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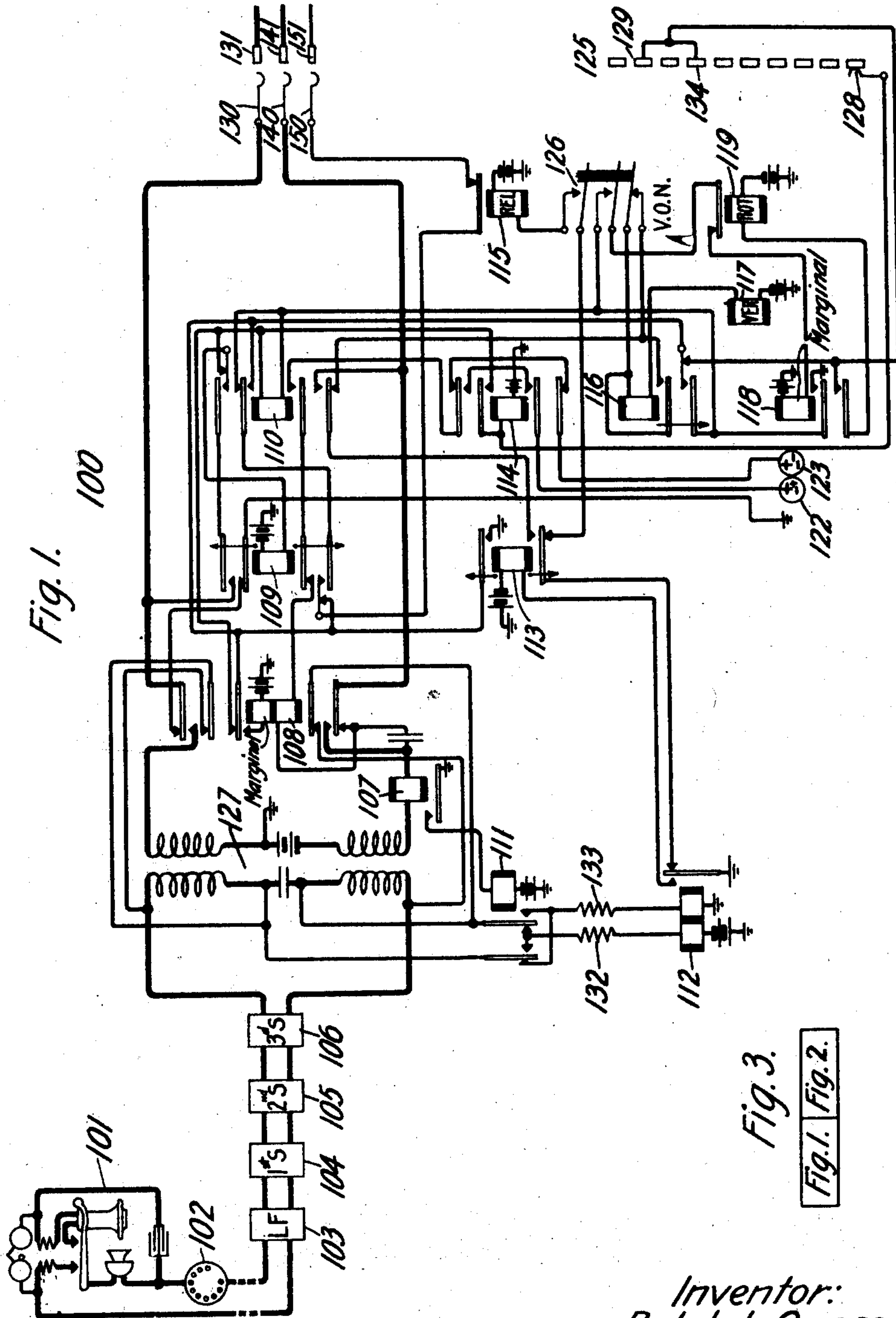
1,660,975

R. L. QUASS

TELEPHONE SYSTEM

Filed July 19, 1926

2 Sheets-Sheet 1



Inventor:
Ralph L. Quass.

by J. H. Roberts Att'y.

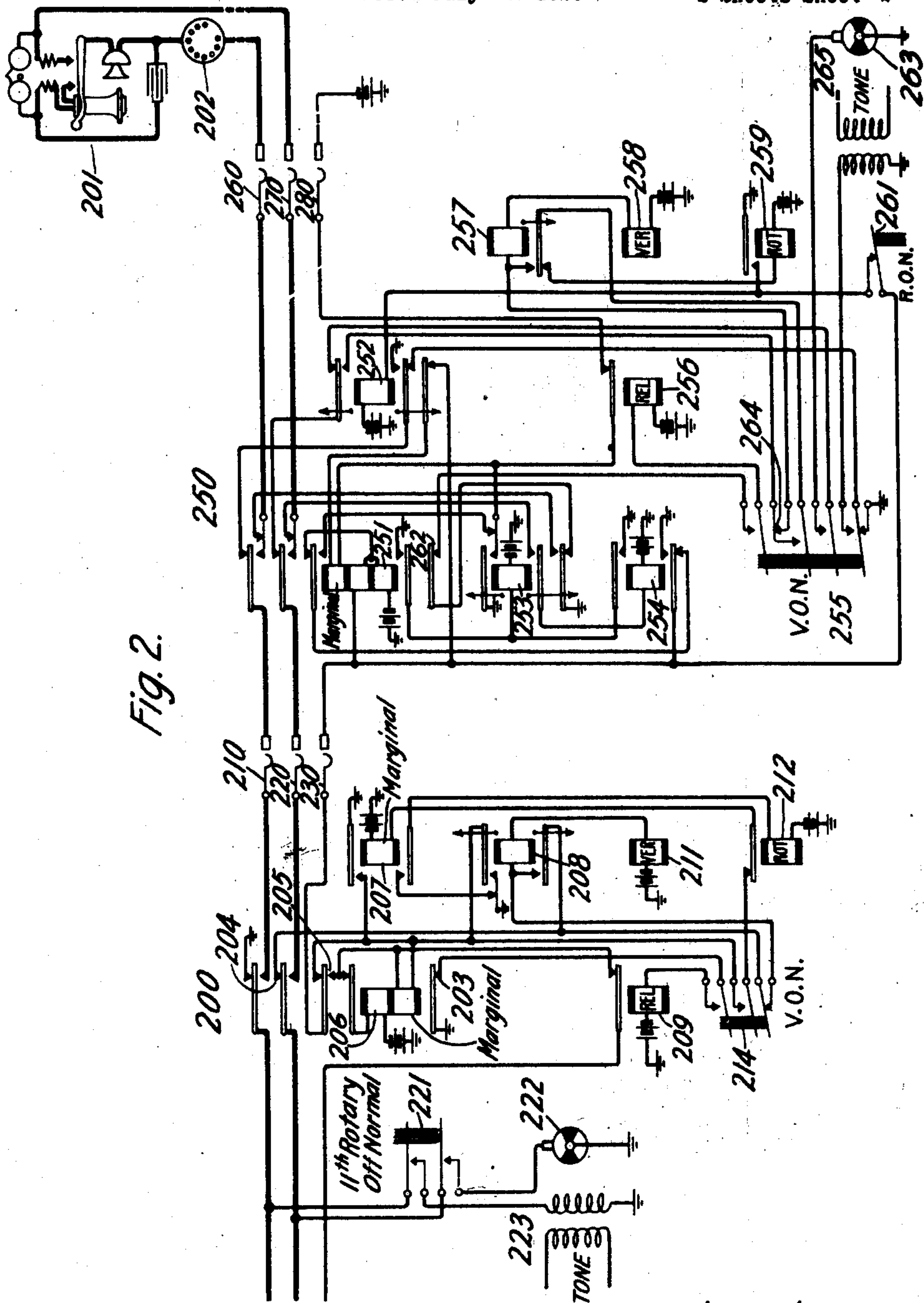
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Inventor:
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UNITED STATES PATENT OFFICE.

RALPH L. QUASS, OF HAWTHORNE, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Application filed July 19, 1926. Serial No. 123,312.

The invention relates to telephone switching systems and particularly to exchange systems in which a plurality of selectors and a connector are used.

5 The principal object of the invention is to improve the operation of the selector and the connector switches of such systems.

Another object is an improved method of controlling the application of ringing
10 current.

It has been the practice heretofore in a connection comprising a plurality of selectors and a connector to have each separate switch controlled directly by the calling
15 subscriber's dial and the ringing current has heretofore been controlled and connected to the called subscriber's station by the connector. The release of the connector has been controlled by a preceding selector
20 switch.

In this invention the last two switches of a plurality are controlled and positioned by means of the preceding switch and the ringing is controlled by the same switch instead
25 of the connector. The release of the connector is controlled by the called subscriber.

The system disclosing the invention consists of a calling subscriber's line and a called subscriber's line, a line finder, a plurality of selectors, and a connector. All of
30 the selectors, except the last, are directly controlled from the subscriber's dial but the last selector and the connector are controlled by a relay in the preceding selector.
35 The ringing of the called station is also controlled by a second relay in said preceding selector. The relay which controls the positioning of the switches follows the dial and repeats the pulses to the following
40 switches. The relay which controls the ringing is released by the removal of ground from the tip of the line when the connector has been connected to an idle line.

A more complete conception of the invention may be had from the following detailed description and the accompanying drawings, of which; Fig. 1 discloses a calling line, a line finder and three selectors in schematic form, and a fourth selector in detail; Fig. 2 discloses a fifth selector, a connector, and a called subscriber's station.
50

When subscriber 101 removes the receiver

from the switchhook the call is carried through line-finder 103 and the first, second and third selector switches 104, 105 and 106
55 under the control of dial 102 in a manner well known to the art. When selector 106 connects with the terminals of the fourth selector 100, a circuit is closed from battery through the left winding of relay 112, resistance 132, inner back contact of relay
60 111, lower inner back contact of relay 108 over the ring of the line through the intervening switches and the loop of station 101, back over the tip of the line, and the intervening switches, upper middle back contact
65 of relay 108, outer back contact of relay 111, resistance 133 to ground through the right winding of relay 112. Relay 112 operates and closes an obvious circuit for relay 113
70 which in turn closes a circuit from ground on its upper front contact to the upper inner back contact of relay 108, upper outer back contact of relay 110 to battery through
75 the winding of relay 109. With relay 109 operated the switch is now in condition for dialing. When the subscriber at station 101 operates dial 102 the circuit for relay 112 is opened, thereby releasing it and closing a
80 circuit for operating relay 116 and magnet 117 in series from battery through the windings of magnet 117 and relay 116, lower normal contact of vertical off-normal spring 126, lower outer back contact of relay 110,
85 lower front contact of relay 113, to ground at the back contact of relay 112. Relay 113 does not release when relay 112 opens its contacts as it is slow to release. Relay 112 follows the impulses from dial 102, thereby operating and releasing magnet 117 and
90 causing the brushes 130, 140 and 150 to be stepped upward. Relay 116 does not release during these impulses as it is slow to release, thereby closing a second operating circuit for magnet 117 through its inner
95 front contact. The first operating circuit is opened after the first impulse has been dialed by the operation of vertical off-normal contact springs 126 and circuits are completed in part for the rotary magnet
100 119 and release magnet 115. The operation of springs 126 also closes a circuit from ground on the upper front contact of relay 113, lower outer front contact of relay 116,

middle alternate contact of off-normal springs 126, back contact of rotary magnet 119 to battery through the winding of relay 118. Relay 118 operates and locks over a circuit from battery through its winding, back contact of magnet 119, middle alternate contact of springs 126 to ground on the inner front contact of relay 118. When the brushes are moved under the control of the vertical magnet 117, brush 128 of commutator 125 is positioned on a contact corresponding to the level to which the brushes have been raised. Certain of these contacts are wired, such as 129 and 134 and correspond to terminals which lead to stations requiring four-party ringing. Should brush 128 come to rest on either terminal 129 or 134 a circuit is closed from battery through the winding of relay 114, brush 128, either contact 129 or 134, lower outer back contact of relay 116 to ground on the upper front contact of relay 113. Relay 114 operates and locks over a circuit from ground on the upper front contact of relay 113, upper inner back contact of ringing cut-off relay 108, upper inner front contact and winding of relay 114 to battery. When relay 114 is not operated, ringing current from source 123 is used but with relay 114 operated, ringing current from source 122 is used. Ringing current is not connected to the connection at this time as relay 109 is operated.

If the brushes in their vertical movement have come to rest on a busy trunk, ground will be found on terminal 151 and a circuit will be closed from this ground over brush 150, back contact of release magnet 115, lower outer front contact of relay 109, upper inner back contact of relay 110, middle alternate contact of vertical off-normal springs 126, back contact of rotary magnet 119 to battery through the winding of relay 118. The release of relay 116 when the dialing was finished opened the locking circuit traced above for relay 118 but it is now held over a circuit to the busy ground. With relay 118 operated a circuit is closed from battery through the winding of rotary magnet 119, lower front contact of relay 118, lower back contact of relay 116 to ground on the upper front contact of relay 113. The operation of rotary magnet 119 opens the operating circuit for relay 118 thereby opening the operating circuit for the rotary magnet. Should the next trunk be busy relay 118 will be reoperated and the cycle repeated until an idle trunk is found at which time there will be no operation of relay 118 and the brushes will come to rest. As long as the brushes were resting on a busy terminal the winding of relay 110 is shunted by the busy ground but when an idle trunk is reached a circuit is closed from ground on the upper front contact of relay 113, upper inner back contact of relay 108,

winding of relay 110, middle alternate contact of off normal springs 126, back contact of magnet 119 to battery through the winding of relay 118. Relay 118 is marginal so does not operate in this circuit as the resistance of relay 110 is too high but relay 110 operates and places a busy ground on the idle trunk terminals from ground on the upper front contact of relay 113, upper inner front contact of relay 110, lower outer front contact of relay 109, back contact of release magnet 115 to brush 150 thereby making the trunk selector test busy to all other selectors and close a circuit for relay 206 from battery, through its upper winding of innermost upper back contact, back contact of release magnet 209, terminal 151, brush 150, back contact of release magnet 115 to the above mentioned ground.

Relay 206 only operates partially at this time. It is so adjusted that only contact 203 is opened while the other contacts remain normal. The opening of contact 203 prevents release magnet 209 from being energized when the switch is stepped off-normal. No circuit is closed at this time through the lower winding of relay 206. A circuit is now closed from ground on the back contact of relay 112, lower front contact of relay 113, lower outer front contact of relay 110, brush 140, terminal 141, back contact of armature 204 of relay 206, normal contact of vertical off-normal spring 214, winding of relay 208 to battery through the winding of vertical magnet 211. Relay 208 operates and locks to ground from relay 112 through its lower front contact and opens at its upper back contact a possible circuit for rotary magnet 212. Selector 200 is now in position for receiving the impulses from dial 102. Relay 112 follows the impulses as before and transmits the first impulse over the circuit traced above to vertical magnet 211. The remaining impulses are transmitted through the lower front contact and winding of relay 208 and a circuit is closed from ground on the upper front contact of relay 208 to shunt the lower winding of relay 206. When the brushes start upward the vertical off-normal springs 214 are operated, thereby closing a circuit from ground on the upper front contact of relay 208, middle alternate contact of off-normal spring 214, back contact of rotary magnet 212, to battery through the winding of relay 207. Relay 207 operates and prepares in part a circuit for rotary magnet 212 which is not closed until relay 208 releases at the end of the dialing of the fifth digit. When relay 208 releases the circuit for rotary magnet 212 is completed at the upper back contact of relay 208 to ground causing the rotary magnet 212 to take one step to bring the brushes 210, 220 and 230 on the terminals of the first trunk in the selective level, on the operation

of magnet 212 the circuit for relay 207 is opened at the armature and back contact of magnet 212 causing relay 207 to release. When the rotary magnet 212 releases and if the brushes 210, 220 and 230 are now resting on the terminals of a busy trunk, a circuit is closed from ground on brush 230 back contact of armature 205 of relay 206, middle alternate contact of off-normal spring 214, back contact of rotary magnet 212, to battery through the winding of relay 207. Relay 207 is now reoperated, and held operated even if the ground on the busy terminal is removed prematurely as before the magnet 212 has had an opportunity to operate as a locking ground is provided through the upper armature and first contact of relay 207. The busy ground on brush 230 normally keeps the lower winding of relay 206 shunted through the back contact of armature 205 of relay 206, but if it is prematurely renewed the ground at the armature and front contact of relay 207 will insure this shunting until magnet 212 operates. If the next trunk is busy ground will be found on its sleeve and the above circuit will again be closed for relay 207 which will reoperate and close the circuit for magnet 212, causing the switch to rotate one step further. This operation will be repeated until an idle trunk is found.

We will consider that connector 250 is idle and that brushes 210, 220 and 230 are resting on its terminals. There being no ground on brush 230, relay 207 does not reoperate and the shunt around the lower winding of relay 206 is removed. A circuit is now closed from ground on the upper front contact of relay 113, upper inner front contact of 110, lower outer front contact of relay 109, back contact of release magnet 115, brush 150, terminal 151, back contact of release magnet 209, lower winding of relay 206, middle alternate contact of vertical off-normal spring 214, back contact of rotary magnet 212 to battery through the winding of relay 207. Relay 207 does not operate at this time as it is marginal and the resistance of the lower winding of relay 206 is too high. Relay 206, however, operates and connects the conductors from terminals 131, 141 and 151 through to brushes 210, 220 and 230. A circuit is now closed for relay 251 from the above traced ground on brush 150, terminal 151, back contact of release magnet 209, front contact of armature 205 of relay 206, brush 230, middle and lower windings of relay 251 in series to battery. Relay 251 is so adjusted that it only operates a sufficient amount to open contact 262 thereby opening a possible circuit for release magnet 256. A circuit is also closed for relay 252 from battery, through the winding of said relay, normal contact of rotary off-normal spring 261 to the ground above traced over

brush 230. Relay 252 closes a circuit for vertical magnet 258 from ground on the back contact of relay 112, over the ring of the connection as traced before, upper middle back contact of relay 251, upper front contact of relay 252, contact 264 of vertical off-normal springs 255 to battery, through the windings of relay 257 and vertical magnet 258. Relay 252 also connects ground from its lower inner front contact to the tip of the line for holding slow to release relay 109 operated after relay 206 operates, thereby holding open any possible circuit for ringing current from either source 122 or 123. The slow to release relay 257 operates and is held operated while magnet 258 follows the sixth set of impulses repeated by relay 112 thereby stepping brushes 260, 270 and 280 upward. That is, after the first impulse the vertical off-normal springs 255 operate to transfer the operating circuit for magnet 258 through the armature and front contact of relay 257. This circuit may be traced from ground on the back contact of relay 112 over the ring of the connection, upper middle back contact of relay 251, upper front contact of relay 252, upper middle alternate contact of off-normal springs 255, front contact of relay 257 to battery, through windings of relay 257 and magnet 258. Relay 257 is slow to release so does not release between impulses. After the last impulse, relay 257 and magnet 258 release and the connector 250 is now in condition to receive the impulses due to the dialing of the seventh digit.

Relay 112 repeats the seventh digit impulses over the ring, upper front contact of relay 252, middle alternate contact of vertical off-normal springs 255, back contact of relay 257 to battery, through the winding of rotary magnet 259. Magnet 259 operated closes a holding circuit for relay 252 during the stepping of magnet 259 as the original circuit for relay 252 is opened at the rotary off-normal contact 261 after the first rotary step. Relay 252 will remain operated until after the last rotary impulse has been dialed. When this final digit has been dialed, the brushes of connector 250 are positioned on the terminals of the desired line.

It will be assumed that station 201 is the desired line and that it is idle. Battery will be found on the sleeve as indicated and a circuit will be closed from this battery, brush 280, back contact of release magnet 256, upper winding of relay 251, lower outer back contact of relay 252, brush 230, front contact of armature 205 of relay 206, back contact of release magnet 209, terminal 151, brush 150 to ground on the upper front contact of relay 113 as traced above, thereby fully operating relay 251. The release of relay 252 and operation of relay 251 remove ground from the tip of the connection, there-

by allowing relay 109 to release and connect ringing current over a circuit from ground on the upper inner back contact of relay 109, upper outer back contact of relay 108, over the tip conductor of the connection to station 201, back over the ring conductor of the connection, lower outer back contact and lower winding of relay 108, lower inner back contact of relay 109, lower inner front contact of relay 110, upper outer and lower outer back contacts of relay 114 to ringing source 123. If the brushes of commutator 125 are resting on either terminals 129 or 134, relay 114 will be operated as described above and ringing source 122 will be connected in place of ringing source 123. When the subscriber at 201 answers by removing the receiver from the switchhook, relay 108 operates and opens the circuit for relay 110 allowing it to release. The release of relay 110 opens the ringing circuit but relay 108 does not release as it is locked up through its upper winding to ground on the upper front contact of relay 113. The operation of relay 108 closes the tip and ring conductors from brushes 130 and 140 through to the right hand windings of repeating coil 127, thereby closing a circuit from battery through the lower right winding of repeating coil 127, winding of relay 107, lower outer front contact of relay 108 over the ring conductor through the fifth selector 200 and connector 250, subscriber's loop at 201, back over the tip conductor of the above switches, upper outer front contact of relay 108, upper right winding of repeat coil 127 to ground. Relay 107 operates in this circuit and closes an obvious circuit for relay 111, causing the battery and ground supplied to the winding of relay 112 to be reversed back to the first selector 104 for supervisory purposes as is well known to the art.

When the calling subscriber restores the receiver on the switchhook, the line finder 103, first selector 104, second selector 105 and third selector 106 release in a manner well known to the art. The release of the first selector 104 opens the circuit for relay 112, thereby releasing relay 113. A circuit is now closed from ground on the back contact of relay 112, lower back contact of relay 113, upper alternate contact of off-normal springs 126 to battery through the winding of release magnet 115. The operation of release magnet 115 causes the brushes 130, 140, and 150 to be restored to normal and all operated relays in this selector released. As the release magnet 115 operates the sleeve circuit through brush 150 is opened, thereby releasing relay 206 which closes an obvious circuit for release magnet 209 from ground on its lower back contact. Release magnet 209 restores the brushes 210, 220 and 230 to normal, thereby releasing relay 251 which now opens the operating circuit for relay

253. Relay 253 being slow to release a circuit is provided on the release of relay 251 as follows: from battery, through the winding of relay 254, lower inner front contact of relay 253, upper middle back contact of relay 251, subscriber's loop at 201, upper outer back contact of relay 251 to ground on the lower outer front contact of relay 253. When relay 254 operates an obvious holding circuit is closed for relay 253, which therefore prevents the connector 250 from releasing to maintain the busy condition on both the sleeve of the connector and the subscriber's line until the called subscriber hangs up.

When the called subscriber at 201 replaces the receiver on the switchhook, relay 254 will release, thereby releasing relay 253 which closes a circuit for release magnet 256 from ground on the lower outer back contacts of relays 253 and 251, upper alternate contact of off-normal spring 255 to battery through the release magnet 256, causing the switch to be restored to normal.

If selector 200 should find during its hunting movement that all of the trunks are busy, the brushes will rotate to the eleventh terminal, at which time the eleventh rotary off-normal springs 221 will be operated to close a circuit from ground through interrupter 222, lower contacts of springs 221, terminal 141, brush 140, lower outer front contact of relay 108, winding of relay 107, lower right winding of repeating coil 127 to battery. Relay 107 operates and releases in this circuit following interruptions by interrupter 222. The operation of relay 107 closes an obvious circuit for relay 111 causing the battery and ground through windings of relay 112 to be reversed, thereby controlling the prior selectors. Tone at 223 is also connected through the upper alternate contact of spring 221 to the tip of the connection for giving the calling subscriber a busy tone.

Should connector 250 find that the desired line is busy, the same operation is followed using interrupter 263 and tone at 265.

What is claimed is:

1. In a telephone system, a series of selectors, a connector, a calling subscriber's station, a dial at said subscriber's station, lines not exceeding three conductors each interconnecting said selectors and the connector, and means in a preceding selector under control of said dial for controlling the operation of the last selector of said series and the connector over the interconnecting lines.
2. In a telephone system, a series of selectors, a connector, lines not exceeding three conductors each interconnecting said selectors and the connector, a calling subscriber's station, a dial at said subscriber's station, all of the selectors except the last in the series being under direct control of said dial,

and means for controlling said last selector and the connector over the interconnecting lines from a preceding selector.

3. In a telephone system, a calling subscriber's station including a dial, a called subscriber's station, a selector, a second selector, a connector, lines not exceeding three conductors each interconnecting said calling station, the selectors, the connector and the called station, said first selector being positioned under control of said dial over the corresponding interconnecting line, a relay in said first selector under control of said dial for controlling the positioning of said second selector and the connector over the respective interconnecting lines, and means in said first selector for connecting ringing current to said called subscriber's station through said second selector over the respective interconnecting lines.

4. In a telephone system, a calling subscriber's station, a called subscriber's station, a series of selectors, a connector, means in one of said selectors for releasing said connector, a slow-to-release relay in said connector, a second relay in said connector, said first relay arranged to close a circuit for said second relay through the called subscriber's station for holding said connector busy until said called subscriber releases.

5. In a telephone system, calling and called lines, a train of automatic switches for interconnecting said lines including a selector, a succeeding selector and a connector, means to position said first selector, circuits in said first selector, means including said circuits to control the operations of said succeeding selector and the connector, means to release said selectors, and means under the control of the called subscriber to release said connector.

6. In a telephone system, calling and called lines, a train of automatic switches for interconnecting said lines including a selector, a succeeding selector and a connector, means to position said first selector, circuits in said first selector, means including said circuits to control the operations of said succeeding selector and the connector, means to release said selectors, and means under the control of the

called subscriber for releasing said connector and for maintaining said connector busy until released.

7. In a telephone system, a series of selectors, a connector, a calling subscriber's station, a dial at said subscriber's station, lines not exceeding three conductors each interconnecting said selectors and the connector, means in a preceding selector responsive to the actuation of the dial for controlling the operation of the last selector of said series and the connector over the interconnecting lines, means for releasing said selectors, and means for holding said connector busy after said selectors are released.

8. In a telephone system, a series of selectors, a connector, a calling subscriber's station, a dial at said subscriber's station, a called subscriber's station, lines not exceeding three conductors each interconnecting said calling station, the selectors, the connector and the called station, means in a preceding selector under control of said dial for controlling the operation of the last selector of said series and the connector over the interconnecting lines, and means in said preceding selector for connecting ringing current to said called subscriber's station through the interconnecting lines.

9. In a telephone system, a calling subscriber's line, a dial associated with said line, a called subscriber's line, a series of selectors, a connector, means responsive to the actuation of the dial for actuating said selectors and connector to interconnect said lines, a source of ringing current in the next to the last of said series of selectors, means in the last mentioned selector responsive to the seizure of the called subscriber's line for connecting the ringing current from said source through the last selector and the connector to the called subscriber's line, means for releasing said selectors, and means for holding said connector busy under control of the called subscriber's line in response to the release of the selectors.

In witness whereof, I hereunto subscribe my name this 13th day of July, A. D., 1926.

RALPH L. QUASS.

DISCLAIMER

1,660,975.—*Ralph L. Quass*, Hawthorne, N. J. TELEPHONE SYSTEM. Patent dated February 28, 1928. Disclaimer filed January 25, 1930, by the assignee by mesne assignments, *Western Electric Company, Incorporated*.

Hereby enters this disclaimer to the said claims of said Letters Patent which are in the following words, to wit:

"1. In a telephone system, a series of selectors, a connector, a calling subscriber's station, a dial at said subscriber's station, lines not exceeding three conductors each interconnecting said selectors and the connector, and means in a preceding selector under control of said dial for controlling the operation of the last selector of said series and the connector over the interconnecting lines.

"2. In a telephone system, a series of selectors, a connector, lines not exceeding three conductors each interconnecting said selectors and the connector, a calling subscriber's station, a dial at said subscriber's station, all of the selectors except the last in the series being under direct control of said dial, and means for controlling said last selector and the connector over the interconnecting lines from a preceding selector.

"3. In a telephone system, a calling subscriber's station including a dial, a called subscriber's station, a selector, a second selector, a connector, lines not exceeding three conductors each interconnecting said calling station, the selectors, the connector and the called station, said first selector being positioned under control of said dial over the corresponding interconnecting line, a relay in said first selector under control of said dial for controlling the positioning of said second selector and the connector over the respective interconnecting lines, and means in said first selector for connecting ringing current to said called subscriber's station through said second selector over the respective interconnecting lines."

"8. In a telephone system, a series of selectors, a connector, a calling subscriber's station, a dial at said subscriber's station, a called subscriber's station, lines not exceeding three conductors each interconnecting said calling station, the selectors, the connector and the called station, means in a preceding selector under control of said dial for controlling the operation of the last selector of said series and the connector over the interconnecting lines, and means in said preceding selector for connecting ringing current to said called subscriber's station through the interconnection lines."

[*Official Gazette February 11, 1930.*]