

Lesson No. 1

FUNDAMENTALS OF TELEPHONY

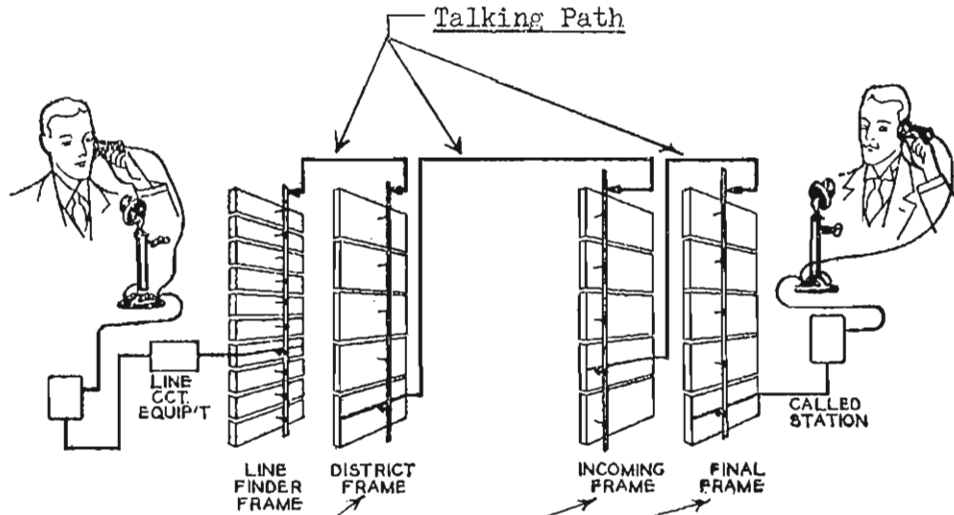
Section 10

The Panel Dial Switching System

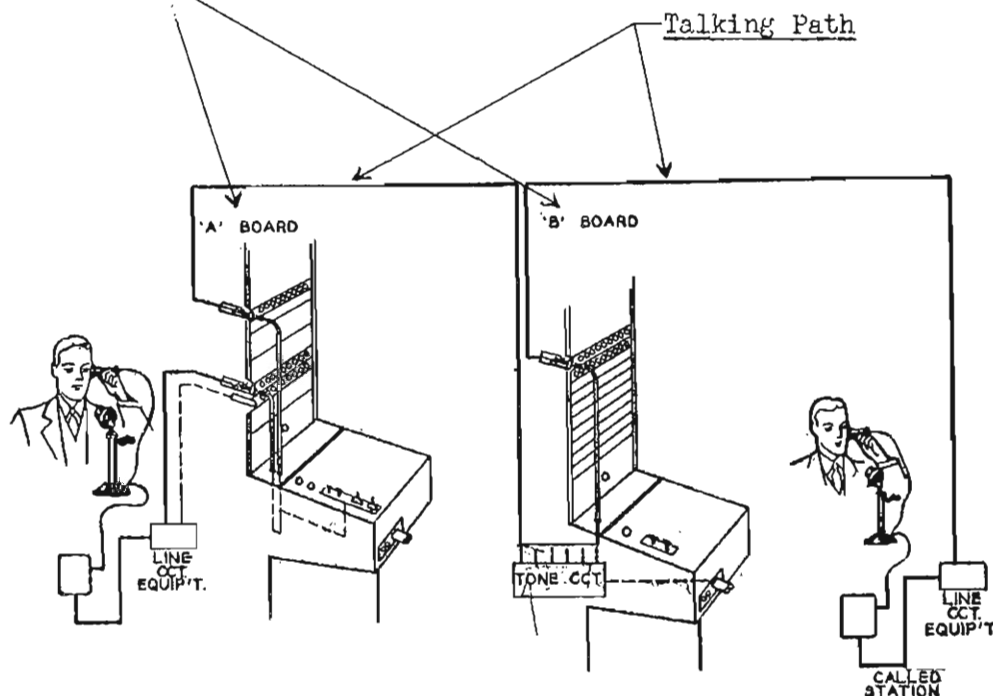
<u>CONTENTS</u>	<u>Page</u>
General Switching Plan	132
Comparison of Panel Dial and Manual Systems	134
Panel Dial Selector Frames	138
Panel Dial Apparatus	140
Comparison of a Manual Call to a Panel Dial Call	144
Manual System - Intraoffice and Interoffice Calls	154
Panel Dial System - Intraoffice and Interoffice Calls	155
Path of a Call from a Manual Subscriber to a Panel Dial Subscriber	156
Path of a Call from a Panel Dial Subscriber to a Manual Subscriber	157
Routing Panel Dial Calls Through the Office Selector Frame	158
Equipment Required for Handling Panel Dial Traffic	159

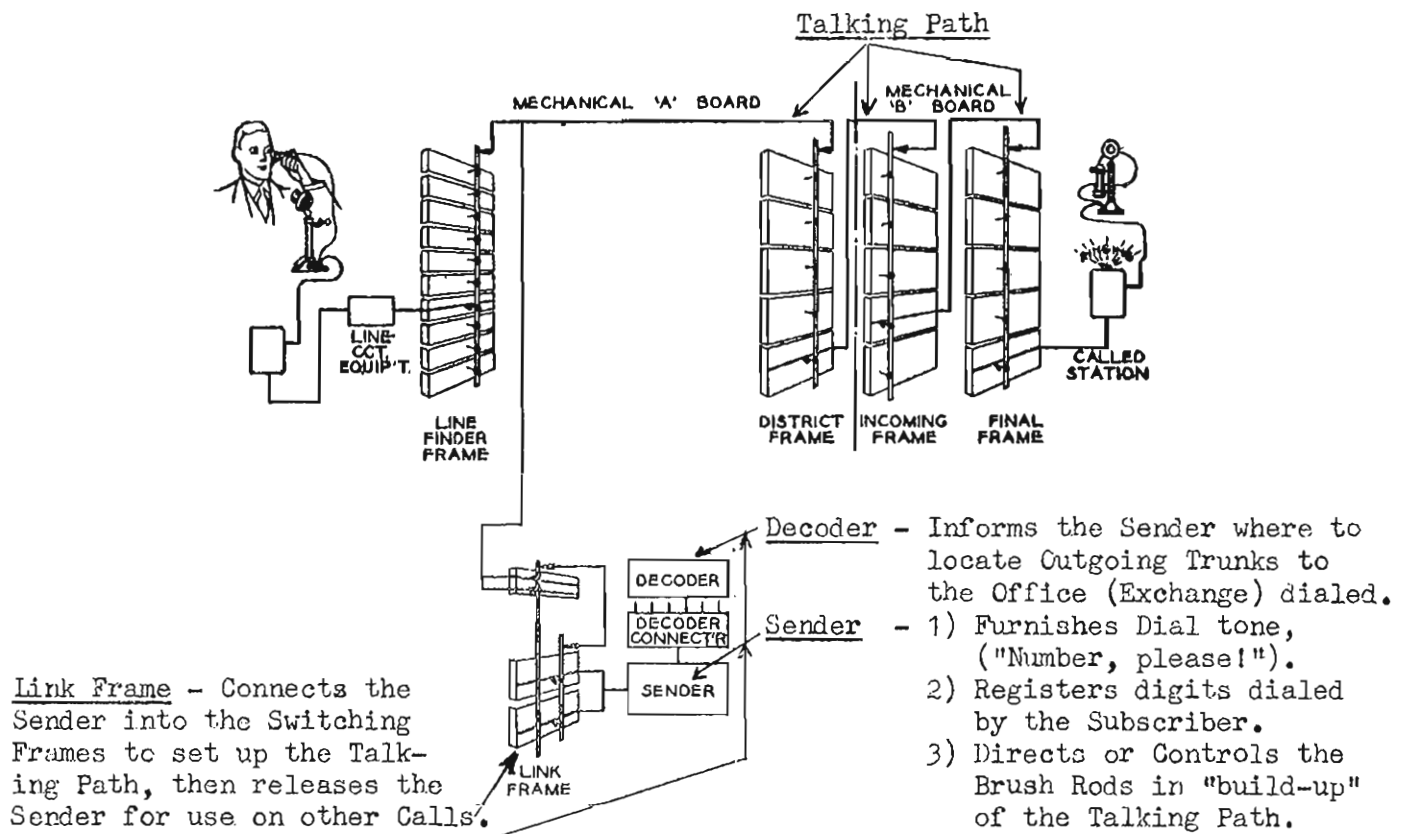
THE PANEL DIAL SWITCHING SYSTEM

Panel Dial Subscriber Lines and Trunks connect to flat "panel-shaped" Multiple Banks, resembling door panels. Multiple Brushes mounted on Elevator or Brush Rods move vertically over panels of Bank Terminals. Brush Rods are driven up and down by electric motors (1/16 horsepower). The Panel Dial Subscriber dials into a register and control device called a SENDER, which controls the upward movement of the Brush Rods on the various Switching Frames.

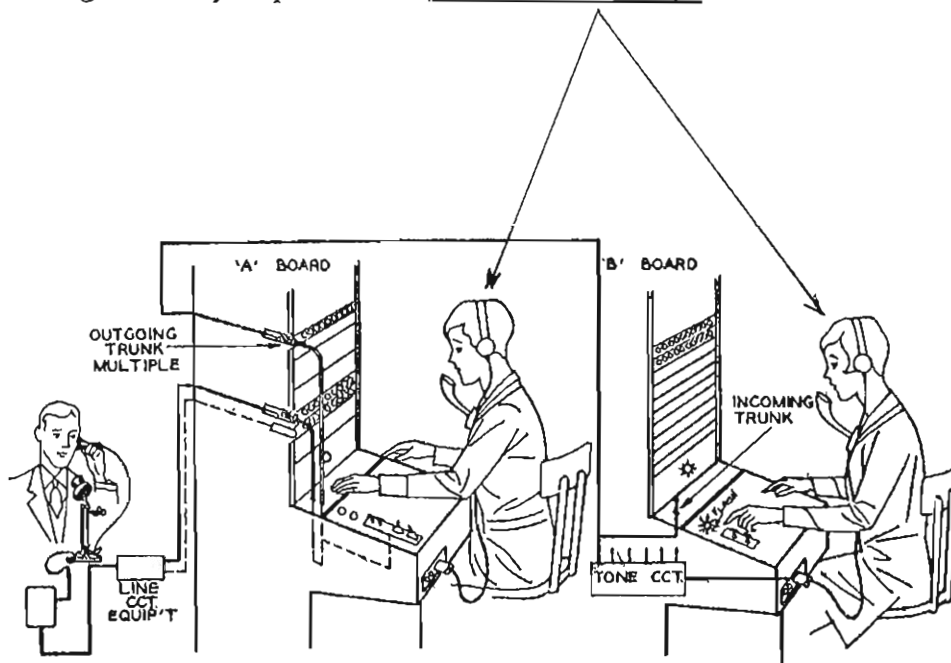


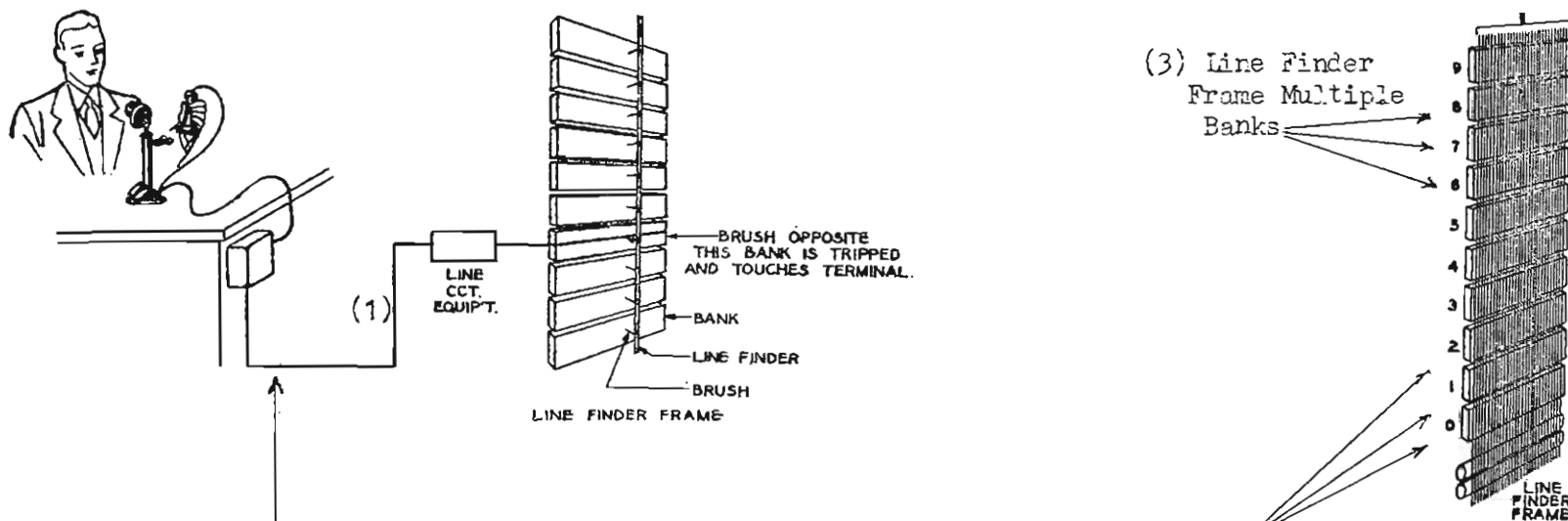
Panel Dial SWITCHING FRAMES, on which a Talking Path is built up, replace the MANUAL SWITCHBOARDS.





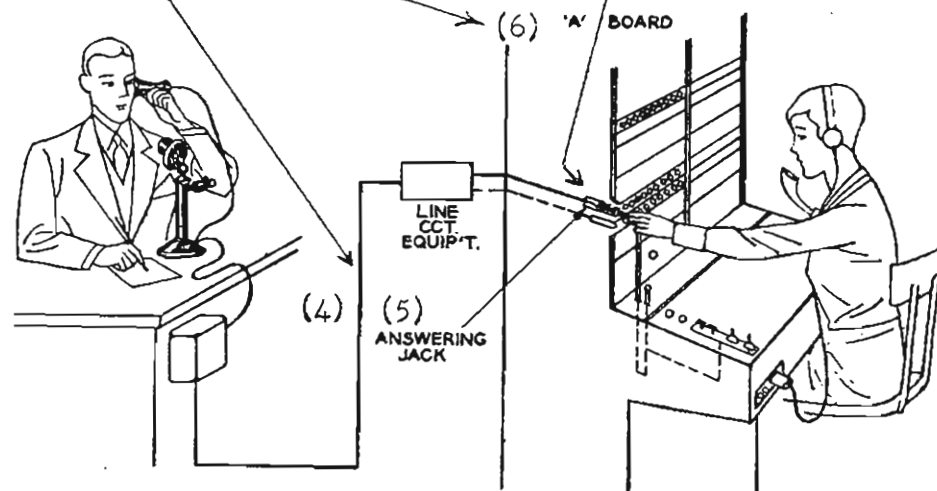
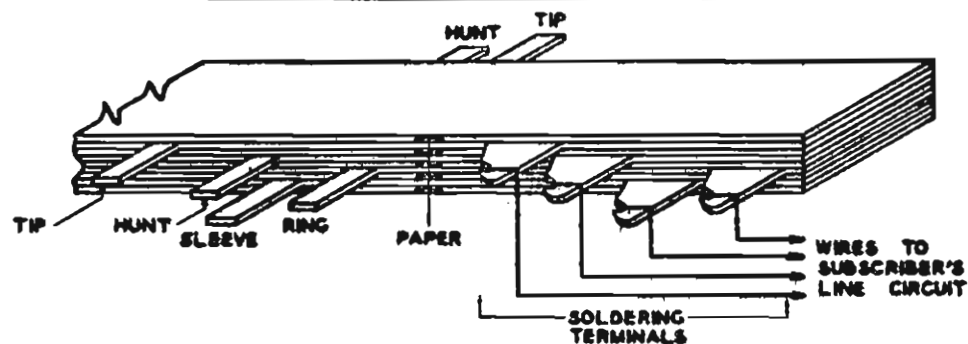
Panel Dial COMMON CONTROL FRAMES, which set up the Talking Path on the Switching Frames, replace the MANUAL OPERATOR/S.

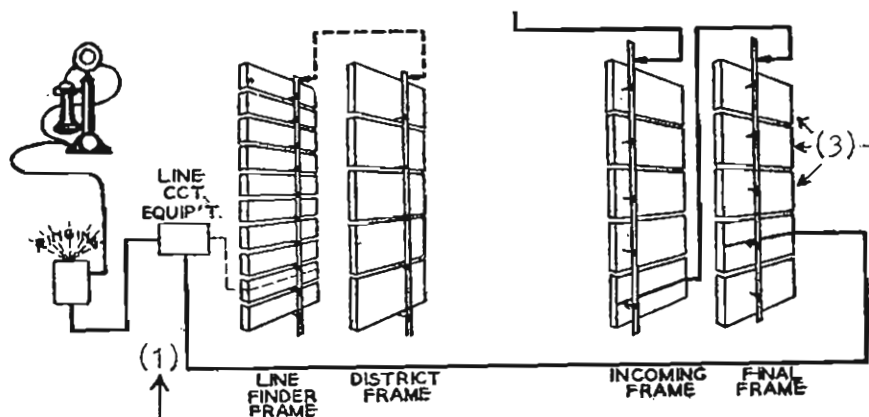




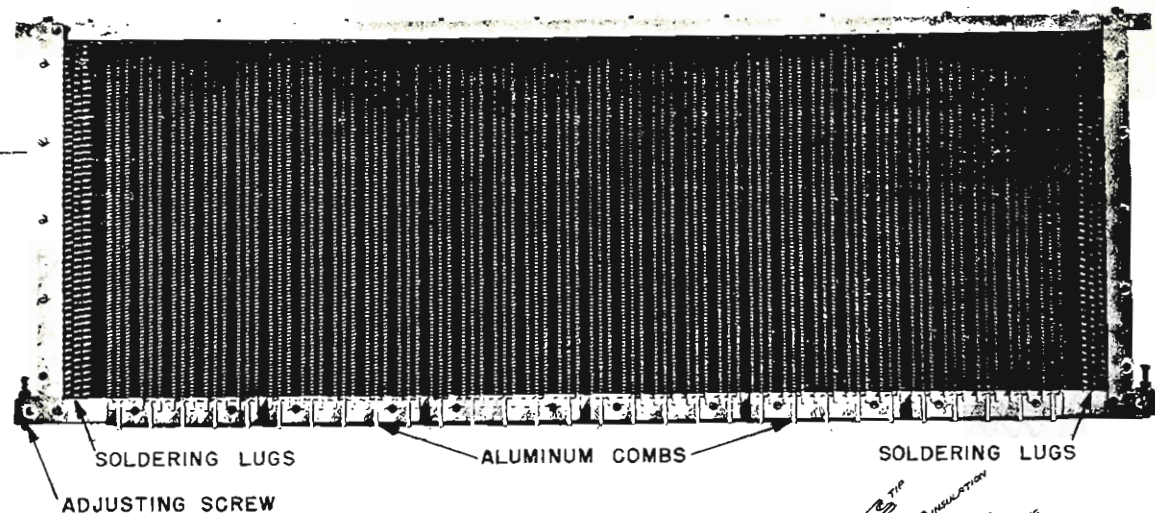
A Panel Dial Subscriber Line (1) is cabled to a set of Multiple Bank Terminal Strips (2) (T, R, S and H), in a Line Finder Frame Multiple Bank (3), corresponding to a Manual Subscriber Line (4), which is cabled to an Answering Jack (5) in the face of an "A" Switchboard (6).

(2) Multiple Bank Terminal Strips

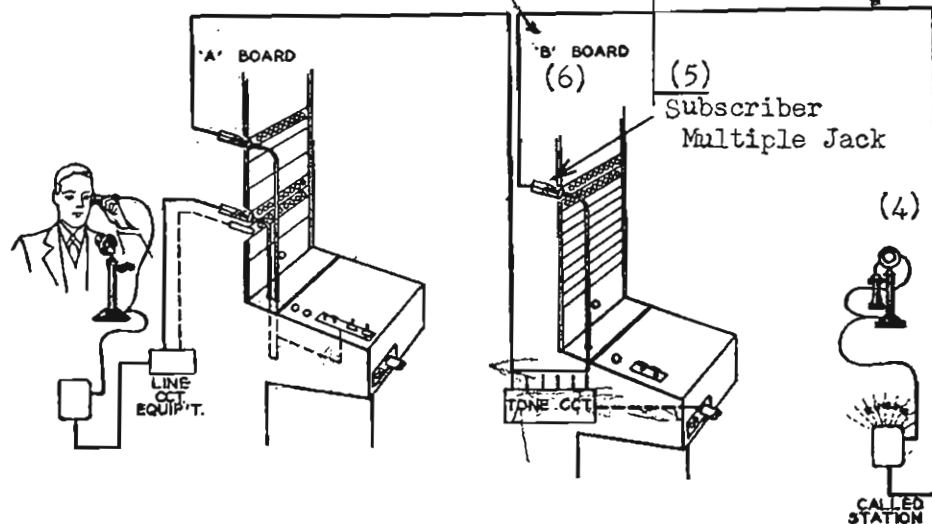
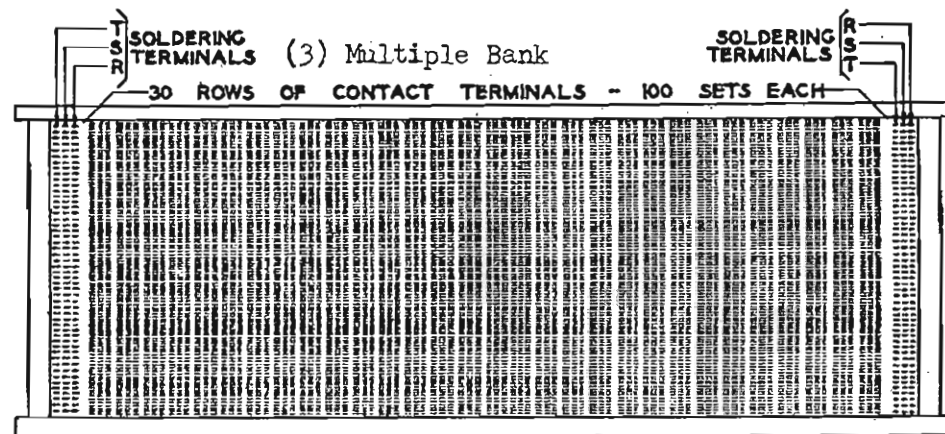
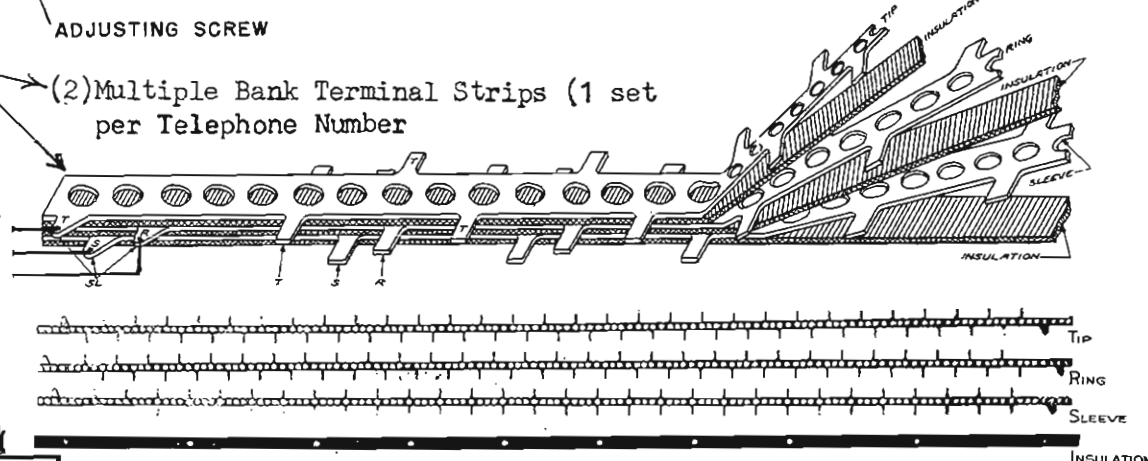


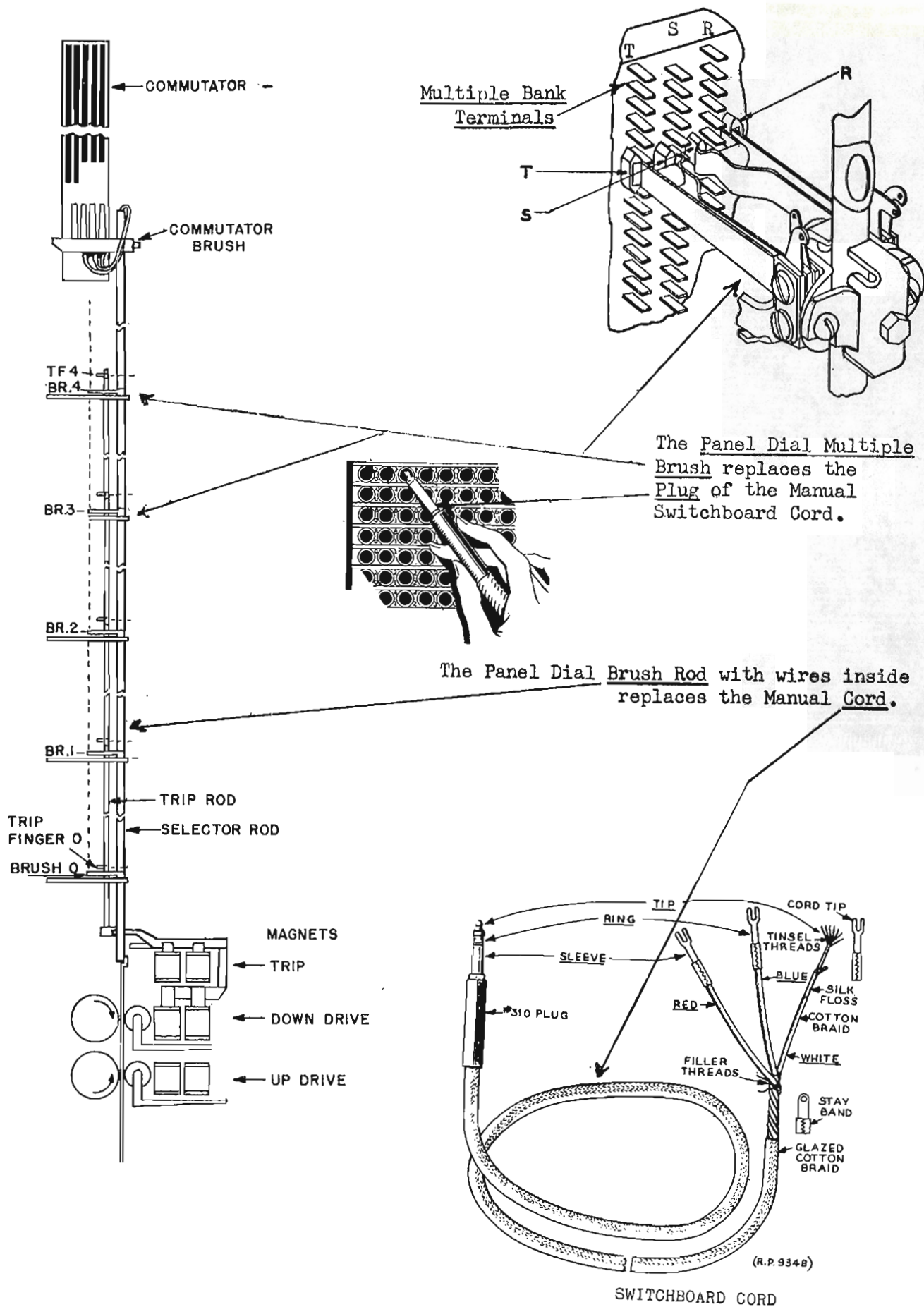


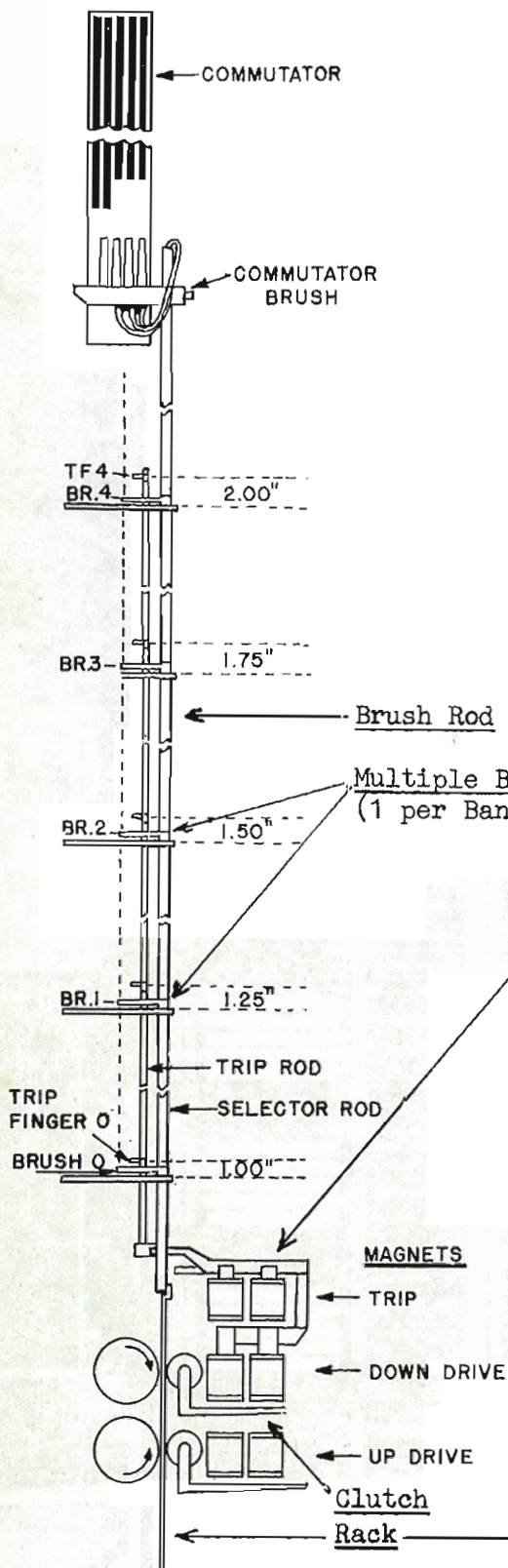
A Panel Dial Subscriber Line (1) also cables to a set of Multiple Bank Terminal Strips (2) (T, R, S) in a Final Selector Frame Multiple Bank (3), corresponding to the Manual Subscriber Line (4), which cables to a Subscriber Multiple Jack (5) in the face of the "B" Switchboard (6).



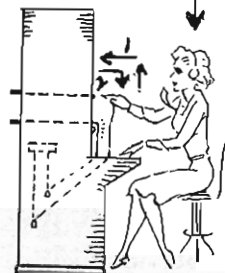
(2) Multiple Bank Terminal Strips (1 set per Telephone Number)







The Panel Dial



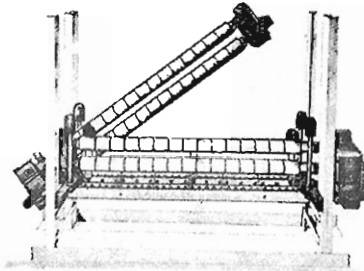
1 Making a Connection
2 Disconnecting



SECTION OF RACK FRONT VIEW

Rack Slot spacing corresponds to the spacing between adjacent Multiple Bank Terminals (approximately 1/8-inch vertical spacing), so that the Pawl drops into the Rack Slot to position the tripped Multiple Brush Shoes directly opposite that set of Bank Terminals in any one of the Multiple Banks.

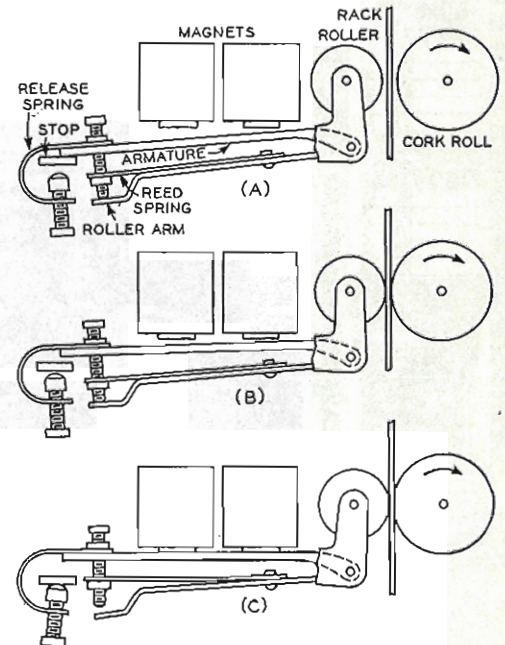
Vertical Column of Multiple Bank Terminals (T, S & R) for each Brush Rod.



Down Drive
Up Drive

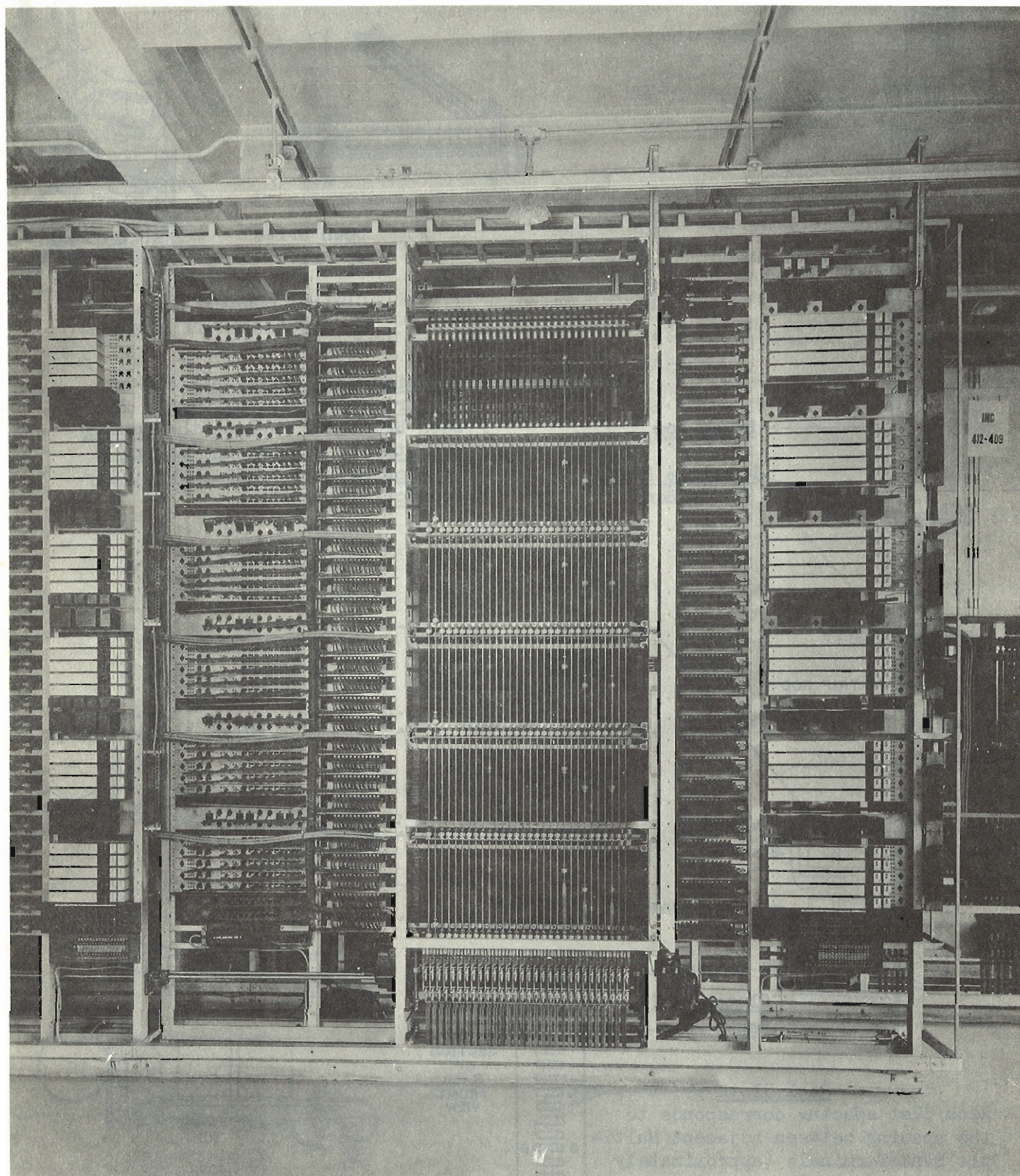
Clutch, mounted on Friction Roll Drive Unit.

The Panel Dial Friction Roll Drive Unit and an Electrically Operated Clutch for each Brush Rod replace the Manual Operator in putting up (making a connection) and taking down (disconnecting) Cords.



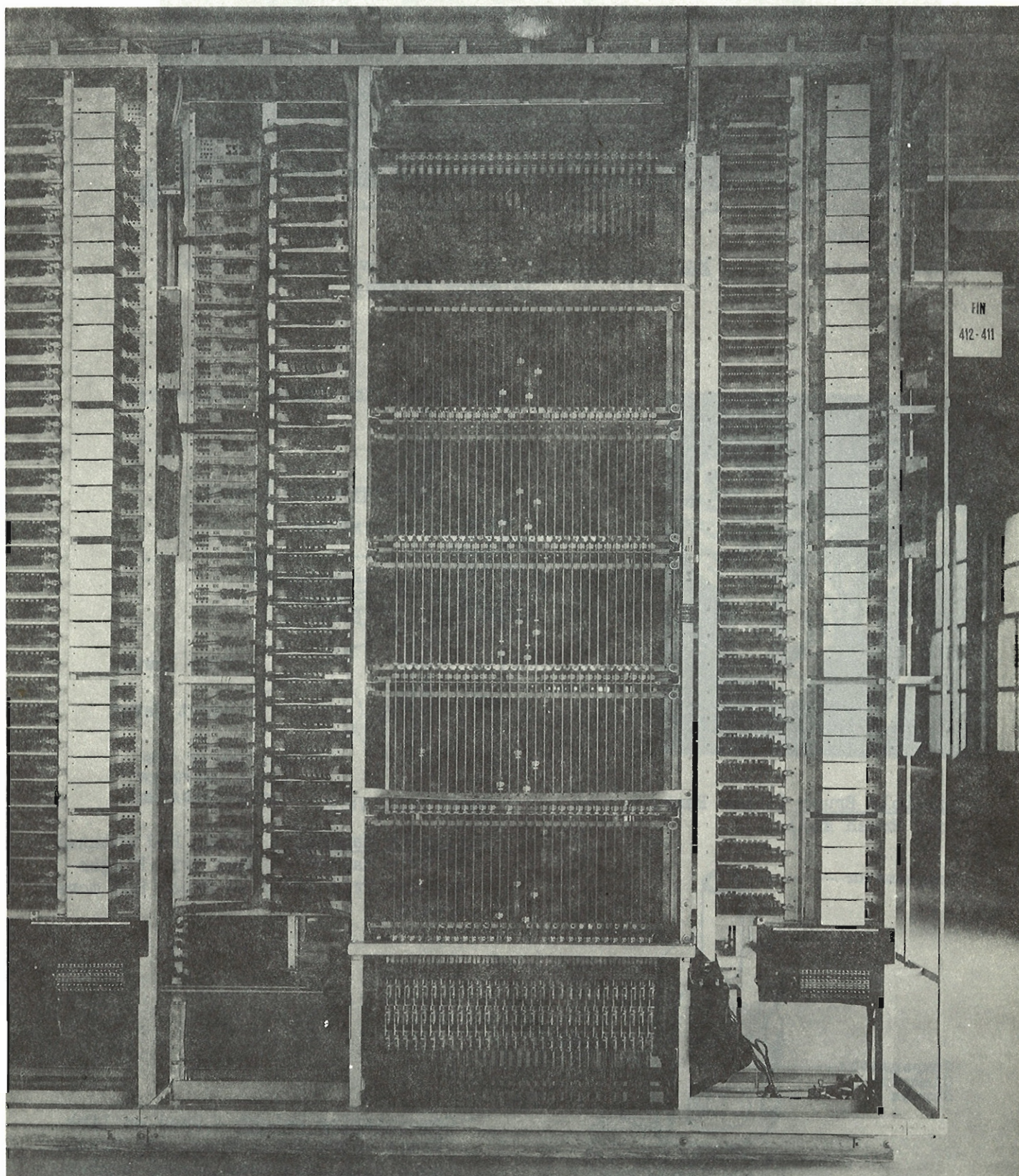
Clutch Magnet

(A) Normal
(B) Partially Operated
(C) Fully Operated



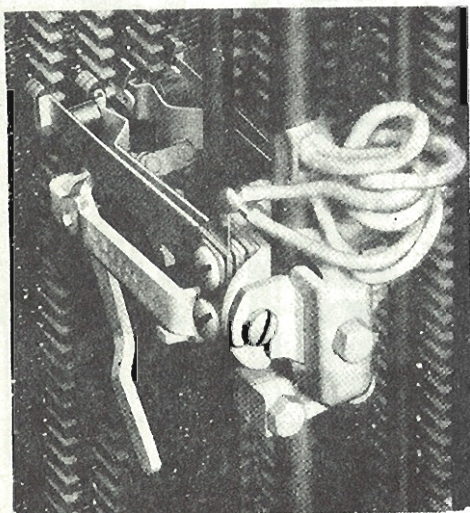
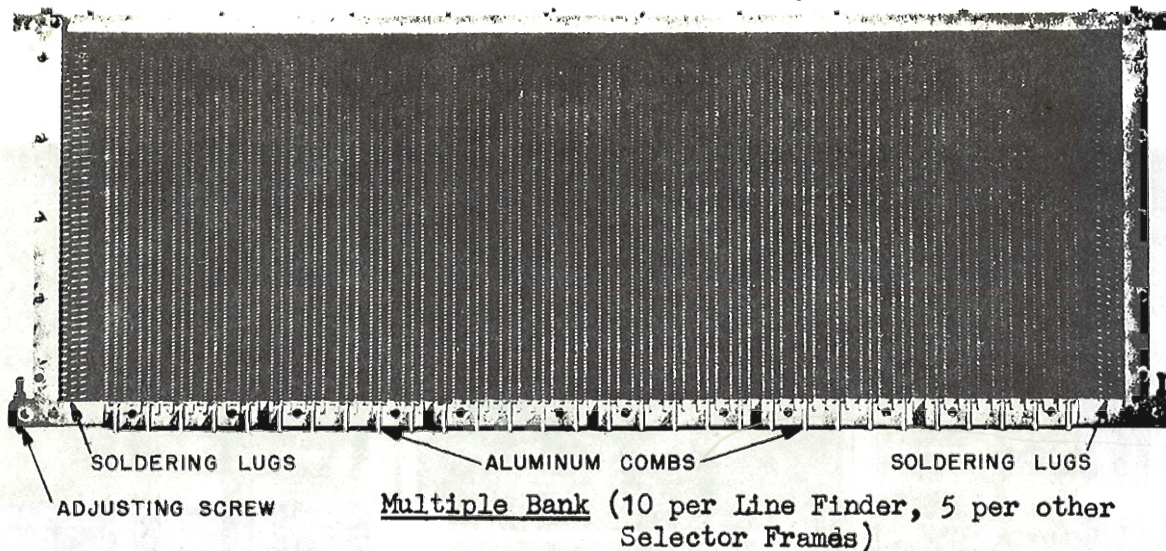
INCOMING SELECTOR FRAME -WABASH OFFICE

166322

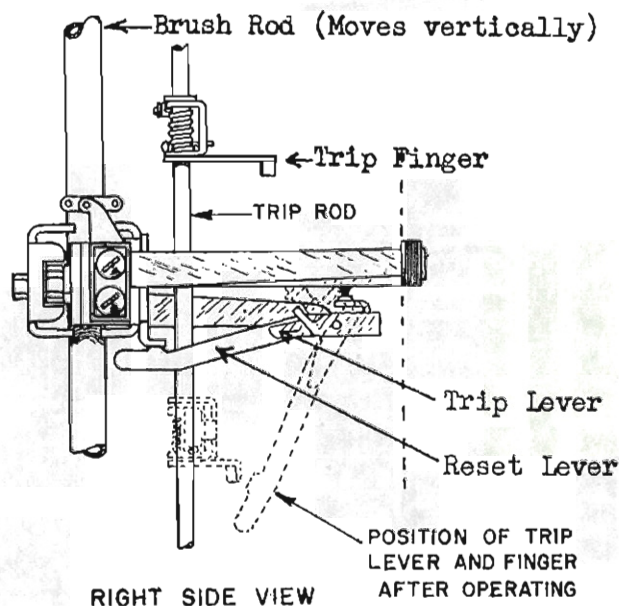


FINAL SELECTOR FRAME-WABASH OFFICE

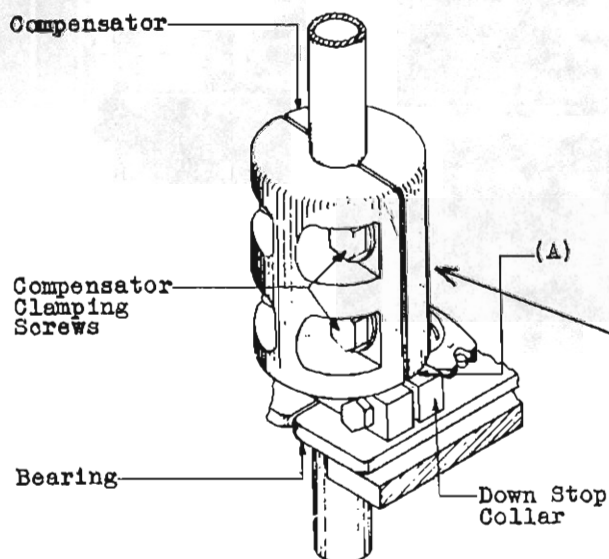
166320



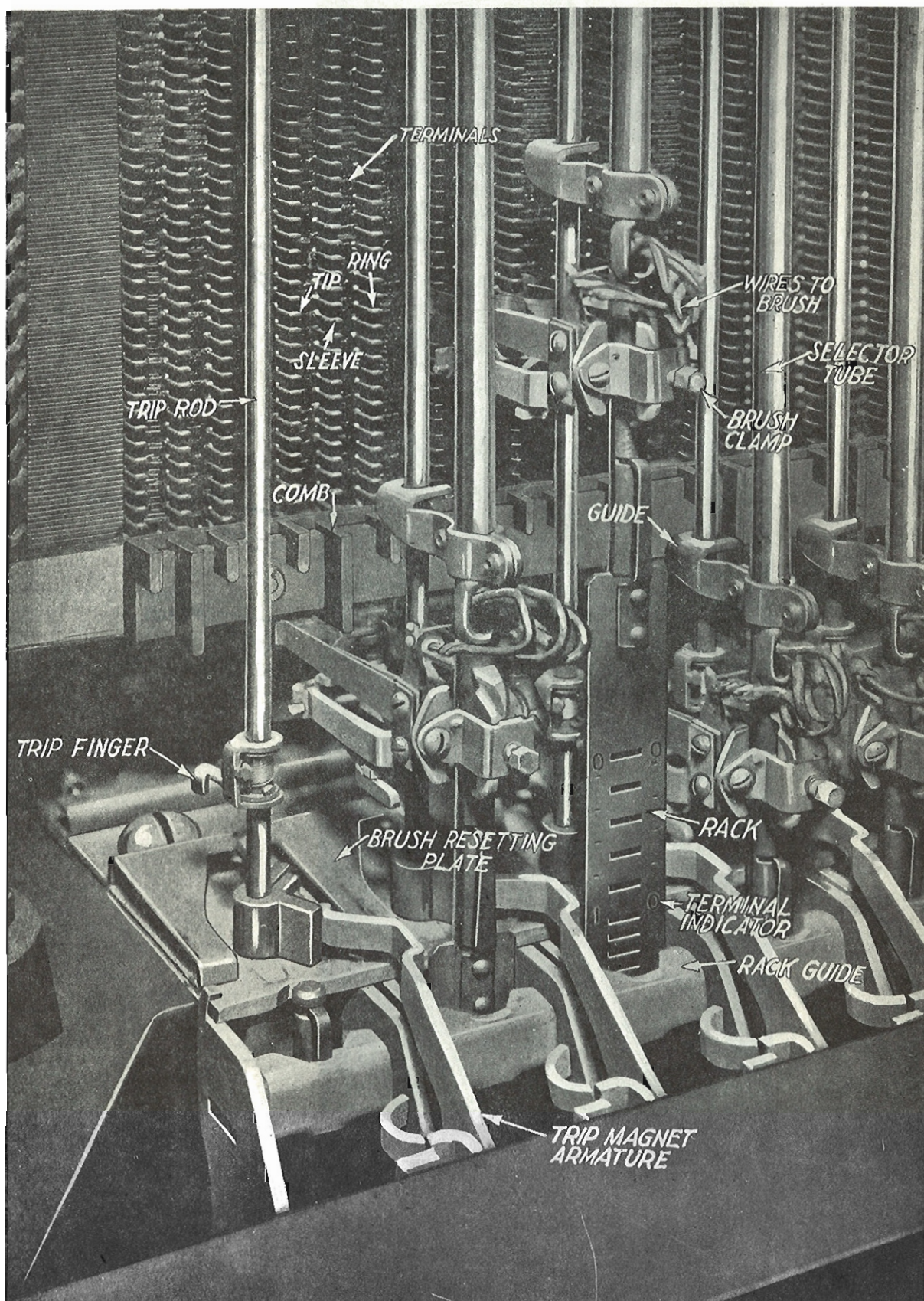
Multiple Brush (1 per Bank, per Brush Rod)



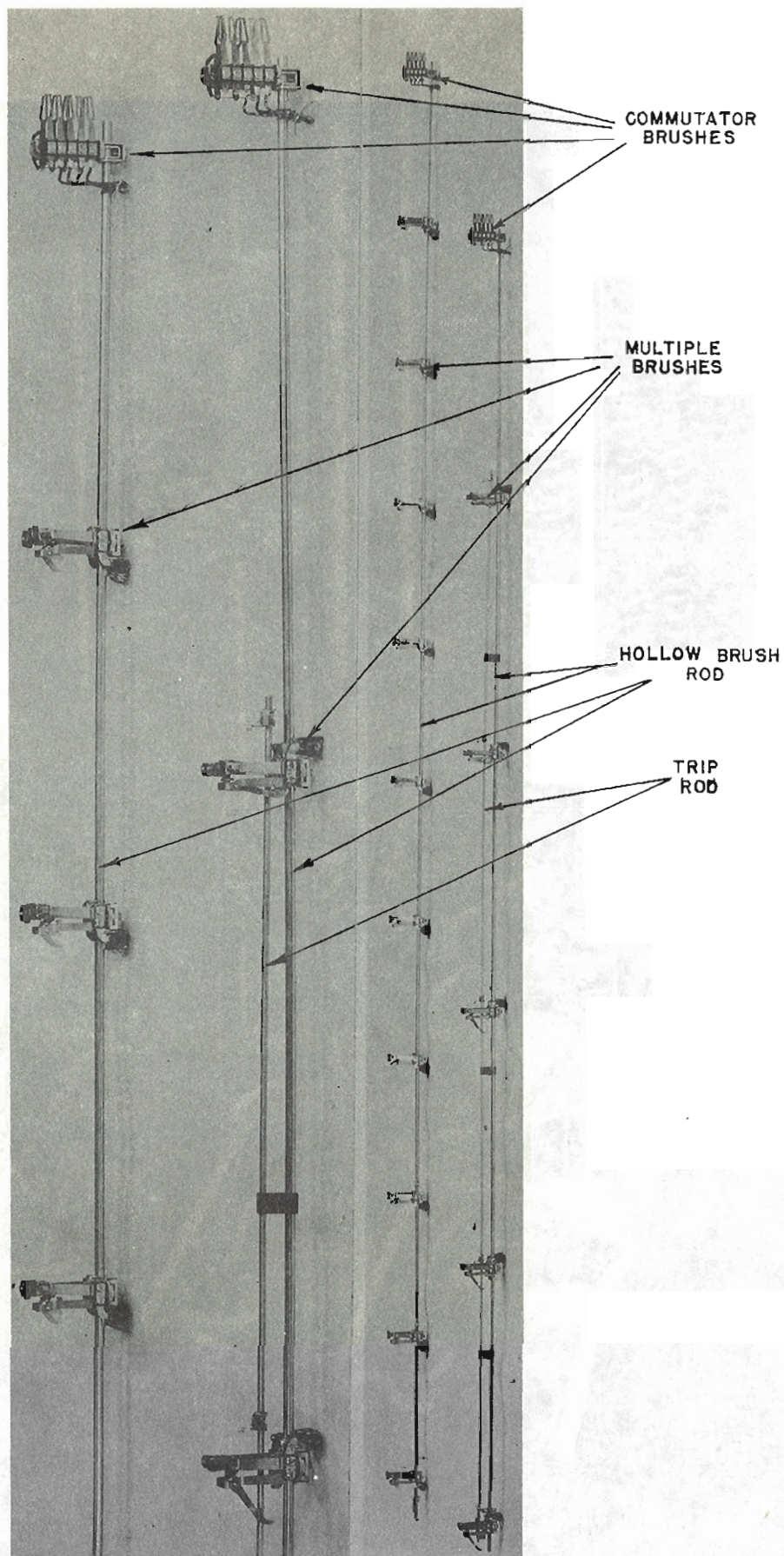
Tripping Mechanism - Trip Rod rotated by Trip Magnet so that Trip Finger engages Trip Lever as Brush Rod moves upward.



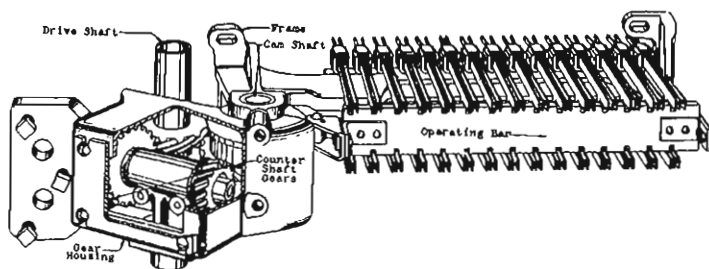
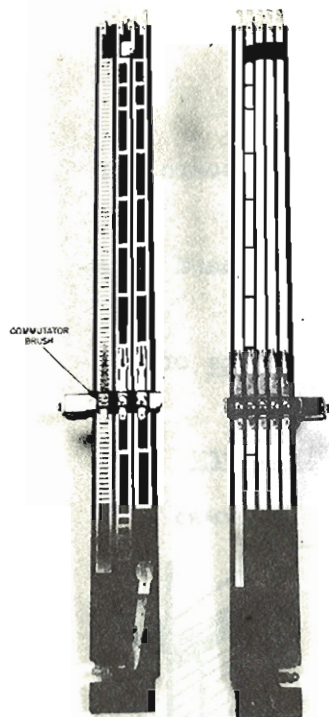
Compensating Weight - Used on Link Frame short Brush Rods, and Brush Rods with less than normal number of Multiple Brushes.



Panel Type Selecting Mechanism

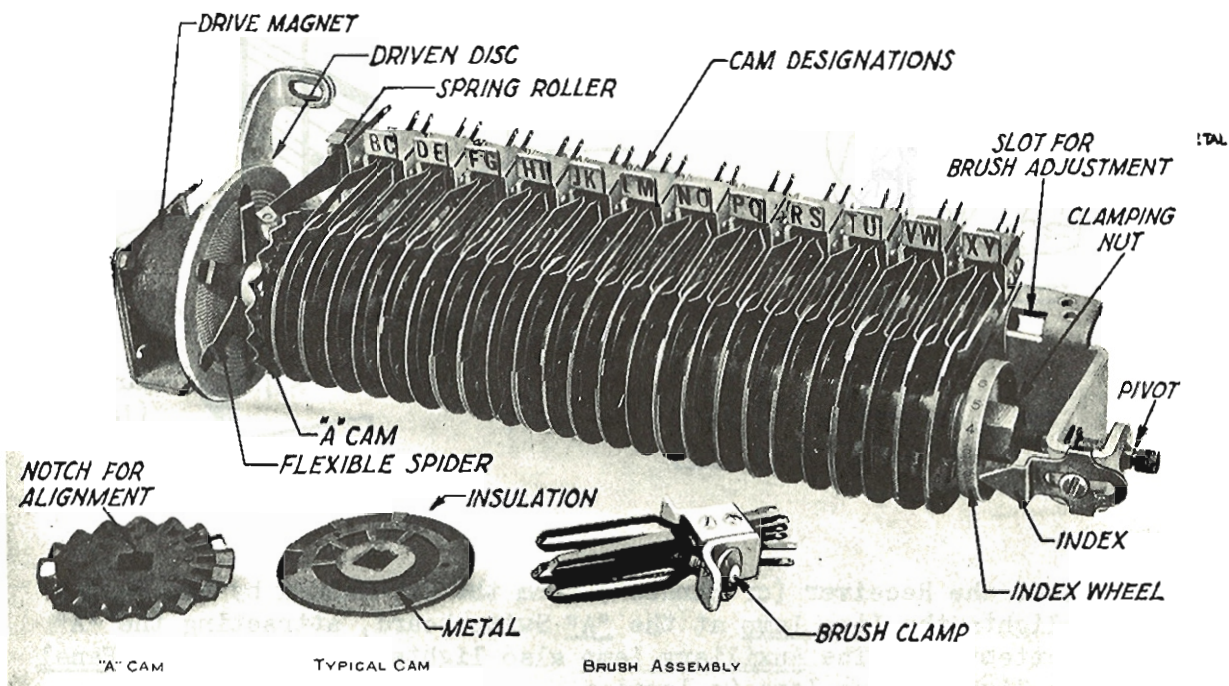
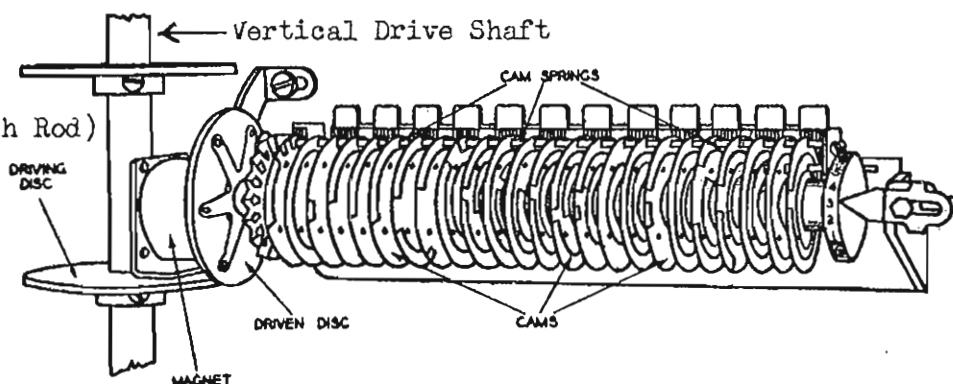


BRUSHES AND BRUSH RODS



Reciprocating Bar Interrupter (Timer) - For opening and closing circuits, such as interrupting Dial Tone to make Busy Tone

Commutator (1 per Brush Rod)

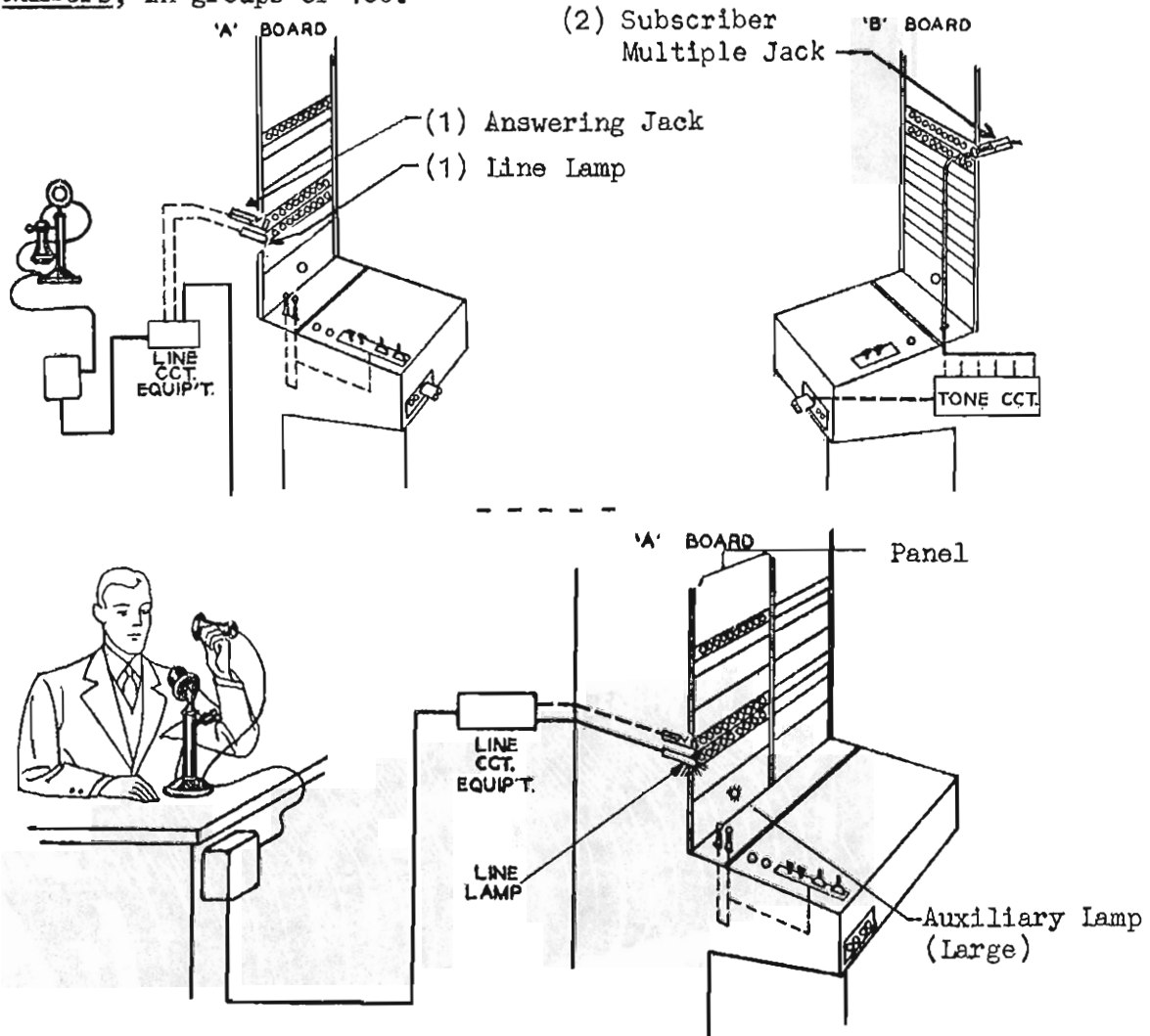


Sequence Switch (Power Driven Relay, driven off Vertical Drive Shaft)

METHOD OF HANDLING A CALL BETWEEN TWO MANUAL SUBSCRIBERS

In the Manual System, a Subscriber Line is cabled to:

- 1) An Answering Jack and Line Lamp in the face of the "A" Switchboard for originating calls.
 - 2) A Subscriber Multiple Jack in each Section of the "B" Switchboard Line-up for terminating calls.
- a) A separate Switchboard Lineup is furnished for each Exchange or Office Unit (Lincoln, Metropolitan, North, etc.).
 - b) Subscriber Multiple Jacks are arranged according to Directory Numbers, in groups of 100.

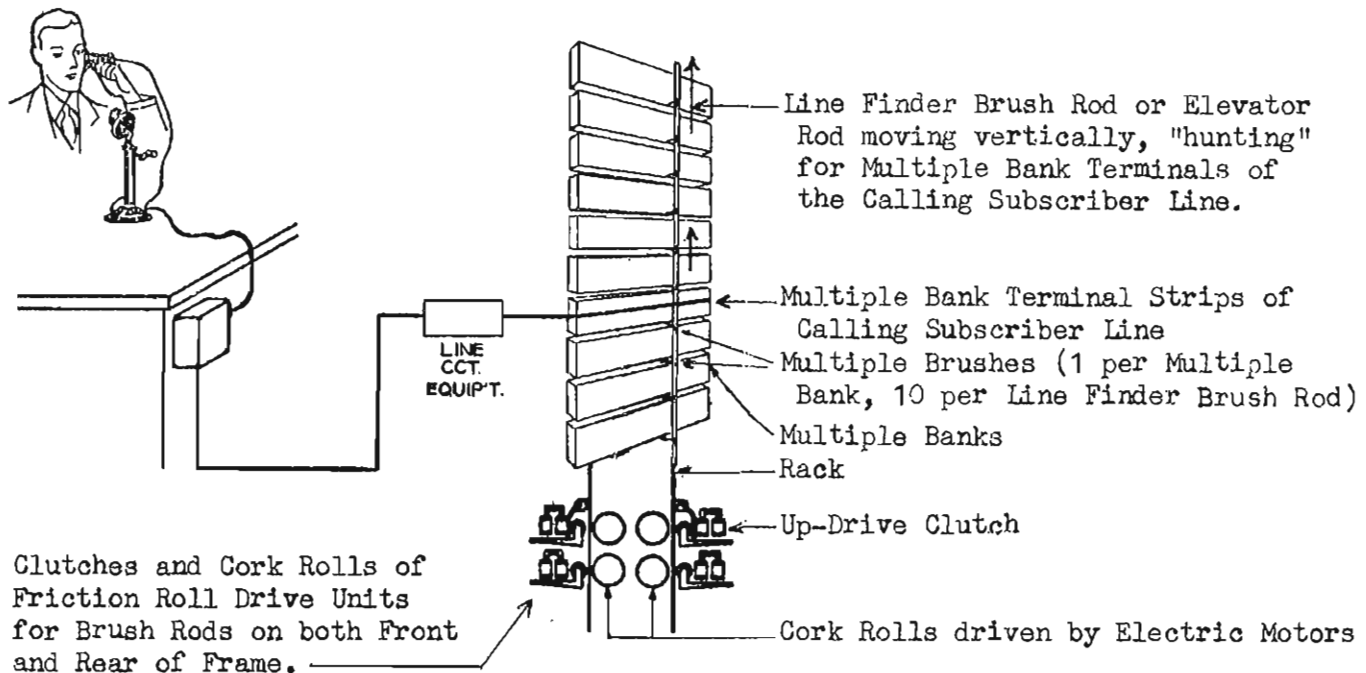
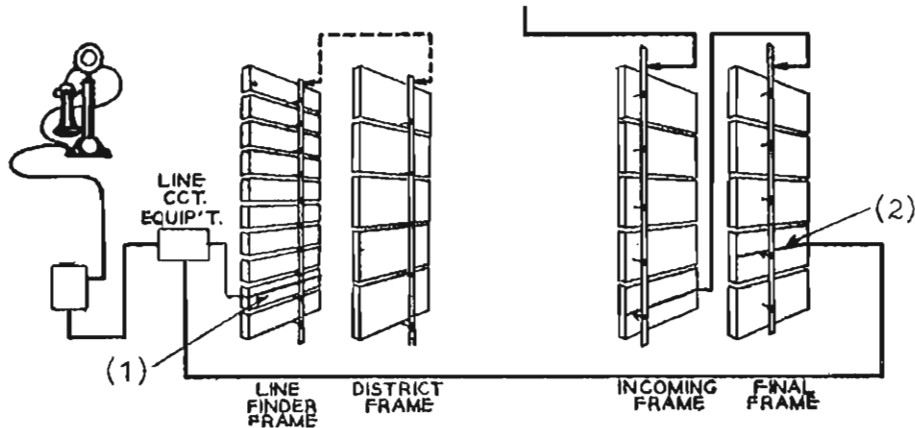


The removal of the Receiver (or Handset) from the Switchhook by the Manual Subscriber lights the Line Lamp at the "A" Switchboard, attracting the "A" Operator's attention. The Auxiliary Lamp also lights to indicate the Panel in which the lighted Line Lamp is located.

METHOD OF HANDLING A CALL BETWEEN TWO PANEL DIAL SUBSCRIBERS

In the Panel Dial System, a Subscriber Line is cabled to:

- 1) A Set of Multiple Bank Terminal Strips (T, R, S and H - "Hunt") in a Line Finder Frame for originating Calls.
- 2) And a Set of Multiple Bank Terminal Strips (T, R, S) in a Final Selector Frame for terminating Calls. Subscriber Line appearances on Final Selector Frames are arranged according to Directory Numbers.



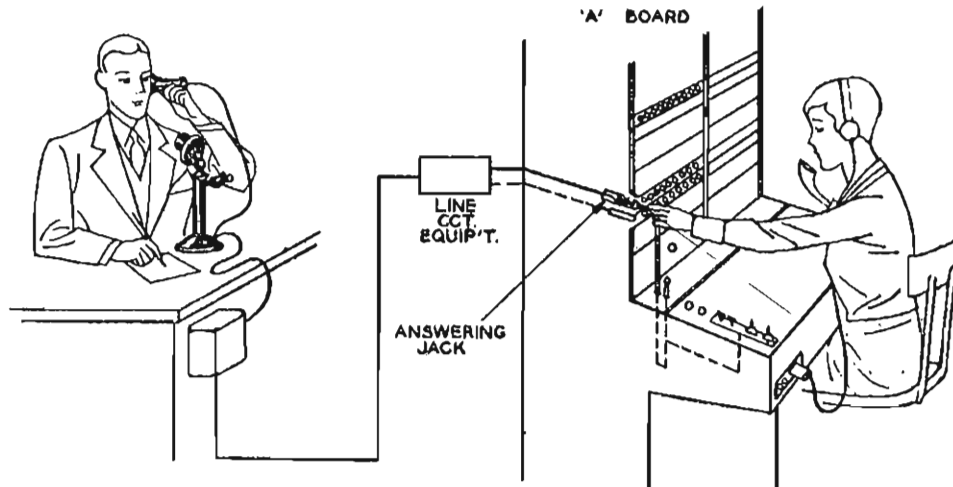
The removal of the Receiver or Handset from the Switchhook (Handset OFF Switchhook) by the Panel Dial Subscriber:

- 1) Energizes the Up-Drive Clutch of one of the Idle Line Finder Brush Rods on his Line Finder Frame, and
- 2) Trips the Multiple Brush (one of 10) for the Multiple Bank in which the Calling Subscriber Line appears.

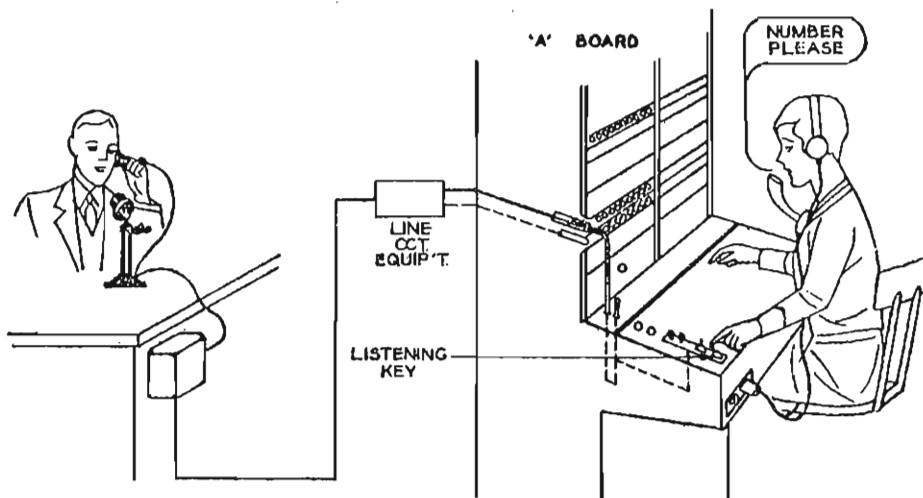
The Line Finder Brush Rod corresponds to the Manual "A" Switchboard Answering Cord. The Panel Dial Multiple Brush replaces the Answering Cord Plug.

MANUAL SYSTEM

The "A" Operator connects to ("finds") the Calling Subscriber Line by selecting an Idle Cord Circuit, and inserting the Answering Cord Plug into the Answering Jack, extinguishing the Line Lamp and Auxiliary Lamp.

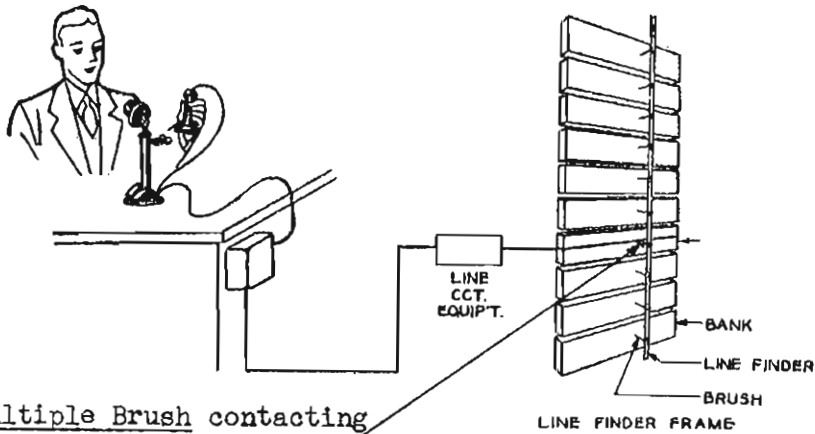


- - - - -



The "A" Operator connects her Telephone Set to the Answering Cord by operating the Listening Key, and says, "Number, please!"

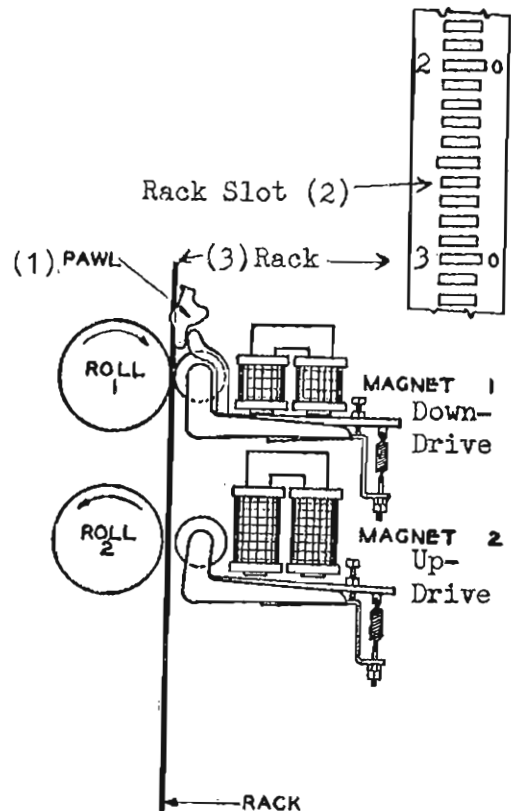
PANEL DIAL SYSTEM



Multiple Brush contacting Multiple Bank Terminals, corresponding to Manual Answering Cord Plug inserted in Answering Jack of the "A" Switchboard

The Up-Drive Clutch of the Line Finder Brush Rod is de-energized when the Multiple Brush Shoes contact ("find") the Multiple Bank Terminals of the Calling Subscriber Line.

A Pawl (1) engages a Slot (2) in the Rack (3) to hold the Brush Rod in position.



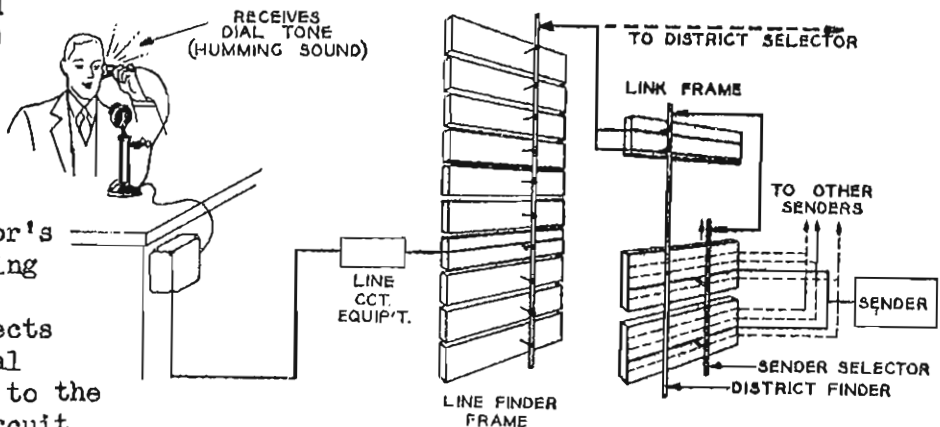
1) The Line Finder Brush Rod (Mechanical Cord Circuit) has been pre-selected by the District Finder of a Link Circuit on the Link Frame.

2) The Link Circuit corresponds to the "A" Operator's Telephone Set and Listening Key.

3) The Link Circuit now selects an Idle Sender (Mechanical Operator), connecting it to the Line Finder Brush Rod Circuit.

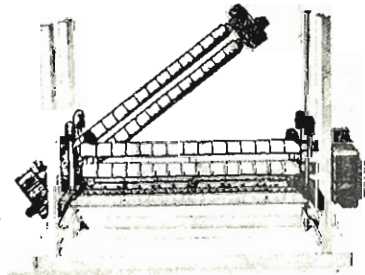
4) The Sender transmits Dial Tone ("Number, please!") to the Calling Subscriber, indicating the Sender (Mechanical Operator) is ready to receive the Called Subscriber Number.

5) Each Line Finder Brush Rod is permanently cabled to a mate Brush Rod on a District Selector Frame; the combination is known as a "Line Finder-District Selector."

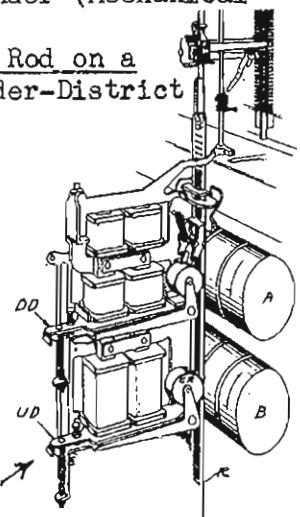


The Friction Roll Drive Unit and Electrically operated Clutches replace the Manual Operator's Hand and Arm movements in putting up and taking down connections at the Switchboards.

Friction Roll Drive Unit

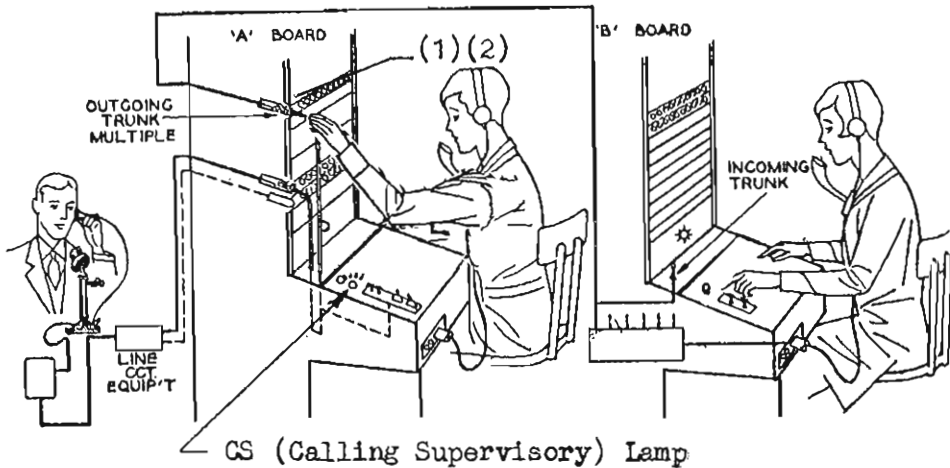
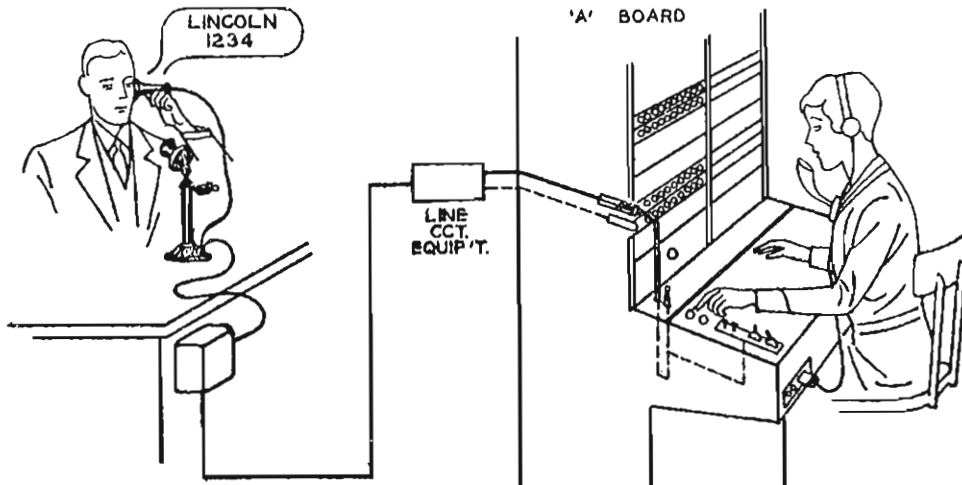


Electrically Operated Clutch



MANUAL SYSTEM

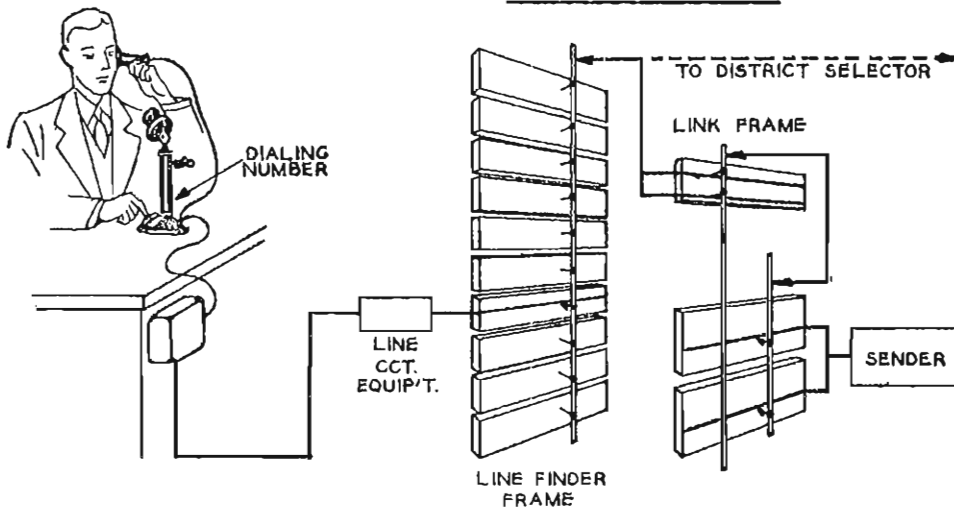
The Manual Calling Subscriber passes verbally to the "A" Operator the Central Office Name or Code and the 4-digit Called Subscriber Number (0000 to 9999 - 10,000 Telephone Numbers or Subscriber Terminals).



When the "A" Operator hears the Central Office Name or Code and the Called Subscriber Number:

- 1) She tests for an Idle Outgoing Trunk to the Called Office by touching the Tip of the Calling Cord Plug to the Sleeve of the Outgoing Trunk Jack.
 - a) A "click" in her Headset indicates a Busy Trunk;
 - b) No "click" indicates an Idle Outgoing Trunk.
- 2) The "A" Operator inserts the Calling Cord Plug into an Idle Outgoing Trunk Jack, lighting the CS (Calling Supervisory) Lamp,

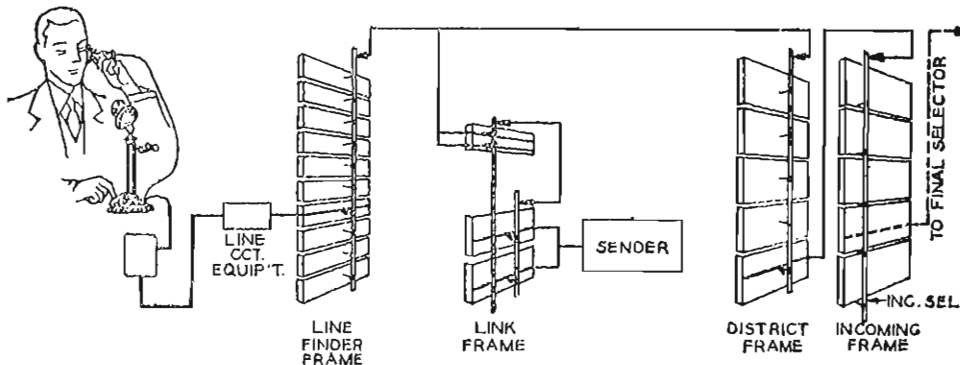
PANEL DIAL SYSTEM



The Panel Dial Subscriber dials the Office Code and 4-digits of the Called Telephone Number, which are stored in Relay Digit Registers in the Sender (Mechanical Operator).

As soon as the Panel Dial Calling Subscriber has dialed the Office Code, the Sender seizes an Idle Decoder.

- 1) The Sender transmits the Office Code to the Decoder.
- 2) The Decoder sets up relay combinations in the Sender to inform the Sender the location on the District Selector Frame Multiple Banks of the Outgoing Trunk Group.
- 3) The Decoder is then released by the Sender to service other calls.
- 4) The District Selector Frame Multiple Banks correspond to the Outgoing Trunk Multiple on the Manual "A" Switchboard.
- 5) The District Selector Frame Brush Rod corresponds to the Calling Cord, and the Multiple Brush to the Plug of the Manual "A" Switchboard.



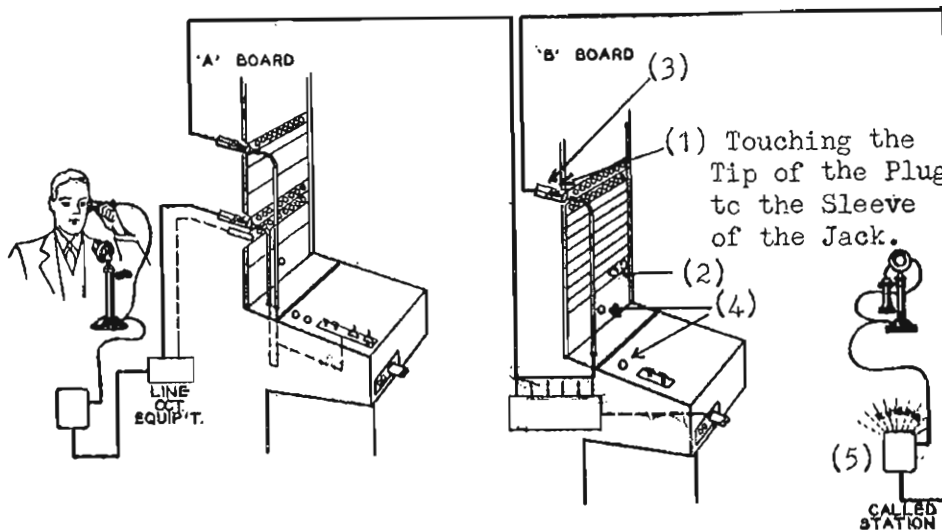
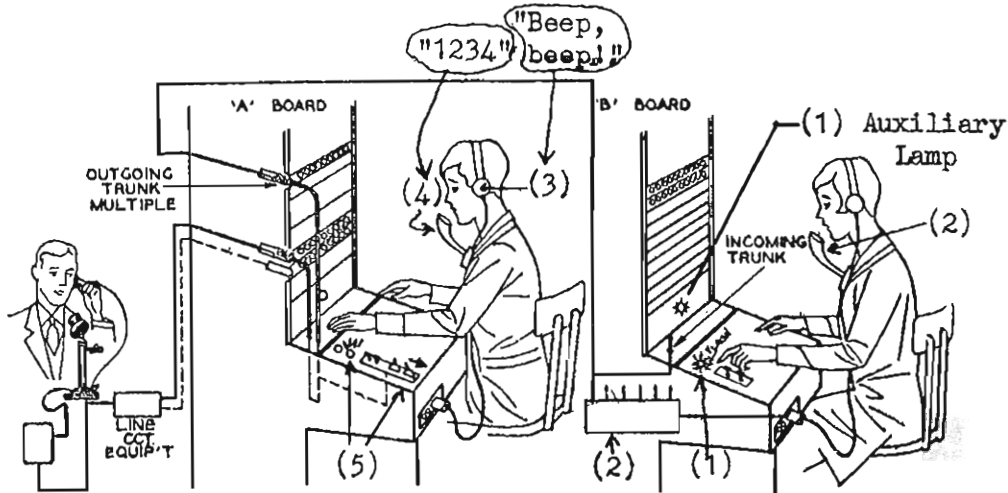
With information obtained from the Decoder, the Sender causes the District Selector Frame Brush Rod to be driven up, so that the Shoes of one of the 5 Multiple Brushes connect with the Terminals of an Idle Outgoing Trunk to the Called Office. Three

steps are taken in driving the District Selector Rod vertically:

- 1) District Brush Selection - The first upward movement - 1" to 2" - positions one of the 5 Multiple Brushes for tripping.
- 2) District Group Selection - The second upward movement trips the selected Multiple Brush, and the Up-Drive Clutch remains energized until the Multiple Brush Shoes contact the First Trunk in the Group terminating in the Called Office. This completes District Selections by the Sender.
- 3) Hunting - If the First Trunk in the Group is Busy, the District Selector Circuit (no longer under control of the Sender) hunts up over the remaining Trunks in the Group, stopping when the Multiple Brush Shoes contact the first Idle Set of Multiple Bank Terminals.

MANUAL SYSTEM

- 1) As soon as the "B" Operator is idle (having completed all other calls assigned ahead of this one), the Trunk Supervisory (Guard and Disconnect) Lamp for the selected Trunk (Outgoing at the "A" Switchboard; Incoming at the "B" Switchboard) flashes 60 times per minute to attract the "B" Operator's attention. The Auxiliary Lamp (1 per each group of 10 Cords) also glows steadily.
- 2) The "B" Operator's Telephone Set is connected automatically to the Incoming Trunk with the flashing Guard (Trunk Supervisory) Lamp.
- 3) Two spurts of Tone (Order Tones - "Beep, beep!") are placed on the Trunk.
- 4) Upon hearing the Order Tones, the "A" Operator repeats the Called Number, "1234," to the "B" Operator.
- 5) Then the "A" Operator releases her Listening Key. The CS (Calling Supervisory) Lamp at the "A" Switchboard is still lighted.



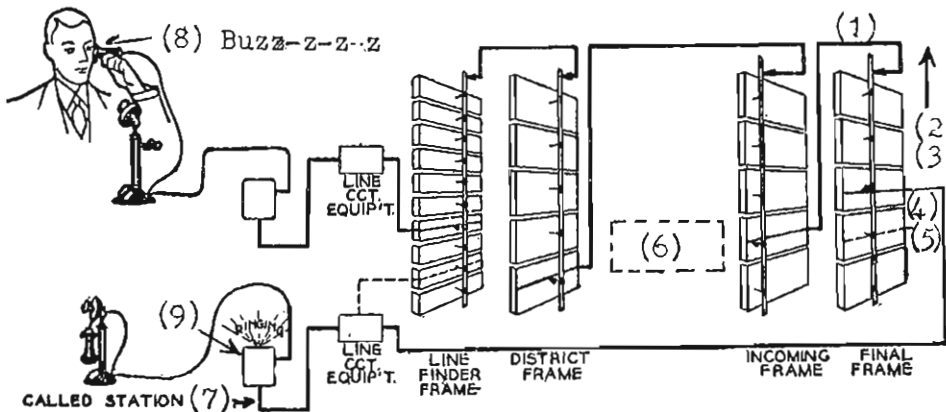
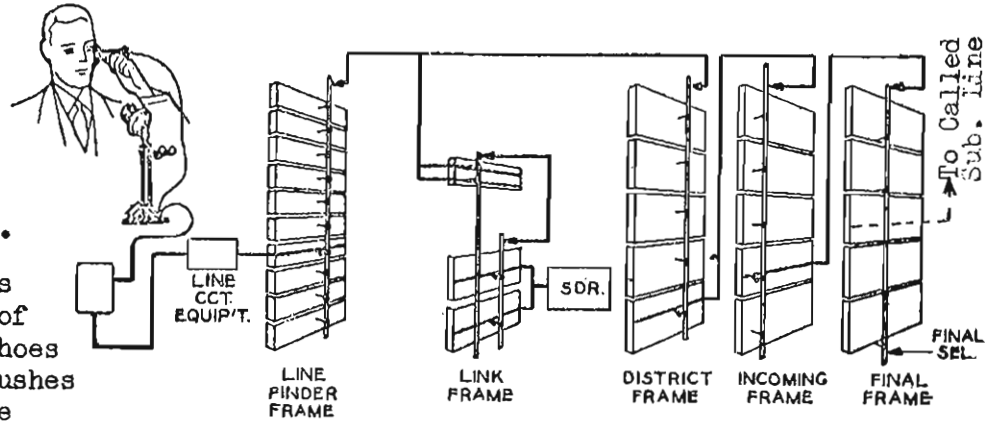
- 1) The "B" Operator makes a Busy Test of Subscriber Multiple Jack "1234."
- 2) If the Called Subscriber Line checks Busy, the "B" Operator inserts the Incoming Trunk Cord into a special Busy Back Jack.
- 3) If the Called Subscriber Line checks Idle, the "B" Operator inserts the Incoming Trunk Cord Plug into Subscriber Multiple Jack "1234."
- 4) Plugging Up the Call extinguishes the flashing Trunk Supervisory (Guard) Lamp, also the Auxiliary Lamp, and disconnects the "B" Operator's Telephone Set from the Incoming Trunk Circuit, ready for assignment to the next Call Waiting.
- 5) Ringing Current is applied automatically to the Called Subscriber Line.

PANEL DIAL SYSTEM

The selected Outgoing Trunk on the District Selector Frame Multiple Bank terminates as an Incoming Trunk on one of the Incoming Frame Brush Rods in the Called Office.

This Incoming Brush Rod is driven up, under control of the Sender, so that the Shoes of one of the Multiple Brushes contact the Incoming Frame Multiple Bank Terminals of an Idle Trunk to the Final Selector Frame on which the Called Subscriber Line appears.

Incoming Selections (IB - Incoming Brush, and IG - Incoming Group) are governed by the "thousands" digit "1" and the "hundreds" digit "2" of the Called Subscriber Number registered in the Sender.



- 1) The selected Trunk on the Incoming Selector Frame Multiple Bank terminates on one of the Brush Rods of the Final Selector Frame serving Directory Numbers 1000 to 1499, including the Called Subscriber, 1234.
- 2) This Brush Rod is driven up, under control of the Sender, so that

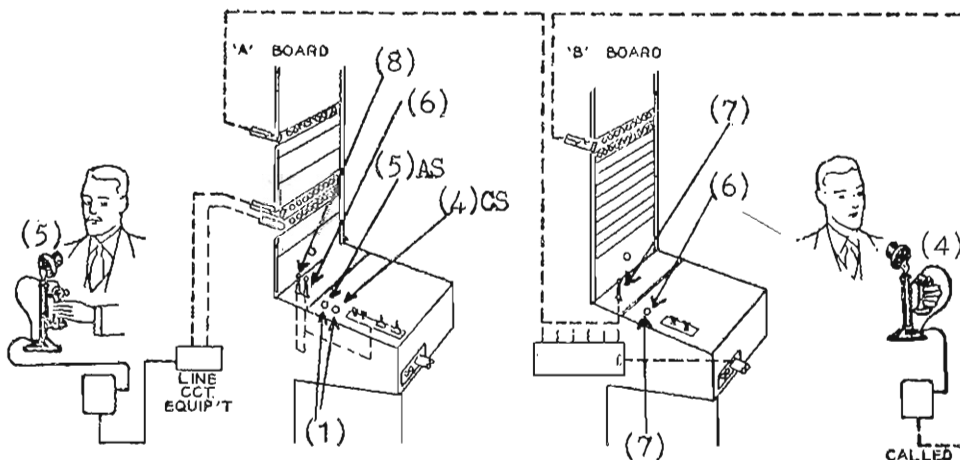
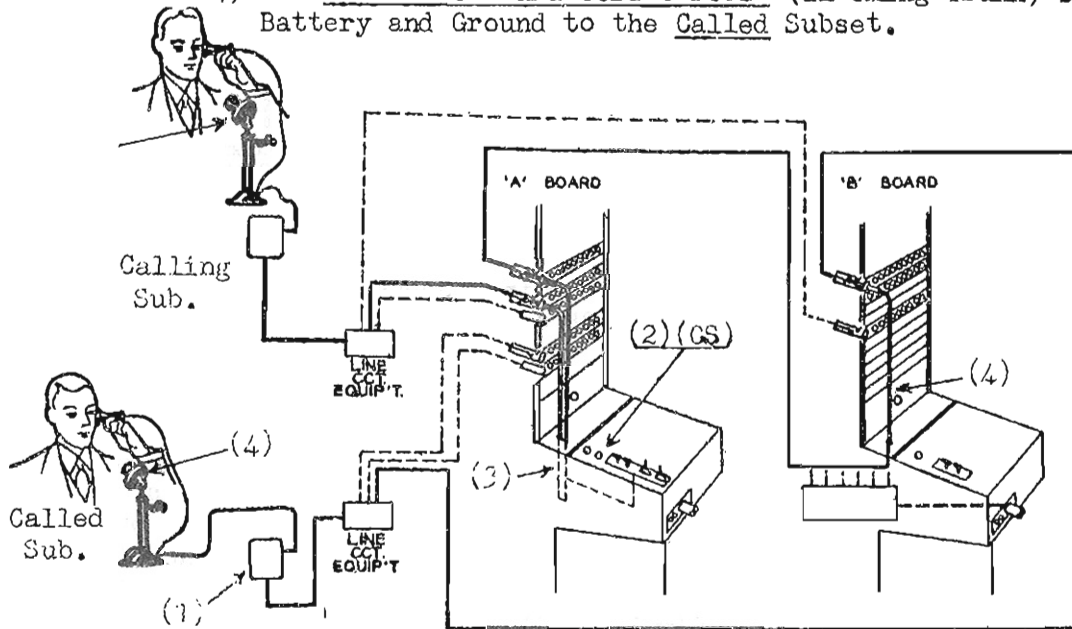
the Shoes of one of the Multiple Brushes connect to the Final Selector Frame Multiple Bank Terminals of the Called Subscriber Line. Upon "cut-through" to the Called Subscriber Line, the Link releases and the Sender restores to normal. Then the Link connects to an Idle Line Finder-District Selector Circuit, ready to handle the next call.

- 3) The "hundreds" digit "2" sets the Final Selector Frame Multiple Brush Rod for tripping (The Brush Rod is driven up, under control of the Sender, 1" off normal for tripping Brush No. 0, 1 1/4" for No. 1, 1 1/2" for No. 2, 1 3/4" for No. 3 and 2" for No. 4.) Multiple Brush No. 2 to "work" in Multiple Bank No. 2 (third up from the bottom) serving Directory Numbers 1200 to 1299.
- 4) The "tens" digit "3" causes the Final Selector Frame Brush Rod to be driven up, tripping Multiple Brush No. 2, and stopping the Brush Rod with the Multiple Brush Shoes contacting Multiple Bank Terminals (T, R, S) No. 30.
- 5) The "units" digit "4" causes the Slow-Speed Up-Drive Clutch to engage, driving the Brush Rod up so that the Multiple Brush Shoes contact Multiple Bank Terminals No. 34 of the Called Subscriber Line.
- 6) The Sender then restores to normal (releases), ready to set up another call.
- 7) The Final Selector Circuit checks the Called Subscriber Line to determine if it is Busy or Idle.
- 8) If the Called Subscriber Line is Busy, the Final Selector Circuit restores to normal, "setting" the Incoming Selector Circuit to return Busy Tone to the Calling Subscriber.
- 9) If the Called Subscriber Line checks Idle, the Final Selector Circuit signals the Incoming Selector Circuit to apply Ringing Current to the Called Subscriber Line.

MANUAL SYSTEM

When the Called Subscriber answers (Called Handset OFF Switchhook):

- 1) Ringing Current is tripped (cut off) automatically.
- 2) The CS (Calling Supervisory) Lamp at the "A" Switchboard is extinguished, signaling the "A" Operator that the Call has been completed.
- 3) The "A" Switchboard Cord Circuit supplies Talking Battery and Ground to the Calling Subset.
- 4) The "B" Switchboard Cord Circuit (Incoming Trunk) supplies Talking Battery and Ground to the Called Subset.



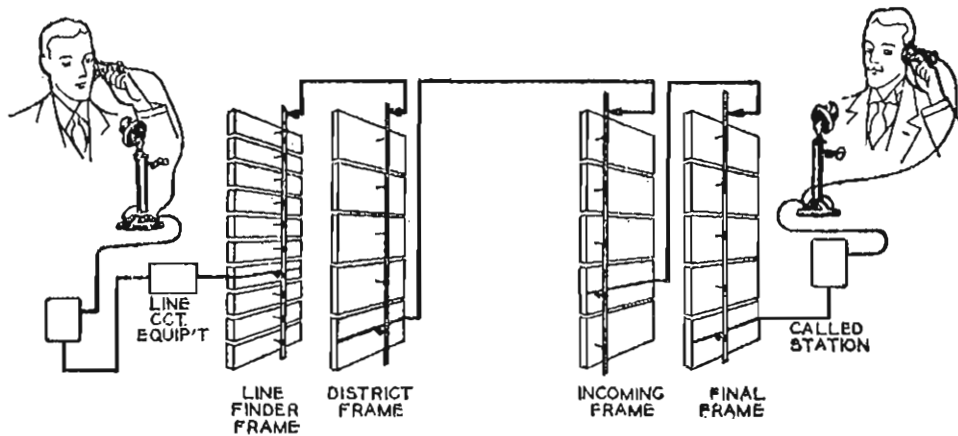
- 1) When the Manual Subscribers finish talking and replace their Handsets, a "Double-Disconnect" Signal appears at the "A" Switchboard.
- 2) The "A" Operator takes down both Cords, which brings up the Disconnect Signal at the "B" Switchboard.
- 3) The "B" Operator takes down the Trunk Cord, restoring the Switchboard Equipment to normal.

- 4) The Called Handset ON Switchhook lights the Calling Supervisory (CS) Lamp at the "A" Switchboard.
- 5) The Calling Handset ON Switchhook lights the Answering Supervisory (AS) Lamp at the "A" Switchboard.
- 6) The "A" Operator takes down the Calling Cord at the "A" Switchboard, extinguishing the Calling Supervisory (CS) Lamp, and lighting the Trunk Supervisory (Disconnect) Lamp at the "B" Switchboard.
- 7) The "B" Operator takes down the Trunk Cord at the "B" Switchboard, extinguishing the Trunk Supervisory (Disconnect) Lamp, and restoring the "B" Switchboard to normal.
- 8) The "A" Operator withdraws the Answering Cord Plug from the Answering Jack at the "A" Switchboard, extinguishing the AS (Answering Supervisory) Lamp, and restoring the "A" Switchboard to normal.

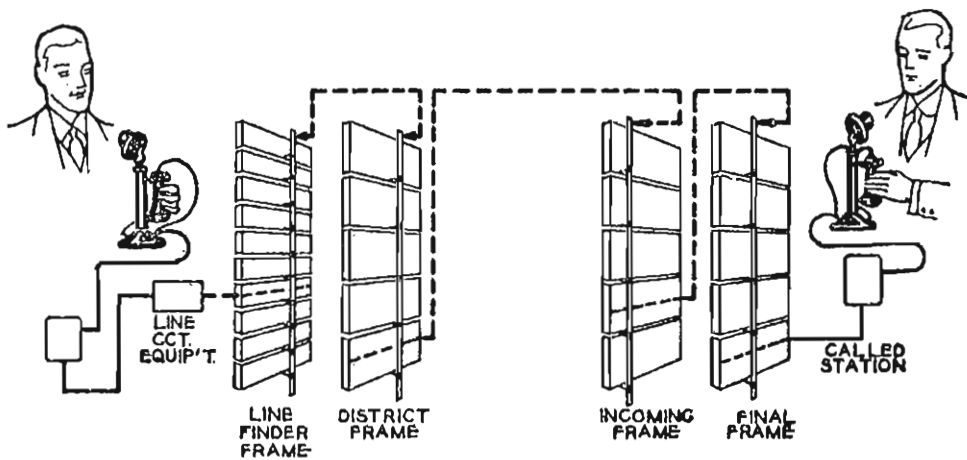
PANEL DIAL SYSTEM

When the Called Subscriber answers (Called Handset OFF Switchhook):

- 1) Ringing Current is tripped (cut off) automatically.
- 2) The District Selector Circuit supplies Talking Battery and Ground to the Calling Subset.
- 3) The Incoming Selector Circuit supplies Talking Battery and Ground to the Called Subset.



- - - - -

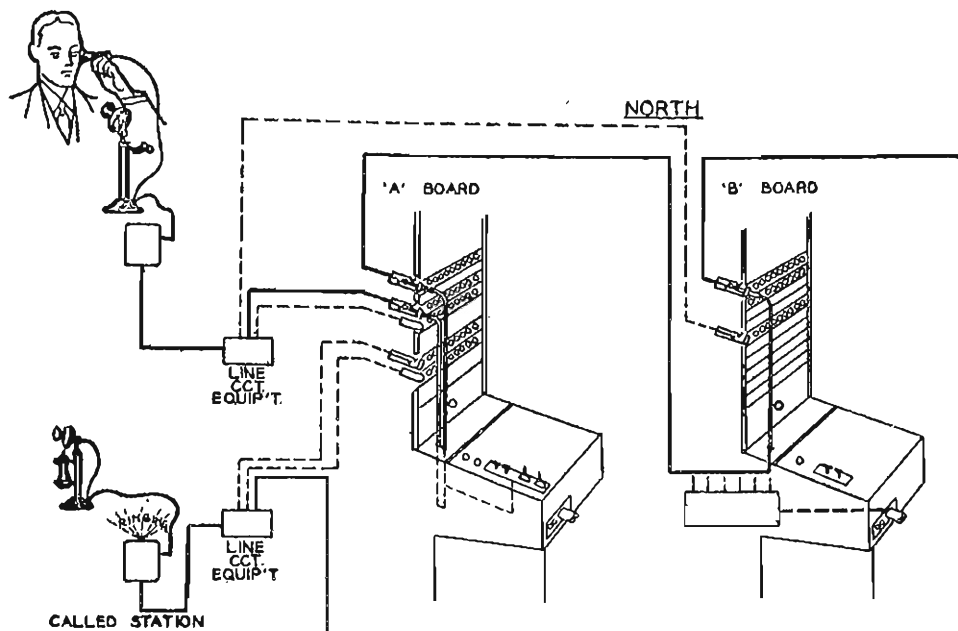


When the Panel Dial Subscribers replace their Handsets, the

- 1) Line Finder,
- 2) District,
- 3) Incoming, and
- 4) Final Selector

Brush Rods restore to normal, ready for use in handling other calls.

MANUAL SYSTEM



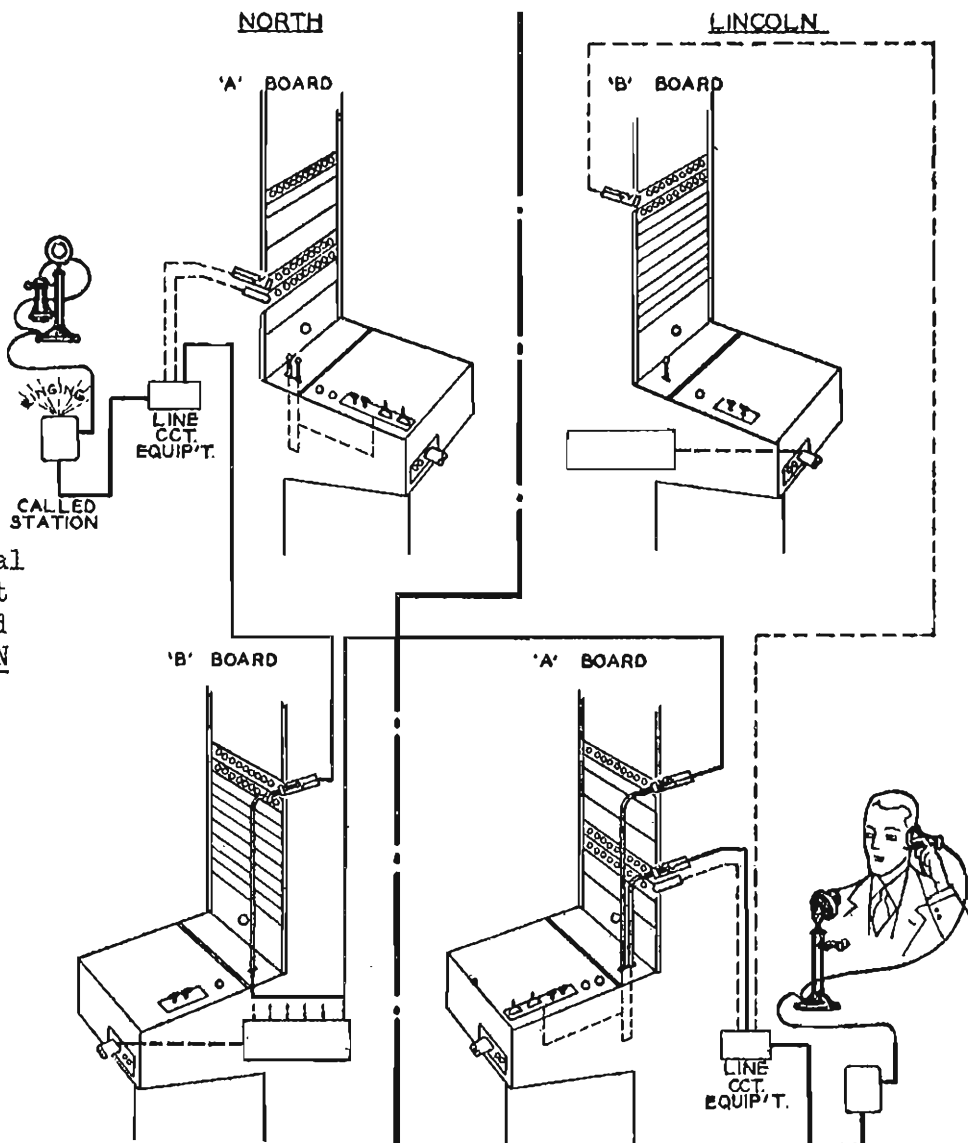
A Call between two NORTH Manual Subscribers would originate at the NORTH "A" Switchboard and terminate through the NORTH "B" Switchboard.

NORTH

LINCOLN

A Call from a LINCOLN Manual Subscriber to a NORTH Manual Subscriber would originate at the LINCOLN "A" Switchboard and terminate through the NORTH "B" Switchboard.

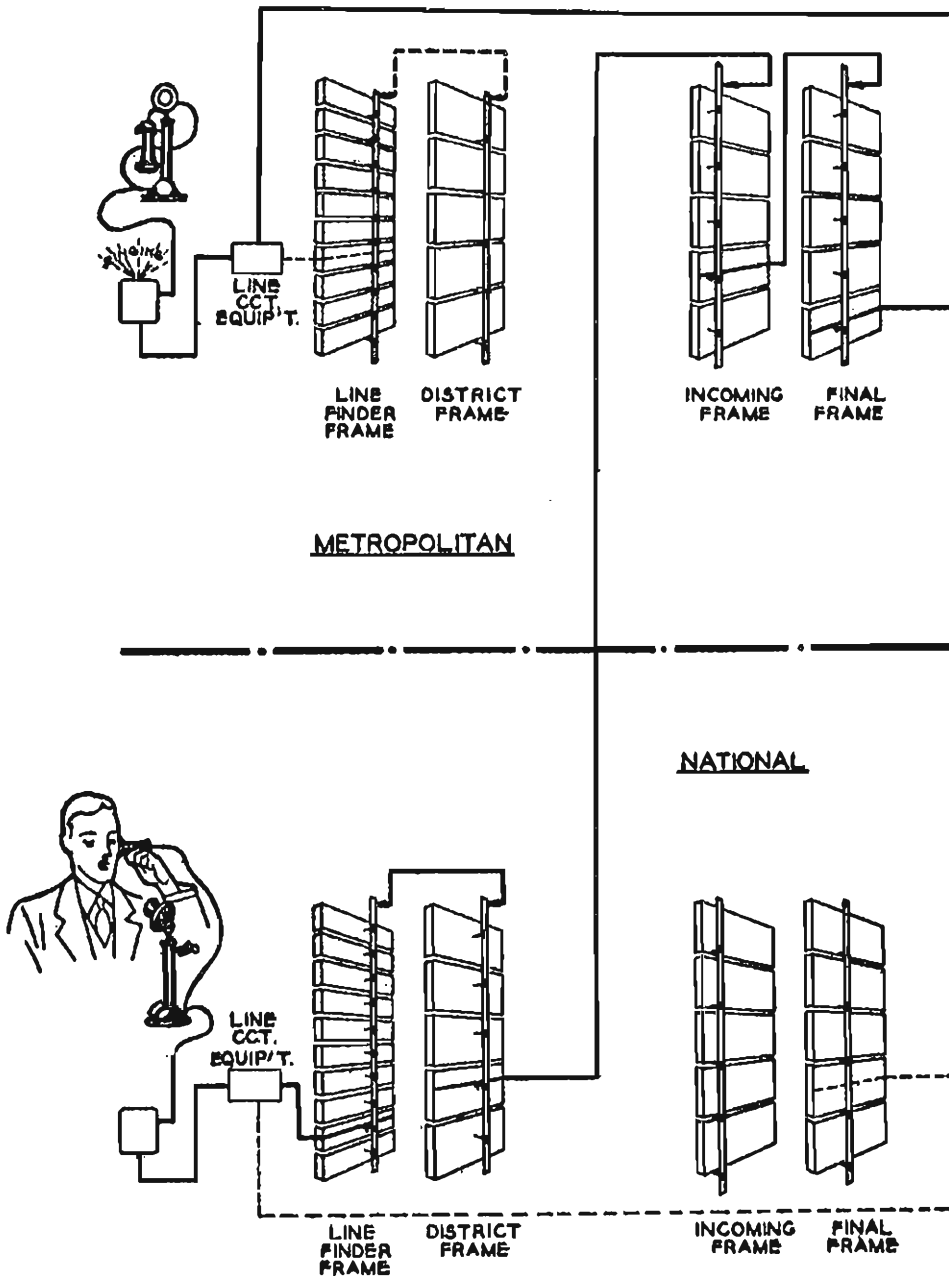
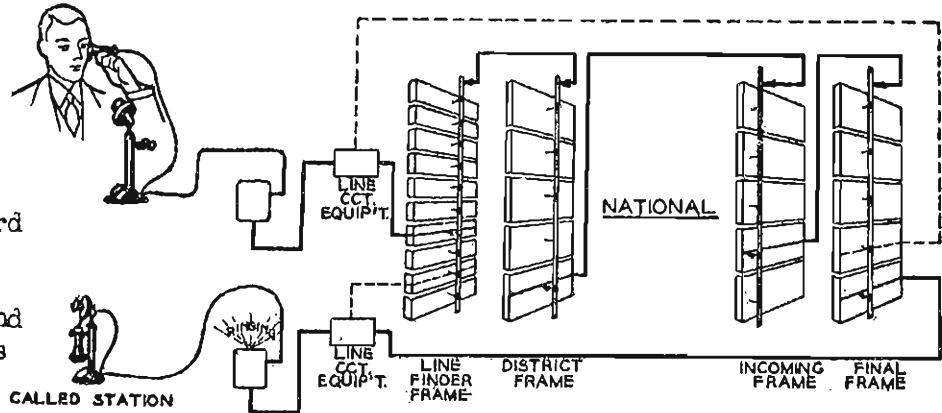
A Call from a NORTH Manual Subscriber to a LINCOLN Manual Subscriber would originate at the NORTH "A" Switchboard and terminate through the LINCOLN "B" Switchboard.



PANEL DIAL SYSTEM

In handling a Call between two NATIONAL Panel Dial Subscribers:

- 1) The Line Finder and District Selector Frames replace the Manual "A" Switchboard as the originating switching equipment.
- 2) While the Incoming and Final Selector Frames replace the Manual "B" Switchboard as the terminating switching equipment.

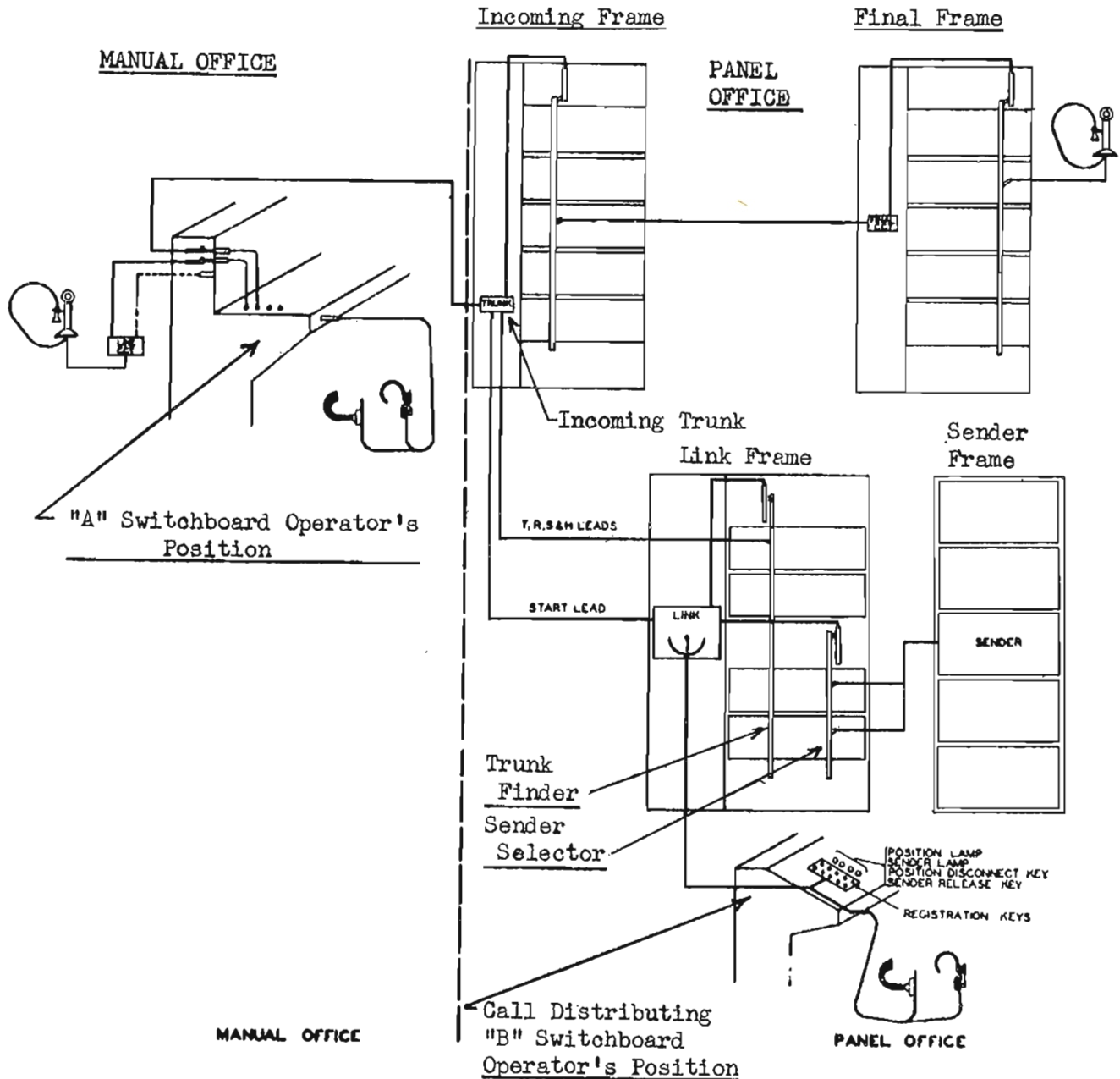


A Call made by a NATIONAL Panel Dial Subscriber to a METROPOLITAN Panel Dial Subscriber is switched through:

- 1) The Line Finder and District Selector Frames in the NATIONAL Central Office Building.
- 2) The Incoming and Final Selector Frames in the METROPOLITAN Central Office Building, and
- 3) The Sender in the NATIONAL Office has control of all selections in both Central Offices.

PATH OF A CALL FROM A MANUAL SUBSCRIBER TO A PANEL DIAL SUBSCRIBER

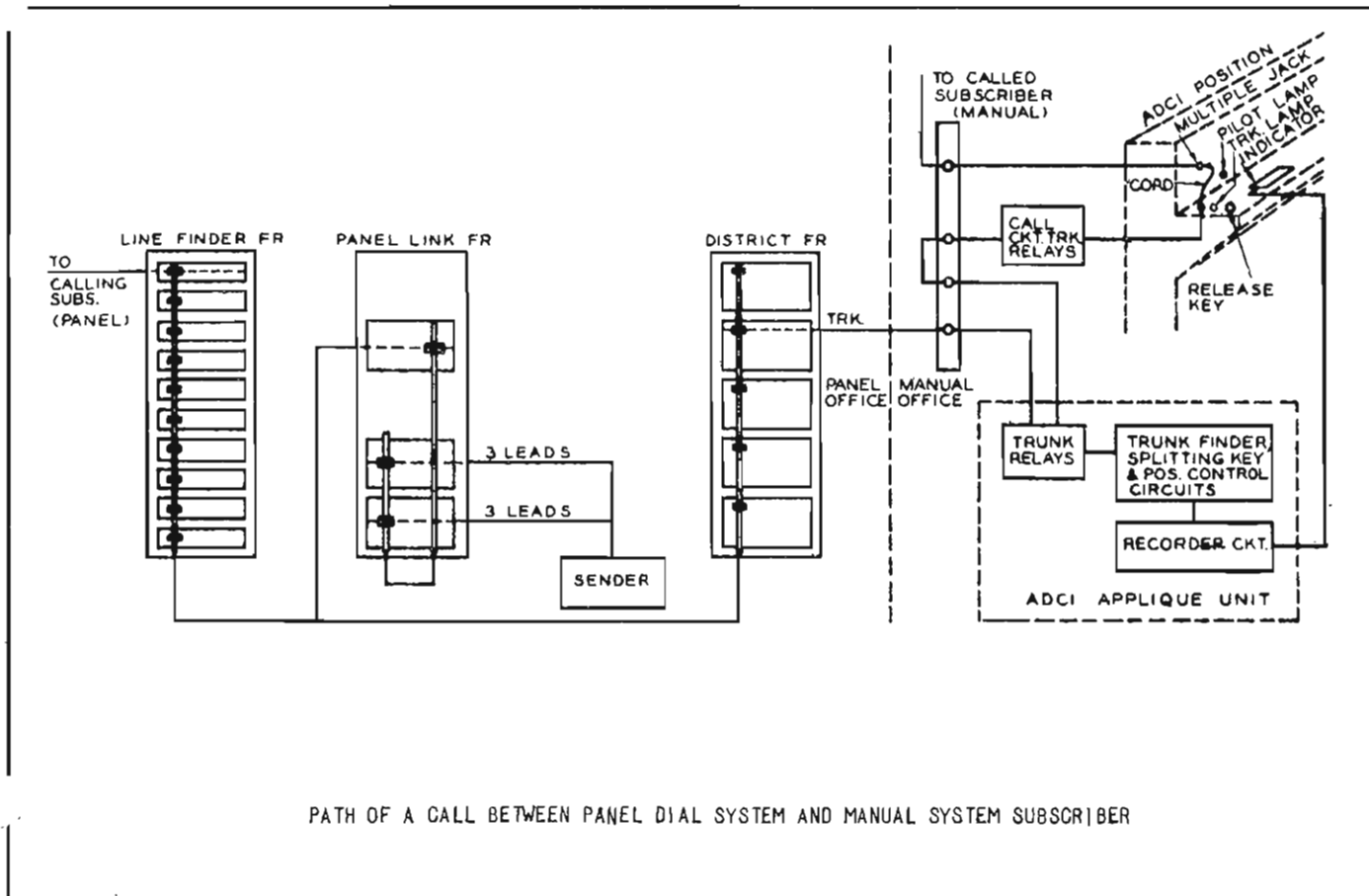
- 1) The Manual "A" Operator passes the Called Subscriber Number to the Panel Dial "B" Operator.
- 2) The Panel Dial "B" Operator keys the Number into the Sender.
- 3) The Sender sets up the Call from the Incoming Trunk to the Called Subscriber Line through the Incoming and Final Selector Frames.



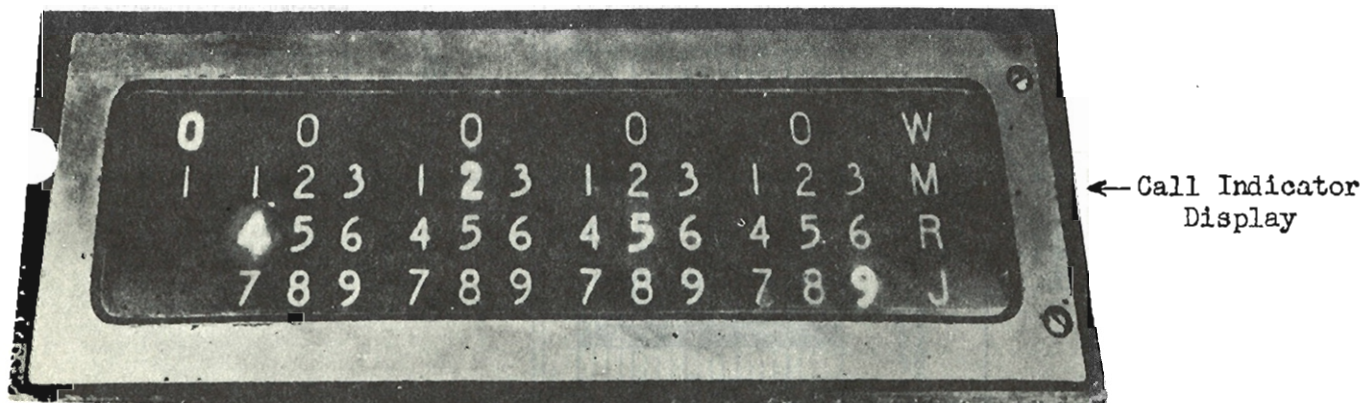
PATH OF A CALL FROM A PANEL DIAL SUBSCRIBER TO A MANUAL SUBSCRIBER

ADCI (Automatic Display Call Indicator) Method

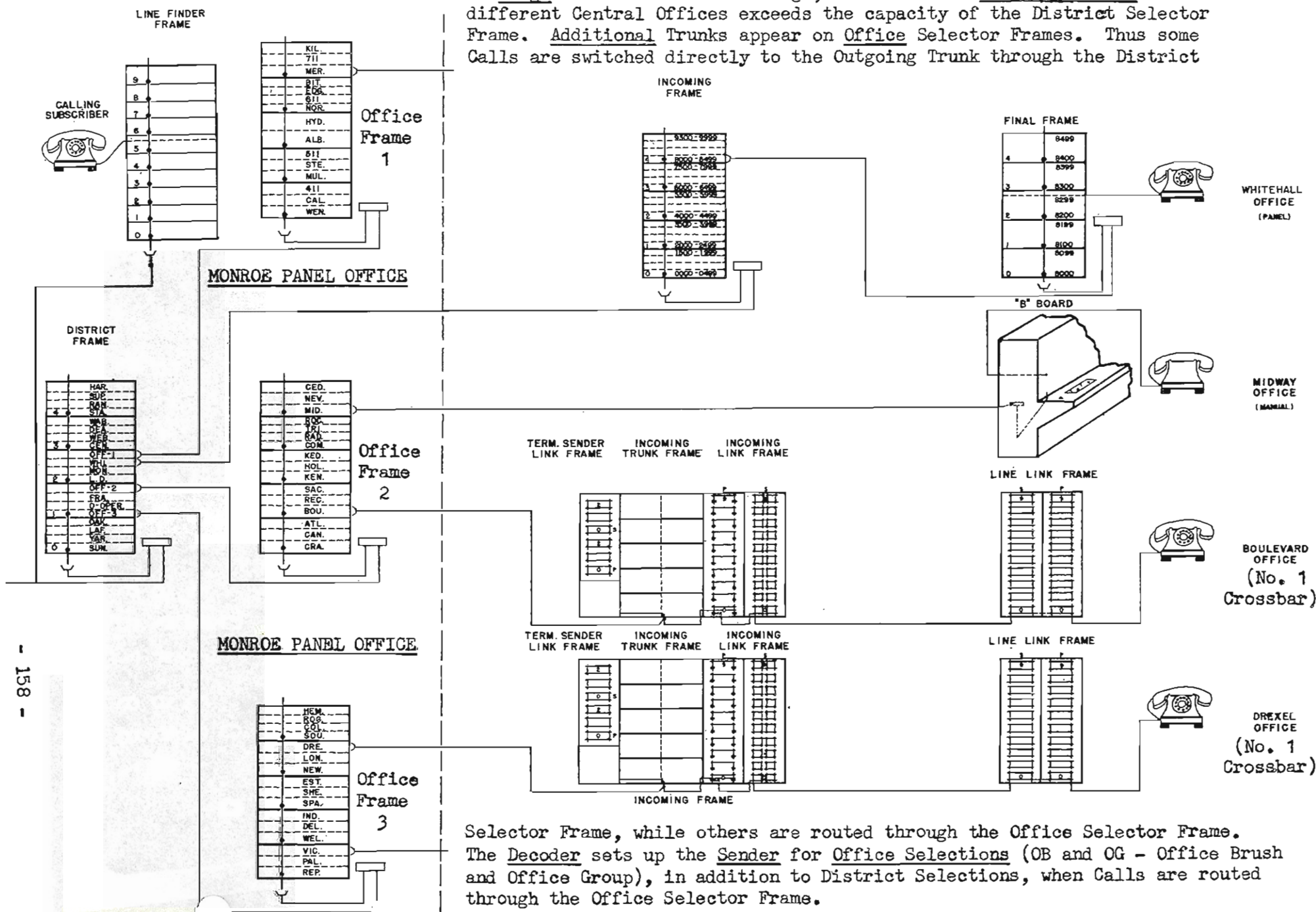
- 1) The Panel Dial Calling Subscriber dials the Called Subscriber Number into the Panel Sender.
- 2) The Sender controls selection of an Idle Outgoing Trunk to the Manual Office.
- 3) The Sender "outpulses" the Called Subscriber Number, over the Trunk, into the ADCI Equipment in the Manual Office.
- 4) The ADCI Equipment registers and translates the pulses into signals which light up the proper digits on the Indicator glass plate.
- 5) The Panel Dial "B" Operator reads the Called Subscriber Number on the Indicator and inserts the Incoming Trunk Cord Plug into the Subscriber Multiple Jack, "wiping out" the display. The ADCI Equipment is now ready to handle the next Waiting Call.
- 6) Since this method of handling calls was developed for the Panel Dial System, the pulses are called PCI (Panel Call Indicator) Pulses.



PATH OF A CALL BETWEEN PANEL DIAL SYSTEM AND MANUAL SYSTEM SUBSCRIBER



In large Central Office Buildings, the number of Outgoing Trunks to the different Central Offices exceeds the capacity of the District Selector Frame. Additional Trunks appear on Office Selector Frames. Thus some Calls are switched directly to the Outgoing Trunk through the District

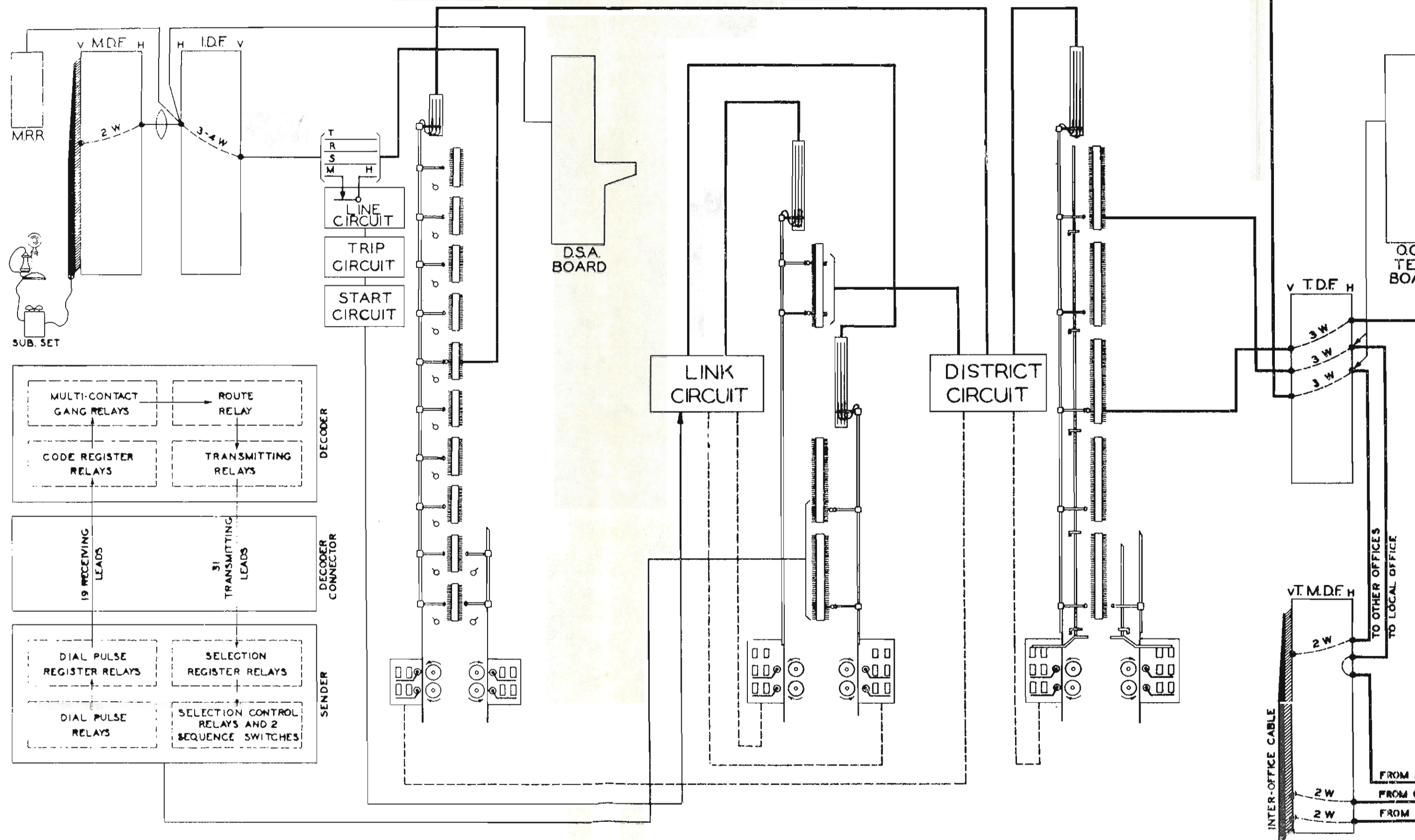


Selector Frame, while others are routed through the Office Selector Frame. The Decoder sets up the Sender for Office Selections (OB and OG - Office Brush and Office Group), in addition to District Selections, when Calls are routed through the Office Selector Frame.

LINE FINDER FRAME

SUB'S LINK FRAME

DISTRICT FRAME



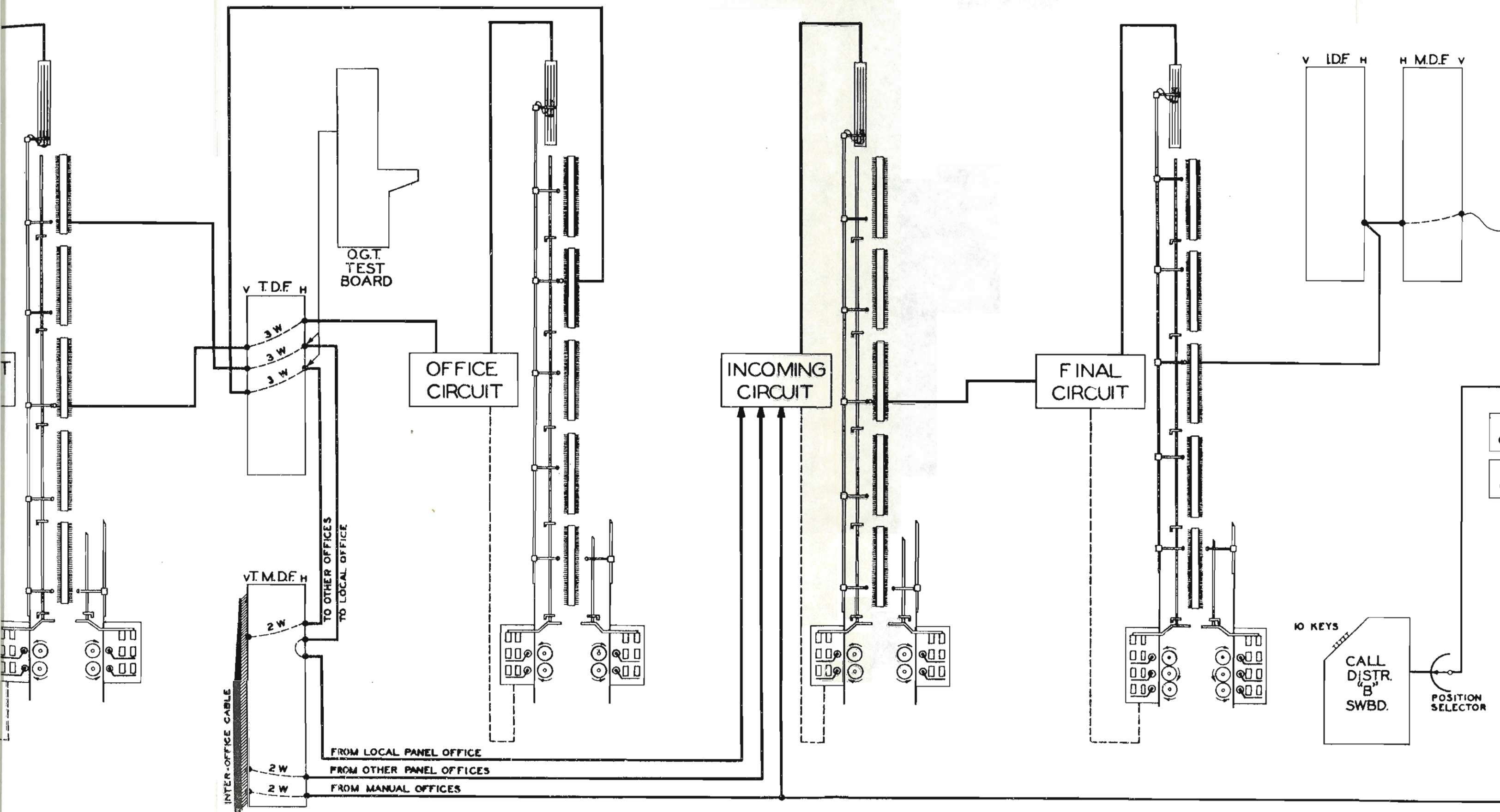
EQUIPMENT REQUIRED F

DISTRICT FRAME

OFFICE FRAME

INCOMING FRAME

FINAL FRAME



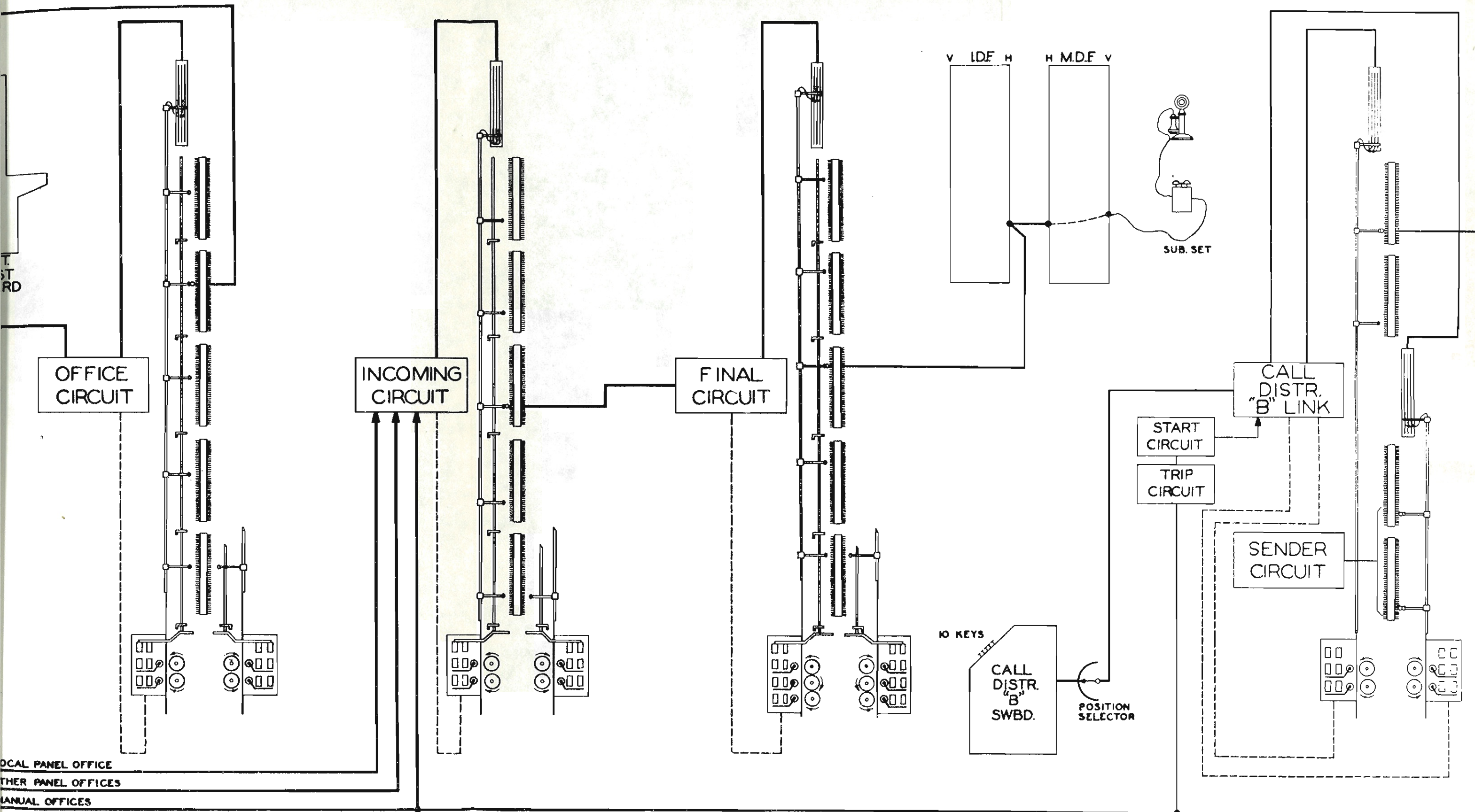
EQUIPMENT REQUIRED FOR HANDLING PANEL DIAL TRAFFIC

OFFICE FRAME

INCOMING FRAME

FINAL FRAME

CALL DIST. "B" LINK FRAME



FOR HANDLING PANEL DIAL TRAFFIC