SELECTOR SWITCH OPERATION STEP-BY-STEP DIAL TELEPHONE SYSTEM

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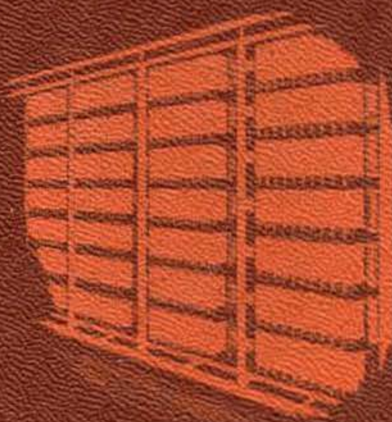

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SELECTOR SWITCH OPERATION

This bulletin is issued to describe the details in connection with the circuit operation of the local selector switch. Information contained herein is to be used for educational purposes only.

CONTENTS

BIBLIOGRAPHY

Standard Drawings

1. OPERATING FEATURES

a. General

The selector switch is one of the switches used in the step-by-step dial system to complete calls. It consists of a number of relays, and a switch mechanism which controls the movement of wipers, attached to a shaft, over two semi-circular banks of terminals. These banks of terminals known as the line (lower) and sleeve (upper) banks are not considered as part of the selector switch but rather as part of the shelf equipment on which the switch is mounted.

The vertical stepping of the shaft and wipers is controlled by the subscriber dial. After the subscriber has dialed a digit of the number wanted, the dial rotates back to normal. In returning to normal the dial mechanism opens and closes a set of springs on the rear of the dial, this in turn opening and closing the line loop (T and R) between the subscriber and the selector switch. These interruptions of the line loop, release a selector relay which in turn operates the vertical magnet of the selector switch, stepping the shaft and wipers upward one step for each interruption until the proper level has been reached.

The relays of the selector switch, in conjunction with the rotary stepping magnet now automatically move the shaft and wipers in a rotary direction, stopping the wipers momentarily on each set of terminals in the level to test whether the equipment (CONNECTOR) associated with the terminal on which the wipers are resting is already in use or if it is idle. If it is idle the rotary stepping ceases; if it is busy the stepping will continue until an idle set of terminals is found.

b. Function of the Five Selector Relays, A, B, C, D, and E

(A) relay is the first relay to operate when the switch is seized and it is through the winding of this relay that both the dial tone (continuous buzz) and trunk busy tone (interrupted buzz) are carried to the subscriber. It releases and operates each time the subscriber dial contacts open and close, and in turn operates the vertical (VERT) magnet for stepping the shaft upward.

(B) relay is the second relay to operate and it places a ground on the sleeve (S) lead to hold the line finder relays and the subscriber cut-off (CO) relay operated.

(C) relay is the third relay that operates and it operates in series with the vertical (VERT) magnet. Its purpose is to keep the circuit to the rotary (ROT) magnet open during vertical stepping and to close it when vertical stepping is completed.

(E) relay is the fourth relay to operate. It operates as soon as the vertical off-normal (VON) springs close on the first vertical step of the shaft and releases on the first rotary step. It, in conjunction with the rotary (ROT) magnet, causes the rotary stepping of the shaft.

(D) relay is the fifth or last relay to operate. It operates when an idle connector is found and closes the tip and ring leads from the line finder through to the connector.

c. Function of the Three Sets of Springs, Vertical Off-Normal, Rotary Interrupter, and 11th Rotary Step Springs

The vertical off-normal (VON) springs operate as soon as the shaft makes the first vertical step. Their purpose is to close a circuit to operate the (E) relay and to partly close a circuit for operating the release (RLS) magnet after the shaft is raised off the normal position.

The rotary interrupter (ROT) springs operate each time the rotary (ROT) magnet operates, and in conjunction with the (E) relay, keeps the shaft and wipers rotating from one set of terminals to the next until an idle set is found.

The 11th rotary step springs are operated by a cam which is attached to the shaft directly below the ratchets. This cam will press against the studs of the spring assembly as the switch rotates from the 10th rotary step to the 11th rotary step, opening some of the contacts and closing others. The opening and closing of the spring contacts break the dial tone circuit and close the busy tone circuit to the subscriber.

d. Function of the Three Magnets, Vertical, Rotary, and Release

The purpose of the vertical (VERT) magnet and armature is to move the shaft carrying the wipers in a vertical direction. When the magnet is energized the armature is pulled up against the magnet core causing the pawl, at the end of the armature, to engage the vertical ratchet and raise the shaft and wipers.

The purpose of the rotary (ROT) magnet and armature is to move the shaft carrying the wipers in a rotary direction. When the magnet is energized the armature is pulled against the magnet core and the pawl, at the end of the armature, engages the rotary ratchet, forcing the shaft and wipers around in a rotary direction. This rotary action winds up the shaft spring located on the upper end of the shaft.

The purpose of the release (RLS) magnet and armature is to allow the shaft and wipers to release and restore to normal. When the magnet is energized the armature is pulled against the magnet core and the release pin, at the end of the armature, presses against the double dog disengaging it from the ratchets on the shaft. The uncoiling of the shaft spring rotates the shaft to the rotary normal position where it is stopped by the normal pin hitting against the shaft spring bracket. The weight of the shaft then causes it to drop to the normal position.

2. CIRCUIT OPERATION

a. Seizure of Selector

After the associated line finder has risen and found the calling line, the (F) relay in the line finder circuit operates and closes the tip (T) and ring (R) leads from the subscriber set through the line finder to the selector, operating the (A) relay. The (A) relay operates the (B) relay and also the permanent (PERM) shelf alarm relay located at the end of the shelf.

The permanent (PERM) shelf alarm relay closes the dial tone circuit through one winding of the dial tone (DT) repeating coil at the end of the shelf. A continuous buzzing tone is induced into the second winding and through the windings of the (A) relay to the subscriber. The permanent (PERM) alarm relay also connects to a common timing circuit which brings in the white permanenent (PERM) shelf alarm lamp if the subscriber fails to dial within a specified time. If dial tone is not to be supplied to the shelf the (DT) repeating coil is not furnished and terminals 15 and 11 of the switch are strapped together.

The (B) relay places a ground on the sleeve (S) lead for holding both the (F) relay in the line finder and the (CO) relay in the subscriber circuit, operated.

Circuit

(A) relay operates (Fig. 1) from ground through the 2-1 windings of the (DT) repeating coil, (DT) terminal of the shelf terminal strip which is strapped (Y wiring) to the (D) terminal, terminal 15 of the switch jack, 4-5 contacts of the 11th rotary step springs, 200 ohm, R (Rear) winding of the (A) relay, 6-7 contacts of (D) relay, terminal 2 of the switch jack, out over the tip (T) lead, line finder and subscriber loop, back on the ring (R) lead, terminal 1 of the switch jack 10-9 contacts of (D) relay, 200 ohm F (Front) winding of (A) relay to battery.

When the (DT) repeating coil is not furnished (A) relay operates (Fig. 1) from ground on the G (1-4) terminals of the shelf terminal strip, terminal 11 of the switch jack which is strapped to terminal 15 (X Wiring).

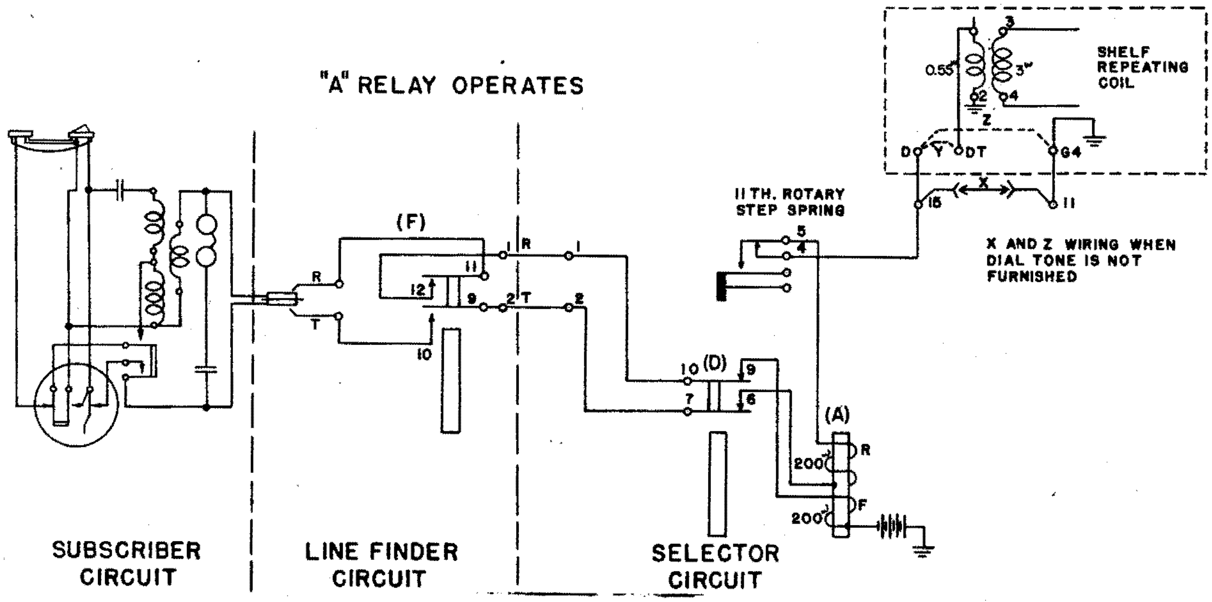


FIG. 1

Relay (B) and permanent (PERM) shelf alarm relay operate in series (Fig. 2) from ground on 2-1 contacts of (D) relay, 2-3 contacts of (A) relay, 800 ohm winding of the (B) relay, terminal 5 of the switch jack, 10 ohm winding of the permanent (PERM) shelf alarm relay, to battery.

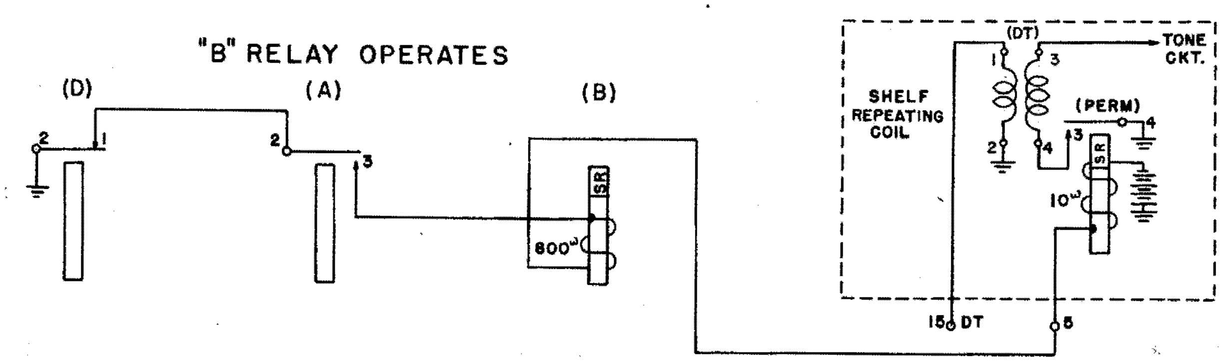


FIG. 2

The ground on the sleeve (S) lead, (Fig. 3) to hold the (F) line finder and (CO) subscriber relays, comes from the 5-4 contacts of the (B) relay, terminal 9 of the switch jack out over the sleeve (S) lead to the line finder and subscriber line circuits.

GROUND ON SLEEVE LEAD

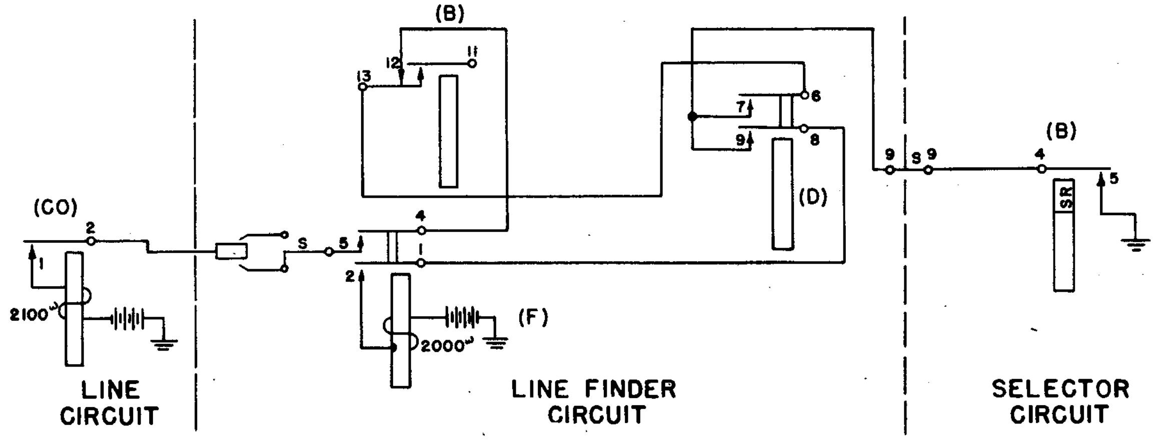


FIG. 3

b. Dialing

The switch is now in position to receive the dial impulses which will cause the shaft to be raised one step at a time in the vertical direction until the proper level has been reached.

The subscriber dials a number (3) and as the dial returns to the normal position it opens and closes the operating circuit of the (A) relay three times. Relay (A) releases and operates three times and each time it releases it opens the circuit through the winding of the (B) relay. The (B) relay, however, is slow releasing and remains operated each time until (A) relay reoperates.

c. Vertical Stepping

On the first release of the (A) relay, the (C) relay and vertical (VERT) magnet operate in series. The (C) relay operates on the release of the (A) relay and due to its being slow releasing stays operated until (A) relay remains operated after the third (last) impulse from the dial. The vertical (VERT) magnet operates and releases each time the (A) relay does, pulling up its armature and releasing the double dog, which engages the ratchet on the shaft. The pawl at the end of the armature engages the vertical ratchet forcing the shaft, carrying the wipers upward. Condenser (C) is used to prevent sparking at 2-1 contacts of (A) relay during vertical stepping. The 200 ohm resistance is to prevent a direct circuit to ground if the (C) condenser becomes shorted.

Circuit

The (C) relay and vertical (VERT) magnet operate (Fig. 4) from a ground on the 2-1 contacts of (D) relay, 2-1 contacts of (A) relay, 2-3 contacts of the (B) relay, 8 ohm winding of (C) relay, 57 ohm winding of the vertical (VERT) magnet to battery.

d. Closure of Vertical Off-Normal Springs

When the shaft is thrust upward on the first vertical step its weight is removed from the vertical off-normal finger allowing the vertical off-normal (VON) springs to close, operating and locking the (E) relay.

"C" AND VERTICAL MAGNETS OPERATE

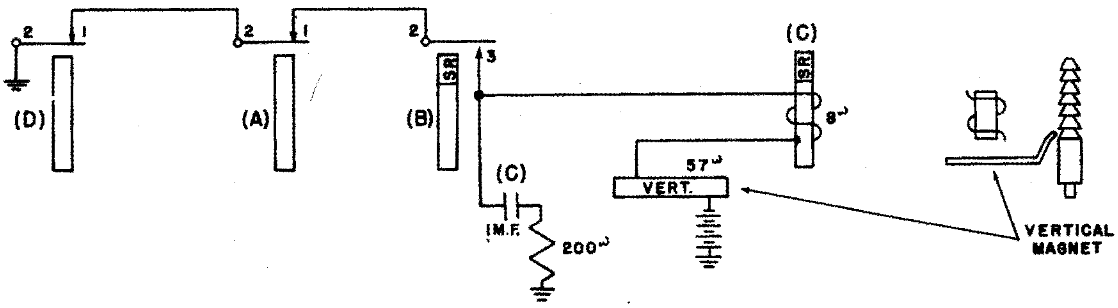


FIG. 4

Circuit

Relay (E) operates (Fig. 5) from ground on the 5-4 contacts of the (B) relay, 3-1 contacts of (C) relay, 1-2 contacts of the vertical off-normal (VON) springs, inductive and non-inductive 181 ohm windings of the (E) relay in parallel to battery.

Relay (E) locks (Fig. 5) from a ground on the 2-1 contacts of the (D) relay, 2-1 contacts of the (E) relay, 2-1 contacts (Rotary Int. Springs) of the rotary (ROT) magnet, 1-2 contacts of the vertical off-normal (VON) springs, inductive and non-inductive 181 ohm windings of the (E) relay in parallel to battery.

"E" OPERATES AND LOCKS

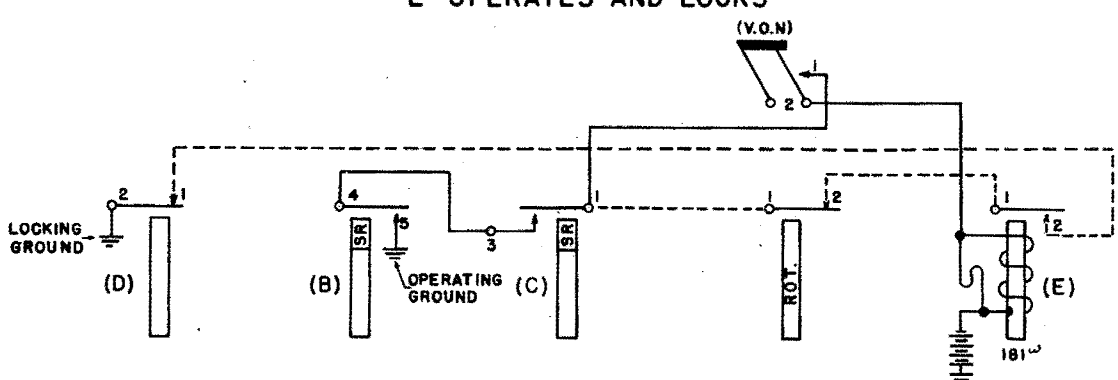


FIG. 5

e. Rotary Stepping

As the shaft reaches the third level and the dial is normal the (A) relay is again held operated through the dial contacts allowing the (C) relay to release. It releases slowly to give the shaft sufficient time to come to rest before the rotary motion takes place. The (C) relay releasing opens the operating circuit of the (E) relay and closes a circuit to operate the rotary (ROT) magnet. The (E) relay is held operated over its locking circuit.

The operation of the rotary (ROT) magnet pulls up the armature, opening the rotary interrupter (ROT) spring contacts 1-2, which open the locking circuit of (E) relay allowing it to release and causing the pawl at the end of the armature to engage the rotary ratchet. This forces the shaft and wipers around and into the bank one step, where the three wipers tip (T) ring (R) and sleeve (S) make contact with the first set of bank terminals on the third level. The (E) relay releasing opens the circuit through the winding of the rotary (ROT) magnet which releases.

Circuit

Rotary (ROT) magnet operates (Fig. 6) from ground on the 5-4 contacts of (B) relay, 3-2 contacts of (C) relay, 3-4 contacts of (E) relay through the 57 ohm winding of the rotary (ROT) magnet to battery. Condenser (CI) prevents sparking at 3-4 contacts of (E) relay. The 200 ohm resistance is to prevent a direct circuit to ground if the (CI) condenser becomes shorted.

ROTARY MAGNET OPERATES

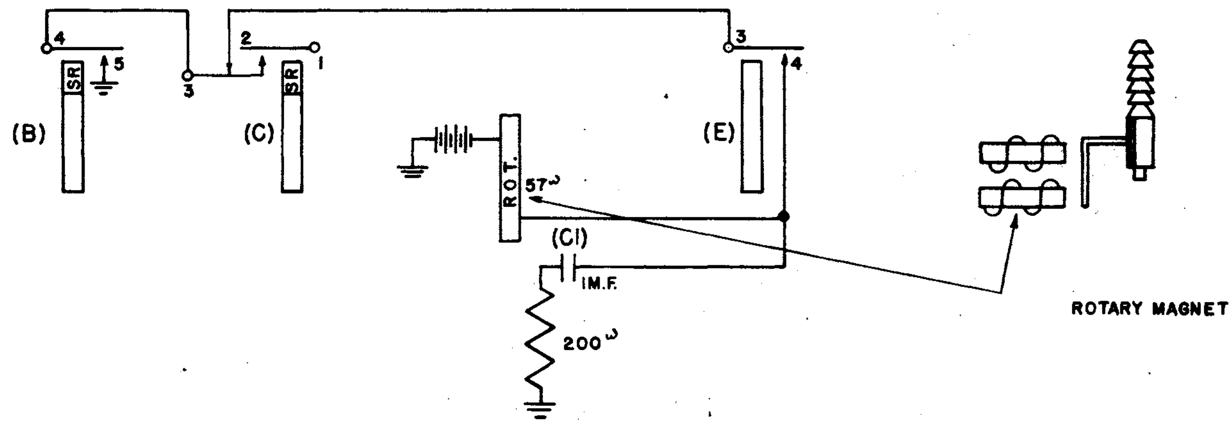


FIG. 6

f. First Trunk Idle

If the connector, which is attached to this first set of bank terminals, has not been previously selected by any other selector and is idle the (D) relay will operate in series with the winding of the (E) relay. (E) relay will not operate in series with the (D) relay as the resistance of both relays in series will not allow sufficient current to flow to operate both relays.

Circuit

Relay (D) operates (Fig. 7) from a ground on the 5-4 contacts of the (B) relay, 1-2 contacts of the 11th rotary step springs, 1300 ohm winding of the (D) relay, 2-1 contacts of the rotary interrupter (ROT) springs, 1-2 contacts of the vertical off-normal (VON) springs, through the 181 ohm inductive and non-inductive windings of the (E) relay in parallel to battery.

g. Seizure of Connector

When the (D) relay operates, the tip (T) and ring (R) leads from the subscriber and line finder are connected through the contacts of the (D) relay to the wipers on the shaft and terminals of the bank operating and (A) relay in the connector circuit. The (A) connector relay operates a (B) connector relay which places a ground on the sleeve (S) lead to the sleeve (S) terminal on the selector bank.

This ground will hold the (D) relay in the selector circuit, the (F) relay in the line finder circuit, and the (CO) in the subscriber circuit operated and also prevent any other selector from seizing this connector at this time.

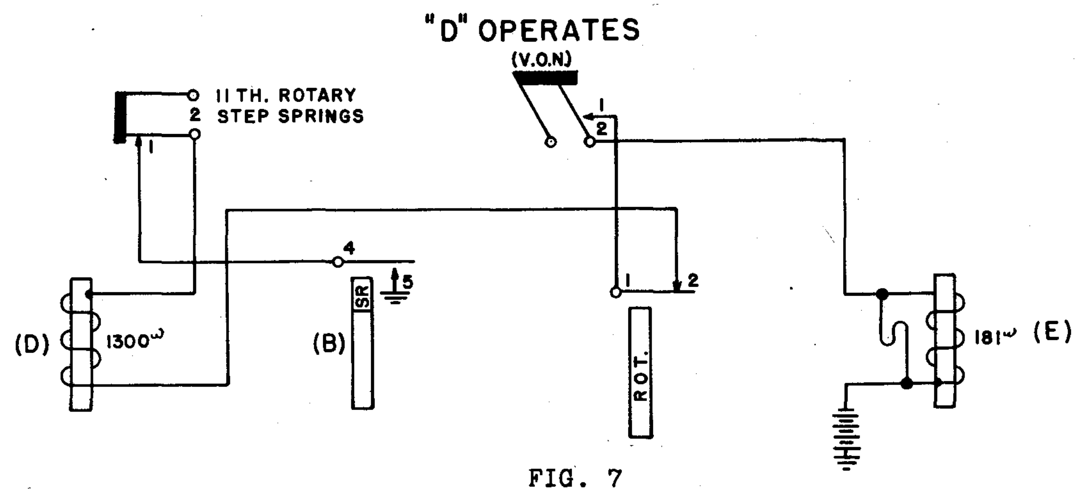


FIG. 7

When the (D) selector relay operated, the circuit from the subscriber to the (A) selector relay is broken releasing the (A) selector relay which in turn releases the (B) selector relay. Selector relay (B) releases slowly so as to allow sufficient time for (A) and (B) relays in the connector to operated and place the ground on the sleeve (S) lead for holding (D) selector relay, (F) line finder relay and (CO) subscriber relay operated. This ground was up to this time supplied on the sleeve (S) lead by the (B) relay of the selector circuit.

Circuit

Tip (T) and ring (R) closure to connector (Fig. 8) is from ground on the (A) relay, 200 ohm winding, in the connector, tip (T) terminal of the selector bank, and wiper (T), 8-7 contacts of (D) relay, terminal 2 of the switch jack out over the tip (T) lead through the line finder (F) relay contacts and subscriber loop back over the (R) leads, terminal 1 of the switch jack, 10-11 contacts of the (D) relay, wiper (R) and ring (R) terminal of the selector bank, through the 200 ohm winding of (A) relay in the connector to battery.

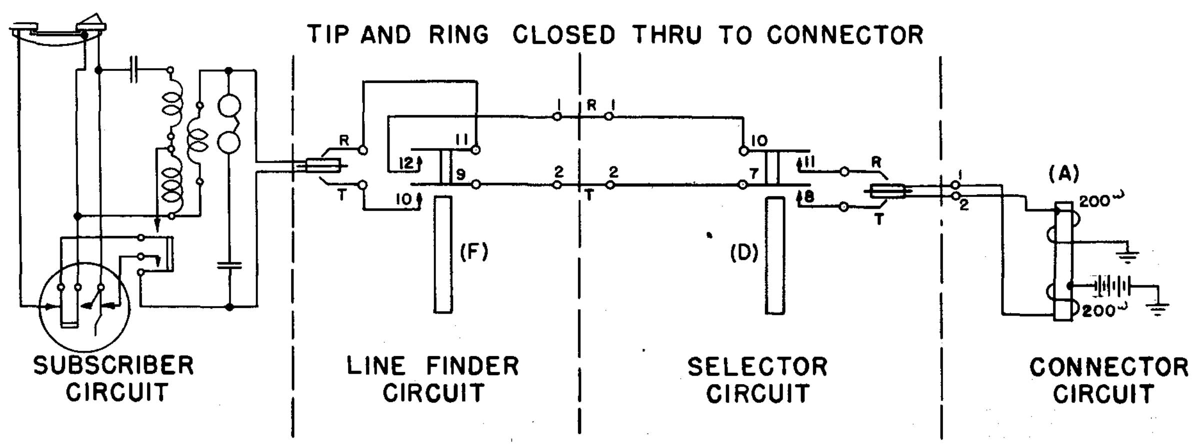


FIG. 8

The ground to hold up the selector, line finder and line circuit (Fig. 9) comes from the 5-4 contacts of the (B) relay in the connector, over the sleeve (S) terminal of the selector bank, 4-5 contacts of (D) relay in the selector to contacts 1 of the 11th rotary step springs. At this point the circuit divides with ground going out over the sleeve (S) terminal (9) of the switch jack to hold up the (F) line finder and (CO) line circuit relays and a second circuit carrying ground through the 1-2 contacts of the 11th rotary step springs, 1300 ohm winding of the (D) relay, 2-1 contacts of the rotary interrupter (ROT) springs, 1-2 contacts of the vertical off normal (VON) springs then through the inductive and non-inductive 181 ohm windings of the (E) relay in parallel to battery.

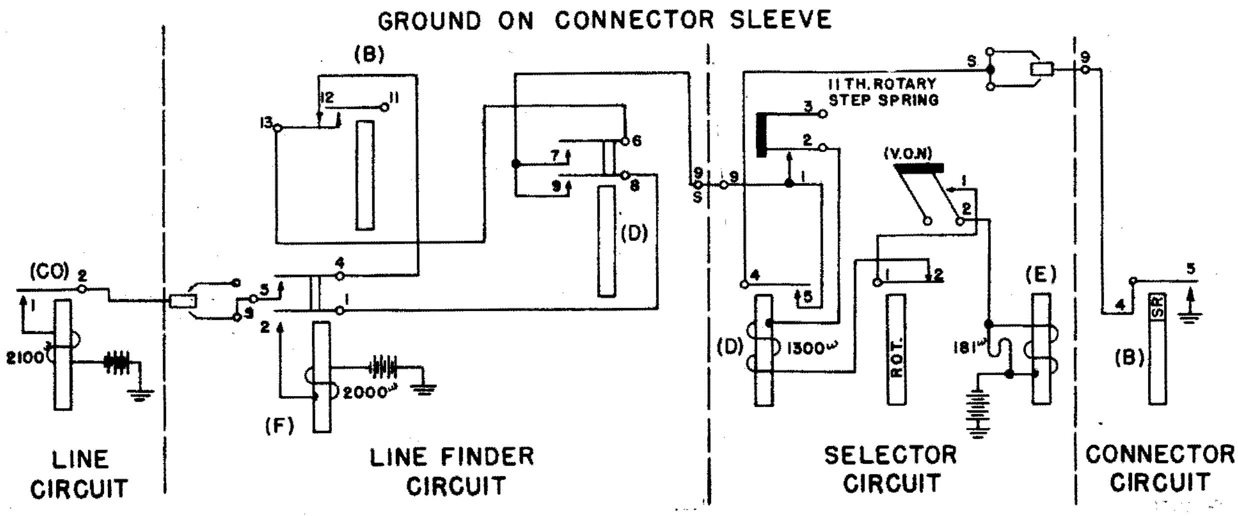


FIG. 9

h. Subscriber Talking

During the time the subscribers are talking the (D) relay remains operated from the ground on the sleeve (S) lead from the connector (B) relay. (Fig. 9) The talking battery to the calling subscriber is supplied from the (A) relay in the connector and to the called subscriber from the (D) relay in the connector. (Fig. 10).

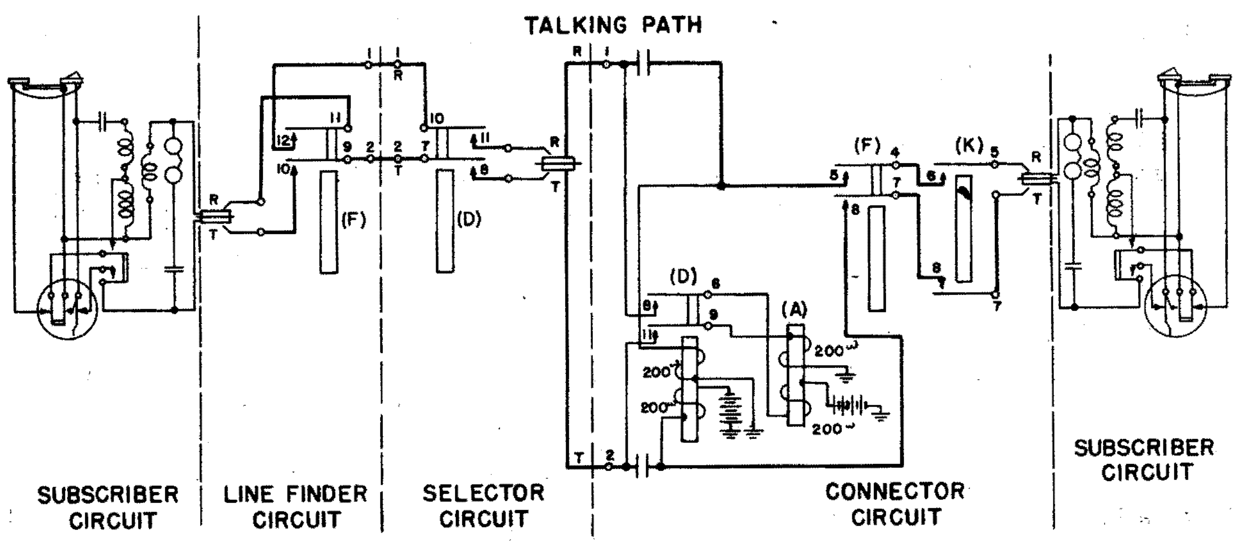


FIG. 10

1. Release of Switch

When the subscribers are finished talking they replace their receivers. This allows the relays in the connector to release. When the (B) connector relay releases, it removes the ground from the sleeve (S) lead allowing the selector (D) relay, line finder (F) relay and subscriber (CO) relay to release. The release of the (D) selector relay operates the release (RLS) magnet and the release (RLS) alarm relay at the end of the shelf. The release (RLS) shelf alarm relay will operate a traffic register when one is furnished, and also will bring in an alarm unless it is released within a certain time. When the release magnet armature is pulled against the magnet core, the release pin at the end of the armature presses against the double dog disengaging it from the ratchets on the shaft. The uncoiling of the shaft spring rotates the shaft to the rotary normal position where it is stopped by the normal pin hitting against the normal pin bracket. The weight of the shaft then causes it to drop to the normal position.

As the shaft falls the normal pin forces the vertical off normal finger down opening the vertical off normal (VON) spring contacts. This opens the operating circuit of the release (RLS) magnet and release (RLS) shelf alarm relay allowing both to release. The selector circuit is now normal.

Circuit

The release (RLS) magnet and release (RLS) alarm relay operates (Fig. 11) from a ground on the 2-1 contacts of (D) relay, 2-1 contacts of (A) relay, 2-1 contacts of (B) relay, 3-4 contacts of the vertical off normal (VON) springs, 115 ohm inductive and non-inductive windings of the release (RLS) magnet, terminal 10 of the switch jack, 2.4 ohm winding of release (RLS) alarm relay to battery.

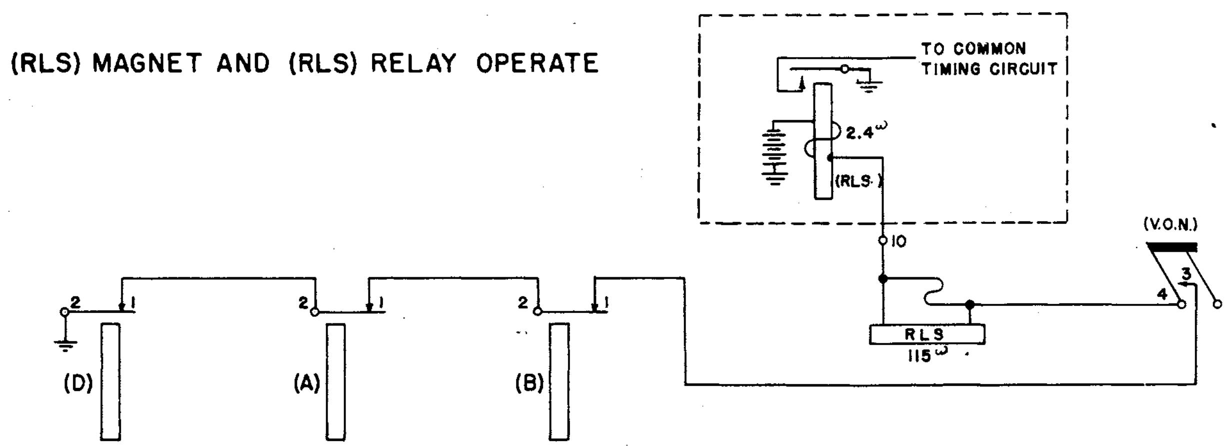


FIG. 11

3. SPECIAL CONDITIONS

a. First Trunk Busy

If the connector, which is attached to the first set of bank terminals, has already been selected and is being used on another call there will be a ground on the sleeve (S) lead and sleeve (S) terminal of the selector bank. This ground shunts the winding of the (D) relay and prevents it from operating.

When the rotary magnet operated on the first rotary step, is released the (E) relay by opening the 1-2 contacts of the rotary interrupter springs. The release of the (E) released the rotary (Rot) magnet. (See Rotary Stepping).

If (D) relay is not operated when the rotary (ROT) magnet releases, the (E) relay will operate from a ground on the sleeve (S) bank terminal coming from the connector, and close a circuit (Fig. 6) to operate the rotary magnet. The operation of the rotary (ROT) magnet pulls up the armature opening the rotary interrupter (ROT) contacts 1-2 which releases the (E) relay and causes the pawl at the end of the armature to engage the rotary ratchet, forcing the shaft and wipers around one step where the three wipers tip (T), ring (R), and sleeve (S) make contact with the second set of bank terminals on the third level. The (E) relay releasing opens the circuit through the winding of the rotary (ROT) magnet which releases.

If there is a ground on the sleeve (S) terminal of the second set of bank terminals the (D) relay cannot operate (shunted) and the (E) relay will again operate, operating the rotary (ROT) magnet stepping the shaft to the third set of bank contacts.

This stepping continues until a set of terminals, which does not have ground on the sleeve (S) terminal, is found in which case the (D) relay operates (shunt removed) as described under first trunk idle (Fig. 7).

Circuits

The ground to shunt the (D) relay comes from the (B) relay of the connector (Fig. 12) over the sleeve (S) terminal of the bank, 4-3 contacts of (D) relay to the winding of the (D) relay. This prevents the ground on the 4-5 contacts of the selector (B) relay, 1-2 contacts of the vertical off-normal (VON) springs, winding the (D) relay from becoming effective. With ground on both sides of the winding the relay cannot operate. (Compare with Fig. 7)

The (E) relay operates (Fig. 12) from the ground on the (B) relay in the connector, sleeve (S) terminal of the selector bank, 4-3 contacts of (D) relay, 2-1 contacts of the rotary interrupter (ROT) springs, 1-2 contacts of the vertical off-normal (VON) springs, inductive and non-inductive winding 181 ohms of the (E) relay to battery.

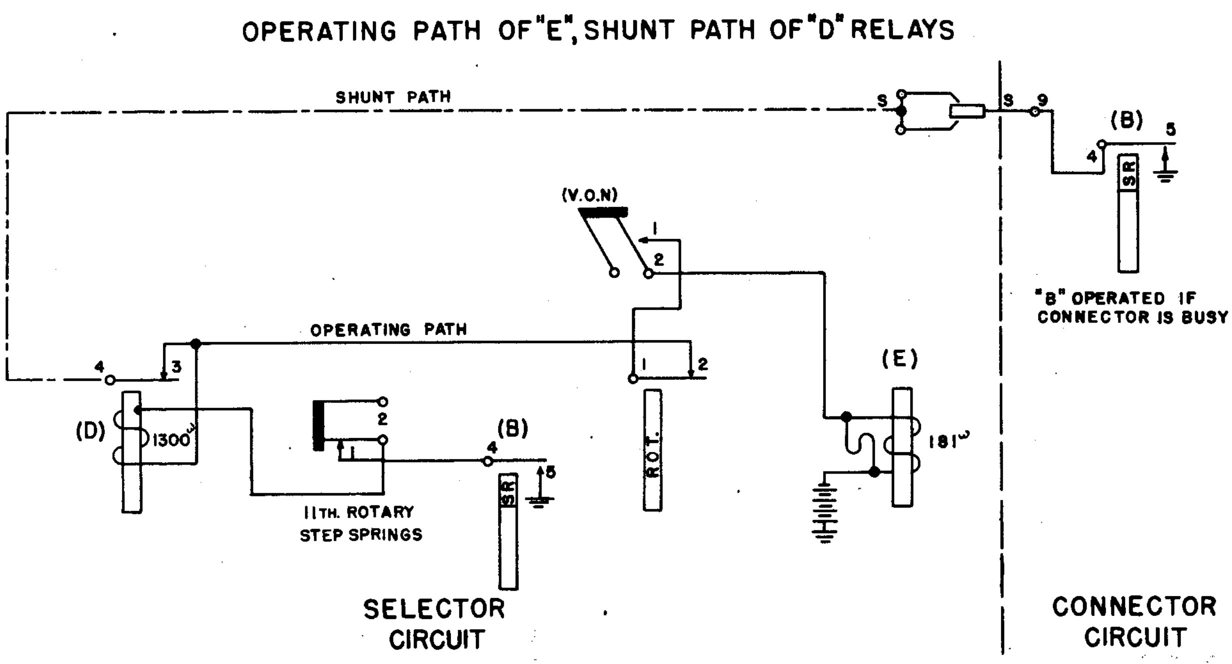


FIG. 12

b. All Trunks Busy

If all the ten connectors which terminate on the third level of the selector bank are busy the shaft carrying the wipers keeps stepping until the wipers leave the tenth set of terminals. As the wipers leave the tenth set of terminals a cam which is attached to the shaft directly below the ratchets bears against the studs of the 11th rotary step springs opening several of the contacts and closing others.

The closure of these contacts place a busy tone (interrupted buzz) on the winding of the (A) relay, and as it is held up over the subscriber loop the subscriber will hear the tone, replace the receiver, and the selector switch will restore as described under release of switch.

Circuits

The busy tone is induced (Fig. 13) through a repeating coil, located on a miscellaneous relay rack, terminal LTI of the shelf terminal strip, terminal 14 of the switch jack, 3-5 contacts of the 11th rotary step springs, 200 ohm (R) winding of the (A) relay, 6-7 contacts of (D) relay, terminal 2 of the switch jack over the (T) lead through the line finder circuit and subscriber loop back over the (R) lead, terminal 1 of the switch jack, 10-9 contacts of the (D) relay, 200 ohm (F) winding of the (A) relay to battery.

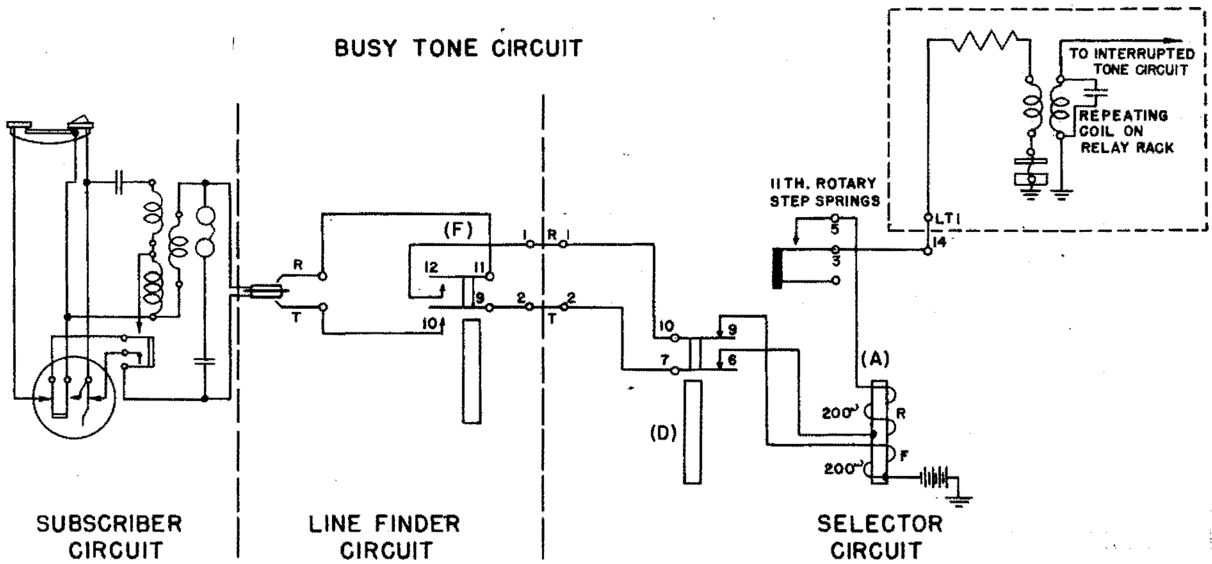


FIG. 13

4. OPERATION CHART

LOCAL SELECTOR CIRCUIT - OPERATION CHART

WHEN THE (F) RELAY OPERATES IN THE LINE FINDER THE
TIP AND RING LEADS OF THE SUBSCRIBER LINE ARE CLOSED TO THE SELECTOR

A+

B+

GRD. ON S LEAD
TO LINE FINDER
AND LINE CKT.

DIAL TONE CKT. CLOSED

SUBSCRIBER DIALS FIRST DIGIT OF CALLED NUMBER (3)

DIAL CONTACTS OPEN

A-

C+

B REMAINS +
(SLOW RELEASING)

VERTICAL MAGNET +
SHAFT AND BRUSHES
STEP UP TO 1st LEVEL
V.O.N. SPRINGS CLOSE
E + X

DIAL CONTACTS CLOSE

A+

C REMAINS +
(SLOW RELEASING)
PREVENTS ROTARY
STEPPING

B HELD +

VERTICAL MAGNET -

DIAL CONTACTS OPEN

A-

C + CKT.
AGAIN CLOSED

B REMAINS +
(SLOW RELEASING)

VERTICAL MAGNET +
SHAFT AND BRUSHES
STEP UP TO 2nd LEVEL

DIAL CONTACTS CLOSE

A+

C REMAINS +
(SLOW RELEASING)
PREVENTS ROTARY
STEPPING

B HELD +

VERTICAL MAGNET -

DIAL CONTACTS OPEN

A-

C + CKT.
AGAIN CLOSED

B REMAINS +
(SLOW RELEASING)

VERTICAL MAGNET +
SHAFT AND BRUSHES
STEP UP TO 3rd LEVEL

DIAL CONTACTS CLOSE

A+

C - (SLOWLY)
ROTARY MAGNET +

B HELD +

VERTICAL MAGNET -

SHAFT AND BRUSHES
STEP INTO 1st
SET OF TERMINALS

E-
ROTARY MAGNET -

ASSUME 1st TRUNK IDLE (SEE ALSO FIRST TRUNK BUSY)
NO GROUND ON SLEEVE TERMINAL FROM CONNECTOR

D+

OPENS DIAL TONE CKT.

A-

B-

GRD. FROM D RELAY WINDING

A+ (CONNECTOR)

B+ (CONNECTOR)

GRD. ON D RELAY WINDING
OVER S TERMINAL

D x TO GRD. ON S TERMINAL
FROM CONNECTOR

RESTORING SWITCH

WHEN SUBSCRIBERS REPLACE RECEIVERS
CONNECTOR REMOVES GRD. FROM S TERMINAL

D-

RELEASE MAGNET +

SWITCH RELEASES

V.O.N. SPRING OPEN

RELEASE MAGNET -

SWITCH NORMAL

F-

(LINE FINDER)

CO-

(LINE CKT.)

ASSUME 1st TRUNK BUSY (SEE ALSO ALL TEN TRUNKS BUSY)

GRD. ON S TERMINAL FROM CONNECTOR

E + X

ROTARY MAGNET +

SHAFT AND BRUSHES
STEP INTO 2nd SET
OF TERMINALS

E-

ROTARY MAGNET-

D REMAINS NORMAL
(SHUNTED)

ASSUME 2nd TRUNK IDLE

D+

OPENS DIAL TONE CKT.

A-

B-

GRD. FROM D RELAY WINDING

A+ (CONNECTOR)

B+ (CONNECTOR)

GRD. ON D RELAY WINDING
OVER S TERMINAL

D x TO GRD. ON S TERMINAL
FROM CONNECTOR
(FOR REMAINDER SEE UNDER SWITCH RELEASE)

ASSUME ALL TEN TRUNKS BUSY

SHAFT AND BRUSHES ROTATE TO THE 11th ROTARY STEP

11th ROTARY STEP SPRINGS +

A + CKT. TRANSFERRED

DIAL TONE CKT. OPENED

BUSY TONE CKT. CLOSED

WHEN SUBSCRIBER
REPLACES RECEIVER

A-

B-

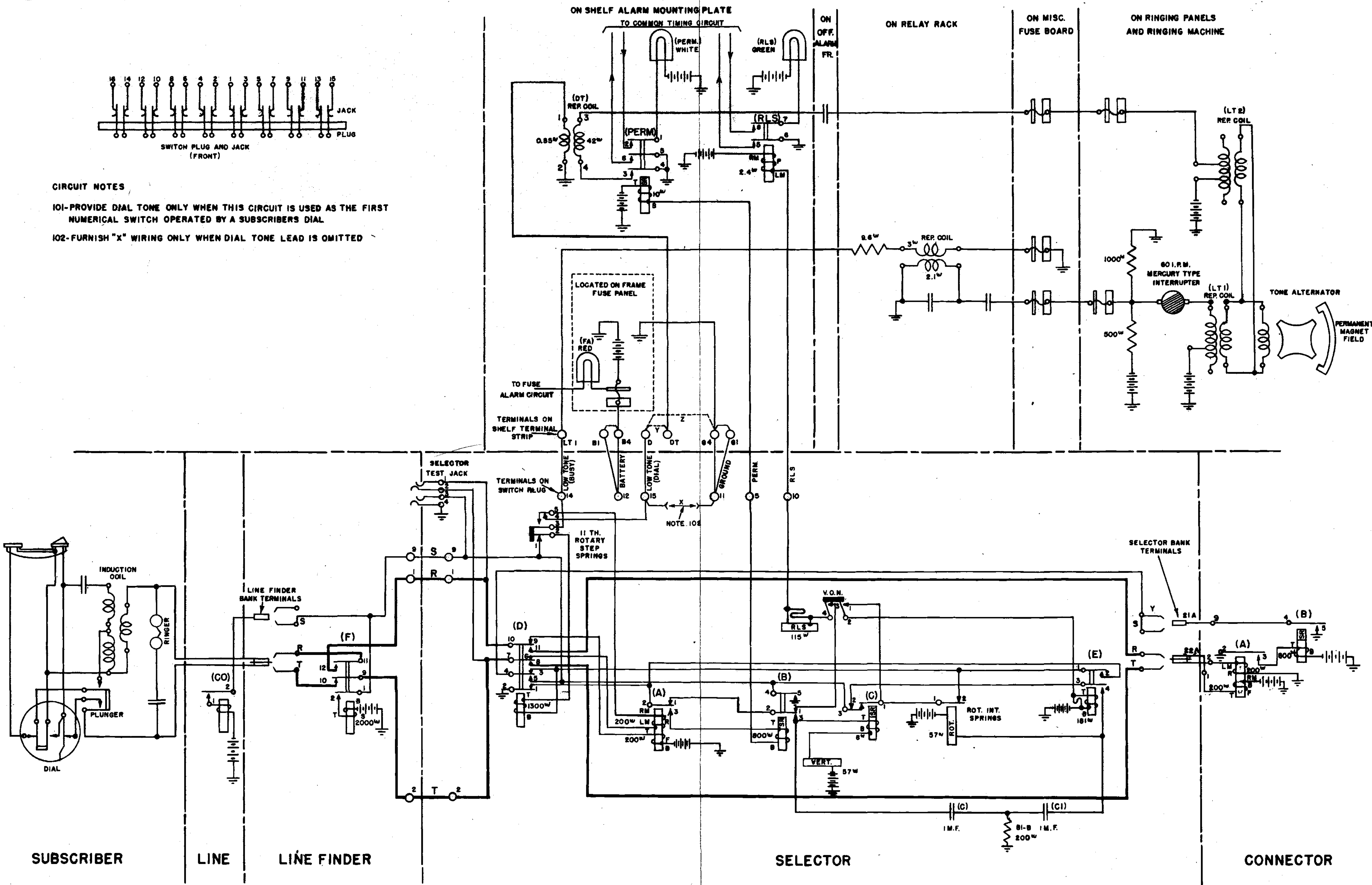
RELEASE MAGNET +

SWITCH RELEASES

V.O.N. SPRINGS OPEN

RELEASE MAGNET -

SWITCH NORMAL



CIRCUIT NOTES

101-PROVIDE DIAL TONE ONLY WHEN THIS CIRCUIT IS USED AS THE FIRST NUMERICAL SWITCH OPERATED BY A SUBSCRIBERS DIAL

102-FURNISH "X" WIRING ONLY WHEN DIAL TONE LEAD IS OMITTED

LOCAL SELECTOR AND ASSOCIATED CIRCUITS

FOR TRAINING PURPOSES ONLY	
LOCAL SELECTOR AND ASSOCIATED CIRCUITS	DATE
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