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METHOD OF OPERATION

Automatic Routine Sender Test Frame - For 2-Digit Subscriber's Senders - Panel Machine Switching System.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

1.1 This circuit is designed to test 2-digit subscriber senders arranged for use with sender selectors. The test circuit is connected to the senders under test by means of master and sender selectors (200-206 type switches) which are automatically advanced to each sender in succession or manually connected to any desired sender.

Particular circuit, repeat and repeat 4 tests can be made and an automatic pass busy feature is provided.

2. WORKING LIMITS

2.1 None.

OPERATION

3. PRINCIPAL FUNCTIONS

The functions of this circuit are as follows:

3.1 To test first all non-coin senders and then the coin senders automatically. The identity of the sender under test is determined by the reading of the index wheels on the master switches and the associated sender switch, and reference to a chart.

3.2 Upon the operation of the multi-test (MT) and start (ST) keys to make a series of tests in a certain order, on each sender in the equipment, each test reproducing a certain type of call. This series of tests includes most types of calls which the sender must handle.

3.3 If the (ST) key is operated without the (MT) Key to make a single test on each sender in rotation, this test being determined by the position in which the route control and numerical switches are set manually, or all numerical and selection switches if a special number is used.

3.4 After connecting to any sender and before starting a test to test the sender for busy and if busy to wait until the sender becomes idle, or to advance to the next sender after a predetermined period.

3.5 In each test to set the sender registers and as the sender advances for selections to act as the selector in sending revertive impulses to the sender and at the same time to count these pulses as a check. (On RCI calls to register the pulses from the sender and to check as on mechanical calls). If the selection does not check, to block the test set, operate an alarm and light lamps to indicate the test and selection which do not check and how they do not check. At the end of each test to restore the sender to normal and to advance for the next test.

3.6 To make tests on a single test basis, and to repeat tests as desired.

4. CONNECTING CIRCUITS

4.1 Two-digit subscribers senders.

4.2 Time alarm circuit as specified.

4.3 Sender monitor inc. call circuit when specified.

4.4 Transfer key circuit when specified.

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TESTING NON-COIN SENDER - MULTI-TEST

6. CONNECTING TO AN IDLE SENDER

Assume that the multi-test key is operated to make all the tests on each sender.

6.1 Advancing the Master Switch R25 Pos. 1

With all switches in their normal positions and the (MT) key operated, the operation of the start key (ST) operates the (T) relay, from ground on cam (K-2), thru normal positions of the R24, 20, 3 and 1 switches operating the (T-1) relay from ground on the (ST) key. The (T-1) relay operated, advances the (R-25) switch to position 2, releasing the (T) and (T-1) relays. As the (R-25) switch enters position 1 3/4, the (MS) relay operates to ground on the normal terminal and (R3) brush of master switch 2 and locks, advancing the (R-25) switch to position 3, ground from SS3-025 (SA wiring) or ground from the RS arc normal (SB wiring), cam (A) advancing it to position 4. In position 4 the (AX) relay operates through the make contact of the (MS) relay, advancing the (R-25) switch to position 5. In position 5, the (AX) relay releases, and ground on cam (O-25), (MS) relay operated advances the (R-25) switch to position 6. In position 6, ground from cam (O-25) is closed through the make contact of the (MS) relay and cam (G-25) to the windings of both master switch magnets, and also through the break contacts of the magnets and cam (I-25) to the non-inductive winding of the (AX) relay, energizing the switch magnets but not the (AX) relay. When the break contacts of both magnets have opened, the (AX) relay operates, advancing the switch to position 7. As the switch leaves position 6, the stepping magnets release, advancing the brush assembly of the master switches one terminal, giving access to sender selector switch 1. The (AX) relay releases in position 7 and ground from cam (O-25) (SA wiring) or thru the SY and RS2 arcs (SB wiring) advances the (R-25) switch to position 17.

6.2 Test Sender Switch Normal R25 Pos. 17

In position 17 a test is made to insure that the selected sender switch is on normal. A circuit is closed from battery through the (R-25) magnet, cam (D-25) normal terminal and brush of arc (TST) of sender switch 1, terminal 1 and brush of arc (TST) of master switch 2, (MS) relay operated, cam (S-25) to ground on (ST) key, advancing the (R-25) switch to position 18. This serves as a test for the selected sender switch since it must be in its normal position before the (R-25) switch will advance from position 17. Should the (R-25) switch remain in position 17 an abnormally long time, the time alarm circuit operates and functions as will be described under TIME ALARM CIRCUIT.

6.3 Advancing Sender Switch R25 Pos. 18

In position 17 3/4 to 18, ground from 3S3-025 (SA wiring) is connected through the (MS) relay operated, cam (G-25) (SM) brush and terminal 1 of master switch 2, to the winding of the magnet of sender selector switch, and also through the break contact of the selector magnet, terminal 1 and (AX) brush of master switch 1, cam (I-25), to one side of the inductive winding of the (AX) relay. The other side of the inductive winding of the (AX) relay is connected to ground at the (RS) arc of master switch 2. The selector magnet operates in this circuit and when its break contacts open, the (AX) relay operates, advancing the (R-25) switch to position 1. The (MS) and (AX) relays and the selector magnet release as the switch leaves position 18. The release of the selector magnet advances the brush assembly of the sender switch to the first terminal, thus connecting the test circuit to a sender.

6.4 Test Sender - Busy - R25 Pos. 1

The (T) and (T-1) relays operate as before, advancing the (R-25) switch to position 2 on its second revolution. The (SB) relay operates. Battery through the secondary winding of the (T) relay, T1 relay operated, (TST) brush and terminal of master switch 2, (TST) brush and terminal of sender switch 1, is connected to lead (TST) of the sender. If the sender is busy, the (T) relay is held operated and the sender busy lamp (SB) lights, remaining lighted until the sender becomes idle or the sender switch is advanced to the next sender.

6.41 Manual Pass Busy R1 Pos. 2

The (BM) key operated, connects ground to the winding of the sender selector magnet which operates. It also operates the (BM) relay and the (BNT) or (BY) meter. The (BM) relay operated holds ground connected to the meter after the (BM) key has been released to insure the meter time to operate. When the meter is fully operated, it short-circuits the (BM) relay releasing the relay. The release of the (BM) relay or key releases the meter. When the key is released, the sender selector magnet releases advancing the sender switch to the next sender. If the (BM) key is not operated, when the sender becomes idle the (T) and (T-1) relays release, connecting to the (TST) lead the (T-2) relay, which operates in series with the sender (T) relay.

6.42 Automatic Pass Busy (PB Wiring) R1 Pos. 2

With the APB key operated when the time alarm switch has advanced to the point preceeding the alarm point the (PB)

relay will operate if the (DC1) relay is normal. This operates the (CA) relay and advances the test to the next sender.

6.5 Prevention of Double Connection

Should a district circuit test a sender at the same time that a test circuit is making a busy test, and if the district (L) relay and the (T) relay in the test circuit release simultaneously, thus connecting the district selector and test circuit to the same sender, the (T-2) relay in the test circuit, connected to the (TST) lead by the release of the (T-1) relay, will not operate, since it is short-circuited by ground on the (TST) lead in the district circuit. With the (T), (T-1) and (T-2) relays released, and the (R-25) switch in position 2, ground through the (ST) key operated, (CA) relay normal, cam (W-25), (T-1) and (AD) relays normal, cam (N-25), is connected to the contacts of the 149-K interrupter (DC). When the interrupter contact B closes, the (DC) relay operates, and locks independent of the interrupter, in the circuit just described. When the 149-K interrupter closes its F contact, the (REP) and (CA) relays operate. The (REP) relay operated, locks and opens the circuit which advances the sender switch. The (CA) relay operated, locks and advances the (R-25) switch to position 17. Circuit: ground on cam (O-25) relays (MS), (S) and (EC) normal, (ST) key and (CA) relay operated, cam (D-25) to the (R-25) magnet. As the (R-25) switch passes position 2 1/2, the (DC-1) relay operates thru the make contact of the (DC) relay, and locks to ground on cam (W-25). The (DC-1) relay operated, opens the operating circuit of the (DC) relay. When the (R-25) switch left position 3, the (DC) relay released. The (R-25) switch advances from position 17 to position 18. Circuit: battery, (R-25) magnet, cam (B-25), (CN) relay normal, (CA-2) relay normal (QB wiring), (CA) key normal, (MS) relay normal, to ground on cam (S-25); or when the (CN) relay is operated, cam (C-25), (F) contact of the interrupter, (KT) relay normal (AK wiring), (SC) and (CT) relays normal, (CA) key operated, (MS) relay normal, to ground on cam (S-25). In position 18 the (AX) relay operates through cam (K-25), to ground on the (RS) brush of master switch 2. The (AX) relay operated, advances the (R-25) switch to position 1, releasing the (CA) and (REP) relays. The operation is the same from this point as described above, except that if the sender is still busy, ground on lead (TST) holds the (T) relay operated, which in turn lights the sender busy lamp, also the (TLT) lamp. As the (R-25) switch leaves position 2 the (DC-1) relay releases.

6.6 Open Test Lead Test R25 Pos. 2

In case the test lead of the sender is open, the operation of the test circuit is the same as described in paragraph 6.5. The (R-25) switch advances from position 1 to position 2 on the second

revolution but the (DC) relay does not again operate since the (DC-1) is locked up and the (R-25) switch is blocked in position 2. The (TLT) lamp lights and the alarm circuit operates giving an audible alarm. The automatic pass busy feature is ineffective as the (DC-1) relay is operated.

6.7 Test Sender - Idle

When the sender selector switch connects to the terminal of an idle sender, the (T) and (T-1) relays release. The (T-1) relay released, closes the (TST) lead of the sender, through the winding of the (T-2) relay, to ground through the (PC) key and SS2-R25, holding the sender busy to all district selectors and operating the (T-2) relay and the sender (T) relay. The (T-2) relay operated, operates the (AD) relay. The (AD) relay is made slow to release so that it will not release in case the (T-2) relay is released momentarily, by a bridging brush connecting ground from an adjacent busy terminal to the test lead. The (AD) relay operated, operates the (CI) relay and advances the (R-25) switch to position 3, the (A) cam advancing it to position 4. The (CI) relay operated, connects leads (FT), (FR), (T) and (R) from the sender, through to the testing circuit; and closes lead (SC) to battery through 1600 ohms resistance to operate the sender (SC) relay. If the (SC) relay in the sender fails to operate, the sender will fail to function, and will block the test circuit. After sufficient time has elapsed an alarm will be given. The (R-25) switch remains in position 4, during the test on the sender.

7. FIRST TEST MECHANICAL DIRECT ABX

Provision is made to enable the testing circuit to test the sender on a mechanical direct call to an automatic PBX. This class call is the first of a series arranged for on the multi-test basis. However, since the senders are not equipped to make PBX selections this test is skipped.

7.1 Skipping First Test

With R25 switch in position 4 the route control switch R1 is advanced to position 2 over the B1 cam, make contact of the (MT) key, cam W-20 cam R-24, cam E-25, (AD) relay operated, (T1) and (CA) relays normal, the (ST) key operated, normal contacts of the (EC), (S) and (MS) relays, to ground at SS3-025. When the route control switch reaches position 2 it advances directly to position 3 by local ground at the B2 cam. The (R1) relay operates through the UI cam, the break contact on the (CH) relay to ground over the circuit for advancing the (R1) switch to position 2. The operation of the (R1) relay connects battery to the winding of the (DB), (DG), (OB), (OG), (CDA), (CDB) and (CDC) relays. Ground through the various cams of the (R1) switch in position 3 is connected through cross

connections to advance the register sequence switches for controlling the code, district brush, district group, office brush and office group selections. A lead which is marked with a number is cross connected to a lead bearing the same number. A lead marked with a cross as may be required by the particular conditions under which the circuit is to be used.

As each register switch is set a circuit is closed to operate the associated relay and when all the register switch relays are operated a series circuit through the relay contacts advances the numerical switch (R2) to position 2. This circuit is through the (NC) relay normal the (CDC), (CDD), (CDA) relays operated, cam (FS), relays (OB) and (DG) operated to ground on the make contact of the (DG) relay. Since the office group switch is not required to be set the (OG) relay is not operated.

The (R2) switch immediately advances out of position 2 by local ground at the (B2) cam.

8. SECOND TEST MECHANICAL DIRECT

This test is for the purpose of checking the operation of the sender in controlling a mechanical direct class call. With the (R2) switch in position 3 the class switch (R4), compensating resistance switch (R23), talking selection, and the several numerical control switches are set from ground on various cams of the (R2) switch through the corresponding cams of the (R1), (R4) etc. switches to battery through the winding of their respective (R) magnets.

The class switch (R4) advances from the position in which it was last used to position 2 for this class of call and the numerical switch advances from the position last used and take a setting to register number 9689. The numerical switches are wired for registering a particular number which is assigned for each routine test on a multi-test basis. The compensating resistance switch and the talking selection switch are cross-connected to meet the actual working conditions under which the sender circuit is used.

For this test, assume the compensating resistance switch (R-23) in position 7, and the talking selection switch (R-5) in position 3. As the class, talking selection and compensating resistance switches take their positions, the (CL), (TS), and (CR) relays operate from battery, make contact of (MI) relay, winding of the (CL), (TS) and (CR) relays in multiple, cams of the corresponding switches, cams of the numerical switches to ground.

For coin senders only, when the class switch (R-4) is set, the (CN-1) and (CN-3) relays operate. Circuits: battery, winding of the (CN-3)

relay, lead 1, and battery winding of the (CN-1) relay, lead 5, cam L-4, cam J-25, (CN) relay operated, CA key and (MS) relay normal, to ground on cam S-25.

The operation of the (CN-1) and (CN-2) relays differentiates between tests to be made on coin and non-coin senders as hereinafter described.

8.1 Priming the Sender R25 Pos. 4 R24 Pos. 1

The (DY) relay operates over the dialing loop as soon as the C1 relay operates. With all of the numerical switches set and relays (CL), (CR), (TS) operated ground is connected to the armature of the (DY) relay. The closure of the F contact on the 149-W interrupter operates the (IN) relay. Circuit: secondary winding (IN) relay, F contact, (DY) relay operated, cam (V-20), lead 4, numerical registers set for number 9689, cam (R-2), (CL), (TS) and (CR) relays operated, make contact (MT) key, lead 5, cam (W-20), lead 2, cam (R-24), cam (E-25), (AD) relay operated, (T-1) and (CA) relays normal, make contact of (ST) key, (EC), (S) and (MS) relays normal, cam (O-25), ground. The (IN) relay locks over the same circuit and when interrupter contact B closes the (R-24) switch advances to position 2 over the same circuit. As the (R-24) switch leaves position 1, the (DY) relay and the (L) relay in the sender circuit release, releasing the (IN) relay. As the (R-24) switch passes position 1 1/2 the (AV) relay operates and locks. Circuit: leads (L) and (D) cam (D-22) to ground on the (ST) key, or, when the (LS) relay is operated, through the make contact of the (LS) relay, lead H, cam (D-21) to ground on the (ST) key. For this test the (LS) relay is not operated. With the (R-24) switch in position 2, the impulser switch (R-3) advances from position 1 to position 2, and the pulsing circuit also is closed, operating the sender (L) relay. The pulsing circuit is traced from battery through the winding of the (L) relay in the sender, (R) over the ring, terminals 4-4' (C1) relay contact, contacts (DT) relay if used, cam (T-24), lead (I), 500w, lead A normally closed contact of "L" dialing interrupter, cam (H-24), lead (N), 500w, lead M contacts of (DT) relay if used, lead 84A normal contact of (TN) relay, or thru tone coil, ("R" wiring) lead 92A (CI) relay contacts, terminal 3-3', back over the tip to ground through the winding of the balancing coil in the sender.

8.2 Preliminary Pulse R25 Pos. 4, R24 Pos. 1-2

The release and reoperation of the sender (L) relay as the (R-24) switch passes from position 1 to 2 simulates a preliminary pulse condition on the sender. When the interrupter closes its (F) contact the (PP) relay operates and locks to ground on cam (K-24). The operation of the (AV) and (PP) relays causes the high speed interrupter switch to advance through one complete revolution. Circuit: battery, winding (R-22) magnet, cam (B-22), lead (B), (LS) relay normal, lead (J),

(AV) and (PP) relays operated, cam (G-24), lead 3, cam (K-4) to ground. During the one complete revolution of the switch the contact of cam (L-22) opens and closes ten times, producing ten impulses representing the maximum loop, fast pulse condition imposed by the dial for controlling the sender. As the interrupter revolves, the pulsing circuit is opened at cam (L) ten times for each revolution. Cam (L) may be short-circuited through the other cams on the interrupter and register switches. Therefore the setting of the register switches determines the number of impulses transmitted to the sender.

8.3 Setting A and B Registers in Sender

As previously stated, the code switches for this test are set in positions 3 and 5. With the first code switch set in position 3, only two pulses are sent, as interrupter cam (L) is short-circuited in all positions except 3 and 4. These two pulses set the sender (A) register in position 2. The short-circuit around cam (L), is closed from cam (H-24), cam (J-24), cam (O-11), cam (N-11), cam (F-22), in position 4 3/4 to 18. As the pulse interrupter switch leaves position 2, the (AV) relay releases. As switch (R-22) leaves position 12 the (PP) relay releases. When the interrupter switch reaches position 13 the (R-24) switch advances to position 3. Circuit: winding (R-24) magnet, cam (C-24), lead (K), lead (C), cam (D-22), to ground on the (ST) key. As the switch passes position 2 1/2, the (AV) relay operates, and locks over the circuit previously described to ground through cam (D-22). The (PP) relay remains locked. When switch (R-22) reaches position 1 it is advanced over the same circuit as before and makes another revolution, sending pulses over the impulse circuit, to set the (B) register in the sender. The short-circuit around the (L) cam is closed through the cams of the second code switch, sending four pulses. The (AV) relay releases as previously described advancing the (R-24) switch to position 4.

8.4 Setting the Numerdcal Registers in Sender

Since for this class of call there is no 10,000 digit, the (R-24) switch advances immediately to position 5. Circuit: battery, winding (R-24) magnet, cam (D-24), lead 3, to ground through cam (K-4). The numerical registers in the sender are set for the test number 9689, in a similar manner to that just described for setting the (A) and (B) sender registers. Pulses for one digit are sent in each position of the (R-24) switch, from position 5 to position 8. When the pulses for the units digit have been sent, the (R-24) switch advances to position 12, by class ground at SS3-D24. As the switch passes position 11 3/4, the (T) and (R) leads are disconnected from the pulse interrupter at cam (H-24) and are closed through the 27-A repeating coil. The circuit is traced as follows: lead (T) from the sender, lead (M),

500w, lead (N), cam (U-24), winding of the 27-A repeating coil "S" wiring, lead 1, cam (Q-4), lead 3 and (O), break contact of the (MAY-1) key, cam (D-1), lead (I), cam (T-24) position 12, over the ring lead to the sender. This circuit holds the sender (L) relay operated. With the (R-24) switch in position 11/12 the (CH) relay operates. Circuit: battery, winding lead 3, (MT) key, cam (P-24), lead 2, to ground on cam (I-3). The (CH) relay operated, (a) locks to ground through cam (S-1) and (E-1), (b) releases the (RI) relay and in turn releases the (DB), (DG), (OB), (CDA) and (CDB) relays, (c) operates the (MC) relay. The (MC) relay operated, releases the (NI) relay, locks, and closes a circuit from ground on its armature, lead 6 and 103, cam (B-24), to battery through the winding of the (R-24) magnet, advancing the switch to position 13, the (A) cam advancing it to position 14. The (NI) relay released releases the (CL), (CR) and (TS) relays. Since the (CH-1) relay is not operated the (R-24) switch advances to position 17.

8.5 Tone for Sender Monitor "R" Wiring

At all times when pulses are not being dialed into the sender the (TN) relay is operated which places a distinctive tone on the "T" and "R" leads for the sender monitor.

8.6 Checking The Sender

The impulse switch (R-3) is in position 2, having advanced off normal, from ground on cam (K-24), as the latter switch entered position 2. When the (R-6) switch is set the (DB) progress lamp and the #0 match lamp light from battery on cam (H-20). When translation in the sender is completed the tip side of the fundamental circuit is closed operating the (L) relay in the impulse circuit and the sender (STP) relay. Circuit: battery, winding of the (L) relay (10-2) and (L-1) relays normal, (AV) key normal, ("Q" wiring) (SS) relay normal, (CK) relay normal, cam (N-3), cam (S-20), (TF2) and (F1) relays normal, cam (Q-24), (CI) relay operated, arcs (FT) of master and sender switches, through the stepping relay and associated apparatus in the sender circuit to ground. The (L) relay operated, (a) locks through the break contact of the (10-2) relay and its own make contact and over the fundamental circuit as just traced, (b) operates the (L-1) and (L-2) relays through cam (M-3), (c) connects ground through the 6 type interrupter, to one side of the windings of the (P), (P-1) and (P-2) relays. The (L-1) relay operated, locks thru the secondary winding the (SS) relay normal the "AV" key to ground on cam (K-3), and opens the operating circuit of the (L) relay which is now locked through its make contact. The operation of the (L-2) relay opens the operating circuit of the (D) relay. The first closure of the 6 type interrupter operates the (P) relay. Circuit: ground through the interrupter,

(L) relay operated, (P-1) relay normal, cam (F-3), lead 5, cam (H-20) to battery. The operation of the (P) relay closes a circuit from one side of the windings of the (P-1) and (P-2) relays, cam (E-3), lead 9, to ground on cam (O-20). When ground is removed at the interrupter the (P-1) and (P-2) relays operate in series with the (P) relay, to battery on cam (H-20). The operation of the (P-1) relay connects the second ground pulse through the interrupter, winding of the (O) counting relay, cam (F-3), lead 5, to battery on cam (H-20), operating the first counting relay. When the interrupter again removes ground from the circuit, the (O') relay operates in series with the (O) relay, both relays locking through cam (E-3) lead 9, to ground on cam (O-20). The operation of the (O') relay transfers the pulsing lead to the winding of the (1) counting relay. The operation of the (P-2) relay connects ground from the interrupter to the fundamental circuit, short-circuiting the releasing the stepping relay in the sender. In this way, the interrupter sends back the pulses to the sender, simulating the (A) commutator in the district circuit, releasing and reoperating the stepping relay, and operating the sender counting relays, until sufficient impulses have been sent to satisfy the sender. At the same time the impulses cause the operation of the counting relays in the impulse circuit. When the sender is satisfied, the fundamental circuit is opened, and the (L) relay releases, disconnecting the interrupter from the counting relays.

8.7 District Brush

For the code set up for this test, the cross connections are assumed to be such as to require district brush 0, district group 8, and no office selections. Therefore, for the district brush selection, one impulse satisfies the sender, and the (L) relay releases, leaving the (O) and (O') relays only, locked. The release of the (L) relay releases the (L-2) relay, operating the (D) relay. Circuit: battery, winding of the (D) relay, cams (C-20), and (G-20), cam (I-6), lead (O), (1) counting relay normal make contact of the (O) counting relay, to ground. This circuit is completed only when the number of operated counting relays in the impulse circuit agrees with the number recorded by the setting of the district brush switch (R-6), showing that the sender has functioned correctly. The (D) relay operated advances the (R-20) switch to position 2, by ground from the blocking relay normal or the "REP" and "TA" keys operated, which position and (D) relay releases. The (P), (P-1), (P-2) and all the operated counting relays release as the (R-20) switch leaves position 1 1/4, and the (DB) progress and #2 match lamps are extinguished.

8.8 Sender Fails

If the number of pulses required to satisfy the sender differs from the number required by the setting of the district brush register switch, the circuit for the (D) relay is open at the contacts of the counting relays and it does not operate. The (R-20) switch will,

therefore, remain in position 1. In this event, the (DB) progress lamp and the zero match lamp remains lighted, indicating that the failure has occurred in selecting district brush 0. When the time alarm circuit has counted a certain period of time, a lamp lights and an audible signal is given. The pulse lamp (PL) key is now operated operating the (PL) and (PL-1) relays which light the lamp which corresponds to the number of pulses received by the sender. Suppose that in this case 4 pulses were required to satisfy the sender. The (0), (1), (2) and (3) counting relays with their corresponding prime counting relays would be locked up, and the 3 lamp will light. Circuit: battery (PL-1) relay operated, 3 lamp, (4) counting relay normal, (3), (2), (1) and (0) counting relays operated, cam (E-3), lead (9), to ground on cam (0-20). The (CA) key is operated as described in paragraph 29.06, to advance the test.

8.9 SC Lead Check; MB Wiring

While the R20 switch is in position 1 the SC lead which was closed by the operation of the (CI) relay applies an operate test of 1600w to the (SC) relay. When the R20 switch arrives in position 2 the (SN2) relay operates closing the progress lamp and SC lead. The (SN) and in turn (SN1) relays operate, closing the SC lead directly to the (SN) relay from SS4-Y20 and closing the checking lead to the (D) relay at SS2-G20. When the selection checks ok , the advance of the R20 switch and release of the (SN-2) relay leaves the (SN) relay locked thru the (SN-1) relay. If the SC lead opens permitting that relay to release, the path for advancing the R3 switch remains open.

8.10 District Group "MA" Wiring

Assuming that the district brush pulses checked correctly, the (R-20) switch is advanced to position 2 by the operation of the (D) relay, as explained in paragraph 8.7. The sender advances to district group selection position reducing the resistance on the (SC) lead sufficiently to operate the (SN) relay but not the (MG) relay. The (SN) relay operated operates the (SN-1) relay. The (R-3) switch then advances to position 3. Circuit: battery, (R-3) magnet, cam (B-3), lead 7, cam (N-20), (SN-1) and (MG) relays normal, cam (W-4), (D) and (BP) relays normal, cam V24 to ground at the "ST" key etc. As the (R-3) switch advances to position 3, the (L-1) relay releases, closing the fundamental circuit as traced in paragraph 7.3. Relays (L), (L-1), (L-2), (P), (P-1) and (P-2) reoperate as explained for district brush selection. The pulses are counted as before, except that the battery and ground for the pulse and counting relays are supplied over leads 6 and 10 in district group selection. Since district group 8 is required by the register setting, 9 pulses will be required by the sender. The operating circuit for the (D) relay is through a cam of the district group register switch, lead 8,

break contact of counting relay (9), make contacts of all other operated counting relays to ground on cam (O-20). The operation of the (D) relay advances the (R-20) switch to position 3, releasing the pulse and counting relays and the (D) relay. The (R-3) switch now advances to position 4. Circuit: battery, winding (R-3) magnet, cam (B-3), lead 8, cam (N-20), (SN-1) relay operated, (MG) relay normal, cam (W-4), (D) relay normal, (BP) relay normal.

8.11 Office Selections

The fundamental circuit for office selection is traced from battery, winding of the (L) relay, (10-2) and (L-1) relays normal, (AV) key, (SS) and (CK) relays normal, cam (N-3), cam (S-20), (TP2) and (F1) relays normal, cam (Q-24), (CI) relay operated, master and sender switches, lead (FT), winding of sender stepping, overflow and (TG) relays, lead (FR), master and sender switches (CI) relays, cam (R-24), one 18-AF resistance (assuming the compensating resistance switch in position 7), cam (J-23), (P-20), to ground on cam (O-20). The (TG) relay in the sender operates advancing the sender to the position for office brush selection but the (L) relay in the test circuit does not operate. When the fundamental circuit again closes, the (TG) relay and resistance are short-circuited, lowering the resistance in series with the (L) relay sufficiently to allow it to operate. The office selections are checked in the same manner as the district selections. The circuit is so arranged that 300 ohms of the compensating resistance is short-circuited through cam (X-20), during office group, incoming group and final tens selection, for the purpose of giving an absolute minimum of 900w in the total fundamental resistance (normal minimum 1200w).

8.12 Skip Office

For this particular test, office selections are skipped. The (D) relay operates to ground on office brush cam (I-8), and advances the (R-20) switch immediately to position 5. In position 5, ground on cam (H-4) advances the (R-20) switch to position 6. The (R-3) switch advances from position 3 to position 5 from ground on cam (O-20), and to position 6 for "incoming test" through contact (B) of the 149-K interrupter, to ground at SS2-L24 when the hundreds digit has been dialed. The (L) relay releases as soon as the (R-3) switch starts advancing. While the (R-20) and (R-3) switches are advancing through the office positions on a skip office test, the (L-1) relay is held operated through cam (K-3), lead 1, to ground on office brush cam (I-8). The fundamental circuit is thus held open, preventing the (L) relay from operating until the (R-3) and (R-20) switches are in their proper positions.

8.13 Trunk Guard Test

The fundamental circuit is closed and the sender (TG) relay is tested for non-operate. Lead (FR) is connected to ground on cam (U-20), and lead (FT) is connected through cam (N-3), to 48V battery through two 40-P resistances (12400 ohms) or to 24 volts without resistance. This represents the most severe non-operate condition of the sender (TG) relay. The (R-3) switch remains in position 6 for a period of 1 second after which it advances to position 7, under control of the 149-K interrupter F. The (A) cam advances it to position 9. In positions 7 and 8 the (TTG) relay is connected in the fundamental circuit in place of the non-operate test. If the (TG) relay in sender operated while the test circuit was in position 6, (non-operate test), the (TTG) relay will operate, lighting the (TTG) lamp and operating the (CK) relay. The (CK) relay operated, locks to ground opening the fundamental circuit and thus preventing the operation of the (L) relay. This blocks the test circuit. When sufficient time has elapsed the time alarm gives an audible and visual signal. If the (TG) relay in the sender has not operated, the (TTG) relay does not operate, due to the high resistance in the sender circuit. When the (R-3) switch reaches position 9, battery through the winding of the (L) relay is connected to the fundamental circuit operating sender (TG) relay but not the (L) relay in the test circuit. The sender is advanced lowering the resistance in series with the (L) relay, causing it to operate.

8.14 Incoming Brush

Incoming brush selection is checked in a manner similar to that of district selections. The fundamental circuit for the incoming selections is the same as described for office selection except that 600 ohms compensating resistance is included instead of 300 ohms. Since for this call, the (TD) switch is set in position 10, 9 impulses were sent to the sender, and incoming brush 4 selected under control of the sender translator; therefore, 5 impulses are required to satisfy the sender. When the (L) and (L-2) relays release, the (D) relay operates to ground on cam (O-20). The operation of the (D) relay advances the (R-20) switch to position 7. The (D) relay releases when the (R-20) switch passes position 6 1/4. The (R-3) switch is advanced to position 10 through cam (B-3), over lead 8, cam (N-20), (SN-1) relay operated, (MG) relay normal, cam (W-4), (D) and (BP) relays normal to ground at the "ST" key.

8.15 Incoming Group, Final Brush, Final Tens

Incoming group 4, final brush 1, and final tens 8 are checked in the same manner, the (R-20) switch being advanced by the

operation of the (D) relay, the operating circuit of which passes through the master switch for each selection in turn, break contact of the first unoperated counting relay, and make contacts of the operated counting relays. If any of the selections does not check, the test is blocked, since the operating circuit for the (D) relay will not be closed. The blocking of the (R-20) switch lights a progress and match lamp as already described and the operation of the (PL) key lights the lamp showing the number of pulses required to satisfy the sender.

8.16 Final Units, Selections

With the (R-24) switch in position 17, the fundamental circuit is closed, and final units are checked as already described. When units selection has been checked the (D) relay advances the (R-20) switch from position 10. Ground from SS3-H4 advances the R20 switch to position 14 where ground on cam (P-20) advances the (R-3) switch to position 17.

8.17 Incoming Advance

When the incoming selector advances to its trunk closure position, after the final selection has been made, battery and ground are applied to the tip and ring of the fundamental circuit in a reversed direction, with respect to regular selections, operating the overflow relay in the sender and advancing the sender for talking selection. The test circuit simulates this by connecting battery thru the winding of the (L) relay to lead (FR) instead of lead (FT). The (L) relay operates advancing the (R-3) switch to position 18. The fundamental circuit is opened and the (L) relay released as the switch leaves position 17. When the advance relay in the sender has operated, the resistance of lead (SC) is increased in the sender, releasing the (SN) relay which in turn releases the (SN-1) relay, and the (R-20) switch advances to position 15. Ground on cam (Q-20), through cams (L-3) and (G-24) advances the (R-24) switch to position 18. In position 18, the (T) and (R) leads are opened, releasing the sender (L) relay, and the (SC) lead is opened.

8.18 Incoming Advance - Immediate Closure

After the check for final units selection is completed the (RB) relay operates in series with the (D) relay and locks on its S winding. The fundamental ring is opened and connected to the (L) relay and the fundamental tip is grounded. The R20 switch advances to position 14 by ground from SS3-H4 and the (R-3) switch then advances to position 17. The (L) relay operates as soon as the sender closes

the fundamental for incoming advance and when the (R-3) switch arrives in position 17. The (RB-1) relay operates, releasing the (RB) relay and the test continues as in paragraph 8.17.

8.19 Fundamental Circuit Test

If testing circuit for 2 digit subscriber's senders is used the operation of the (L) and (F) relays operates the (RB1) relay which advances the R3 switch to position 18. As the impulse switch leaves position17, the reverse battery fundamental circuit is opened and the (L) relay releases. The release of the (L) relay allows the operation of the (F1) relay which introduces relays (TF) and (TF1) to test the fundamental tip and ring leads of the sender for crosses or grounds which in service might result in false trunk closure. If either of these relays operate the (TF2) relay operates and locks opening the fundamental tip and lighting the "TF" lamp.

When the (ADV) relay in the sender has operated ground through the high resistance is introduced in the SC lead circuit releasing the testing circuit (SN) and (SN-1) relays, which advances the impulse switch R20 to position 15. The dial control switch R24 is advanced to position 18. In leaving position 17, the control switch R24 opens the tip and ring leads releasing the sender (L) relay. The testing circuit (F) and (F1) relays release and the fundamental circuit is closed for talking selection through the test circuit (L) relay to ground in the sender.

8.20 Talking Selection

For talking selection, the fundamental circuit is closed through the winding of the (L) relay as for other selections, to ground in the sender circuit. The (L) relay functions as on the other selections to send and count impulses until the sender is satisfied, and then releases. The release of the (L) relay releases the (L-2) relay. If talking selection checks, the (R-20) switch is advanced to position 16 by the operation of the (D) relay. The (D) relay operates through cams (C-20) and (F-20), cam (T-4), lead 5, cam (G-5) (set in position 2), lead 1, break contact of counting relay 2, (two pulses being required to satisfy the sender for talking selection as determined by the position of the talking selection switch), make contact of the counting relays (1) and (0), cam (E-3), lead 9 to ground through cam (O-20).

8.21 Resetting the Switches

As the (R-20) switch enters position 16, the (R-3) switch advances to position 1. Circuit, ground on cam (Q-20), cam (M-24),

cam (B-3) to battery thru the (R-3) magnet. When the (R-3) switch reaches position 1, ground on cam (J-3) operates the (D) relay which advances the (R-20) switch to position 17. With the (R-20) switch in position 17, the (R-1) switch advances to position 4. Circuit: ground, cam (Q-20), lead 5, make contact of the (MT) key, lead 7, (CH) relay operated, (R-1) magnet to battery. The (CH) relay releases, as the (R-1) switch leaves position 3 operating the (RI) relay. Circuit: battery, (RI) relay, cam (U-1), (CH) relay normal, lead 7, make contact of the (MT) key, lead 5, cam (Q-20) to ground. The district brush and group, office brush and group, and two code letter register switches are set as described in paragraph 7.1 under control of the cross connections to the route control switch (R-1). As each register switch is set, the relay associated with it operates from battery on the make contact of the (RI) relay, to ground on the cams of the (R-1) switch. When all the relays are operated, the numerical switch (R-2) advances to position 4. Circuit: battery, (R-2) magnet, (NC) relay operated, make contacts of register relays, (DB) relay operated to ground. As the switch leaves position 3, the (NC) relay releases, operating the (NI) relay, to ground on the make contact of the (DB) relay. The advance of the (R-2) switch sets the numerical register switches (no change), class, compensating resistance and talking selection switches in positions controlled by the numerical switch. As each switch is set, its associated relay operates from battery on the make contact of relay (NI), to ground on the cams of the (R-2) switch.

8.22 Sender Restored to Normal

When all register switches are set, the (T) relay operates. Circuit: F winding of (T) relay, cam (F-25), make contact of the (MT) key, lead 6, cam (V-20), lead 4, contacts of the numerical register cams, set for the number 9669, lead 72, cams (S-2) and (R-2), (CL), (TST), and (CR) relay operated, make contact of the (MT) key, lead 5, to ground on cam (Q-20). The (T) relay operated, operates the (T-1) relay. The (T-1) relay operated; (a) disconnects ground from the (TST) lead, thus allowing the sender to return to normal, and releasing the (T-2) relay, (b) advances the (R-20) switch to position 18 (Circuit: battery, (R-20) magnet, cam (B-20), lead 3, cam (T-25), (T-1) relay operated, (S) relay normal to ground) (c) connects battery through 17,500 ohm winding of the (T) relay to lead (TST), holding the (T) relay operated until the sender is restored to normal. Ground through 80 ohms is connected to lead (TST) by the sender to hold the terminal busy until all the sender register switches have reset. The ground is then removed. The (T-2) relay released, releases the (AD) and (CI) relays. When the sender returns to normal, ground is removed

from lead (TST) releasing the (T) and (T-1) relays, and reoperating the (T-2), (AD) and (CI) relays as previously described for the first test. When the (R-20) switch reaches position 18 the (R-24) switch returns to normal in a circuit through cam (C-24), lead 10, to ground on cam (C-20). The (DY) and (IN) relays reoperate as previously described in position 1 of the (R-24) switch. When the (B) contact of the interrupter makes, ground through the interrupter contact, make contact of the (IN) relay to cam (B-24) advances the (R-24) switch to position 2. The (R-20) switch is advanced from position 18 to position 1 by ground on cam (L-24). The (R-25) switch remains in position 4. The circuit is now ready for the next test "INCOMING OVERFLOW".

9. THIRD TEST - INCOMING OVERFLOW

The purpose of this test is to check the operation of the sender when an incoming selector goes to overflow. For this test, the numerical code, district and office registers remain in the position last used. The maximum line condition is used. The (LS) relay operates over lead 12, (HS) and (LS) keys lead 3, to ground on cam (T-1). The operation of the (LS) relay transfers the pulsing circuit from the high speed to the low speed pulse interrupter to produce the most severe slow pulse condition. The fast and slow pulses are obtained by having one switch geared to revolve twice as fast as the other. (Coin senders only) The (R-4) switch is set in position 3, opening the circuit of the (CN-1) and (CN-3) relays at cam (L-4). The release of the (CN-1) relay causes the preliminary coin test to be omitted.

9.1 Priming the Sender

The impulses are sent to prime the sender, as for a mechanical direct call. Positions 4, 9, 10 and 11, of the (R-24) switch are passed, since a 10,000 digit, and stations digits are not required, the (R-24) switch being advanced through these positions by ground on cam (K-4). With the (R-24) switch in position 12, the (CH) relay operates to ground on cam (I-3), locks to cam (S-1) and operates the (NC) relay. Ground on the make contact of the (NC) relay advances the (R-24) switch to position 13, the (A) cam advancing it to position 14. (See paragraph 8.4). Ground on the break contact of the (CN-1) relay, advances the (R-24) switch to position 17.

9.2 Checking the Sender

The selections are checked as in the case of full mechanical calls until incoming group selection has been checked. The (R-20) switch being in position 7, the (D) relay operates, advancing the (R-20) switch to position 8. In position 7 1/2 to 13, ground from cam (I-4), to cam

(C-20), holds the (D) relay operated, advancing the (R-20) switch to position 14, where the (D) relay releases. The (R-3) switch is advanced from position 16 to position 17 by ground on cam (P-20). Ground on cam (M-4) advances the (R-3) switch to position 18. As the (R-3) switch passes through position 17, battery and ground are reversed over the fundamental circuit including the added resistance at cam SS4-T20. The reversal of battery operates the overflow relay in the sender which advances for talking selection. This reproduces the condition in the sender when an incoming selector goes to overflow. The sender should now restore the district and office circuits to normal and then return to normal itself. Four pulses are required by the sender to advance the district to the last talking position, from which it is released as after disconnection. The advance of the sender circuit after the (OFL) relay operates opens lead (SC), releasing the (SN) and (SN-1) relays, which in turn advances the (R-20) switch to position 15. Circuit: battery (R-20) magnet, cam (B-20), (SN-1) and (MG) relays normal, cam (W-4) to ground on the break contact of the (D) relay. Talking selection is then checked. The talking selection switch must be set in position for the maximum number of pulses for this test, as this number will be required by the sender. The (R-20) switch is advanced to position 16 by the operation of the (D) relay, if the impulses for talking selection check. Should the overflow relay in the sender fail to operate, the sender will not advance and release the (SN) relay, thus the (R-20) switch is blocked in position 14, and when a sufficient length of time has elapsed, an alarm will be given.

9.3 Resetting the Switches

When the (R-20) switch reaches position 17, ground on cam (Q-20) through the make contact of the (CH) relay advances the (R-1) switch to position 5. As the switch leaves position 4, the (CH) relay releases. The release of the (CH) relay sets the register switches for testing calls to the zero operator. When the registers are set, ground through the make contact of the (NC) relay, advances the (R-2) switch to position 5.

10. FOURTH TEST - ZERO OPERATOR

This test is for the purpose of checking the operation of the serder on a call to a special "A" operator. For this test, the class switch (R-4) is set in position 5 and the (CDA) switch in position 1, but the (CDB) and numerical registers remain in the position last used. The (CR) and (TS) registers for this test are cross connected so as to produce conditions in the sender equivalent to those obtained by dialing zero in register service. The settings of the (DB), (DG), (OB) and (OG) switches are controlled by that one of the (CL) relays which is operated. The

maximum line is used, and the low speed interrupter, the (LS) relay being held operated with the (R-1) switch in position 5.

10.1 Priming the Sender

The priming of the sender requires only one set of ten pulses which are set in position 2 of the (R-24) switch. With the (R-24) switch in position 3, ground on cam (J-4), advances the (R-24) switch to position 12. When the (R-3) switch is in position 2, the (CH) relay operates, operating the (NC) relay which in turn advances the (R-24) switch. The latter stops in position 17.

10.2 Checking the Sender

The district and office selections are checked as on the previous tests. The (R-20) switch reaches position 6 and the (R-3) switch reaches position 6. If the sender has functioned properly, the (SC) lead resistance is now increased due to the operation of the (ADV) relay in the sender. This releases the (SN) and (SN-1) relays advancing the (R-20) switch to position 8. In position 8, the (D) relay operates to ground on cam (I-4). The (R-20) switch advances to position 14 and immediately to position 15. With the (R-20) switch in position 14, the (D) relay releases and ground on cam (P-20) advances the (R-3) switch from position 6 to position 17. The (L-1) relay, operated in position 5 of the (R-3) switch, locks to ground on cam (H-4), holding the fundamental circuit open until the (R-3) switch is in position 17, when the (L-1) relay releases. Ground on cam (M-4), advances the (R-3) switch to position 18. Talking selection takes place and if it checks, the operation of the circuit is as already described. If the sender fails to take the proper setting from the code dialed, it will not advance and release the (SN) relay, and the (R-20) switch will be blocked in position 6.

10.3 Resetting the Switches

When the (R-20) switch reaches position 17, ground on cam (Q-20), advances the (R-1) switch to position 6. In position 6, the (CH) relay releases stopping the (R-1) switch to position 6. The separate settings of the (R-1) switch for the two classes of senders on calls to the two digit operator, is made to provide for cases where coin and non-coin senders make different district and office selections for calls to toll and long distance operators.

11. FIFTH TEST - OPERATOR - TWO DIGIT - NON-COIN

The purpose of this test is to check the operation of the sender as it functions on calls to the toll or special operator. For this test, two

digits are dialed, setting the two code registers in the sender. The register switches are therefore set for sending two sets of code impulses, but the numerical registers remain in the position last used. The district and office register switches are set for the proper code, and the (R-4) switch is set in position 6. The (LS) relay is held operated in position 6 of the (R-1) switch; hence the low speed pulse interrupter is used, and the closures on cams (C-1) and (D-1) give a maximum line condition. The (CN-1) relay remains unoperated and the preliminary coin test is omitted. The priming of the sender and the checking proceeds as already described with the following exception. When the (R-24) switch advances to position 4, after the sending of the pulses for code B, ground on cam (J-4), advances the (R-24) switch to position 12, thus sending only two sets of pulses. The test is completed as described in paragraph 10, and the (R-1) switch is advanced to position 7. Since a holding circuit is closed in position 7 for the (CH) relay the (R-1) switch advances to position 8 and the register switches are set for testing calls using an unassigned code. As the (R-1) switch leaves position 6 the (LS) relay releases.

12. SIXTH TEST - UNASSIGNED CODE AND RESTRICTED SERVICE

This test is for the purpose of checking the operation of the sender when a blank number is dialed, or when a number is dialed to which the calling station has not direct access because its service is restricted. However, when the "repeating coil in" method of selection is used, this test can not be made. Also when there is no code for restricted service calls common to all senders, this test can not be made. In either of the above cases lead (SKC) is connected to lead (A-8) and lead (SKC-1) is connected to (CR-8) causing the (R-1) and (R-2) switches to advance to position 9, skipping this test. Assume however, that the test is to be made. The sender under normal conditions should route these calls to a special operator. For this test, the (R-4) switch is set in position 7 and the numerical register switches set for number 0-0-0-0. The high speed pulse interrupter is used and a maximum line. The pulses are sent as already described. The district and office selections are checked and the circuit functions as described in paragraphs 8.10 and 8.11. The (R-1) and (R-2) switches are advanced one position and the switches reset.

13. SEVENTH TEST - DELAYED WIPE OUT

This test is to check the operation of the sender when a call is abandoned before completion. In regular service, when the receiver is replaced on the switchhook after dialing has been completed, the sender continues to make all selections so that no switch be left off-normal. The counting relays are disconnected however, and all selections are made from the zero counting relay, until final units selection where tell-tale occurs.

13.1 Priming the Sender

When the (R-1) switch advances to position 9, the (LS) relay operates, transferring the pulsing leads of the control circuit to the low speed pulse interrupter. For this test, the maximum line condition is used. The register switches are set for 0-0-0-0, and cross connected to check all selections on 0. The class switch (R-4) is set in position 8. A full mechanical code is used. The (R-24) switch advances thru position 2 and 3 as on former tests, sending pulses for setting the sender (A) and (B) register. Ground on cam (K-4) causes the (R-24) switch to pass position 4. In position 5, a lead from cam (K-21) thru cam (S-4) to cam (J-24) causes the impulser to send four single pulses, in positions 3, 5, 7, and 9. These four pulses set the four numerical registers in the sender for the number 1111. The (T) lead is connected, after position 11 of the (R-24) switch, over leads (M) and (N), cam (U-24), 27-A repeating coil, lead 1, cam (R-20) leads 3, 0, and I, cam (T-24), to lead (R). Ground on cam (X-24), winding of the (CC) relay, lead 13, is connected to the pulsing circuit thru cam (Q-4) at cam (R-20). This coin feature does not perform any useful function at this time.

13.2 Checking the Sender

The pulses are sent into the sender and the selections checked as on the other tests. When the (R-20) switch reaches position 5, the (T) and (R) leads are opened at cam (R-20), releasing the sender (L) relay. The sender then advances connecting low resistance ground to lead (SC), operating the (MG) relay. The previously operated (SN) relay, operated the (SN-1) relay. The (R-20) switch advances immediately to position 6. Circuit: battery (R-20) magnet, lead (9), cam (U-25), lead 8, (MG) relay operated, cam (W-4), lead (12), cam (X-25), (CN) and (CA-2) relays normal, (CA) key, (MS) relay normal, to ground on cam (S-25). From this point on, the test is completed as described in paragraph 13. The remaining selections are checked for zero selections in a manner similar to that described in paragraph 8.6. Should the sender fail to connect release ground to lead (SC), the check circuit will be blocked and an alarm given.

14. EIGHTH TEST - REGISTER CONTROL

This test is for the purpose of testing the register control switch in the sender. A full mechanical code is used, and the numerical registers are set for code numbers 1111. The (LS) relay is held operated to cam (M-2), connecting the low speed pulse interrupter to the pulsing leads; the 500 ohm resistances are short-circuited through cam (C-1), and (D-1), thus

simulating a minimum loop with the 10,000 ohm leak in parallel with the pulsing cam. The (R-4) switch is set in position 9. The method of making the test is identical with that described under "Second test - Mechanical Direct" (see paragraph 8) except that the method of setting the sender numerical registers in the sender, is the same as described for the wipe-out test (paragraph 13.1). The operation of the (CH) and (NC) relays advances the (R-1) and (R-2) switches to position 11, resetting the register switches for the testing of RCI calls, in a manner similar to that already described.

15. NINTH TEST - RCI BELOW 10,000 WITH STATIONS

This test is for the purpose of checking the operation of the sender on calls to manual offices, equipped with relay call indicator trunks. For this test the numerical registers are set for number 6789-M. The other switches are set to suit an RCI code. The (LS) relay operates to ground on cam (T-1), connecting the low speed pulse interrupter to the circuit. The short circuits around 500 ohm resistances are opened in position 11, thus employing a maximum line loop in this test. The (R-4) switch is set in position 11.

15.1 Priming the Sender

The pulses are sent to prime the sender as in any full mechanical test.

15.11 (S) Relay Check

When "H" wiring is used a test of the sender (S) relay is made. The sender (S) relay operates and opens the fundamental circuit if dial pulses are delayed. Similarly the thousands pulses are delayed until the (STS) relay operates. The (STS) relay operates when office brush has been checked and the (R-20) switch is in position 5. The (STS) relay locks and prepares the circuit for advancing the (R-24) switch to the thousands position after the code has been checked. This allows the sender (S) relay to operate. If it does not operate and delay the trunk test the sender will spill wrong RCI pulses prematurely. A premature trunk closure and assignment is simulated at cam M24, closed position 3/7. Since the number is under 10,000 ground on cam (K-4), advances the (R-24) switch through position 4 to position 5. Positions 9, 10 and 11 of the (R-24) switch are passed, due to the closure of the same circuit in those positions. In position 12, the (CH) relay operates to ground on cam (I-3), operating the (NC) relay and advancing the (R-24)

switch to position 13, the (A) cam advancing it to position 14, and ground on the (Cn-1) relay advancing it to position 17.

15.2 Checking District and Office Selections

District brush, district group, office brush, and office group selections are checked as on a mechanical direct call. With the (R-20) switch in position 5 the (DR, RCI) lamp lights and the fundamental tip is closed through cam (M-24), cam (O-24), winding of the (LH) relay and 15300 ohms resistance. The (TG) relay in the sender circuit and the (LR) relay operate. The operation of the (TG) relay advances the sender and the operation of the (LR) relay operates the (G-1) relay. The (G-1) relay operated, (a) supplies locking ground for the register and master relays, and (b) advances the (R-3) switch to position 6. Ground on cam (M-4) advances the (R-3) switch from position 6 to position 12. The (DR) and (DR-1) relays operate thru cam (V-4) to ground on cam (Q-20) and connect leads from the contacts of the (Z) and (W) relays to the stations register and lamp relays. The (G) relay operates through the make contact of the (DR-1) relay, break contact of the (ST) relay, lead (8), cams (W-3) and (T-3), cam (N-4), cam (P-20) to ground. The operation of the (G) relay supplies the locking ground for the register and lamp relays, and operates the (CO) relay, over lead (4), cam (N-4), to ground on cam (P-20). The operation of the (CO) relay simulates the operation of the assignment key at an RCI position. The (FT) and (FR) leads are connected through the make contacts of the (CO) relay, to the winding of the (SN+), (SN-), and (MG) relays. Battery and ground are disconnected from the fundamental circuit, releasing the (TG) relay in the sender and advancing the sender to the position for sending RCI impulses. The (LR) relay is released by the operation of the (CO) relay.

15.3 Registering RCI Impulses

The RCI pulses sent out by the sender are of three classes; battery through a low resistance giving a heavy negative pulse, battery through a high resistance giving a light negative pulse, and reverse battery through a high resistance giving a light positive pulse. A group of four pulses is sent for registering each digit, the pulses for the stations letter being sent first. One or two pulses in a group of 4 may consist of an open circuit.

15.31 Stations

The code set up for this test is 6789-M. For M, the first pulse is open circuit, second a light negative, the third open circuit and the fourth heavy negative. The

lamp relay (D) is to be operated. The operation in order is as follows: The first pulse, open circuit, causes no operation. The light negative pulse over the fundamental circuit operates the (SN-) relay, which in turn closes a circuit from ground on its armature, (Z) relay nor. 1, winding of the (W) relay to battery through the 450 ohm winding of the (Z) relay. This circuit operates the (W) relay but does not operate the (Z) relay. The (W) relay operated, closes a circuit from ground on its make contact, (DR) relay operated, (ST-1) relay normal, to battery through the winding of the (ST) relay, which operates. The (ST) relay operated, connects ground to the (ST-1) relay, which however, does not operate, being short-circuited by ground through the make contact of the (W) relay. The third pulse being open circuit, the operating ground for the (W) relay is removed. A circuit is now closed from ground on the (W) relay operated, 190 ohm winding of the (Z) relay, holding the (W) relay operated and operating the (Z) relay. The operation of the (Z) relay performs no useful function at this time. The last pulse, a heavy negative, operates the (SN-) and (MG-2) relays. The operation of the (SN-1) relay short-circuits and releases the (W) relay, but holds the (Z) relay operated. The operation of the (MG-2) relay closes a circuit through the (Z) and (DR-1) relays operated, (ST-1) relay normal, operating the (D-3) relay. The (D-3) relay operated; (a) locks to ground through its windings in series, (b) closes in part a circuit for lighting a progress, a match and an RCI lamp. The release of the (W) and (Z) relays removes the short-circuit from the winding of the (ST-1) relay, allowing it to operate in series with the (ST) relay. The operation of the (ST) and (ST-1) relays, transfers the selecting leads to the thousands lamp relays.

15.32 Thousands

For thousands digit 6, the pulses required are positive, heavy negative, open, light negative; and lamp relays (A) and (B) are operated. The positive pulse releases the (SN-) relay and in turn the (Z) relay from the previous digit, and operates the (SN+) relay which closes a circuit from ground, (SN+) relay operated, (W) relay normal (DR) and (ST) relays operated, (TH) relay normal, operating the (A-4) relay, which locks through both windings in series. The heavy negative pulse releases the (SN+) relay and operates the (SN-) and (MG-2) relays. The operation of the (SN-) relay operates the (W) relay as described above. The operation of the (W) relay,

operates the (TH) relay in a circuit from battery, winding of the (TH) relay, (TH-1) relay normal, (ST-1) and (DR) relays operated, to ground on the make contact of the (W) relay. The operation of the (MG-2) relay closes a circuit from ground on the make contact of the (MG-2) relay, (Z) relay normal, (DR-1) and (ST-1) relays operated, (TH-1) relay normal, to battery through the winding of the (B-4) relay, which operates. The (B-4) relay operated, locks through its windings in series and closes in part a circuit for lighting a progress, a match, and an RCI lamp. The next pulse, an open circuit, allows the (Z) and (W) relays to operate in series, and the last pulse a light negative, releases the (W) relay. The (W) relay released, allows the (TH-1) relay to operate in series with the (TH) relay in the same manner as described for the (ST-1) relay. The operation of the (TH) and (TH-1) relays transfers the selecting leads to the hundreds lamp relays.

15.33 Hundreds, Tens, Units

In a similar manner, the lamp relays (B-5) and (D-5) are operated in the hundredths group for hundreds digit 7, (A-6), (B-6) and (D-6) for tens digit 8; (C-7) and (D-7) for units digit 9. As each set of relays is operated, the corresponding pair of transfer relays is operated.

15.34 Final H.P. Pulse (ZC Wiring & App.)

When the senders are arranged to send a final positive pulse, this pulse operates the (SN+) relay, and closes a circuit from ground, (SN+) relay operated, (W) relay normal, (DR) relay operated, (TH), (H), (T) and (U) relays operated, to battery through the inner winding of the (PT) relay which operates and locks.

15.35 Final H.P. Pulse (ZD Wiring & App.)

If ZL wiring is used no final pulse is checked and the (U) relay operates the (F) relay, the operation of the (U1) relay permitting the operation of the (F1) relay. If ZM wiring is used the operation of the (U2) relay reverses the connection of the marginal and sensitive relays and the final heavy pulse is registered by the (F) and (F1) relays.

15.36 Registering RCI Impulses Min. CI Key Operated

When the impulse switch arrives in the position for checking the first RCI digit, ground is connected for operating the

(G) relay and also to the (MG-4) relay. The (MG-4) relay locks to the operating ground shunting the path thru the normal contact of the (GC) relay. The (MG-3) relay operates thru the normal contact of the (MG-1) relay and the (SN-3) relay operates thru the normal contact of the (SNP) relay. These relays are held operated in order to secure speedy release with definite contact pressure when their associated relays operate from RCI impulses. The (GC) relay operates following the (SN-3) relay, holding the operating path of the (MG-4) relay open during the call and preventing its reoperation if released by a false heavy positive pulse which operates the (MG+) relay. The first pulse, positive if any, operates the (SNP) relay, releasing the (SN-3) relay connecting ground thru the (W) relay normal, to the (A) relay. The second pulse if light negative releases the (SNP) relay if operated, causing the reoperation of the (SN-3) relay. The (SNN) relay operates, operating the (W) and in turn the first steering relay (TT or ST). If this pulse is heavy the (MG-1) relay also operates releasing the (MG-3) relay, and operating the (B) relay thru the (Z) relay normal.

The third pulse, positive or open, releases the (SNN) relay also the (MG-1) relay if operated, which in turn reoperates the (MG-3) relay. The (Z) relay operates. If the (SNP) relay is operated releasing the (SN-3) relay ground thru the (W) relay operated, operates the (C) relay.

The last pulse if light negative operates the (SNN) shunting and releasing the (W) relay. If heavy negative the (MG-1) relay also operates releasing the (MG-3) relay, and operating the (D) relay. The first pulse of the next digit or an open period releases the last operated relays and the (Z) relay. The A, B, C and D relays remain locked during the test. At the end of the digit and second steering relay (TT-1 or ST-1) operates and locks. When the (U-2) relay operates at the end of the units pulse the FT and FR leads are reversed and the final heavy positive pulse should operate the (SNN) and (MG-1) relays, releasing the (MG-3) relay. This operates the (F) relay. The (F-1) relay operates at the end of the pulse.

If a heavy positive pulse is received during the check the (MG+) relay operates releasing the (MG-4) relay lighting the HP lamp and preventing further checking. The detailed operation of the register circuit is similar to sheet 2 and the operation when the "MIN. CI" key is normal.

15.37 False Trunk Closure or Fundamental Crosses and Grounds

As soon as the final heavy positive pulse (or final units if no FHP pulse is used) is checked the (TF) and (TF-1) relays are connected from 48 and 24 volt battery to the FR and FT respectively to detect any crosses or grounds preceding incoming advance. If such failures occur the operation of either the (TF) or (TF-1) relay operates the (TF-2) relay which locks lighting the "TF" lamp and blocking the test.

15.4 Checking the Sender

As soon as the (H) relay is operated, the check of the RCI call starts. Each digit is checked separately against the corresponding setting of the register switches. If the pulses received from the sender set the lamp relays to agree with the test number, as indicated by the setting of the register switches, the (R-3) switch advances to "Talking Selection". If, however, any digit fails to check correctly, the test is blocked and a lighted progress lamp indicates the digit which did not check; a lighted RCI lamp indicates the digit received, and a lighted match lamp shows the digit which should have been received.

15.41 Stations

The station digit is checked first with the (R-3) switch in position 12. Circuit; battery through the winding of the (RCI) relay, cam (O-3), lead 15, (D-3) relay operated, lead 13 cam (N-17) of the stations register switch set for party M, lead O, cross-connected to the break contact of the (A-3) relay, (B-3) and (C-3) relays normal, (H) relay operated, lead 8, cams (W-3), (T-3) and (N-4), to ground on cam (P-20). This circuit, which is closed only if the stations digit checks, operates the (RCI) relay, which advances the (R-3) switch to position 13.

15.42 Thousands

In position 13 of the (R-3) switch, the (RCI) relay is again operated if the thousands digit checks correctly. Circuit; battery, winding (RCI) relay, cams (O-3) and (P-3), cams (S-13) and (Q-13) of the thousands register switch set for thousands digit 6, lead (6) which is cross-connected to the break contact of the (D-4) relay, (A-4) and (B-4) relays operated, (C-4) relay normal, (T) relay operated, lead 9, cams (W-3) and (T-3), cam (N-4), to ground on cam (P-20). The (RCI) relay operated advances the (R-3) switch to position 14.

15.43 Hundreds, Tens, Units

In position 14, a circuit is closed from battery winding of the (RCI) relay, cams (O-3) and (P-3), lead 28, make contact of the (D-5) relay, lead 26, cams (T-14 and (S-14) of the hundreds register switch set for hundreds 7, lead 2, (A-5) relay normal, (B-5) relay operated, (C-5) relay normal, (U) relay operated, lead 10, cams (V-3) and (T-3) cam (M-4), to ground on cam (P-20). This circuit operates the (RCI) relay, advancing the (R-3) switch to position 15. Similar circuits operate the (RCI) relay and advance the (R-3) switch to position 17. These circuits pass through the tens register switch cams and the contacts of the tens lamp relays, the units register switch cams, units lamp relays and the (PT) relay, when operated. These circuits are dependent for their closure on the lamp relays being set to register the same number as the register switch. If the lamp relays are set wrong, the circuit for operating the (RCI) relay is opened at one of the relay contacts, and the (R-3) switch is blocked.

15.44 (R-3) Switch Blocked

When the (R-3) switch is blocked, an RCI progress lamp, an RCI numerical lamp and a match lamp light as explained above. After the time alarm circuit has counted off sufficient time, an audible alarm is given. Assume that the (R-3) switch is blocked in position 15 due to the tens selection not checking. A circuit is closed from battery, cam (P-4), cams (R-3) and (S-3), RCI progress lamp (T), lead (5), cams (E-15) and (C-15), of the tens register switch, set in position 9 or 18 for tens digit 8, (8) match lamp to ground. Thus RCI progress lamp (T) and match lamp (8) light, showing that the circuit was blocked during the checking of tens digit 8. Assume that the sender sent out impulses for tens digit 6 instead of 8. The lamp relays (A-6) and (D-6) are then operated. In position 15 of the (R-3) switch, the (TR) and (TR-1) relays are operated to ground on cam (T-3). The (TR) and (TR-1) relays are operated whenever the (D) relay in the group of lamp relays for the digit being checked, is operated. A circuit is then closed from battery through the 6 RCI lamp, (TR) relay operated, lead 1, (A-6) relay operated, (B-6) and (C-6) relays normal, lead (11), to ground on cam (V-3), lighting the RCI lamp, corresponding to the number sent by the sender.

15.45 Talking Selection

When all digits check correctly, the (R-3) switch advances from position 17 to position 18 after units checking. Circuit: battery, winding (R-3) magnet, cam (D-3), to ground on cam (M-4). With the (R-3) switch in position 18, the (D) relay operates, advancing the (R-20) switch from position 5 to position 14. Circuit: battery, winding the (D) relay, relay (L-2) normal, cam (C-20), cam (D-20) to ground on cam (J-3). When the sender has advanced and opened lead (SC), the (SN) and (SN-1) relays release and advance the (R-20) switch to position 15. The (D) relay releases in position 14. The (R-24) switch advances to position 18. Talking selection is checked, the sender returns to normal, and the switches are re set for the next test, as previously described.

16. TENTH TEST - RCI DIRECT - ABOVE 9999

For this test, the route control (R-1), class (R-4) and numerical (R-2) switches are set in position 12. The numerical register switches are set for 03841, the 10,000 digit being set up on the stations hundreds register switch. The operation is the same as that just described, except that the number 0 is sent in place of the party letter. It is registered on the same relays and switch as the party letter.

17. ELEVENTH TEST - RCI AND MECHANICAL TANDEM BELOW 10,000 - WITHOUT STATIONS

For this class, the route control (R-1), class (R-4) and numerical switches (R-2) are set in position 13, and the numerical registers are set for the number 43210. Zero must be registered in place of the party letter, and handled as such. The code is translated by the sender in such a manner that it sends two extra sets of RCI impulses, for registering and displaying the numerical office code. These impulses are sent first, and registered on separate sets of lamp relays. The setting of the two code letter switches controls the checking of the hundreds and tens digits.

17.1 Registering RCI Impulses

When the (R-20) switch is in position 5, the tip and ring are connected to the RCI relays as described in paragraph 15. The (DR) and (DR-1) relays do not operate, the circuit being opened at the contacts of cam (V-4). The (R3) switch advances from position 3 or 5 by ground from the (G1) relay operated, this from the (LR) relay operated when the sender closes the trunk testing circuit. The (R-3) switch advances from positions 6 to 10 in a circuit from battery, winding of the (R-3) magnet, cam (C-3), lead 4, to ground

on cam (J-4). In position 10, the (G) relay operates through the break contact of the (DR-1) and (TAN-H) relays, lead 6, cams (W-3) and (T-3), cam (N-4) to ground on cam (P-20). The (G) relay functions as described in paragraph 15.2, operating the (CO) relay, checking the time required for the (TG) relay train to function and starting the sender producing RCI pulses. The method of recording impulses is the same as described in paragraph 15.3, except that the operation of the (Z) and (W) relays on the first two sets of pulses, sets up the (A), (B), (C) and (D), (A-1), (B-1), etc. and (A-2), (B-2), etc. relays. After each set of pulses has been completed, the (TT), (TT-1), and (TU) and (TU-1) relays operate, one pair after each set of pulses. The circuits are traced through the break contacts of the (DR) and (DR-1) relays. The register relays for the remaining digits are set up as described in paragraph 15.3, the stations relays being set for zero. The circuits are traced through the break contacts of the (DR) and (DR-1) relays and the make contacts of the (TT), (TH) and (TU) relays.

17.2 Checking the Sender

The checking of the call is accomplished as already described except that it starts with the (R-3) switch in position 10. The (R-20) switch remains in position 5 during the check. If the setting of the lamp relays checks 04321, the (RCI) relay operates and successively advances the (R-3) switch from position 10 to position 17.

17.3 Resetting the Switches

As the (R-20) switch reaches position 17, ground from cam (Q-20), advances the (R-1) switch to position 14, the (A) cam advancing it to position 18. In position 14, the (CH) relay releases, and ground on cam (S-1), advances the (R-2) switch to position 1. The register switches are not reset.

18. SKIPPING COIN COLLECT AND REFUND TESTS

When the (R-20) switch reaches position 17 after making the last test the (R-25) switch advances to position 5. Circuit: battery, (R-25) magnet, cam (D-25), (TA) and (REP) keys normal, (REP-1) relay normal "G" or "H" wiring or "K" wiring, lead (2), cam (U-1), (CH) relay normal, lead (7), (MT) key operated, lead (5), to ground on cam (Q-20). The (R-25) switch then advances to position 6. Circuit: battery, (R-25) magnet, cam (B-25), (CN) and (CA-2) relays normal, (CA) key, (MS) relay normal, cam (S-25), to ground. The (R-25) switch then advances to position 7 in the circuit traced for advancing from position 4, and to position 18, in the circuit for advancing from position 5.

19. ADVANCING THE SENDER SWITCH

With the (R-25) switch in position 18, the following circuits are closed to advance the sender switch: from battery, winding of the magnet of the sender switch associated with the sender in use, brush and terminal of arc (SM) of master switch 2, make contact of the (ST) key, break contact of the (REP) relay, cam (K-25), brush and terminal of arc (SY), brush of arc (RS), to ground. Battery through both windings of the (AX) relay is connected to cam (K-25). The magnet operates but the (AX) relay is short-circuited by the ground which operates the magnet, through the break contact of the magnet, terminal and brush of arc (AX), cam (I-25), to the other side of the 500 ohm winding of the (AX) relay. When the magnet operates the short-circuit is removed from the inductive winding of the (AX) relay, allowing it to operate and advance the (R-25) switch to position 1. As the switch leaves position 18, the magnet releases advancing the brush assembly of the sender switch to the next sender. The (AX) relay also releases. With the (R-25) switch in position 1, the (D) relay operates through cam (S-25) to ground on cam (O-25) and advances the (R-20) switch from position 17 to position 1. The same ground advances the (R-24) switch from position 17 to position 1 and advances the (R-3) switch from position 18 to normal. Ground on cam (Q-25) advances the (R-1) switch to normal. The test circuit is now ready to make the same series of tests on the next sender. All switches being in normal and the start key operated, the (T) and (T-1) relays operate as described in paragraph 6, advancing the (R-25) switch to position 2.

20. ADVANCING THE MASTER SWITCHES

When the first 20 senders have been tested, the (MS) relay operates as the (R-25) switch reaches position 2 of the next revolution. Circuit: battery, (MS) relay, twenty-first terminal and brush on arc (TST) of the sender switch, first terminal and brush of arc (TST) of master switch 2, break contact of the (T-1) relay, winding of the (T-2) relay, (PC) key normal, to ground through cam (R-25). The (MS) relay operated, locks and advances the (R-25) switch to position 3, by ground from SS3-O-25(TA wiring) or ground thru the (SY) and (RS) arcs in step (TB wiring), the (A) cam advancing it to position 4. In positions 3/4 the sender switch magnet is energized. Circuit: battery, winding of the magnet, (SM) terminal and brush of master switch 2, cam (G-25), (MS) relay operated, cam (O-25), or (SY) and (RS) arcs, to ground. The (AX) relay operates to ground on cam (O-25), advancing the switch to position 5. The sender switch magnet releases in position 5 and advances the sender switch brush assembly to normal. (MS) relay operated advances the (R-25) switch to position 6. In position 6, the master switches are advanced one terminal as described for advancing the first terminal in paragraph 6.1, and the (R-25) switch is advanced to position 17. The next sender switch is then tested and advanced to the first terminal as described in paragraphs 6.2 and 6.3.

TESTING COIN SENDERS - MULTI-TEST

21. COIN SENDERS

When all non-coin senders have been tested the master switch is advanced to the coin senders which are connected to separate sender switches. Either the (CL-1), (CL-2) or (CL-3) relay is connected to the CL arc of the (M-2) switch to which the brush is contacted. The operation of the relay closes special routes for district and office selections also grounding the (CN-) terminal. All of these terminals used for coin groups are cross-connected to the (CN) terminal resulting in the operation of the (CN) relay. The test proceeds in practically the same manner as in the case of a non-coin sender except that the preliminary coin tests and the coin collect and refund tests at the end of certain tests are made. The sender is tested for "Operator 2 Digit - Coin" instead of "Operator 2 Digit Non-Coin".

21.1 Preliminary Coin Tests

Whenever the (R-4) switch is set in position 1, 2, 9, 10, 11, 12, 13, 14 or 15 the (CN-1) relay operates. Circuit: (CN-1) relay, (FC) key normal, cam (L-4), cam (J-25), (CN) relay operated, (CA-2) relay normal, (CA) key and (MS) relay normal, to ground through cam (S-25). The operation of the (CN-1) relay holds the (R-24) switch in position 14 for the purpose of making a preliminary coin test previous to final units selection on mechanical tests and just after office group selection on RCI tests. The preliminary coin test is made during certain tests as follows:

21.11 (R-1), IN 2, 10, or 12

The (R-24) switch is held in position 14, since lead (FT) passes through cam (N-24). This is for the purpose of checking the sender on that part of the preliminary coin test which tests the line to insure that a coin is deposited. In the case of a coin sender, the (R-24) switch remains in position 14 until the (R-3) switch reaches position 13 on mechanical tests or until the (R-20) switch reaches position 5 on RCI tests. With the (R-3) switch in position 13, the (R-24) switch advances to position 15. Circuit: winding (R-24) magnet, cam (C-24), lead (9), cam (N-4), to ground on impulse cam (I-3). F.M. calls or SS1-P20 for RCI calls. With the (R-24) switch in position 15, 110 volt battery and ground, through the windings of the coin test relay in the sender are connected to leads (T) and (R). With the (FC) key normal, ground through 3675 ohms is connected to the tip and ring to test the

non-operate of the preliminary coin test relay (CT-9) in the sender. Under this condition, the (CT-9) relay should not operate, and the fundamental circuit should not be closed. Should the fundamental circuit be closed at this time, the (PCT) and (SC) relays operate, removing ground from the interrupter and preventing the (R-24) switch from advancing out of position 15, thus indicating that the sender failed to block a call which should have been blocked. The operating circuit is from battery, winding of the (PCT) relay, make contact of the (CN-1) relay, cam (N-24), cam (T-20), cam (Q-24), (CI) relay operated, master and sender switches, lead (FT), stepping relay and associated apparatus in the sender, lead (FR), master and sender switches, (CI) relay, cam (R-24), two 18-AF resistances in series, cam (L-23), to ground on cam (U-20). If the (CT-9) relay in the sender does not operate, the (IN) relay operates. Circuit: primary winding of the (IN) relay, cam (P-24), B contact of the interrupter, (SC), (CT) and (CA-2) relays normal, (CA) key, and (MS) relay, to ground through cam (S-25). The (IN) relay operated, locks thru the primary winding to cam (K-24) and advances the (R-24) switch to position 16, when the F interrupter closes. As the switch leaves position 15, the (IN) relay releases. In position 16, the (IN) relay operates when the interrupter closes its back contact, and advances the (R-24) switch when the interrupter closes its front contact, as before. In position 17, ground thru 2040 ohms is connected to the line to test the operate of the sender (CT-9) relay. Under this condition, the (CT-9) relay should operate. The sender then advances, closing the fundamental circuit for the next selection. If it fails to operate, both the sender and testing circuit fail to advance.

21.12 CT4 Test R1 Pos. 3, 11 or 13

When the (R-1) switch is in positions 3, 11 or 13 or the "CT-4" key is operated the (CN-3) relay operates with the (CN-1) relay to the same ground. With the (R-3) switch in position 13 on mechanical tests or with the (R-20) switch in position 5 on RCI tests the fundamental circuit is open at cam (N-24) until the preliminary coin test is made. In this test, the non-operate feature of the coin test relay (CT-4) in the sender is tested. With the (R-3) switch in position 13, the (R-24) switch advances to position 15. In position 15, the (T) and (R) leads are connected as described in paragraph 21.11 and a resistance of 3675 ohms is connected to the tip and ring of the line. The circuit functions as in the first test, and the (R-24) switch advances to position 16 under control of the

interrupter. Direct ground is now connected to the tip of the line, operating the (CT-9) relay in the sender. The operation of the (CT-9) relay operates the sender (CT-3) relay which connects the (CT-4) relay to the line. The operation of the (CT-4) relay causes a signal to be given to the sender monitor operator. The (R-24) switch advances under control of the interrupter to position 17. As the switch leaves position 16 the line circuit is opened and as the switch passes position 16 5/8, 110 volts negative thru a 6-D resistance lamp is connected to the tip of the line to release the sender (CT-4) relay. In position 17 ground thru 400 ohms is connected to the tip, as a non-operate test for the (CT-4) relay. If the (CT-4) relay does not operate, the fundamental circuit is closed for the next selections as on the first test.

21.13 Operator - 2 Digit - Coin

When the (R-1) switch is in position 5 the (CN-2) relay operates over lead 1, cam (J-25), (CN) and (CA-2) relays operated, (PC) key and (MS) relay normal, to ground through cam (S-25). Under this condition when the (R-1) switch advances to position 6 the (CH) relay holds, advancing the (R-1) switch directly to position 7. The call to the two digit operator coin is tested in the same manner as "Operator 2 Digit - Non-Coin", see paragraph 11, except that the preliminary coin test as described above is included in the test. Separate positions on the (R-1) switch are provided, since separate routes to the toll operator must be selected by coin and non-coin senders.

21.14 Wipe Out - Coin

For testing the wipe out on coin senders, the coin return test is as follows: The subscriber's line circuit is opened in position 5 of the (R-20) switch. The sender is advanced by the release of the sender (L) relay and connects ground to lead (SC) to operate the (MG) and (SN) relays in the test circuit. The pulsing circuit is open at SS3-Q4 and the tip is connected through the 1020 ohm winding of the (CC) relay, reproducing the condition of the receiver on the hook and a coin in the slot. Circuit, SS2-Q4, operated contacts of (CWO) relay, lead 13 winding of (CC) relay, lead 75 to ground at (X-24) cams. The (DWO) relay opens this path except immediately after the wipe out. Under this condition, the sender sends out negative coin battery on both sides of the line to return the coin, operating the (CC) relay which

in turn operates the (CT) relay to ground on cam (Y-25), "G" wiring, or (S-25) "H" wiring. The operation of the (CT) relay advances the (R-20) switch to position 6. Circuit; battery, (R-20) magnet, cam (B-20), lead (9), cam (U-25), lead (8), (MG) relay, operated, cam (W-4), lead (12), cam (X-25), (CT) relay operated, (CA-2) relay normal, "CA" key normal, (MS) relay normal to ground on cam (S-25). The operation proceeds as described in paragraph 13.2.

21.2 Coin Collect and Refund - R25 Pos. 4

With the (R-1), (R-20) and (R-24) switches in positions 14, 17 and 18 respectively, the (R-25) switch advances from position 4 to position 5. Circuit: battery, (R-25) magnet, cam (D-25), (TA) key normal, break contact of the (REP) key, (REP) relay normal, lead (2), cam (U-1), (CH) relay normal, lead (7), make contact of the (MT) key, lead (5), to ground on cam (Q-20). With the (R-25) switch in position 5, the (T) relay operates through its 2000 ohm winding, cam (F-25), make contact of the (CH) relay, (CA-2) relay normal, break contact of the (CA) key and (MS) relay, to ground through cam (S-25). The (T) relay operated, operates the (T-1) relay which disconnects ground through the winding of the (T-2) relay from lead (TST), and connects battery through the 17,500 ohm winding of the (T) relay to the (TST) lead. The removal of ground from lead (TST) allows the sender to return to normal. While the sender is returning to normal, 80 ohm ground is connected to the (TST) lead in the sender to hold the sender busy. This ground holds the (T) relay operated. The (T-2) relay releases, releasing the (AD) and (CI) relays. The operation of the (T-1) relay advances the (R-25) switch to position 6. Circuit: battery, (R-25) magnet, cam (B-25), (T-1) relay operated, (S) relay normal, to ground.

21.21 Coin Return - Receiver on Switchhook R25 Pos. 6

When the sender reaches normal the (T) and (T-1) relays release, connecting ground to the (TST) lead to reoperate the (T-2) relay and to advance the sender off-normal. The (T-2) relay operated, operates the (AD) relay. The (AD) relay operated, operates the (CI) relay, which closes the fundamental and pulsing leads through to the sender. The (R-25) switch advances from position 6, to position 7. Circuit; same as from position 4. With the (R-25) switch in position 7, the artificial line is traced from ground at SS2-P25, winding of the (CC) relay, 18-AC resistance, SS3-H25, SS4-H25, cam (M-25), (CI) relay operated, lead (T) to the

sender, and lead (R), (CI) relay, cam (L-25), to ground through the winding of the (RT) relay. This approximates the condition of the line when the receiver has been replaced on the switchhook. Ground through the winding of the (CC) relay on the tip of the line represents the coin in the slot and ground through the 12,000 ohm winding of the (RT) relay on the ring approximates a leak. The sender connects 110 volts negative battery to both sides of the line to return the coin, when lead (FR) is open; and 110 volts positive, to collect the coin, when lead (FR) is grounded. In position 7 lead (FR) is open, in effect therefore 110 volt negative battery is connected to both sides of the line operating the (RT) and (CC) relays. The (CC) relay is poled to respond only to negative current at this time. The operation of the (RT) and (CC) relays operates the (CT) relay. The (CT) relay operated, locks and advances the (R-25) switch to position 8. Circuit: battery, (R-25) magnet, cam (D-25), (CT) relay operated, (CA-2) relay normal, break contacts of the (CA) key and (MS) relay, cam (S-25), to ground. The operation of the (CT) relay also closes through the (SC) lead.

21.22 Non-Operate Test of (CTS) Relay R25 Pos. 8

The sender now tests the line to ascertain whether the coin has been returned by connecting battery through the two windings of the (CT-8) relay in the sender circuit to the tip and ring of the line. If the (CT-8) relay operates, due to ground on the tip because the coin is still in the slot, an alarm is given in the sender. In position 8 of the (R-25) switch, the (CT-8) relay in the sender is tested for non-operate by connecting the tip lead to ground through 6300w and the winding of the (CC) relay, AJ wiring or 9550w and the (CC) relay AK wiring. This represents a more severe non-operate than the (CT-8) relay will ever be called upon to meet. If the (CT-8) relay does not operate, the sender is not blocked and advances, connecting ground to lead (SC), which operates the (MG) and (SN) relays. The operation of the (MG) relay advances the (R-25) switch to position 9. Circuit: battery, (R-25) magnet, cam (B-25), (MG) relay operated, cam (W-4), (D) relay normal, (BP) relay normal, V24 cam ground at (ST) key, or, if the (R-4) switch is in position 8, through cam (W-4), cam (X-25) to ground. If the (CT-8) relay in the sender operates falsely under this condition, the sender does not advance and connect ground to lead (SC) blocking the test circuit and giving the alarm. The (CR) lamp is lighted by ground on cam (R-25).

21.3 Coin Return - Receiver Off Switchhook R25 Pos. 9

The (T) relay operates. Circuit: battery, P winding, cam (F-25), (CN) relay operated, (CA-2) relay normal, break contacts of the (CA) key, and (MS) relay, to ground through cam (S-25). The (T-1) relay operates and functions to return the sender to normal as previously described. The operation of the (T-1) relay also advances the (R-25) switch to position 10, from ground on the (S) relay normal. When the sender has returned to normal, the (T) and (T-1) relays release, and the (T-2), (AD) and (CI) relays reoperate, reseizing the sender. The sender is again tested for coin return, the tip being grounded thru the winding of the (CC) relay, and the ring thru the winding of the (RT) relay, and lead (FR) being open. The coin return current operates the (CC) and (RT) relays which in turn operates the (CT) relay. The (CT) relay operated, advances the (R-25) switch to position 11. In position 11, the (T) and (R) leads are connected together through 1,000 ohms and 1,020 ohms to ground connected between the two 500 ohm resistances. Circuit: lead (T), (CI) relay, cam (M-25), cam (H-25), two 18-AC resistances cam (L-25), (CI) relay, lead (R), to the sender. The winding of the (CC) relay is connected from between the 18-AC resistances to ground. The fundamental ring is open. This reproduces the condition existing when another coin is deposited and the receiver is removed from the switchhook to make a second call directly after the completion of the first call. In this case, the sender advances, even though the test on the line shows a coin in the slot. The sender repeats the coin test as described in paragraph 21.22. The (CT-8) relay in the sender should not operate; being connected differentially to the tip and ring, and the sender should connect ground to lead (SC), operating the (MG) relay and advancing the (R-25) switch to position 12 over the circuit traced for advancing from position 8 to position 9. If the (CT-8) relay in the sender operates falsely, the testing circuit is blocked and the (CR) lamp remains lighted.

21.4 Coin Collect R25 Position 12

The (T) relay operates over the circuit traced for operating it in position 9, and functions to return the sender to normal and advance the (R-25) switch to position 13. In position 13, the coin collect feature of the sender is tested. The subscriber's line is traced over lead (T), (CI) relay operated, cam (M-25), cam (V-25), winding of the (CC) relay, 18-AC resistance to ground on cam (P-25). The connection of the (CC) relay is now reversed, so that it will respond to positive battery over the tip of the line. The ring is connected through the contact of the (CI) relay, cam (L-25), to ground through the winding of the (RT) relay. Lead (FR) is grounded

through the make contact of the (CI) relay, cam (J-25), (CN) relay operated, (CA-2) relay normal, break contacts of the (CA) key, and (MS) relay to ground through cam (S-25). This condition causes the sender to connect 110 volts positive battery to the line to collect the coin, operating the (CC) and (RT) relays and in turn the (CT) relay. The operation of the (CT) relay operates the (SC) relay. Circuit: battery, winding of the (SC) relay, cam (U-25), (CT) relay operated, break contacts of the (CA) key, and (MS) and (CA-2) relays normal, to ground on cam (S-25). The sender advances and opens the circuit through the (CC) and (RT) relays which release, releasing the (CT) relay. The (R-25) switch advances to position 14. When the (R-25) switch leaves position 13, the (SC) relay releases.

21.5 Operate Test of (CT-8) Relay R25 Pos. 14 AJ Wiring

The sender connects the windings of the (CT-8) relay to leads (T) and (R) to test whether the coin has been collected. The operation of the (CT-8) relay is tested in the following manner. Lead (R) is opened; lead (T) is connected through the make contact of the (CI) relay, cam (M-25), 18-CR and 18-AP resistances (2500 ohms), winding of the (CC) relay, 18-AC resistance (500 ohms), to ground through cam (P-25). If the (CT-8) relay in the sender does not operate, the sender advances and connects ground to lead (SC) which operates the (MG) relay as before. The operation of the (MG) relay operates the (SC) relay. Circuit: battery, winding of the (SC) relay, cam (U-25), make contact of the (MG) relay, cam (W-4), to ground on the break contact of the (D) relay (TA wiring) or cam (W-4), lead (12), to ground on cam (S-25), when the (R-4) switch is in position 8. The (SC) relay operated, locks to ground on cam (P-25), and blocks the test, thus giving an alarm and lighting the lamp. If the (CT-8) relay in the sender operates, the (SC) relay does not operate, and the (R-25) switch advances from position 14 to position 15. Circuit: battery, (R-25) magnet, cam (C-25), (B) contact of the 149-J interrupter, break contacts of the (SC), (CT) and (CA-2) relays, (CA) key and (MS) relay, to ground through cam (S-25). From position 15 to 16 the (R-25) switch is advanced through cam (C-25) and (F) contact of the interrupter over the circuit just traced; from position 16 to position 17, through cam (C-25) and the back contact of the interrupter; and from position 17 to position 18 through cam (C-25) and the (F) contact of the interrupter, provided the (MS) relay is not operated. The purpose of the interrupter is to give the sender time to function and block the test circuit provided the (CT-8) relay in the sender does not operate.

21.6 Operate Test of (CT-8) Relay (AK Wiring and Apparatus)

When AK wiring and apparatus are used, the (CTO) relay and the 19 KL resistance are introduced in the tip circuit, in place of the

18 AP and 18 CR resistances, when the R25 switch leaves position 13. The test circuit awaits the sender to apply the (CT-8) relay, which is tested through its secondary winding for operate. The (CTO) relay operates and causes the operation of the (KT) relay which locks. When the sender advances under control of the sender interrupter from the terminal over which the (CT-8) relay circuit is closed, the circuit opens and the (CTO) relay releases. The (KW) and (KZ) relays are employed at this stage, under control of the 160A interrupter to measure a minimum time interval. The first interrupter closure operates the (KW) and the (KZ) operates on the first open. The second closure releases the (KW) and the time interval is determined by the (KW) down and the (KZ) up, which combination allows the R25 switch to advance from position 14 to position 17.

The advance from position 17 is dependent upon the (SC) relay, which will have had time to operate and block the test in case the (CT-8) relay failed to operate. This arrangement minimizes the time the sender is held after the (CT-8) operating path is closed.

As the switch leaves position 17, ground is disconnected from the (TST) lead, allowing the sender to return to normal and releasing the (T-2) relay. The (T-2) relay released, releases the (AD) and (CI) relays. The sender switches are now advanced to the next sender as described in paragraphs 19 and 20 and all tests are made on this sender.

22. SKIPPING SPARE TERMINALS R25 POSITION 1

The first spare terminal of a group of spare terminals on arc (TST) is connected to the 800 ohm winding of the (S) relay. All the other spare terminals of the group are strapped and connected to the corresponding terminal of arc (AX) of master switch 1. When a sender switch advances to a spare terminal, the (R-25) switch being in position 1, the (T) relay operates, operating the (T-1) relay and advancing the (R-25) switch to position 2 as described in paragraph 6.1. In position 2, the (T) and (T-1) relays release, and the (S) relay operates. Circuit: first spare terminal of arc (TST), brush and terminal of arc (TST) of master switch 2, (T-1) relay normal, winding of the (T-2) relay, (PC) key normal, cam (R-25), to ground. The (T-2) relay also operates in turn operating the (AD) and (CI) relays. The operation of the (S) relay advances the (R-25) switch to position 17. Circuit: battery (R-25) magnet, cam (D-25), (S) relay operated, (MS) relay normal, cam (O-25), ground. In position 17, a circuit is closed from battery, (R-25) magnet, cam (C-25), front contact of the interrupter, break contacts of the (SC) and (CT) relays, break contacts of the (CA-2) relay (CA) key

and (MS) relay, to ground through cam (S-25), advancing the switch to position 18. The sender switch selector magnet is energized through the brush and terminal (SM) of master switch 2, make contact (S) relay, break contact (REP) relay, cam (K-25), to ground through brushes and terminals (SY) and (RS). The (AX) relay is short-circuited. When the magnet breaks its contacts, the (AX) relay operates, through cam (K-25), and arcs (SY) and (RS) to ground. The operation of the (AX) relay advances the (R-25) switch to position 1, releases the magnet and advances the brush assembly of the sender switch one terminal. The (S) relay locks through its 1000 ohm winding, arc (AX), of master switch 1 strapped spare terminals on sender arc (TST), to ground on the make contact of the (S) relay. In position 1, relays (T) and (T-1) operate as before, but the (R-25) switch does not advance since the ground for its advance is supplied thru the break contact of the (S) relay. A circuit is closed from battery, winding and break contact of the selector magnet, strapped terminals and brush of arc (TST), terminal and brush of (TST) arc of master switch 2, to ground on the make contact of the (S) relay. Through this circuit the selector magnet energizes and releases until a used terminal is reached, when the (S) relay releases. Ground from the break contact of relay (S), make contact of the (T-1) relay, advances the (R-25) switch to position 2, releasing the (T) and (T-1) relays.

23. ADVANCING SWITCH AT END OF CYCLE R25 POSITION 1

When all the senders have been tested and the last sender switch has advanced to the 21st terminal, relays (EC) and (T-2) operate in series, to ground through cam (R-25). The (T-2) relay operated, operates the (AD) relay, which in turn operates the (CI) relay. The (EC) relay operated, locks and lights the (EC) lamp. The operation of the (T) and (T-1) relays advances the (R-25) switch to position 2. In position 2, a circuit is closed from battery, (R-25) magnet, cam (E-25), (AD) relay normal and (T-1) relay operated, cam (W-25), cam (S-25) to ground, advancing the switch to position 3, the (A) cam advancing the switch to position 4. The (EC) relay being operated prevents the test circuit from functioning. The (EC) key is now operated, extinguishing the (EC) lamp and operating the (MS) relay. The (MS) relay operated, locks and operates the (AX) relay to ground on cam (O-25), advancing the switch to position 5. The switch is then advanced to position 6 through the make contact of the (MS) relay to ground on cam (O-25). In position 6, the master switch selector magnets are energized as described in paragraph 20. The (AX) relay operates, the (R-25) switch is advanced to position 7, and the release of both selector magnets advances the brush assembly of both master switches to the first spare terminal. Circuits are then closed from ground on the brush of the (RS) arc of master switch 1, strapped spare terminals, break contacts of selector magnets (MS-1) and (MS-2), windings of magnets (MS-1) and (MS-2) to battery, advancing the 200 type selectors to the normal terminals. In

position 7, a circuit is closed from battery (R-25) magnet, cam (E-25), (MS) relay operated to ground on cam (O-25), advancing the switch to position 17. Ground through the brush and normal terminal of the (RS) arc of master switch 2, cam (D-25), to battery through the (R-25) magnet, advances the switch to position 18. In position 18, the (AX) relay operates to ground through the normal terminal and brush of arc (ES) of master switch 1, advancing the (R-25) switch to position 1. The (EC) relay releases. The test circuit will repeat the tests on all the senders unless the (ST) key has been restored when the (EC) key was operated, in which case the circuit for operating the (T) relay is open and the test circuit remains normal.

24. TEST ABANDONED - START KEY RESTORED

The restoration of the start key with the (MS), (EC) and (S) relays normal, and the (R-25) switch in any position except position 1, i.e. at any time during the routine testing advances the (R-25) switch to position 1. This closes circuits to advance the (R-24), (R-20) and (R-3) switches from any position to position 1. The (R-1) switch is also returned to position 1, if the (MT) key is operated, and it in turn restores the (R-2) switch to normal.

25. SINGLE TESTS

When testing on a single test basis, the MT key is not operated and the (R-1) and (R-2) switches are set manually, causing the register switches to advance to their corresponding settings, except that the (RI) and (MI) relay, and the relays associated with the register switches do not operate. Under this condition, the circuit for operating the (IN) relay for advancing the (R-24) switch now is closed around the relays associated with the register switches, since lead 4 is connected to lead 5 thru the MT key when normal. The test is made essentially as described in connection with the multi-test. As soon as the (R-20) switch reaches position 17, the (R-25) switch advances to position 5. Circuit: ground, cam Q-20, lead 5, MT key normal, lead 4, cam V-20, lead 6, MT and REP keys, cam D-25, R-25 magnet to battery. The circuit then proceeds with the coin tests, or advances the sender and master switches, depending on whether or not the sender is a coin sender.

25.1 Class Switch Positions Reserved For Single Tests

Several positions of the class switch are not used in connection with the multi-test. These positions are for classes of calls similar to these represented in the multi-test, but each

class requires a slightly different setting of the sender. These classes are used for testing on the Single Test or Particular Number basis, and the test circuit numerical registers and other switches are set by hand according to the requirements of the sender for the class of call involved.

25.2 Office Overflow

The purpose of this test is to check the operation of the sender when an office selector goes to overflow. The class switch R4 is set in position 4, and the district brush, district group, office brush and office group switches are set as required. The sender is primed and the call progresses until office group selection is completed and checked. The check switch R20 will be in position 5, and the impulse switch R3 will be in position 5. With the class switch R4 in position 4, ground at cam I4 causes the check switch R20 to advance directly into position 14. In position 14, ground from cam P20 over lead 11 causes the impulse switch R3 to advance from position 5 to position 17. During the rotation of the impulse switch the fundamental circuit is prevented from closing because the (L1) relay is held locked through the K3 cam to ground at the L4 cam.

With the impulse switch in position 17 and the check switch in position 14, the reverse battery fundamental circuit is closed which represents the office overflow condition to be recognised by the sender. The sender should function to register the overflow talking selection requirement, and to advance to release the test circuit (SN) relay. The release of the (SN) relay moves the check switch R20 into position 15, and advances the impulse switch R3 to position 18, where overflow talking selection is made and checked.

25.3 RCI Direct, Below 10,000, Without Station (R4) Position 10)

The preparation and completion of this test is similar to other single tests and the checking is the same as for RCI classes described in paragraph 15 except that no station is dialed, the R24 switch being advanced past position 9 by ground from SS 3-K4.

25.4 RCI and Mechanical Tandem Classes (R4 Position 14/15)

Class 14 is similar to class 11 and class 15 is similar to class 12 except the tandem feature, which is described under class 13, paragraph 17.

26. TIME ALARM CIRCUIT "TA" WIRING

The operation of the time alarm circuit gives the alarm when the test is blocked at any point. The operation of the (ST) key operates the (TA) relay. The (TA) relay operated, (a) locks to ground through cam (V-24), (b) connects ground from the interrupter, through terminal and brush of arc 3, operating the selector magnet, and (c) connects ground to the brush of arc 2. Each closure of the interrupter contacts energizes the magnet which releases when the interrupter contacts open, advancing the brush assembly of the switch one terminal. When the (R-20) switch returns to normal, the (R-24) switch advances from position 18 to position 1, releasing the (TA) relay. The (TA) relay released, connects ground from its break contact, terminals and brush of arc 1 restoring the selector to normal. If the test circuit is blocked on any test, when sufficient time has elapsed to allow the switch to reach the terminal to which the signal apparatus is connected, the (ALM) meter operates the (TA) lamp lights, and the alarm circuit gives an audible alarm. (When "H" wiring is used the (ALM) meter does not operate if the time interval is caused by a busy sender holding the (R-25) switch in position 2). This circuit is so timed that it will require slightly longer for the switch to reach the alarm terminal than is required for the test circuit to complete one cycle of tests. The operation of the (TA) key releases the (TA) relay, restoring the circuit to normal.

26.1 Time Alarm and Blocking Circuit "TB" Wiring

When the "ST" key is operated ground is connected to any normal point of the D arc "TA" selector, operating the (TA) relay which locks to off normal ground thru the V24 cam and "TA" key normal. When the "TA" selector has advanced to the alarm point by ground thru the "TA" interrupter and (TA) relay operated the "TA" lamp is lighted and the (BP) relay is operated only if the R25 switch is in positions 3 to 18 (H wiring). The "TA" lamp is in series with the equipment in the alarm circuit and brings in a signal. The (BP) relay if operated locks to the same off normal ground as the (TA) relay and opens the checking ground from the armatures of the (RCI) and (D) relays. The (BP) and (TA) relays release if the R24 switch is advanced to position 1. If the "TA" key is operated the alarm is retired but the R25 switch cannot be advanced from position 4 after a regular test until the "TA" key is restored to normal. With the "TA" and "REP" keys operated ground is connected to the armatures of the (D) and (RCI) relays preventing blocking irrespective of the operation of the (BP) relay. "H" wiring must be used to prevent false blocking after a long busy wait preceding an oked test.

27. CONTROL ADVANCE

The "CA" key is used for advancing the sender under test to normal and advancing the (R-25) switch to a point where the test circuit will return to normal, when the CA key is restored. It is used to advance the test circuit to test the next sender, when a sender sticks or fails. The operation of the key (a) connects ground from its make contact to lead TST of the sender, holding the sender busy as long as the key is operated, (b) operates the (CA) relay, which locks and closes a circuit for advancing the (R-25) switch to position 17. The (R-25) switch cannot advance from position 17 until the CA key is restored, since the circuit for advancing it is open at the contacts of the CA key. When the CA key is restored to normal, the (R-25) switch advances to position 18. In position 18, the sender switch is advanced to the next terminal as already described. When the (R-25) switch reaches position 1 the (R) relay cannot operate to advance it until the (R-24), (R-20) and (R-3) switches are normal. These switches are restored to normal as described in paragraph 19. If the MT key is operated ground on cam Q-25, make contact of the MT key, lead 5, advances the (R-1) switch to position 1. With the (R-3), (R-20), (R-25) and (R-25) switches in position 1, the (R) relay operates through cam P-25, make contact of the ST key, cam Q-24, cam X-20, cam L-3, cam V-1, Q-2 to ground at K-2. The operation of the (T) relay starts the test on the next sender.

28. METERS

The circuit is provided with five meters: circuits tested meter (CT), alarm meter (ALM), busy not tested meter (BNT) or (BY), single test meter (ST) or (BST), and multi-test meter (MT) or (BMT).

28.1 (CT) Meter

The (CT) meter operates while the (R-25) switch is in positions 7 to 9, through cam (T-25), make contact of the (ST) key, break contact of the (EC), (S) and (MS) relays, to ground on cam (O-25). If the (MS), (EC) or (S) relays are operated as on resolutions of the (R-25) switch when advancing the sender and master switches, the meter does not operate. Therefore, the meter registers only the number of senders tested.

28.2 (ALM) Meter

See paragraph 26.

28.3 (BNT) or (BY) Meters

See Paragraph 6.4.

28.4 (ST) Meter "G" Wiring

The (ST) meter operates, to ground on cam (L-24), when the (R-24) switch is in positions 3 to 5. Since the (R-24) switch makes one revolution for each test, the (ST) meter registers the number of single tests made.

28.5 (RST) Meter - "H" Wiring

This meter operates with the (MT) key normal and the (REP) key operated once for each revolution of the (R-24) switch, indicating the number of times a single test is repeated on a sender.

28.6 (MT) Meter- "G" Wiring

The (MT) meter operates through the make contact of the (NI) relay, cam (T-2) in position 13, cam (R-2), make contact of the (CL), (TS) and (CR) relays, make contact of the (MT) key, lead (5), to ground on cam (Q-20). The meter records the number of complete cycles of tests made.

28.7 (RMT) Meter - "H" Wiring

This meter operates with the (R-2) switch in position 3 and the (R-24) switch in positions 3 to 5 with the (MT) and (REP) keys operated. It records the number of cycles repeated on a repeat multi-test.

29. KEYS

29.001 Start Key (ST)

See paragraphs 6.1 and 24.

29.002 Multi-Test Key (MT)

Used to make a series of tests on each sender.

29.003 Particular Number Key (PN)

This key is used when it is necessary to test the sender on selections for a particular number. When operated, the (PN) key connects ground to lead (5) advancing the (R-1) switch to position 1. With the (R-1) switch in position 1, the (R-2) switch advances to position 1. The numerical registers are then set manually for the code and number required.

29.004 Pulse Lamp Key (PL)

See paragraph 8.8.

29.005 End Of Cycle (EC)

See paragraph 23.

29.006 Control Advance Key (CA)

See paragraph 27.

29.007 Repeat Key (REP)

See paragraph 33.

29.008 Particular Circuit Key (PC)

This key operated, disconnects ground, from the winding of the (T-2) relay in the (TST) lead. The (T-2), (AD) and (CI) relays therefore cannot operate and the (T), (R), (PT), and (PR) leads are thus held open, which prevents any interference with busy senders, by the advance of the sender switch. The sender switch is advanced by means of the associated stepping key as described hereinafter, to any sender as desired.

29.009 Busy Meter Key (BM)

This key is used to pass senders when made busy by a make busy plug. See paragraph 6.4.

29.01 Low Speed Key (LS)

The operation of the (LS) key operates the (LS) relay, which causes all tests to be made on the low speed pulse interrupter.

29.02 High Speed Key (HS)

The operation of the (HS) key opens the operating circuit for the (LS) relay, so that all tests are made with the high speed pulse interrupter.

29.03 Maximum Line Key (Max. L)

With this key normal, the (R-1) switch is arranged to use a maximum subscriber's loop for some tests, and minimum subscriber's loop for others. When the key is operated, the maximum subscriber's line is used for all tests.

29.04 **Minimum Line Key (Min. L)**

The operation of this key gives a minimum subscriber's line for all tests.

29.05 **Free Call Key (FC)**

The operation of this key opens the operating circuit for the (CK-1) relay, permitting coin senders to be tested for free calls.

29.06 **(CT-4) Key**

The (CT-4) key is operated to test the operate and non-operate function of sender relay (CT-4) on any class of call in addition to positions 5-11-13 of the (B-1) switch.

29.07 **Non-Coin Only Key (NCO)**

This key is used to step the test after all non-coin senders have been tested and before testing the coin senders. The coin senders are connected to a separate sender switch, or switches. The operation of the (NCO) key opens the circuit through the 21st terminal of the last switch for operating the (MS) relay, which advances the master switches; hence the test cannot proceed on the coin senders until the (NCO) key is restored. This key is necessary because the same register setting does not always apply to both non-coin and coin senders, as in the case of calls to the distant operator. When the (MT) key is not operated, the (B-1) switch must be moved to the correct position manually.

29.08 **Stepping Keys**

An individual key is provided for advancing each selector switch. These are used to test a particular sender, or for stepping the selector switches for any reason other than for passing a busy sender. Before a selector is advanced in this manner, the test leads must be cleared by restoring the (ST) key and operating the (PC) key. The operation of a stepping key connects ground from the (ST) key normal and (PC) key operated directly to the winding of the magnet of the switch with which it is associated. When the key is restored, the magnet, by its release, advances the selector one position. Thus the selector is advanced one position for each operation of the key.

29.09 Step-by-Step Keys (SS) and (AV)

The check may be carried on step-by-step by means of the (SS) and (AV) keys. With the (SS) key operated, the (L-1) relay is held operated after the (L) relay releases, thus holding the fundamental circuit open. The (L-2) relay releases and the (R-20) switch advances, advancing the (R-3) switch. The circuit is blocked as the (L) relay cannot reoperate until the (L-2) relay is released by the operation of the (AV) key. As each step progresses the progress and match lamps light as an indication that the circuit is ready for the next step.

29.1 Repeat Coin Key (REP-CM)

See paragraph 33.1.

29.2 Time Alarm Key (TA)

This key when operated releases the (TA) relay restoring the time alarm circuit to normal. It also opens the circuit for advancing the (R-25) switch from position 4 "TB" wiring.

29.3 Minimum CI Key (MIN. CI)

This key is for testing RCI calls using a minimum loop. It disconnects the (MG-2) relay from the circuit and substitutes the (MG-1) relay, shunting out 1500w from the fundamental.

29.4 Capacity Key (CAP. RCI)

The operation of this key connects capacity to the fundamental circuit on RCI test calls.

29.5 Repeat Key (REP-4)

When the (REP) and (REP-4) keys are operated a certain test determined by the position of the (R-1) switch is repeated on each sender as follows. The (Z) and (W) relays count the tests as follows: When the (R-24) switch advances to position 3 on the first test the (W-1) relay operates. The advance of the (R-24), switch from position 5 operates the (Z-1) relay. The advance of the (R-24) switch to position 3 on the second test releases the (W-1) relay, operating the (W-2) relay. The advance of the (R-24) switch out of position 5 releases the (Z-1) relay, operating the (Z-2) relay. The advance of the (R-24) switch to position 3 on the third

test operates the (W-1) relay again and the advance from position 5 operates the (Z-1) relay. On the fourth test the (W-1) relay releases, releasing the (W-2) relay which operates the (REP-1) relay. The advance of the (R-24) switch out of position 5 releases the (Z-1) and (Z-2) relays. The (REP-1) relay operated, locks and closes the circuit for advancing the (R-25) switch from position 4 as described in paragraph 33.1 and causes the test circuit to advance to the next sender as described in paragraph 33.1.

30. REMOTE CONTROL FEATURE

The (REP) key must be operated in order for the remote control feature to be effective.

This feature controls the testing circuit from jacks which are multipled on the sender frame for the purpose. A No. 32-A test set is intended for use for the remote control of the testing circuit.

The white button of the 32-A test set when operated and released, performs the same function as the (AV) key "AB" wiring on the testing circuit, used primarily in connection with the step-by-step test feature when the (SS) key is operated.

The red button of the 32-A test set performs the same function as the (CA) key of the testing circuit excepting that the R25 switch does not wait in position 17 until the red button is released. (QA wiring)

If this key is held depressed or the make busy plug is left in the jack the (CA-2) relay is held operated preventing the R25 switch from advancing from position 17. (QB wiring)

A standard #184 make busy plug inserted momentarily in the sender frame jack will accomplish the same purpose as the operation of the red button.

31. DIAL TONE TEST

Figures A and A1 or Figures A, B and C provide means for checking that the dial tone is satisfactory. To listen for dial tone the (DT) key is operated which causes the (DT) relay to operate either in position 18-1/2 of the control switch or in position 2 of the connector switch. This relay when operated locks to ground at the control switch V24 cam. The operation of this relay lights the (DT) lamp and indicates to the test frame operator that the dial tone should be audible at that time. It also connects the dialing tip and ring to the receiver circuit so that the tone may be heard.

The operation of the (DTA) key releases the (DT) relay causing the dialing tip and ring leads to be connected through the (DY) relay. The testing circuit is then in position to prime the sender.

32. TALKING CIRCUIT TO SENDER MONITOR

When Figures A, B and C are used means are provided to enable the attendant at the test frame to communicate with the sender monitor, using the handset shown in figure C. The (SM) key when operated connects the handset to the sender monitor call circuit. This talking line is ordinarily required only when the monitor position is located at the trouble desk because the sender make busy jacks will then be located at the trouble desk. When the monitor position is at the "A" switchboard, the sender make busy jack will appear at the sender frame and ordinarily a talking line between the test frame and the sender monitor will not be required.

33. REPEAT TESTS

When it is desired to repeat a single test or the multi-test, the REP key is operated. The operation of the key opens the circuit for advancing the (R-25) switch from position 4, and operates the (REP) relay which locks and opens the circuit for advancing the sender switches. The operation of the REP key, when the MT key is normal, operates the (T) relay when the (R-25) switch is in position 4 and the (R-20) switch is in position 17 allowing the sender to be restored to normal before starting to repeat the test. Circuit: battery, winding of the (T) relay, cam F-25, make contact of the REP key, break contact of the MT key, lead 6, cam V-20, lead 4, break contact of the MT key, to ground at SS3-L24. If only a single repeat is desired, the repeat key must be restored before the test circuit completes the cycle it is in at the time the key is operated. The operation of the REP key does not cause the coin collect and refund tests to be repeated.

33.1 Repeat Coin Tests

When it is desired to repeat the coin tests ("H" wiring), the (REP-CN) key is operated in conjunction with the (REP) key. The (REP-CN) key operated operates the (REP-1) relay. The (REP-1) relay operated, closes the circuit for advancing the (R-25) switch from position 4 and opens the circuit for operating the (T) relay in position 4 of the (R-25) switch. The (R-25) switch therefore advances thru the coin test positions of each repeat, thereby repeating the coin tests.

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The operation of the (DTA) key releases the (DT) relay causing the dialing tip and ring leads to be connected through the (DY) relay. The testing circuit is then in position to prime the sender.

52. TALKING CIRCUIT TO SENDER MONITOR

When Figures A, B and C are used means are provided to enable the attendant at the test frame to communicate with the sender monitor, using the handset shown in Figure C. The (SM) key when operated connects the handset to the sender monitor cell circuit. This talking line is ordinarily required only when the monitor position is located at the trouble desk because the sender make busy jacks will then be located at the trouble desk. When the monitor position is at the "A" switchboard, the sender make busy jack will appear at the sender frame and ordinarily a talking line between the test frame and the sender monitor will not be required.

53. NORMAL TESTS

When it is desired to repeat a single test or the multi-test, the NRP key is operated. The operation of the key opens the circuit for advancing the (B-2D) switch from position 6, and operates the (NRP) relay which locks and opens the circuit for advancing the sender switches. The operation of the NRP key, when the MT key is normal, operates the (T) relay when the (B-2D) switch is in position 6 and the (B-2D) switch is in position 17 allowing the sender to be restored to normal before starting to repeat the tests. Circuit battery, winding of the (T) relay, cam B-2D, make contact of the NRP key, break contact of the MT key, lead 6, cam V-2D, lead 4, break contact of the MT key, to ground at SSP-LS4. If only a single repeat is desired, the repeat key must be restored before the test circuit completes the cycle it is in at the time the key is operated. The operation of the NRP key does not cause the coin collect and return tests to be repeated.

53.1 Repeat Coin Tests

When it is desired to repeat the coin tests ("P" wiring), the (NRP-CK) key is operated in conjunction with the (NRP) key. The (NRP-CK) key operated operates the (NRP-1) relay. The (NRP-1) relay operated, closes the circuit for advancing the (B-2D) switch from position 6 and opens the circuit for operating the (T) relay in position 6 of the (B-2D) switch. The (B-2D) switch therefore advances thru the coin test positions of each repeat, thereby repeating the coin tests.