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# METHOD OF OPERATION
# PANEL LINE FINDER CIRCUIT.

**Line Circuit - Trip Circuit - Start Circuit - Line Finder Circuit - District Selector Circuit - Time Alarm Circuit - Arranged For 2 Party Message Register Line - Full Mechanical Power Driven System.**

## GENERAL DESCRIPTION

1. This common panel line finder and district selector circuit is used for passing calls originated by a dial subscriber on a flat or individual message rate line in a full mechanical office. It consists of six funtionally connected circuits as follows:-

1.1 The LINE circuit consists of a line relay (L), cut-off relay (CO), and a message register, one line circuit for each subscriber's line. When the receiver at a calling station is removed from the switchhook, battery is connected to the hunting (H) lead of the calling line and the associated apparatus functions and starts a line finder selector hunting for the battery on the hunting lead. When the calling line is found, battery and ground from the line circuit is disconnected from the tip and ring of the line, which awaits the closure of talking battery from the associated district circuit. The associated trip circuit is also released, thus permitting another call to start in that half of the group.

1.2 A TRIP circuit is provided for each bank group of 20 lines, thus making 15 trip circuits on a panel line finder frame of 300 lines. Each trip circuit is divided into two units, trip unit A, having access to the first 10 lines in a bank, and trip unit B, having access to the last 10 lines in a bank. The trip circuit mechanically trips the selector brushes of the particular bank in which the terminals of its associated lines appear and connects to a starting 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.

1.3 The STARTING circuit controls the routing of calls to the respective line finder selectors and starts an idle selector hunting over the line terminals for the calling line. It also at the same time releases a trip relay in the associated trip unit, thus permitting another call to start in any other group. There is one starting circuit for each frame of 300 lines. The circuit consists of three 200 type distributing selectors, one of which permits the distributing of thie circuit so as to give each line group an equal preference. The other two distributing selectors distribute the calls uniformly to the respective line finder selectors. Each regular starting circuit is provided with means for testing any line finder circuit and is equipped with an emergency plug and jack for immediately replacing the regular circuit with an emergency circuit at any time.

1.4 The LINE FINDER circuit is arranged to find the calling subscriber's line and connect it with the various switching apparatus necessary to complete a call.

Each line finder circuit is permanently connected to a district selector circuit and consists of a power driven selector having 15 sets of contact brushes wired in multiple, one set of brushes associated with each line bank. At the same time the line finder selector starts upward hunting for the calling line, associated district circuit functions and selects an idle sender. This circuit also includes a MAKE BUSY jack and a TEST jack.

1.5 The DISTRICT SELECTOR circuit, which is the other end of the line finder selector, is provided with a magnet driven selector switch, by means of which an idle sender is selected and associated with the district until all selections have been completed, when the sender is discharged. The district circuit is selector ended and selects and connects to the proper outgoing trunk, under the control of a sender, for the completion of an originating call. It also supplies talking battery to the calling station, connects battery for the operation of the message register in the line circuit on a charge call, and connects the busy tone to the calling station if required.

1.6 The LINE FINDER TIME ALARM circuit is for the purpose of giving visual and audible signals to the attendant when an originating call is not connected to a line finder in a specified time period.

PANEL LINE FINDER FRAME:

2. A panel line finder frame consists of 15 banks (at times known as panels) of line terminals, each bank consisting of 20 sets of multiple line terminals, making a total capacity of 300 lines. The multiple terminals appear on both sides of the bank and each set consists of four terminals namely: tip (T), sleeve (S), and hunting (H). Each frame and bank has a capacity of 60 line finder selectors, 30 selectors mounted on the front of the frame and the other 30 selectors mounted on the rear of the frame. This number of selectors for each 300 lines may be reduced to 40 or 28 selectors. The arrangemant of the selectors may be accomplished by splitting the line multiple banks of a frame in the following manner:-

2.1 Each 60 selector bank on a frame is split in the center and arranged for a cross connecting cable, so that the first or bottom line on one side of the split will connect to and appear at the last or top line on the other half of the bank. This practice is used where 60 line finder selectors are required for each 300 lines.

2.2 Each 60 selector bank on a frame is split into three sections of 20 selectors each, two of these sections to be arranged for cross connecting to each other, the other sections to be cross connected to a corresponding bank section on another frame. This practice is used where 40 selectors are required for each 300 lines, thus permitting 900 lines to be accommodated on two frames.

2.3 A 56 selector bank split into four sections of 14 selectors each, the first and second sections to be arranged for cross connecting to each other and the third and fourth sections arranged for cross connecting to each other. This practice is used where 28 selectors are required for each 300 lines, thus permitting 600 lines to be accomodated on the one frame.

3. Each group of selectors for each 300 lines is divided into two sub-groups, "A" and "B". The "A" sub-group of selectors is on one side of the transposition split and the "B" sub-group is on the other side of the transposition split. By this method, a call originating in a group of 20 lines causes a selector in the "A" or "B" sub-group to start hunting, the sub-group depending upon the calling line being in the first or last 10 lines of the group. Should two calls in the same group originate at the same time, one being in the first 10 lines and the other being in the last 10 lines, two selectors will start, one selector in sub-group "A" the other in sub-group "B". Should all line finders in a sub-group be busy, a call originating within the corresponding 10 lines will start a selector in the adjacent sub-group.

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

DETAILED DESCRIPTION.

ORIGINATING CALL:

5. The operation for a call originating in the first 10 lines of a group is as follows:- When the receiver is removed from the switchhook at the calling L station, the L relay in the line circuit operates over a circuit from battery through the 200 ohm resistance, winding of the L relay, break contact of the CO relay, over the ring side of the line, through the subscriber's loop, back over the tip side to ground on the armature of the CO relay. The line L relay operated, connects battery to the H terminal of the line at the line finder multiple bank and operates the BA relay through its inner winding. The BA relay operated, operates the TR relay over a circuit from ground on the armature of the BA relay, break contact of the K relay, 700 ohm outer winding of the TR relay, break contacts of the A, ST-A, and ST-B relays, to battery on the armature of the STP-G magnet. The TR relay operated performs the following functions: (a) operates the two TRIP magnets from ground on its armature (b) opens the locking series circuit through the TR relays in the other bank groups, as hereinafter described, (c) locks in a circuit from ground through its 600 ohm inner winding and make contact, terminals 1 and brush of the G group distributor selector, break contacts of the C, CA, and SB relays, to battery through the winding of the ST-A relay, which operates. Each TRIP magnet operates its trip rod, thus tripping the corresponding group brushes of the associated selectors on its respective side of the frame. The ST-A relay operated, functions as follows: (a) closes a circuit from ground on its left inner armature, to battery through the winding of the STP-G magnet, which operates and remains operated until the ST-A relay releases, (b) short circuits the 500 ohm winding of the CA relay preventing it from operating and starting a line finder in sub-group "B", as described under "ALL SELECTORS IN ONE SUB-GROUP BUSY", while a call is going through, (c) operates the K relay over a circuit from battery through the winding of the K relay, make contact of the TR relay, to ground on the armature of the ST-A relay, (d) Closes a circuit operating the LF relay in the line finder circuit. This circuit is traced from ground on the right outer armature and inner make contact of the ST-A relay, through the break contacts of the GA and C relays, the A1 bridging brush and terminal of the A selector, over lead ST, break contact of the MB relay in

the line finder circuit, break springs of the TEST jack, to battery through the 10000ohm outer winding of the LF relay. The K relay operated, (a) Locks to ground on the armature of the BA relay through its make contact and the break contact of the O relay (b) opens the circuit through the 700 ohm winding of the TR relay, thus preventing another line finder selector from being started by this call, (c) Closes a circuit from ground on its make contact through the 1500 ohm winding of the O relay, but the O relay does not operate at this time on account of insufficient amount of current through the winding. The LF relay operated, (a) locks to ground on the break contact and armature of the H relay, through its make contact and both windings in series, (b) closes a circuit operating the GA relay in the starting circuit from ground on the break springs of the Make Busy jack, make contact of the LF relay, break contact of the MB relay, lead Y, to battery through the break contact and winding of the GA relay. (c) operates the UP magnet from ground on the N commutator brush and segment, causing the line finder selector to travel upward and brush and segment, causing the line finder selector to travel upward and hunt for the terminals of the calling line to which battery is connected, as hereinafter described, (d) closes a circuit from the same ground on the N commutator brush and segment, through the break contact of the line finder E relay, to battery through the inner winding of the CI relay, operating the CI relay. The GA relay operated, removes ground from lead ST, locks to ground on the armature of the ST-A relay and closes a circuit operating the STP-A magnet. This circuit is traced from ground on the armature and inner make contact of the ST-A relay, make contact of the GA relay, terminal and brush of the A-3 arc of the A selector, to battery through the winding of the STP-A magnet. The STP-A magnet remains operated until the release of the ST-A relay. The CI relay operated, operates the CI-1 relay. This circuit is traced from ground on cam H, upper inner contact of cam I, make contact of the E relay, make contact of the CI relay to battery through the winding of the CI-1 relay.

6. As the line finder selector starts upward hunting for the calling line, a circuit is closed through the M commutator slightly after the brushes of the selector move off-normal. Ground on the M commutatos brush and segment operates the line finder E relay. The E relay operated, (a) operates the MB relay from ground on its armature, through the break springs of the MB jack, to battery through the inner winding of the MB relay, (b) closes a circuit from ground on the upper inner contact of cam I, make contact of the E relay, to battery through the inner winding of the D relay, operating the D relay, (c) opens the operating circuit of the CI relay, thus permitting the relay to release, should the TEST brush of the sender selector be making contact with the TEST terminal of an idle sender. If the TEST brush of the sender selector is making contact with the TEST terminal of a busy sender, the CI relay locks through its outer winding, the lower contacts of cam S make contact of the relay, to ground on the TEST brush of the sender selector. With the CI relay held operated, the operation of the line finder E relay also closes a circuit operating the F relay in the line finder circuit and the district selector STP magnet. This circuit is traced from battery through the 1000 ohm winding of the F relay and in parallel with battery through the break contact and winding of the STP magnet, make contacts of the CI and E relays, to ground on the upper outer contact of cam H, thereby stepping the sender selector brushes one step on its back stroke. If the next sender circuit is idle, the CI relay releases, in turn stopping the selector, but if the next terminal is busy, the CI remains operated and the sender selector continues to step until an idle sender is found. When the CI relay releases, the TEST terminal of the selected sender is immediately made busy to all hunting sender selectors by ground connected to the TEST brush from the upper outer contact of cam F through the make contact of the E relay and the break contact of the CI relay. This busy ground is connected until the switch advances from position

1-3/4. The operation of the F relay opens the tip and ring leads between the line finder commutator and the district circuit. This is to prevent the calling station being connected to the T and R brushes of the sender selector while the selector is hunting over the terminals of busy senders, should the line finder selector connect to the terminals of the calling line before the sender selector finds an idle sender.

7. The MB relay operated; (a) locks from ground on the armature and outer make contact of the ST-A relay, lead X, make contact and outer winding of the MB relay, to battery on the break contact and armature 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 through the break springs of the MB jack, make contacts of the LF rand MB relays, to battery through the 800 ohm 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 hthe selector, (c) connects ground on its armature to the series circuit through the MB relays 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.

8. As the line finder selector continues upward, at the end of the tripping tone, ground on the K commutator brush and segment, short circuits the 600 ohm winding of the TR relay through the break contact of the DS relay, over lead K and through the break contact SA relay, thus releasing the TR relay. The ST-A relay remains operated from the same ground until the K brush moves off the K commutator segment, when the circuit through the winding of the ST-A relay is opened, releasing the relay. This occurs before the brushes of the line finder selector have reached the first set of line terminals. The TR relay released, closes the locking series circuit through the TR relays in the other groups and opens the circuit through the two TRIP magnets, which release. The STA relay released, (a) opens the locking circuit through the GA relay, which releases, (b) opens the circuit through the locking (outer) winding of the MB relay, but the relay does not release as it is held operated over its operating circuit, (c) opens the circuit through the STP-A magnet, which releases and steps the brushes of the G group distributor selector to the next terminals, (d) opens the circuit through the STP-A magnet, which releases and steps the brushes of the A group distributor selector to the next terminals, (e) removes the short circuit from the 500 ohm winding of the CA relay. which does not operate unless all selectors in the group are busy as described under "ALL SELECTORS IN ONE SUB-GROUP BUSY".

9. When the selector brushes make contact with the terminals associated with the calling line, battery on the H terminal operates the O relay in the trip circuit and the H relay in the line finder circuit. This circuit is traced from battery in the trip circuit, through the 500 ohm winding of the O relay and the 500 ohm resistance connected in parallel, make contact of the L relay, over lead H, through the H multiple terminal and brush, H commutator brush and segment, outer contacts of cam W, winding of the H relay, to ground on the break contact and armature of the DS relay. With the H relay operated, a 50 ohm non-inductive shunt is connected around its winding to ground on its armature for the purpose of increasing the

amount of current through the 500 ohm winding of the O relay, thus speeding its operation. This is necessary on account of the very short time period during which the H brush makes contact with the H terminal before the circuit over lead H is opened by the over throw of the selector. The H relay operated, opens the circuit which holds the LF relay operated, but the LF relay does not release immediately on account of a circuit being closed from ground through the C commutator brush and segment, to battery through both windings of the LF relay in series. 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. The LF relay released, (a) opens the circuit through the UP magnet, which stops the selector brushes on the terminals of the calling line, (b) opens the circuit through the 800 ohm winding of the F relay, so that when the circuit through its 1,000 ohm winding is opened, by the release of the CI relay when the district sender selector seizes an idle sender, the F relay releases, (c) closes a circuit operating the SL relay. This circuit is traced from ground through the break contact springs of the MB jack, break contact of the LF relay, make contact of the E relay, winding of the SL relay, inner contacts of cam T, make contacts of the D relay, to battery on the break contact of the DS relay.

9.1 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 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.

10. The O relay operated, opens the locking circuit of the K relay. The K relay is very slow in releasing to hold the O relay operated through its 1500 ohm winding, in order to permit the BA relay to release before the O relay, otherwise another finder may be started by this call.

11. The release of the F relay closes the tip and ring leads from the calling line through to the T and R leads of the associated sender circuit, thus permitting a dialing tone to be transmitted back over the dialing circuit from the associated sender, as an indication that the apparatus is ready to receive the call by the operation of the station dial. The tip side of the dialing circuit is closed from the T lead of the line through the break contact of the F relay, inner contacts of cam P to the T brush of the sender selector. The ring side of the dialing circuit is closed from the R lead of the line, through the break contact of the F relay, inner contacts of cam Q, make contacts of the CI-1 relay to the R brush of the sender selector.

12. The SL relay operated, closes a circuit which operates the CO relay in the line circuit from battery on its armature, through the two 110 ohm resistances

(18-Q)in series, over lead S, to ground through one or both windings of the CO relay in series. This same battery is connected to the multiple sleeve terminals of the line at the final frame, making the line test busy to all hunting final selectc on a terminating call. The CO relay operated, releases the line L relay, which in turn releases the BA relay, which opens the circuit through the O and H relays, which release. Another call may now start within this same group of 10 lines if the starting circuit is ready for the call. The operation for a call originating in the last 10 lines of a group of 20 will be similar to that already described for the first 10 lines, except that the BA-1, K-1, O-1, TR-1, ST-B and GB relays are involved instead of the BA, K, O, TR, ST-A, and GA relays.

13. If there is a simultaneous call in both the first and last 10 lines of a group of 20 lines, the relays of both sub-groups will operate as already described, starting two line finder selectors in different sub-groups at the same time. In this case, the inner windings of the O and O-1 relays are connected together through the make contacts of the BA and BA-1 relays. The O and O-1 relays will therefore operate in parallel when the H brush of either or both line finder selectors make contact with the H terminal of the calling line.

14. The operation of the SL relay also closes a circuit operating the district CH and L relays. The circuit in which the CH relay operates is traced from ground on the N commutator brush and segment, through the break contact of the F relay, make contact of the SL relay, lower inner and upper outer contacts of cam O, to battery through the 600 ohm winding of the CH relay. This same ground is connected through the inner contacts of cam O, upper outer and lower inner contacts of cam R, to battery through the 800 ohm winding of the district L relay. The CH relay operated closes a circuit from ground on the upper outer contacts of cam I, break contact of the CS relay, make contact of the CH relay, to battery through the selector time alarm circuit (not shown), which operates providing an idle sender is not selected in a reasonable length of time. L relay operated, closes a circuit advancing the district switch to position 2. This circuit is traced from battery through the R magnet lower contacts of cam B, make contact of the L relay, to ground through the lower contacts of cam M. As the switch advances from position 1, the circuit through the L and CH relays is opened, releasing the relays and disconnecting the selector time alarm circuit. In position 1-1/2 to 2 the associated sender is held busy by ground through the lower inner contact of cam I and the outer contacts of cam C.

15. With the switch in position 2, the CI relay operates through its outer winding to ground on cam S, and remains operated until the switch advances from position 10. The CI relay operated, (a) connects ground through the inner contacts of cam S to the TEST brush of the sender selector, thus making the associated sender test busy after the switch advances from position 2, (b) closes the tip side of the fundamental circuit through to the sender (c) operates the CI-1 relay. The operation of the CI-1 relay closes the sender control (SC) lead through its make contact and lower contacts of cam V. lower inner and upper outer contacts of cam U, to battery through the outer winding of the D relay. After the sender functions the fundamental circuit is established for the operation of the district L relay and the strpping relay in the sender. This circuit is traced from ground in the sender circuit, through the FT brush, make contact of the CI relay, inner contacts of cam L, to battery through the 1200 ohm winding of the L relay, which operates. The L relay operated, locks through its 1200 ohm winding and make

contact through the upper contacts of cam L to the same ground over the FT lead and advances the switch to position 3 from ground on cam M. In position 3, ground through the lower inner contact of cam H is connected to the FR lead, thus permitting the sender to function. The 500 ohm winding of the CH relay is also connected through the lower contacts of cam U in parallel with the outer winding of the D relay to the SC lead previously described. Should the CH relay operate at this time due to a high resistance ground in the sender circuit, no useful function will be performed.

DISTRICT BRUSH AND GROUP SELECTIONS:

16. With the switch in position 3, the UP magnet is operated for brush selection over a circuit traced from battery through the winding of the magnet, inner contacts of cam C, make contact of the L relay, to ground through the lower contacts of cam M. 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 it and permitting its re-operation 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. The L relay released, opens the circuit through the UP magnet, thereby stopping the upward movement of the selector and advances the switch to position 4. This circuit is traced from ground through the lower contacts of cam M, break contact of the L relay, upper outer contact of cam B, to battery through the R magnet. When 2 digit senders are used with this circuit, the advance of the sender replaced the high resistance ground on the SC lead with a 500 ohm ground, thus insuring the operation of the CH relay. In position 4, the trip magnet (TM) is operated from ground through the upper contacts of cam S, and the L relay is operated and locked to ground over the fundamental circuit previously described, advancing the switch to position 5.

17. With the switch in position 5, the UP magnet is re-operated and the trip magnet being operated, causes the previously selected set of brushes to trip when the selector starts upward as the set of brushes engage the trip finger which was previously operated by the trip magnet. As the selector moves upward for group selection, carrying the 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 district L relay operated, but successively short circuiting the stepping relay in the associated sender circuit, thus releasing it and permitting its re-operation 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, which in turn opens the circuit through the UP magnet and advances the switch to position 6. In position 5 to 6 1/4, a circuit is closed from battery through the B-2 brush and 1 terminal of the line test selector, winding of the BT selector, brush and 1 terminal of the S-4 arc, to ground through the lower outer contact of cam H, energizing the BT selector magnet. When the switch advances from position 6 1/4, the energizing circuit is opened, releasing the BT 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 10.

When 3 digit senders are used with this circuit, the advance of the sender replaces the high resistance ground on the SC lead with a 500 ohm ground, thus insuring the operation of the CH relay. With the switch in position 6, a circuit is closed from ground on the line finder N commutator brush and segment, through the break contact of the SL relay, inner contacts of cam O, upper outer and lower inner contacts of cam R, to battery through the 800 ohm winding of the L relay, operating the relay. The L relay operated, advances the switch to position 7 in a circuit traced from battery through the R magnet, lower outer contact of cam B, make contact of the L relay, inner contacts of cam M, make contacts of the D relay, to ground through the lower outer contact of cam I.

TRUNK HUNTING:

18. 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. When the switch enters position 6 1/2, ground is connected to the sleeve of the selected trunk through the outer contacts of cam M, break contact of the L relay, lower outer and upper inner contacts of cam E, as a busy condition until the switch advances to position 8.

19. 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 inner winding and make contact, lower outer and upper inner contacts of cam E, to ground on the sleeve terminal of the busy trunk. With the switch in position 7, the UP magnet is re-operated from ground on cam M under control of the L relay and the selector travels upward until an idle trunk is found, the locking circuit thru 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 outer winding inner contacts of 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 L relay released also advances the switch to position 8.

"C" COMMUTATOR:

19.1 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 inner winding of the L relay is open, 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 other holding circuit through the outer winding of the L relay is opened at the C commutator, releasing the relay, which 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 C, under control of the L relay. This is to prevent the re-operation of the L relay by the closing of a circuit between the C commutator brush and segment, on the overthrow of the selector, as it drops into place.

20. As the switch advances from position 7, ground on cam H is removed from the fundamental ring (FR) lead, and in position 7 3/4, ground through the upper contacts of cam E is connected to the sleeve of the selected trunk as a busy condition. With the switch in position 8, a circuit is closed from ground on the armature and make contact of the CH relay, through the lower outer and upper inner contacts of cam O, upper outer and lower inner contacts of cam R, to battery through the outer winding of the L relay, which operates, advancing the switch to position 9. In position 9, the tip and ring sides of the outgoing fundamental circuit are closed to 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, in turn releasing the L relay. The L relay released, advances the switch to position 10. As the switch leaves position 9 1/2, the dialing circuit is opened at the upper inner contact of cams P and Q, and in position 9 3/4, the tip and ring leads from the line finder are closed thru the lower contacts of cams P and Q, respectively, to 24 volt battery and ground in the district, holding the DC relay operated under the control of the station switchhook. With the DC relay operated, a locking circuit is closed for the D relay after the switch advances from position 10. This circuit is traced from battery through the inner winding of the D relay, make contact of the DC relay, make contact of the D relay, to ground through the lower outer contact of cam I. The D relay (178 AK) is made slow in releasing so that the connection shall not be lost if the switchhook at the calling station is momentarily depressed.

FIRST TEST OF CALLING LINE:

21. As the district switch enters position 9 3/4 to 10 1/2, the BT magnet operates in a circuit through the S-4 brush and 2 terminal, to ground on the lower outer contact of cam H. The BT magnet operated, steps the brush assembly to 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 brush of the selector, and lower contacts of cam P. The charge in the station condensers 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, CI-1 relays. The circuit for the D relay is

traced from battery through its inner winding, make contact of the DC relay, make contact of the D relay, to ground on the lower outer contact of cam I. The holding circuit for the CI-1 relay is traced from battery through the winding of the relay, make contact of the CI relay, make contacts of the DC rel D relays, to ground on the lower outer contact of cam I. With the line test switch on terminal 3, a circuit is also closed from battery through its B brush and 3 terminal, to ground through the inner winding of the RT relay which operates. The RT relay operated, (a) Closes a circuit from ground through the inner contact of cam W, C 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.

22. 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 and terminal 3, S 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.

23. 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 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 B brush and terminal 5 of the selector, winding of the PT magnet, S 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 interrupter, advancing the line test switch. At terminals 7 and 8 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 lower contacts of cam P, T 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 relay, to battery through the outer winding of the RC relay which operates. The RC relay operated, (a) locks in a circuit through its armature and make contact, make contact of the SL relay, break contact of the F relay, to ground on the N commutator, and (b) transfers the message register circuit through its continuity contacts for operating message register #1 as explained hereinafter. 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 inner 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 lower outer contact of cam B, make contact of the L relay terminal 8 and C brush of the line test switch to ground through the inner contacts of cam W. As the switch advances to position 11, this circuit is transferred from ground on cam W to ground on the lower contacts of cam M. As the switch advances, ground is intermittently connected to the tip side of the fundamental circuit through the outer contacts of cam E, holding the L relay operated, but sucessively short circuiting and permitting the re-operation 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 12, 13 or 14, depending upon the class of call. With the line test switch on terminal 8 and the district sequence switch in position 10, a circuit is closed energizing the 200-S selector. This circuit is from ground on the lower outer contact of cam H, terminal 8 and S brush of the switch, winding of the PT magnet, to battery through terminal 8 and B 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 on its back stroke to terminal 9. The advancement of the line test switch to terminal 9, (a) releases the T relay, (b) disconnects 48 volt battery from the tip of the line and (c) closes a circuit from ground through terminal 9 and S brush to battery through the winding and break contact of the PT magnet operating the magnet which steps its brushes to terminal 10. With the test switch on terminal 10, 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 thru one winding of the repeating coil, winding of the DC relay, R brush and terminal 10 of the line test switch, lower contacts of 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 brush and terminal 10 of the test switch to ground through the other winding of the repeating coil. As the switch leaves position 10, the holding circuit of the CI relay is transferred from ground on cam I to ground on cam E under the control of the L relay. This circuit is traced from battery through the outer winding of the CI relay, inner contacts of cam U, make contact of the CI-1 relay, lower inner upper outer contacts of cam V, make contact of the L relay, to ground through the lower inner and upper outer contacts of cam E. The release of the L relay opens the holding circuit through the CI relay, releasing the CI-1 relay and disconnecting the sender from the district circuit.

CALLED PARTY ANSWERS:

24. When the receiver at the called station is removed from the switch-hook, with the switch in position 11 or 12, reversed battery and ground from the incoming circuit operates the CS relay. This circuit is traced from battery over the ring side of the circuit, through the outer contacts of cam G, winding of the repeating coil, outer and lower inner contacts of cam X, through the winding of the CS relay, upper inner and outer contacts of cam Y, another winding of the repeating coil, outer contacts of cam F, to ground over the tip side in the incoming circuit. The CS relay operated, closes a circuit from ground on the upper outer contact of cam I, through its make contact, outer contacts of cam N through the 111 contact of the 149-J interrupter 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 IV contact of the interrupter closes, the I relay operated closes a circuit from ground on the interrupter contact to battery through the 500 ohm winding of the CH relay, operating the relay. The CH relay operated, locks through its windings in series and the outer contacts of cam O, to ground on its make contact and armature and closes a circuit from battery on its make contact for holding the SL relay operated after the D relay releases.

22.1 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.

OPERATOR ANSWERS:

25. The switch advances to position 13 as described above, and when the operator inserts the plug of an answering 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 the lower outer contact of cam H, terminal 10 and S brush of the line test switch, winding of the stepping magnet to battery through terminal 10 and B brush of the selector, energizing the stepping magnet. The CS relay operated, closes a circuit from the same ground on cam I, through the upper outer and lower inner contacts of cam R, to battery through the outer 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 cam U, releasing the relay which in turn releases the CI-1 relay. The release of these relays 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 the upper inner and lower outer contacts of cam E, to battery through the make contact and inner 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 the upper contacts of cam J. In position 14, a checking tone circuit is closed over the sleeve of the operator's trunk, inner contacts of cam E, make contact of

the L relay, upper contacts of cam V, lower contacts of cam Y, 2 m.f. condenser, 1 lower inner and upper outer contacts of cam X, the S brush and terminal at the line finder bank, to ground through the winding of the CO relay for number checking.

DISCONNECTION - REGULAR CALL:

26. 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 15, ground is connected through cam H, terminal 11 and S brush of the line test switch to battery through the winding of the PT magnet and terminal 11 and B 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 cam H, releasing the magnet and advancing the line test switch to terminal 12. The 149-J rinterrupter steps the switch to terminal 16.

SECOND TEST OF CALLING LINE:

27. As the line test switch passes over terminals 12 and 13 with the district switch in position 16, battery is connected through the T 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 ringside 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 inner winding, terminal 12 and C brush of the line test switch, to ground through the inner contacts of cam W, and remains operated until the line test switch advances from position 15. If the T relay operates in positions 14 and 15 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, break contacts of the RT and CI-1 relays, 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 from ground through the inner contacts of cam W, C brush and terminal 16 of the line test switch, to battery through the selector time alarm, operating the alarm. When the alarm is investigated, the sequence switch must be advances 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 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 than 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 terminals 17, 18 or 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.

MESSAGE REGISTERING.

28. 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 its 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 with a grounded ringer, the MR-1 message register in the line circuit operates. This registering circuit is traced from battery on the make contact and armature of the CH relay, inner contacts of cam T, break contact of the I relay, make contact of the RC relay, through the 18-AN resistances in multiple, brush and commutator of the LF selector break contact of the L relay, make contact of the CO relay, to ground through the winding of the MR-1 message register.

29. On calls originating by the station whose ringer is permanently connected in series with the condenser, the RC relay does not operate and lock, therefore a circuit is closed, short circuiting the E relay and releasing it. This circuit is traced from ground on the inner contacts of cam W, C brush and terminal 17 and 18 and 19 of the line test switch, break contact of the RC relay to one side of the winding of the E relay, short circuiting the winding of the E relay. The E relay released, (a) Opens the circuit through the SL relay which releases. (b) Opens the locking circuit for the MB relay, but the MB relay does not release on account of a circuit being closed through its outer winding to battery on the break contact of the SL relay. The release of the SL relay closes a circuit operating the F relay. This circuit is traced from ground on the lower outer contact of cam I, break contacts of the D and SL relays to battery through the 800 ohm winding of the F relay, which operates and disconnects the tip and ring of the trunk from the line. The release of the SL relay also disconnects battery, releasing the CO relay. When the CO relay releases, the MR-1 message register is disconnected from lead H and the MR-2 message register is connected to it. The registering circuit for the second party station now being prepared, the MR-2 register operates. This register circuit is traced from battery on the make contact of the CH relay, outer contact of cam T, break contacts of the I, RC, and E relays, 18-AN resistance, over lead H, break contact of the L and CO relays to ground through the winding of the MR-2 message register.

29.1 Registration takes place during the interval of time that the 149-J interrupter steps the line test switch over terminals 17, 18 and 19.

30. 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 the inner contacts of cam E, cam L, cam K, winding of the G relay, over the S lead to battery on the S lead of the final selector which seized this line. As the line

test switch steps to terminal 20, a circuit is closed from ground through the inner contacts of cam W, C, brush and terminal 20 of the line test switch, break contact of the L relay, upper outer contacts of 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 17, 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, inner contacts of cam N, break contact of the D relay, to battery on the break contacts of the DS relay. The DS relay operated, (a) locks through its make contact and 350 ohm winding to the same ground, (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 M commutator segment, releasing the E, DS and MB relays. With the district switch in position 18, a circuit is closed from ground on the lower contacts of cam I, break contact of the D relay, inner contact of cam D, terminal 20 and S brush of the test switch, to battery through the winding of the PT magnet which operates and advances the switch to terminal 21.

31. With the line test switch on terminal 21, the circuit is closed from ground through the inner contacts of cam W, C brush and terminal 21 of the test switch to battery through the down magnet restoring the selector to normal.

32. When the district selector reaches the bottom of the frame, a circuit is closed from ground through the Y commutator brush and segment, B brush and terminal 21, S 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 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 brush and terminal 1 of the line test switch, upper inner contact of 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.

33. 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 the upper contact of cam I over the circuit previously described, thereby notifying the switchman of the existing condition.

DISCONNECTION - TALKING TO OPERATOR:

34. 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, opens the circuit through the SL relay, which releases, and operates the F relay, which advances the district switch to position 16 from ground on the N commutator brush and segment. In position 16 ground on the armature of the SL relay through the lower contacts of cam D advances the switch to position 17, the A cam advancing it 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 under "Disconnection - Regular Call."

DISCONNECTION ON ABANDONED CALLS

(a) DISCONNECTION BEFORE LINE FINDER SELECTOR FINDS LINE

35. 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 under "Originating Call". 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 combination at the top 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, outer contacts of cam Y, H brush of the selector to battery on the terminal of the H combination, supplied through the 1,000 ohm non-inductive winding of the BA-1 relay and the break contacts of the BA-1 and BA relays. 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.

POSITIONS 2 TO 6.

36. 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, causing the D relay to release on account of the increased current flowing through the outer winding of the relay. The D relay is connected differentially, but does not release when its inner winding is connected directly to ground and its outer winding connected to ground in series with a resistance. The D relay released, operates the DS relay, which restores the line finder selector to normal, as described under "Disconnection - Regular Call". The D relay released, also opens the circuit through the SL relay, which releases. The SL relay released, disconnects battery from lead S, releasing the CO relay in the line circuit, and advances the district switch to position 6 from ground on its armature and break contact through the lower contacts of cam D. With the switch in position 6, a circuit is closed from battery through the DOWN magnet, upper contacts of cam D, break contact of the D relay, lower outer contact of cam I to ground operating the DOWN magnet, restoring the 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, brush and terminal 1 of the line test switch, upper inner contact of cam B to ground through the R magnet, advancing the switch to position 1. As the district switch enters position 5, the PT selector is energized from battery over the B brush and terminal winding of the PT magnet, S brush and terminal 1 of the line test switch to ground on cam H. When the district switch advances from position 6 1/4 under control of the Y commutator segment, the PT magnet releases stepping the test switch to position 2. Ground on the Y commutator brush and segment through the terminal 2 and D brush steps the line test switch to terminal 3. On the terminal 3 of the line test switch the PT magnet operates from battery through its make contact to ground on the Y commutator and segment, stepping the switch to terminal 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-J interrupter. As the district switch enters position 9 3/4 , the PT magnet operates in a circuit from battery through the brush B and terminal 8, winding of the PT magnet, S brush and terminal 8 to ground on the lower outer contact of cam H. As the district switch advances from position 10 1/2 the PT magnet releases, stepping the line test switch to terminal 9. Ground on terminal 9 of the S arc advances the test switch to terminal 10. The test switch steps to terminal 12 in a circuit from ground on cam H of the sequence switch and is advanced to terminal 16 by the 149-J interrupter. 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-J interrupter. Ground on the lower outer contact of cam I, break contact of the D relay, inner contacts of cam D, S 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 brush steps the switch to terminal 1.

37. When the D relay released, a circuit was closed operating the DS relay. This circuit is traced from ground on the M commutator, outer and tertiary windings of the DS relay in parallel, inner contacts of cam N, and break contact of the D relay, to battery on the make contact of the DS relay. The DS relay operated, locks to the same battery on its make contact and closes a circuit operating the F relay. With the DS relay operated, a circuit is also closed energizing the line finder DOWN magnet, restoring the line finder selector to normal. When the line finder selector returns to normal, ground is disconnected from cam M, thus releasing the E, DS, and 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.

IN POSITIONS 7 to 10.

38. 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 switch advances to position 11, as described under "Regular Call". With the switch in position 11, the D relay releases closing a circuit from ground on the lower outer contact of cam I, break contact of the D relay, upper inner and lower outer contacts of 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 of the sequence switch, 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 under "MESSAGE REGISTERING"

ALL SELECTORS IN ONE SUB-GROUP BUSY:

39. 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, 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

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.

ALL SELECTORS IN BOTH SUB-GROUPS BUSY:

40. 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 operate 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.

LINE FINDER TIME ALARM.

41. 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 winding's 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 rmagnet, 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.

42. 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 188-A 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.

WIRING OF GROUP DISTRIBUTOR BANK:

43. The wiring of the two group distributor arcs of the regular G distributing selector bank, shown on the regular starting circuit, and of the emergency G distributor selector 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 are 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 arrangements 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 through a number of idle groups with the same speed as though the 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.

44. 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 through jack 16. 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 utrip 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 the 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.

LINE FINDER DISTRIBUTOR:

45. 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.

46. 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 CALL", 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.

47. 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 this 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.

48. 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.

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

49. 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 GA 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.

TESTING LINE FINDER SELECTORS:

50. 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.

51. 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 to-

gether. 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, opens the circuit through the 700 ohm windings of the TR and TR-1 relays in the trip circuit and connects ground to 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-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 C1 relays from ground on its armature, through the break contact of the E relay, (c) closes the ring side 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 C1 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.

52. 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 C1 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 winding of the STA relay, which operates. The STA relay operated, functions as described under "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.

53. 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 C1 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 C1 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.

TELL TALE - LINE FINDER SELECTOR:

54. 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.

55. 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 combination at the top of the multiple bank, H multiple brush of the line finder selector, outer 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".

TELL TALE-DISTRICT SELECTOR.

56. Should the selector travel to the tell tale position during selection, ground on the X commutator brush and segment is connected through the lower inner contact of cam B, to battery through the R magnet, advancing the switch to position 18. In position 18, the DOWN magnet operates and restores the selector to normal. When the selector returns to normal, ground on the Y commutator brush and segment advances the switch to position 1.

OVERFLOW

57. 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. In position 9, a circuit is closed from ground on the Z commutator brush and segment, through the upper contacts of cam K, to battery through the R magnet, advancing the switch to position 10. In position 10, a circuit is closed from ground on the Z commutator brush and segment, through the upper outer contact of cam K, lower inner contact of cam 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 the upper couter contact of 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 relay, 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, upper contacts of cam G, winding of the repeating coil, 2 M.F. condenser, upper outer and lower inner contacts of cam Y, upper contacts of cam V, lower outer and upper inner contacts of cam 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".

"O" COMMUTATOR

58. The function of the "O" 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 selectpr reaching overflow would make the sleeve multiple terminals busy, thus causing succeeding selectors to continue upward

into the next group of trunks. The "O" commutator segment is open at overflow, but the S bar is continuous. Both the "O" and "S" commutator brushes are permanently strapped together and wired to the multiple sleeve brush. When the selector is at overflow, the "O" commutator brush is resting on an open (dead) segment, and as the busy ground is fed through the "O" commutator bar only, this arrangement maintains a non-busy condition on 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 held operated at this time, and the selector therefore hunts past the "made busy" terminals into the next group.

TERMINATING CALL

59. 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 and the last line of a group of consecutive lines; or through the 100 ohm winding of the CO relay on an intermediate line 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 windings of the CO relay is opened, releasing the relay and restoring the circuit to normal.

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|

### MECHANICAL REQUIREMENTS

**Spl. 177-E**
D-20921
(CS)

(a) Armature travel .015" to .020"
(b) Armature must move freely in bearings
(c) There must be follow in the contact springs.
(d) There shall be .005" air gap between the hard rubber bridge and the swinging spring.

206-L
(CS)

(a) Total contact travel .004"
(b) The biasing spring shall be tensioned against the aramture with sufficient force to meet the release requirement.
(c) Contact pressure between the armature and either contact screw shall be approximately equal.

### ELECTRICAL REQUIREMENTS.

| | | | |
|---|---|---|---|
| **Spl. 177-E** D-202 91 (CS) | **For a trunk loop not exceeding 3560 ohm resistance.** Readj. .003 amp. Test .0059 amp. W.C.C. .0059 amp. | | On open circuit |
| | When the trunk loop is more than 3560 ohms but does not exceed 5000 ohms Readj. .003 amp. Test .0035 amp. W.C.C. .0042 amp. | | On open circuit |
| | When the trunk loop exceeds 5000 ohms resistance. Readj. .003 amp. Test .0032 amp. W.C.C. .0035 amp. | | On open circuit |
| | Note: TRUNK LOOP includes the resistance of the trunk conductors, relays and repeating coils, in the District and connecting circuit. | | |
| 178-AK (D) Inner wdg. (500 ohms) | Special requirement to insure slow release. Readj. .044 amp. Test .047 amp. W.C.C. .086 amp. | | Readj. .004 amp. Test .0038 amp. |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| Outer wdg. (500 ohms) | Test .046 amp.<br>W.C.C. .086 amp. | | With windings connected differentially. |
| | Note: When necessary to readjust this relay, the bent springs of both make break spring combinations shall be adjusted to give 20 grams contact pressure against the back contact spring. | | |
| 206 L (CS) | After a soak of .045 amp. in the direction opposite to the operating current.<br>Readj. .003 amp.<br>Test .0032 amp.<br>W.C.C. .0032 amp. | | On open circuit after a soak of .045 amp. in the same direction of operating current. |
| B-1 (DC) | After a soak of approximately .3 amp.<br>Readj. .015 amp.<br>Test .021 amp.<br>W.C.C. .0258 amp. | | After a soak of approximately .3 amp.<br>Readj. .005 amp.<br>Test .0047 amp.<br>W.C.C. .0025 amp. |
| B-9 (B) | After a soak of approximately .3 amp.<br>Readj. .054 amp.<br>Test .063 amp.<br>W.C.C. .072 amp. | | After a soak of approximately .3 amp.<br>Readj. .006 amp.<br>Test .0057 amp. |
| B223 (G) | Special requirements to insure fast operation.<br>Readj. .006 amp.<br>Test .0063 amp.<br>W.C.C. .035 amp. | | Readj. .0035 amp.<br>Test .0033 amp. |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| B226 (T) | Special requirements to meet circuit conditions.<br>Readj. .0107 amp.<br>Test .0113 amp.<br>W.C.C. .0113 amp. | Readj. .009 amp.<br>Test .0085 amp. | |
| E106 (SA,SB) | Readj. .030 amp.<br>Test .035 amp.<br>W.C.C. .039 amp. | Readj. .015 amp.<br>Test .014 amp. | |
| E399 (D) | Readj. .013 amp.<br>Test .028 amp.<br>W.C.C. .043 amp. | | Readj. .002 amp.<br>Test .0019 amp. |
| E428 (C) | Through relay winding.<br>Readj. .016 amp.<br>W.C.C. .0214 amp.<br>Through parallel combination with E568 relay.<br>Readj. .034 amp.<br>Test .039 amp. | Through relay winding.<br>Readj. .010 amp.<br>Through parallel combination with E568 relay<br>Readj. .021 amp.<br>Test .019 amp. | |
| E461 (A) | Readj. .012 amp.<br>Test .013 amp.<br>W.C.C. .0143 amp. | Readj. .008 amp.<br>Test .0076 amp. | |
| E461 (B) | Special requirements to insure hold.<br>Readj. .012 amp.<br>Test .014 amp.<br>W.C.C. .0214 amp. | Readj. .008 amp.<br>Test .0076 amp.<br>Hold; W.C.C. .0143 amp. | |
| E533 (L) Inner wdg. (1200 ohms) | Test requirement of outer winding is proportional to test requirement of inner winding.<br>Readj. .017 amp.<br>Test .018 amp.<br>W.C.C. .0181 amp. | Readj. .012 amp.<br>Test .0114 amp. | |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| Outer winding (800 ohms) | Test .046 amp.<br>W.C.C. .054 amp.<br><br>Note: Relay to be equipped with special armature stop (piece part 163914) | | |
| E555 (A) | Readj. .009 amp.<br>Test .012 amp.<br>W.C.C. .0143 amp. | | Readj. .0013 amp.<br>Test .0006 amp. |
| E568 (CI-1) | Readj. .015 amp.<br>Test .018 amp.<br>W.C.C. .0214 amp. | Readj. .009 amp.<br>Test .0085 amp. | |
| E568 (C-1) | Through relay winding.<br>Readj. .015 amp.<br>W.C.C. .0214 amp.<br>Through parallel combination with E428 relay (C)<br>Readj. .032 amp.<br>Test .038 amp. | Through relay winding.<br>Readj. .009 amp.<br><br>Through parallel combination with E428 relay (C)<br>Readj. .019 amp.<br>Test .018 amp. | |
| E632 (TR, TR-1) Outer Wdg. (700 ohms). | Special requirements to insure fast operation.<br>Readj. .045 amp.<br>Test .048 amp.<br>W.C.C. .061 amp. | Readj. .022 amp.<br>Test .020 amp. | |
| Inner winding (600 ohms) | Test .040 amp.<br>Hold:<br>W.C.C. .039 amp. | | |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| E637 (CA,CB) Inner winding (500 ohms) | Readj. .025 amp.<br>Test .032 amp. | Readj. .015 amp.<br>Test .014 amp. | |
| Outer winding (1000 ohms) | Hold.<br>Test .043 amp.<br>W.C.C. .043 amp. | | |
| E638 (STB) | Special requirements to insure fast operation.<br>Readj. .025 amp.<br>Test .027 amp.<br>W.C.C. .039 amp. | | Readj. .004 amp.<br>Test .0038 amp. |
| E639 (GA GB) | Special requirements to insure fast operation.<br>Readj. .015 amp.<br>Test .016 amp.<br>W.C.C. .057 amp. | | Readj. .003 amp.<br>Test .0028 amp. |
| E743 (F) | Test requirements of outer winding is proportional to test of inner winding. | | |
| Inner winding (1000 ohms). | Readj. .039 amp.<br>Test .041 amp.<br>W.C.C. .043 amp. | Readj. .025 amp.<br>Test .023 amp. | |
| Outer winding (800 ohms). | Test .042 amp.<br>W.C.C. .054 amp. | | |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| E748 (LF) | Special requirements to meet Hold circuit condition.<br>Readj. .025 amp.<br>Test .027 amp.<br>W.C.C. .043 amp. | Readj. .016 amp.<br>Test .015 amp. | |
| | Hold:<br>W.C.C. .026 amp. | | |
| E750 (MB) Inner winding (1000 ohms) | Special requirements to meet hold circuit condition.<br>Readj. .028 amp.<br>Test .030 amp.<br>W.C.C. .043 amp. | Readj. .014 amp.<br>Test .013 amp. | |
| Outer winding (1000 ohms) | Hold:<br>Test .043 amp.<br>W.C.C. .043 amp. | | |
| E788 (CO) Windings in series aiding. | Special requirements to meet testing condition.<br>Readj. .016 amp.<br>Test .017 amp.<br>W.C.C. .033 amp. | Readj. .011 amp.<br>Test .010 amp. | |
| Inner wdg. (100 ohms) | Test .078 amp.<br>W.C.C. .134 amp. | Test .039 amp. | |
| E868 (E) | Readj. .024 amp.<br>Test .027 amp.<br>W.C.C. .030 amp. | | Readj. .003 amp.<br>Test .0028 amp. |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| E892 (I) Inner (1000 ohms) | Readj. .038 amp.<br>Test .041 amp.<br>W.C.C. .043 amp. | Readj. .020 amp.<br>Test .019 amp. | |
| Outer winding (1000 ohms) | Test .041 amp.<br>W.C.C. .043 amp. | | |
| E896 (B) | Readj. .047 amp.<br>Test .050 amp.<br>W.C.C. .050 amp. | | Readj. .007 amp.<br>Test .0065 amp. |
| E897 (A) | Readj. .013 amp.<br>Test .028 amp.<br>W.C.C. .043 amp. | Readj. .0075 amp.<br>Test .007 amp. | |
| E899 (STA) | Special requirements to insure fast operation.<br>Readj. .026 amp.<br>Test .028 amp.<br>W.C.C. .039 amp. | | Readj. .005 amp.<br>Test .0047 amp. |
| E901 (L) | Readj. .018 amp.<br>Test .019 amp.<br>W.C.C. .019 amp. | | Readj. .0052 amp.<br>Test .0049 amp.<br>W.C.C. .0045 amp. |
| E995 (RC) | Readj. .015 amp.<br>Test .018 amp.<br>W.C.C. .0214 amp. | | Readj. .003 amp.<br>Test .0028 amp. |
| E996 (DS) Inner winding (1000 ohms) | Test requirement outer winding proportional to test of inner winding.<br>Readj. .040 amp.<br>Test .042 amp.<br>W.C.C. .043 amp. | | Readj. .007 amp.<br>Test .0065 amp. |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| Outer winding (350 ohms) | Test .091 amp.<br>W.C.C. .122 amp. | | |
| E1027 (CI) Inner winding (800 ohms) | Readj. .040 amp.<br>Test .047 amp.<br>W.C.C. .054 amp. | Readj. .020 amp.<br>Test .019 amp. | |
| Outer winding (800 ohms) | Test .048 amp.<br>W.C.C. .054 amp. | | |
| E1085 (SL) | Readj. .015 amp.<br>Test .018 amp.<br>W.C.C. .0214 amp. | Readj. .010 amp.<br>Test .0095 amp. | |
| E1148 (BA) (BA-1) Inner winding (1000 ohms) | Readj. .022 amp.<br>Test .032 amp.<br>W.C.C. .043 amp. | Readj. .012 amp.<br>Test .011 amp. | |
| E1149 (0,0-1) Inner winding (500 ohms) | Maximum armature travel .018".<br>Through relay winding.<br>Readj. .015 amp.<br>W.C.C. .016 amp. | Through relay winding.<br>Readj. .010 amp. | |
| | Through parallel combination with 500 ohm (0) resistance.<br>Readj. .032 amp.<br>Test .034 amp. | Through parallel combination with 500 ohm (0) resistance.<br>Readj. .021 amp.<br>Test .020 amp. | |

## CIRCUIT REQUIREMENTS

| | OPERATE | NON-OPERATE | RELEASE |
|---|---|---|---|
| Outer winding (1500 ohms) | Hold: Readj. .027 amp. Test .0285 amp. W.C.C. .0285 amp. | | |
| E1190 (RT) | Readj. .019 amp. Test .034 amp. W.C.C. .050 amp. | Readj. .011 amp. Test .010 amp. | |
| E1321 (CH) Inner winding (500 ohms) | Readj. .025 amp. Test .027 amp. W.C.C. .0286 amp. | | Readj. .003 amp. Test .0028 amp. W.C.C. .0016 amp. |
| E1325 (H) | Special Requirement to insure fast operation. Readj. .009 amp. Test .0095 amp. W.C.C. .029 amp. | Readj. .0068 amp. Test .0064 amp. W.C.C. .0047 amp. | |
| F10 (K,K-1) | After operating on .047 amps relay must remain operated when the circuit is broken for a minimum period of .1 second and release on open circuit within a time interval of .3 seconds. W.C.C. .0505 amp. | | |
| 5 M message register | Test .036 amp. W.C.C. .071 amp. | Test .032 amp. | |
| 5-S message register. | Test .330 amp. W.C.C. .350 amp. | Test .270 amp. | |
| Spl. message register per D-20060. | Test .030 amp. W.C.C. .043 amp. | Test .025 amp. | |

ENG.--VCD-ML. CHK'D.--ASP-CVP. APPROVED- C.L.SLUYTER, G.M.L.
10/8/21.