,000 ohm winding of the (TO) relay, to battery on the make contact of the REP. key, operating the (TO) relay. If the office selector has not been seized by this time by a second district selector, the operation of the (TO) relay performs no useful function. If, however, the office circuit has been seized, the (TO) relay is held operated in a circuit through its own winding to ground on the TS lead. When the office selector circuit becomes idle, the (TO) relay releases, the energizing of the circuit through the 1,000 ohm winding of the relay being opened at cam L when the R-3 switch advances to position 10 and then performs its usual function as described under "ROUTINE TEST". In position 10 the second test of the office selector circuit is repeated 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 (RS-3) relay at the conclusion of the test. From this point, the test circuit functions and advances the district elevator to the next set of office selector terminals.

AUTOMATIC PASS BY (APB) KEY

49. The operation of the APB key causes the automatic test circuit to pass all busy terminals and stop the district selector on the first idle office selector terminals. The operation of the APB key removes the

short circuit from around the winding of the (PB) relay, allowing it to operate in series with the 800 ohm winding of the (TO) relay, when the office selector circuit is tested for a busy condition. The operation of the (PB) relay closes a circuit from ground through the break contact of the (RS-4) relay to the (RS-3) relay, which operates. The (RS-3) relay operated, in turn operates the (RS-2) relay. The (RS-2) relay is made slow release to prevent the premature release of the (TO) relay in case the movement of the district elevator carries it momentarily beyond the last terminal of a series of busy terminals. The premature release of the (TO) relay would cause the test circuit to seize a busy trunk. The (RS-3) relay also closes a circuit operating the (RS) relay. From this point, the (RS-1) and (RS-4) relays operate, advancing the district elevator to the next terminal in exactly the same manner as described under "ROUTINE TEST". Should this office selector also be busy, the (PB) relay reoperates repeating the above described operation of the ("RS") relays until an idle office selector circuit is found. The (PB) relay releases each time the brush of the district elevator leaves the terminals of a busy office trunk.

50. Should the district elevator step to a set of overflow terminals, with the APB key operated, the (TO) and (PB) relays release and the (ZC) relay operates from ground supplied over the TA lead. The operation of the (ZC) relay advances the switch to an even numbered terminal, from which point it is advanced to the next odd numbered terminal by the operation of the (RS-4) relay and the (DC) relay as described under paragraph 25. Should the first trunk in the next group be busy, the (TO) and (PB) relays re-operate, performing the same function as described above. When the terminals of an idle sender selector are found, the automatic test proceeds in the usual way until the next busy terminal is found and causes the (PB) relay to operate, unless meanwhile the APB key is restored to normal.

MANUAL PASS BY (MPB) KEY

51. If it is desired to move the district elevator from the terminals of a busy office selector to the next set of office selector terminals which may, or may not be busy, the MPB key is operated. The operation of the MPB key removes the short circuit from the winding of the (PB) relay, allowing it to operate in series with the (TO) relay, to ground over the TS lead. The operation of the (PB) relay connects ground to the (RN-3) relay which operates in turn operating the (RN-2) relay. The (RN-2) relay operated, holds the (TO) relay operated through the 1,000 ohm winding and closes a circuit through the 1,000

ohm winding of the (MPB) relay, operating the relay. The (MPB) relay operated, locks on its outer winding. The operation of the (RN-3) relay causes the other ("RS") relays to operate and move the district elevator up to the next terminal. When the district elevator brushes are properly centered on the trunk terminals, the ("RS") relays release. The operation of the (MPB) relay prevents the operation of the (RS-3) relay should the terminals test busy and operate the (PB) relay. The release of the MPB key releases the (MPB) relay. If it is desired to step by the second busy office selector circuit, the MPB key is re-operated, causing the circuit to function as just described, stepping the district elevator to the next set of terminals. Should the operation of the MPB key step the elevator from the last terminals of the group to the overflow terminals, the (ZC) relay operates, moving the DC switch to the next even numbered terminal. With the release of the key the (MPB) relay releases allowing the (RS-3) relay to operate from ground on the break contact of the (ZC) relay. From this point the circuit functions as described under paragraphs 25 and 26 advancing the district to the next set of terminals. When the overflow terminal happens to be the last of a series of groups to be tested, the district elevator is returned to normal in the same manner as described under paragraph 29. The test then proceeds to another district elevator which is used to continue the automatic test. Whenever a busy office selector circuit is encountered, the BO lamp lights and burns until the MPB key is operated or the elevator is moved pass the busy terminal if the APB key is operated.

52. When the REP. key is operated, with either the APB key or MPB key operated, the operation of the (REP.) relay short circuits the winding of the (PB) relay through the contacts of the (REP.) relay. This short circuit prevents the (PB) relay from operating over the district lead of the incoming selector and thereby prevents the district elevator from stepping off the busy terminals.

ENG.--A.F.H.
November 18, 1924
BS

CHK'D.--J.I.

APP'D.--H. L. MOYNES
E. R. C.