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

Issue 3 BT 502494
Appendix 1
May 20, 1927.

This Appendix was prepared from Issue 41 of Drawing T-502494.

METHOD OF OPERATION

Line Circuit - Trip Circuit - Start Circuit - Line Finder Circuit - District Selector Circuit and Time Alarm Circuit - Arranged for Two Party Message Register - Panel Machine Switching System.

Page 32:

Under 51 - Tell-Tale - Line Finder Selector, add the following paragraph:

"S" Wiring

With the circuit connected per S wiring the (LF) relay releases when the line finder reaches tell-tale, due to the N and C segments being open. The release of the (LF) relay releases the UP magnet, and also releases the (F) relay when a sender is found. The release of the (F) relay operates the (DS) relay which locks, operates the DOWN drive magnet and reoperates the (F) relay, returning the line finder to normal.

Under 52 With Brushes Tripped, change the last sentence to read:

"T" Wiring

With the circuit connected per T wiring, the operating circuit for relay (DS) is held open until relay (LF) has released, thus preventing simultaneous operation of the UP and DOWN drive magnets.

ENG: D.C.W.
May 20, 1927
IB

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Western Electric Co., Incorporated,
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(34 Pages, Page 1)
Issue 3 BT 502494
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Replacing all previous issues.

This Method of Operation was prepared from Issue 39 of Drawing T-502494.

METHOD OF OPERATION

Line Circuit - Trip Circuit - Start Circuit - Line Finder Circuit - District Selector Circuit and Time Alarm Circuit - Arranged for Two Party Message Register - Panel Machine Switching System.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

1.1 This circuit is used in completing calls originated by a subscriber on two party message rate lines in full mechanical offices.

2. WORKING LIMITS

2.1 Maximum external subscribers loop resistance of 750 and 900 ohms and a minimum leak of 10,000 ohms.

2.2 Maximum trunk loop resistance 3025, 3910 and 5010 ohms for 24 volt battery or 7350, 9200 and 11470 ohms for 48 volt battery.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are:-

3.1 To establish talking connection.

3.2 To disconnect battery and ground from the subscribers line on an incoming call.

3.3 To furnish battery and ground to the subscribers line on outgoing calls.

3.4 To operate the proper message register on a charge call.

3.5 To connect busy tone to the calling station if required.

3.6 This circuit is made up of the following divisions:-

3.61 A Line Circuit

Which consists of a line relay (L), cut-off relay (CO) and a message register, there being one line circuit for each

subscriber's line. When the receiver is removed from the switchhook at a subscriber's station on an originating call, battery is connected from the line circuit to the hunting lead (H) of the calling line. The associated TRIP and START circuits described below, cause a LINE FINDER circuit to hunt for and connect the calling line to a district selector circuit. When the calling line is found, battery is disconnected from the lead H and the TRIP and START circuits are released, permitting their use on another originating call in the group of lins with which they are associated.

3.62 A Trip Circuit

One of which is provided for each group or bank of twenty lines on a panel line finder frame. A frame of 300 lines will therefore have fifteen trip circuits associated with it. Each trip circuit is divided into the two units, trip unit A being associated with the first ten lines of the bank and trip unit B being associated with the last ten lines of the bank. The TRIP circuit mechanically trips the trunk finder selector brushes which have access to the line terminals in that bank with which the trip circuit is associated, and connects to a START circuit. Each TRIP circuit is equipped with an emergency plug and jack, by means of which a defective TRIP circuit can be immediately replaced by an emergency circuit.

3.63 A Start Circuit

One of which is provided for each frame of 300 lines. The circuit consists of three distributing selectors, one of which distributes the use of this circuit so as to give each bank of lines an equal opportunity to use it on an originating call. The other two selectors distribute the calls uniformly to the associated LINE FINDER circuit, causing an idle selector to hunt over the line terminals for the calling line. At the same time, the start circuit releases a trip relay in the associated TRIP circuit, thus permitting another call to originate in any other bank. Each regular start circuit is provided with means for testing the associated line finder circuit and with an emergency plug and jack, whereby a regular circuit may be replaced by an emergency circuit.

3.64 A Line Finder Circuit

Which finds and connects the terminals of the calling line

with the DISTRICT SELECTOR circuit, there being a district selector circuit associated with and permanently connected to each line finder circuit. The line finder circuit consists of a power driven selector having fifteen sets of brushes wired in multiple, each set of brushes having access to the lines in one of the banks of twenty. At the same time that the line finder selector starts upward hunting for the calling line, the associated district circuit functions and selects an idle sender. This circuit also includes a TEST and a make busy (MB) jack.

3.65 A District Selector Circuit

Which is the other end of the line finder selector consists of a rotary magnet and sequence switch, and a magnet driven sender selector switch which selects and connects the district selector circuit to an idle sender circuit. The district selector selects and connects to an outgoing trunk under control of the sender with which it is connected. It also supplies talking battery to the calling station and connects battery for the operation of the message register in the line circuit on a call for which a charge is made, and connects a busy tone to the calling station when required.

3.66 A Line Finder Time Alarm Circuit

Which gives visual and audible signals when a subscriber's line is not connected to a line finder circuit within a specified time after a call has been originated.

3.7 Panel Line Finder Frame

3.71 A panel line finder frame consists of fifteen banks - (otherwise known as panels) of line terminals, each bank consisting of twenty sets of multiple line terminals, the total capacity being 300 lines. The multiple terminals appear on both sides of the frame and each set consists of four terminals namely, tip (T), ring (R), sleeve (S), and hunting (H). Each frame and bank has a capacity of sixty line selectors, thirty on the front and thirty on the rear of the frame. This number of line selectors for a frame of 300 lines may be reduced to 40 or 28. This arrangement of selectors for each 300 lines may be accomplished by splitting the line multiple banks of a frame in the following manner.

3.72 Where sixty line selectors are required for each 300 lines, the banks are split vertically in the center and the terminals in one section are cross connected to the terminals in the other section, so that the first or bottom terminal in a bank in one section will be connected to the last or top terminal in the corresponding bank in the other section.

3.73 Where forty line selector are required for each 300 lines, the frame is split vertically into three sections, and the terminals in two of the sections are cross connected as just described for a two section split. The other section being cross connected in a similar manner to the third section of a corresponding bank on another frame. In this way, 900 lines terminate on each two frames, the terminal in each section being accessible to twenty line selectors, ten on each side of the frame.

3.74 Where twenty eight line selectors are required for each 300 lines, the banks are split into four sections - the first and second being cross connected together, and the third and fourth sections being cross connected together, the terminals of each section being accessible to 14 line selectors, 7 on each side of the frame.

3.75 Each group of selectors for 300 lines is divided into two sub-groups (A and B). The selectors of the A sub-group have access to the terminals in one section of 300 lines and the selectors of the B sub-group have access to the terminals of the same 300 lines in the other section of the frame to which the terminals in the first section are cross connected. By this method a call originating in a group of twenty lines, causes a selector in the A or B sub-group to start hunting, the sub-group depending upon whether the calling line is in the first or last ten lines of the group. Should two calls originate in the same group simultaneously, one being in the first and the other in the last ten lines of the group, two selectors will start, one in each sub-group of selectors. Should all line finders in a sub-group be busy, the call originating within the corresponding ten lines will start a selector in the other sub-group.

3.76 When both sub-groups of selectors for 300 lines are on the same frame, the TRIP magnets are used, one on the front and the other on the rear of the frame. When the sub-groups of selectors for 300 lines are on different frames, four TRIP magnets are used, two on the front and two on the rear of each frame.

4. CONNECTING CIRCUITS

4.1 This circuit will function with any standard subscriber's sender of sender selector type.

DESCRIPTION OF OPERATION

5. ORIGINATING CALL - 2 PARTY MESSAGE RATE LINES

The operation of this circuit in connection with a call originating in the first ten lines of a group, is as follows: When the receiver at the calling station is removed from the switchhook, the (L) relay in the line circuit operates in a circuit from battery through the 200 ohm resistance, winding of the (L) relay, contact of the (CO) relay, out over the ringside of the line, back over the tip side, to ground on the armature of the (CO) relay. The operation of the (L) relay connects battery through the 18-AC resistance in the TRIP circuit, and the 500 ohm winding of the (O) relay in parallel, through its make contact to the hunting terminal (H) of the calling line in the line finder multiple bank, and also closes a circuit in which the (BA) relay operates. The operation of the (BA) relay closes a circuit from ground on its armature through the break contact of the (O) relay when "O" wiring is used, thru the break contact of the (K) relay, 700 ohm winding of the (TR) relay, break contact of the (A), (STA), and (STB) relays to battery through the contact of the STP-G magnet, operating the (TR) relay. The (TR) relay locks and the (STA) operates in a circuit from ground through the (TR) relay 600 ohm winding and make contact, terminal 1 and brush of the G group distributor selector, contact of the (C), (CA) and (SB) relays, to battery through the 18-BH resistance and the winding of the (STA) relay in parallel, operating the (STA) relay. The operation of the (TR) relay also closes a circuit operating the TRIP magnets and opens the series locking circuit through the (TR) relays in the other bank groups.

6. STARTING LINE FINDER

The operation of each TRIP magnet places its TRIP rod in position to trip the corresponding bank brushes of any selector on the same side of the frame as the selector is moved upward. The operation of the (STA) relay (A) closes a circuit from ground on its left armature to battery through the winding of the STP-G magnet which operates, (b) short circuits the 500 ohm winding of the (CA) relay, preventing its operation, (c) closes a circuit in which the (K) relay operates from battery through the winding of the (K) relay, make contact of the (TR) relay, to ground through the contact of the (STA) relay, and (d) closes a circuit operating the (LF) relay in the line finder circuit, from ground through contact of the (GA), and (C) relay, (A-1) bridging brush and terminal of the A selector, over lead ST, contact of the (MB) relay in the line finder circuit, contact

of the TEST jack, to battery through the 1,000 ohm winding of the (LF) relay. The (K) relay locks in a circuit through its winding, contact of the (O) relay, contact of the (K) relay, to ground through the contact of the (BA) relay, when "O" wiring is used or the (K) relay locks in a circuit through its own make contact, contact of the (O) relay to ground through the contact of the (BA) relay. The operation of the (K) relay opens the circuit through the 700 ohm winding of the (TR) relay, thus preventing another line finder selector from being started by this call, and closes a circuit from ground on its make contact, through the 1,500 ohm winding of the (O) relay, but the (O) relay does not operate until the line finder selector makes contact with the terminals of the calling line. The (LF) relay operated, (a) locks through its make contact and 650 ohm non-inductive winding to ground on the contact of the (H) relay, (b) closes a circuit to operate the (GA) relay to ground on the M commutator when the line finder selector starts upward. The (LF) relay operated, (a) closes a circuit from ground on the N commutator brush and segment, operating the line finder up magnet, (b) closes a circuit from ground through the N commutator brush and segment, break contact of the (E) relay to battery through the primary winding of the (CI) relay, operating the (CI) relay, and (c) closes a circuit operating the STP-A magnet. The STP-A magnet remains operated until the (STA) relay releases.

7. FINDING THE LINE AND SELECTING A SENDER

The operation of the UP magnet as described in the preceding paragraph, causes the line selector to move upward, hunting for the terminals of the calling line. Slightly after the line selector moves off normal, a circuit is closed from ground through the M commutator brush and segment, operating the (E), and (GA) relays. The (GA) relay operated locks to ground on the make contact of the (STA) relay and opens the operating path of the (LF) relay. The operation of the (E) relay, (a) closes a circuit from ground through its make contact, contact of the MB jack, to battery through the primary winding of the (MB) relay, operating the (MB) relay, (b) closes a circuit from ground through cam H and I, make contact of the (E) relay, to battery through the inner winding of the (D) relay, operating the (D) relay, (c) opens the circuit through the inner winding of the (CI) relay, thus permitting the (CI) relay to release unless the TEST brush of the sender selector is making contact with the TEST terminal of a busy sender, in which case the (CI) relay locks in a circuit from battery through its secondary winding, contacts of cam S, make contact of the (CI) relay, to ground on the test terminal of the busy sender. If the (CI) relay holds, the operation of the (E) relay also closes a circuit from battery through the primary winding of the line finder (F) relay in parallel with the winding and break contact of the SS magnet, through the make contacts of the (CI) and (E) relays, to ground through cam H, and operating the (F) relay and the SS magnet. The operation of the (F) relay opens the tip and

ring leads in the line finder circuit, to prevent the operation of the district (L) relay if the line selector connects to the terminals of the calling line before the sender selector finds an idle sender. The operation of the SS magnet, opens the circuit through its winding and break contact, causing its release. The release of the SS magnet advances the sender selector brushes one step to the terminals of the next sender. If this sender is idle, the (CI) relay releases; if not, the (CI) relay holds and the SS magnet again operates and releases, advancing the sender selector brushes another step. The SS magnet continues to operate and release until the sender selector brushes make contact with the terminals of an idle sender selector. The (CI) relay then releases, connecting ground in position 1 to 1-1/4 of the district switch through cam H, make contact of the (E) relay, and break contact of the (CI) relay, to the TEST terminal of the sender which has been selected, to make it test busy to all hunting sender selectors. The release of the (CI) relay also opens the circuit through the inner winding of the (F) relay.

8. MAKING DISTRICT BUSY

The (MB) relay operated, (a) locks in a circuit from ground on the armature and outer make contact of the (ST-A) relay, lead X, make contact and secondary winding of the (MB) relay, to battery through the break contact of the (SL) relay, so that the (MB) relay will not release should the selector return to normal while another call is going through, (b) closes a circuit from ground on the commutator make contact of the (LF) and (MG) relays, to battery through the outer winding of the (F) relay, which operates if the relay was not previously operated, thus keeping the tip and ring leads to the district circuit open until the calling line is found by the selector, (c) connects ground on its armature to the series circuit through the (MB) relay of the other selectors, in the same group, thus permitting the operation, over lead CH, of the (CA) or (CB) relays in the starting circuit when all line finder selectors in the group are off normal, (d) opens the circuit over lead Y, to prevent the (GA) relay from re-operating, (e) transfers the ST lead to the next line finder which if busy transfers the call over the ST lead in the same manner until an idle line finder is found.

9. RELEASING THE TRIP AND START CIRCUIT

During the selection of an idle sender, as line finder selector is moving upward, the line may be found before the sender is selected or vice versa. As soon as the line finder selector has moved up beyond the tripping zone, ground is connected to the K commutator brush and segment, thru the break contact of the (DS) relay, over lead K, through the make contact of the (GA) relay, break contacts of the (SA) and (C) relays and

over lead I, thereby short circuiting the 600 ohm winding of the (TR) relay, causing it to release. The (ST-A) relay holds in a circuit to the K commutator ground, until the K commutator brush moves off the commutator segment, just before the line selector brushes reach the first set of line terminals. The release of the (TR) relay closes the series locking circuit through the winding of the (TR) relays in the other groups, and releases the two associated TRIP magnets. The release of the (STA) relay (a) releases the (GA) relay; (b) opens the holding circuit through the secondary winding of the (MB) relay, the (MB) relay now holding in its operating circuit, (c) releases the STP-G magnet, thereby advancing the brushes of the G group distributor selector to the terminals of the tip circuit in the next group, (d) releases the STP-A magnet thereby advancing the brushes of the A sub-group distributor selector to the terminals of the next line finder circuit, and (e) removes the short circuit from the 500 ohm winding of the (CA) relay which operates if all the line finders in the group are busy as described in paragraph 43. "All Selectors in one Group Busy".

10. EMERGENCY RELEASE OF START CIRCUIT

The circuit is arranged to free the start and trip circuit in case a K lead becomes open or a K brush and segment fail to function. The (KF) and (KA) relays and the 149-J interrupter are provided for this purpose and are so wired that when either the (STA) or (STB) relay remains operated, due to the failure of the K lead to short circuit and release the (TR) or (TR-1) relay in the trip circuit, the (KF) relay operates as soon as the interrupter contacts I, III and V close. The (KF) relay operated, locks to ground on the contact of the (STA) or (STB) relay. If the (KF) relay remains locked for a period of 2 seconds interrupter contacts II and IV close and connects ground to the 600 ohm winding of either the (TR) or (TR-1) relay in the trip circuit depending on whether the call is going through the A or B sub-group, thus releasing the (TR) and (TR-1) relay. When the interrupter contacts II or IV open, the (STA) or (STB) relay releases in turn releasing the (KF) relay restoring the start circuit to normal.

11. START CIRCUIT ALARM

The interrupter contacts VI close at the same time as contacts II and IV and with the (KF) relay operated, a circuit is closed operating the (KA) relay. The (KA) relay operated, (a) locks under control of a key in the trouble desk, (b) lights a lamp in the trouble desk which is individual to the line finder frame and (c) operates the alarm. When the key at the trouble desk is operated, the (KA) relay releases, extinguishing the lamp and silencing the alarm.

12. FINDING CALLING LINE

When the selector brushes make contact with the terminals of the calling line, a circuit is closed from battery in the trip circuit, through the 500 ohm winding of the (O) relay and the 500 ohms resistance connected in parallel, make contact of the (L) relay, over lead H, the contacts of the line finder cam W, winding of the (H) relay, to ground on the break contact of the (DS) relay, operating the (H) relay in the line finder circuit and the (O) relay in the trip circuit. The operation of the (H) relay connects the 18-T resistance in parallel with its winding for the purpose of speeding the operation of the (O) relay by increasing the current through its 500 ohm winding. The (O) relay must operate before the H brush breaks contact with the H terminal in case the selector brushes are carried past the calling line terminals. The operation of the (O) relay opens the (H) relay holding circuit, causing its release. The operation of the (H) relay opens the circuit in which that the (LF) relay has been holding but the (LF) relay does not release immediately since ground is connected to the C commutator brush and segment. The (LF) relay is thus held operated, until the brushes are centered on the terminals of the calling line. When the circuit through the C commutator segment is opened, the (LF) relay releases and (a) opens the circuit through the UP magnet, stopping the upward movement of the selector, (b) closes a circuit operating the (SL) relay from ground on the M commutator, break contact of the (LF) relay, make contact of the (E) relay, winding of the (SL) relay, inner contacts of cam T, make contact of the (D) relay, to battery through the break contact of the (DS) relay and (c) opens the circuit through the secondary winding of the (F) relay. When both the (LF) and (CJ) relays have released after the line has been found and the sender selected, the (F) relay releases, connecting the calling line to the district circuit.

13. ADJUSTMENT OF "C" COMMUTATOR BRUSH

The adjustment of the C commutator brush with relation to the tripped H multiple brush, is such that it does not break contact with the C commutator segment until slightly after the holding circuit through both windings of the (LF) relay is opened by the operation of the (H) relay when the H brush makes contact with the H terminal to which battery is connected. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the line terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time the holding circuit through both windings of the (LF) relay is opened at the C commutator, releasing the relay. The (LF) relay released, releases the UP magnet. The selector then drops into place, thus centering the brushes on the line terminals.

14. RELEASING THE TRIP CIRCUIT

The operation of the (SL) relay closes a circuit from battery through its make contact, two 18-Q resistances, sleeve brush and terminal, to ground through both windings of the (CO) relay in series, operating the (CO) relay. This same battery is connected to the sleeve terminal of the line at the final frame making the line test busy to all hunting final selectors on a terminating call. The (CO) relay operated releases the (L) relay, which in turn releases the (BA) relay and (H) relays. The release of the (BA) relay releases the (O) relay. The (K) relay whose locking circuits was opened when the (O) relay operated is very slow to release in order to hold the circuit through the 1500 ohm winding of the (O) relay closed and the (O) relay operated, until after the (BA) relay released; otherwise another line finder may be started for this call. After the (O) relay releases, another call may start in the same group of ten lines, if the starting circuit is ready for call. For a call originating in the last ten lines of a bank of twenty, the operation will be similar to that above described, except that the (BA-1), (K-1), (O-1), (TR-1), (ST-B) and (GB) relays are used instead of the (BA), (K), (O), (TR), (ST-A) and (GA) relays.

15. SIMULTANEOUS CALLS

If a call originates in each of the first and last ten lines of a group simultaneously, the relays of both trip units A and B and of both distributor selectors in the starting circuit operates as above described, starting two line selectors, one in each sub-group. In this case, the primary winding of the (O) and (O-1) relays are connected in parallel through the make contacts of the (BA) and (BA-1) relays and both will operate when either one or both of the line finder selectors finds the terminals of a calling line.

16. ADVANCING THE SWITCH TO POSITION 2

The operation of the (SL) relay, also closes circuits from ground on the N commutator brush and segment, break contact of the (F) relay, make contact of the (SL) relay, cam O, to battery through the windings of the (CH) relay, operating the (CH) relay, and through cam O, cam R, to battery through the outer winding of the (L) relay, operating the (L) relay. The operation of the (L) relay closes a circuit from battery through the winding of the district R magnet, cam B, make contact of the (L) relay, to ground through cam M, advancing the district switch to position 2. The (L) and (CH) relays release when the switch advances from position 1. In position 1-1/2 to 2 inclusive, the test terminal

of the sender is connected through cams C, and I to ground. The (CH) relay operated, performs no useful function if the district advances to position 2. Should the district fail to advance from position 1, the (CH) relay closes a circuit from ground on cam I, through the contacts of the (CS) and (CH) relays to the Selector Time Alarm Circuit (not shown) which functions, giving a visual and audible signal.

17. COMPLETING THE FUNDAMENTAL CIRCUIT

With the switch in position 2, the tip and ring leads from the calling line are connected through the break contact of the (F) relay, cams P and Q, to the T and R leads to the sender for dialing. In position 2, the (CI) relay operates and (a) connects ground to the test brush of the sender selector to make the associated sender test busy after the switch advances from position 2 and until the (CI) relay again releases, (b) operates the (CI-1) relay (c) connects lead FT from the sender to battery through the inner winding of the (L) relay. The (CI-1) relay operated connects the SC lead from the sender, through cam V, make contact of the (CI-1) relay, cam U to battery through the outer winding of the (D) relay, and connects the R lead through to the R lead of the sender. The associated sender then receives impulses originated at the subscriber's dial and the sender advances to the position in which the sender controls district brush selection. In this position it connects ground through the winding of the sender stepping relay to the lead FT, operating the stepping relay in the sender circuit and the (L) relay in the district circuit. The (L) relay locks in a circuit from battery through its primary winding and make contact and cam L, make contact of the (CI) relay to ground on lead FT. The operation of the (L) relay advances the district switch to position 3 "BRUSH SECTION" in the circuit described for advancing it to position 2. In position 3, the 500 ohm winding of the (CH) relay is connected in parallel with the outer winding of the (D) relay through cam U break contact of the (CI) relay, cam U to the lead SC. The (CH) relay may operate at this time but serves no purpose in so doing. With the switch in position 3, the UP magnet is operated in a circuit from battery through its winding, cam C, make contact of the (L) relay, to ground through cam M, causing the selector to move upward for brush selection.

18. "A" COMMUTATOR

As the selector moves upward in position 3, carrying the commutator brushes over the commutator segments, the A segment and brush intermittently connects ground to the tip side of the fundamental circuit, through cams K and L holding the (L) relay operated, but successively short circuiting the stepping relay in the associated sender circuit,

thus releasing and permitting its reoperation until the proper brush has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay.

19. DISTRICT BRUSH SELECTION

The release of the (L) relay opens the circuit through the UP magnet thereby stopping the selector in the position in which the proper set of brushes will be tripped when the selector again moves upward, and advances the district switch to position 4 in a circuit from battery through the winding of the R magnet, cam B, contact of the (L) relay, to ground through cam M. When the associated sender is a two digit sender, it advances from the position in which it controls district brush selection and reduces the resistance to ground over lead SC sufficiently to cause the (CH) relay to operate if not already operated. In position 4, the trip magnet (TM) operates in a circuit from battery through its winding, to ground through cam S, and the district (L) relay operates and locks as it did in position 2, advancing the district switch to position 5 for group selection. With the switch in position 5, the UP magnet is reoperated, causing the selector to move upward for group selection. The TM magnet is held operated in position 5 and when the selector starts upward, the proper brush is tripped.

20. "B" COMMUTATOR

As the selector moves upward for group selection, carrying the commutator brushes over the commutator segments, the B segment and brush intermittently connects ground to the tip side of the fundamental circuit, through cam L, holding the (L) relay operated, but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its reoperation, until the proper group has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay.

21. DISTRICT GROUP SELECTION

The release of the (L) relay opens the circuit through the UP magnet stopping the selector in that position in which its brushes are resting on the terminals of the first trunk in the desired group of trunks, advances the district switch to position 6. In position 5 to 6 1/4, a circuit is closed from battery through the B-T brush and 1 terminal of the line test selector, winding of the FT selector, brush

and 1 terminal of the S-4 arc, cam H, to ground energizing the PT selector magnet. When the switch advances from position 6 1/4, the energizing circuit is opened, releasing the PT selector which steps its brushes one terminal on its back stroke. The line test selector remains in position 2 until the sequence switch is advanced to position 9 3/4. With the switch in position 6, the (L) relay operates in a circuit from battery through its outer winding, cam R, cam O, make contact of the (SL) relay, break contact of the (F) relay, to ground through the N commutator segment and brush. The operation of the (L) relay advances the switch to position 7 in a circuit from battery through the winding of the R magnet, cam B, make contact of the (L) relay, cam M, make contact of the (D) relay, to ground through cams I and H.

22. TRUNK HUNTING WITH TRUNK IDLE

Should the first trunk in the group in which the selector is hunting be idle, the (L) relay releases as the switch leaves position 6 1/4. While the switch is in position 6 1/2 and 7 3/4 inclusive, ground is connected through cam M, break contact of the (L) relay, cam E, to the sleeve terminal of this trunk, making it test busy to any other selector. The release of the (L) relay advances the switch to position 8.

23. TRUNK HUNTING WITH TRUNK BUSY

Should the first trunk in the group in which the selector is hunting be busy, the (L) relay is held operated in a circuit from battery through its primary winding and make contact, cam E, to ground on the S terminal of the busy trunk. With the switch in position 7, the UP magnet is reoperated and the selector travels upward, until an idle trunk is found. When an idle trunk is found, the locking circuit through the inner winding of the (L) relay is opened, but the relay does not release immediately due to a circuit being closed from battery through its secondary winding, cam R, to ground through the C commutator brush and segment. When the brushes are centered on the trunk terminals, the circuit through the C commutator segment is opened and the (L) relay releases, in turn opening the circuit through the UP magnet which stops the selector brushes on the terminals of the selected trunk. The release of the (L) relay also advances the switch to position 8.

24. "C" COMMUTATOR

The adjustment of the C commutator brush, with relation to the tripped sleeve multiple brush is such that it does not break contact with the C commutator segment, until slightly after the holding circuit through the

primary winding of the (L) relay is opened, by the sleeve brush leaving the busy terminal and making contact with the sleeve terminal of the idle trunk. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the trunk terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time the holding circuit through the secondary winding of the (L) relay is opened at the C commutator, releasing the relay. The (L) relay released, disconnects ground from the commutator feed bar (G) and releases the UP magnet. The selector then drops into place, thus centering the brushes on the trunk terminals. During trunk hunting, in position 7 only, the commutator feed ground is supplied from ground on cam M, under control of the (L) relay. This is to prevent the reoperation of the (L) relay by a closing of a circuit between the C commutator brush and segment, on the overthrow of the selector, or as it drops into place.

25. SELECTION BEYOND

When the switch enters position 7 3/4, ground is connected through cam E to the S terminal of the selected trunk making it test busy. With the switch in position 8, a circuit is closed from ground on the armature and make contact of the (CH) relay, cam O, cam R, to battery through the outer winding of the (L) relay, operating the (L) relay and thereby advancing the switch to position 9. In position 9, the tip and ring sides of the outgoing fundamental circuit are closed through the tip and ring terminals of the selected trunk for selection beyond through the FT and FR brushes of the sender selector and cams F and G respectively. After selection beyond has been completed, ground in the sender is removed from the SC lead, releasing the (CH) relay. The release of the (CH) relay releases, the (L) relay. The release of the (L) relay advances the switch to position 10. As the switch leaves position 9 1/2, the dialing circuit is opened at cams P and Q and in position 9 3/4, the tip and ring leads from the line finders are closed through cams P and O respectively, to 24 volts battery and ground in the district.

26. FIRST TEST OF CALLING LINE

As the district switch enters position 9 3/4 to 10 1/2, the PT magnet, operates in a circuit through the S-4 brush and 2 terminal, to ground on cam H. The PT magnet operated, steps the brush assembly to terminal 3. With the line test switch on terminals 3, 4, 5, and 6, 48 volt battery is connected to the tip side of the subscriber's line, through terminal 3 and T-1 brush of the selector and cam P. The charge in the station condenser is thus neutralized so that it will not

interfere with the proper functioning of the (T) relay as the line is tested, when the line test switch enters a test position. A circuit is also closed from battery through one winding of the repeating coil, winding of the (DC) relay, R-3 brush and terminal 3 of the test switch, to ground through the non-inductive winding of the (RC) relay, operating the (DC) relay. The operation of the (DC) relay closes a holding circuit for the (D) relay. With the line test switch on terminal 3, a circuit is also closed from battery through its B-2 brush and 3 terminal, to ground through the primary winding of the (RT) relay which operates.

27. ROUTINE TEST

The (RT) relay operated, (a) closes a circuit from ground on cam W thru the C-5 brush and 3 terminal of the line test switch, make contact and 3400 ohm winding of the (RT) relay, to battery through the winding of the (T) relay which operates and (b) connects ground on its armature to the selector time alarm circuit. The function of the (RT) relay is to make a routine test of the (T) relay on each call before it is connected to the line in connection with making two party tests. If the (T) relay operates satisfactorily in series with the 3400 ohm winding of the (RT) relay, it does so on less current than it would receive under the worst line circuit conditions, thus assuring its operation under the worst circuit condition. If the (T) relay does not operate in series with the 3400 ohm winding of the (RT) relay, the PT selector remains on terminal 3, causing the selector time alarm circuit to function. When the (T) relay operates on a routine test, a circuit is closed from ground on its armature, make contact of the (RT) relay, to battery through the inner winding of the (I) relay, which operates. The (I) relay operated, closes a circuit from ground on its armature, terminal 3 and S-4 brush of the party line test switch to battery through the winding and break contact of the PT magnet, operating the selector which steps the brushes to terminal 4. With the line test switch on terminal 4, the operating circuit for the (T) relay is opened, at the C brush, releasing the (T) relay. The (T) relay released, opens the circuit through the (I) relay which releases. The (I) relay released, steps the selector to terminal 5 in a circuit traced from ground on the armature and break contact of the (I) relay, terminal 4 and S-4 brush of the selector, to battery through the winding of the PT magnet. With the line test switch on terminal 5, a circuit is closed from battery through the winding of the PT magnet, S-4 brush and terminal 5 to ground through the make contact of the 149-A interrupter, operating the 200-S selector. When the contacts of the interrupter break, the energizing circuit of the selector magnet is opened, releasing the magnet, which steps the brushes to terminal 6. The 200-S selector continues to operate under control of the 149-A type

interrupter, advancing the line test switch to position 8, ground thru the S-4 brush and terminal 8 advances the switch to position 9.

28. TESTING SUB-STATION

At terminal 7 of the line test switch the subscriber's line is tested to determine which party on the line has originated the call, in order that the call may be registered correctly. If the call originates at the station whose ringer is connected to ground through a condenser, the (T) relay does not operate. If, however, the call originates at the station with the grounded ringer, the (T) relay operates in turn operating the (RC) relay. The (T) relay operates in a circuit from ground through the sub-station ringer, over the tip side of the line, through the cam P, T-1 brush and terminal 7 of the line test selector, to battery through the winding of the (T) relay. The operation of the (T) relay closes a circuit from ground on its armature, break contact of the (RT) relay, make contact of the (CI-1) relay to battery through the primary winding of the (RC) relay which operates. The (RC) relay operated, transfers the circuit to the message register as explained herinafter.

29. TALKING SELECTION

With the switch in position 10, the sender circuit functions and connects ground to the FT lead, causing the (L) relay to operate and lock through its primary winding over the tip of the fundamental circuit previously described. The (L) relay operated, advances the switch for talking selection. This circuit is traced from battery through the R magnet, cam B, make contact of the (L) relay, to ground through terminal 9 and C-5 brush of the line test selector to ground on cam W. As the switch advances, ground is intermittently connected to the tip side of the fundamental circuit through cam E, holding the (L) relay operated, but successively short circuiting and permitting the reoperation of the stepping relay in the sender circuit. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay. The (L) relay released, opens the circuit through the R magnet, stopping the switch in position 11, 12 and 13, depending upon the class of call. With the line test switch on terminal 8, the (T) relay releases, the 48 volts battery is disconnected from the tip side of the line. With the line test switch on terminal 9 and the district sequence switch in position 10, a circuit is closed energizing the 200-S selector. This circuit is from ground cam H, terminal 9 and S-4 brush of the switch, winding of the PT magnet, to battery through terminal 9 and B-2 brush of the selector. As

the district switch advances from position 10 1/2, the operating circuit of the PT magnet is opened at cam H, releasing the magnet which steps its brushes to terminal 10. With the test switch on terminal 9, the holding circuit of the (DC) relay is transferred from the non-inductive winding of the (RC) relay and closed metallic over the sub-station loop. This circuit is traced from battery through one winding of the repeating coil, winding of the (DC) relay, R-3 brush and terminal 9 of the line test switch, cam Q, break contact of the (F) relay, terminal and brush of the line finder, through the station loop, back through the terminal and brush of the selector, break contact of the (F) relay, lower contacts of cam P, T-1 brush and terminal 9 of the test switch to ground through the other winding of the repeating coil.

30. DISCHARGING THE SENDER

With the (DC) relay operated, a locking circuit is closed for the (D) relay after the switch advances from position 9. The (D) relay is slow to release so that the connection will not be lost if the switchhook at the called station is momentarily depressed. As the sequence switch leaves position 10, the holding circuit of the (CI) relay is transferred from ground on cam S to ground on cam E, under control of the (L) relay. This circuit is traced from battery thru the secondary winding of the (CI) relay, inner contacts of cam U, make contact of the (CI-1) relay, cam V, make contact (L) relay to ground thru cam E. The release of the (L) relay opens the holding circuit through the (CI) relay, disconnecting the sender from the district circuit.

31. CALLED PARTY ANSWERS

When the receiver at the called station is removed from the switchhook, with the switch in position 11 or 12, reversed battery and ground from the incoming circuit operates the (CS) relay. The (CS) relay operated closes a circuit from ground on cam I, through the #3 contact of the 149-J interrupter secondary winding of the (I) relay, to battery. When the interrupter contact closes, the (I) relay operates and locks to the same ground through its make contact. When the 4 contact of the interrupter closes with the (I) relay operated the (CH) relay operates through its windings in series and locks through cam O, to ground. The (CH) relay operated also closes a circuit from battery on its make contact to hold the (SL) relay operated after the (D) relay releases. The 149-J interrupter is so connected in the circuit that the operation of the (CH) relay is delayed for at least two seconds after the (CS) relay operates. This delay is to prevent the false operation of the (CH) relay should the (CS) relay operate momentarily before the called party answers due to any line disturbances.

32. OPERATOR ANSWERS

The switch advances to position 13 as described above and when the operator inserts the plug of a cord in the answering jack of the trunk, the (CS) relay operates on reversed battery and ground over the trunk. With the switch in position 13, a circuit is closed from cam H, terminal 10 and S-4 brush of the line test switch, winding of the PT magnet to battery through terminal 10 and B-2 brush of the selector, energizing the stepping magnet. The (CS) relay operated, closes a circuit from the same ground on cam I, through cam R, to battery through the secondary winding of the (L) relay, which operates and advances the switch to position 14. As the switch leaves position 13, the holding circuit of the (CI) relay is opened at the cam U, releasing the relay. The release of the (CI) relay releases the (CI-1) relay and disconnects the sender circuit from the district. As the switch leaves position 13 1/2, the operating circuit of the PT magnet is opened at cam H, releasing the magnet and stepping the line test selector brushes to terminal 11. With the switch in position 14, the repeating coil and battery are disconnected and the T and R leads are connected directly to the T and R brushes of the selector through cams P and Q, respectively. As the switch enters position 13 1/2 the (L) relay locks in a circuit from ground over lead S of the selected trunk, through cam E, to battery through winding of the (L) relay, and in position 14, the locking circuit through the inner winding of the (D) relay is transferred from the contacts of the (DC) relay to cam J. In position 14, a checking tone circuit is closed over the sleeve of the operator's trunk, cam E, make contact of the (L) relay, cams V, and Y 2 m.f. condenser, cam X, the S brush and terminal at the line finder bank, to ground through the winding of the (CO) relay for number checking.

33. DISCONNECTION - REGULAR CALL

When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, in turn releasing the (D) relay. The (D) relay released, closes a circuit through the R magnet, advancing the switch to position 16. As the switch enters position 14 3/4 ground is connected through cam H, terminal 11 and S-4 brush of the line test switch to battery through the winding of the PT magnet and terminal 11 and B-2 brush of the test switch, energizing the magnet. When the switch leaves position 15 1/4, the energizing circuit for the PT magnet is opened at the cam H, releasing the magnet and advancing the line test switch to terminal 12. The 149-J interrupter steps the switch to terminal 16.

34. SECOND TEST OF CALLING LINE

As the line test switch passes over terminals 12 and 13 with the district switch in position 16, battery is connected through the T-1 brush and cam P to the tip side of the line to discharge the sub-station condenser. On terminals 14, 15 and 16 of the line test switch, a second test is made on the line. During this test, the tip and ring of the line are short circuited through the make contact of the (CH) relay, in order to test for a foreign ground on either side of the line. With the district switch in position 16, the (I) relay operates in a circuit from battery through its primary winding, terminal 12 and C-5 brush of the line test switch to ground on cam W, and remains operated until the line test switch advances from position 15. If the (T) relay operates in position 14 to 16 of the test switch, the (I) relay is held operated and the line test switch steps to terminal 16. This holding circuit is traced from ground on the armature of the (T) relay, make contact of the (RT) relay, to battery through the inner winding of the (I) relay. With the (I) relay operated, the test switch is held on this terminal and a circuit is closed operating the selector time alarm circuit. When the alarm is investigated, the sequence switch must be advanced to position 17, manually, to prevent a false charge to the calling station. If, however, the line is free from ground when the second test is made, the (T) relay does not operate and the (I) relay releases and closes a circuit from ground through its break contact, terminal 16 and S-4 brush of the test switch, to battery through the winding and break contact of the PT magnet, stepping the brushes to terminal 17. The selector then steps to position 20 under control of the 149-J interrupter in order to allow sufficient time for the operation of the message register in the associated line circuit. As the line test switch passes over terminal 19, a message register circuit is closed from battery through the make contact and armature of the (CH) relay, operating the proper message register in the associated line switch circuit as explained below.

35. MESSAGE REGISTERING

As explained under first test of calling line, the (RC) relay operates and locks on the first line test when the call originates at the station with the grounded ringer but does not operate on line tests when the call originates at the station whose ringer is connected in series with a condenser. The operation or non-operation of the (RC) relay determines which station register shall register the call. If a call originates at the station whose ringer is connected to ground in series with a condenser, the MR-1 message register in the line circuit operates. The registering circuit is traced from battery on the make contact of

the (CH) relay through cam T break contact of the (I) relay break contact of the (RC) relays, through the 18-AN resistance in multiple break contact of the (L) relay make contact of the (CO) relay, through winding of the (MR-1) message register to ground. On calls originating at the station whose ringer is permanently connected to ground, the (RC) relay operates and locks and closes a circuit short circuiting the (E) relay which releases. This circuit is traced from ground on C-2 brush and terminals 18 and 19 of the line switch make contact of the (RC) relay to the winding of the (E) relay short circuiting the inductive winding of the (E) relay. The (E) relay released, (a) opens the circuit through the (SL) relay which releases, (b) opens the operating circuit for the (MB) relay, but the (MB) relay does not release on account of a circuit being closed to ground on cam I. The release of the (SL) relay opens the circuit, releasing the (CO) relay. When "P" wiring is used the (F) relay also operates opening the tip and ring leads. When the (CO) relay releases, the MR-2 message register is connected to lead H and the registering circuit for the second party station is traced from battery on the make contact of the (CH) relay, break contact of the (I) relay, make contact of the (RC) relay, contact of the (G) relay, through the 18-AN resistance in multiple, cam W, brush and commutator of the LF selector, over lead H, break contact of the (L) and (CO) relays, to ground through the winding of the MR-2 message register. As the operation of register MR-2 is dependent on the release of the (SL) relay, it will be noted that the sleeve of the line at the final frame is left unguarded by the release of the (SL) relay. In the event that the line is again seized by a final selector immediately upon the release of the (SL) relay, the (G) relay operates and opens the register circuit, thus preventing the wrong station being charged with the call. The (G) relay operates in a circuit from ground through cam E, cam L, cam K, through the winding of the (G) relay, over the S lead to battery on the S lead of the final selector which seized this line.

36. DISCONNECTION REGULAR CALL

As the line test switch steps to terminal 20, a circuit is closed from ground onthe C-2 brush and terminal 20 of the line test switch, break contact of the (L) relay through cam B to battery through the R magnet, advancing the district switch to position 17. The A cam advances the switch to position 18. As the switch enters position 18, a circuit is closed operating the (DS) relay in the line finder circuit. This circuit is traced from ground on the M commutator brush and segment, through the 350 ohm winding of the (DS) relay, cam N, break contact of the (D) relay, to battery on the break contact of the (DS) relay. The (DS) relay operated, (a) locks through its make contact and 350 ohm winding to the same battery (b) closes a circuit through the

outer winding of the (F) relay, thus insuring the holding of this relay until both the line finder selector and the district selector have returned to normal, (c) operates the line finder DOWN magnet from ground on its armature, which restores the line finder selector to normal. When the line finder selector returns to normal, ground is disconnected from the H commutator segment, releasing the (E); (DS), and (MB) relays. With the district switch in position 18, a circuit is closed from ground on cam I, break contact of the (D) relay, cam D, terminal 20 and S-4 brush of the test switch, to battery through the winding of the PT magnet which operates and advances the switch to terminal 21.

37. RESTORING DISTRICT TO NORMAL

With the line test switch on terminal 21, the circuit is closed from ground on the C-2 brush and terminal 21 of the test switch to battery through the down magnet restoring the selector to normal. When the district selector reaches the bottom of the frame, a circuit is closed from ground through the Y commutator brush and segment, D-6 brush and terminal 21, S-4 brush and terminal to battery through the PT magnet, stepping the brushes to terminal 22. With the test switch on terminal 22, a circuit is closed from ground on the terminal 22 and S-4 brush to battery through the PT magnet stepping the switch to terminal 1. With the line test switch on terminal 1, ground through the Y commutator brush and segment, D-6 brush and terminal 1 of the line test switch, cam B to battery through the R magnet, advances the district switch to position 1. As the switch leaves position 18, the circuit through the DOWN magnet is opened, and after position 18 1/4, the circuit through the outer winding of the (F) relay is opened, releasing the relay.

38. DELAYED DISCONNECT

Should the calling subscriber fail to replace the receiver on the switchhook after the called subscriber has disconnected, the release of the (CS) relay, due to the incoming trunk functioning, operates the selector time alarm circuit from ground through cam I over the circuit previously described, thereby notifying the switchman of the existing condition.

39. DISCONNECTION - TALKING TO OPERATOR

With the plug of the answering cord in the trunk jack at the incoming end, ground is connected to the sleeve terminal of the trunk to hold the district (L) relay operated. If the plug of the cord is removed from the trunk jack before the receiver at the calling station is replaced on the switchhook, the line relay in the trunk circuit operates, thereby holding the ground on the sleeve terminal of the trunk. When the receiver at

the calling station is replaced on the switchhook and the plug of the answering cord is removed from the trunk jack at the incoming end, the (DC) relay releases, and ground is disconnected from the sleeve of the trunk, releasing the (L) relay, thus advancing the switch to position 15. As the switch advances from position 14 1/4, the locking circuit through the inner winding of the (D) relay is opened at cam J, releasing the relay. The (D) relay released, releases the (SL) relay and then advances the switch to position 16 in a circuit traced from battery through the R magnet, cam D, break contact of the (D) relay, to ground through cam I. With the test switch in position 20 a circuit is closed on the C-5 brush and terminal 20, break contact of the (L) relay, cam B to battery through the R magnet advancing the switch to position 17, the A cam advancing to position 18. In position 16, the (CH) relay being normal, battery is not connected over lead H to operate the message register in the line circuit, as the call is not chargeable. From this point on, the line finder and district selectors are restored to normal as described in paragraphs 36 to 38 inclusive.

40. DISCONNECTION BEFORE LINE FINDER SELECTOR FINDS LINE

Should the calling subscriber replace the receiver on the switchhook before a hunting selector finds the line, the (L) relay in the line circuit releases, removing battery from the H terminal at the multiple bank. Assuming the calling line to be in sub-group A, the release of the (L) relay releases the (BA) relay. The (TR) relay having operated, locks and operates the (ST-A) relay, which operates the (LF) relay in the line finder circuit and the selector is started hunting, as described in paragraph 12. The selector therefore travels to the top of the bank and the H brush of the selector makes contact with the terminal of the H comb. at the tip of the multiple bank. The (H) relay operates from ground on the break contact and armature of the (DS) relay, winding of the (H) relay cam W, H brush of the selector to battery. The (H) relay operated, releases the (LF) relay, which in turn releases the (F) relay and opens the circuit through the UP magnet, stopping the selector. The N commutator segment is opened with the selector brush resting on the H combination terminal to prevent the district switch from advancing from normal when the (F) relay is released by the release of the (LF) relay. When the (F) relay releases, the (DS) relay operates from ground on the X commutator brush and segment, through its 1,000 ohm winding. The (DS) relay operated, operates the DOWN magnet, restoring the selector to normal.

41. POSITIONS 2 to 6

If the receiver is replaced on the switchhook at the calling station while the district switch is in positions 2 to 6, the dialing circuit is opened at the calling station, causing the sender circuit to function and connect a direct ground to the SC lead operating the (CH) relay and causing the (D) relay to release on account of the increased current flow through the secondary winding of the relay. The (D) relay is connected differentially, but does not release when its primary winding is connected directly to ground and its secondary winding connected to ground in series with a resistance. The (D) relay released, advances the switch to position 6 in a circuit traced from ground through cam I, break contact of the (D) relay, cam D to battery through the R magnet. In position 6 the DOWN magnet operates, restoring the district selector to normal. When the selector reaches the bottom of the bank, a circuit is closed from ground through the Y commutator brush and segment, D-6 brush and terminal 1 of the test switch, cam B to battery through the R magnet, advancing the switch to position 7. In position 7, a circuit is closed from battery, break contact of the (DS) relay, break contact of the (D) relay, cam N, through the outer winding of the (DS) relay, to ground on the M commutator, operating the (DS) relay. When the district switch advances from position 6 1/4, the (L) relay releases and closes a circuit advancing the switch to position 8. As the district switch enters position 5, the PT selector is operated from battery over the B-2 brush and terminal, winding of the PT magnet, S-4 brush and terminal 1 of the line test switch, cam R, cam O, make contact of the (SL) relay, break contact of the (F) relay to ground through the N commutator brush and segment. When the district switch advances from position 6 1/4, the PT magnet releases stepping the test switch to position 2. Ground on the Y commutator through the D and S brushes steps the test switch to position 4. The test selector steps to terminal 5 in a circuit from ground on the break contact of the (I) relay and steps to terminal 8 under control of the 149-A interrupter. Ground on terminal 8 advances it to terminal 9. Ground on the Y commutator through the D9 and 10 terminal advances the district to position 14. As the district switch passes through position 9 3/4 to 10 1/2, the PT magnet operates in a circuit from battery through the B-3 brush and terminal 9, winding of the PT magnet, S-4 brush and terminal 9 to ground on cam H. With the test switch in position 9, a circuit is closed from ground on the Y commutator through the D-6, brush and terminal 9, advancing the district switch to position 11. As the district switch advances from position 10 1/2, the PT magnet releases, stepping the line test switch to terminal 10. When the district switch advances to position 11, a circuit is closed from ground on cam I, break contact of the (D) relay, cam D to battery through the R magnet, advancing the switch to position 16. The district switch passes through position 13, the PT magnet operates, and when the district switch

advances from 13 1/2, the PT magnet releases, stepping the line switch to terminal 11. In position 14 3/4 the PT magnet again operates and releases when the district switch advances from position 15 1/4. The release of the PT magnet advances the test switch to terminal 12. Ground through the 149-A interrupter is connected through the PT magnet, advancing the test switch to terminal 16. On terminal 16, ground on the break contact of the (I) relay advances the test switch to terminal 17. The switch advances to terminal 20, under control of the 149-A interrupter, and closes a circuit from ground through the C-2 brush and terminal 20, advancing the district switch to position 17, the A cam advancing it to position 18. Ground on cam I, break contact of the (D) relay, cam D, S-4 brush and terminal 20 of the test selector advances the switch to terminal 21. The Y segment advances the switch to terminal 22. On terminal 22 ground through the S-4 brush steps the test switch to terminal 1, where a circuit is closed from groundon the Y commutator, D-4 brush and terminal 1, advancing the district switch to position 1. When the line finder selector returns to normal, ground is disconnected from the M commutator, thus releasing the (E), (DS), (CI) relays. The (DS) relay released, releases the (F) relay, and the (E) relay released, releases the (SL) relay. The (SL) relay released opens the circuit releasing the (CO) relay, thus restoring the circuit to normal.

POSITION 7 to 10

42. If the receiver at the calling station is replaced on the switchhook while the district switch is in position 7 to 10, the switch advances until selection beyond is completed, when ground is disconnected from the SC lead in position 10, and connected to the FT lead, operating the (L) relay. The (L) relay operated advances the switch to position 11. With the switch in position 11, the (D) relay releases closing a circuit from ground on cam I, break contact of the (D) relay, cam D, to battery through the R magnet, advancing the switch to position 16. As the switch advances from position 16, the line test switch steps to terminal 21, and in position 16, the (L) relay releases, advancing the switch to position 17, the A cam advancing it to position 18. From this point on the circuit is restored to normal as described in paragraphs 36 to 38 inclusive.

43. ALL SELECTORS IN ONE SUB-GROUP BUSY

If all the selectors in sub-group "A", for example, are busy, the (CA) relay operates over a circuit from ground on the armature of the (MB) relay in the line finder circuit, through the make contacts of all

the other operated (MB) relays in sub-group "A", over lead CH to the starting circuit, 500 ohm winding of the (CA) relay, to battery through the 600 ohm resistance (C). The (CA) relay operated, transfers the circuit through the 600 ohm winding of the (TR) relay in the trip circuit from the winding of the (ST-A) relay, to battery through the winding of the (SA) relay and the break contact of (SB) relay. When a call is now received, the (SA) relay operates in series with the 600 ohm winding of the (TR) relay, in turn operating the (ST-B) relay. This circuit is traced from battery through the winding of the (ST-B) relay, in parallel with the 18-BH resistance, make contact of the (SA) relay, 600 ohm resistance (B), to ground on the armature of the (CB) relay. The (ST-B) relay operated, operates the (K) relay, starts a selector in the "B" sub-group hunting for the calling line operates the STP-G magnet and closes a locking circuit through the 1000 ohm winding and make contact of the (CA) relay. This is to prevent the release of the (CA) relay should a selector become available in the "A" sub-group while a call is going through the "B" sub-group. If all selectors in sub-group "B" are busy, the operation is similar except that the (CB), (SB), and (ST-A) relays now operate. The (ST-A) relay operated, starts a selector in the "A" sub-group hunting, as explained before.

44. ALL SELECTORS IN BOTH SUB-GROUPS BUSY

If all selectors in both sub-groups are busy, both the (CA) and (CB) relays are operated. Should a call be received in either sub-group under these conditions, the corresponding (SA) or (SB) relay operates, but neither the (ST-B) nor (ST-A) relay operates as the circuits to ground on the armature of the (CA) and (CB) relays are open. When a call is received in the "A" or "B" sub-group while all selectors are busy, the special message register (MR) in the starting circuit operates through the make contact of the (SA) relay to ground on the armature of the (CB) relay, if the call is in sub-group "A", or through the make contact of the (SB) relay to ground on the armature of the (CA) relay, if the call is in sub-group "B". The message register thus indicates the number of calls which were originated while all the line finder selectors were busy.

45. LINE FINDER TIME ALARM

If a line finder does not find the subscriber's line within 35 seconds after the receiver at the calling station is removed from the switchhook, an alarm is given in the following manner. When the receiver at the calling station is removed from the switchhook, the line (L) relay operates, operating the (BA) relay. The (BA) relay operated, connects battery to the contact of the 152-D interrupter in the time

alarm circuit over a circuit from battery through the non-inductive (outer) winding and make contact of the (BA) relay, lead B winding of the (B) (frame) relay in the time alarm circuit, brush and terminal 1, of the START arc of the time alarm selector, break contact of the (A) frame relay, to the interrupter contact. When the interrupter contact closes, the (B) relay operates. The A (frame) relay does not operate, however, due to its windings being short circuited by ground on the interrupter. When the interrupter contact opens, the short circuit is removed from the winding of the (A) relay, which now operates in series with the winding and make contact of the (B) relay, to ground on the armature of the (B) relay, thus holding both relays operated. The next closure of the interrupter operates the STP magnet, over a circuit from ground on the make contact of the interrupter, make contact of the (A) relay, terminal 1 and brush of the STEP arc of the selector, to battery through the winding of the STP magnet. When the interrupter contact opens, the STP magnet releases and steps its brushes one step on its back stroke. The selector brushes thus advance one step for each make and break of the interrupter contact, which is of an interval of 7 seconds, until the fifth terminal of the selector is reached when the circuit through the interrupter is opened. When the fifth terminal of the selector is reached, the BA-1 lamp in the trip circuit lights over a circuit from battery on the armature of the (A) (frame) relay, terminal 5 and brush of the LAMP arc of the selector, lead A, through the make contact of the (BA) relay, BA-1 lamp, lead C, to ground through the winding of the (B) (aisle) relay in the time alarm circuit, which operates. The (B) relay operated, operates the A (aisle) relay. The (A) relay operated, lights the aisle pilot and main or monitoring board lamps through their respective auxiliary alarm circuits. When the source of trouble is removed and the (BA) relay in the trip circuit has released, the circuits over leads A and B are opened, in turn releasing both the frame and aisle (A) and (B) relays, extinguishing the aisle and main or monitoring board lamps and silencing the alarm. The release of the (B) (frame) relay also closes a circuit from ground on its armature, through terminal 5 and the bridging brush of the RETURN arc of the selector, to battery through the break contact and winding of the STP magnet, which operates and steps the selector brushes to terminal 6, in which position it awaits the next closure of lead B. Should the (BA) relay release before the fifth terminal is reached by the selector, the (A) and (B) (frame) relays release. The (B) relay released, causes the selector to advance to the next normal position, awaiting closure of lead B, as previously described. The operation of the NL key steps the selector brushes to the next normal position by way of the STEP bridging brush and 5, 10, 15, or 20 terminal as the case may be. If the selector had been at normal position 6, 11

or 16 when the (BA) relay operated, the operation would have been the same as described for position 1.

46. WIRING OF GROUP DISTRIBUTOR BANK

The wiring of the two group distributors arcs of the regular C distributing selector bank, shown on the regular starting circuit, and of the emergency G distributor selecter bank, is shown in detail in the circuit associated with the series circuit through the emergency jack and the contacts of the (TR) and (TR-1) relays for the 15 groups of a panel line finder frame. For a complete frame of 300 lines, the wiring of the terminals for both arcs of each G distributor selector is shown in a table on the drawing. As a trip circuit is divided into two units, A and B, calls originating in the first 10 lines of a group of 20 lines are connected through trip unit A and a terminal and brush of the G arc normally having access to the line finders in sub-group "A". Calls originating in the last 10 lines of a group are connected through trip unit B and a corresponding terminal and brush of the other arc normally having access to the line finders in sub-group "B". This arrangement permits the distributing of the 30 trip circuit A and B units to sub-groups "A" and "B", respectively, in the starting circuit, so as to give each group an equal preference, thus preventing any one group from having a permanent preference over the other groups. This is accomplished by the G selector being advanced one step to the next group after each call. The series circuit through the contacts of the (TR) and (TR-1) relays permits the passing of a call originated on a line within the group having the preference at that time. Should two or more calls start in two or more groups at the same time, the group nearest the one having the preference at that time will be completed first, because of the series locking arrangement of the (TR) or (TR-1) relay holding the relay of this group locked and releasing the other relays.

47. LOCKING CIRCUIT THRU (TR) RELAYS

The (TR) relay in any group locks from ground through its 600 ohm winding and make contact, jack 10, terminal and brush of the associated arc of the G selector, to battery in the starting circuit through jack 15. The (TR-1) relay locks through its 600 ohm winding and make contact, jack 12, corresponding terminal and brush of the associated G arc, to the starting circuit. Jacks 10 and 12 of each group circuit wire to the selector arc terminals and jacks 9 and 11 loop to the next group circuit, so that though the selector may be giving preference to one group, this group being idle, and a call originates in some other group, a circuit is closed back through the intervening jacks and break contacts of the

intervening relays of each group until the terminal which the distributor brush is resting on is reached. Assume a call originates in group 15 and is passing through trip unit A and the brushes of the G distributor selector are resting on the first group terminal, which is terminal 1. The locking circuit for the (TR) relay is as follows: Through the 600 ohm winding and make contact of the (TR) relay and jack 10 of group 15, jack 11, break contacts of (TR-1) and (TR) relays, and jack 10 of group 14 (not shown), through all other groups in the same manner to jack 10 of group 1, terminal 1 and brush of the selector, to jack 15 of the starting circuit. It will be seen that if two calls start at the same time in two different groups causing the (TR) relays in the two groups to operate together, the call originating in the group nearest the one having the preference of the starting circuit will be completed first. For example, if a call started in group 10, trip unit A, and another in group 15, trip unit A, the operation of the (TR) relay in the former group would release the (TR) relay in the latter circuit, but remain locked itself. The magnet of the G selector is operated by ground on the armature of the (ST-A) or (ST-B) relay and the brushes advance one step on the release of the selector armature when the (ST-A) or (ST-B) relay releases after each call.

48. LINE FINDER DISTRIBUTOR

The distributing selectors A and B shown in detail on "The Selector Start Wire Circuit" are used for distributing calls uniformly to the line finder selectors in sub-groups A and B, respectively. When the number of line finder selectors for a group does not exceed 40 selectors for each 300 lines, the starting circuit shall be equipped with two 200-R distributor selectors. Figure 1 shows these selectors wired and equipped for 16 line finder selectors for each sub-group. When the operation of the (STA) relay in the starting circuit connects ground on the start (ST) lead, as described under "ORIGINATING CALL", the (LF) relay which operates depends upon the terminal on which the A-1 bridging brush is resting. Assume the A-1 brush is resting on terminal 1 in the regular start circuit of sub-group A. In this case if the first selector is not busy the associated (LF) relay operates and functions as previously described. If the first selector is busy, the associated (MB) relay is operated and the circuit through the (LF) relay open. In this case the (LF) relay associated with the next idle selector operates. Assuming this to be the tenth selector, a circuit is then closed from ground at the (ST-A) relay (not shown), through the break contacts of the (GA) and (C) relays, the A-1 bridging brush and terminal 1 of the A-1 arc of the distributor selector, the ST lead, make contact of the first (MB) relay, the series make contacts of the succeeding operated

(MB) relays, break contact of the tenth (MB) relay, to battery through the inner winding of the (LF) relay, which operates. The operation of the (GA) relay, as described under "ORIGINATING CALLS", operates the STP-A magnet from ground on the armature of the (STA) relay, through terminal 1 and the A-3 brush, to battery through the winding of the magnet, so that when the (GA) relay releases on the completion of a call, the STP-A magnet releases, in turn stepping the selector brushes one step and giving the next selector the preference. When the brushes of the distributor selector advance from the terminals of the last line finder selector, terminal 16, the selector is advanced over the spare terminals to the first terminal from ground on the strapped spare terminals through the A-2 brush. A call made at the time, the selector is advancing over the spare terminals, will be routed to the first selector through the A-1 brush and strapped spare terminals by the strap from terminal 22 to the terminal 1 on the A-1 arc. When the number of line finder selectors for a group exceeds 40 selectors for each 300 lines, the starting circuit shall be equipped with two 200-P distributor selectors. Figure 2 shows these selectors wired and equipped for 26 line finder selectors for each sub-group. It will be noted that the ST leads from the first 15 line finder selectors of each sub-group are connected in their respective order to the first 15 terminals of the A-1 and B-1 arcs and the ST leads of the last 11 line finder selectors of each sub-group are connected in their respective order to the first 11 terminals of the A-4 and B-4 arcs. It will also be noted that the brushes of the first three arcs of each selector are in the opposite position from the brushes of the last three arcs, so that only three brushes of a selector make contact with terminals at the same time the other three brushes being open at that time. On a regular call in sub-group A, the circuit functions as described for figure 1 until the first three brushes of the A distributor selector advance from terminals 22. At this time the first three brushes are open and the last three brushes are now resting on the first terminal of the A-4, A-5 and A-6 arcs. The next call in the sub-group then starts #17 selector, if idle, hunting for the calling line. Assume the last three brushes are resting on terminal 11 of the associated arcs and the 26 line finder selector is idle. The operation of the (STA) relay in the starting circuit closes a circuit from ground on its armature, break contact of the (GA) and (C) relays, A-4 brush and terminal 11 over the ST lead, through the break contact of the (MB) relay of the last or #26 line finder selector in the sub-group, to the associated (LF) relay. The operation of the (GA) relay operates the STP-A magnet through the A-6 brush and terminal 11. The release of the (STA) relay releases the STP-A magnet, advancing the brushes to the next or terminal 12. Ground on spare terminals 12 to 22 through the A-5 brush advances the brushes of the selector until the first three brushes are resting on the first terminal

of the A-1, A-2 and A-3 arcs. A call made while the selector is advancing over the spare terminals will be routed to the first selector through the A-4 brush and strapped spare terminals by the strap to terminal 1 of the A-1 arc. The number of line finder selectors for a sub-group may thus be arranged by changing the necessary strapping on the selector arcs. The operation for the emergency selector for sub-group "A", and the regular and emergency selectors for sub-group "B" are similar.

49. ANOTHER SELECTOR RETURNS TO NORMAL WHILE A CALL IS GOING THROUGH

When the (STA) relay operates on a regular call, ground is connected to the line finder circuit over lead X so that when the (MB) relay operates it is held operated through its outer winding from battery on the armature of the (SL) relay. This locking circuit prevents the (MB) relay from releasing, should a selector return to normal while a call is going through, until the call is safely started. There is the possibility that a circuit may have been closed from ground on the armature of the (STA) relay, through the make contacts of several (MB) relays, to an (LF) relay associated with some other line finder, but the (CA) relay in the starting circuit not having had time to operate and open the ST lead. Then if an intermediate (MB) relay released, due to the associated line finder selector returning to normal, it would find ground on the ST lead and operate a second (LF) relay, thereby starting two line finder selectors for the same call.

50. TESTING LINE FINDER SELECTORS

This circuit, which is shown associated with the starting circuit, enables the testing of any particular line finder selector at any time. The test line used with the test box circuit for making the test is the first or bottom line of the bottom bank in both the "A" and "B" sub-groups, the first line terminals in both sub-groups being connected together. When the 184 plug (shown on the line finder circuit) is inserted in the TEST jack of the line finder under test, the ST and ST-1 leads are connected together. The 1000 ohm winding of the (LF) relay is disconnected from the break contact of the (MB) relay and connected to the make contact of the (C) relay in the starting circuit through the strapped ring and sleeve of the TEST plug. When the plug of the test box cord is inserted in either 159 test jack, the (A) relay operates from ground on the sleeve of the test box cord. The (A) relay is quick in operating to precede the (TR) relay in the trip circuit on a simultaneous call. The (A) relay operated, closes a circuit through the winding of the (B) relay, which operates. This circuit is traced

from ground on the right inner armature of the (A) relay, winding and break contact of the (B) relay, break contacts of the (STA) and (STB) relays, to battery on the armature of the STP-G magnet when the previous step of the G distributor selector has been completed. The (B) relay is slow in operating to prevent a call which has just reached the (ST-A) or (ST-B) relay from being interrupted and to prevent there being the possibility of two selectors arriving on the test line. The (B) relay operated, (a) locks to battery on its make contact, (b) operates the (C) and (CI) relays from ground on its armature, through the break contact of the (E) relay, (c) closes the ringside of a loop through the test box, which operates the (L) relay associated with the test line. The (C) relay operated, (a) transfers the circuit for operating the (STA) relay in the starting circuit from the G distributor selector bank, (b) opens the normal ST lead, (c) closes the circuit through the (LF) relay and TEST jack to the make contact of the (ST-A) relay, as hereinafter described, (d) opens the operating circuit for the (ST-B) relay, which would otherwise operate and lock on a call within the last 10 lines in the group. The (CI) relay operated, (a) closes a circuit for operating the (TR) relay in the trip circuit from battery on the armature of the STP-G magnet, (b) connects the K lead of sub-group "A" with the K lead of sub-group "B", thus connecting the K commutator segments of all the selectors of both sub-groups together, (c) connects the Y lead of sub-group "A" with the Y lead of sub-group "B", so the (GA) relay will be operated by a selector in either sub-group. The (L) relay of the test line operated, in turn operates the (BA) relay. The (BA) relay operated, operates the (TR) relay through its 700 ohm winding over the same circuit as described under "ORIGINATING CALL" except this time through the make contact of the (CI) relay, the (A) relay being operated. The (TR) relay operated, functions as previously described and locks in a circuit traced from ground through its 600 ohm winding and make contact, make contact of the (C) relay, break contacts of the (CA) and (SB) relays, to battery through the 18-BH resistance and the winding of the (STA) relay in parallel. The (STA) relay operated, functions as described under paragraph 5, "ORIGINATING CALL" and in addition closes a circuit operating the (D) relay. The circuit for operating the (LF) relay of the line finder circuit under test is traced from ground on the armature and inner make contact of the (STA) relay, through the break contact of the (GA) relay, make contact of the (C) relay, sleeve and ring of the TEST jack and plug in the line finder circuit, to battery through the 1000 ohm winding of the (LF) relay. The (LF) relay operated, starts the selector hunting for the battery on the H terminal of the test line, as in the case of a regular call. With the exceptions already stated, the line, trip, starting, line finder; and district circuits function as for a regular call. With the (STA) relay operated, the circuit for operating the (D) relay is traced from ground on the armature and outer make

contact of the (STA) relay, break contact and winding of the (D) relay, to battery on the armature of the (B) relay. The (D) relay operated, locks to ground on the armature of the (A) relay. When the (STA) relay releases, the (E) relay operates from ground on the left inner armature of the (STA) relay, make contact of the (D) relay, to battery through the break contact and winding of the (E) relay. The (E) relay operated, (a) locks to ground on the armature of the (A) relay, (b) releases the (C) and (CI) relays, thereby restoring the starting circuit to normal, (c) closes the circuit from battery on the armature of the STP-G magnet, which was opened by the operation of the (A) relay and later closed by the operation of the (CI) relay, through to the 700 ohm windings of the (TR) and (TR-1) relays. When the plug of the test box cord is removed from the test jack, the (A) relay is released, releasing the (B), (D) and (E) relays, thereby restoring the test circuit to normal.

51. TELL- TALE - LINE FINDER SELECTOR

Should the selector travel to the tell tale position while hunting, due to the multiple brush not being tripped, the (F) relay remains operated through its outer winding. Ground on the X commutator brush and segment is thereby connected to the lead "To Tell Tale Circuit", giving a visual signal to the attendant. As the N commutator segment is open at tell tale, the district is prevented from advancing from its normal position. The selector in this case is restored to normal manually by the attendant.

52. WITH BRUSHES TRIPPED

Should the selector travel to the tell tale position while hunting, with the multiple brush tripped, a circuit is closed from battery in the trip circuit through the 500 ohm winding of the (O) relay in parallel with the 500 ohm resistance, make contact of the (BA) relay, terminal of the H comb. at the top of the multiple bank, H multiple brush of the line finder selector, contacts of cam W, winding of the (H) relay, to ground on the armature of the (DS) relay, operating the (O) and (H) relays. The (O) relay operated, functions as previously described and the (H) relay operated, releases the (LF) relay, which in turn releases the (F) relay and the UP magnet. The (F) relay released, opens the circuit through the tell tale alarm and connects ground through the X commutator brush and segment to battery through the 1000 ohm winding of the (DS) relay, which operates, in turn operating the DOWN magnet, restoring the selector to normal. The receiver at the calling station being still removed from the switchhook, the (L) and (BA) relays are still operated and the call again goes through as described under "ORIGINATING CALL".

53. TELL TALE DISTRICT SELECTOR

Should the selector travel to the tell tale position during brush selection, ground on the X commutator brush and segment is connected through cam B, to battery through the R magnet, advancing the switch to position 8. Under this condition, ground is disconnected from the SC lead in the sender, releasing the (CH) relay and the district remains in position 8 until it is restored to normal manually. If the district goes to tell tale during group selection, ground on the X commutator advances it to position 8. In position 8, ground on the SC lead holds the (CH) relay operated which, in turn operates the (L) relay. The (L) operated advances the switch to position 9. The (CH) and (L) relays remain operated and the district remains in position 9 until it is restored to normal manually.

54. OVERFLOW

If all the trunks in the group are busy, the district selector, while trunk hunting in position 7, travels to the top of the group and rests on the overflow terminals. As the sleeve terminal at overflow is open, the (L) relay releases, in turn advancing the switch to position 8. In position 8, the (L) relay re-operates from ground on the armature of the (CH) relay, advancing the switch to position 9, where ground on the Z commutator advances it to position 10. In position 10, a circuit is closed from ground on the Z commutator brush and segment, through cams K, and L, to battery through the 1200 ohm winding of the (L) relay, operating the (L) relay. The (L) relay operated, locks through its 1200 ohm winding and make contact to the same ground, through cam L, advancing the switch to position 14 from ground on cam M. As the switch advances from position 13, the (L) relay releases, and in position 14 advances the switch to position 15. The release of the (L) relay also releases the (CI) and (CI-1) relays, disconnecting the sender from the district circuit. With the switch in position 15, a circuit is closed from the "Miscellaneous Tone Circuit" over lead C, 2 M.F. condenser, cam C, winding of the repeating coil, 2 M.F. condenser, cams Y, V and J, make contact of the (D) relay, to ground on cam I. A tone is therefore induced in the other winding of the repeating coil, thus causing the "All Trunks Busy" tone to be sent back to the calling subscriber. When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, opening the locking circuit through the (D) relay, which releases. From this point on, the switch is advanced to position 1 as described under "Disconnection - Talking to Operator".

55. "0" COMMUTATOR

The function of the "0" commutator segment is to maintain an idle condition on the multiple overflow terminals, so that more than one selector may stop on overflow at one time; otherwise, the first selector reaching overflow would make the sleeve multiple terminals busy, thus causing succeeding selectors to continue upward into the next group of trunks. The "0" commutator segment is open at overflow, but the S bar is continuous. Both the "0" and "S" commutator brushes are permanently strapped together and wired to the multiple sleeve brush. When the selector is at overflow, the "0" commutator brush is resting on an open (dead) segment, and as the busy ground is fed through the "0" commutator bar only, this arrangement maintains a non-busy condition of the sleeve terminals. When necessary to combine two or more groups of trunks, the multiple sleeve overflow terminals between the combined groups are made permanently busy by being connected to ground. As the "S" commutator bar is closed at overflow, the (L) relay is heldooperated at this time, and the selector therefore hunts past the "made busy" terminals into the next group.

56. TERMINATING CALL

When a final selector connects to the tip, ring and sleeve terminals of an idle line at the final multiple, battery through a resistance in the final circuit is connected over the sleeve lead S, to ground through the both windings of the (CO) relay on individual lines or the last line of a group of consecutive lines; or through the 100 ohm winding of the (CO) relay on the intermediate lines of a group of consecutive lines. The (CO) relay operated, disconnects the (L) relay battery bridge from across the tip and ring of the line circuit. When the final selector returns to normal, the circuit through the winding of the (CO) relay is opened, releasing the relay and restoring the circuit to normal.