

Nov. 19, 1935.

E. D. BUTZ

2,021,286

TELEPHONE SYSTEM

Filed Dec. 20, 1932

9 Sheets-Sheet 1

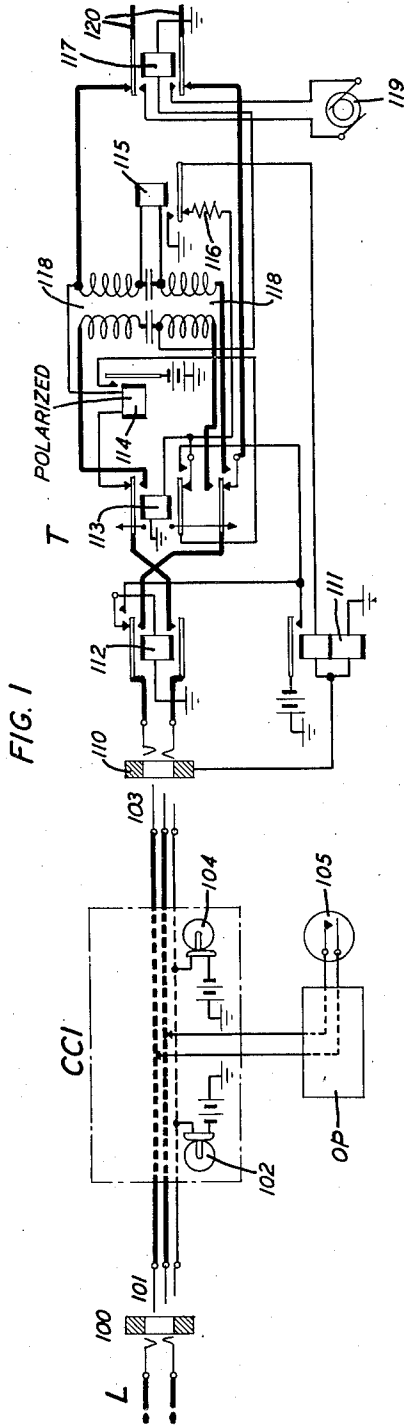


FIG. 1

FIG. 11

FIG. 4	FIG. 5 FIG. 5a	FIG. 6 FIG. 6a	FIG. 10
FIG. 1	FIG. 2	FIG. 3 FIG. 3a FIG. 3b	FIG. 7 FIG. 8 FIG. 9

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9 Sheets—Sheet 2

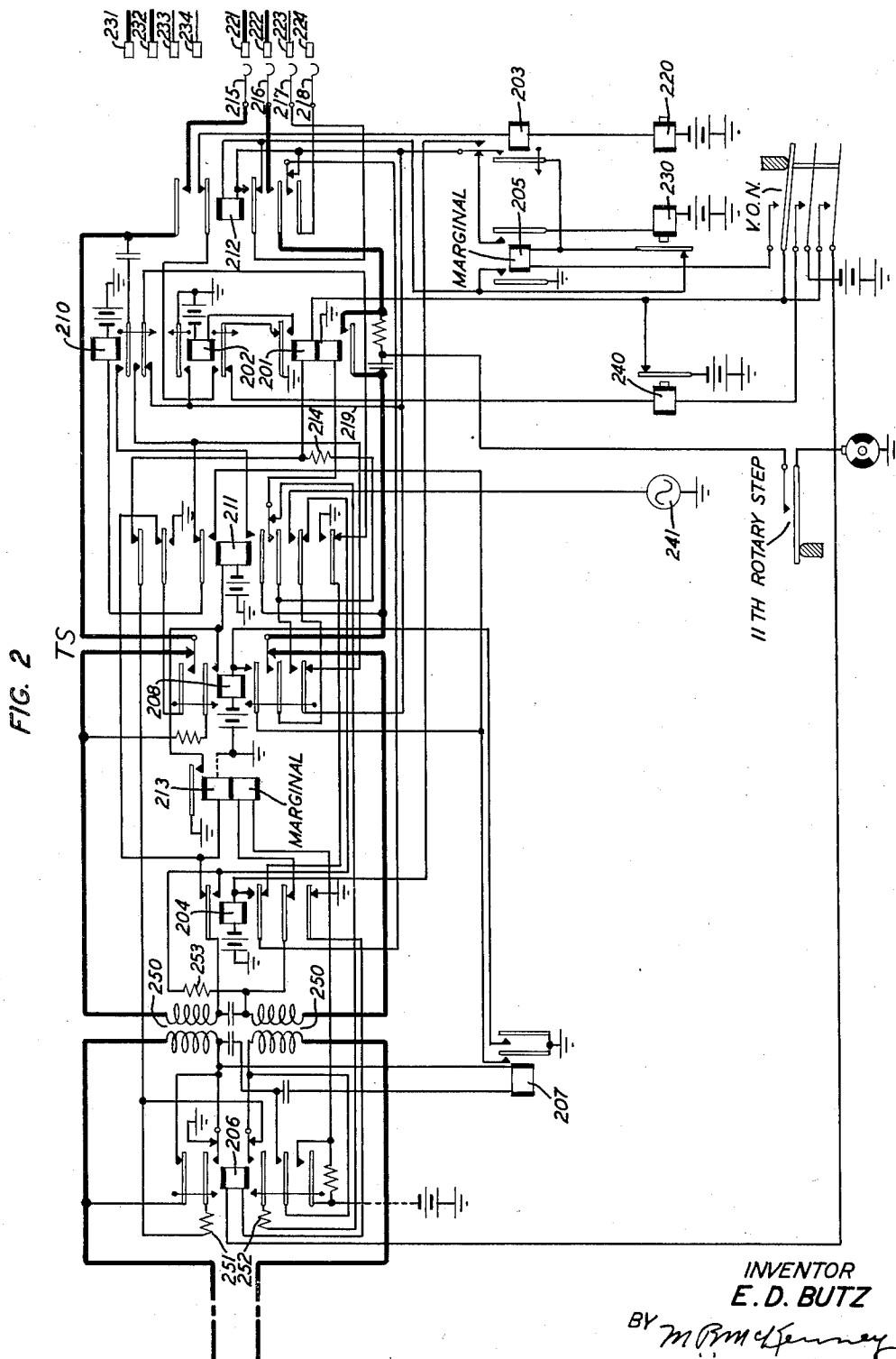


FIG. 2

TS

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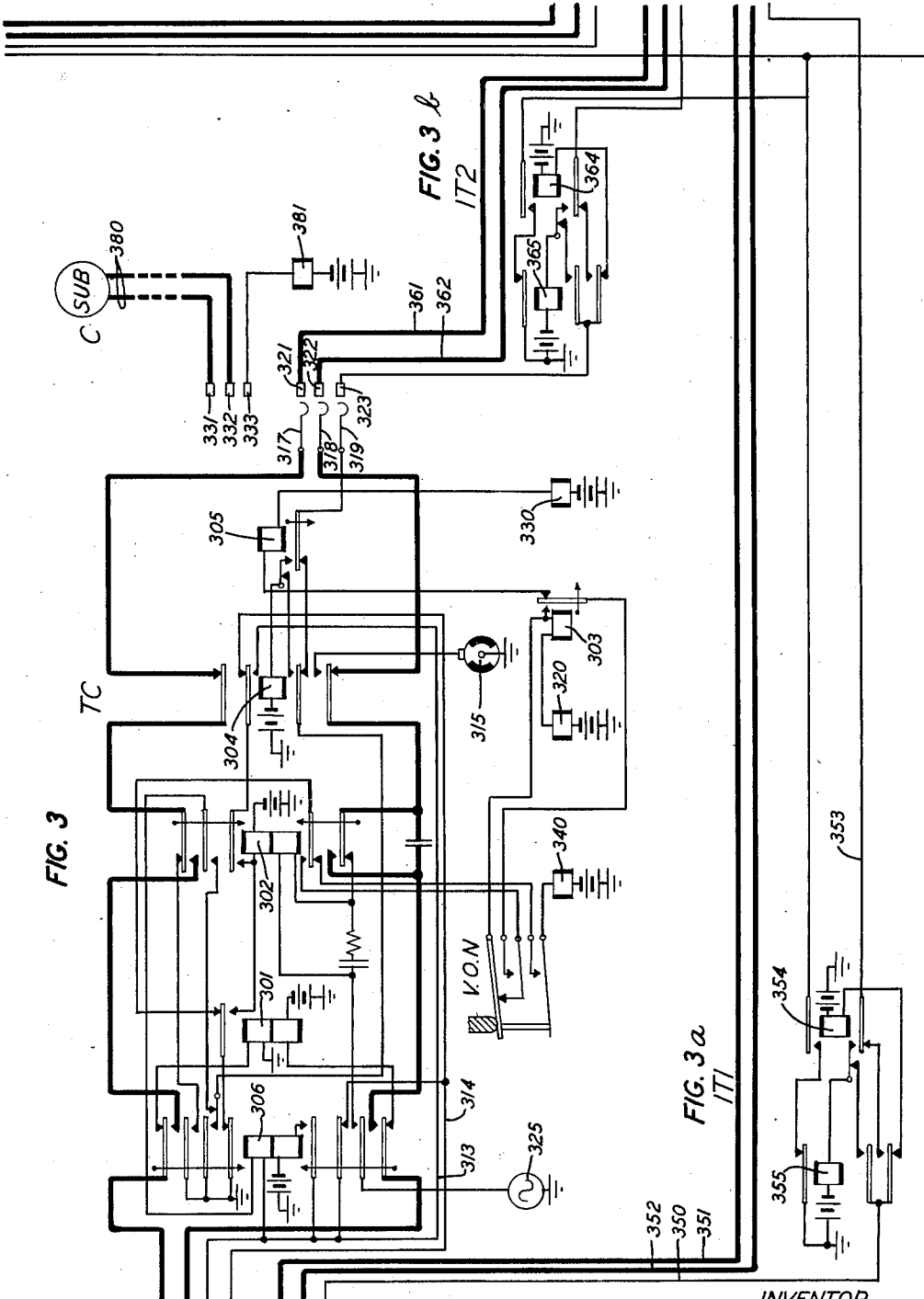


FIG. 3

FIG. 3 a

FIG. 3 b

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Filed Dec. 20, 1932

9 Sheets-Sheet 4

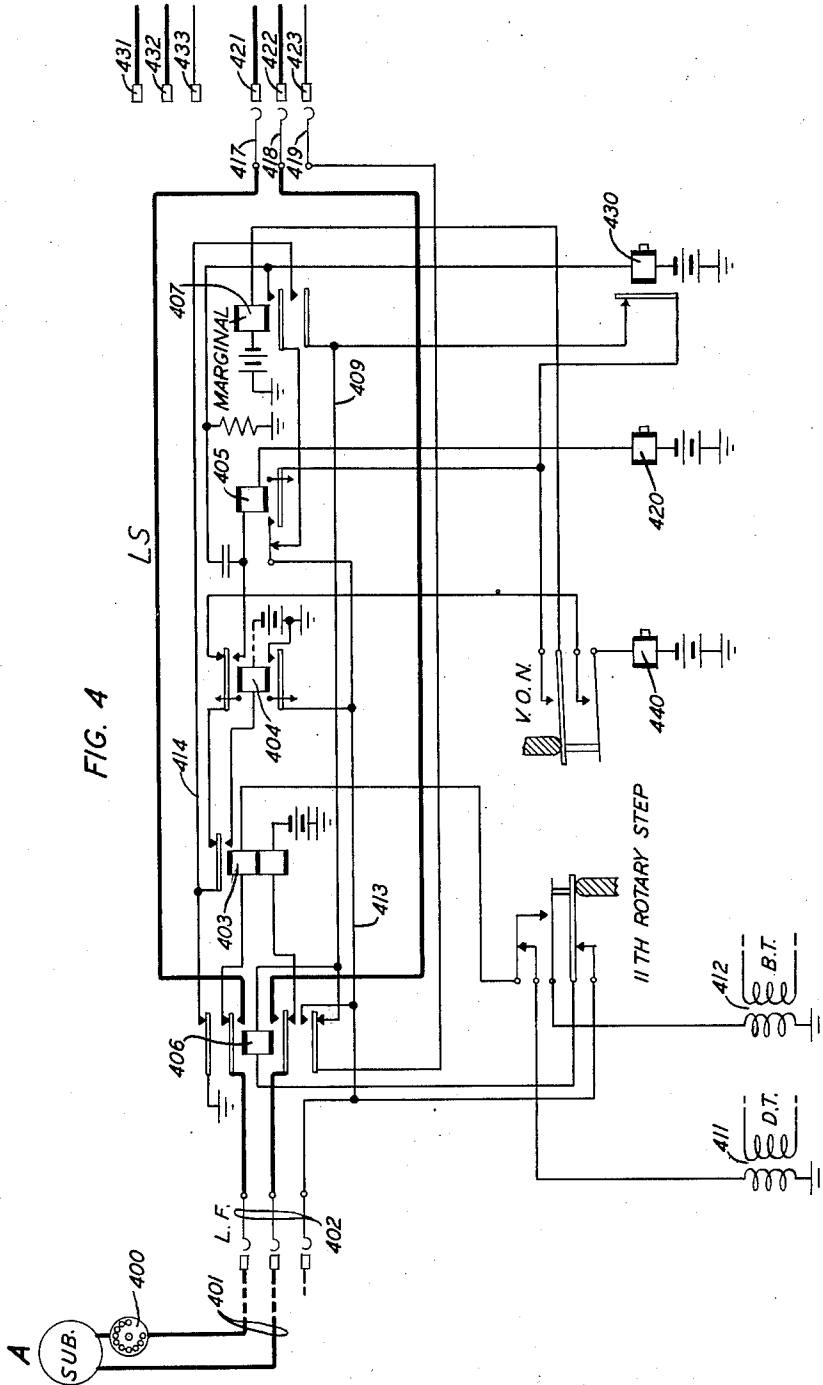


FIG. 4

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Filed Dec. 20, 1932

9 Sheets-Sheet 5

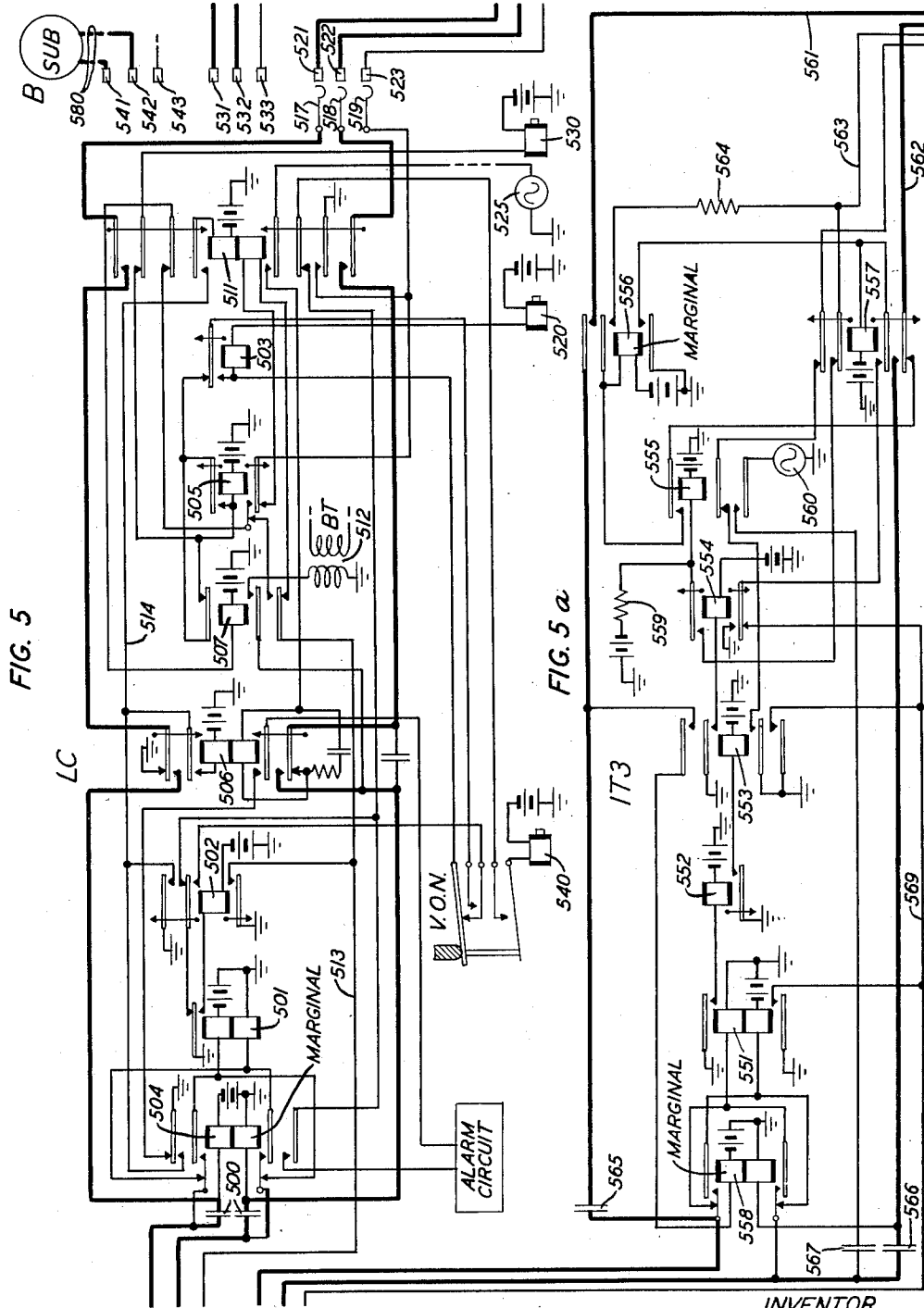


FIG. 5

FIG. 5 a

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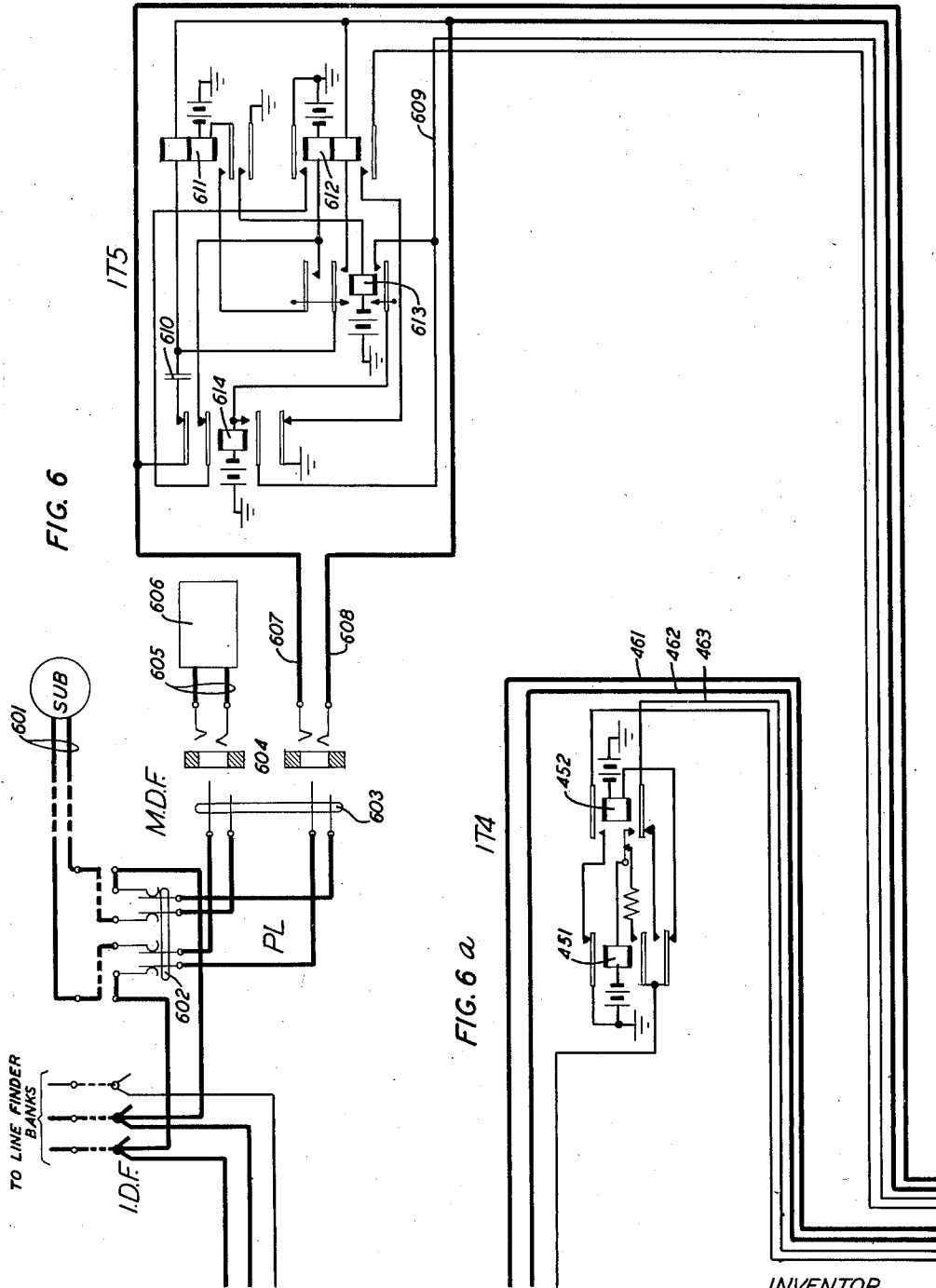
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Filed Dec. 20, 1932

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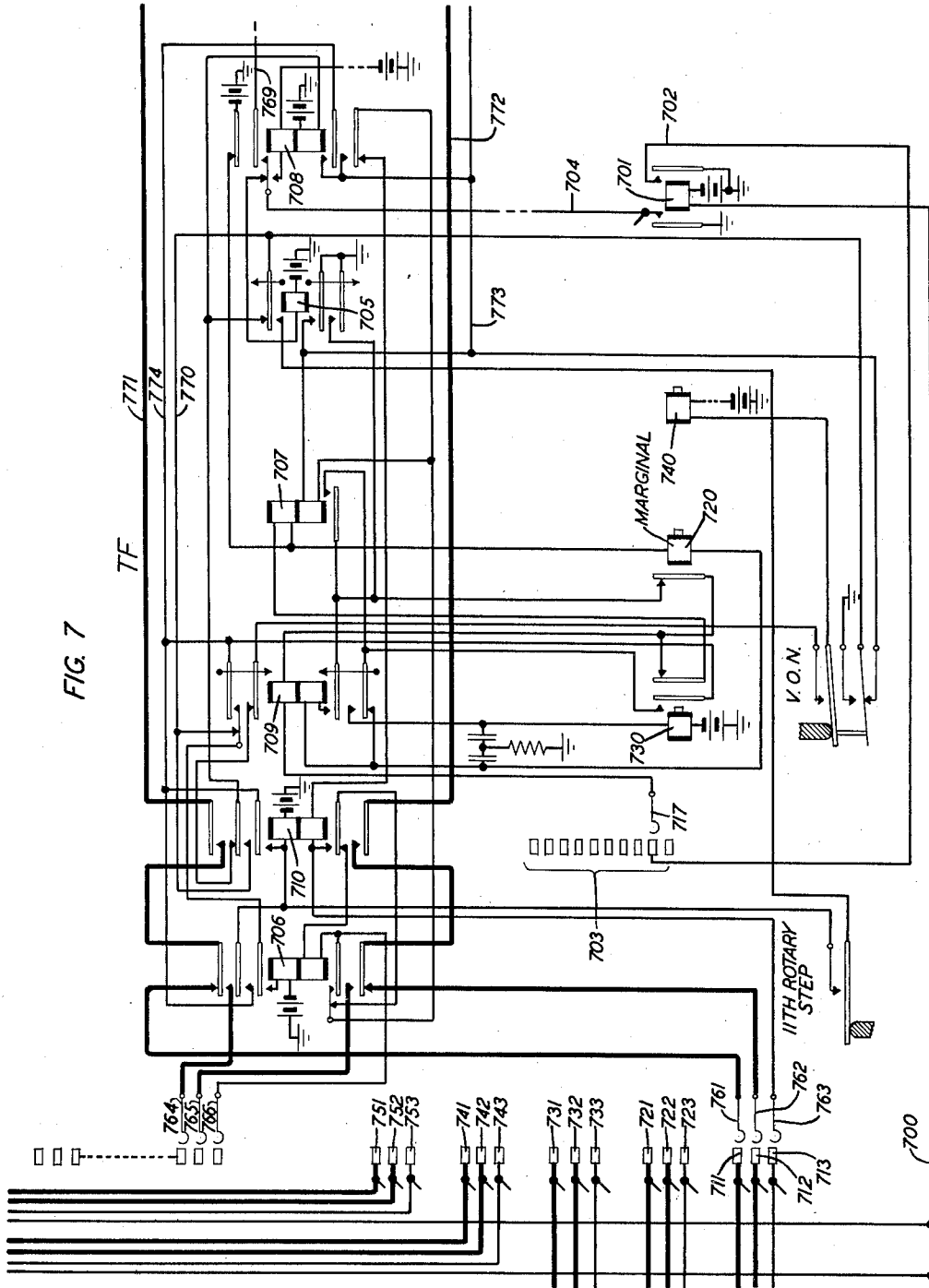


FIG. 7

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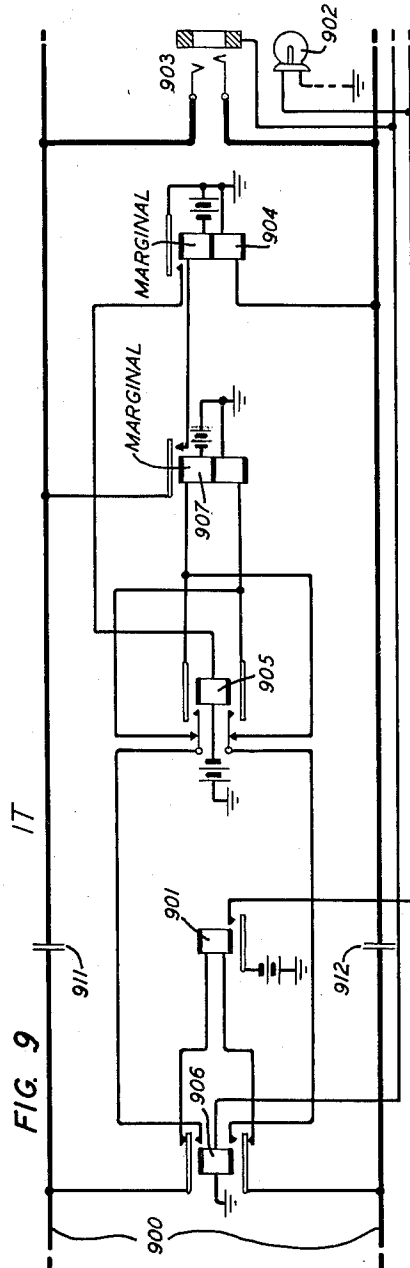
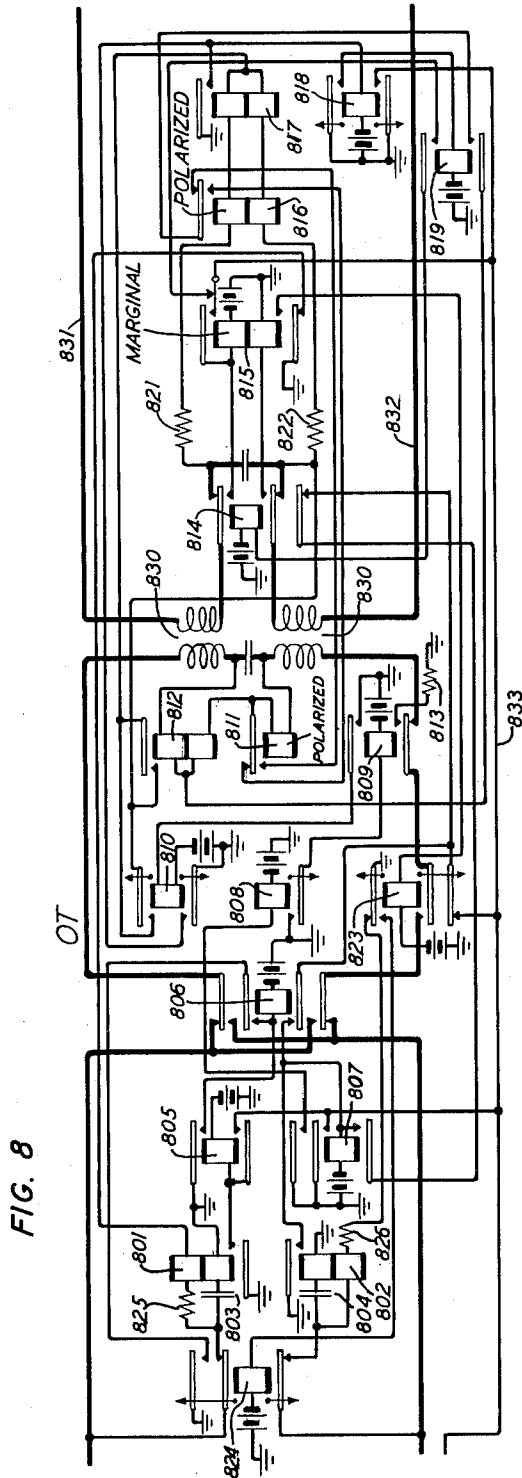
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9 Sheets-Sheet 8



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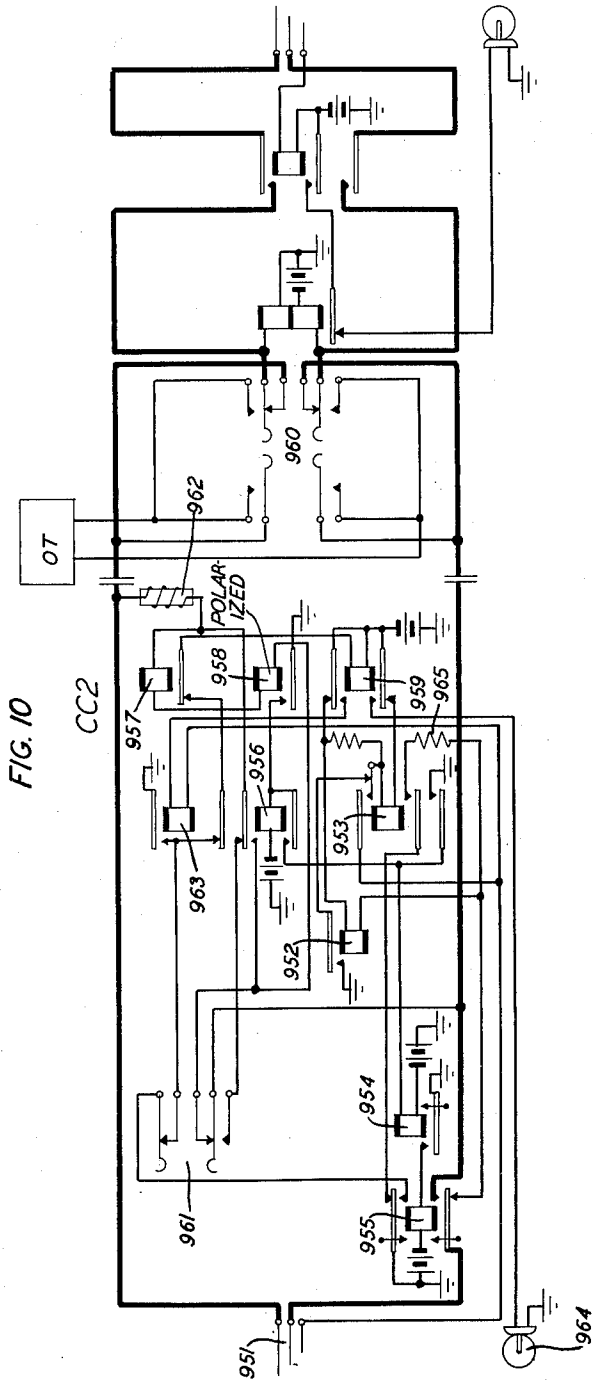


FIG. 10

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# UNITED STATES PATENT OFFICE

2,021,286

## TELEPHONE SYSTEM

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Application December 20, 1932, Serial No. 648,052

11 Claims. (Cl. 179—27)

This invention relates to telephone systems and more particularly to traffic intercepting equipment for use in automatic telephone systems.

The object of the invention is to provide an improved arrangement for extending intercepted calls to a centralized "A" switchboard.

In automatic telephone systems it is usual to connect an intercepting trunk to blank terminals in the selector and connector banks and also to provide an intercepting trunk from a plugging-up line for intercepting calls to a subscriber whose line is temporarily removed from service. The intercepting operators' positions may be located in a distant office, in which case all intercepted calls may be extended over a single group of two-wire trunks to the intercepting switchboard. The inter-office trunks may terminate at the automatic office in individual trunk finders which have access to the intercepting trunks from the connector and selector banks and from the plugging-up lines. This arrangement permits the economical use of interoffice trunks for extending intercepted calls.

According to this invention, the outgoing and incoming ends of two-wire trunks between an automatic office and intercepting operators' positions are arranged to transmit the necessary supervisory signals dependent upon whether the intercepted call is a local call or a call from a toll operator. The supervisory bridge provided in the outgoing trunk circuit for connection across the line conductors from the trunk finder include a polarized relay and a relay having high and low resistance windings. If the intercepted call is from a toll operator, the polarized relay operates and the high resistance winding is thereby short circuited, the resulting low resistance bridge being effective to give the toll operator a supervisory signal. If the intercepted call is from a local subscriber or operator, the polarized relay does not operate and the high resistance bridge is maintained across the trunk conductors to prevent operation of the supervisory relay in the connector and the charging of the calling subscriber in case the call is intercepted at a connector or over a plugging-up line. Flashing by the intercepting operator changes this bridge from a high resistance bridge to a low resistance bridge or vice versa depending upon whether the intercepted call is a toll or local call. If the call is intercepted at the bank of a local selector, release by the calling subscriber or originating local operator is effective to give the intercepting operator a disconnect signal. The trunk circuits are arranged to hold the trunk finder until the

intercepting operator disconnects when the call is intercepted at a local selector or local connector or plugging-up line and to hold the trunk finder until both ends have disconnected when the call is intercepted at a toll connector or toll selector. When the call is intercepted over a plugging-up line, or is intercepted at the terminals of a local selector, the trunk finder releases when the intercepting operator disconnects, irrespective of whether the calling end has or has not disconnected.

The invention will be better understood by considering a telephone system in which its features have been embodied, such a system being shown schematically in the drawings which form a part of this specification. The use of the invention is not limited, however, to the particular system illustrated and other applications of the invention will readily occur to one skilled in the art.

Referring to the drawings:

Fig. 1 represents schematically a toll line L, a toll operator's cord circuit CC1, position equipment OP and an outgoing trunk circuit T for use in extending calls to a distant step-by-step office;

Fig. 2 shows a toll selector TS in the step-by-step office for use in completing calls incoming from a manual toll office;

Fig. 3 shows a toll connector circuit TC for use in completing calls incoming from a toll office;

Fig. 3a shows a trunk circuit IT1 for intercepting connections extended to blank terminals in the banks of toll selectors;

Fig. 3b shows a similar trunk circuit IT2 for intercepting connections extended to blank terminals in the banks of toll connectors;

Fig. 4 shows an automatic subscriber's station A, a line finder LF and a first selector LS;

Fig. 5 shows a connector LC for completing local calls;

Fig. 5a shows a trunk circuit IT3 for intercepting calls extended to blank terminals in the bank of local selectors;

Fig. 6 shows a plugging-up line circuit PL and an intercepting trunk circuit IT5 from the plugging-up line for extending calls to an intercepting operator;

Fig. 6a shows a trunk circuit IT4 for use in intercepting calls extended to blank terminals in the banks of local connectors;

Fig. 7 shows a trunk finder TF having access to the intercepting trunks from toll and local selectors, from toll and local connectors and from plugging-up lines;

Fig. 8 shows an outgoing trunk circuit OT associated with a trunk finder, such as is shown in Fig. 7, and used in extending intercepted calls to a centralized intercepting operator's position in the same office or in a distant office;

Fig. 9 shows an incoming trunk circuit IT for receiving incoming intercepted calls;

Fig. 10 shows a cord circuit CC2 for use in answering incoming intercepted calls; and

Fig. 11 shows the manner in which Figs. 1 to 10, inclusive, are to be connected to form an operative arrangement.

The toll operator's cord and position circuits of Fig. 1 may be similar to those shown and described in the patent to R. C. Paine, No. 1,836,549, December 15, 1931. The selector and connector switches of Figs. 2, 3, 4 and 5 are of the well known two-motion step-by-step type as is also the trunk finder of Fig. 7. Reference may be had to pages 53 to 65 inclusive, of the second edition of "Automatic telephony" by Smith and Campbell, published in 1921, for a description in detail of the construction and operation of such switches.

The various intercepting trunks IT1 from the bank toll selector TS, IT2 from the bank of the toll connector TC, IT3 from the bank of local selector LS, IT4 from the bank of the local connector LC and IT5 from the plugging-up line PL all terminate in the bank of the trunk finder TF and in the banks of similar trunk finders, each of which is associated with a trunk terminating at the centralized intercepting switchboard. The operation of the system to extend intercepted calls to a centralized intercepting operator's position will be described first for calls incoming from a toll operator's position and second for local calls.

Referring to Fig. 1, a call incoming over toll line L may be answered by inserting plug 101 of the cord CC1 into jack 100. The talking key (not shown) is then operated to extend the connection to the operator's position circuit OP. Upon inquiry the operator receives the number of the called subscriber with which the calling subscriber or operator desired connection. If the called subscriber's line terminates in a distant automatic office, the plug 103 of the cord circuit CC1 is inserted in a jack connected to a trunk leading to the desired office, such for instance as the jack 110. The sleeve relay 111 of the outgoing trunk circuit T is thus operated by the energization of its lower winding in series with the supervisory lamp 104 of the cord circuit CC1, the current being insufficient to light the lamp. Upon operation of the dial key (not shown), a circuit is closed from battery (not shown) in the position circuit through the upper conductor of cord CC1 and plug 103, upper spring of jack 110, and through the upper back contact and winding of relay 112, to ground. Relay 112 operates, locks under control of the sleeve relay 111, and closes the dialing circuit from battery at the back contact of the release magnet 240 of the toll selector TS, through the upper winding of line relay 201, upper outer back contact of relay 211, lower back contact of relay 206, left lower winding of repeating coil 250, over the lower conductor of the interoffice trunk line 120, through the lower back contact of relay 117 in the outgoing trunk circuit T, outer lower back contact of relay 113, inner upper front contact of relay 112, tip conductors of jack 110, plug 103 and cord CC1 through the interrupter contacts of the dial 105, back through the ring conductors

of cord CC1, plug 103 and jack 110, lower front contact of relay 112, upper back contact of relay 113, winding of polarized relay 114, upper back contact of relay 117, over the upper conductor of trunk 120, outer upper back contact of relay 206, to ground at the inner upper back contact of relay 206. The line relay 201 of the selector TS operates thereby closing an obvious circuit for energizing release relay 202. Relay 202 connects ground at its upper front contact to conductor 219, causing the operation of relay 210. The circuit for operating relay 210 is traced from battery through the winding of relay 210, inner upper back contact of relay 211, lowermost back contact of relay 208, to the ground on conductor 219.

When the toll operator dials the first digit of the called subscriber's number the line relay 201 responds to the train of impulses thereby created, in the usual and well known manner. The first release of relay 201 closes a circuit from battery through the winding of the vertical stepping magnet 220, winding of relay 203, upper back contact of relay 212, lower front contact of relay 202, to ground at the back contact of relay 201. The vertical stepping magnet 220 and relay 203 both operate, the operation of the magnet being effective to step the brushes 215, 216, 217 and 218 up to the first level of the terminal bank. Relay 203 closes a circuit from battery through the winding of relay 204, inner front contact of relay 203, over conductor 219 to ground at relay 202. Relay 204 operates and it locks through its inner lower front contact and lowermost back contact of relay 212 to the ground on conductor 219. As soon as the shaft and brushes of the switch move out of normal position, the vertical off-normal springs VON are actuated, thereby closing a circuit for operating relay 205; this circuit is traced from battery through the back contact of the release magnet 240, upper contacts of the VON springs, winding of relay 205, outer front contact of relay 203 to the ground on conductor 219. Relay 205 locks to ground at its left front contact, under control of the back contact of the rotary stepping magnet 230, but independent of the continued operation of relay 203. The reoperation of relay 201 at the end of the first impulse causes the release of the magnet 220. Each succeeding release and reoperation of line relay 201 in response to the dialing of the first digit of the called subscriber's number causes a corresponding operation and release of the magnet 220, thereby stepping the selector brushes up to the level which corresponds to the digit dialed. Being slow to release, relay 203 remains operated until all of the first train of impulses have been received. Relay 202 is also slow to release and remains operated during the receipt of dial impulses.

When relay 203 releases after all of the first train impulses incoming to relay 201 have been received, a circuit for operating the rotary stepping magnet 230 is traced from battery through the winding of magnet 230, right front contact of relay 205, back contact of relay 203, over conductor 219 to ground at relay 202. The operation of the magnet 230 rotates the brushes 215, 216, 217 and 218 into engagement with the first set of terminals in the selected level and also opens the circuit through the winding of relay 205. Relay 205 releases thereby opening the circuit through the winding of the magnet 230; and magnet 230 releases. The first set of terminals are now tested to determine whether they are

idle or busy; the test circuit is traced from battery through the back contact of release magnet 240, upper contact of the VON springs, winding of relay 205, back contact of rotary magnet 230, through the inner lower back contact of relay 212, and through the sleeve or test brush 217 to the test terminal of the engaged set of terminals. If the first set of terminals is idle, the test terminal is not connected to ground and relay 212 is operated in a circuit from battery through the back contact of release magnet 240, upper contact of the VON springs, winding of relay 205, back contact of rotary stepping magnet 230, winding of relay 212, over conductor 219 to ground at relay 202; being marginal, relay 205 does not operate in this circuit. If the first set of terminals is busy, the winding of relay 212 is short circuited by the busy ground potential on the test terminal, which potential is effective to reoperate relay 205. The rotary stepping magnet 230 is thus reoperated to advance the brushes to the next set of terminals. Reoperation of relay 205 and magnet 230 continues as long as test brush 217 encounters the busy potential, but as soon as an idle set of terminals is reached, relay 212 operates as above described. Relay 212, operated, connects the ground on conductor 219, through its inner lower front contact, and through test brush 217 to the test terminal to prevent selection of the trunk connected to these terminals by any other hunting selector having access thereto. The busy ground is also effective as a holding potential connected through brush 217 and terminal 223 to hold the succeeding switches employed in establishing the desired connection.

The levels of the toll selector banks which represent assigned groups of telephone numbers may connect to intermediate toll selectors which in turn have access to groups of toll connectors. In the drawings, however, the terminals 231, 232, 233 and 234 are shown connected directly to the toll connector TC, intermediate selectors being omitted. The terminals 221, 222, 223 and 224 represent a level of the toll selector bank in which the terminals are connected to intercepting trunk circuits, the corresponding digit being one which represents an unassigned group of subscribers' numbers.

Assume, first, that the call from the toll operator's position in Fig. 1 is extended over trunk T and toll selector TS to the toll connector TC, the brushes of selector TS having been advanced into engagement with terminals 231, 232, 233 and 234. With relay 212 operated, a circuit is closed for operating the line relay 301 of connector TC; this circuit is traced from battery through the lower winding of relay 301, lowermost back contact of relay 306, terminal 232 and brush 216 of selector TS, middle lower front contact of relay 212, lower front contact of relay 201, inner lower back contact of relay 200, right lower winding of repeating coil 250, resistance 253, upper front contact of relay 204, upper right winding of repeating coil 250, upper back contact of relay 208, upper front contact of relay 212, brush 215 and terminal 231, uppermost back contact of relay 306, and through the upper winding of relay 301 to ground. Relay 301 closes an obvious circuit for operating the release relay 302. Relay 302 locks through its inner upper front contact, the inner upper back contact of relay 304, conductor 314, inner lower back contact of relay 306, conductor 313, terminal 233 and brush 217, inner lower front contact of relay 212, over conductor

219 to ground at relay 202. This ground is further extended from conductor 314 through terminal 234 and brush 218, the lowermost front contact of relay 212, and through the lower front contact of relay 204 to hold relay 204 operated.

When the toll operator dials the next digit of the called subscriber's number, relay 201 of selector TS alternately releases and reoperates causing the corresponding release and reoperation of relay 301 of connector TC, once for each dial impulse. The first release of relay 301 closes a circuit from ground at the inner upper back contact of relay 306, back contact of relay 301, inner lower front contact of relay 302, normally closed contacts of the vertical off-normal springs VON, winding of relay 303, and through the winding of the vertical stepping magnet 320 to battery. The magnet 320 operates thereby advancing the brushes 317, 318 and 319 up to the first level of the terminal bank. Relay 303 also operates and as soon as the switch moves out of its normal position the circuit for energizing the windings of magnet 320 and relay 303 is traced through the front contact of relay 303 and the upper front contact of the VON springs instead of through the normally closed contact of the VON springs. The magnet 320 releases when relay 301 reoperates at the end of the first impulse, each additional impulse causing the reoperation and release of magnet 320 to advance the connector switch brushes to the level corresponding to the digit dialed. Relay 303 is slow in releasing and remains operated until all of the impulses of the series have been received. Relay 302 is also slow in releasing and remains operated during receipt of dial impulses.

When the next and last digit of the called number is dialed, the first release of relay 301 closes a circuit from ground at the inner upper back contact of relay 306, back contact of relay 301, inner lower front contact of relay 302, upper front contact of the VON springs, back contact of relay 303, winding of relay 305, and through the winding of the rotary stepping magnet 330 to battery. The operation of magnet 330 advances the brushes 317, 318 and 319 to the first set of terminals in the selected level and the operation of relay 305 connects the winding of test relay 304 to the sieve brush 319. The magnet 330 releases when relay 301 reoperates at the end of the first impulse, each additional impulse causing the reoperation and release of magnet 330 to advance the brushes into engagement with the set of terminals corresponding to the digit dialed. Relay 305 is slow in releasing and remains operated until all of the impulses of the series have been received. Relay 304, being somewhat slow in operating, does not operate if the brush 319 engages a grounded test terminal during the advance of the brushes; but as soon as the brushes come to rest on the selected set of terminals, relay 304 operates in case the called line is busy as indicated by the presence of a ground potential on the test terminal.

Assuming that the called line is the line 309 connecting station C to terminals 331, 332 and 333 of the switch TC and that this line is idle when selected, the release of relay 305 closes a circuit from battery through the winding of the cut-off relay 301 of line 300, through terminal 333 and brush 319, lower back contact of relay 305, inner lower back contact of relay 304, middle upper back contact of relay 306, middle upper front contact of relay 302, through the upper winding of relay 306 to the holding ground from

relay 202 of selector TS on sleeve conductor 313. Relay 306 is sufficiently energized to close its inner lower front contact and thus lock through its lower winding to the holding ground. The operation of relay 306 extends the connection from the calling line through its outermost front contacts, the outermost front contacts of relay 302, the outermost back contacts of relay 304, and through brushes 317 and 318 to the called line. The operation of relay 306 also disconnects control conductor 314 from sleeve conductor 313 thereby causing the release of relay 204 of the toll selector TS. The release of relay 204 closes a circuit from battery at the back contact of release magnet 240, lower front contacts of the VON springs, winding of relay 206, to ground at the lowermost back contact of relay 204. Relay 206 operates, thereby reversing the current over trunk 120, the tip conductor of trunk 120 being connected through the upper left winding of repeating coil 250, the upper front contact of relay 206, resistance 251, uppermost back contact of relay 211, upper winding of relay 201, to battery at the back contact of release magnet 240; and the ring conductor of trunk 120 is connected through the lower left winding of repeating coil 250, inner lower front contact of relay 206, resistance 252, inner lower back contact of relay 211, through the lower winding of relay 201 to ground. This reversal of current is effective to operate the polarized relay 114 of the trunk circuit T and a polarized relay (not shown) in the toll operator's position equipment, thereby causing the dial 105 to be disconnected from the cord CCI. The operation of relay 114 closes an obvious circuit for operating relay 113. Relay 113 locks under control of relay 111 and the connection from the line conductors of cord CCI is extended through the front contacts of relays 112 and 113 to the left-hand windings of repeating coil 118. The inner end of the lower left-hand winding of coil 118 is further connected through the winding of relay 117 to ground, this relay being under control of the ringing key (not shown) of the cord circuit. With relay 113 operated, the supervisory relay 115 and right-hand windings of repeating coil 118 are bridged across the conductors of trunk 120 leading to the toll selector TS in the distant step-by-step office, thereby operating relay 115 of trunk circuit T and maintaining the energization of the line relay 201 of the toll selector TS. The operation of relay 115 connects the upper winding of relay 111 in parallel with the lower winding, thus reducing the resistance of the sleeve circuit of the cord CCI sufficiently to light the supervisory lamp 104.

The aforementioned operation of relay 306 of the toll connector TC also causes the release of relay 301 but relay 302 is held operated through its upper winding and inner upper front contact, inner upper back contact of relay 304, control conductor 314, terminal 234 and brush 218, the lowermost front contact of relay 212, inner lower back contact of relay 204, outer lower back contact of relay 211, outer front contact of relay 210, outer lower back contact of relay 208, over conductor 219 to ground at release relay 202.

Further operation now awaits the operation of the ringing key at the toll operator's position in response to which relay 117 of trunk circuit T is operated. Relay 117 connects the alternating ringing current source 119 across the outgoing conductors of trunk 120, thereby causing the operation of relay 207 of the toll selector TS. Relay 207 closes a circuit for operating relay 208.

The operation of relay 208 disconnects the holding ground on conductor 219 from brush 218, thereby causing the release of relay 302 of the connector TC. The operation of relay 208 also causes the release of relay 210 and the release of relay 210 reconnects the ground on conductor 219 to the brush 218; relay 210 is slow in releasing to insure the release of relay 302 of the connector. The release of relay 302 closes a ringing circuit from the source of ringing current 325, middle lower front contact of relay 306, lower winding and outer lower back contact of relay 302, outer lower back contact of relay 304, brush 318 and terminal 332, over line 300 and through the ringer (not shown) at station C, back through terminal 331 and brush 317, outer upper back contacts of relays 304 and 302, to ground at the middle upper front contact of relay 306. When the ringing key at the toll operator's position is released relays 207 and 208 release and relay 210 reoperates. When the subscriber at station C removes the receiver to answer the call, relay 302 is operated by the current through its lower winding and this relay is again locked through its upper winding and inner upper front contact over the control conductor 314 to ground at relay 202 of the toll selector TS. Talking current is now supplied to the called subscriber in a circuit from battery through the lowermost front contact of relay 206 of the toll selector TS, lower winding of supervisory relay 213, middle lower back contact of relay 204, lower right winding of repeating coil 250, inner lower back contact of relay 206, lower front contact of relay 201, middle lower front contact of relay 212, brush 216 and terminal 232, lowermost front contacts of relays 306 and 302 of connector TC, lowermost back contact of relay 304, brush 318 and terminal 332, over line 300 and through the subscriber's telephone at station C, back through terminal 331 and brush 317, the uppermost back contact of relay 304, the uppermost front contacts of relays 302 and 306, through terminal 231 and brush 215, upper front contact of relay 212 of selector TS, upper back contact of relay 208, upper right winding of repeating coil 250, upper back contact of relay 204, and through the upper winding of relay 213 to ground. The supervisory relay 213 operates to effect the operation of relay 211. Relay 211 disconnects the windings of relay 201 thereby causing the release of relay 115 of the trunk circuit T. With relay 115 released the circuit through the upper winding of relay 111 is opened thus causing the supervisory lamp 104 to be extinguished. The voice currents are now transmitted through repeating coils 118 and 250, the trunk 120 having no direct current flowing thereover. Relay 201 of the toll selector is held operated by connecting resistance 214 in series with its windings, this connection being made at the next-to-the inner lower front contact of relay 211. The operation of relay 211 also causes the release of relay 210.

When the called subscriber replaces the receiver on the receiver hook, supervisory relay 213 releases causing the release of relay 211. Relay 201 now holds in the circuit over trunk 120 causing the reoperation of relay 115 of trunk circuit T and the lighting of supervisory lamp 104. Relay 210 reoperates. The operator may rering the called subscriber if this is found desirable. When the plug 103 is removed from jack 110, relays 111, 112 and 113 release, thus restoring trunk circuit T to normal. The release of relay

113 opens the bridge across trunk 120 causing the release of relay 201 of the selector TS followed by the release of relay 202. The release of relay 202 causes the release of relays 210 and 212 of selector TS and the release of relays 302 and 306 of the connector TC. The release of relay 202 closes a circuit from battery through the middle front contact of the VON springs, winding of release magnet 240, through back contacts of relays 202 and 201 to ground. Magnet 240 operates causing the shaft and brushes of switch TS to be restored to normal in the usual manner and causing the release of relay 206. When the shaft reaches normal the VON springs are restored to normal, releasing magnet 240.

The release of relays 302 and 306 of connector TC closes a circuit from battery through the winding of release magnet 340, lower front contact of the VON springs, inner lower back contact of relay 302, back contact of relay 301, to ground at the inner upper back contact of relay 306. Magnet 340 operates causing the shaft and brushes of switch TC to be restored to normal. When the shaft reaches normal the VON springs are restored to normal releasing magnet 340.

Should the called line 300 be busy when seized by the switch TC as hereinbefore described, the operation of test relay 304 disconnects the tip and ring conductors of the connector from the brushes 317 and 318 to prevent interference with the call already in progress over the called line. When relay 305 releases, a locking circuit for relay 304 is closed before the operating circuit is opened, the locking circuit being traced from battery through the winding of relay 304, back contact of the continuity springs of relay 305, inner lower front contact of relay 304, middle upper back contact of relay 306, middle upper front contact of relay 302, upper winding of relay 306, to the holding ground from selector TS on conductor 313. Relay 305 is sufficiently energized to close its inner lower front contact thus locking through its lower winding to the ground on conductor 313. The operation of relay 306 connects ground through its inner upper front contact to the inner lower armature of relay 304 to hold relay 304. With relay 304 operated, relay 302 holds through its inner upper front contact and the inner upper front contact of relay 304 to the holding ground on conductor 313. The operation of relay 306 also causes the release of relay 301 and disconnects the holding ground on conductor 313 from the control conductor 314 thereby causing the release of relay 204 of the toll selector TS. The release of relay 204 causes the operation of relay 205, reversing the current over trunk 120. This reversal of current operates relay 114 of trunk circuit T and causes the dial 105 to be disconnected. Relay 113 operates to connect the left-hand windings of repeating coil 113 to the cord CC1 and to bridge the winding of relay 115 across the conductors of trunk 120 as hereinbefore described. With relay 204 of the toll selector TS released a circuit is closed from ground through interrupter 315 of the toll connector TC, through the lowermost front contacts of relays 304, 302 and 306, terminal 232 and brush 216 of the toll selector TS, middle lower front contact of relay 212, lower front contact of relay 201, middle lower back contact of relay 203, right lower winding of repeating coil 250, middle lower back contact of relay 204, lower winding of relay 212, and through the

lowermost front contact of relay 206 to battery. The alternate closing and opening of this circuit under control of interrupter 315 causes the alternate operation and release of relays 213 and 211. Relay 211 thus alternately opens and closes the connection from battery and ground through the windings of relay 201 to the conductors of trunk 120 to cause the alternate release and reoperation of relay 115 of trunk circuit and the flashing of lamp 104 to indicate that the called line is busy. When the toll operator removes plug 103 from jack 110, the trunk circuit T, toll selector TS and connector TC are restored to normal in the same manner as hereinbefore described, the release of relay 306 of the connector TC causing the release of relay 304.

Assume, next that the call from the toll operator's position in Fig. 1 is extended over trunk T and through toll selector TS to the intercepting trunk circuit IT1 in Fig. 3a, the brushes of switch TS having been advanced into engagement with terminals 221, 222, 223 and 224. Since relay 204 requires a locking circuit through its lower front contact and brush 218 in order to remain operated after relay 212 operates and since the trunk IT1 has no conductor connected to terminal 224 with which brush 218 is in contact, the aforementioned operation of relay 212 causes the release of relay 204. With relay 204 released, relay 206 operates as hereinbefore described thereby connecting battery through the lowermost front contact of relay 206, lower winding of relay 213, middle lower back contact of relay 204, lower right winding of the repeating coil 250, inner lower back contact of relay 208, lower front contact of relay 201, middle lower front contact of relay 212, brush 216 and terminal 222 to the ring conductor 352 of trunk IT1 and connecting ground through the upper winding of relay 213, upper back contact of relay 204, upper right winding of repeating coil 250, upper back contact of relay 208, upper front contact of relay 212, brush 215 and terminal 221 to the tip conductor 351 of trunk IT1. The operation of relay 206 is also effective to reverse the current over trunk 120 and thus cause the disconnection of dial 105, the extension of the line conductors of cord CC1 to the windings of repeating coil 118, the lighting of supervisory lamp 104, and the connection of the winding of relay 115 across the conductors of trunk 120, all as hereinbefore described. Further operation of the dial is ineffective and the lighting of lamp 104 prior to the completion of dialing indicates that the call is being intercepted and the ringing key will not be operated.

Upon seizure of the trunk circuit IT1, a circuit is closed from the busy and holding ground connected to the test terminal 223, over test conductor 350, through the lower back contact of relay 355 of trunk circuit IT1 and through the winding of trunk relay 354 to battery. Relay 354 operates thereby connecting the winding of cut-off relay 355 over the sleeve conductor 353 of trunk IT1 to test terminals in the banks of the trunk finders which have access to this trunk. Thus, the line conductors 351 and 352 of trunk IT1 are connected to terminals 711 and 712 in one of the terminal banks of finder TF and the sleeve conductor 353 is connected to the corresponding test terminal 713 in the test bank of finder TF. Relay 354 also closes a circuit from ground through the upper back contact of relay 355, the upper front contact of relay 354, over the group conductor 700, through the winding of group relay

701 to battery. Group relay 701 operates thereby connecting ground through its right front contact, over conductor 702, to the corresponding segment of the vertical commutators of all of the trunk finders having access to the group of trunks which includes the trunk IT1. In the drawings this is shown as the second segment of commutator 703 and corresponding to the second level of the bank of switch TF.

Assuming the trunk finder TF to be the first idle trunk finder in the group, the operation of relay 701 also closes a circuit for operating relay 705; this circuit is from ground at the left front contact of relay 701, over the start conductor 704, through the inner upper back contact of relay 708 and winding of relay 705 to battery. Relay 705 connects ground through its inner lower front contact over conductor 773 to the sleeve conductor of the outgoing trunk circuit OT in Fig. 8 and closes a circuit, for operating relay 707, from battery through the uppermost back contact of relay 708, upper winding of relay 707, back contacts of the rotary stepping magnet 730 and vertical stepping magnet 720, to ground at the lowermost front contact of relay 705. Relay 707 operates thereby closing a circuit from battery at the uppermost back contact of relay 708, winding of the vertical stepping magnet 720, lowermost back contact of relay 708, front contact of relay 707 to ground at the lowermost front contact of relay 705. The magnet 720 operates, thereby stepping the two sets of brushes 761, 762 and 763 and 764, 765 and 766 up to the first level of terminals in the associated banks. The vertical commutator brush 717 is also stepped up to make contact with the first segment of the commutator 703. The operation of magnet 720 also causes the release of relay 707; and the release of relay 707 causes the release of magnet 720.

Although the calling trunk may be connected to terminals in the banks associated with brushes 761, 762 and 763 or to terminals in the banks associated with brushes 764, 765 and 766, the intercepting trunks IT1, IT2, IT3, IT4 and IT5 are all shown connected to terminals in the second level of the banks with which the brushes 761, 762 and 763 are associated and description of the terminal hunting operating of the trunk finder will, therefore, be limited to the case where the calling trunk is encountered by the latter set of brushes. Since the trunk, for which the trunk finder TF is seeking, is connected to terminals in the second level, the commutator brush 717 does not encounter ground potential on the first commutator segment to stop further hunting. With magnet 720 released, relay 708 reoperates again closing the circuit for operating magnet 720. The brushes are thus stepped up to the second level of the terminal banks. Since trunk IT1 is connected to terminals in the second level, a circuit is closed for energizing relay 709 as soon as the commutator brush 717 comes in contact with the second commutator segment; this circuit is traced from battery through the uppermost back contact of relay 708, upper winding of relay 707, back contact of magnet 730, upper winding of relay 709, commutator brush 717, second commutator segment, conductor 702 to ground at the right front contact of group relay 701. This circuit is also effective to hold relay 707 operated. Relay 709 is slow in operating to ensure proper positioning of the brushes before the first rotary step. Relay 709 opens the circuit through the winding of magnet 720 so that magnet 720 releases. Relay 709 also closes a circuit, for operating the rotary stepping magnet 730, from battery through the winding of magnet 730, lowermost front contact of relay 709, front contact of relay 707 to ground at the lowermost front contact of relay 705. The operation of magnet 730 steps the two sets of brushes into contact with the first set of terminals in the second level of each of the associated banks. The circuit through the upper windings of relays 707 and 709 is opened when magnet 730 operates and is also opened at the commutator due to brush 717 being rotated out of alignment with the segments. Relay 707 releases but relay 709 is held operated in a circuit from battery through the upper most back contact of relay 708, winding of magnet 720, lower winding and inner lower front contact of relay 709, to ground at the lowermost front contact of relay 705; the current in this circuit is not sufficient to operate the magnet 720. If the first set of terminals in the second level is not the set to which the calling trunk IT1 is connected, magnet 730 releases when relay 707 releases; relay 707 reoperates when magnet 730 releases and causes the reoperation of magnet 730 to advance the brushes into engagement with the second set of terminals. The alternate reoperation and release of relay 707 and rotary stepping magnet 730 continues until the test brush 763 encounters test terminal 713 to which conductor 353 is connected; at which time a circuit is closed from battery through the winding of the cut-off relay 355 of trunk circuit IT1, lower front contact of relay 354, conductor 353, terminal 713, brush 763, lower winding of relay 710, lowermost back contact of relay 708, lower winding of relay 707 to ground at the inner lower front contact of relay 705. Relay 707 is held energized, and relay 710 is operated in this circuit sufficiently to close its inner upper front contact. Relay 710 is thus fully energized and locked operated in the circuit from battery through its upper winding and inner upper front contact, conductor 774, front contact of magnet 730, front contact of relay 707, to ground at the lowermost front contact of relay 705. Magnet 730 is held operated under control of relays 709 and 707. The cut-off relay 355 of trunk circuit IT1 is also operated by closure of the above circuit through brush 763 and terminal 713, thereby disconnecting the ground at the upper back contact of relay 355 from group conductor 700. The operation of relay 355 also causes the release of relay 354, thereby extending the holding ground at the upper front contact of relay 202 of toll selector TS, over conductors 219 and 350, through the inner front contact of relay 355 and inner back contact of relay 354, to hold relay 355; and from conductor 350 through the outer front contact of relay 355 and the lowermost back contact of relay 354 to sleeve conductor 353 to hold the trunk finder TF in its operated position. The aforementioned operation of relay 710 extends the connection from the toll operator's position, over conductors 351 and 352 of trunk IT1 through terminals 711 and 712 and brushes 761 and 762, outer back contacts of relay 706, outer front contacts of relay 710, over conductors 771 and 772 of the trunk finder TF to the outgoing trunk circuit OT. Relay 710 also closes a circuit from battery through the lower winding of relay 708, middle upper front contact of relay 710, over conductor 770 to ground at the lower front contact of the vertical off-normal springs VON; the VON springs were operated when the shaft and brushes stepped up to the first level. The operation of relay 708 causes the release of relay 705 and extends the holding ground on

sleeve conductor 353 (from the toll selector TS) through terminal 713 and brush 763, through the inner lower front contact of relay 710, the inner lower back contact of relay 766, and the lowermost front contact of relay 798 to the sleeve conductor 773 leading to the outgoing trunk circuit OT. This holding ground is further extended from conductor 773, through the inner lower front contact of relay 798, over conductor 774, to hold relay 710 operated. Relay 798 also disconnects the battery at its uppermost back contact from the windings of relay 797 and magnet 729 and short circuits the lower winding of relay 797 thereby causing the release of relays 707 and 799. The group relay 761 releases when relay 355 of the trunk circuit IT1 releases unless another trunk in the same group is awaiting connection to another outgoing trunk, in which case the ground at the left front contact of relay 701 is extended over conductor 764, through the outer upper front contact of relay 708, over conductor 769 to the next trunk finder (not shown) in the group. The rotary magnet 730 releases when relay 799 releases leaving only relays 708 and 710 operated during the further extension of the connection to the intercepting operator.

With conductors 351 and 352 of intercepting trunk IT1 extended over conductors 771 and 772 to the outgoing trunk circuit OT, and with relays 204 and 208 of the toll selector normal, relay 802 of the outgoing trunk circuit OT is operated in a circuit from ground at the upper back contact of relay 823, resistance 826, lower winding of relay 892, lower back contact of relay 824, conductor 772 of trunk finder TF, lowermost front contact of relay 710, lowermost back contact of relay 796, brush 762, terminal 712, conductor 352 of intercepting trunk IT1, terminal 222 and brush 216 of toll selector TS, middle lower front contact of relay 212, lower front contact of relay 261, inner lower back contact of relay 269, right lower winding of repeating coil 250, middle lower back contact of relay 294, lower winding of relay 213, lowermost front contact of relay 296, to battery. The resistance 826 is high enough to prevent the operation of relay 213 in this circuit. The operation of relay 892 closes an obvious circuit for operating relay 897. Relay 897 connects ground to sleeve conductor 833 and locks through its lower front contact and the lower back contacts of relays 814 and 823 to this same ground. Relay 897 also closes a circuit for operating relay 898. Relay 898 closes a circuit for operating relay 899, and relay 899 closes a circuit for operating relay 819. Relay 819 closes a circuit for operating relay 814, from battery through the winding of relay 814, upper front contact of relay 819, upper back contact of relay 815, to the ground on conductor 833. With relay 814 operated, battery and ground are connected to the tip and ring conductors of the interoffice trunk 969 leading to the centralized intercepting switchboard to cause the operation of the line relay 991 at the distant end of the trunk. The circuit for operating relay 961 is traced from battery through the upper winding of relay 815, upper front contact of relay 814, right upper winding of repeating coil 830, conductor 831 and upper conductor of trunk 999 leading to the intercepting switchboard, upper back contact of relay 996, winding of relay 991, lower back contact of relay 996, ring conductor of trunk 990, conductor

832, right lower winding of repeating coil 830, inner lower front contact of relay 814, lower winding of relay 815 to ground. Relay 815 is marginal and does not operate in this circuit. Relay 901 closes a circuit for lighting the answering lamp 902.

When an operator at the intercepting switchboard inserts the plug of an answering cord in jack 993 to answer the call and assuming the cord CC2 to be the one used in answering, a circuit is closed from battery through the upper back contact of relay 959, winding of relay 952, lower back contact of relay 955, ring conductor of plug 951 and jack 993 through the lower winding of relay 994 to ground. Relay 994 is marginal and does not operate; but relay 952 operates, thereby closing a circuit for operating relay 953 from battery through the lower back contact of relay 959, winding and front contact of the continuity springs of relay 953, to ground at the front contact of relay 952. Relay 953 locks through the front contact of its continuity springs, over the sleeve conductor of plug 951 and jack 993 through the winding of relay 996 to ground, thereby operating relay 996. Relay 953 also closes a circuit for operating relay 954 and relay 954 closes a circuit for operating relay 955. The aforementioned operation of relay 996 disconnects relay 991 from the conductors of trunk 990 and extends those conductors through the front contacts of relay 996 and the back contacts of relay 995, through the windings of relay 997 to battery and ground. Relay 815 of the outgoing trunk circuit OT and relay 997 of the incoming trunk circuit IT are thus operated by the energization of their upper windings in series and their lower windings in series. With relay 997 of the trunk circuit IT and relay 955 of the cord circuit CC2 both operated, a circuit is closed from battery through the upper winding of relay 994 and front contact of relay 997 of trunk IT, through the tip conductors of jack 993 and plug 951, retard coil 956, windings of relays 957 and 958, lower back contact of flashing key 961, lower front contact of relay 955, through the ring conductors of plug 951 and jack 993, and through the lower winding of relay 994 to ground. Relay 957 operates, but relay 958 does not operate because it is polarized and the marginal relay 994 does not operate because the current in this circuit is insufficient.

The aforementioned operation of marginal relay 815 of the outgoing trunk circuit OT as a result of the answer of the call by an operator at the intercepting switchboard, causes the release of relay 814 and the operation of relay 823. The release of relay 814 disconnects the windings of relay 815 from conductors 831 and 832 and connects a supervisory bridge, comprising resistances 821 and 822 and the windings of relays 816 and 817, across these conductors. The upper windings of relays 816 and 817 are of low resistance and the lower windings of these relays are of high resistance, the lower windings and resistance 822 being short circuited by the upper front contact of relay 810. Relay 816 is polarized and does not operate, but relay 817 is operated by the current through its upper winding in series with the line relay 997 of the incoming trunk circuit IT. Relay 817 provides a ground connection for holding relay 818 operated after relay 819 releases. Relay 815 does not release, when relay 814 releases, being locked through its upper winding and upper front contact to ground on sleeve conductor 833, the hold-



ing ground being supplied from the front contact of relay 818 and also from the release relay of the toll selector TS. Relay 823 closes a circuit for operating relay 824, thereby disconnecting relays 801 and 832 from the tip and ring conductors 771 and 772. The release of relay 802 causes the release of relay 807 since its locking circuit is open at the lowermost contacts of relay 823. The release of relay 807 causes the release of relays 808, 809 and 810. With relay 823 operated and before relay 809 releases, the ring conductor 772 is extended through the lower back contact of relay 808, the lower front contacts of relays 823 and 809, and through resistance 813 to ground; the resistance 813 is low enough to cause the operation of the tripping relay on calls intercepted at connector switches arranged to transmit ringing current over the intercepting trunk. When relay 809 releases, the resistance 813 is disconnected from conductor 772 and a supervisory loop is closed from the tip conductor 771 of trunk finder TF, through the upper back contact of relay 808, left upper winding of repeating coil 830, windings of relay 812, winding of relay 811, left lower winding of repeating coil 830, lower back contact of relay 809, lower front contact of relay 823, lower back contact of relay 806 to the ring conductor 772 of trunk finder TF. Relay 812 operates and since the current in this circuit is in the operating direction for polarized relay 811, this relay also operates. The operation of relay 811 short circuits the high resistance lower winding of relay 812, thereby increasing the current in the supervisory circuit sufficiently to operate the marginal supervisory relay 213 of the toll selector as an indication that the call has been answered. When relay 213 of the toll selector operates, it closes a circuit for operating relay 211, thereby disconnecting the winding of relay 201 from the conductors of trunk 120, but holding relay 201 operated by bridging resistance 214 across its windings. With battery and ground disconnected from trunk 120, relay 115 of the trunk circuit T releases thereby causing the supervisory lamp 104 of cord circuit CC1 to be extinguished.

With the talking key 960 of cord CC2 operated, conversation may be carried on between the toll operator and the intercepting operator. The connection is under the joint control of the two operators. Should it be necessary for the intercepting operator to attract the toll operator's attention, the flashing key 961 of cord circuit CC2 is alternately operated and released thereby intermittently eliminating the windings of relays 957 and 958 from the bridge across the tip and ring conductors of cord CC2 to cause the alternate operation and release of the marginal relay 904 of the trunk circuit IT. The operation of relay 904 closes a circuit for operating relay 905 and relay 905 interchanges the connections between the conductors of trunk 900 and the windings of relay 907 so as to cause the current over trunk 900 to be reversed and thus operate the polarized relay 816 of the outgoing trunk circuit OT. The alternate operation and release of relay 816, under control of the flashing key, causes the short circuit around the lower winding of relay 812 to be intermittently opened, thereby causing the alternate release and reoperation of relay 213 of the toll selector TS. Relay 211 is thus alternately released and reoperated to cause the alternate operation and release of relay 115 of the trunk circuit T which results

in the flashing of the supervisory lamp 104 of the cord circuit CC1.

Upon release of the connection at the calling end by the removal of the plug 103 from jack 110, relay 111 releases thereby causing the release of relays 112 and 113. The release of relay 113 opens the bridge across the conductors of trunk 120, but further release of the connection is under control of the intercepting operator. Since no disconnect signal is given the intercepting operator when the toll operator releases the connection, the plug 951 of cord CC2 should be removed from jack 903, as soon as conversation is completed. Upon removal of plug 951, relay 953 of the cord circuit and relay 906 of trunk circuit IT both release; relay 957 also releases. The release of relay 953 is followed by the release of relays 954 and 955 thus restoring the cord circuit CC2 to normal. Relay 906 disconnects the conductors of trunk 900 from the windings of relay 907 and reconnects the winding of relay 901 across the trunk. Relay 907 of the incoming trunk circuit IT and relay 817 of the outgoing trunk circuit OT are thus released. The release of relay 817 causes the release of relay 818. The release of relay 818 disconnects the ground on its lower armature from sleeve conductor 833 and causes the release of relay 819. Relay 819 opens the short circuit around the high resistance winding of relay 812 to release the supervisory relay 213 of the toll selector TS. The release of relay 213 is followed by the successive release of relays 211, 201 and 202. The release of relay 202 disconnects the holding ground from conductor 219 and causes the return of the toll selector TS to normal in the usual manner. The release of relay 201 causes the release of relays 811 and 812 of the outgoing trunk circuit OT. With holding ground disconnected from sleeve conductor 219 of selector TS due to the release of relay 202 and with holding ground disconnected from sleeve conductor 833 of the outgoing trunk circuit OT due to the release of relay 818 (both the toll and the intercepting operators having released the connection) relay 355 of the trunk circuit IT1, relay 710 of the trunk finder TF and relay 815 of the outgoing trunk circuit OT release. The release of relay 815 causes the successive release of relays 823 and 824. When relay 710 of the trunk finder TF releases, a circuit is closed from battery through the winding of release magnet 740, upper front contact of the VON springs, inner upper back contact of relay 709, upper back contact of relay 710, back contact of relay 705, to ground at the lower front contact of the VON springs. The release magnet 740 is thus operated to return the trunk finder to normal. When the shaft reaches normal, the circuits through the winding of the release magnet 740 and the lower winding of relay 708 are opened. If the start conductor 704 is free from ground potential when the circuit through the lower winding of relay 708 is opened, or as soon thereafter as conductor 704 is free from ground potential, relay 708 releases. All of the various circuit units involved in extending a call intercepted at the bank of a toll selector to an operator at a central intercepting switchboard have now been restored to normal. Should the called line number be an unassigned number in a partially assigned group of one hundred line numbers, the connection is extended by the operation of the toll selector TS and a toll connector TC, the terminals corresponding to unassigned numbers in the bank of

connector TC being connected to one or more intercepting trunks. Such a trunk is shown connected to terminals 321, 322 and 323 in the bank of switch TC, the associated trunk circuit IT2 shown in Fig. 3b being similar to the trunk circuit IT1 of Fig. 3a. The trunk IT2 connects to terminals 721, 722 and 723 of trunk finder TF and the further extension of the connection to an intercepting operator's position is completed in a similar manner to that hereinbefore described for the call intercepted by trunk IT1 except that relay 802 receives ringing current from connector TC. The direct current path for operating relay 802 during the silent interval of the ringing cycle is through the lower winding of this relay and resistance 826 to ground at the upper back contact of relay 823; and the alternating current path is traced from conductor 772 through condenser 804, and the upper winding of relay 802 to ground. When resistance 813 is temporarily connected to conductor 772 in response to the answer of the intercepting operator, as hereinbefore described, the tripping relay 302 of connector TC operates to complete the supervisory circuit between the toll selector TS and the outgoing trunk OT. The supervisory operations are similar to those on a call intercepted over trunk IT1, the connector TC being released when the selector TS releases in the usual and well known manner.

Consider next a call originated by the subscriber at station A in Fig. 4. The telephone set at station A may be of any type suitable for use in an automatic telephone system, the dial 400 being provided for dialing the number of any subscriber's line with which connection is desired. The line 401 connects station A to the usual line circuit (not shown) in the central office and also to terminals in the banks of a group of line finders one of which designated LF is represented by the brushes 402 and the associated terminals. This line finder may also be of the well known Strowger type. For a disclosure of such a finder and a description of its operation, reference may be had to the patent to H. Hovland No. 1,711,682 granted May 7, 1929.

Assume the line 401 to have been extended through the brushes 402 of line finder LF to the line relay 403 of the associated first selector LS. Relay 403 operates closing an obvious circuit for operating the release relay 404. Relay 404 connects ground through its lower front contact to sleeve conductor 413 to hold the line finder LF in its operated position and to hold the cut-off relay (not shown) of the line 401 in the well known manner. The dialing of the first digit by the subscriber at station A causes the alternate release and reoperation of relay 403 in response to the dial impulses thus created. The first release of relay 403 closes a circuit from ground through the uppermost back contact of relay 406, back contact of relay 403, the upper front contact of relay 404, winding of relay 405, and through the winding of the vertical stepping magnet 420 to battery. The relay 405 and magnet 420 operate, the operation of the magnet causing the shaft and brushes of switch LS to be stepped up to the first level of the terminal bank. The reoperation of relay 403 at the end of the first impulse causes the release of magnet 420. Relay 405 is slow in releasing and remains operated until all of the impulses in the train have been received. Relay 404 is also slow in releasing and remains operated during the receipt of dial impulses. Each succeeding release

and reoperation of relay 403 in response to dial impulses are effective to cause a corresponding operation of magnet 420, the brushes 417, 418 and 419 being thereby stepped up to the level of terminals corresponding to the digit dialed.

When the shaft of switch LS is moved out of its normal position upon receipt of the first dial impulse, the vertical off-normal springs VON are actuated and with relay 404 operated as above described, a circuit is closed from battery through the winding of relay 407, upper contact of the VON springs, front contact of relay 405, to the holding ground on conductor 413. Relay 407 closes a locking circuit traced from the upper contact of the VON springs, through the bank contact of the rotary stepping magnet 430, conductor 409, and the outer front contact of relay 407 to ground at the uppermost back contact of relay 406. When relay 405 releases after all of the impulses corresponding to the first digit have been received, a circuit is closed from battery through the winding of magnet 430, inner front contact of relay 407, back contact of relay 405, to ground on sleeve conductor 413. The operation of magnet 430 advances the brushes of switch LS into contact with the first set of terminals in the selected level and opens the circuit through the winding of relay 407. The release of relay 407 causes the release of magnet 430. The release of magnet 430 connects the winding of relay 407, through the upper contact of the VON springs, back contact of magnet 430, to conductor 409 thence through the lowermost back contact of relay 406 to sleeve brush 419 and also from conductor 409 through the winding of relay 406 and the lower back contact of the 11th ROTARY STEP springs to the holding ground on conductor 413. If the first set of contacts is idle, relay 406 operates in series with relay 407. Relay 407 is marginal and does not operate unless the first set of terminals is busy, in which case the brush 419 encounters ground potential on the terminal with which it is in contact, the winding of relay 406 being short circuited. With relay 407 reoperated, the rotary stepping magnet 430 reoperates thereby advancing the brushes of switch LS to the next set of terminals in the selected level. Relay 407 and magnet 430 thus continue their cycle of operations as above described to advance the brushes of switch LS until an idle set of terminals is encountered at which time relay 406 operates to extend the connection from line 401 through its inner front contacts to brushes 417 and 418. With relay 406 operated the sleeve conductor 413 is connected through the lowermost front contact of relay 406 to sleeve brush 419. The operation of relay 406 also causes the release of relays 403 and 404. Relay 404 being slow in releasing maintains the holding ground on conductor 413 until a holding ground has been supplied through brush 419 from the succeeding switch or trunk as a result of its seizure as hereinafter described. Relay 406 is thus held operated, after relay 404 releases, by the holding ground supplied through brush 419.

The levels of the local selector banks which represent assigned groups of telephone numbers may connect to intermediate selectors which in turn have access to groups of local connectors. In Fig. 4, however, the terminals 431, 432 and 433 are shown connected directly to the local connector LC of Fig. 5. The terminals 421, 422 and 423 represent a level of the first selector bank in which the terminals are connected to inter-

cepting trunk circuits, the corresponding digit being one which represents an unassigned group of subscribers' numbers.

Assuming first that the call is for an assigned number and that brushes 417, 418 and 419 have been advanced into engagement with terminals 431, 432 and 433, the connection from line 401 is extended through brushes 417 and 418 and terminals 431 and 432, and through the inner back contacts of relay 504 of connector LC to the windings of line relay 501. Relay 501 operates, in turn causing the operation of relay 502. Relay 502 connects ground through its lower front contact over sleeve conductor 513 to test terminal 433 to hold relay 406 of the selector LS and also to hold the line finder LF in its operated position and to hold the cut-off relay (not shown) of the line 431 all in the well known manner. When the calling subscriber dials the penultimate digit of the called subscriber's number, relay 501 is alternately released and reoperated in response to the dial impulses thus created. The first release of relay 501 closes a circuit from ground at its back contact, through the inner upper front contact of relay 502, normally closed contact of the vertical off-normal springs VON, winding of relay 503 and through the winding of the vertical stepping magnet 520 to battery. The relay 503 and magnet 520 both operate, the operation of the magnet stepping the shaft and brushes of switch LC up to the first level of the terminal bank. When the relay 501 reoperates, magnet 520 releases, but relay 503 is slow in releasing and remains operated until all of the impulses in the train have been received. Relay 502 is also slow in releasing and remains operated until the connection is released by the calling subscriber. Each succeeding release of relay 501 causes the reoperation of magnet 520 thereby advancing the brushes 517, 518 and 519 up to the level corresponding to the digit dialed. After the switch is advanced from its normal position in response to the first impulse, the circuit for holding relay 503 and reoperating magnet 520 is traced through the upper front contact of the vertical off-normal springs VON and the front contact of relay 503 instead of through the normally closed contact of the VON springs.

When relay 501 releases in response to the first impulse created by the dialing of the last digit of the called subscriber's number, relay 505 and the rotary stepping magnet 530 are operated in a circuit from battery through the winding of magnet 530 and outer upper back contact of relay 511 in parallel with battery through the winding of relay 505, through the upper back contact of relay 507, back contact of relay 503, upper front contact of the VON springs, inner upper front contact of relay 502, to ground at the back contact of relay 501. The operation of relay 505 renders the energization of this relay and magnet 530 independent of relay 507, the upper front contact of relay 505 being in parallel with the upper back contact of relay 507. The operation of magnet 530 advances the brushes 517, 518 and 519 into contact with the first set of terminals in the selected level. The reoperation of relay 501 at the end of the first impulse causes the release of magnet 530. Each succeeding release of relay 501 causes the reoperation of magnet 530, thereby advancing the brushes of switch TC into engagement with the set of terminals connected to the line of the called subscriber. Relay 505

is slow in releasing and remains operated until all of the impulses have been received. Before relay 505 releases, a busy test circuit is traced from battery through the winding of relay 507, inner upper back contact of relay 511, lower front contact of relay 505, through sleeve brush 519 to the sleeve terminal of the selected line. If the line is busy, relay 507 operates due to there being a busy-ground potential on this terminal. If relay 507 operates, it remains operated after relay 505 releases, the holding circuit being traced through the inner back contact of relay 505 and the front contact of relay 507 over conductor 513 to ground at the lower front contact of relay 502. A busy tone is transmitted to the calling station by connecting the left-hand winding of the tone source 512 through the inner lower front contact of relay 507 to the lower one of talking condensers 500.

Assuming that the called line is the line 580 connecting the station B to the terminals 541, 542 and 543 and that this line is idle, the release of relay 505 closes a circuit from battery through the winding of the cut-off relay (not shown) of line 580, through terminal 543 and brush 519, outer back contact of relay 505, lower winding of relay 511, lower back contact of relay 507 to ground at relay 502. Relay 511 is sufficiently energized by the current through its lower winding to close its inner upper front contact. The circuit from battery through its upper winding and inner upper front contact over conductor 514 to ground at the uppermost front contact of relay 502 is effective to complete the operation of relay 511. With relay 511 operated, ground is connected through its next to the outer lower front contact to sleeve brush 519 as a line busy condition. With relay 511 operated, a signaling circuit is closed from the ringing current source 525, through the inner lower front contact of relay 511, lower winding and lower back contact of relay 505, lowermost front contact of relay 511, brush 518, terminal 542, over the line 580 and through the ringer (not shown) at station B, back through terminal 541 and brush 517, uppermost front contact of relay 511, to ground at the outer upper back contact of relay 506. When the subscriber at station B removes the receiver, relay 506 is energized sufficiently by the current through its lower winding to operate its inner upper front contact thereby closing a circuit from battery through its upper winding and inner upper front contact to ground on conductor 514. The operation of relay 506 connects a source of talking current to the line 580; battery is connected through the upper winding of relay 504 and uppermost front contacts of relays 506 and 511 to brush 517 and ground is connected through the lower winding of relay 504 and lowermost front contacts of relays 506 and 511 to brush 518. With the receiver removed from the receiver hook at station B relay 504 is operated thereby reversing the connections between the windings of relay 501 and the line conductors incoming to the connector LC. The current is thus reversed over the calling line circuit to indicate that the called subscriber has answered the call. Talking current is furnished to the calling station through the windings of relay 501, the voice frequency currents being transmitted through condensers 500.

When the connection is released by the subscriber at station A, relay 501 releases and when the receiver is replaced at station B relay 504

releases. The release of relay 501 causes the release of relay 502. Relays 506 and 511 are held until relays 502 and 503 are both released. With relays 501, 502 and 511 normal, a circuit is closed from battery through the winding of release magnet 540, lower contact of the VON springs, lower back contact of relay 511, and upper back contacts of relays 502 and 501 to ground. The operation of magnet 540 causes the switch to restore to normal in the usual manner. When the shaft and brushes reach normal position, the circuit through the winding of magnet 540 is opened at the VON springs.

Upon release of relay 502, as above described, the holding ground is disconnected from conductor 513 thereby causing the release of relay 406 of the selector LS, the release of the line finder LF, and the release of the cut-off relay (not shown) of line 401, the line finder LF being restored to normal in the usual manner. The release of relay 406 closes a circuit from battery through the winding of release magnet 440, lower contact of the VON springs and upper back contacts of relays 404, 403 and 406 to ground. The operation of magnet 440 causes the switch LS to restore to normal in the usual manner. When the shaft and brushes reach normal position, the circuit through the winding of magnet 440 is opened at the VON springs.

If the selector LS is advanced to a level of the terminal bank which represents an unassigned group of subscribers' numbers, the call is extended to an intercepting operator, the terminals in this level being connected to one or more intercepting trunks. Thus, the terminals 421, 422 and 423 in the bank of selector LS are shown connected to the intercepting trunk IT3 in Fig. 5a. Since the local selectors have no means for signaling over a selected trunk, as do the connectors and tool selectors, the trunk IT3 is arranged to respond to its seizure to initiate the further extension of the connection to the intercepting operator and to hold the selector and line finder switches in their operated positions. Upon seizure of trunk IT3, the calling line loop is extended through brushes 417 and 418, terminals 421 and 422, and through the back contacts of relay 558 to the windings of line relay 551. The operation of relay 551 causes the successive operation of relays 552, 553 and 554. The operation of relay 553 connects ground through its outer lower front contact over sleeve conductor 569 to sleeve terminal 423 to hold relay 406 of selector LS and to hold the line finder LF and cut-off relay (not shown) of line 400 in the usual manner. The trunk IT3 is shown connected to terminals 731, 732 and 733 in the bank of trunk finder TF and is shown as being in the same group of trunks as are the trunks IT1 and IT2, having the common group relays 701. The operation of relay 553 connects ground through its inner lower front contact, the lower back contact of relay 555 and the uppermost back contact of relay 557 to conductor 700 thereby operating the group relay 701. The operation of relay 554 connects battery through the winding of the cut-off relay 555 in parallel with resistance 559, through the upper front contact of relay 554 and the inner upper back contact of relay 557, over the sleeve conductor 563 to terminal 733 in the bank of finder TF. The trunk finder TF, or a similar finder having access to trunk IT3, is thereupon operated in the manner hereinbefore described to step its brushes up to the level in which the terminals of trunk IT3 are located and

to rotate its brushes into engagement with these terminals. When brushes 761, 762 and 763 engage the terminals 731, 732 and 733, the connection from the winding of the cut-off relay 555 is extended through brush 763, the lower winding of relay 710, lower back contact of relay 708, lower winding of relay 707, to ground at the inner lower front contact of relay 705. The finder switch TF is thus stopped on the terminals in question to extend the connection from trunk IT3 to the outgoing trunk circuit OT. The operation of relay 555 connects the source of ringing current 560 through the lower front contact of relay 555 and through condenser 567 to one of the incoming line conductors thereby transmitting a ringing tone to the calling subscriber. Relay 555 also disconnects the ground at relay 553 from group conductor 700. The operation of relay 555 closes a circuit from battery through the winding of relay 556 through the upper front contact of relay 555, and the lower back contact of relay 557, conductor 562, through terminal 732 and brush 762 to conductor 772 of the outgoing trunk circuit OT, to effect the operation of relay 802. Relay 556 is marginal and does not operate in this circuit. The operation of relay 802 causes the further extension of the intercepted call through trunk circuit OT out over trunk 900 to the incoming trunk circuit IT at the intercepting operator's position in the manner hereinbefore described. When the operator answers the call the connection of the tripping resistance 813 to the conductor 772 as hereinbefore described causes the operation of relay 556. Relay 556 locks through its inner upper front contact and resistance 564, over sleeve conductor 563, through terminal 733 and brush 763, through the inner lower front contact of relay 710, inner lower back contact of relay 706, outer lower front contact of relay 708, sleeve conductor 773 of trunk finder TF and over sleeve conductor 833 of the outgoing trunk circuit OT to ground at the lower front contact of relay 818. The operation of relay 556 also causes the operation of relay 557. Relay 557 locks under control of relay 554, and causes the release of relay 555 to disconnect the audible ringing tone. With relays 556 and 557 operated, a supervisory circuit is closed from battery through the upper winding of relay 558 of trunk IT3, outer upper front contacts of relays 553 and 556, over conductor 561, through terminal 731 and brush 761 of trunk finder TF, uppermost back contact of relay 706, uppermost front contact of relay 710, conductor 771, upper back contact of relay 806 of the outgoing trunk circuit OT, upper left winding of repeating coil 830, windings of relay 812, winding of relay 811, lower left winding of repeating coil 830, lower back contact of relay 809, lower front contact of relay 823, lower back contact of relay 806, conductor 772, lowermost front contact of relay 710, lowermost back contact of relay 706, brush 762 and terminal 732 of trunk finder TF, conductor 562, lowermost front contact of relay 557, through the lower winding of relay 558 to ground. Relay 812 operates in this circuit but relay 811 being polarized does not operate since the connection of battery to the tip conductor 561 of trunk IT3 and ground to the ring conductor 562 results in current in the non-operating direction. With relay 811 non-operated, the high resistance lower winding of relay 812 is not short circuited and relay 558 of trunk IT3 being marginal the latter relay does not operate. The voice currents between

the calling station and intercepting operator are transmitted through condensers 565 and 566 of trunk circuit IT3 and through the windings of the repeating coil 830.

5 If the flashing key at the intercepting operator's position is operated, the alternate operation and release of relay 816 as hereinbefore described causes the intermittent short circuiting of the lower winding of relay 812 thereby causing  
10 the alternate operation and release of relay 558 of trunk IT3. The operation and release of relay 558 in response to the operation of the flashing key causes the temporary reversal of the connections between the windings of relay 551 and  
15 the calling line loop. These reversals are effective on calls originated by a local operator to signal this operator, but are not of long enough duration to cause the operation of the message register of a calling subscriber. When the calling  
20 subscriber replaces the receiver on the receiver hook relay 551 releases. Relays 552, 553 and 554 release in turn. The release of relay 553 opens the supervisory circuit between trunk circuit IT3 and outgoing trunk circuit OT causing  
25 the release of relay 812. The release of relay 553 also disconnects ground from the incoming sleeve conductor 569 thereby causing the release of relay 406 of selector LS and the release of the line finder LF and cut-off relay (not shown) of  
30 line 400, the line finder LF and selector LS being restored to normal in the usual manner. Relay 555 is held operated over sleeve conductor 563 to the ground at relay 818 of the outgoing trunk circuit OT as long as the connection is held  
35 by the intercepting operator. Relay 557 is held by the ground at the lower front contact of relay 556; and when relay 554 releases this ground is also extended through the inner lower front contact of relay 557 and the back contact of relay  
40 554 to the incoming sleeve conductor 569 as a busy potential to prevent the re-seizure of trunk IT5 prior to the release of the trunk finder TF.

The aforementioned release of relay 812 opens  
45 the short circuit around the lower windings of relays 816 and 817 thus decreasing the current over trunk 900 sufficiently to cause the release of relay 907 of the incoming trunk circuit IT. The release of relay 907 disconnects the upper winding  
50 of relay 904 from the tip conductor of jack 903 thus causing the release of relay 957 of the cord CC2. The release of relay 957 closes a circuit for operating relay 959 from battery through the winding of this relay, back contact  
55 of relay 957, outer upper back contact of relay 956, upper back contact of the flashing key 961, to ground at the upper front contact of relay 955. Relay 959 closes a circuit for lighting lamp 964 as a disconnect signal, causes the release of relay  
60 953, and causes the operation of relay 963 by connecting the winding of relay 963 in series with relay 906 of the incoming trunk circuit IT in place of the winding of relay 953. Relay 906 releases due to the high resistance of the winding  
65 of relay 963. Relay 963 closes a holding circuit for relay 959. The release of relay 953 causes the successive release of relays 954 and 955. The release of relay 906 of trunk circuit IT restores the bridge across trunk 900 thereby causing the  
70 release of relay 817 of the incoming trunk circuit IT; and the resultant release of relay 818 causes the release of relays 555 and 710. With relay 556 released, relay 557 releases and the ground is disconnected from conductor 569. With relay 710 released the trunk finder TF is restored  
75 to normal as hereinbefore described. When the

intercepting operator removes the plug 951 from the answering jack 903, relays 963 and 959 release and lamp 964 is extinguished, thus restoring the cord CC2 to normal.

If the called line number is an unassigned  
5 number in a partially assigned group of numbers, the corresponding terminals in the bank of the connector switches are connected to an intercepting trunk. The terminals 521, 522 and 523  
10 represent such a called number and are shown connected to the intercepting trunk circuit IT4 which is similar in all respects to the trunk IT1. The trunk IT4 is connected to terminals 741, 742  
15 and 743 in the bank of trunk finder TF and to corresponding sets of terminals in the banks of other trunk finders similar to TF. The extension of a connection from intercepting trunk IT4 to an intercepting operator is completed in a  
20 similar manner to that hereinbefore described for a connection from trunk IT1 except that the relay 802 responds either to alternating current through its upper winding incoming through condenser 804 from the ringing current source of  
25 connector LC or to direct current through its lower winding during the silent period of the ringing cycle. The operation of relays 807, 808, 809, 810, 813, 814 and 901 causes the lighting of lamp 932 at the intercepting switchboard all as hereinbefore described. The operation of  
30 relay 815 is effected as hereinbefore described in response to the answer of the intercepting operator to cause the operation of relays 823 and 824. The tripping resistance 813 is thus connected to conductor 772 for an interval sufficient  
35 to effect the operation of tripping relay 506 of the connector LC. The operation of relay 824 is followed by the release of relays 802, 807, 808, 809 and 810. The aforementioned operation of tripping relay 506 closes a supervisory circuit  
40 from battery through the upper winding of relay 504 of connector LC, uppermost front contacts of relays 506 and 511, brush 517 and terminal 521, conductor 491 of trunk IT4, terminal 741 and brush 761 of trunk finder TF, uppermost back contact of relay 706, uppermost front  
45 contact of relay 710, conductor 771, upper back contact of relay 806, upper left winding of repeating coil 830, windings of relays 812 and 811, lower left winding of repeating coil 830, back contact of relay 803, inner lower front contact of  
50 relay 823, lower back contact of relay 806, conductor 772, lowermost front contact of relay 710, lowermost back contact of relay 706, brush 762 and terminal 742, conductor 462, terminal 522 and brush 518, lowermost front contacts of re-  
55 lays 511 and 506, through the lower winding of relay 504 to ground. Relay 504 being marginal does not operate in series with the high resistance lower winding of relay 812. Relay 812 operates, but relay 811 does not operate, the current  
60 through its winding being in the non-operating direction. Relay 812 short circuits the high resistance lower windings of relays 816 and 817 thus causing the operation of the marginal relay 907 of trunk circuit IT. The further operation  
65 of the trunk circuits OT and IT and cord CC2 in establishing a talking connection is similar to that hereinbefore described. Upon release of the connection at the calling end, relays 501  
70 and 502 of connector LC release and since relay 503 was not operated the connector LC, selector LS and line finder LF are immediately restored to normal in the usual manner. The release of connector LC causes the release of relay 812 of  
75 the outgoing trunk circuit OT, thereby opening

the short circuit around the lower windings of relays 816 and 817 and thus give the intercepting operator a disconnect signal as hereinbefore described. The trunk circuit OT and the trunk finder TF are therefore restored to normal, and the cut-off relay 451 of trunk circuit IT4 is released. When the intercepting operator removes plug 951 from jack 923 the trunk circuit IT and the cord circuit CC2 are restored to normal.

If the called line is one which is temporarily removed from service it is connected to a plugging-up line circuit. Such a line is represented by the line 601 serving the subscriber's station C in Fig. 6. The plugging-up line PL comprises a plug 602, the plug 603 and the cord connecting these plugs. With the plug 602 inserted in place of the heat coils at the main distributing frame MDF and the plug 603 inserted in an available jack 604 in one of the jack panels associated with the main frame, the conductors of line 601 are extended over the upper pair of conductors of plug 603 and jack 604 to a line 605 leading to the local test board 606; and the conductors from the connector switch terminals normally connected to the line 601 are extended over the lower pair of conductors of plug 603 and jack 604 and over conductors 607 and 608 to the intercepting trunk circuit IT5. The line conductors 607 and 608 are further extended and together with the sleeve conductor 609 connect to terminals 751, 752 and 753 in the bank of trunk finder TF.

Assuming the station A in Fig. 4 to have called the number of line 601, seizure of terminals 531, 532 and 533 by the connector LC in response to the dialing of the last digit, extends a connection to trunk circuit IT5. In the trunk circuit IT5, the condenser 610 and upper winding of relay 611 are bridged across conductors 607 and 608, so that closure of the ringing circuit by the operation of relay 511 of connector LC causes the operation of relay 611. The impedance of condenser 610 and relay 611 is high enough to prevent the operation of relay 506 of the connector. The operation of relay 611 in response to the ringing current from connector LC causes the operation of relay 613. With relay 613 operated the lower winding of relay 612 is connected in parallel with the upper winding of relay 611 so that relay 612 is also operated by ringing current from connector LC. Relays 611 and 612 are held operated, independently of the ringing current, by a circuit from battery through the lower winding and inner front contact of relay 611 and the outer upper front contact of relay 613, in parallel with battery through the upper winding of relay 612, thence through the inner upper back contact of relay 614, to ground through the upper front contact of relay 612. With relay 612 operated, ground is connected from the lower back contact of relay 614, through the lower front contact of relay 612 to the group conductor 700 (or a similar conductor if the trunk IT5 is in a different subgroup from that which includes the trunk IT1). The operation of the associated group relay such as relay 701 initiates the operation of an idle trunk finder such as TF to establish connection with terminals 751, 752 and 753 or the corresponding set of terminals in finders other than TF. Assume the finder TF to be the one thus started in search for the calling trunk. When the brushes of finder TF reach the terminals to which the trunk IT5 connects, a circuit is closed from battery through the cut-off relay 614 of the trunk circuit IT5, lower front contact of relay 613, over sleeve conductor 609 and through ter-

minal 753 to brush 763 of trunk finder TF, and thence to ground through the windings of relays 710 and 707 as hereinbefore described. Relay 614 operates and the trunk finder extends the connection from trunk IT5 through its brushes over conductors 771 and 772 to the outgoing trunk circuit in the manner hereinbefore described. Relay 614 locks over conductor 609, through terminal 753 and brush 763 to the ground at relay 818 of the outgoing trunk circuit. Relay 614 opens the ringing circuit bridge, disconnects ground from conductor 700 and opens the locking circuit for relays 611 and 612, causing the release of these relays. The release of relay 611 causes the release of relay 613.

Ringing current from the connector LC is now transmitted over conductor 608, through terminal 752 and brush 762, the lowermost back contact of relay 705 and lowermost front contact of relay 710, over conductor 772, through the lower back contact of relay 824 of outgoing trunk circuit OT, and through condenser 804 and the upper winding of relay 802 to ground or, during the silent interval of the ringing cycle, through the lower winding of relay 802 and resistance 826 to ground. Relay 802 is thus operated to initiate the operations hereinbefore described for lighting the signal lamp 902 at the intercepting operator's position. The further operation of trunk circuits OT and IT, in response to the answer of the operator is the same as that hereinbefore described. When the connection is released by the calling subscriber, the connector LC, selector LS and line finder LF are immediately restored to normal in the usual manner. The release of the calling subscriber does not cause a disconnect signal to be given to the intercepting operator as is the case on calls intercepted from other than plugging-up lines, relay 812 being held operated from battery and ground through the line relay (not shown) of line 601. The intercepting operator should remove plug 951 from jack 923 as soon as conversation is completed thereby causing the release of the cord circuit CC2, incoming trunk circuit IT, outgoing trunk circuit OT, and the trunk finder TF in the manner hereinbefore described. The cut-off relay 614 of trunk circuit IT5 releases when relay 818 of the outgoing trunk circuit OT disconnects holding ground from the sleeve conductor 833.

Should the plugging-up line PL be connected to the terminals of a line which normally receives ringing current over the tip conductor instead of over the ring conductor, the connections at the intermediate distributing frame IDF being such as to secure this result, then the ringing current incoming to the outgoing trunk circuit OT on a call intercepted from this plugging-up line will energize relay 801 instead of relay 802. Either the energization of the lower winding by ringing current received through condenser 803 or the energization of the upper winding by direct current during the silent period of the ringing cycle is effective to operate relay 801. The operation of relay 801 causes the successive operation of relays 805 and 806. Relay 805 connects ground from the front contact of relay 801 through the lower front contact of relay 805 to the sleeve conductor 833. Relay 806 reverses the conductors incoming to the trunk circuit OT with respect to the windings of the repeating coil 830 so that the subsequent operation of relay 823 will be effective to complete the connection from the conductor over which ringing current is being received to the low, tripping, resistance 813. Re-

lay 806 also closes a circuit from battery through the winding of relay 807, through the inner lower front contact of relay 806, and lower back contact of relay 823 to the ground on sleeve conductor 833. Relay 807 then locks through its lower front contact, the outer lower back contact of relay 814 and the lower back contact of relay 823 over sleeve conductor 833 to ground at the inner upper front contact of relay 807. The call is thus locked in to insure its extension to the intercepting operator. The further operation of the outgoing trunk circuit OT and the operation of the incoming trunk circuit IT is similar to that hereinbefore described. Relay 805 is locked to the sleeve conductor 833 and relay 805 is locked to ground at the upper front contact of relay 824 during the time that the latter relay is operated. Release of the connection is effected in the manner hereinbefore described, relays 805 and 806 being released when relay 818 releases.

On calls intercepted at the terminals of toll selector or connector switches and on calls intercepted at the terminals of local connector switches, the release of the trunk finder is under the joint control of the intercepting operator and the calling subscriber or operator; but on calls intercepted at the terminals of local selectors or from plugging-up lines, the trunk finder is restored to normal as soon as the intercepting operator disconnects, irrespective of whether or not the connection has been released by the calling subscriber or operator. The release of relay 906, when the intercepting operator removes plug 951 from jack 903, reconnects the winding of relay 901 across the conductors of trunk 900 in all cases, thereby causing the release of relays 817 and 818 of the outgoing trunk circuit OT. On calls intercepted at local selectors and over plugging-up lines, the release of relay 818 disconnects the holding ground from conductor 833 to cause the release of relay 710 of the trunk finder and the release of relay 556 of the intercepting trunk IT3 or the release of relay 614 of intercepting trunk IT5; and the release of relay 710 causes the return of the trunk finder to normal. But on calls intercepted at toll selector or connector switches or at local connectors, the release of relay 818 does not cause the release of relay 710, since a holding ground is also being supplied from relay 202 of the toll selector TS, from relay 396 of the toll connector TC, or from relay 511 of the local connector LC. By this arrangement the trunk finders of trunks leading to the centralized intercepting operator's position are made available for use on other calls as soon as possible so as to increase the efficiency of the trunk group.

What is claimed is:

1. In a telephone system, lines, automatic switches for use in completing calls from local subscribers or operators, automatic switches for use in completing calls from toll operators, terminals in the banks of said switches which represent unequipped lines, intercepting trunks connected to said terminals, a trunk finder switch, said intercepting trunks being connected to terminals in the banks of said switch, means responsive to the seizure of one of said intercepting trunks for causing the operation of said trunk finder switch to connect with said seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a high resistance supervisory bridge connected across and individual to the conductors of said trunk incoming from said

trunk finder, and means in said bridge operative if the intercepted call is a toll call for changing said bridge to a low resistance bridge.

2. In a telephone system, lines, automatic switches for use in completing calls from local subscribers or operators, automatic switches for use in completing calls from toll operators, terminals in the banks of said switches which represent unequipped lines, intercepting trunks connected to said terminals, a trunk finder switch, said intercepting trunks being connected to terminals in the banks of said switch, means responsive to the seizure of one of said intercepting trunks for causing the operation of said trunk finder switch to connect with said seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a cord circuit at said position for connecting with said trunk, a supervisory signal associated with said cord, and means effective if the intercepted call is a local call for operating said signal when said connection is released at the calling end.

3. In a telephone system, lines, automatic switches for use in completing calls from local subscribers or operators, automatic switches for use in completing calls from toll operators, terminals in the banks of said switches which represent unequipped lines, intercepting trunks connected to said terminals, a trunk finder switch, said intercepting trunks being connected to terminals in the banks of said switch, means responsive to the seizure of one of said intercepting trunks for causing the operation of said trunk finder switch to connect with said seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a high resistance supervisory bridge connected across and individual to the conductors of said trunk incoming from said trunk finder, a cord circuit at said position for connecting with said trunk, and means controlled by said intercepting operator for alternately changing the resistance of said bridge.

4. In a telephone system, lines, automatic switches for use in completing calls from local subscribers or operators, automatic switches for use in completing calls from toll operators, terminals in the banks of said switches which represent unequipped lines, intercepting trunks connected to said terminals, a trunk finder switch, said intercepting trunks being connected to terminals in the banks of said switch, means responsive to the seizure of one of said intercepting trunks for causing the operation of said trunk finder switch to connect with said seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a high resistance supervisory bridge connected across and individual to the conductors of said trunk incoming from said trunk finder, a cord circuit at said position for connecting with said trunk, a flashing key in said cord circuit, and means for changing the resistance of said bridge when said intercepting operator connects said cord with said trunk and for changing the resistance of said bridge each time said flashing key is operated or released.

5. In a telephone system, lines, selector and connector switches for use in completing connections from calling subscribers and from toll and local operators to called lines, terminals in the banks of said switches which represent unequipped lines, plugging-up lines for use in intercepting calls to and from a line which is tem-

porarily removed from service, intercepting trunks connected to said terminals, intercepting trunks connected to said plugging-up lines, a trunk finder switch, said intercepting trunks being connected to terminals in the bank of said trunk finder switch, means responsive to the seizure of one of said intercepting trunks for initiating the operation of said trunk finder to connect with the seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a cord circuit at said position for connecting with said trunk, means for holding said trunk finder until the calling subscriber or operator and the intercepting operator have both released the connection, and means effective on a call incoming from a plugging-up line to release said trunk finder when the intercepting operator disconnects said cord and trunk irrespective of whether or not the call has been released by the calling subscriber or operator.

6. In a telephone system, lines, connector switches for use in connecting with called lines, toll selector switches for use in extending a call from a toll operator to one of said connector switches, local selector switches for use in extending calls from subscribers or local operators to said connector switches, plugging-up lines for intercepting calls to or from a line which has been temporarily removed from service, terminals in the banks of said switches which represent unequipped lines, a first intercepting trunk connected to terminals in the bank of said local selector switches, a second intercepting trunk connected to terminals in the bank of said connector and toll selector switches, a third intercepting trunk connected to one of said plugging-up lines, a trunk finder, said intercepting trunks connected to terminals in the bank of said trunk finder, an intercepting operator's position, a trunk connecting said trunk finder with said operator's position, means responsive to the receipt of a call by one of said intercepting trunks for initiating the operation of said trunk finder to extend said call to said position, means at said position for answering said call, means effective on a call incoming to said position from a connector switch or toll selector switch for holding said trunk finder until the connection has been released by the calling subscriber or toll operator and by said intercepting operator, and means effective on a call incoming to said position from a local selector or plugging-up line for releasing said trunk finder switch when the intercepting operator disconnects from said trunk irrespective of whether or not the call has been released by the calling subscriber or operator.

7. In a telephone system, lines, automatic switches for use in completing calls from local subscribers or operators, automatic switches for use in completing calls from toll operators, terminals in the banks of said switches which represent unequipped lines, intercepting trunks connected to said terminals, a trunk finder switch, said intercepting trunks being connected to terminals in the banks of said switch, means responsive to the seizure of one of said intercepting trunks for causing the operation of said trunk finder switch to connect with said seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a high resistance supervisory bridge connected across and individual to the conductors of said trunk incoming from said trunk finder, and means for closing said bridge

across the conductors of said trunk incoming from said trunk finder in response to the answer of the intercepting operator.

8. In a telephone system, lines, selector and connector switches for use in completing calls from local subscribers or operators, selector and connector switches for use in completing calls from toll operators, terminals in the banks of said switches which represent unequipped lines, intercepting trunks connected to said terminals, a trunk finder switch, said intercepting trunks being connected to terminals in the banks of said switch, means responsive to the seizure of one of said intercepting trunks for causing the operation of said trunk finder switch to connect with said seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a cord circuit at said position for connecting with said trunk, a supervisory signal associated with said cord and means effective only if the call is intercepted at a local selector or a local connector for operating said signal when said connection is released at the calling end.

9. In a telephone system, lines, selector and connector switches for use in completing connections from calling subscribers and from toll and local operators to called lines, terminals in the banks of said switches which represent unequipped lines, plugging-up lines for use in intercepting calls to and from a line which is temporarily removed from service, intercepting trunks connected to said terminals, intercepting trunks connected to said plugging-up lines, a trunk finder switch, said intercepting trunks being connected to terminals in the bank of said trunk finder switch, means responsive to the seizure of one of said intercepting trunks for initiating the operation of said trunk finder to connect with the seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a cord circuit at said position for connecting with said trunk, and means effective on a call intercepted at the terminals of a local selector to release said trunk finder when the intercepting operator disconnects said cord and trunk irrespective of whether or not the call has been released by the calling subscriber or operator.

10. In a telephone system, lines, selector and connector switches for use in completing connections from calling subscribers and from toll and local operators to called lines, terminals in the banks of said switches which represent unequipped lines, plugged-up lines for use in intercepting calls to and from a line which is temporarily removed from service, intercepting trunks connected to said terminals, intercepting trunks connected to said plugging-up lines, a trunk finder switch, said intercepting trunks being connected to terminals in the bank of said trunk finder switch, means responsive to the seizure of one of said intercepting trunks for initiating the operation of said trunk finder to connect with the seized intercepting trunk, an intercepting operator's position, a trunk extending from said trunk finder to said position, a cord circuit at said position for connecting with said trunk, means for holding said trunk finder until the calling subscriber or operator and the intercepting operator have both released the connection, and means effective on a call intercepted at the terminals of a local selector to release said trunk finder when the intercepting operator disconnects said cord and trunk irrespective of



whether or not the call has been released by the calling subscriber or operator.

5 11. In a telephone system, toll selector and connector switches, local selector and connector switches, terminals in the banks of said switches representing unequipped lines, intercepting trunks connected to said terminals, trunk finder switches having access to a plurality of intercepting trunks, an intercepting operator's posi-

tion, other trunks one for each of said trunk finders for extending calls to said operator's position, supervisory means in each of said other trunks, and means in each of said other trunks for automatically varying the character of said supervisory means in accordance with the character of the switch at which the call is intercepted. 5

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