## CHANGES

B. CHANGES IN APPARATUS

| B. 1 Superseded | Superseded By |
| :--- | :--- |
|  | 346 B Electron |
| Tube 184 Plug | 346 C Electron |
|  | Tube 184B Plug |

B. 2 Added

185A Network, Option "2H"

## C. CHANGES IN CIRCUIT REQUIREMENTS OTHER THAN THOSE APPLYING TO ADDED OR REMOVED APPARATUS

C. 1 Additional requirements are added for relay (T) B226 for use where $1500 \Omega$
sub loop operation is required.
C. 2 Test Note 75 added.
D. DESCRIPTION OF CIRCUIT CHANGES
D. 1 "ZF" option is added to provide for shows the arrangement prior to this issue.
D. 2 Options " ZE ", " ZF " and " ZH " are added to the Options Used table.
D. 3 In Fig. 1K lead "TU" to the traffic usage recorder and lead to "2B" terminal of the (LF) relay are removed from punching Number 31.
D. 4 " ZH " option is added to reduce erosion of the $G$ commutator brush: it is to be provided when " S " or "N" options are provided.
D. 5 Circuit Notes 41,42 and 43 are added.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 2335-DJC-FBB-C5

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PANEL SYSTEMS
SELECTOR CIRCUIT DISTRICT AND PANEL LINE FINDER WITH 2 PARTY MESSAGE REGISTER AND TIMING CIRCUIT

## CHANGES

A. CHANGED AND ADDED FUNCTIONS
A.1 This circuit is arranged to permit the application of traffic usage measurements.
D. DESCRIPTION OF CIRCUIT CHANGES
D. 1 Option "ZD" is added to show connection to the Traffic Usage Recorder Circuit.
4. CONNECTING CIRCUITS
4.2 Traffic Usage Recorder Circuit -SD-95738-01.
All other headings, no change.

BELL TELEPHONE LABORATORIES, INCORPORATED

PANEL SYSTEMS<br>SELECTOR CIRCUIT<br>DISTRICT AND PANEL LINE FINDER<br>WITH 2 PARTY MESSAGE REGISTER<br>AND TIMING CIRCUIT

## CHANGES

B. CHANGES IN APPARATUS
B. 1 Added
KS-13490, L2-10,000 ohm)
resistor (MS)
185 A network (MS) ) option ng
D-179637 sequence switch
B. 2 Superseded
EAl relay (C)
option "An"
0.5 MF capacitor ( $P$ )
\& D-78038 res. (P)
option "ZBn

Superseded By
EA25 relay (C), option "ZA"
177E network ( $P$ ), option "ZC" option "ZB"
C. CHANGES IN CI RCUIT REQUIREMENTS OTHER THAN THOSE APPLYING TO ADDED OR REMOVED APPARATUS
C. 1 New requirements are added for relay
(E) E868, E904 or ElO26 which are necessary when option "G" is furnished.
D. DESCRIPTION OF CI RCUIT CHANGES
D. 1 The D-179637 sequence switch is added to arrange position 11 as a no charge talking position.

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D. 2 Relay EAL is designated opt. "A," rated Mfr. Disc., and is superseded by relay EA25, opt. "ZA."
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D. 3 177E (P) network, opt. "ZC," replaces old contact protection with Mr. Disc. resistor.
D. 4 Bleeder resistor (MS) and 185 A (MS) network, opt. "G" is added to reduce erosion of $G$ commutator brush.

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D. 5 Notes 36 to 39 are added and Note 22 is expanded.
D. 6 Options "G,n "A,n "ZA," "ZB" \& "ZC" are added to Options Ưsed table.
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All other headings under Changes, no change.

## 1. PURPOSE OF GIRCUIT

1.1 This circuit is arranged to find the
calling subscriber's line and connect it with the various switching apparatus necessary to complete a call. It is designed to convert individual message rate districts per ES-207198 and ES-207199 and

ES-240071, to 2 party message rate districts.

## 2. WORKING LIMITS

2.1 Bl relay (DC) maximum subscriber's loops 1500 ohms with minimum leak of 10,000 ohms.
2.2 206L relay (CS) maximum external circuit loop 3415 ohms for 24 volt battery or 8000 ohms for 48 volt battery.
2.3203 A or 177 E per $\mathrm{D}-20921$ maximum external circuit loop 3050 ohms and 3925 ohms.
2.4 Max. external trunk loop for remote control zone registration 2640 ohms, with a minimum insulation resistance of 60,000 ohms, with a voltage variation of +160 to +165 volts on tip, and +125 to +130 volts on ring, with a minimum difference of potential between tip and ring of 32 volts, with a maximum earth potential of $\pm 20$ volts, and with a maximum external circuit resistance of 2750 ohms in each side of trunk.

## 3. FUNCTIONS

The principal functions of this circuit are:
3.01 To find the proper line and start the sender selector hunting for an idle
senter.
3.02 To establish talking connections.
3.03 To supply talking battery to the calling station.
3.04 To test the line to determine which party is calling.
3.05 To connect battery for the operation of the message register in the line circuit on a charged call.
306 To connect a busy tone to the calling station, if required.
3.07 To free the called subscribers line if calling sub. fails to hang up wi trin a predetermined minimum interval after the called sub. had hung up or operates \& selector time alarm, depending on optional wiring used.
3.08 Provides for multiple operation of the subscriber line register on zone
and overtime basis, controlled from distant office.

### 3.09 Provides for non-zone overtime registration.

3.10 Provides No Charge Talk Position 11.
4. CONNECTING CIRCUITS
4.1 Any standard start circuit or subscribers sender of Sender Selector
Type or office or incoming circuit.

## DESCRIPTION OF OPERATION

## 5. FINDING SUBSCRTBER LINE

When the receiver at the calling station is removed from the switchhook, various relays in the line circuit operate and connect battery to the $H$ terminal of the line at the line finder multiple bank. When ground is connected to the ST lead the (LF) relay operates and (a) locks through its windings in series to ground on the BREAK contact of the (H) relay, (b) operates the UP magnet causing the line finder selector to travel upward and hunt for terminals of the calling line, to which battery is connected, as hereinafter described, (c) closes a circuit from commutaton segment "M" over lead $Y$ operating the (GA) relay in the start circuit when the line finder selector starts upward, (d) closes a circuit operating the (CI) relay.

## 6. SELECTOR SENDER

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 $M$ commutator brush and segment, operates the line finder (E) relay. The (E) relay operated, (a) operates the (MB) relay, (b) operates the (D) relay which, when R' wiring, is furnished, operates the (RT) relay to start the time alarm should the district fail to move out of position $1,(c)$ opens the operating. circuit of the ('心I) relay, thus permitting the relay to release if the test brush of the sender selector is 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 secondary winding, 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 operates the ( $F$ ) relay and the sender selector (STP) magnet thereby stepping the sender selector brush es one step on every back stroke. If the next sender circuit is idle the (UI) relay releases, in turn stopping the selector but if the next terminal is busy, the (CI) relay remains operated and the sender selector continues to stop until an idle sender is found.

When an idle sender is found the holding circuit of the (CI) relay is opened and the (CI) relay releases. 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 cam $H$, 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 1-1/4. The operation of the (F) relay opens the tip and ring leads between the line finder commutator and the district circuit and prevents the district (L) relay from operating and advancing the district switch from normal, should the line finder selector connect to the terminals of the calling line before the sender selector finds an idle sender.

## MAKING DISTRICT BUSY

## 7. THE (MB) RELAY OPERATED

(a) Locks to ground on lead $X$ so that the (MB) relay will not release should the selector return to normal while another call is going through, (b) operates the (F) relay to ground on the "M" commutator, if it was not previously operated by the operation of the (E) relay, (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 start 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 reoperating, (e) transfers the $S T$ 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. RELEASING THE TRIP AND START CIRCUITS

As the line finder selector continues upward, at the end of the tripping zone, the $K$ brush makes contact with the $K$ commutator, thus connecting ground to the $K$ lead which short-circuits and releases various relays in the trip and start circuits. The t-rip and start circuits are thus released and the circuit over the $X$ lead is opened, but the (MB) relay will not release as it is held operated through its primary winding.

## 9. FINDING CALLING LINE

When the selector brushes make contact with the terminals associated with the calling line, the (H) relay operates from battery in the trip circuit, over lead $H$, the $H$ multiple terminal and brush, the (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. When the (H) relay operates a $50-0 h m$ non-inductive shunt is connected to its

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winding for the purpose of increasing the current through the 500 ohm winding of the (0) relay in the trip circuit, 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 the H lead is opened by the overthrow of the selector. The (H) relay operated, opens the circuit which holds the (LF) relay operated, but the (LF) relay does not release inmediately on account of a circuit being closed from ground on the C commutator brush and segment, to battery through both windings of the (LF) relay is 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 $C$ ommutator 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 ( $F$ ) 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 and (c) closes a circuit operating the (SL) relay.

## 10. THE ADJUSTMENT OF THE "C" COMMUTATOR BRUSH

The adjustment of the "C" commutator brush, with relation to the tripped "H" multiple brush is such, that it does not break contact with the "C" commutator segment, until slightly after the holding circuit through both windings of the (LF) relay is opened by the operation of the (H) relay when the $H$ brush makes contact with the $H$ terminals 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.

## 11. ADVANCING THE DISTRICT AND CLASS OF SERVICE

The (SL) relay operated, operates the (L) relay from ground on the $N$ commutator brush and segment and, if S or N wiring is furnished, also operates the ( CH ) relay. The (L) relay operated, closes a circuit advancing the district switch to position 2. The ( CH ) relay if operated, operates the time alarm, either directly or through the district release circuit, in case the district fails to move out of position 1. As the switch advances from position 1, the circuits through the (L) and (RT) or (CH)
relays are 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 cams $I$ and $C$.

When two or three classes of service are required with indications to a common group of senders over the FR lead only, absence of ground on the FR lead in position 2 (Fig. 4 provided) will identify the first class. Fig. 5 and "C" option when provided will identify the second class and Fig. 5 and "D" option when provided will identify the third class.

## 12. COMPLETING FUNDAMENTAL CIRCUIT

In position 2, the (CI) relay operates through its secondary winding to ground on cam $S$, and remains operated until the switch advances from position 10. The (CI) relay operated, (a) connects ground from cam $S$, to the test brush of the sender selector, thus making the associated sender test busy after the switch advances to position 2, (b) closes the tip side of the fundamental circuit through to the sender, and (c) when Fig. 4 is provided operates the (CII) relay. When Fig. 5 is provided, the (C) relay operates as the switch passes pos. 1-1/2. When the (CI) relay operates in pos. 2 a path is closed from ground on the (C) relay, through a make contact on the (CI) relay to operate the (CL) relay. The (CL) relay operated operates the (CI-1) relay and grounds the "FR" lead to the sender. The (CII) relay operated, closes the ring lead from the calling line to the ring of the associated sender circuit and also closes the sender control SC lead to battery through the secondary winding of the (D) relay. With the (CII) relay operated and the switch in position 2, the tip and ring leads are closed from the calling line to the tip and ring leads of the associated sender circuit, thus permitting the 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. After the sender functions, ground from the sender is comnected to lead' nFTn operating the (L) relay. The (L) relay operated, locks through its 1200 ohm winding to ground over the FT lead, and advances the $s$ witch to position 3 from ground on cam M. The 500 ohm winding of the $(\mathrm{CH})$ relay is also connected through cam $U$, in parallel with the winding of the (D) relay. Should the (CH) relay operate at this time due to a high resistance ground in the sender circuit no useful function will be performed.

## 13. DISTRICT BRUSH SELECTION

With the switch in position 3, the UP mapret is operated for brush selection. As the selector moves upward in position 3, carrying the comutator brushes over the cormutator segments, the A segment ad brush intermittently connect ground to the tip
side of the fundamental circuit through cams $K$ and $I$, holding the (L) relay operated but successively short-circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its reoperation until the proper brush has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay. The (L) relay releases, opens the circuit th ugh the UP magnet, thereby stopping the upward movement of the selector and advances the switch to position 4. When two digit senders are used with this circuit, the advance of the sender replaces the high resistance on the SC lead with a 500 ohm ground, thus insuring the operation of the $e$ (CH) relay. In position 4, the trip magnet (TM) is operated from ground through cam S, and the (L) relay is operated and locked to ground on the fundamental circuit previously described, advancing the switch to position 5.

As the switch advances thru position $4-1 / 2$, the selector group register operates to ground thru the front contact of relay (SL) and the back contact of relay (F), thereby registering the number of calls in a group of districts, which have not been abandoned before group selection.

## 14. DISTRICT GROUP SELECTION

With the switch in position 5, the UP magnet is reoperated and the trip magnet being operated, causes the previously selected set of brushes to trip when the selector starts upward. As the selector moves upward for ${ }_{4}$ group selection, carrying the brushes. over, the commutator segments, the $B$ segment and brush intermittently connects grouna to the tip side of the fundamental circuit through cam $L$ holding the district (L) relay operated, but successively shortcircuiting the stepping relay in the associated sender circuit, thus releasing and permitting its operation until the proper group has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, feleasing the (L) relay which in turn opens the circuit through the UP magnet and advances the switch to position 6. When three 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 $(\mathrm{CH})$ relay. In position 5 to $6-1 / 4$ a circuit is closed from battery through the (B) brush and 1 terminal of the winding of the (PT) selector, brush 1 and terminal of the (S) arc, cam $\hat{H}$ to ground energizing the (PT) selector magnet. When the switch advances from position $6-1 / 4$, the energizing circuit is opened releasing the (PT) selectOr which steps its brushes one terminal on its back stroke. The line test selectior remains in position 2 until the sequence switch is advanced to position 9-3/4. With the switch in position 6, a circuit is closed from ground on the line finder N commutator, brush and segment, to battery
through the secondary winding of the (L) relay, operating the relay. The (L) relay operated, advances the switch to position 7.

## 15. TRUNK HUNTING WITH TRUNK IDLE

Should the first trunk in the group in which the selector is hunting be idle, the (L) relay releases as the switch leaves position 6-1/4. When the switch enters position $6-1 / 2$ to $7-3 / 4$, ground is connected to the sleeve of the selected trunk through cam $M$, break contact of the (L) relay, cam E, as a busy condition until the switch advances to position 7-3/4.
16. TRUNK HUNTING WITH TRUNK BUSY

Should the first trunk in the group in which the selector is hunting be busy, the (L) relay is held operated through its primary winding to ground on the sleeve terminal of the busy trunk. With the switch in position 7, the UP magnet is reoperated from ground on cam $M$ under control of the (L) relay and the selector travels upward until an idle trunk is found. When the idle trunk is found, the locking circuit through the primary 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, 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 and opens the circuit through the UP magnet, which stops the selector brushes on the terminals of the sel ected trunk. The (L) relay released, also advances the switch to position 8.

## 17. "C" COMMUTATOR

The adjustment of the "C" commutator brush, with relation to the tripped sleeve multiple brush, is such, that it does not break contact with the C commutator, until slightly after the holding circuit through the primary winding of the (L) relay is opened, by the sleeve brush, leaving the busy terminal and making contact with the sleeve terminal of the idle trunk. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the trunk terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time, the holding circuit through the secondary winding of the (L) relay is opened at the " CH commutator releasing the (L) relay which in turn releases the UP magnet. The selector then drops into place, thus centering the brushes on the trunk terminals. During trunk hunting, in position 7 only, the commutator feed ground is supplied from ground on cam $M$ under control of the (L) relay. This is to prevent the reoperation of the (L) relay by the closing
of a circuit between the C commutator brush and segment on the overthrow of the selector or as it drops into place.

## 18. SELECTION BEYOND

As the switch advances to position $73 / 4$, ground through 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, to battery through the secondary winding of the (I) relay, which operates advancing the switch to position 9. In position 9, the tip and ring sides of the outgoing fundamental circuit are closed through the tip and ring terminals of the selected trunk for selection beyond, through the FT and FR brushes of the sender selector, and cans $F$ 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, the dialing circuit is opened at cam $P$ and as it leaves position $91 / 2$ the dialing circuit is opened at cam $Q$ and, in position $93 / 4$, the ring lead from the line finder is olosed through cam Q to the (PT) selector switch and in position 10 the tip lead is closed from the line finder thru cam $P$ to the (PT) selector switch.
19. FIRST TEST OF CALLING LINE

As the district switch enters position $93 / 4$ to $101 / 2$, the (PT) magnet operates through the $S$ brush and 2 terminal, to ground on cam H. The (PT) magnet operated, steps the brush assembly to terminal 3. With the line test switch on terminals 3, 4, 5 and 6,48 volt batt,tery is connected to the tip side of the subscriber's line, through terminal 3 ana 'I') orush of the selector and cam $P$. The charge in the station condenser is thus neutralized so that it will not interfere with the proper functioning of the (T) relay as the line is tested, when the line test switch enters a test position. A circuit is also closed from battery through one winding of the reoperating coil, winding of the (DC) relay, $R$ brush and terminals 2 to 8 of the test switch, to ground through the noninductive winding of the (RC) relay, operating the (DC) relay. The operation of the (DC) relay closes a holding circuit for the (D) relay. With the line test switch on terminal 3, battery is connected through its (B) brush and 3 terminal, to ground through the primary winding of the (RT) relay which operates.

## 20. ROUTINE TEST

The (RT) relay operated, (a) connects ground from 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 terminals 3, causing the selector time alarm circuit to function. When the (T) relay operates on a routine test, ground on its armature is connected to battery through the primary winding of the (I) relay, which operates. The (I) relay operated, connects ground on its armature, terminal 3 and $S$ 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. 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. With the line test switch on terminal 5, a circuit is closed to ground through the make contact of the (TST) interrupter, operating the (PT) 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 (PT) selector continues to operate under control of the (TST) interrupter advancing the line test switch to position 9.

## 21. TESTING SUB-STATION

At terminal 7 of the line test switch the subscriber's line is tested to determine which party on the line has originated the call, in order that the call may be registered correctly. If the call originates at the station whose ringer is connected to ground through a condenser, the (T) relay does not operate. If, however, the call originates at the station with the grounded ringer, the (T) relay operates in turn operating the (RC) relay. The (T) relay operates in a circuit from ground through the sub-station ringer, over the tip side of the line, through 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 asmature, break contact of the (RT) relay, make contact of the (CII) relay to battery through the inner winding of the (RC) relay which operates. The (RC) relay operated, prepares a circuit for the operation of the tip party's message register as explained hereinafter.

## 22. TALKING SELECTION

With the switch in position 10, the sender circuit functions and connects ground to the FT lead, causing the (L) relay to operate and lock through its inner winding over the tip of the fundamental circuit. The (L) relay operated, advances the switch for talking selection. As the switch advances, ground is intermittently connected to the tip side of the fundamental circuit through cam E, holding the (L) relay operated, but successively short-circuiting and permitting the reoperation of the stepping relay in the sender circuit. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay. The (L) relay released, opens the circuit through the $R$ magnet, stopping the switch in positions 11, 12 or 13, depending upon the class of call. With the line test switch on terminal 9, the (T) relay releases, if operated, and 48 volt battery is disconnected from the tip side of the line. With the line test switch on terminal 9 and the district sequence switch in position 10, a circuit is closed energizing the (PT) selector magnet. As the district switch advances from position $101 / 2$, the operating circuit of the (PT) magnet is opened at cam $H$, releasing the magnet which steps its brushes to terminal 10. With the test switch on terminal 9, the holding circuit of the (DC) relay is transferred from the noninductive winding of the (RC) relay and closed metallic over the sub-station loop.

## 23. DISCHARGING THE SENDER

With the (DC) relay operated, a locking circuit is closed for the (D) relay after the switch advances from position 9. The (D) relay is made slow in releasing so that the connection will not be lost if the switchhook at the called station is momentarily depressed. As the switch leaves position 10, the holding circuit of the (CI) relay is transferred from ground on cam $S$ to ground on cam E, under control of the (L) relay. The release of the (L) relay opens the holding circuit through the (CI) relay, disconnecting the sender from the district circuit and releasing the (CII) relay.
24. CALLED PARTY ANSWERS

When the receiver at the called station is removed from the switchhook, with
the switch in position 11 or 12 , reversed battery and ground from the incoming circuit operates the (CS) relay. The (CS) relay operated, closes a circuit from ground on cam I, to battery through the winding of the (i) relay and $F$ contact of the (CHG) interrupter. When the interrupter contact closes, the (I) relay operates and locks on the same ground through its make contact. When the B contact of the interrupter closes, the operation of the (I) relay closes a circuit from ground on the interrupter contact to battery through both windings of the (CH) relay, operating the relay. The (CH) relay operated, locks and, when $R$ wiring is furnished, closes a circuit from battery on its make contact to hold the (SL) relay operated. The ( CHG ) interrupter is so connected in the circuit that the operation of the ( CH ) relay is delayed for at least two seconds after (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 disturbance.

## 25. REMOTE CONTROL ZONE REGISTRATION

When "S" wiring and apparatus are furnished and a call is made to a zone which requires multiple registration or timing the connection is routed thru the remote control registration point and the district switch is directed to position 11. After the called subscriber has answered in the case of the initial charge, or after a time interval, in the case of an overtime charge, the remote control registration point replaces negative battery and ground on the trunk with high voltage positive battery on both the tip and ring, with a difference of potential between the tip and ring so as to hold the (CS) relay operated during registration. This battery causes the (V) tube to break down and allow current to flow for operating relay (SX). Relay (SX) operating, connects positive 48 volt battery thru front contact of the (RC) relay to the $H$ lead for operating the tip party's register in case the tip party is calling, or it connects negative 48 volt battery thru back contacts of the (RC) relay to the $H$ lead for operating the ring party's register, in case the ring party is calling. Removal of positive battery from trunk and reconnection of negative battery causes the (V) tube to restore and release relay (SX), which disconnects register battery.
26. NON-ZONE OVERTIME REGISTRATION

When "N" wiring and apparatus and Fig. 2 are furnished and a non-zone

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call is made, the district switch is directed to position 12. The (CS) relay operates when the called subscriber answers, and operates the (I) and (CH) relays under control of the ( CHG ) interrupter as covered in paragraph 24. When relay ( CH ) operates, a circuit is closed from ground thru contacts of the (CS) relay, to battery thru the (ROT) magnet of the timer, cam $Z$ and contacts of the (CH) relay. This causes the timer to engage with the drive shaft that is being driven by the telechron motor which furnishes the driving power for 20 timers of the associated group of 20 districts. When the (ROT) magnet is energized, contacts $L$ and CH function immediately. Contact $L$ remains closed as long as the magnet is energized, and connects ground thru the normally closed contacts HD to the (ROT) magnet as a holding circuit, to guard against the possibility of interference with the timing by momentary switchhook flashing of the called party. Contacts CH connect positive 48 volt battery thru resistance (RI) and front contacts of the (RC) relay to the "H" lead for operating the tip party's register, in case the tip party is calling, or they connect negative 48 volt battery thru resistance (C) and back contacts of the (RC) relay to the "H" lead for operating the ring party's register, in case the ring party is calling. Contacts CH are closed only for a brief interval which is sufficiently long to operate the register, and then these contacts open as the timing gear advances from its normal position. Contacts CH close once for each interval of 5 minutes and 7 seconds of conversation. As the timer approaches the end of each interval, the HD contacts open and the timer will advance to the succeeding timing cycle only if relays (CS) and (CH) are operated and the switch is in position 12. This insures that charging for any interval will not occur unless both the calling and the call subscribers are still on the line at the start of each interval. If neither subscriber has disconnected, the timer will continue its progress until the HD contacts reclose prior to the start of a new timing interval, and from this point on, the operation for the new or overtime interval is the same as described for the initial interval.
ionen disconnection occurs, the operation is the same as described in paragraph 28 except that as the switch leaves position 12 , the (HOT) magnet of the timer, if operated, will release, and the timer will restore to normal.

## 27. OPERATOR ANSWERS

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 reverse battery and ground over the trunk. The (CS) relay operated, closes a circuit operating the (L) relay, advancing the switch to position 14. 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 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 contacts of cam. J. In position 14, a checking tone circuit is closed over the sleeve of the operator's trunk, cam $E$, make contact of the (L) relay, cam V, 2 mf condenser, cam $X$ the $S$ brush and terminal at. the line finder bank, to ground through the winding of the (CO) relay for number checking.
28. DISCONNECTION - REGULAR CALL

When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, in turn releasing the (D) relay. The (D) relay released, closes a circuit through the $R$ magnet, advancing the switch to position 16. The test switch advances to position 11 as the sequence switch passes position 13-1/2. As the switch enters position 14-3/4 ground is connected through to 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 (TST) interrupter steps the switch to terminal 16.

## 29. SECOND TEST OF CALLING LINE

As the line test switch passes over terminals 12 and 13 with the district switch in posi.tion 16, battery is connected through the ( $T$ ) brush and cam $P$ to the tip side of the line to discharge the substation condenser. On terminals 14, 15 and 16 of the line test switch, a second test is made on the line. During this test, the tip and ring of the ine 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, to ground on terminal 12 and (C) brush of the line test switch, and remains operated until the line test switch advances from position 15. If the (T) relay operates in positions 14 to 16 of the test switch, the (I) relay is held operated and the line test switch steps to terminal 16. With the (I) relay operated, the test switch is held on this terminal and a circuit is closed, operating the selector time alarm circuit. When the alarm is investigated, the sequence switch must be advanced to position 17, manually to prevent a false charge to the calling station. If, however, the line is free from ground when the second test is made, the ( $T$ ) relay does not operate and the (I) relay releases and
closes a circuit from ground through its break contact, terminal 16 and (S) brush of the test switch, to battery through the winding and break contact of the (PT) magnet, stepping the brushes to terminal 17. The selector then steps to position 20 under control of the (TST) interrupter in order to allow sufficient time for the operation of the message register in the associated line circuit. As the line test $s$ witch passes over terminals 17 to 19, a message register circuit is closed, operating the proper message register in the associated line circuit.

If the circuit is arranged for non-zone overtime registration per $N$ wiring, the registration circuit is open in sequence switch position 16, registration takes place during conversation as previously described, and the test. switch advances to position 20 with out timing, on closure of the (TST) interrupter.

When $S$ wi ring and apparatus are furnished, and a call is made to a zone requiring multiple registration or timing, the (CH) relay releases as the sequence switch advances out of position 11. The ( CH ) relay releasing, prevents registration.

The tip and ring of the line are shortcircuited during the second test thru the contacts of the (CH) and (I) relays in series; so that the short circuit is removed when the (I) relay releases at the end of the second line test. This prevents the possibility of this short circuit being on at the time the (CO) relay of the line circuit is released to register the grounded party thereby allowing the (L) relay of the line circuit to operate momentarily and prevent registration.

## 30. MESSAGE REGISTERING ON NON-ZONE CALLS - WITHOUT NON-ZONE OVERTIME REGISTRATION

30.1 Circuit not Arranged for Remote Control Zone Registration ("R" Wiring)
As explained under first test of calling line, the ( $R C$ ) relay operates and locks on the first line test when the call originates at the station with the grounded ringer, but does not operate on line tests when the call originates at the station whose ringer is connected in series with a condenser. The operation or non-operation of the ( $R C$ ) relay determines which station register shall register the call. If a call originates at the station whose ringer is connected to ground in series with a condenser, the (MRI) message register in the line circuit operates. The registering circuit is traced from battery on the make contact of the (CH) relay through cam $T$, break contact of the (I) relay, break contact of the (RC) relay, through the (C) resistance over lead $H$, through winding of the (MRI) message register to ground.

On calls originating at the station whose ringer is permanently connected to ground, the (RC) relay operates and locks and closes a circuit short-circuiting the (E) relay which releases. The (E) relay released, (a) opens the circuit through the (SL) relay which releases, (b) opens the operating circuit for the (MB) relay, but the (MB) relay does not release on account of a circuit being closed to ground on cain I. The release of the (SL) relay opens the circuit, releasing the (CO) relay and closes a circuit operating the (F) relay which opens the tip and ring leads. When the (CO) relay releases, the (MR2) message register is connected to 1 ead $H$ and registering circuit for the second party station is traced from battery on the make contact of the (CH) relay, break contact of the (I) relay, make contact of the (RC) relay, contact of the (G) relay, through the (C) resistance, brush and commutator of the (LF) selector, over lead H , to ground through the winding of the (MR2) message register.

As the operation of register (MR2) 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 over the (S) lead to battery on the $S$ lead of the final selector which seized this line.

### 30.11 CIRCUIT ARRANGED FOR NO CHARGE TALKING POSITION 11

When it is desired to make position 11 a no charge talking position with neither Remote Control Zone Registration or Non-Zone Overtime provided it is necessary to furnish Sequence swltch D-179637. With this arrange ment, as the sequence switch advances out of position 11, the ground to the armature of the (CS) relay is opened at SS3-I and the (CH) relay locking circuit is opened at SS3-0 releasing the (CH) relay. No charge is made in position 16 as the charging circuit is open with (CH) relay normal. The message register will be operated in position 16 as outlined above when position 12 is the talking position.

### 30.2 Gircuit Arranged for Remote Control Zone Registration (S and SL Wiring)

As explained in paragraph 30.1 relay (RC) will be operated if the call originates at the station with the grounded ringer, ans will not be operated, if the call originates at the station with the grounded ringer, and will not be operated, if the call originates at the station with the nongrounded ringer. With the sequence switch in position 16, the (PT) selector in position 17 to 19 and the (RC) relay operated, positive battery thru resistance (Rl), back contacts of relay (I),

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cam T and front contacts of relay (CH), is connected to lead H , causing the operation of the (MR2) message register in the line circuit, thereby registering a call for the station with the grounded ringer.

With relay (RC) normal under the above conditions, negative battery thru resistance (C), back contacts of relay (I), cam $T$ and front contacts of relay ( CH ) is connected to lead H, causing the operation of the (MRI) message register in the line circuit, thereby registering a call for the station with the nongrounded ringer.

## 31. RESTORING LINE FINDER TO NORMAL

As the line test switch steps to terminal 20, a circuit is closed 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. The (DS) relay operated, (a) locks through its make contact and 350 ohm winding to battery, (b) closes a circuit through the outer winding of the ( $F$ ) relay, thus insuring the holding of this relay until both the line finder selector and the district selector have returned to normal, (c): operates the line finder DOWN magnet from ground on its armature, which restores the line finder selector to normal. When the line finder selector returns to normal, ground is disconnected from the $M$ commutator segment, releasing the (E), (DS) and (MB) relays.

## 32. RESTORINC DISTRICT TO NORMAL

With tke district switch in position 18 , a circuit is closed through the winding of the (PT) nagnet which operates and advances the switch to terminal 21. With the line test swioch on terminal 21, a circuit is closed through the DOWN magnet, restoring the seiector to normal. When the district selector reaches the bottom of the frame, a circuit is closed from ground through the $y$ commutacor brush and segment, (D) brush and termiral 21, (S) brush and terminal to battery through the (PT) magnet, stepping the brusies to terminal 22. With the test switch on :erminal 22 a circuit is closed from ground on terminal 22 and (S) brush to battery trrough the (PT) magnet, stepping the switch ts terminal 1. With the line test switch on ferminal 1, ground through the Y commutator brush and segment (D) brush and terminal 1 of the line test switch, cam $B$ to battery through the $R$ magnet; advances the district switch to position 1. As the switch leaves position 18, the circuit through the DOWN magnet is opened, and after position 18 1/4, the circuit through the outer winding of the (F) relay is opened, releasing the relay. The (C) relay in Fig. 5 releases after position 18 1/4.

## 33. TIMED RELEASE

When the timed release feature is furnished and "T" wiring omitted, if the calling subscriber fails 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 starts the district release circuit counting time. At the end of the release interval ground is connected to operate relay (F) on its secondary winding. Relay (F) operated opens the calling subscriber's bridge which causes the (DC) relays to release. Relay (D) released causes the district to advance as explained in paragraph 28. In the case of nongrounded party the district will return to normal. However, in the case of the grounded party the district will block in the second test position as covered in paragraph 29 and the time alarm will function. When "T" wiring is furnished, if the calling subscriber fails to disconnect, a selector time alarm is operated thru the back contact of the (CS) relay and the front contact of the (CH) relay.

## 34. DISCONNECTION - TALKING TO OPERATOR

With the plug of the answering cord in the trunk jack at the incoming end, ground is connected to the sleeve terminal of the trunk to hold the district (L) relay operated. If the plug of the cord is removed from the trunk jack before the receiver at the calling station is replaced on the switchhook, the line relay in the trunk circuit operates, thereby holding the ground on the sleeve terminal of the trunk. When the rem ceiver 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 $14 i / 4$, the locking circuit through the inner winding of the (D) relay is opened at cam $J$, releasing the relay. The (D) relay released, advances the switch to position 16. With the test switch in position 20, a circuit is closed through the $R$ magnet, advancing the switch to position 17, the $\mathbb{A}$ 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 norm mal as described in paragraphs 31 and 32.

## 35. DISCONNECTION BEFORE LINE FINDER SELECTOR FINDS LINE

Should the calling subscriber replace the receiver on the switchhook before a huntselector finds the line, the (L) relay in the
line circuit releases, removing battery from the $H$ terminal at the multiple bank. The selector therefore travels to the top of the bank and the H brush of the selector makes contact with the terminal of the $H$ comb at the 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, cam $W, H$ brush of the selector to battery. The (H) relay operated, releases the (LF) relay, which in turn releases the ( $F$ ) relay and opens the circuit through the UP magnet. The $N$ commutator segment is opened with the selector brush resting on the $H$ comb 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.

## 36. POSITIONS 2 TO 6

If the receiver is replaced on the switchhook at the calling station while the district switch is in position 2 to 6 , the dialing circuit is opened at the calling station causing the sender circuit to function and connect a direct ground to the SC lead operating the (CH) relay and causing the (D) relay to release on account of the increased current flow through the 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, advances the switch to position 6 .

In position 6 the DOWN magnet operates, restoring the district selector to normal. When the selector reaches the bottom of the bank a circuit is closed from ground through the $Y$ commutator to battery through the $R$ magnet, advancing the switch to position 7. In position $2 / 10$ or $2 / 9$ a circuit is closed through the outer winding of the (DS) relay to ground on the $M$ commutator, operating the (DS) relay, which operates the line finder DOW magnet returning the line finder to normal.

As the district switch enters position 5, the (PT) selector is operated. When the district switch advances from position $61 / 4$, the (PT) magnet releases, stepping the test switch to position 2. Ground on the Y commutator through the D and $S$ brushes steps the test switch to position 4. The test selector steps to terminal 5 in a circuit from ground on the break contact of the (I) relay and steps to terminal 8 under control of the (TST) interrupter. Ground on terminal 8 causes the test selector to step to terminal 9. With the test switch in position 9, a circuit is closed from ground on the $Y$ '
commutator advancing the district switch to position 1l. As the district switch passes through position $93 / 4$ to $101 / 2$, the (PT) magnet operates. As the district switch advances from position $101 / 2$, the (PT) magnet releases, stepping the line test switch to terminal 10. When the district switch advances to position 10, a circuit is closed from ground on cam I, break contact of the (D) relay, cam D to battery through the R magnet, advancing the switch to position 16. As the district switch passes through position 13, the (PT) magnet operates, and when the district switch advances from $131 / 2$, the (PT) magnet releases, stepping the test switch to terminal 11. In position $14 \cdot 3 / 4$ the (PT) magnet again operates and releases when the district switch advances from position 15 1/4. The release of the (PT) magnet advances the test switch to terminal 12. Ground through the (TST) interrupter is connected through the (PT) magnet, advancing the test switch to terminal 16. On terminal 16, ground on the break contact of the (I) relay advances the test switch to terminal 17. The switch advances to terminal 20, under control of the (TST) interrupter, and closes a circuit from ground thru the (C) brush and terminal 20, advancing the district switch to position 17, the A cam advancing it to position 18. Ground on cam I, break contact of the (D) relay, cam D, (S) 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 test switch to terminal 1, where a circuit is closed advancing the district switch to position 1 .

When the line finder selector returns to normal, ground is disconnected from the $M$ commutator, thus releasing the (i) , (DS) and (MB) relays. The (DS) relay released, releases the (F) relay, restoring the circuit to normal.

## 37. POSITION 7 TO 10

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. After subscriber's line is tested and line test selector steps to position 9, the (DC) relay releases, releasing the (i) relay which closes a circuit through the $R$ magnet, advancing the switch to position 16. As the switch advances to oosition 16 , the line test switch steps to terminal 30, and in position 16, the (L) relay being released, advances the switch to position 17 , the $A$ cam advancing it to position 18. From this point on the district returns to normal as covered in paragraph 32.

## 38. TELLTALE - LINE FINDER SELECTOR

### 38.1 Brushes Not Tripped

The (LF) relay releases when the line finder reaches telltale, due to the $N$ and $C$ segments being opened. The release of the (LF) relay releases the UP magnet, and also releases the (F) relay provided a sender has been found. The release of the (F) relay operates the (DS) relay which locks, operates the down drive magnet and re-operates the (F) relay, returning the line finder to normal.

### 38.2 With Brushes Tripped

Should the selector travel to the telltale position while hunting, with the multiple brush tripped, a circuit is closed from battery in the trip circuit, terminal of the $H$ comb at the top of the multiple bank (shown on TRIP circuit), H multiple brush of the line finder selector, contacts of cam W, winding of the (H) relay, to ground on the armature of the (DS) relay, operating the (H) relay. 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 telltale alarm if furnished 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.

## 39. TELLTALE DISTRICT SELECTOR

Should the selector travel to the telltale position during brush selection, ground on the $X$ commutator brush and segment is connected through cam B, to battery through the $R$ magnet, advancing the switch to position 8. Under this condition the resistance of the circuit over the SC lead is not sufficient to operate the (CH) relay, and the district remains in position 8 until it is restored to normal manually. If the district goes to telltale during group selection, ground on the $X$ commutator advances it to position 8. In position 8, ground on the SC lead holds the ( CH ) relay operated, which in turn operates the (L) relay. The (L) relay operated, advances the switch to position 9. The (C'H) and (L) relays remain operated and the district remains in position 9 until it is restored to normal manually.

## 40. OVERFLOW

If all the trinks 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 reoperates 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 ' 2 commutator brush and segment, through cam $K$ to the $R$ winding advancing the switch to position 10. In position 10, (L) relay operates, through 1200 ohm winding. The (L) relay operated, locks through its 1200 ohm . winding and make contact to ground, through cam L, advancing the switch to position 14 from ground on cam M. As the switch advances from position 13, the (L) relay releases, and in position 14 advances the switch to position 15. The release of the (L) relay also releases the (CI) and (CII) relays, disconnecting the sender from the district circuit. With the switch in position 15, a circuit is closed from the Miscellaneous Tone Circuit" over lead C, 2 mf condenser, cam $G$, winding of the repeating coil, 2 mf condenser, cams $V$ and $J$, make contact of the (D) relay, to ground on cam I. A tone is therefore induced in the other winding of the repeating coil, thus causing the "All Trunks Busy" tone to be sent back to the calling subscriber. When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, opening the locking circuit through the (D) relay, which releases. From this point on, the switch is advanced to position 1 as described in paragraph 34.

## 41. "O" COMMUTATOR

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 selector 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 nonbusy condition of the sleeve terminals. When necessary to combine two or more groups of trunks, the multiple sleeve overflow terminals between the combined groups are made permanently busy by being connected to ground. As the "S" commutator bar is closed at overflow, the (L) relay is held operated at this time, and the selector therefore hunts past the "made busy" terminals into the next group.

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