

July 27, 1937.

J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 1

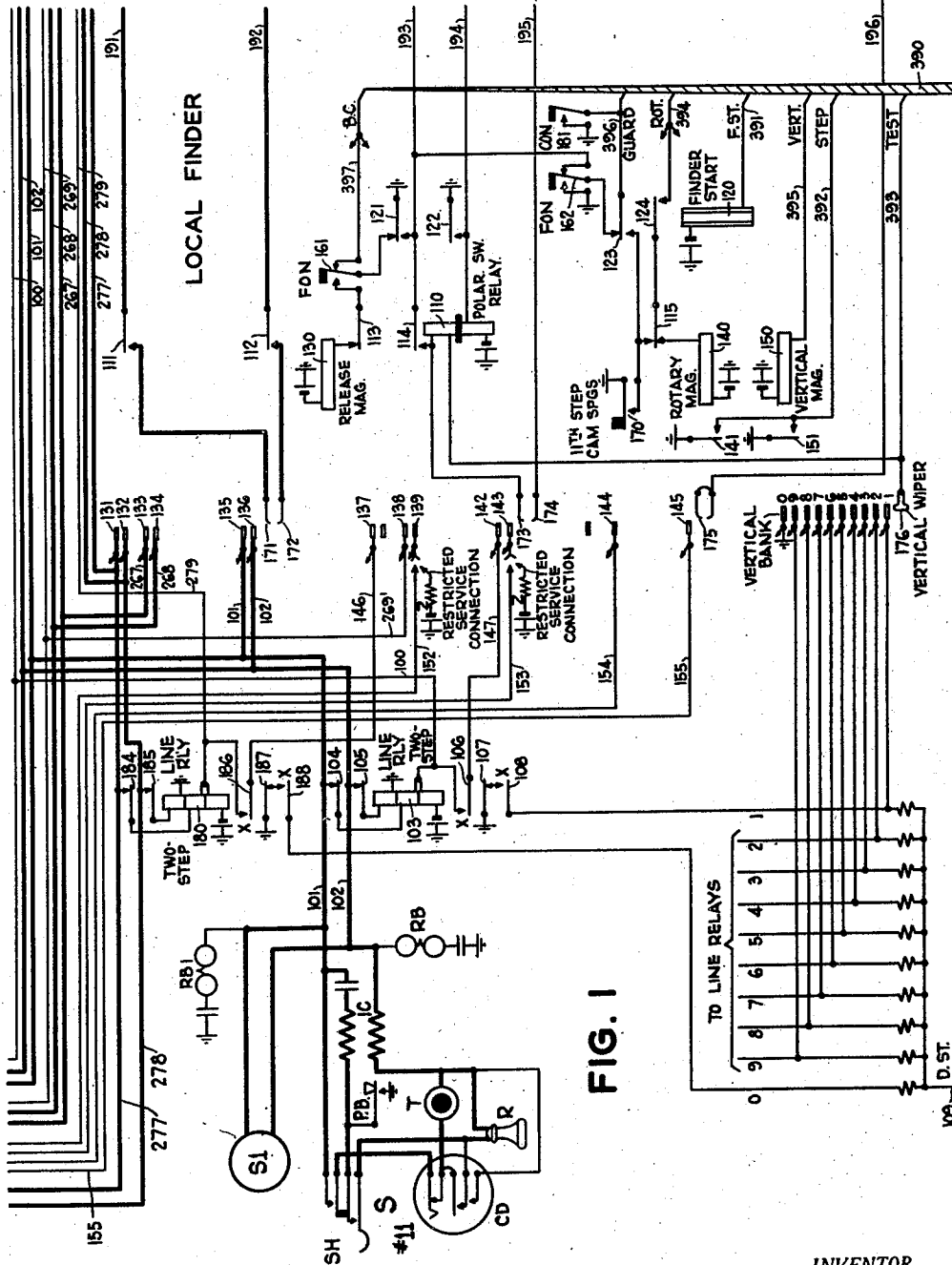


FIG. 1

INVENTOR.
JOHN H. VOSS

BY
Chas. T. Candy
ATTORNEY.

2,087,930

Filed July 5, 1935

10 Sheets-Sheet 2



BY
Chas. F. Candy
ATTORNEY.

July 27, 1937.

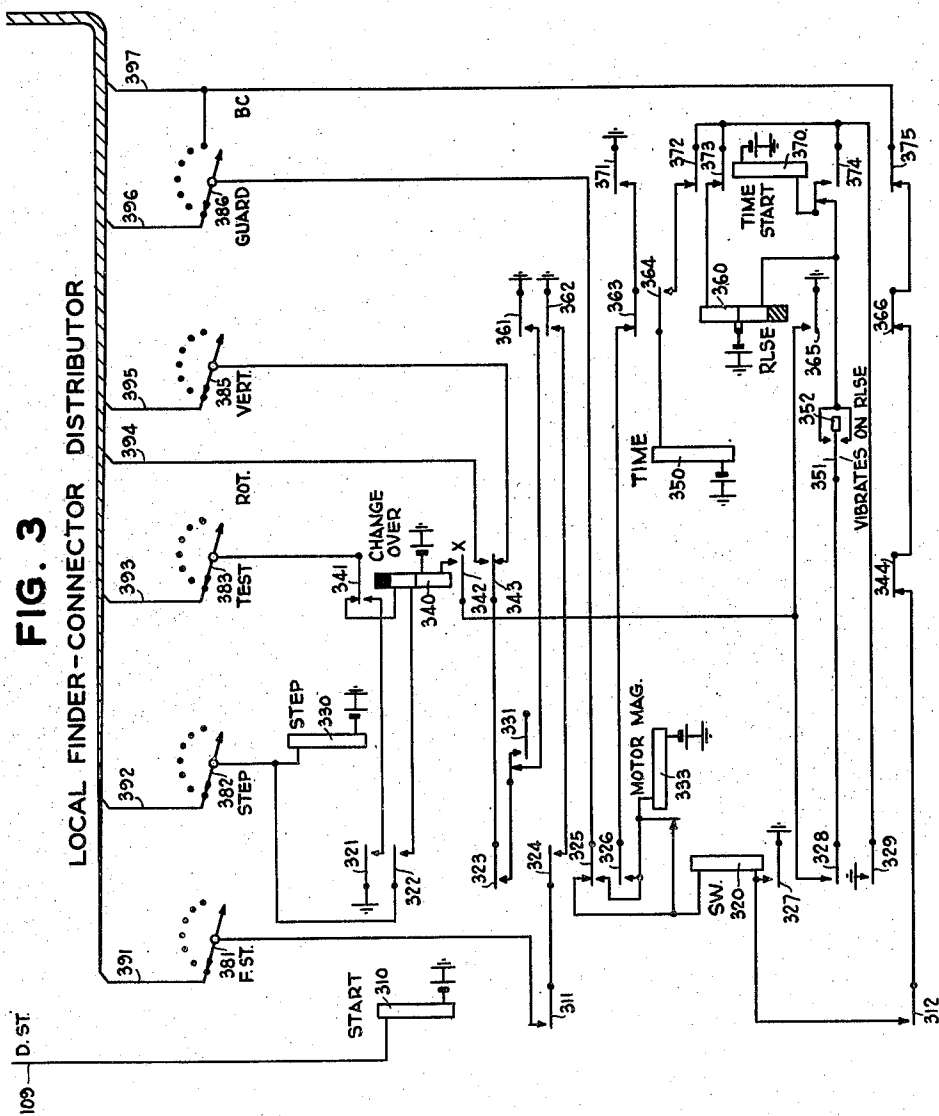
J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 3



INVENTOR.
JOHN H. VOSS

BY
Chas. H. Candy
ATTORNEY.

July 27, 1937.

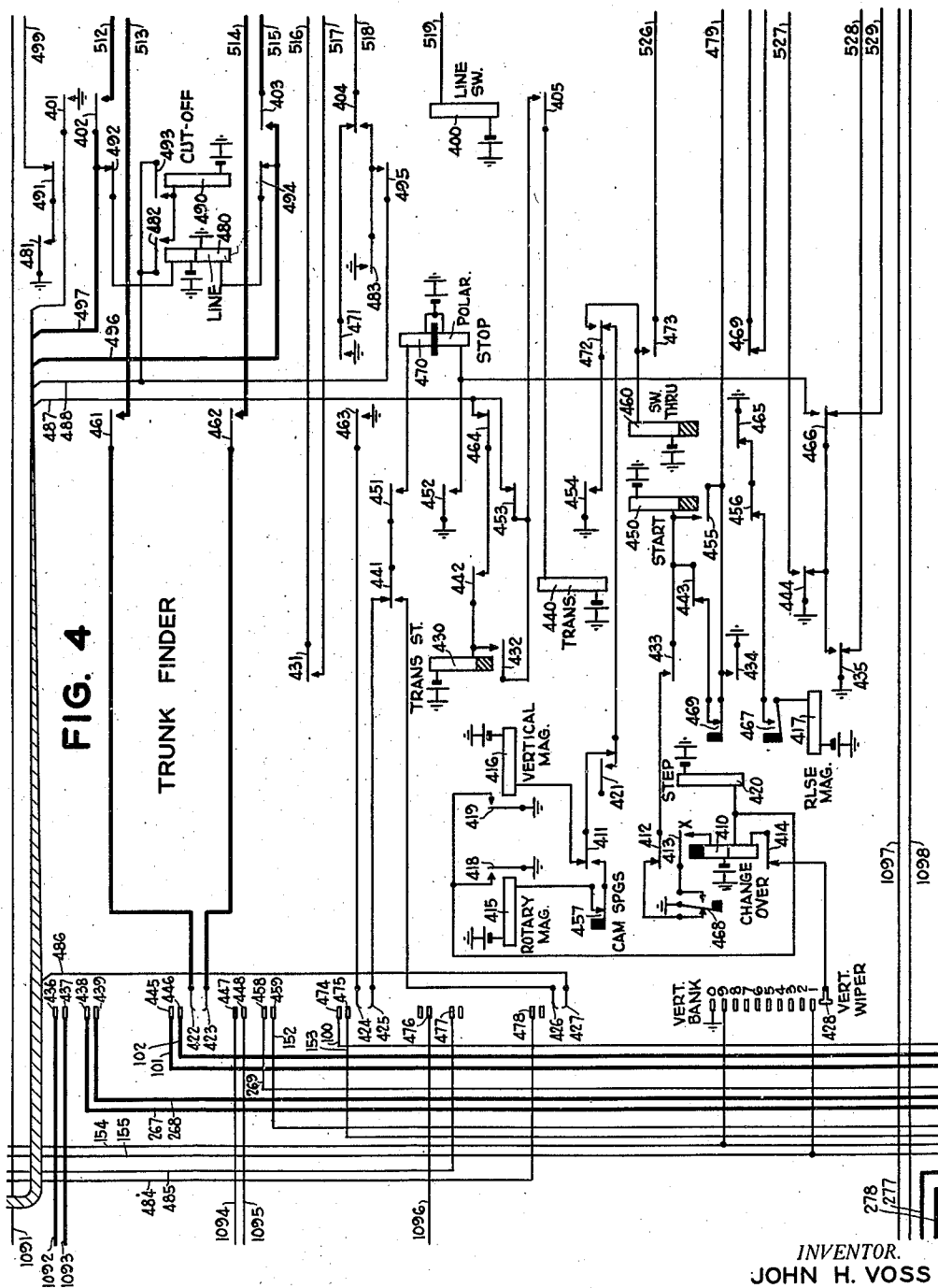
J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 4



INVENTOR.
JOHN H. VOSS

BY
Chas. T. Condy
ATTORNEY.

July 27, 1937.

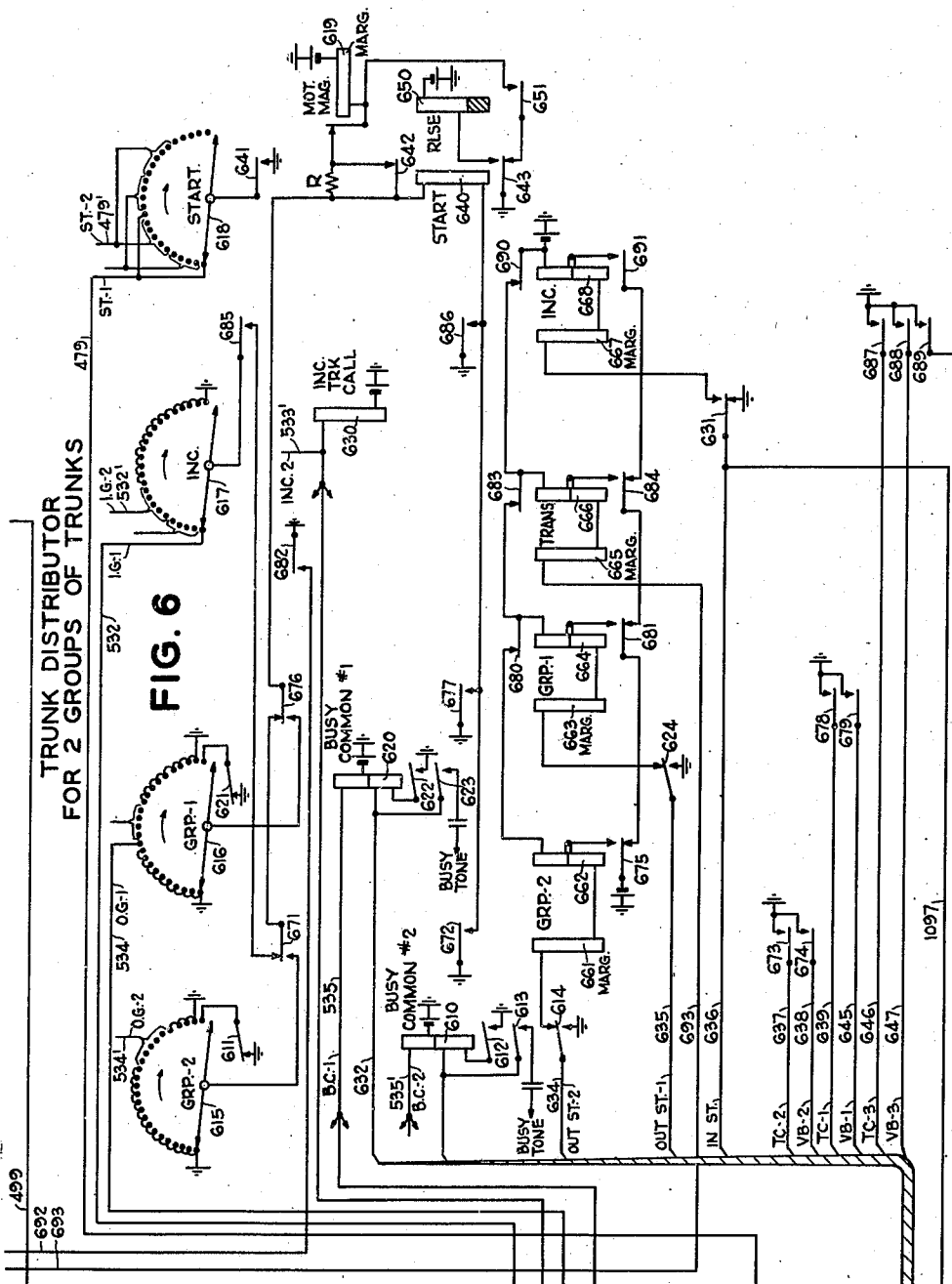
J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 6



INVENTOR.
JOHN H. VOSS

BY
Chas. E. Candy
ATTORNEY.

July 27, 1937.

J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 7

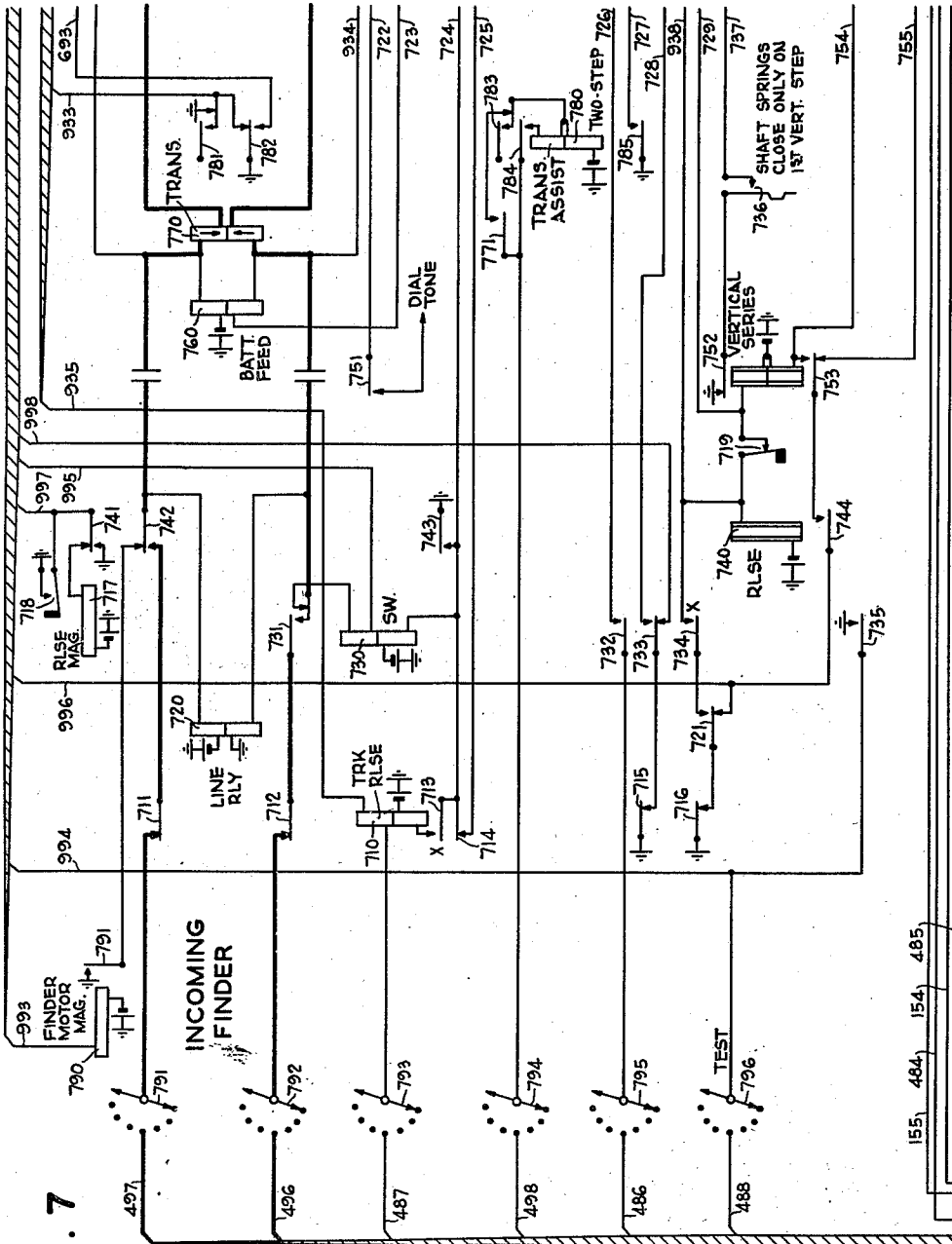


FIG. 7

INVENTOR.
JOHN H. VOSS

BY
Chas. H. Candy
ATTORNEY.

July 27, 1937.

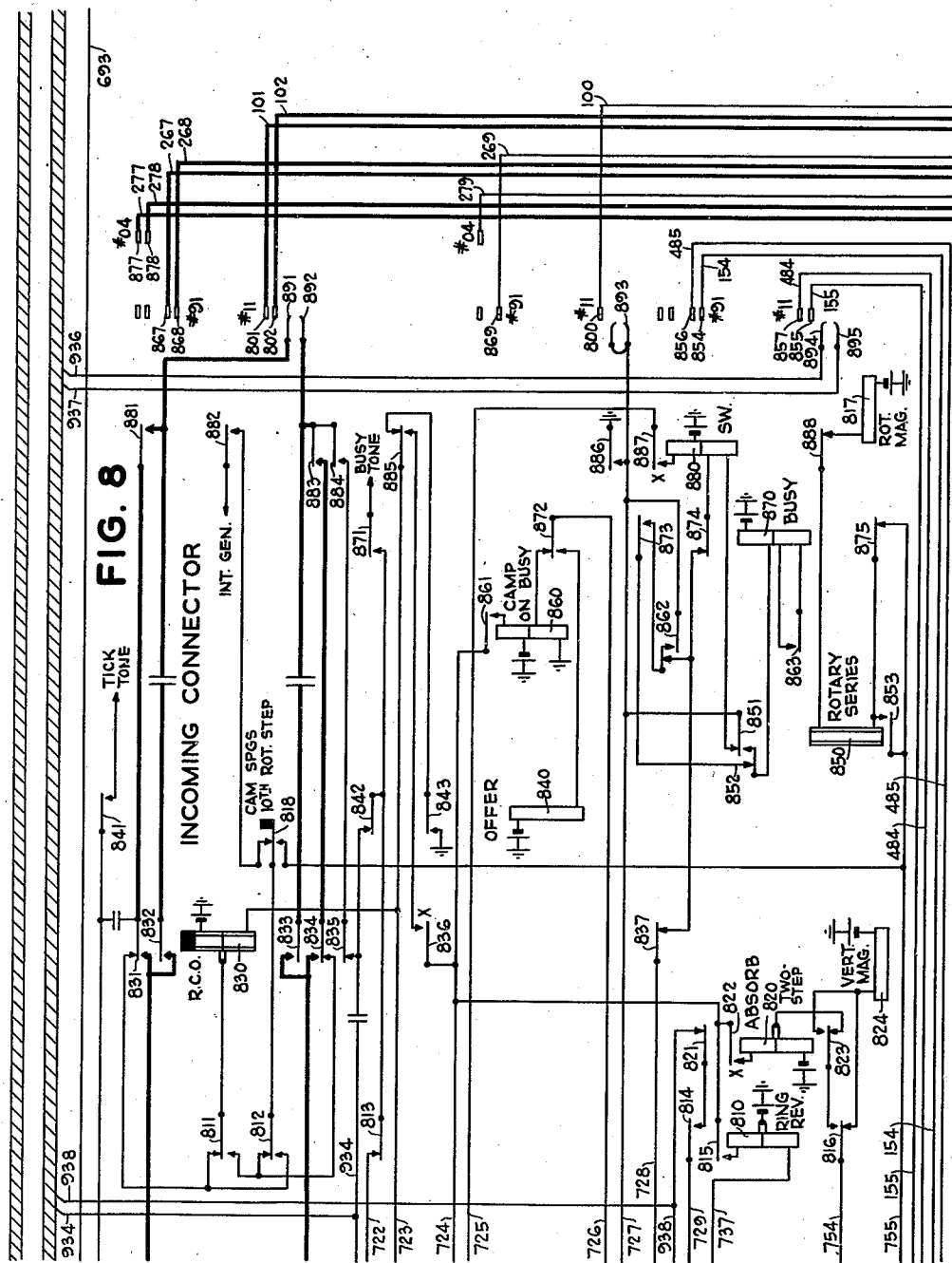
J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 8



INVENTOR.
JOHN H. VOSS

BY
Chas. W. Candy
ATTORNEY.

July 27, 1937.

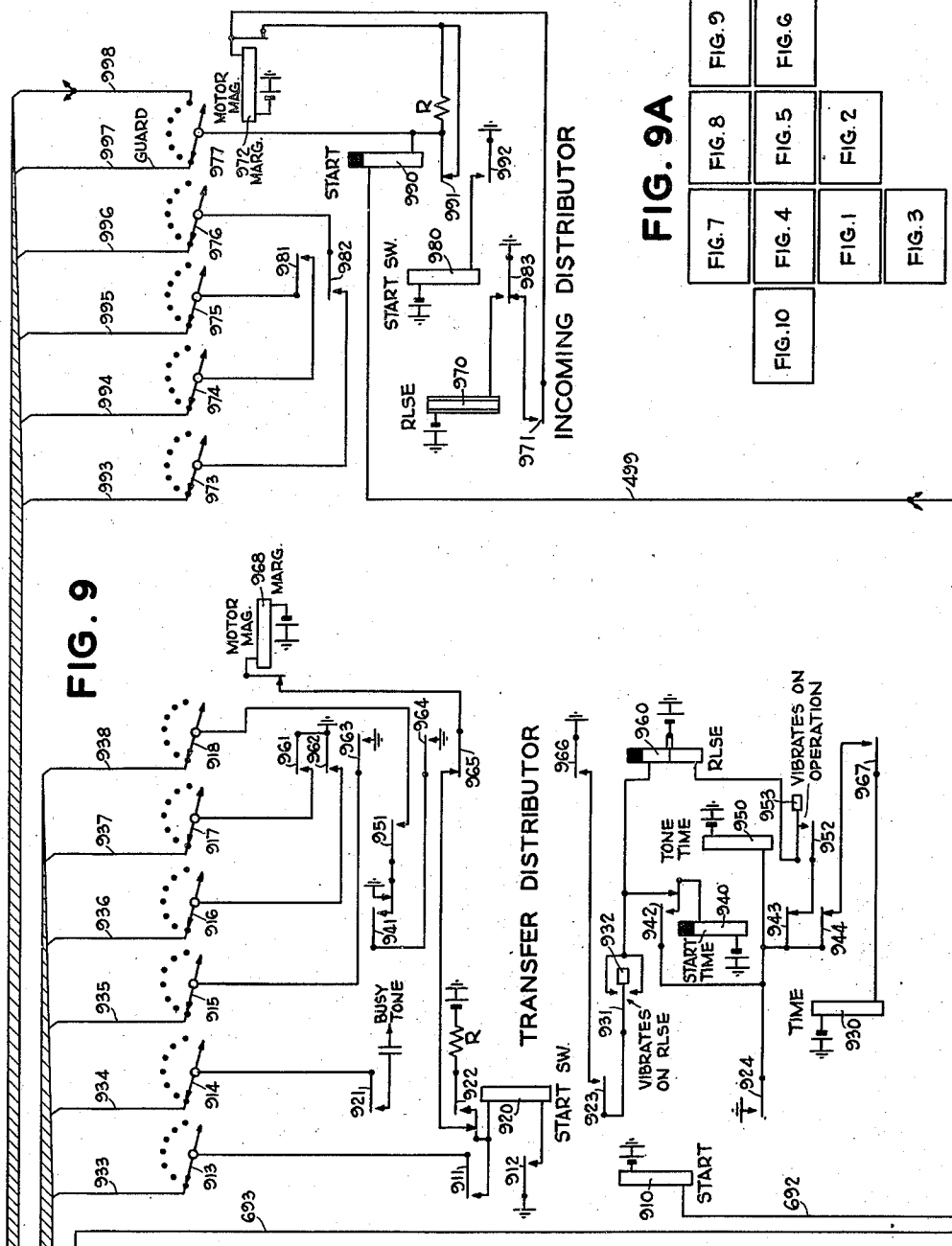
J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 9



INVENTOR.
JOHN H. VOSS

BY
Chas. T. Candy
ATTORNEY.

July 27, 1937.

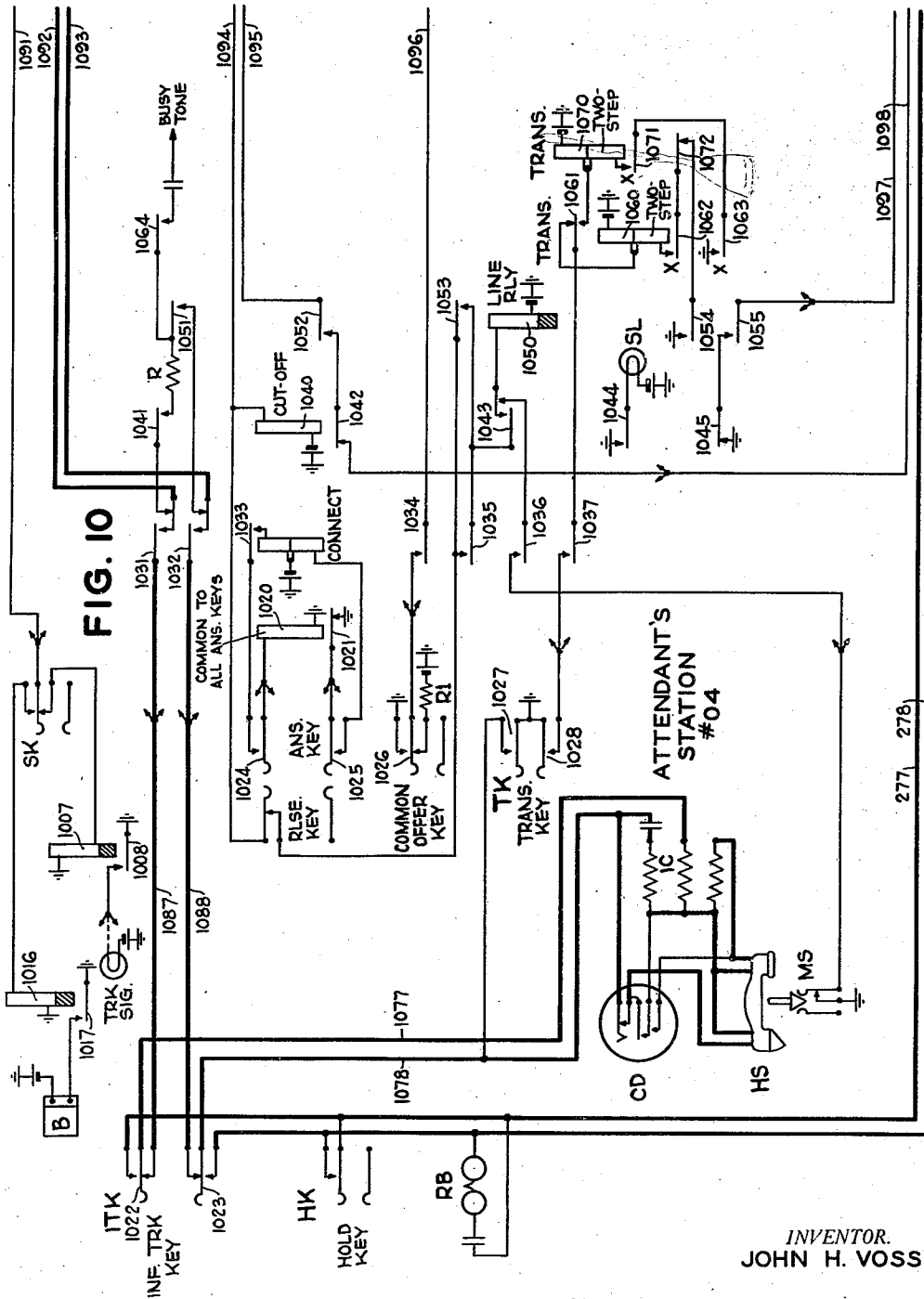
J. H. VOSS

2,087,930

TELEPHONE SYSTEM

Filed July 5, 1935

10 Sheets-Sheet 10



INVENTOR.
JOHN H. VOSS

BY
Chas. W. Candy
ATTORNEY.

UNITED STATES PATENT OFFICE

2,087,930

TELEPHONE SYSTEM

John H. Voss, Downers Grove, Ill., assignor to
Associated Electric Laboratories, Inc., Chicago,
Ill., a corporation of Delaware

Application July 5, 1935, Serial No. 29,864

23 Claims. (Cl. 179-27)

This invention relates to telephone systems in general, but is concerned more particularly with small systems of the type commonly known as private automatic exchanges.

Private automatic exchanges are as a rule privately owned by individuals or corporations and are installed in factories or other establishments for providing local service between a number of local telephone lines and for establishing connections over trunk lines to one or more offices of the telephone company's network.

The main object of the invention is to provide an improved private automatic exchange system of the type shown in my copending application S. N. 704,465, filed December 29, 1933, now Patent No. 2,056,752.

One of the features of the invention relates to the provision of incoming finder and connector links for selecting and transferring trunk calls to local subscriber's lines even if all of the local finder connector links are busy.

Another feature relates to the provision of a trunk distributor used for two groups of trunk lines on both incoming and outgoing calls over the two groups of trunks.

Another feature relates to the provision of divided ringing arrangement provided in both the incoming connectors in the local connectors whereby the subscribers may selectively ring either one of the two subscribers on the called line.

Another feature of the invention relates to the improved attendant's cabinet whereby the incoming connector is arranged to camp on busy called local lines and whereby the attendant may offer a trunk call to a busy called line.

Other features of the invention relate mostly to circuit improvements which will be apparent from the following detailed description of the drawings comprising Figs. 1 to 10, inclusive, which show by means of the usual circuit diagrams a sufficient amount of apparatus to enable the invention to be described and understood.

Fig. 1 illustrates at its left-hand side a local subscriber's telephone S equipped with a push-button PB by means of which the subscriber can make and receive trunk calls, can transfer trunk calls, and can hold a trunk call while making or receiving local calls. The ringer RB of the subscriber S is connected to the lower or positive talking conductor 102 while the other subscriber on this line has his associated ringer connected to the upper or negative talking conductor 101. Two line circuits are shown terminating in the line relays 100 and 103. The local finder shown

to the right of Fig. 1 is a vertical and rotary Strowger switch having vertical motion to find the group the calling line is located in and then rotary movement to find the particular calling line in the group selected. The polar switching relays such as relay 110 in the local finder are polar relays similar to that described in Patent No. 1,673,884, issued June 19, 1928 to H. C. Pye. The wipers of the local finder have access to the local subscribers' lines and to one or more lines terminating in the attendant's cabinet. While only one line is shown extending to the attendant's cabinet it will be understood that additional lines off of this same finder level may extend to the attendant's cabinet. The local subscriber's line and the attendant's line are multiplied in the manner shown to the banks of the trunk finders, incoming connectors, and the local connectors. The lower left-hand corner of Fig. 1 shows the group-marking and starting circuit arrangement for the local finders.

Fig. 2 shows the local connector end of the finder connector link. The local connectors are vertical and rotary Strowger switches directly operated by impulses to find the called line. The lower right-hand corner diagrammatically illustrates one party line having subscribers S2 and S3 thereon, while the rectangle illustrates the line relay and circuit connections similar to the connections to line relay 103 for the party line shown in Fig. 1. The local subscribers' lines terminate in the first to the ninth levels inclusive while the 0-level of the local connectors are used for the purpose of originating outgoing trunk calls, for incoming trunk calls, and for calling the attendant.

Fig. 3 shows the local finder connector distributor for preselecting idle local finder connector links and for causing the operation of the local finder in response to a subscriber initiating a call.

The switch shown in Fig. 3 is mechanically similar to the well known type of rotary line switch which advances its wipers upon the de-energization of its motor magnet.

Fig. 4 shows one of the trunk finders which is similar in mechanical construction and operation to the local finder and which has access to the local subscriber's line and to one or more lines extending to the attendant's cabinet.

Fig. 5 shows the two-way trunk which is individual to the trunk finder shown in Fig. 4. While only one trunk finder and its associated two-way trunk is shown in Fig. 5 it will be understood that there are two groups of such trunk lines and trunk finders, the separate groups of trunk lines

extending to different automatic exchanges. Each trunk finder and trunk line has a branch extending therefrom terminating in the banks of the incoming finders, one of which is shown in Fig. 7.

Fig. 6 diagrammatically illustrates the trunk distributor for use with the two groups of trunk lines previously mentioned. The switch shown in the upper portion of Fig. 6 is mechanically similar to the well known rotary line switch in which the motor magnet advances the wipers of this switch upon deenergization. Wipers 615 and 616 are respectively used for outgoing trunk calls to the second and first groups respectively. Wiper 617 is used to find the trunk line in use on an incoming trunk call, while wiper 618 is used to start the trunk finder in operation. The lower group of relays 661 to 668 may be called sequence control relays or marking relays for controlling the different types of calls to the two groups of trunk lines. Relays 661 and 662 are used on outgoing calls to the second trunk group, relays 663 and 664 on outgoing calls to the first trunk group, relays 665 and 666 are used when a trunk call is to be transferred from one local subscriber to another, while the relays 667 and 668 are used when there is an incoming trunk call from either group.

Fig. 7 illustrates one of the incoming finders and its associated relays, while Fig. 8 illustrates the incoming connector and associated relays. The incoming finder is mechanically similar to the well known rotary type of line switch and has access to the trunks shown in Figs. 4 and 5. The incoming connector shown in Fig. 8 is a vertical and rotary connector which is directly operated by impulses and has access to the local subscribers' lines and to the lines terminating in the attendant's cabinet.

The incoming finder connector links are used during the transfer of trunk calls or are used by local subscribers to complete a local connection while the calling local subscriber is holding a trunk call.

Fig. 9 shows a transfer distributor in its left-hand portion and in its right-hand portion shows the incoming distributor. The transfer distributor is used when a trunk call is transferred from one local subscriber's line to another, while the incoming distributor is used to allot an idle incoming finder connector link for use. The switches shown in the upper portion of Fig. 9 are mechanically similar to the well known rotary type of lineswitch and advance the wipers on the deenergization of their corresponding motor magnets.

Fig. 9A illustrates the manner in which the various sheets of drawings should be assembled.

All of the local subscribers' lines, such as S, S1, S2, and S3, are equipped with a standard well known automatic telephone set comprising a calling device CD, receiver R, transmitter T, switchhook SH, ringer RB, and an induction coil. Non-restricted subscribers entitled to make and receive trunk calls have a push-button, such as PB, mounted in the base of the telephone or in the associated ringer box. Semi-restricted subscribers entitled to answer trunk calls but not originate trunk calls are similarly provided with a push-button, but such subscribers' lines are connected to battery through a resistance such as Z, over an individual conductor to its corresponding bank contact accessible to finder wiper 174. Restricted subscribers are not provided with a push-button and can only make and receive local calls.

Referring now to the attendant's cabinet shown in Fig. 10, the attendant's telephone circuit is mounted on a base and comprises a calling device CD, a handset HS comprising a transmitter and a receiver, monophone springs MS which are closed when the handset HS is removed from the cradle, an induction coil IC, and ringer RB. The information key, the hold key, the transfer key, key SK, the supervisory light SL, the two or more release and answer keys, and the common offering key are mounted on top of the base alongside the attendant's telephone. The relay 1020 is common to all of the release and answer keys, while the remaining relays shown in Fig. 10 are individual to one of the answering positions comprising the conductors 1092 to 1096, inclusive. The other release and answer keys (not shown) each have a similar group of relays and similar conductors terminating in the banks of the switches. The buzzer B is used when the attendant answers all incoming trunk calls, while the trunk signals are used when any non-restricted local line may answer incoming trunk calls. There are as many common trunk signals placed throughout the establishment as required to enable telephone subscribers to determine when an incoming trunk call is to be answered.

Having described the equipment and apparatus, a detailed description of the operation will now be given.

Briefly, local calls are completed in the following manner; the local calling party removes his receiver, and after hearing dial tone dials the number of the desired station. If the called line is not busy, the called station will be rung automatically and intermittently. If the called line is busy, the called party will receive the busy tone. The release of the local call is under control of the calling party.

In order to describe a local call in detail, it will be assumed that subscriber S desires to call subscriber S2 shown in Fig. 2. Responsive to the removal of the receiver, switchhook springs SH closes a circuit for energizing the combined line and cut-off two-step relay 103 in its first step as follows: from ground through the upper winding of relay 103, armature 105, conductor 102, lower winding of induction coil IC, transmitter T, impulse springs of the calling device, upper switchhook springs, conductor 101, armature 104, and through the middle and lower windings of line relay 103, to battery. Due to the resistance in one of these windings relay 103 operates in its first step to close only armatures 106 and 108. At armature 106 relay 103 connects negative battery potential from the lower winding of relay 103 by way of conductor 147 to bank contact 142 to mark the line of station S as calling; and at armature 108 connects ground to the No. 1 vertical bank contacts and also completes a circuit by way of the resistance and common start conductor 109 through the winding of start relay 310 in the local finder connector distributor.

Relay 310, upon energizing, at armature 311 prepares the circuit for the finder start relay 120 and at armature 312 closes the circuit for relay 320 in case the distributor wipers are in engagement with bank contacts terminating an idle finder connector link. The circuit for energizing relay 320 may be traced from ground on the busy common conductors 397, armatures 375, 366, 344, 312, relay 320, interrupter springs of the motor magnet 333, and through the winding of motor magnet 333 to battery. In case the wipers of the distributor are in engagement with

a busy finder connector link the guard conductor 396 thereof will be grounded with the result that switching relay 320 is short circuited from ground on the guard conductor by way of wiper 386, armature 325 and back contact, to the upper terminal of relay 320. This same ground extends by way of the interrupter springs of the motor magnet 333 and through the windings thereof to cause the motor magnet to step the wipers of the distributor until an idle local finder connector link is selected, at which time the relay 320 is energized over the previously traced circuit. Due to the high resistance of relay 320 motor magnet 333 will not energize in series therewith. At armature 321 relay 320 prepares a point in the circuit for the polar switching relay 110 in the local finder, at armature 322 prepares the group test circuit for the changeover relay 340, at armature 323 prepares the circuit for vertical magnet 150, at armature 324 prepares the circuit for the finder start relay 120, at armature 325 opens the preselecting circuit and prepares a new circuit for the motor magnet 333, at armature 326 prepares the time-release circuit to the motor magnet 333, at armature 327 completes its own locking circuit, at armature 328 prepares the circuit for relays 360 and 370, and at armature 329 completes the circuit for release relay 360. Release relay 360 energizes over the following circuit: from ground by way of armature 329, armature 373, and through the upper winding of relay 360 to battery. At armature 361 relay 360 completes the circuit for vertical magnet 150, at armature 362 completes the circuit for the finder start relay 120, at armature 363 opens the time-release circuit to motor magnet 333, at armature 364 completes the circuit for time relay 350, at armature 365 prepares the locking circuit for changeover relay 340 and a holding circuit for the lower winding of relay 360 as well as the circuit for time-start relay 370, and at armature 336 opens the original energizing circuit of relay 320. Relay 350 energizes by way of ground at armature 329, armature 372, and armature 364. The armature 351 is operated upon the energization of relay 350 to close its upper contacts and is provided with a weight 352 which, upon deenergization of relay 350, causes the armature to vibrate between its upper and lower contacts for a predetermined time. At armature 351 relay 350 completes a locking circuit through the lower winding of relay 360 by way of armatures 365, 328, and 351, and also completes the energizing circuit for the time-start relay 370 through the normally closed springs controlled by armature 374. At armature 371 relay 370 prepares a point in the time-release circuit to motor magnet 333, at armature 372 opens the circuit of relay 350, at armature 373 opens the circuit through the upper winding of relay 350, at armature 374 completes a locking circuit for itself from grounded armature 329, and at armature 375 opens a further point in the circuit to relay 320. Relay 350 deenergizes to cause armature 351 to vibrate for a predetermined time between its upper and lower contacts. Due to the copper slug on release relay 360 this relay is maintained energized by the vibrating armature 351 for a predetermined length of time.

Finder start relay 120 is energized over the following circuit: from ground at armature 362 by way of armature 324 and 311, wiper 381, conductor 391, and through the winding of finder start relay 120 to battery. At armature 121 relay 120 disconnects one of the ground connec-

tions from the busy common conductor 397 at its back contact, and at its front contact grounds conductor 193. At armature 122 relay 120 grounds the hold conductor 194 as well as completing a circuit through the lower polarizing winding of polar switching relay to enable the latter relay to energize when the circuit through its upper operating winding is completed in the proper direction; at armature 123 connects the guard conductor 396 to cam springs 170, and at armature 124 prepares the circuit for rotary magnet 140. Vertical magnet 150 is energized over the following circuit: from ground by way of armature 361, normally closed springs controlled by armature 331, armature 323, armature 343 and back contact, wiper 385, vertical conductor 395, and through the winding of vertical magnet 150 to battery. Each operation of vertical magnet 150 operates the shaft and wipers of the local finder one step in a vertical direction. On the first vertical step of the shaft the finder off normal springs 161 and 162 are operated. At off normal spring 161 the circuit to release magnet 130 is prepared and at off normal springs 162 a circuit is prepared for grounding the guard conductor 396. Each energization of vertical magnet 150 likewise completes a circuit for the stepping relay 330 from contacts 151, conductor 392, wiper 382, and through the winding of stepping relay 330 to battery. Relay 330 energizes over the above-traced circuit and at armature 331 interrupts the circuit to the vertical magnet 150, which accordingly deenergizes. The deenergization of vertical magnet 150 opens the circuit to stepping relay 330 at armature 151 to cause the stepping relay 330 to deenergize and again complete the circuit for vertical magnet 150. This inter-acting between vertical magnet 150 and stepping relay 330 continues until such time as the vertical test wiper 176 encounters a grounded bank contact at which time a circuit is completed for energizing the change-over relay 340 in series with the stepping relay 330 as follows: from ground at armature 170 by way of armature 108, vertical bank contact 1, vertical test wiper 176, conductor 393, wiper 383, armature 341 and back contact, through the upper winding of change-over relay 340, armature 322 and through the winding of relay 330 to battery. Stepping relay 330 is maintained energized over this circuit to hold the stepping circuit to vertical magnet 150 open and the change-over relay is energized to close its locking circuit at armature 342 through its lower winding from ground at armature 365. At armature 341 relay 340 opens its original energizing circuit and grounds the test lead 393 to prepare the energizing circuit for polar switching relay 110, at armature 344 opens a further point in the original energizing circuit of relay 320, and at armature 343 transfers the stepping circuit from the vertical magnet 150 to rotary magnet 140. The operation of armature 341 at its back contacts opens the circuit to stepping relay 330 whereupon the latter relay deenergizes, and at armature 331 completes the circuit for energizing rotary magnet 140 as follows: from ground by way of armature 361, normally closed springs controlled by armature 331, armature 323, armature 343 and front contact, conductor 394, armature 124, armature 115 and back contact, through the winding of rotary magnet 140 to battery. The rotary magnet operates to rotate the wipers of the local finder in the well known manner and at armature 141 grounds conductor 392 to operate the

stepping relay 330 which at armature 331 interrupts the circuit of rotary magnet 140. This inter-action between rotary magnet 140 and stepping relay 330 continues until such time as the line test wiper 173 encounters the marked contact terminating the calling line, at which time the polar switching relay 110 is energized.

The circuit for energizing the polar switching relay 110 may be traced as follows: from ground by way of armature 321, front contact and armature 341, wipers 383, conductor 393, through the upper operating winding of relay 110, wiper 173, in engagement with bank contact 142, conductor 147, armature 106, and through the lower winding of line relay 103 to battery. Relay 110, upon operating, at armatures 111 and 112 connects up line relay 210; at armature 113 opens a point in the circuit to release magnet 130, at armature 114 grounds wiper 173 to fully operate line cut-off relay 103 and to mark the calling line busy, and at armature 155 opens the circuit to rotary magnet 140 and prepares a circuit to guard conductor 396.

Line relay 210 of the local connector is now connected in bridge of the calling line by way of wipers 171 and 172 and the heavy talking conductors, and at armature 211 completes the circuit for energizing release relay 250 and vertical series relay 260 by way of the connector off normal springs 214. At armature 251, relay 250 prepares the test circuit for the switching relay 200, at armature 252 grounds conductor 193 to maintain the calling line busy, at armature 253 places another ground on hold conductor 194, and at armature 254 opens a point in the circuit to release magnet 217 as well as preparing a point in the impulsing circuit. Vertical series relay 260, upon energizing, at armature 261 connects dial tone to the lower talking conductor by way of armatures 261 and 273 and contacts 234, at armature 262 opens a point in the energizing circuit of relay 270, and at armature 263 prepares a point in the impulsing circuit to vertical magnet 218.

Two-step line and cut-off relay 103 is energized from grounded test wiper 173 to operate its armatures through their second step. At armatures 104 and 105 relay 103 disconnects itself from the calling subscriber's line, and at armature 107 disconnects ground from vertical bank No. 1 and the common start conductor 109 to cause the deenergization of start relay 310 in case no other subscriber is calling at this time. Relay 310, upon deenergizing, at armature 311 opens the circuit of the finder start relay which deenergizes after an interval. At armature 121 relay 120 prepares a point in the circuit to release magnet 130 and at armature 123 grounds the guard conductor 396 by way of finder off normal springs 162. When guard conductor 396 is grounded a circuit is completed for the motor magnet by way of armature 325 and front contact and through the winding of motor magnet 333 to battery. Motor magnet 333 positions its pawl and operates its interrupter springs to open the circuit of switching relay 320 which thereupon deenergizes. At armature 325 relay 330 opens the circuit to motor magnet 333 at its front contact and at its back contact completes the self-interrupting circuit to motor magnet 333, whereupon the motor magnet 333 operates in the manner of a buzzer to step the wipers of the local finder connector distributor in a buzzer-like manner until wiper 386 no longer engages a contact terminating a grounded guard conduc-

tor. At armature 328 relay 320 opens the circuit through the lower winding of relay 360 to cause the release of the latter relay, and at armature 329 opens the locking circuit of relay 370 to cause the latter relay to deenergize. Relay 370 deenergizes first before relay 360 and after an interval relay 360 deenergizes. At armature 365 opens the locking circuit of change-over relay 340 whereupon the latter relay deenergizes.

Assuming now that start relay 310 is held energized due to the start conductor 109 being grounded by another call. The operation of armature 115 of relay 110 completes a circuit for operating motor magnet 333 when stepping relay 330 deenergizes, as follows: from ground by way of armature 361, normally closed springs controlled by armature 331, armature 323, armature 343 and front contact, conductor 394, armature 124, armature 115 and front contact, front contact and armature 123, guard conductor 396, wiper 386, armature 325 and front contact, and through the winding of motor magnet 333 to battery. At its interrupter springs motor magnet 331 opens the circuit of relay 320 which accordingly deenergizes, and at the back contact of armature 325 completes the self-interrupting circuit to motor magnet 333 to cause the distributor to select an idle local finder connector link over which this other call may now proceed. Also, if for some reason the local finder does not find the calling line then the shaft and wipers are rotated to their eleventh position, in which position the cam springs 170 are closed to ground the guard lead 396 to cause the distributor to find another idle finder connector link.

If, due to some fault, the change-over relay 340 does not operate, then the time-release arrangement is operative after a predetermined time to cause the distributor to find another local finder connector link. In this case relay 360 is held energized through its lower winding for a predetermined time by the vibrations of armature 351 and after this predetermined time relay 360 releases shortly after armature 351 ceases to make contact with its upper and lower springs. Relay 360, upon deenergizing, at armature 361 opens the circuit to vertical magnet 150, at armature 362 opens a circuit to finder start relay 120, and at armature 363 completes the circuit to motor magnet 333. This circuit may be traced from grounded armature 371, armature 363, armature 326, and through the winding of motor magnet 333 to battery. The operation of motor magnet 333 at its interrupter springs opens the circuit of relay 320 which thereupon deenergizes. Relay 320 deenergizes with the same result as previously described, and at armature 326 opens the circuit of motor magnet 333 to cause the wipers of the distributor to be operated one step, from which point on the distributor operates over its preselecting circuit to find another idle finder connector link. In the local finder relay 120 deenergizes, and at armature 123 grounds the guard lead 396 to maintain this local finder connector link busy until the same is fully released, and at armature 121 completes the circuit for release magnet 120 by way of off normal springs 161 and armature 113. By the operation of release magnet 130 the finder shaft and wipers are restored to their normal position and the finder off normal springs 161 and 162 are restored to their normal position when the wipers reach normal, thereby opening the circuit to release magnet 130 and removing ground from the guard conductor 396.

Returning now to the correct operation of the local finder connector link and at a time when the calling subscriber S receives dial tone over the heavy talking conductors and such subscriber in response to dial tone will dial the digits 9 and 1 to call station S2. The operation of the calling device CD in accordance with the first digit or digit 9, causes the line relay 210 to be deenergized nine times. Each deenergization of line relay 210 transmits an impulse over the impulsing circuit to vertical magnet 218 as follows: from ground by way of armature 211 and back contact, armature 254 and front contact, armature 263 and front contact, armature 276 and back contact, and through the winding of vertical magnet 218 to battery. The vertical magnet 218 operates the shaft and wipers of the connector one step for each impulse received, after which the wipers come to rest opposite the bank contacts in the ninth level. On the first vertical step of the shaft and wipers the connector off normal springs 181, 214, and 215 are operated. The operation of off normal springs 181 grounds guard conductor 396, the operation of off normal springs 215 prepares a point in the circuit to release magnet 217 of the local connector, while off normal springs 214 opens the original energizing circuit of vertical series relay 216, but this latter relay, due to its slow release characteristics, is held energized through its lower winding from the impulses being transmitted to the vertical magnet. The shaft springs 213 close only on the first vertical step of the wiper shaft and are opened in response to the second vertical step and since at this time armature 252 is operated the ring-reversing relay 270 is not operated. Shortly after the impulsing period relay 260 deenergizes, and at armature 261 disconnects dial tone from the calling line, and at armature 262 prepares the circuit to ring-reversing relay 270 and at armature 263 transfers the impulsing circuit from the vertical magnet 218 to the rotary magnet 219.

The calling subscriber now dials the second digit, or digit 1, to cause the connector to rotate into engagement with the line of the called substation. Line relay 210 again follows the dial impulses and at armature 211 completes the following circuit for rotary magnet 219: from ground by way of armature 211 and back contact, armature 254 and front contact, armature 263 and back contact, armature 223, through the winding of rotary series relay 290, armature 209, and through the winding of rotary magnet 218 to battery. By the operation of rotary magnet 219 the connector wipers are rotated one step into engagement with the first bank contact in the ninth level, or the bank contact terminating the line of substation S2. The rotary series relay 290 energizes in series with rotary magnet 219 and due to its slow release characteristic maintains its armature attracted throughout the rotary movement. At armature 291 relay 290 closes a circuit to the busy test relay 220, and at armature 292 shunts armature 223 to maintain the impulsing circuit should the busy relay 220 operate during such movement.

In case the called line is busy conductor 269 will be grounded from the busy connection, and the busy relay 220 will be energized from conductor 269 by way of bank contact 266, wiper 226, armature 291 and front contact, armature 205, and through the upper winding of busy relay 220 to battery. At armature 223 relay 220 opens a point in the circuit to the rotary magnet to prevent the further operation of rotary magnet

219 after relay 290 deenergizes, at armature 222 and back contact opens a point in the energizing circuit of switching relay 200, and at its front contact prepares a locking circuit for itself. At armature 221 relay 220 connects the busy tone to the lower talking conductor by way of contact 234 to transmit the busy tone to the calling subscriber over the heavy talking conductors in the well known manner. When the rotary series relay 290 deenergizes after the impulsing period the locking circuit for busy relay 220 is completed from grounded armature 251, armature 222 and front contact, normally closed springs controlled over armature 291, armature 205, and through the upper winding of busy relay 220 to battery. When the calling party hears the busy tone such subscriber will replace his receiver and release the local finder connector link in a manner to be more fully described hereinafter.

Assuming now that the called line is idle instead of busy, then busy relay 220 does not operate and when slow release series relay 290 deenergizes shortly after the impulsing period a circuit is completed for the switching relay 200 in series with the lower winding of the line and cut-off relay, similar to the relay 103, of the called line. The circuit for energizing switching relay 200 in series with the line and cut-off relay of the called line may be traced from ground at armature 251, armature 222 and back contact, lower winding of switching relay 200, back contact and armature 291, wiper 226, contact 266, conductor 269, and through the lower winding of the line and cut-off relay of the called line to battery. The line and cut-off relay of the called line is energized over this circuit to fully operate all of its armatures, to disconnect itself from the called line, and to open the circuit to the common start conductor 109. At the armature, similar to armature 106, the line and cut-off relay connects conductor 269 to conductor 269' to maintain the called line busy in the banks of the local finder. Relay 200 first operates its armature 207 to complete a circuit through its upper winding from ground at armature 253 to operate its remaining armatures. Armatures 201, 202, and 204 at relay 200 completes the ringing circuit, at armature 203 completes the ring-back circuit through the ring-back condenser RBC1 at armature 205 opens a point in the circuit to busy relay 220, at armature 206 grounds conductor 269, at armature 208 prepares a point in the circuit to transfer relay 240, and at armature 209 opens the circuit to rotary magnet 219. The ringing circuit for operating the bell of the called station S2 may now be traced as follows: from interrupted generator by way of armature 202, back contact and cam spring 212, armature 272 and back contact, back contact and armature 233, armature 204, wiper 225, bank contact 265, conductor 268, and through the ringer at substation S2 to ground.

When the subscriber at substation S2 answers by removing the receiver a circuit may be traced for operating the ring cut-off relay 230 as follows: from interrupted generator over the previously traced ringing circuit through the switch-hook springs at the called station, conductor 267, wiper 224, armature 201, armature 231 and back contact, back contact and armature 271, and through the upper winding of cut-off relay 230 to battery. Ring cut-off relay 230 operates over the above-traced circuit and closes a locking circuit for itself at armature 232, as well as the circuit for fully energizing its remaining armatures. The locking circuit for ring-cut-off relay

230 may be traced from grounded armature 253, armature 232, through the lower and upper windings of ring cut-off relay in series to battery. At armatures 231 and 233 relay 230 opens the ringing circuit and completes the talking circuit over the heavy conductors. Relay 220 now energizes over the called subscriber's loop from ground at armature 253 by way of armature 232, lower winding of relay 220, front contact and armature 233, armature 204, wiper 225, conductor 268, through the substation loop, conductor 267, wiper 224, armature 201, armature 231 and front contact, and through the upper winding of busy relay 220 to battery. Talking battery to the called line is furnished through the windings of relay 220 over the circuit just traced while the talking battery to the calling line is transmitted through the windings of line relay 210.

After conversation and in response to the called party replacing his receiver, relay 220 deenergizes. When the calling party replaces his receiver line relay 210 deenergizes and at armature 211 opens the circuit of release relay 250. Release relay 250, upon deenergizing, at armature 252 disconnects ground from conductor 193 to release line and cut-off relay 103 and to free the calling line, at armature 253 removes ground from conductor 194 to cause the release of relays 110, 230, and 200, and at armature 254 completes the circuit for release magnet 217 by way of armature 211 and connector off normal springs 215. Polar switching relay 110 deenergizes when ground is removed from hold conductor 194, and at armature 113 completes the circuit for release magnet 130 of the local finder by way of finder off normal springs 161 and armature 121. Relays 230 and 200 deenergize, the latter relay at armature 206 disconnects ground from conductor 269 to free the called line and to deenergize the associated line and cut-off relay. When the finder and connector are released, the off normal springs open the circuit to their respective release magnets. The finder off normal springs 161 again grounds the busy common conductor 297 and the connector off normal contacts 181 disconnects ground from the guard lead 396 to indicate that this local finder connector is now available for other calls.

It will now be assumed that subscriber S calls subscriber S3. Since the ringer at substation S3 is connected to the negative line conductor 267 the calling subscriber must prefix the digit 1 to the number of his line, or 91, in order to operate the ringer at the substation S3. The finder and distributor operate in the same manner as before and in response to the subscriber S dialling the digit 1 the connector operates its wipers opposite the first level of bank contacts. In this case since the wipers of the connector are opposite the first level, the shaft springs 213 are closed and when vertical series relay 260 deenergizes shortly after the impulsing period, the circuit for energizing relay 270 is completed at armature 262 through the lower winding of ring-reversing relay 270. Ring-reversing relay 270 energizes and at armature 274 completes a locking circuit for itself from grounded hold conductor 194. At armatures 271 and 272 relay 270 reverses the generator connections, at armature 273 opens the dial tone circuit, at armature 275 completes a circuit for reenergizing relay 260, and at armature 276 transfers the impulsing circuit from the vertical magnet to the two-step absorbing relay 280. The circuit for energizing relay 260 at this time may be traced from ground

by way of armature 211 and front contact, armatures 275 and 282, and through the upper winding of relay 260 to battery. At armature 262 relay 260 opens the original energizing circuit to relay 270 which is locked to hold conductor 194, and at armature 263 prepares the impulsing circuit for relay 280.

The subscriber S now dials the second digit, or the digit 9. Line relay 210 follows the impulses to operate relay 280 in response to only the first impulse, and the vertical magnet for the remaining impulses of the second digit. In response to the first impulse, line relay 210 completes the circuit for energizing relay 280 in its first step as follows: from ground by way of armature 211 and back contact, armature 254 and front contact, armature 263 and front contact, armature 276 and front contact, armature 283 and back contact, and through the lower winding of relay 280 to battery. Relay 280 is energized over the above-traced circuit to close only its armature springs 281 and in so doing short circuits its upper winding from ground on the hold conductor 194. When line relay 210 energizes the short circuit around the upper winding of this relay is removed and the relay now energizes in its second step to operate armatures 282 and 283. At armature 282 relay 280 opens the circuit to relay 260, but this relay, due to its slow release characteristics, is maintained energized during the impulsing period, and at armature 283 and back contact opens the original energizing circuit of relay 280, and at its front contact prepares the circuit for vertical magnet 218. The remaining eight impulses of the second digit are now transmitted to the vertical magnet. The vertical magnet is now operated eight times to position the connector wipers opposite the ninth level of bank contacts. From the foregoing it will be seen that relay 280 absorbs the first impulse of the second digit and that the remaining impulses of this digit reoperated the vertical magnet to cause the shaft and wipers to take additional vertical steps to position the wipers opposite the ninth level. The first digit, if digit 1, therefore determines that the ringing current will be transmitted out over the negative conductor, and such first digit conditions relays 270 and 280 so that only the first pulse of the next digit to be dialled is absorbed and the remaining impulses then reoperate the shaft to the desired level.

The operation from here on is the same as before, except that the generator is transmitted over the negative line conductor as follows: from interrupted generator, armature 202, back contact and cam spring 212, armature 272 and front contact, back contact and armature 231, armature 201, wiper 224, conductor 267, and through the ringer at substation S3 to ground. The ring-back tone to the calling subscriber is transmitted by way of the heavy talking conductors through the ring-back condenser RBC. When subscriber S3 answers, ring cut-off relay 230 is energized over the previously traced circuit and from thence through the substation of subscriber S3, conductor 268, wiper 225, armature 204, armature 233 and back contact, front contact and armature 271, and through the upper winding of cut-off relay 230 to battery.

Cam springs 212 are operated on the tenth rotary step of the selector and are provided to enable subscribers to connect with a code call switch and dial such switch to transmit a desired code call to operate the code call signals

placed throughout the establishment. The impulsing circuit over which the code call switch is operated may be traced from armature 211 and back contact, armature 254 and front contact, armature 263 and back contact, front contact and cam springs 212, armature 272 and back contact, back contact and armature 233, armature 204, wiper 225, and from thence over the bank contacts terminating the code switch in the banks of the local connector.

Incoming trunk calls

It will now be assumed that an incoming trunk call is received over conductors 507 and 503. Ringing current from the central office extends by way of conductor 107, condenser, the A C signalling relay 504, armature 562, conductor 508 back to the central office. A C signalling relay 504 is energized over this circuit and at armature 505 completes the circuit for signalling relay 500. At armature 501 relay 500 completes a circuit for energizing relay 1007 in Fig. 10 in case the signalling key SK is in normal position, at armature 502 completes the circuit for time relay 509, and at armature 503 completes the circuit for operating relay 580. The circuit for energizing signalling relay 1007 extends from ground through the winding of said relay, back contact and middle spring of signal key SK, over the common signalling conductor 1091 to armature 591, and through the resistance to battery. At armature 1008 relay 1007 grounds the common conductor extending to all of the trunk signals which are placed in different locations throughout the establishment to call the attention of the local subscribers to the fact that an incoming trunk call is to be answered. At armature 591 relay 590 prepares a locking circuit for time release relay 580. Armature 591 is provided with a weight 592 which vibrates between its upper and lower contacts when the time relay 590 is released. Relay 580 is energized over the following circuit: from ground by way of armature 444 and back contact, armature 466 and back contact, conductor 529, armature 503, and through the lower winding of relay 580 to battery. At armature 583 relay 580 completes a circuit for energizing busy relay 570, at armature 581 and back contact removes ground from conductor 532 to mark this trunk line as calling in the incoming bank of the trunk distributor and at the front contact of armature 581 grounds the incoming start conductor 533 to energize the common incoming trunk call relay 630. At armature 582 relay 580 completes a locking circuit through its lower winding from grounded conductor 529 by way of armature 591. Relay 630, upon energizing, at armature 631 and back contact disconnects ground from incoming start conductor 636, and from conductor 1097. Ground is thus removed from conductor 636 to enable a local subscriber to answer this incoming trunk call. At the front contact of armature 631 the circuit for the incoming relays 667 and 668 is prepared.

Any non-restricted subscriber may answer this trunk call by dialling the answer number, in this case the digits 0 and 3. In response to a non-restricted subscriber removing his receiver and dialling the digits 0 and 3 to answer the trunk call, the local finder and connector operate in the same manner as before, and when rotary series relay 290 deenergizes after the impulsing period the switching relay 200 is energized in series with relays 667 and 668. This circuit may be traced as follows: from ground by way of armature 251,

armature 222 and back contact, lower winding of relay 200, back contact and armature 291, wiper 226, bank contact 255, conductor 635, armature 631 and front contact, through the winding of marginal relay 667, and through the lower and upper windings of relay 668 to battery. Relay 667 being marginal will not operate in series with both windings of relay 668. Relay 200, upon energizing, at armature 206 grounds conductor 636 to busy this position to other connector switches, at armature 207 completes its locking circuit through its upper winding, and at armature 208 prepares a circuit for transfer relay 240.

In the trunk distributor relay 668 energizes over the previously traced circuit, and at armature 690 disconnects battery from the remaining sequence control relays, and at armature 691 locks itself through its lower winding and causes the energization of marginal relay 667 in case the trunk distributor is not in use on other calls, in which case either of the armatures 675, 681, or 684 may be in operated position. In case the trunk distributor is not in use then marginal relay 667 is energized from ground at armature 206, wiper 226, conductor 696, armature 631, winding of relay 667, through the lower winding of relay 668, and by way of armatures 691, 694, 681 and 675 to battery. At armature 685, relay 667 completes the test circuit to enable the trunk distributor to find the trunk line having the incoming call, at armature 686 completes the circuit for energizing the start relay 640 in case the incoming wiper 617 is on an ungrounded bank contact, at armature 687 grounds conductor 646 to mark the answering line in the trunk finder bank by way of the local finder and connector link at armature 689 grounds the conductor 647 to mark the group the answering line is located in, and at armature 689 grounds conductor 1090 which is used only when the attendant answers incoming calls.

The operation of the trunk distributor at this time is dependent upon whether the wiper 617 is in engagement with a grounded bank contact in which case the start relay 640 is short circuited and the motor magnet 619 is operated in a self-interrupting circuit until the incoming wiper 617 loses ground. The circuit for short circuiting relay 640 and operating the motor magnet 619 may be traced from grounded conductor, such as conductor 532 extending to the idle trunk line, the bank contact terminating these conductors, incoming wiper 617, armature 685, resting contact and armature 671, resting contact and armature 676, through the winding of relay 640 to short circuit relay 640, and by way of armature 642, interrupter springs, and the winding of motor magnet 619 to battery.

As soon as wiper 617 engages a non-grounded bank contact or a contact corresponding to the trunk line having an incoming call thereon, the short circuit around relay 640 is removed and relay 640 thereupon energizes in series with the motor magnet 619 as follows: from ground by way of armature 686, relay 640, armature 642, interrupter springs, and the winding of magnet 619 to battery. Motor magnet 619 is marginal and will not energize in series with the high resistance winding of relay 640. At armature 641 relay 640 grounds the start lead 479 of the corresponding trunk line to operate the start relay 450 thereof, at armature 642 opens its original energizing circuit and the circuit of rotary magnet 619 but due to the resistance R in bridge of armature 622 the relay 640 is maintained in

energized position, and at armature 643 operates the release relay 650. Relay 650, upon energizing, at armature 651 prepares a circuit for the magnet 619.

5 The circuit for energizing start relay 450 on this trunk line may be traced as follows: from ground by way of armature 641, start wiper 618, start conductor 479, trunk finder off normal springs 469, armature 443, and through the winding of start relay 450 to battery. At armature 10 451 relay 450 prepares the circuit for operating winding of the polar-stop relay 470, at armature 452 energizes the polarizing winding of the polar relay 470, at armature 453 opens a point in the circuit to relay 440, at armature 454 completes the circuit for the vertical magnet 415, at armature 455 completes a locking circuit for itself from grounded conductor 479, and at armature 15 456 opens a point in the circuit to release magnet 417.

20 The circuit for operating the vertical magnet 416 extends from ground by way of armature 454, armature 472 and back contact, normally closed springs controlled by armature 421, armature 411 and back contact, and through the winding of vertical magnet 416 to battery. Vertical magnet 416 operates the shaft and wipers one vertical step in response to each energization, and at contacts of 419 completes the circuit for operating the stepping relay 420. On the first 30 vertical step of the wipers off normal springs 467 close to prepare the circuit to release magnet 417, and off normal springs 469 opens the original energizing circuit of start relay 415 which is now held energized by way of its armature 455. Stepping relay 420 at armature 421 interrupts the circuit to the vertical magnet 415 which de-energizes and disconnects ground from stepping relay 420 which thereupon deenergizes to again 40 close the normally closed springs controlled by armature 421 to again complete the circuit for the vertical magnet 416. This interaction between the vertical magnet 416 and 420 continues until the vertical wiper 428 finds the marked vertical bank contact which has been grounded by the operation of relay 667. When the vertical wiper engages a grounded bank contact the change-over relay 410 is energized in series with the stepping relay 420 when ground is opened at 45 armature 419 by the deenergization of vertical magnet 416. The circuit for energizing the change-over relay and for maintaining the stepping relay 420 in energized position may be traced as follows: from ground at armature 688, 50 conductor 647, bank contact 257 in the local connector, local connector wiper 228, conductor 196, finder wiper 175, bank contact 145, conductor 155, and in this case through the first vertical bank No. 1, vertical wiper 428, armature 414, lower winding of relay 410, and through the winding of stepping relay 420 to battery. Relay 410 operates its armature 413 to complete a circuit from ground at the off normal springs 468 for maintaining the change-over relay in energized position when it opens its original energizing circuit and the circuit of stepping relay 420 at armature 414. At armature 411 change-over relay 410 transfers the stepping circuit from the vertical magnet 416 to the rotary magnet 415, at 60 armature 412 opens a point in the circuit to start relay 450, and at armature 414 opens the circuit to stepping relay 420 which accordingly deenergizes. At armature 421 stepping relay 420 completes the circuit for operating rotary magnet 75 415, and the rotary magnet 415 at contacts 418

completes the circuit for energizing stepping relay 420. The operation of stepping relay 420 at armature 421 opens the circuit to rotary magnet 415 whereupon the rotary magnet deenergizes to cause the deenergization of stepping relay 420. Each operation of the rotary magnet 415 rotates the wipers of the trunk finder one step in a rotary direction. The above inter-action between the rotary magnet 415 and stepping relay 420 continues until such time as the polar stop relay 470 is energized in response to wiper 425 5 encountering the marked contact marked by the trunk distributor. When wiper 425 finds the marked contact polar stop relay 470 and transfer relay 240 in the local connection energize in series over the following circuit: from ground by way of armature 687, conductor 646, bank contact 256, wiper 227, armature 208, the lower winding of transfer relay 240, conductor 195, wiper 174, bank contact 143, conductor 153, trunk find- 10 er bank contact 475, wiper 425, back contact and armature 441, armature 451, and the upper operating winding of polar stop relay 470 to battery. Polar stop relay 470, upon energizing over the above traced circuit, at armature 471 completes 15 a circuit by way of the back contact and armature 404 for energizing recall relay 530, at armature 472 and back contact opens the stepping circuit to the rotary magnet and at its front contact completes the circuit for energizing the switch through relay 460 from grounded armature 454, at armature 473 completes a holding circuit for the switch through relay 460, and at armature 469 removes the short circuit from around the upper winding of time release relay 20 580 to render the latter relay quick to release. Relay 460, upon energizing, at armatures 461 and 462 connects the talking conductors 102 and 101 to both windings of the differential recall relay 510 and through the lower and upper windings of line relay 550 to ground and battery, respectively. At armature 463 relay 460 grounds conductor 100 by way of wiper 424 to maintain the line and cut-off relay 103 energized and to maintain the answering line busy. At armature 45 464 relay 460 opens a point in the circuit to relay 430, at armature 465 opens a further point in the circuit to release magnet 417, at armature 466 and back contact opens the holding circuit of release relay 580, and at the front contact of armature 466 connects ground at armature 444 to the polarizing windings of the polar stop relay 470 to maintain this relay in operated position. Relay 530, upon energizing, at armature 531 prepares a holding circuit for the two-step 55 relay 520. The circuit for energizing the line relay 550 may be traced as follows: from ground through the lower winding of line relay 550, the lower left-hand winding of the repeating coil, and thence over the heavy talking conductors by way of the normally closed springs controlled by armature 522, the lower winding of differential relay 510, conductor 514, armature 462, wiper 423, conductor 102, through the answering substation loop to conductor 101, wiper 422, armature 461, conductor 513, through the upper winding of differential relay 510, normally closed springs controlled by armature 521, upper left-hand winding of the repeating coil, and through the upper winding of line relay 550 to battery. 70 The recall relay 510 being differential will not energize over the above-traced circuit. Line relay 550, upon energizing, at armature 552 completes the circuit for energizing release relay 560, and at armature 551 bridges the right-hand wind- 75

ing of the repeating coil across the trunk conductors 507 and 508 to cause the ring cut-off relay in the central office to operate and disconnect ringing current from conductors 507 and 508.

5 Release relay 560, upon energizing, at armature 561 maintains the busy relay 570 in operated position and at armature 562 disconnects the A C signalling relay 504 from in bridge of the trunk conductors 507 and 508. Relay 504 releases and at armature 505 opens the circuit of signalling relay 500 which deenergizes after an interval. Relay 580 deenergizes when its locking circuit is opened by relay 460 and at armature 581 and front contact disconnects ground from conductor 533 to cause the deenergization of the incoming trunk call relay 630 in the trunk distributor in case no other incoming calls have come in, and at armature 581 and back contact grounds conductor 532 to short circuit the start relay 640 in the trunk distributor to cause the same to deenergize. Relay 500 deenergizes a short interval after its circuit is permanently opened at armature 505, and at armature 501 opens the circuit to relay 1007 which deenergized and extinguishes the trunk signal lamps throughout the establishment. At armature 502 relay 500 opens the circuit of time relay 590 which relay thereupon releases its armature 591 which now vibrates for a predetermined time. The vibration of armature 591 is without effect at this time because the trunk finder has switched through to its answering local line.

In the distributor the incoming trunk call relay 630 deenergizes only in case a second incoming trunk call has not arrived by this time, and at armature 631 opens the circuit to relays 667 and 668 at its front contact, and at its back contact grounds the conductors 636 and 1097. In case a second trunk call has arrived, relay 630 is maintained in operated position and the relays 667 and 668 are deenergized when the local connector releases and removes ground from conductor 636 in a manner to be described hereinafter. Relay 640 deenergizes when it is short circuited and such short circuit may be traced as follows: from ground by way of armature 686, winding of relay 660, armature 676, and back contact, armature 671 and back contact, armature 685, incoming wiper 617, conductor 532, resting contact and armature 581 to ground. At armature 641 relay 640 opens the circuit to start relay 540 which thereupon deenergizes. At armature 642 relay 640 closes a self interrupting circuit to the motor magnet 619 which is effective after the release of relay 650 in case another call has arrived. At armature 643 and front contact relay 640 opens the circuit of release relay 650 which thereupon deenergizes after an interval and at back contact completes a circuit by way of armature 651 for maintaining the rotary magnet 619 in energized position during the release time of release relay 650. Relay 667, upon energizing, at armature 685 opens the self-interrupting circuit to motor magnet as well as opening the short circuit around relay 640, and at armature 686 opens the circuit of start relay 620 to insure the deenergization of the latter relay. At armature 687 relay 680 disconnects ground from conductor 646 to remove the marking potential from the finder at the connector banks, at armature 688 likewise removes the marking ground from conductor 647, and at armature 689 removes ground from conductor 1098. Relay 668, upon deenergizing, at armatures 690 and 691 reconnects battery to permit the energization of any of the sequence con-

trol relays in Fig. 6. When slow-to-release relay 650 deenergizes, said relay at armature 651 opens the circuit to motor magnet 619 to cause the trunk distributor wipers to take one step. The trunk distributor is now at normal and may be used for subsequent calls.

Returning to the local finder connector link and at a time when transfer relay 240 energizes in series with the polar stop relay 470. Relay 240, upon energizing, at armature 223 completes a locking circuit through its upper winding from hold conductor 194 and at armatures 241 and 242 opens the circuit to line relay 210. Line relay 210 deenergizes and at armature 211 opens the circuit to release relay 250. Release relay 250, upon deenergizing, at armature 252 disconnects ground from wiper 173 and conductor 147 which is now grounded by way of conductor 100. At armature 253 opens the holding circuit of relays 110, 220, 270, 280, 230, and 200, which now deenergize, and at armature 254 completes the circuit for release magnet 217. By the operation of the release magnet 217 the local connector wipers are restored to their normal position. The off-normal springs 215 open the circuit to release magnet 217. The deenergization of switching relay 200 at armature 206 or the release of the switch wipers disconnects ground from conductor 636 to cause the deenergization of relays 667 and 668 in case the same has not by this time deenergized. Relay 110, upon deenergizing, at armature 113 completes the circuit for the finder release magnet 130, whereupon the magnet restores the finder wipers and the finder off normal spring 161 opens the circuit to the release magnet 130. All of the relays and the apparatus in the local finder connector link are now at normal and may be used on subsequent calls.

In the trunk finder, start relay 450 deenergizes when its circuit is opened in response to the deenergization of start relay 640 disconnecting ground from conductor 479 at armature 641. At armature 451 relay 450 opens the original operating circuit of relay 470, at armature 452 disconnects one of the grounded connections from the lower polarizing winding of relay 470, at armature 453 prepares a point in the circuit to transfer relay 440, at armature 454 opens the original energizing circuit of relay 460 and at armature 456 prepares a point in the circuit to release magnet 417. The answering subscriber S is now connected to the two-way trunk by way of the heavy talking conductors 101 and 102, trunk finder wipers 422 and 423, armatures 461 and 462, conductors 513 and 514, through the windings of the differential recall relay 510, through the normally closed springs controlled by armatures 521 and 522, and through the windings of the repeater coil and line relay 550 to ground and battery. Talking battery is furnished to the subscriber S over the circuit just traced, while the talking battery for the central office subscriber is furnished at that office.

The release of the established trunk connection is controlled by the local subscriber. After conversation and in response to subscriber S replacing his receiver the circuit to line relay 550 is opened and this relay accordingly deenergizes. At armature 551 relay 550 opens the bridge across the trunk conductors 507 and 508 to release the central office switches and connections, and at armature 522 opens the circuit to release relay 560. After an interval slow-to-release relay 560 deenergizes to open the circuit to busy relay 570

at armature 561, and at armature 562 reconnects the A. C. signalling relay 504 in bridge of the trunk conductors. Slow-to-release relay 570 deenergizes after an interval to disconnect ground from conductor 534 and to ground the busy common conductor 535 at armature 571, and at armature 572 opens the holding circuit to relay 460 to cause the latter relay to release. After an interval slow-to-release relay 460 deenergizes to open the talking circuit at armatures 461 and 462, at armature 463 disconnects ground from conductor 100 to release line and cut-off relay 103 and to free the local line, at armature 456 completes the circuit for energizing the release magnet 417, and at armature 466 opens the circuit through the lower polarizing winding of relay 470 to cause the latter relay to deenergize. Relay 470, upon deenergizing, at armature 471 causes the release of relay 530. The circuit for energizing release magnet 417 may be traced from armature 465, armature 456, finder off normal springs 467, and through the winding of release magnet 417 to battery. By the operation of the release magnet 417 the shaft and wipers of the trunk finder are restored to their normal position. Off normal springs 467, 468, and 469 are likewise restored to their normal positions when the shaft reaches its normal position. At off normal springs 467 the circuit to the release magnet 417 is opened, at off normal springs 468 the circuit to change-over relay 410 is opened, whereupon the latter relay releases, and at off normal springs 469 the circuit is again prepared for relay 450. The trunk finder and trunk are now at normal and may be used on other trunk connections.

In case of fault, such as failure of a trunk finder to find the answering line, or in case the incoming trunk call is not answered the time release is effective to free the trunk and apparatus after a predetermined time. Shortly after ringing current from the central office is cut off, signalling relay 500 deenergizes to open the signalling circuit at armature 501, to open the circuit of time relay 590 at armature 502, and to open the original energizing circuit of time release 580 at armature 503. When relay 590 deenergizes armature 591 vibrates between its upper and lower contacts to maintain time release relay 580 energized for a predetermined time. At this time since the upper winding is short circuited by normally closed armature 469, the relay is rendered slow to release and is therefore held energized by the vibrating armature 591. When the vibrations of armature 591 are of insufficient magnitude to hold relay 580 energized, this relay thereupon deenergizes. At armature 583 relay 580 opens the circuit to the busy relay 570 to deenergize the same, at armature 581 and front contact disconnects ground from conductor 533 to release the incoming trunk call relay 630 and at the back contact grounds the conductor 532 to mark this trunk line as busy for incoming calls in the bank of the trunk distributor. The relay 570 deenergizes after an interval and at armature 571 disconnects ground from 534 to enable the trunk distributor to seize the trunk line for use in an outgoing trunk call, and at the back contacts of armature 571 connects ground to busy common conductor 535 to maintain the busy common relay 630 in energized position. At armature 572 relay 570 disconnects ground from conductor 526 to permit the release of the trunk finder in case the same has been operated.

Outgoing trunk calls

Any non-restricted subscriber may originate an outgoing trunk call by removing his receiver and dialling the digits 01 or 02, dependent upon which group of trunks is wanted. Assuming now that subscriber S desires to make an outgoing trunk call over the first group of trunks and in response to the removal of the receiver at substation S, an idle local finder connector link is connected to the line of substation S. In response to dial tone subscriber S dials the digits 0 and 1 to operate the local connector wipers into engagement with the connector bank contacts 234, 235, 236, and 237, in a manner similar to that previously described. In case no other local subscriber is at this time originating an outgoing trunk call then the switching relays 200 in the local connector and relay 664 in the trunk distributor are operated over the following circuit: from ground by way of armature 251, armature 222 and back contact, lower winding of switching relay 200, back contact and armature 291, wiper 226, bank contact 235, conductor 635, armature 624 and front contact, through the winding of marginal relay 663 and through the lower and upper winding of relay 664, and armatures 683 and 690 to battery. Relay 663 is marginal and will not energize in series with the upper winding of relay 664. Switching relay 200, in the same manner as before, at armature 207 locks itself energized, at armature 206 grounds conductor 635, and at armature 208 prepares a circuit for transfer relay 240. In the trunk distributor relay 664 energizes in case the trunk distributor is not in use and at armature 680 disconnects battery from the group 2 sequence control relays 661 and 662, and at armature 681 connects battery from armature 675 through the lower winding of relay 664 to cause the energization of marginal relay 663. At armature 676 relays 663, upon energizing, connects the test circuit of the group 1 wiper 616 to start relay 640 and motor magnet 619. At armature 677 relay 663 prepares the circuit of start relay 640, at armature 678 grounds conductors 639 to mark the calling line in the trunk finder bank, and at armature 679 grounds conductor 645 to mark the group including the calling local line in the banks of the trunk finder. As long as the wiper 616 is in engagement with a grounded bank contact the self-interrupting circuit for motor magnet 619 is completed and the start relay 640 is short circuited to prevent its operation. This circuit may be traced from the grounded bank contacts engage by wiper 616, front contact and armature 676, to relay 640, and by way of armature 642 and interrupter springs and winding of motor magnet 619 to battery. When wiper 616 engages a bank contact terminating a conductor, such as conductor 534, with no ground thereon the short circuit around start relay 640 is opened and this relay thereupon energizes in series with the motor magnet. The motor magnet being marginal will not energize in series with relay 640. Start relay 640, upon energizing, at armature 641 again grounds conductor 479 to energize start relay 450 in the trunk finder. At armature 642 relay 640 opens the stepping circuit to motor magnet 619, and at armature 643 operates release relay 650. Relay 640 is now held over a circuit including the resistance R and the interrupter spring and the winding of magnet 619.

The operation of the trunk finder is similar to that described for an incoming call, and the various operations will, therefore, be briefly de-

scribed. Start relay 540, upon energizing, at armatures 451 and 452 prepares the circuit for polar stop relay 470, and at armature 454 operates the vertical magnet 416. The vertical magnet steps the wipers and operates the stepping relay 420 as before. The stepping relay 420 and vertical magnet 416 interact in the same manner as previously described, until wiper 428 finds the marking ground applied thereto from the trunk distributor. This circuit may be traced from ground at armature 679, conductor 645, bank contact 237, wiper 228, conductor 196, wiper 175, conductor 155, first vertical bank contact, vertical wiper 428, armature 414, the lower winding of change-over relay 410, and through the winding of stepping relay 420 to battery. Stepping relay 420 is held energized over this circuit and change-over relay 410 is energized to transfer the stepping circuit from the vertical magnet 416 to the rotary magnet 415. Stepping relay 420 deenergizes when relay 410 energizes and at armature 421 now completes the stepping circuit for the rotary magnet 415, whereupon the rotary magnet steps the wipers of the trunk finder in search of the marking ground applied from the trunk distributor. When this marking ground is found by the trunk finder polar stop relay 470 is operated in series with the transfer relay 240 in the local connector over the following circuit: from ground by way of armature 678, conductor 639, bank contact 236, wiper 221, armature 203, lower winding of transfer relay 240, conductor 195, wiper 174, bank contact 143, conductor 153, bank contact 475, back contact and armature 441, armature 451, and through the upper operating winding of polar stop relay 470 to battery. At armature 471 relay 470 completes the circuit for operating relay 530, at armature 472 opens the circuit to rotary magnet 415 and completes the circuit for operating switch-through relay 460, and at armature 473 completes the holding circuit for relay 460. Relay 460, upon energizing, at armatures 451 and 452 connects the talking conductors of line S to the line relay 550 to cause the latter relay to energize, at armature 453 maintains line and cut-off relay 103 in energized position and the calling line is busy, at armature 455 opens a point in the release circuit and at armature 456 grounds the polarizing winding of relay 470. Line relay 550 operates over the calling subscriber's loop, and at armature 551 completes the loop across the trunk conductors 507 and 508 to cause the switches in the central office to select an idle trunk, and at armature 552 operates the release relay 560. At armature 561 relay 560 operates the busy relay 570 and at armature 562 opens the signalling circuit. Busy relay 570, upon energizing, at armature 571 and back contact disconnects ground from conductor 535, and at its front contact grounds conductor 543 to busy this trunk in the trunk distributor, and to short circuit relay 640. At armature 572 relay 570 completes the holding circuit for switching-through relay 460.

Relay 240 in the local connector energizes in series with relay 470 and causes the release of the local finder connector link as previously described. In the trunk distributor, relay 640 deenergizes and restores relay 650 to cause the motor magnet 619 to step the trunk distributor wipers one step as previously described. Relays 663 and 664 in the trunk distributor deenergize when the local connector releases.

When an idle trunk is found in the central office dial tone is transmitted back over the talk-

ing conductors of the trunk line and subscriber S in response thereto dials the number of the central office subscriber whereupon the line relay 550 at armature 551 repeats the impulses over the trunk conductors to operate the switches at the central office to complete the connection in the well known manner. Relay 560 is maintained energized during the impulsing period. When the called central office subscriber answers conversation takes place over the heavy talking conductors. After conversation and in response to subscriber S replacing his receiver, line relay 550 deenergizes and causes the release of the trunk finder in the same manner as previously described, and at armature 551 opens the circuit to the central office to cause the automatic switches therein to release.

In case all of the trunks in group 1 become busy on either outgoing or incoming trunk calls all of the ground connections are disconnected from conductor 535 to open the circuit to the normally energized busy common relay 620. Relay 620, upon deenergizing, at armature 621 provides a stopping place for the trunk distributor by disconnecting ground from the bank, it being remembered that all of the individual trunk conductors such as conductor 534 are grounded when the trunk line is in use. At armature 624 relay 620 disconnects relays 663 and 664 and grounds conductor 635 to busy the outgoing call contacts in the banks of the local connector for this group of trunk lines. At armature 622 relays 620 grounds conductor 632 through the lower winding of relay 620 to cause the operation of the ring cut-off relay 230 in the local connector in case an outgoing call was originated by a local subscriber, and the local connector switched through on this position at a time when the last available trunk in this group was taken into use on an incoming trunk call. In this case the incoming trunk call is given preference, and the busy tone is transmitted to the local calling subscriber, as follows: from busy tone source, armature 623, conductor 632, bank contact 234, wiper 224, and from thence over the heavy talking conductors to the calling subscriber. The local subscriber in response to the busy tone will release the local connector as before. As soon as one of the trunk lines in group 1 becomes idle, the busy common lead 535 is grounded, and the busy common relay 620 is energized to remove the busy condition at armature 624. The busy common relay 610 for the second group of trunk lines is controlled in a similar manner when all of the trunks in the second group are busy.

Hold and transfer circuits

In order to describe the trunk holding circuits and how a local subscriber may transfer trunk calls from one local line to another, it will be assumed that the line of substation S is connected to the trunk line shown in Figs. 4 and 5 and that the subscriber S desires to transfer the call to substation S2. Since the line of substation S is connected to the trunk line at this time, then the following relays are in energized position: relays 410, 460, 470, 530, 550, 560, and 570. Subscriber S now operates his push-button PB in order to hold the trunk connection. In response to the operation of the push-button PB ground is connected to conductor 102 to unbalance the differential recall relay 510 to cause such relay to energize. The differential recall relay 510 is energized in response to the short-circuiting of its lower winding from ground 75

through the lower winding of line relay 550 and ground extending over the conductor 102 from the push-button PB. The line relay 550 is, however, maintained in energized position over its upper winding. At armature 511 relay 510 completes a circuit for operating relay 520 in its first step by way of armature 524 and back contact, and through the upper winding of relay 520 to battery. Relay 520 closes only its armature 525, thereby short-circuiting its lower winding from ground at armature 435 and back contact, conductor 528, armature 531, normally closed spring controlled by armature 542, and through the lower winding of relay 520 to ground at armature 511. When subscriber S releases the push-button PB and disconnects ground from conductor 102 the differential relay 510 deenergizes, and at armature 511 removes the short circuit from around the lower winding of two-step relay 520 to permit this relay to operate in its second step from ground at armature 435 through the lower and upper windings of relay 520 to battery. Relay 520, upon energizing through its second step, operates armature 521 to open the upper talking circuit, at armature 522 opens a further point in the talking circuit and bridges the resistance R across the windings of line relay 550, at armature 523 completes a circuit for energizing line switching relay 400, and at armature 524 opens its original energizing circuit and prepares the circuit for transfer release relay 540. Relay 400, upon energizing, at armature 401 grounds conductor 498, at armatures 402 and 403 bridges the trunk line relay 480 across the calling subscriber's loop, at armature 404 transfers the circuit of relay 530 to control of relay 480, and at armature 405 prepares the circuit for relay 440. The circuit for energizing trunk line relay 480 may be traced as follows: from the subscriber's loop at substation S over conductors 101 and 102, wipers 422 and 423, armatures 461 and 462, conductors 513 and 514, upper and lower windings of relay 510, conductors 512 and 515, armatures 402 and 403, armatures 492 and 494, and through the lower and upper windings of line relay 480 to ground and battery. At armature 481 relay 480 grounds conductor 499 to energize start relay 990 in case the incoming distributor has preselected an idle incoming finder connector link, at armature 482 connects battery through the cut-off relay 490 to mark the trunk in the incoming finder and at 483 maintains relay 530 energized.

The incoming distributor in Fig. 9 preselects idle incoming finder connector links as follows: all of the busy incoming finder connector links have their guard conductors, such as conductor 997 grounded, and therefore motor magnet 972 is intermittently operated from ground on the guard conductors terminating in the bank contacts accessible to wiper 977 and from there by way of armature 991, interrupter springs and the winding of motor magnet 972 to battery. When wiper 977 no longer encounters a grounded bank contact the interrupting circuit through the motor magnet 972 is opened with the result that the wipers of the incoming distributor preselect an idle incoming finder connector link. When conductor 499 is grounded by the operation of relay 480 start relay 990 energizes in case wiper 977 is standing on a non-grounded bank contact over the following circuit: from ground by way of armature 481, armature 491, conductor 499, winding of start relay 990, armature 991, interrupter springs and the winding of motor

magnet 972 to battery. Motor magnet 972 is marginal and will not energize in series with the winding of relay 990 or the resistance R shown to the right of relay 990. At armature 991 start relay 990 opens the preselecting circuit previously traced as well as opening its original energizing circuit, whereupon the relay is now maintained energized in series with resistance R and the motor magnet 972. At armature 992 relay 990 completes the circuit for operating start switch relay 980. At armature 981 relay 980 prepares the test circuit for the incoming finder, at armature 982 closes the stepping circuit to the finder motor magnet 790, and at armature 983 operates the release relay 970. At armature 971 release relay 970 prepares the holding circuit for motor magnet 972.

The circuit for energizing the incoming finder motor magnet 790 may be traced as follows: from ground by way of armature 716, armature 721 and back contact, conductor 996, wiper 976, armature 982, wiper 973, conductor 993, and through the winding of finder motor magnet 790 to battery. Finder motor magnet 790 energizes over the above-traced circuit and positions its pawl preparatory to stepping the wipers of the incoming finder, and at contacts 791 completes the circuit for energizing the combined line and stepping relay 720 as follows: from grounded armature 791, back contact and armature 742, and through the upper winding of line relay 720 to battery. At armature 721 line relay 720 opens the previously traced circuit to the finder motor magnet 790, whereupon the finder motor magnet deenergizes and opens the circuit to relay 720 at armature 791. When line relay 720 deenergizes, the circuit at armature 721 is again completed for the finder motor magnet with the result that motor magnet of the incoming finder is again operated to reenergize line-stepping relay 720. This interaction between the motor magnet 790 and the line relay 720 continues until the test wiper 796 of the incoming finder finds the marking potential applied to its test contact through the winding of cut-off relay 490.

When the test wiper finds the marked contact the cut-off relay 490 energizes in series with switching relay 730 and the lower winding of line relay 720 over the following circuit; from ground through the lower winding of line relay 720, normally closed springs controlled by armature 731, upper winding of switching relay 730, conductor 995, wiper 975, armature 981, wiper 974, conductor 994, test wiper 796, conductor 488, armature 482, and through the winding of cut-off relay 490 to battery. Line relay 720 is held energized over this circuit to prevent further stepping of the incoming finder while switching relay 730 energizes over the above-traced circuit to close only its armature 734. The closure of armature 734 at this time completes a circuit by way of armature 716, armature 721 and front contact, armature 734 and through the winding of release relay 740 to battery, for energizing this relay, and by way of off-normal springs 719 and the upper winding of vertical series relay 750 to battery for energizing the latter relay.

Release relay 740, upon energizing, at armature 741 opens the circuit to the release magnet 717 and grounds the guard conductor 997 to guard this link against further seizure, at armature 742 opens the stepping circuit to line relay 720 and prepares a new circuit for relay 75

720, at armature 743 completes a circuit through the lower winding of switching relay 730 to fully energize the latter relay, and at armature 744 prepares a point in the impulsing circuit. Relay 750, upon energizing, at armature 751 connects the dial tone by way of conductor 792, armatures 813 and 840, condenser, conductor 934, to the lower heavy talking conductors for transmitting dial tone to the calling subscriber. At armature 752 relay 750 opens a point in the circuit to the ring-reverse relay 810, and at armature 753 prepares a further point in the impulsing circuit and a circuit to its lower winding. When the circuit is completed through the lower winding of switching relay 730 the relay operates its remaining armatures and at armature 731 connects both windings of line relay 720 in bridge of the calling loop, and also connects dial tone to the calling subscriber. At armature 732 prepares a point in the circuit to relay 860, at armature 733 and back contact disconnects ground from the busy common conductor 998, at armature 733 and front contact prepares the circuit for switching relay 880, and at armature 735 grounds the test wiper 796 to hold the cut-off relay 490 energized and to busy this trunk line to other incoming finders. Line relay 720 is maintained energized over the calling loop as follows: from the substation loop at S, conductors 101 and 102, wipers 422 and 423, armatures 461 and 462, conductors 513 and 514, upper and lower windings of differential relays 510, conductors 512 and 515, armatures 402 and 403, conductors 497 and 496, wipers 791 and 792, armatures 711 and 712, armatures 742 and 731, and through the lower and upper windings of line relay 720 to ground and battery.

In the trunk finder cut-off relay 490 energizes over the previously traced circuit, and at armature 491 disconnects ground from conductor 499 to open the circuit to start relay 990 in the incoming distributor. At armatures 492 and 494 relay 490 disconnects line relay 480 from conductors 497 and 496 to cause this relay to de-energize, at armature 493 locks itself over conductor 488 and grounded armature 735, and at armature 495 establishes a new holding circuit for relay 530 from grounded conductor 488.

When start relay 990 in the incoming distributor of Fig. 9 energizes, said relay at armature 991 reestablishes the preselecting stepping circuit for motor magnet 972 to cause the distributor to find an idle incoming finder connector link, and at armature 992 opens the circuit to relay 980. Relay 980, upon deenergizing, at armature 981 opens a point in the original testing circuit, at armature 982 opens a point in the stepping circuit, and at armature 983 opens the circuit to release relay 970, and completes a circuit for maintaining the motor magnet 972 in operated position by way of armature 971. After an interval release relay 970 deenergizes, and at armature 971 opens the holding circuit of motor magnet 972 to permit the motor magnet to operate the incoming distributor to preselect the idle incoming finder connector link, as previously described.

When subscriber S hears dial tone informing her that an idle incoming finder connector link has been selected such subscriber will dial the number of substation S2 or the digits 9 and 1. In response to the operation of the calling device CD at substation S in accordance with the first digit, or digit 9, the circuit of line relay 720 is interrupted nine times with the result that relay 720 deenergizes in accordance therewith. Each

time line relay 720 deenergizes a circuit may be traced for operating the vertical magnet 824 as follows: from ground by way of armature 716, armature 721 and back contact, armature 744, armature 753 and front contact, conductor 754, armature 816 and back contact, and through the winding of vertical magnet 824 to battery. A branch of this impulsing circuit extends through the lower winding of vertical series relay 750 in order to hold the slow-to-release series relay in operated position during the impulsing period. By the operation of the vertical magnet 824 the shaft and wipers of the incoming connector are operated opposite the ninth level of bank contacts. On the first vertical step of the shaft off normal springs 718 prepare the circuit to release magnet 717 and off normal springs 719 open the original circuit of vertical series relay 750. Shortly after the impulsing period series relay 750 deenergizes to disconnect dial tone from the calling line at armature 751 and at armature 753 transfers the impulsing circuit from the vertical magnet 824 to the rotary magnet 817. The armature 752 is ineffective at this time because the shaft springs 736 are not closed on the ninth step of the shaft.

In response to subscriber S dialling the second digit, or digit 1, line relay 720 transmits a single impulse to rotary series relay 850 and rotary magnet 817 as follows: from ground by way of armature 716, armature 721 and back contact, armature 744, armature 753 and back contact, conductor 755, armature 875, winding of relay 850, armature 888, and through the winding of rotary magnet 817 to battery. The rotary magnet 817 rotates the wipers one step for each impulse received and since only one pulse has been transmitted the wipers stop in engagement with the bank contacts 867, 868, 869, 856, and 854. Rotary series relay 850 energizes in series with the rotary magnet 817, and due to its slow release characteristics, is maintained energized throughout the impulsing period. At armature 851 and back contact relay 850 opens the circuit to switching relay 880, at armature 851 and front contact closes the busy test circuit to busy relay 870, and at armature 853 maintains the circuit of itself and motor magnet 817 independent of armature 875 of the busy relay 870.

If the line of substation S2 is busy, then conductor 269 is grounded and the busy relay 870 is energized over the following circuit: from ground at conductor 269, bank contact 869, wiper 893, armature 851 and front contact, and through the upper winding of relay 870 to battery. At armature 871 busy relay 870 connects the busy tone to the lower talking conductor of the incoming finder connector link by way of armature 842, the condenser, and conductor 934 from whence the tone is transmitted to the calling subscriber over the heavy talking conductors in the usual manner. At armature 872 relay 870 transfers the circuit from relay 860 to 840, at armature 873 prepares a locking circuit for itself, at armature 874 opens the circuit to switching relay 880, and at armature 875 opens the impulsing circuit to relay 850 and magnet 817. Shortly after the impulsing period slow to release series relay 850 deenergizes to open the original energizing circuit of busy relay 870 at the front contact of armature 851, and at the normally closed springs controlled by armature 851 completes the following locking circuit for busy relay 870: from ground at armature 715, armature 733 and front contact, conductor 728, armature 837, normally

closed springs controlled by armature 862, armature 873, spring 852, front contact of armature 851, and through the upper winding of busy relay 870 to battery.

5 When subscriber S hears the busy tone such subscriber will reoperate the push-button PB to again actuate the differential relay 510, this time by short circuiting the lower winding in series with the lower winding of line relay 720 as follows: from ground at the push-button PB, over
10 the previously traced circuit to conductor 102 and the lower winding of differential relay 510, conductor 515, armature 403, conductor 496, wiper 792, armature 712, armature 731 and front contact, and through the lower winding of line relay 720 to ground. Since the two-step relay 520 is in its operated position, the reoperation of armature 511 at this time completes the circuit for transfer release relay 540 by way of armature
20 524 and front contact. Relay 540, upon energizing, at armature 541 connects a bridge across the winding of line relay 550 including the resistance R, and at armature 542 substitutes a new holding circuit for two-step relay 520 from grounded armature 511. When subscriber S releases the push-button PB differential relay 510 deenergizes, and at armature 511 opens the holding circuit of relay 520 and the circuit of relay 540. Relay 520, upon deenergizing, at armature
30 521 prepares one of the points for connecting the line of substation S to the line relay 550, at armature 522 connects another point in the circuit for connecting the line of substation S to relay 550 as well as opening the original holding circuit across the windings of line relay 550, at armature 523 opens the circuit of relay 400, and at armature 524 prepares the original energizing circuit of two-step relay 520. Relay 400, upon deenergizing at armature 401 disconnects ground
40 from conductor 498, at armatures 402 and 403 disconnects relay 720 and at armature 404 holds relay 530 energized from ground at armature 471. Relay 540 deenergizes shortly after the release of relays 520 and 400, and at armature 541 opens the bridge across the windings of line relay 550, but since the substation loop is connected across the windings of the line relay at this time the same is maintained in operated position.

In the incoming finder line relay 720 deenergizes and at armature 721 opens the circuit to release relay 740. Release relay 740 deenergizes after an interval and at armature 741 disconnects one of the grounds from the guard conductor 997, and completes the circuit for operating the release magnet 717. At armature 743 release relay 740 disconnects ground from the hold conductor 724 to deenergize switching relay 730. Relay 730, at armature 731 again prepares the test circuit, at armature 733 opens the locking circuit of busy relay 870 at its front contact, and at its back contact grounds the busy common conductor 998, at armature 735 disconnects ground from conductor 994 to deenergize the cut-off relay 490 in the trunk finder and to disconnect ground from conductor 488. Busy relay 870, upon deenergizing, at armature 871 opens the busy tone circuit, at armature 874 prepares the test circuit for switching relay 880, and at armature 875 prepares the impulsing circuit. Release magnet 717 is energized from ground at off normal springs 718 by way of armature 741 and back contact, and through the windings of release magnet 717 to battery. By the operation of the release magnet the switch wipers of the incoming connector are restored to their normal
75

position in which position the off normal springs 718 and 719 are operated to their normal position. At off normal springs 718 the circuit to release magnet 717 is opened, while at off normal springs 719 the original energizing circuit of vertical series relay 750 is again prepared. The incoming finder connector link has now been released and is available for other calls.

The line of substation S is again connected to the trunk and when the holding bridge at armature 541 is removed by the deenergization of relay 540 subscriber S advises the central office subscriber that subscriber S2 is busy. After further conversation it will be assumed that subscriber S wishes to transfer the call to another local line or again to line S2. Subscriber S accordingly reoperates the push-button PB to cause the operation of relays 510, 520, 400, 480, 990, 980, 720, 730, 740, 750, and 490 and magnet 790 as previously described. When the subscriber S hears dial tone she dials the digits 9 and 1 to operate the connector wipers into engagement with the contacts of the called line in the same manner as previously described.

Assuming now that the line of substation S2 is idle instead of busy as previously described, busy relay 870 does not energize and therefore switching relay 870 operates when rotary series relay 850 deenergizes shortly after the rotary impulses. The circuit for operating the switching relay 880 may be traced as follows: from ground at armature 715, armature 733 and front contact, conductor 728, armature 837, armature 874, lower winding of switching relay 880, back contact and armature 851, wiper 893, bank contact 869, conductor 269, and through the lower winding of the individual line and cut-off relay, similar to relay 103, to battery. The individual line and cut-off relay associated with the line at substation S2 is energized in series with the switching relay 200 to disconnect itself from its associated talking conductors 267 and 268 and to prevent the grounding of start conductor 109 by the operation of its armatures through their second step. Relay 880, upon energizing, at armature 881 prepares a point in the ringing circuit and the circuit for the ring cut-off relay 830, at armature 882 and 883 connects interrupted generator to the line of substation S2 to signal the subscriber thereat as well as preparing a point in the talking circuit. At armature 884 connects up the ring-back circuit, at armature 885 prepares a point in the locking circuit for relay 830, at armature 886 grounds wiper 893 to hold the individual line and cut-off relay in energized position and the called line busy, at armature 887 completes a locking circuit for itself from grounded armature 743 by way of armature 714 and conductor 725, and at armature 888 opens the circuit to rotary magnet 817.

The ringing circuit for operating the ringer associated with substation S2 may be traced from interrupted generator, armature 882, back contact and cam springs 818, armature 812 and back contact, back contact and armature 834, armature 883, wiper 892, conductor 268, and through the ringer at substation S2 to ground. The ring-back circuit for the calling subscriber may be traced from interrupted generator over the previously traced circuit to armature 883, and thence by way of armature 884, armature 835, the condenser, conductor 934, over the lower talking conductor in Fig. 7, from whence it is transmitted over the heavy talking conductors to the calling subscriber.

When the called subscriber at station S2 removes his receiver ringing current extends through the substation circuit back over conductor 267 to wiper 891 and back contact, back contact and armature 811, and through the upper winding of cut-off relay 830 to battery. Ring cut-off relay 830 energizes over this circuit and disconnects the signaling current. Relay 830 first closes its armature spring 836 to complete a circuit for fully operating its remaining armatures over the following circuit: ground on the hold conductor 724, armature 836, front contact and armature 885, and through the lower and upper windings of ring cut-off relay 830 to battery. At armature 831 relay 830 opens its original energizing circuit, at armatures 831 and 832 and 833 and 834 completes the talking circuit over the heavy talking conductors, at armature 834 and back contact opens the ringing circuit, at armature 835 opens the ring-back circuit, and at armature 837 opens a point in the original energizing circuit of switching relay 880. Subscriber S and subscriber S2 now converse over the heavy talking conductors 101 and 102, 513, 512 and 515, 497 and 496, the heavy talking conductors of the incoming finder connector link, and conductors 267 and 268. Talking battery is furnished to the calling subscriber S through the windings of line relay 720 and to the called subscriber through the windings of battery feed relay 760. The ground connection for this battery feed of relay 760 extends from ground at armature 743 by way of armature 836, front contact and armature 885, to the lower winding of battery feed relay 760. Subscriber S and subscriber S2 converse over the talking circuit while the trunk connection is held by the bridge including the resistance R in Fig. 5.

Subscriber S may again connect her line to the trunk in the same manner as previously described by reoperating her push-button, but in order to transfer the call subscriber S advises subscriber S2 that the latter called subscriber is desired on a trunk call. Subscriber S2 will accordingly operate her push-button PB, thereby grounding the positive conductor 268 to unbalance the differential transfer relay 770 in Fig. 7. The differential transfer relay 770 is unbalanced from ground at the push-button at substation S2, conductor 268, wiper 892, armature 883, armature 834 and front contact, lower winding of transfer relay 770, and through the lower winding of battery feed relay 760 to ground at armature 743. Relay 770 operates its armature 771 to complete the circuit for energizing the transfer assist relay 780 in its first step as follows: from ground at armature 401, conductor 498, wiper 794, armature 771, normally closed spring controlled by armature 782, and through the lower winding of relay 780 to battery. Relay 780 closes only its armature 784 over this circuit and due to this closure short circuits its upper winding.

When subscriber S2 releases the push-button ground is disconnected from conductor 268 with the result that the transfer differential relay 770 deenergizes. At armature 771 relay 770 removes the short circuit from around the upper winding of relay 780 with the result that relay 780 operates its remaining armatures through their second step when the upper and lower windings of relay 780 are energized in series. At armatures 781 and 782 relay 780 disconnects ground from conductor 933 to provide a stop position for the transfer distributor wiper, at armature 782

grounds conductor 693 to energize relay 666 in the trunk distributor in case the trunk distributor is not in use, at armature 783 opens its original energizing circuit and at armature 785 grounds conductor 727 and wiper 893 to maintain conductor 269 grounded.

The circuit for energizing relay 666 may be traced from grounded armature 787, conductor 693, through the winding of marginal relay 665, through the lower and upper windings of relay 666, armature 690 to battery. Relay 665 is marginal and will not energize in series with both windings of relay 666. Relay 666 energizes over the above traced circuit in case the trunk distributor is not in use and at armature 683 disconnects battery from the windings of relays 662 and 664 and at armature 684 connects battery by way of armature 675 and back contact, armature 681 and back contact, armature 684 and front contact, through the lower winding of relay 666 to cause the energization of marginal relay 665. By the operation of armatures 683 and 684 the trunk distributor is prevented from being taken into use on incoming or outgoing trunk calls during the time a call is being transferred. Relay 665, upon energizing, at armature 682 grounds conductor 693 to energize start relay 910 in the transfer distributor. At armature 911 relay 910 completes a self-interrupting circuit for motor magnet 968 in case the wiper 913 is on a grounded contact, and at armature 912 short circuits start switching relay 920 in case the wiper 913 is grounded.

Assuming that the wiper 913 is in engagement with the grounded bank contact, then the motor magnet 968 operates in the manner of a buzzer until wiper 913 loses ground at which time the short circuit from around relay 920 is removed and relay 920 thereupon energizes in series with the motor magnet 968. The circuit for intermittently operating the motor magnet 968 may be traced from the grounded bank contact engaged by wiper 913, armature 911, normally closed springs controlled by armature 922, armature 965, interrupter springs and the winding of motor magnet 968 to battery. Then wiper 913 no longer engages a grounded bank contact the short circuit around relay 920 is removed and this relay energizes over the following circuit: ground at armature 912, relay 920, normally closed spring controlled by armature 922, armature 965, interrupter springs and winding of motor magnet 968 to battery. At armature 921 busy tone is connected to conductor 934 by way of wiper 914 to transmit the tone to both subscribers S and S2 over the heavy talking conductors to warn such subscribers that the call is being transferred. At armature 922 relay 920 completes a new locking circuit for itself through the resistance R, at armature 923 prepares the circuit to relays 940 and 960 and at armature 924 completes the circuit for operating relay 950. Relay 950, upon energizing, at armature 951 grounds conductor 936 by way of wiper 918 to maintain release relay 740 in the incoming finder in operated position, and, due to the weight on the front contact of armature 952 causes this contact to vibrate and intermittently close the circuit through the lower winding of relay 960. Due to the copper slug on the upper end of release relay 960 as diagrammatically represented by the solid black square, relay 960 is appreciably slow to energize and will not immediately energize in response to the intermittent closures of the front contact and armature 952. Weight 953 therefore vibrates for

a predetermined time before armature 952 is held in engagement with its front contact long enough to energize relay 960. The circuit for energizing relay 960 extends by way of grounded armature 924, armature 943, armature 952, and through the lower winding of release relay 960 to battery. At armature 961 relay 960 grounds conductor 937 by way of wiper 917 to mark the vertical bank in the trunk finder by way of incoming connector wiper 895 and conductor 154. At armature 962 relay 960 grounds conductor 936 to mark trunk finder bank contacts 477 by way of incoming connector wiper 894 and conductor 485. At armature 963 relay 960 completes the circuit for energizing trunk release relay 710 and transfer relay 440, at armature 964 prepares a circuit for grounding conductor 938, at armature 965 opens the circuit to motor magnet 958, at armature 966 prepares a circuit for relay 940 and the upper winding of relay 960, and at armature 967 completes a circuit for energizing time relay 930 from ground at armature 924 by way of armature 944. At armature 931 relay 930 completes a circuit for energizing time start relay 940 from grounded armature 966 by way of armature 923, and also completes a circuit through the upper winding of release relay 960 for maintaining the latter relay in energized position. The weight on armature 931 causes armature 931 to vibrate only on release of relay 930. At armature 941 relay 940 substitutes ground at armature 964 for the ground at the normally closed contact of armature 941 for maintaining hold conductor 938 grounded, at armature 942 completes a locking circuit for itself to ground at armature 924, at armature 943 opens the original energizing circuit for relay 960, and at armature 944 opens the circuit to relay 930 which accordingly deenergizes to cause armature 931 to vibrate. Due to the weight on armature 931 such armature vibrates for a predetermined length of time or sufficient to permit the transfer of the call.

The circuit for energizing trunk release relay 710 and transfer relay 440 may be traced as follows: from ground at armature 963, wiper 915, conductor 935, upper winding of trunk release relay 710, wiper 793, conductor 487, armature 453, armature 405, and through the winding of transfer relay 440 to battery. Trunk release relay 710 first operates its armature 713 to complete a locking circuit through its lower winding from ground at armature 743 and to fully operate its remaining armatures. At armatures 711 and 712 relay 710, upon fully operating, disconnects the line relay 720 from the subscriber's line to cause the deenergization of relay 720, at armature 714 opens the locking circuit of switching relay 880, which accordingly deenergizes. At armature 715 opens the circuit to the lower winding of relay 880, and at armature 716 opens the impulsing circuit and the original energizing circuit to release relay 740 which is now held from grounded conductor 938. Line relay 790 deenergizes at this time without effect because the release relay 740 is held over conductor 938. Switching relay 880, upon deenergizing, at armature 885 opens the locking circuit of bridge cut-off relay 830 which likewise deenergizes, and at armature 886 disconnects one of the ground connections to wiper 893 which, however, is maintained at ground potential from grounded conductor 727 to hold the individual line and cut-off relay, similar to relay 103, of the called line in operated position.

In the trunk finder in Fig. 4 transfer relay 440 energizes over the previously traced circuit in se-

ries with relay 710, and at armature 441 transfers the test circuit from wiper 425 to wiper 426. At armature 442 relay 440 prepares the circuit for relay 430, at armature 443 opens a point in the circuit to start relay 450, and at armature 444 grounds conductor 527 and opens the circuit through the lower winding of polar stop relay 470 to cause the latter relay to deenergize.

Relay 470, upon deenergizing, at armature 472 prepares a point in the circuit to vertical magnet 416, at armature 473 opens the holding circuit to switchthrough relay 460, which accordingly deenergizes, and at armature 469 again short circuits the upper winding of relay 580. Switchthrough relay 460 deenergizes after an interval, and at armatures 461 and 462 disconnects the calling subscriber S. At armature 463 disconnects one of the grounds from conductor 100, at armature 464 completes the circuit for operating transfer start relay 430 from grounded conductor 487, and at armature 465 completes the circuit for operating the release magnet 417 to release the trunk finder from engagement with the contacts of line S.

Transfer start relay 430, upon energizing, at armature 431 completes another bridge including the resistance R across the windings of line relay 550 in order to hold the trunk connection, at armature 432 locks itself to grounded conductor 487 by way of armature 453, at armature 433 prepares a new circuit for start relay 450, at armature 434 grounds conductor 479, and at armature 435 disconnects ground from conductor 528 and grounds conductor 529. In response to the operation of release magnet 417 the wipers of the trunk finder are restored to their normal position, as previously described. When the wipers are fully restored off normal springs 468 open the circuit to change-over relay 410, which accordingly deenergizes, and off-normal springs 467 open the circuit to release magnet 417. Change-over relay 410, upon deenergizing, at armature 411 prepares a further point in the circuit to vertical magnet 416, at armature 412 completes the circuit for energizing start relay 450, and at armature 414 prepares its own operating circuit.

Start relay 450 now energizes over the following circuit: from ground at off normal springs 468 and back contact, armatures 412 and 433, and through the winding of start relay 450 to battery. At armature 451 relay 450 prepares the operating circuit through the upper winding of polar stop relay 470, at armature 452 completes the circuit through the polarizing lower winding of relay 470, at armature 453 opens the original circuit of relay 440, which relay, however, is held energized from grounded conductor 487 by way of armatures 464, 442, 432, and 405. At armature 454 relay 450 again completes the circuit for vertical magnet 416 at armature 455 locks itself to grounded armature 434, and at armature 456 opens a point in the circuit to release magnet 417. The vertical magnet energizes to step the wipers and close contacts 419 to operate the stepping relay 420 in the same manner as previously described until the vertical wiper 428 finds the marked vertical bank contact at which time the change-over relay 410 is energized to transfer the stepping circuit to the rotary magnet. The circuit for energizing change-over relay 410 may be traced as follows: from grounded armature 961, wiper 917, conductor 937, connector wiper 895, conductor 154, ninth vertical bank contact, vertical wiper 428, armature 75

414, lower winding of relay 410, and through the winding of stepping relay 420 to battery. Stepping relay 420 is maintained energized over this circuit until its circuit is opened by both the vertical magnet 416 and relay 410. Stepping relay interacts in the manner previously described until the transfer wiper 426 encounters the marked bank contact at which time polar stop relay 470 is operated. The circuit for operating the polar stop relay 470 may be traced from ground at armature 962, wiper 916, conductor 936, connector wiper 894, conductor 485, bank contact 477, wiper 426, front contact and armature 441, armature 451, and through the upper operating winding of polar stop relay 470 to battery. At armature 472 relay 470 opens the circuit to the rotary magnet 415 and also operates the switchthrough relay 460, which is thereafter held operated over armature 473. The trunk finder at this time has been reoperated to find the contacts marked from the transfer distributor, and because the incoming connector is in engagement with the bank contacts terminating the line of substation S2, the trunk finder is also operated into engagement with the bank contacts terminating the same line.

Relay 460, upon energizing, at armatures 461 and 462 completes the talking circuit from the line at substation S2 by way of conductors 267 and 268 and wipers 422 and 423. At armature 463 relay 460 grounds conductor 269 to maintain line S2 busy and its individual line and cut-off relay energized, at armature 464 opens the circuit to relays 440 and 430, at armature 465 opens a point in the circuit to release magnet 417, and at armature 466 prepares a circuit for grounding the lower polarizing winding of relay 470. Relay 440, upon deenergizing, at armature 441 opens the operating circuit of relay 470 which is now held in operated position over its lower winding and at armature 444 connects ground to the lower polarizing winding of relay 470 by way of armature 466 and front contact. At the front contact of armature 444 relay 410 opens the locking circuit of two-step relay 520 which accordingly deenergizes.

Relay 520, upon deenergizing, at armatures 521 and 522 complete the talking circuit over the trunk and removes one of the bridges from across the line relay 550, at armature 523 opens the circuit of relay 400, and at armature 524 prepares the original energizing circuit of relay 520. Relay 430 deenergizes after an interval, and at armature 431 removes the last bridge from across the windings of line relay 550 to permit the relay 550 to be held over the line of substation S2. At armature 434 relay 430 disconnects ground from conductor 479 to release relay 450, and at armature 435 grounds the conductor 429 after the release of relay 520. Relay 400, upon deenergizing, at armature 401 disconnects ground from conductor 498 to release relay 780, at armatures 402 and 403 disconnects conductors 497 and 496, at armature 404 transfers the holding circuit of relay 530 to ground at 471, and at armature 405 opens a further point in the circuit to relay 440. Relay 450 deenergizes after an interval and at armature 451 opens the original operating circuit of relay 470, which relay is now held over its lower winding from grounded armature 444 by way of armature 466. At armature 454 relay 450 opens the original energizing circuit of relay 460 which is now held over armature 473 and armature 572. The call has now been transferred from the line of sub-

station S to the line of substation S2, and the trunk finder is in the same condition as if subscriber S2 had answered the trunk call.

In the incoming finder relay 780 deenergizes, and at armature 781 and 782 grounds conductor 933 to short circuit relay 920 in the transfer distributor by way of wiper 913 and armature 911. At armature 782 relay 780 disconnects ground from conductor 693 to cause the deenergization of relays 665 and 666, and at armature 785 disconnects ground from wiper 893, which is without effect at this time because the combined line end cut-off relay individual to line S2 is now held energized from the trunk finder.

In the trunk distributor relays 665 and 666 deenergize when their circuits are opened by relay 780 and relay 665 at armature 682 disconnects ground from conductor 692 to deenergize start relay 910 in the transfer distributor. Relay 666, upon deenergizing, at armatures 683 and 684 prepares circuits to allow the other sequence control relays to operate.

Relay 910 in the transfer distributor deenergizes and at armature 912 opens the circuit to start relay 920. Start relay 920 deenergizes in response to the previously traced short circuit or in response to the operation of armature 912, as set forth. At armature 921 relay 920 disconnects busy tone from conductor 934, at armature 922 opens a point in its own locking circuit, at armature 923 opens the circuit to relay 960 which deenergizes after an interval, and at armature 924 opens the circuit to both relays 940 and 950. Relay 950 is the first relay to deenergize, and at armature 951 disconnects ground from conductor 938 to permit the deenergization of release relay 740 in the incoming connector, and at armature 952 opens the circuit of the lower winding of relay 960. Relay 940 releases shortly after the release of relay 950 and at armature 941 grounds armature 951 only after it is opened by relay 950. Relay 960, upon deenergizing, at armature 961 disconnects ground from conductor 937 to remove the marking ground from wiper 895, at armature 962 disconnects ground from conductor 936 to remove marking ground from wiper 894, and at armature 963 disconnects ground from conductor 935, and at armature 965 prepares the circuit for motor magnet 968. The transfer distributor is now at normal and may be used on subsequent transfers.

Relay 740 in the incoming finder connector link deenergizes when ground is removed from conductor 938 by the transfer distributor and at armature 741 and front contact disconnects one of the ground connections from guard conductor 997. At armature 741 and back contact relay 740 completes the circuit from grounded off-normal springs 718 for operating the release magnet 717, at armature 742 prepares the stepping circuit to relay 720, at armature 743 disconnects ground from conductor 724 to cause relays 710, 730, 830, and relays 810 and 820 and 860, if operated, to release, and at armature 744 opens the impulsing circuit. When relays 710 and 730 deenergize the busy common conductor 998 is again grounded by way of armatures 715 and 733. By the operation of the release magnet the shaft and wipers of the incoming connector are restored to their normal position, in which position off-normal springs 718 opens the circuit to release magnet 717 and removes the last ground from the guard conductor 997. The incoming finder connector link is now restored to normal and may be used on other calls. Subscriber S2

can hold the trunk call and make a local call, and if desired may transfer the trunk connection to another local subscriber in the same manner as previously described.

5 The transfer distributor has a time release arrangement, which is effective a predetermined time after relay 930 deenergizes, to cause the release of the incoming finder connector link in case, for some reason, the transfer above described
10 does not take place. A predetermined time after relay 930 deenergizes, the weighted armature 931 stops vibrating with the result that relay 960 deenergizes. At armatures 961, 962, and 963, relay 960 disconnects ground from conductors 937,
15 936, and 935 as previously described. At armature 964 relay 960, upon deenergizing, disconnects ground from conductor 938 to cause the release of release relay 740 which upon deenergizing causes the release of the incoming finder connector link as previously described. At armature
20 963 relay 960 disconnects ground from conductor 935 to cause the release of relays 710, 440 if operated, and permits the release of the trunk finder. If relay 440 fails to operate, then trunk
25 finder has not been released automatically and therefore the subscriber releases the same upon restoring his receiver.

The incoming finder connector link is also provided with divided ringing relays 810 and 820,
30 which operate in the same manner as described for relays 270 and 280 in the local connector, to enable the incoming connector to signal subscribers, such as the subscribers S1 and S3, having their ringers connected to the negative line conductors. Since relays 810 and 820 operate in the
35 same manner as relays 270 and 280, only a brief description of the operation will be given. In order to signal a subscriber such as S3, the digit 1 is prefixed to the line number and when vertical series relay 750 deenergizes after transmitting the first digit, or digit 1 relay 810 is energized over the following circuit: from ground at
40 armature 752, shaft springs 736 closed when the wipers are opposite the first vertical level conductor 737, and through the lower winding of relay 810 to battery. At armatures 811 and 812 relay 810 reverses the generator connections so as to ring over the negative conductor. At armature 813 relay 810 disconnects dial tone, at armature 814 completes the circuit for reoperating relay 750, at armature 815 locks itself to grounded
50 conductor 724, and at armature 816 transfers the impulsing circuit from vertical magnet 824 to the lower winding of relay 820. Relay 750 is reenergized over the following circuit: from ground at armature 716, armature 721 and front contact, armature 734, conductor 938, armature 821, armature 814, conductor 729, and through the upper winding of vertical series relay 750
60 to battery.

The first impulse of the next digit is absorbed causing the energization of relay 820 while the remaining impulses of this digit operate the vertical magnet 824 to again step the wipers in a
65 vertical direction. In response to the first deenergization of line relay 720 relay 820 is energized in its first step to close only armature 822 as follows: from ground at armature 716, armature 721 and back contact, armature 744, armature 753 and front contact, conductor 754, armature 816 and front contact, armature 823 and back contact, and through the lower winding of relay 820 to battery. At armature 822 relay 820 short circuits its upper winding from ground at
75 armature 724. When relay 720 energizes on the

termination of the first pulse of the second digit ground is disconnected from conductor 754 to remove the short circuit from the upper winding of relay 820, thereby causing the relay 820 to fully operate its remaining armatures from
5 ground extending through the upper and lower windings of this relay in series. Relay 820, upon operating through its second step, at armature 821 opens the last traced circuit for relay 750 which, however, is held in operated position during the impulsing period and at armature 823
10 transfers the impulsing circuit to vertical magnet 824. The remaining impulses of the second digit now operate the vertical magnet to step the wipers of the incoming connector opposite the
15 desired level. The remaining operations are the same as previously described with the exception that ringing current is sent out over the negative line conductors.

Restricted service

Some subscribers are restricted from originating and answering trunk calls and such subscribers are not provided with a push button and in addition have negative battery potential connected through a resistance to its individual bank contact accessible to wiper 174. For example,
25 as shown at Z in Fig. 1, assume that bank contact 143 is connected to the resistance and battery Z shown instead of conductor 153. In this case then the line of substations S and S1 is restricted. In this case, therefore, if substations S should attempt to originate or answer a trunk call relay 240 is energized over the following circuit: from
30 ground on either conductor 639, 637, or 646, placed thereon in response to the operation of the sequence control relays such as relays 663, 661, and 667, dependent upon whether an outgoing call is being originated or an incoming call is being answered, and from thence by way of wiper
40 227, armature 208, lower winding of transfer relay 240, conductor 195, wiper 174, bank contact 143, and through the resistance Z to negative battery at the restricted service connection. Relay 240 thereupon energizes when a restricted
45 subscriber attempts to originate an outgoing call or answer an incoming trunk call, and at armatures 241 and 242 opens the circuit of line relay 210, while at armature 243 completes a locking circuit through its upper winding from ground at
50 armature 253. Line relay 210, upon deenergizing, at armature 211 opens the circuit of release relay 250, whereupon the latter relay deenergizes and causes the release of the local connector link, as previously described.

Semi-restricted subscribers are subscribers provided with a push button, and also have the restricted service connections, such as shown at Z, connected to its individual bank contact. Such semi-restricted subscribers can, however, be connected to trunk lines only in response to a non-restricted subscriber transferring the call thereto. Since this transfer is similar to that previously described an explanation thereof will not at this time be given.

Attendant's cabinet

The attendant's cabinet shown in Fig. 10 is in reality one of the local subscriber's lines equipped with special facilities for answering incoming trunk calls when traffic is of such a nature that it is desirable to have one party answer all incoming trunk calls and then transfer such trunk calls to the parties desired. As will be seen, whenever the information key is depressed, the
75

attendant's substation is connected to the local equipment over talking conductors 277 and 278 the same as any other local nonrestricted subscriber's line. The transfer key, instead of a push-button PB, is provided to enable the attendant to control the operation of the differential relays in the trunk circuits both to transfer and receive transferred trunk calls over the line conductors 277 and 278. In the same manner as previously described, local subscribers desiring to call the attendant dial the digits 0 and 3 to cause the local connector to connect with and signal the attendant by operating the bell RB in Fig. 10. The attendant operates the information trunk key and removes the handset from the cradle, thereby completing the local connection. In a manner similar to that described for local subscribers the attendant, by operating the information key and calling device CD, can complete connections over conductors 277 and 278 and the local finder connector link to desired local subscribers' lines. In addition, the attendant can hold any local subscriber's connection by operating the hold key, thereby bridging conductors 277 and 278 to hold the local connection, after which the attendant may restore the information key and answer any incoming trunk calls. Since these local connections over conductors 277 and 278 are established in the same manner as described for the other local subscribers' lines, it is therefore thought unnecessary at this time to describe the detailed operation other than set forth above.

Assuming now that the attendant is to answer all incoming trunk calls, then signal key SK in Fig. 10 is operated and locks in its working position. Under these conditions relay 1007 is disconnected so as to prevent the operation of the common trunk signals and relay 1016 is connected in place thereof. Now, when any trunk is seized on an incoming call the alternating current signalling relay, such as relay 504, operates its corresponding relay 500 to connect battery to common signalling conductor 1091 to energize relay 1016. Assuming that the trunk shown in Figs 4 and 5 is the trunk in use on an incoming trunk call, then relay 504 is energized to cause the energization of relay 600 at armature 606. Relay 500 at armature 501 connects battery through the resistance to signalling conductor 1091 and thence through operated key SK through the winding of relay 1016 to ground. At armature 1017 relay 1016 completes a circuit for operating the buzzer B in order to inform the attendant that there is an incoming trunk call on one of the trunks.

While only one two-way release and trunk answer key and its associated relays 1030, 1040, 1050, 1060, and 1070 are shown, it will be understood that this attendant's cabinet is provided with a second key and a second set of similar relays and that such second set is connected to the trunk finder in the same manner as the first set. This second set is provided to enable the attendant to handle more than one trunk call at the same time. In response to the operation of the buzzer B, the attendant will operate either one of the trunk answer keys and remove the handset HS from the cradle. Assuming that the attendant operates the trunk answer key shown, then a circuit is completed for energizing connect relay 1030 as follows: from ground by way of armature 1021, lower springs 1025 of the answer key, and through the lower winding of connect relay 1030 to battery. At armatures

1031 and 1032 relay 1030 connects the talking conductors 1092 and 1093 to the attendant's station by way of the information key. At armature 1033 relay 1030 completes a locking circuit through its upper winding and a circuit for energizing common relay 1020 by way of the upper answer springs 1024. At armature 1034 relay 1030 prepares a circuit for the camp on busy relay 860 in the incoming connector, at armature 1036 completes a circuit for energizing line relay 1050 when the handset is removed from the cradle, at monophone springs MS, and at armature 1037 prepares a point in the circuit to the first transfer relay 1060. Common relay 1020 energizes in series with the upper winding of connect relay 1030 and at armature 1021 disconnects ground from the remaining answer keys to prevent the energization of another connect relay, such as relay 1030. This arrangement, therefore, necessitates the restoration of the first answer key before a second answer key is operated in order to properly operate the connect relay associated with the second key. Line relay 1050, upon energizing, at armature 1051 prepares a point in the circuit for connecting a bridge across the conductors 1092 and 1093, at armature 1052 connects the individual connector 1095 of the common conductor 1098, at armature 1053 prepares a holding circuit for itself, at armature 1054 prepares a locking circuit for relay 1060, and at armature 1055 grounds conductor 1087 to energize relay 668 in Fig. 6, since at this time the incoming trunk call relay 630 is energized in response to the incoming call. The circuit for energizing relay 668 extends from ground at armature 1045, armature 1055, common conductor 1097, armature 631 and front contact, winding of marginal relay 667, and through the lower winding of relay 668 to battery. Relay 668 energizes in the same manner as before, and at armatures 690 and 691 locks out other calls and causes the operation of marginal relay 667 by connecting battery to its lower winding alone. Relay 667, upon energizing, at armature 685 completes the operating circuit for the motor magnet 619, and for short circuiting start relay 640 until wiper 617 finds the bank contact terminating the ungrounded conductor designating the trunk line having the incoming call. Since the operation of the trunk distributor is similar to that previously described only a brief resume of the operations will be given at this time. At armature 686 prepares a circuit for the start relay 640 and at armature 689 grounds conductor 1098 to mark the attendant's line as answering in the trunk finder bank. When incoming wiper 617 of the trunk distributor finds the calling trunk relays 640 and 650 energize as before. At armature 641 relay 640 grounds conductor 479 to cause the operation of start relay 450 in the calling trunk. The operation of the trunk finder is similar to that previously described and the detailed description from here on will include only the new circuits needed to fully understand the operation.

In response to the operation of the start relay 450 in the trunk finder the finder wipers are operated as before and stop opposite the 0 level in response to the vertical wiper 428 encountering ground on the 0 vertical bank contact, whereupon the changeover relay 410 operates and locks. The wipers are now rotated by the rotary magnet 415 in the same manner as before until the test wiper 425 finds the marked bank contact whereupon the polar stop relay 470

is energized over the following circuit: from ground at armature 589, common conductor 1098, armature 1042, armature 1052, conductor 1095, bank contact 448, wiper 425, back contact and armature 441, contact 451, and through the upper operating winding of polar stop relay 470 to battery. Polar stop relay 470, upon energizing, at armature 472 opens the circuit to the rotary magnet to prevent further rotation of the wipers and also causes the operation of switch-through relay 460. Switchthrough relay 460, upon energizing, at armature 463 grounds the wiper 424 to ground conductor 1094 thereby causing the operation of the cut-off relay 1040 in the attendant's cabinet, and at armatures 461 and 462 connects the talking conductors to conductors 1092 and 1093 by way of wipers 422 and 423. Cut-off relay 1040, upon energizing, at armature 1041 prepares a further point in the holding bridge, at armature 1042 disconnects ground from conductor 1095 to open the circuit through the upper operating winding of the polar relay 470 but this relay is now held in operated position through its lower winding alone. At armature 1043 relay 1040 connects the grounded conductor 1094 to the winding of line relay 1050 by way of armatures 1035 and 1053 to hold line relay 1050 in operated position independent of the monophone springs MS. At armature 1044 relay 1040 operates the supervisory lamp SL to indicate to the attendant that the connection has been completed and at armature 1045 disconnects ground from conductor 1097 to release the relays 667 and 668 in the trunk distributor. The talking circuit extends over the heavy talking conductors 1077, 1078, 1087, 1088, 1092, 1093, and the talking conductors of the trunk. Talking battery to the attendant's substation is furnished by line relay 550, while the talking battery at the main exchange is furnished to the central office subscriber.

If the attendant wishes to answer a second incoming trunk call before he has disposed of the first one, he will restore the answer key to normal causing the deenergization of relays 1020 and 1030. When relay 1030 deenergizes a holding circuit is completed across the talking conductors 1092 and 1093 at the normally closed springs controlled by armatures 1031 and 1032. The holding bridge extends by way of armature 1041, resistance R, and armature 1051 for maintaining the line relay 550 in operated position. The attendant now operates the second answer key (not shown) which causes another trunk finder associated with the second incoming trunk call to connect with the attendant's substation in the same manner as described for the first call. In this case the trunk finder would rotate an additional step to engage the marked conductor, similar to conductor 1095 individual to this second answering position. Such conductor terminating, in this instance, in the second bank contact in the O level accessible to wiper 425. If the attendant should answer two trunk calls in this manner, he may hold or transfer either trunk call at will, as the restoration of either answer key holds the trunk.

It will now be assumed that the attendant, after talking to the central office subscriber over the first trunk connection, desires to transfer the call to substation S. In order to transfer the call the attendant operates the transfer key TK momentarily to cause an idle incoming finder connector link to be connected to this trunk line. In response to the operation of the transfer key

TK, springs 1028 complete a circuit for energizing the first transfer relay 1060 in this first step as follows: from ground by way of springs 1028 of key TK, armature 1037, armature 1061 and back contact, and through the upper winding of relay 1060 to battery. Relay 1060 operates only its armatures 1062 and 1063, and at armature 1062 short circuits its lower winding from ground at armature 1054 by way of armature 1072. At transfer springs 1027 ground is connected to conductor 1078 and thence by way of spring 1023 and back contact of the information key, conductor 1088, armature 1032 and front contact, conductor 1093, wiper 423, armature 462, conductor 514, through the lower winding of differential relay 510, normally closed contacts controlled by armature 522, lower left-hand winding of the trunk repeating coil, and through the lower winding of line relay 510 to ground. The circuit just traced short circuits the lower winding of differential relay 510 whereupon the latter relay is unbalanced and thereupon operates its armature 511. At armature 511 relay 510 operates the line switching relay 520 in its first step as before and when the transfer key TK is released the differential relay 510 deenergizes and removes the short circuit from around the lower winding of relay 520 to permit the latter relay to operate through its second step as before.

In the attendant's cabinet and in response to the opening of trunk transfer key TK at springs 1028 the transfer relay 1060 operates through its second step due to the short circuit being removed from the lower winding of relay 1060, and the latter relay energizes through its second step from ground at armature 1054 through both its windings in series. At armature 1061 relay 1060 prepares a circuit for the second transfer relay 1070 and at armature 1064 prepares a point in the circuit for connecting the busy tone to conductors 1092 and 1093.

The operation of two-step relay 520 in the trunk circuit causes the operation of the relay 400 in the trunk finder in the same manner as previously described. The operation of relay 400 causes the operation of the incoming distributor to preselect an idle finder connector link and the operation of the incoming finder to connect with the trunk in use and transmit dial tone to the attendant in a manner similar to that previously described. The attendant now transmits the digits of the desired local subscriber to cause the incoming connector to connect with such line in the same manner as previously described. The impulsing circuit to the line relay 720 in the incoming finder connector link may be traced as follows: from the impulse springs of the calling device CD at the attendant's station, over the heavy talking conductors 1077, 1078, information key, conductors 1087 and 1088, armatures 1031 and 1032, conductors 1092 and 1093, wipers 422 and 423, armatures 461 and 462, conductors 513 and 514, the windings of differential relay 510, conductors 512 and 515, conductors 497 and 496, wipers 791 and 792, armatures 711 and 712, armatures 742 and 731, and through the windings of line relay 720 to battery and ground.

When subscriber S answers the attendant converses over the heavy talking conductors and advises the called local subscriber that he is wanted on a trunk call, whereupon the local subscriber operates the push-button PB to cause the operation of transfer relay 770 whereupon the trunk finder is operated to find and connect with this local line in the same manner as previously

described. When the switchthrough relay 460 deenergizes in the trunk finder the circuit to the cut-off relay 1040 in the attendant's cabinet is opened, whereupon this relay deenergizes. At armature 1044 relay 1040 extinguishes the supervisory lamp SL to inform the attendant that the call has been transferred and at armature 1043 transfers the circuit for relay 1050 to the monophone springs MS. The attendant now restores the answering key and replaces the monophone whereupon relays 1020, 1030 and 1050 deenergize. When relay 1050 deenergizes armature 1054 opens the holding circuit of relay 1060 whereupon the latter relay deenergizes.

The attendant after calling a local subscriber to transfer a call thereto may restore the answer key before the called local subscriber responds. In this case relays 1020 and 1030 deenergize, but relays 1040, 1050 and 1060 are maintained energized. When the local subscriber answers such subscriber will hear busy tone extending by way of armature 1064 and armatures 1041 and 1051, and thence over the heavy talking conductors. When the local subscriber answers and hears the busy tone such subscriber will understand that the attendant has called her and that he is wanted on a trunk call. The local subscriber then operates the push button PB to transfer the call independent of the attendant and when the trunk finder releases and reoperates relays 1040, 1050, and 1060 deenergize. When the call is transferred and relay 1040 deenergizes the supervisory lamp SL is extinguished to advise the subscriber that the trunk call has been transferred.

Relay 1070 in the attendant's cabinet is provided to release relay 1060 so that the busy tone at armature 1064 will not be transmitted to the central office subscriber in case the subscriber first called by the attendant does not answer or in case the attendant desires to transfer this call to a second local line instead of the first line. For example, it will be assumed that the attendant desires to connect the central office subscriber on this trunk call to a second local subscriber's line because either the first subscriber did not answer or because when the first subscriber did answer and the attendant was informed that the desired subscriber could be reached at the second local line. In order to call a second local line the attendant reoperates the transfer key TK to close springs 1028 which causes the operation of relay 1070 in its first step over the following circuit: ground at armature 1028, armature 1037, armature 1051 and front contact, and through the upper winding of relay 1070 to battery. The reoperation of the transfer springs 1027 again grounds conductor 1078 to again cause the energization of the differential relay 510 which at armature 511 causes the operation of relay 540. When the transfer key is released the short circuit around the lower winding of transfer relay 1070 is removed with the result that relay 1070 operates in its second step to open armature 1072. At armature 1072 the holding circuit to the first transfer relay 1060 is opened, whereupon this latter relay now deenergizes. At armature 1064 relay 1060 disconnects the busy tone and at armature 1063 opens the circuit to relay 1070 which likewise deenergizes. The restoration of the transfer key also disconnects ground from conductor 1078 to cause the deenergization of relay 510. Relay 510, upon deenergizing, at relay 511 opens the circuits of both relays 520 and 540. Due to the slow releasing characteristics of relay 540 relay 520 deenergizes first to

reconnect the attendant's line to the central office subscriber over the trunk conductors at armatures 521 and 522. At armature 523 relay 520 releases relay 400. When relay 400 deenergizes armatures 402 and 403 disconnect the trunk conductors from the incoming finder connector, at armature 401 disconnects ground from conductor 490, and at armature 404 holds relay 530 in energized position. Relay 540 deenergizes after an interval and opens the holding bridge at armature 541 to permit conversation to take place between the attendant and the central office subscriber.

In the incoming finder line relay 720 deenergizes when armatures 402 and 403 are opened to 15 cause the release of the incoming finder connector link as previously described. The attendant is now again connected to the trunk and the relays are in the same condition as when the attendant first answered the incoming call. In order to call the second line the attendant again operates the transfer key TK to cause an idle incoming finder connector link to be connected to her station after which the attendant operates the incoming connector to the second line 25 in the same manner as previously described. The second subscriber accepts the call by operating the push button to transfer the trunk call thereto as before.

The attendant can release a trunk call by restoring the answer key and operating such key to open the release key, thereby opening the holding circuit of line relay 1050. Relay 1050, upon deenergizing, at armature 1051 opens the holding bridge across the trunk conductors 1092 and 1093 35 to cause the release of the trunk finder. The release of the trunk finder causes the deenergization of the cut-off relay 1040 and the latter relay extinguishes the lamp L to inform the attendant that the trunk finder has released. From the foregoing it will be seen that by the use of the incoming finder connector switches the attendant can transfer trunk calls even though all of the local finder connector links are busy.

The incoming connectors are arranged to offer 45 calls to busy lines and are also arranged to camp on busy lines when such incoming connectors are taken into use from the attendant's station. For the purpose of describing this operation it will be assumed that the incoming connector in Fig. 8 has been operated by the attendant to engage the line of substation S2 and S3 which at the time is busy. The trunk finder relays, the incoming finder and the incoming connector operate in the same manner as previously described and when 55 switching relay 730 in the incoming finder operates the circuit for the camp-on-busy relay 860 is completed as follows: from ground through the lower winding of camp-on-busy relay 860, back contact and armature 872, conductor 726, armature 732, wiper 795, conductor 486, trunk finder wiper 427, bank contact 476, conductor 1096, armature 1034, and through the resistance R1 to battery. At armature 861 camp-on-busy relay 860 completes a locking circuit through its 60 upper winding from grounded hold conductor 724, at armature 862 prepares a locking circuit for busy relay 870 which is effective only as long as the called line is busy, and at armature 863 short circuits the lower winding of busy relay 870 to make this relay appreciably slow to deenergize.

Busy relay 870 energizes in the same manner as previously described when the called line is busy, and at armature 871 connects the busy tone to the attendant's line. At armature 872 relay 75

870 opens the original energizing circuit of relay 860 and prepares the circuit for offer relay 840, at armature 873 prepares a locking circuit for itself, at armature 874 opens the circuit to switching relay 880, and at armature 875 opens the impulsing circuit. When the rotary series relay 850 deenergizes after the impulsing period the relay 870 is locked in operated position from ground on the test conductor of the called line, wiper 893, armature 862 and front contact, armature 873, springs 852 and front contact of armature 851, and through the winding of busy relay 870 to battery. When the attendant hears the busy tone the attendant can either camp on this line and wait until the same becomes idle, or else can offer the call to the busy called line.

Assume first that the attendant camps on the busy line and when the busy called line becomes idle the locking ground is removed from wiper 893 with the result that the busy relay 870 deenergizes. Relay 870, upon deenergizing, at armature 871 removes the busy tone and at armature 874 closes the circuit for operating the switching relay 880 which now energizes to connect generator to the called line. The operation from here on is the same as previously described, and when the subscriber answers the attendant advises such subscriber to take the trunk call and in case the attendant has restored the answer key then the called subscriber hears busy tone which advises her to accept the trunk call, which she does by operating her push button to cause the release of the incoming finder connector link and the release and reoperation of the trunk finder to her line as previously described.

Assuming now that the attendant desires to offer this call to the busy called subscriber, the attendant then operates the offering key 1026 to ground conductor 1096, thereby energizing relay 840 over the following circuit: from grounded conductor 1096 by way of bank contact 476, wiper 427, conductor 486, wiper 795, armature 732, conductor 726, armature 872 and front contact and through the winding of offer relay 840 to battery. At armature 841 relay 840 connects a tick tone to the upper talking conductor to advise the local subscribers that the attendant is listening in on their conversation, at armature 842 disconnects the busy tone and at armature 843 operates the ring cut-off relay 830 over the following circuit: from grounded armature 843, back contact and armature 885, and through the lower and upper windings of ring cut-off relay 830 to battery. At armatures 832 and 833 the talking connection from the attendant's station to the busy called local connection is completed over the heavy talking conductors and the attendant advises the busy local called subscriber that a trunk call is awaiting her attention. Afterward the attendant restores the offering key 1026 and releases relay 840. Relay 840, upon deenergizing, at armature 841 removes the tick tone advising both local subscribers that the attendant is now off the line, and at armature 843 opens the circuit of ring cut-off relay 830, which accordingly deenergizes. When the busy local connection is released the busy relay 870 deenergizes as before and causes the called subscriber to be rung in the same manner as previously described. The called subscriber, upon answering, accepts the trunk call which is transferred to her as previously described.

Having described the invention, what is considered to be new and is desired to be protected

by Letters Patent will be set forth in the following claims.

What is claimed is:

1. In a telephone system, local subscribers' lines, local finder-connector links having access to said local lines, trunk lines, trunk finders terminating said trunk lines and having access to said local lines, incoming finder-connector links, said incoming finders having access to said trunk lines and said incoming connectors having access to said local lines, means for operating said local finder-connector links to complete connections between local subscribers' lines, means for operating said trunk finders to complete connections between said trunk lines and said local lines, and means for operating said incoming finder-connector links to complete connections between local subscribers' lines by way of said trunk finders.

2. In a telephone system, local subscribers' lines, local finder-connector links having access to said local lines, trunk lines, trunk finders terminating said trunk lines and having access to said local lines, incoming finder-connector links, said incoming finders having access to said trunk lines and said incoming connectors having access to said local lines, means for operating said local finder-connector links to complete connections between local subscribers' lines, means for operating said trunk finders to complete connections between said trunk lines and said local lines, means for operating said incoming finder-connector links to complete connections between local subscribers' lines by way of said trunk finders, means for operating said trunk finder to connect the local subscriber's line engaged by the incoming connectors to said trunk line, and means responsive to said last connections for releasing said incoming finder-connector links.

3. In a telephone system, trunk lines, a two-motion step-by-step finder terminating each trunk line, local subscribers' lines divided into groups and accessible to said finders, means controlled by a local subscriber in response to answering an incoming call on one of said trunk lines for marking both the group and the line of the answering local line in the finder banks, and means for thereafter operating the finder associated with the trunk line having the incoming call in one direction to find said group marking and in a second direction to find said line marking to complete the connection from said trunk line to the answering subscriber's line.

4. In a telephone system, trunk lines, a two-motion step-by-step finder terminating each trunk line, local subscribers' lines divided into groups and accessible to said finders, means controlled by a calling subscriber for operating one of said trunk finders to connect the associated trunk line with the calling subscriber's line, incoming finders having access to said trunk lines, incoming connectors having access to said local lines, means controlled by said calling subscriber for holding said trunk connection and for operating one of said incoming finders and one of said incoming connectors to connect the calling subscriber's line to a called local subscriber's line, means for marking both the group and line of the called subscriber's line in the trunk finder banks, and means controlled by the called subscriber for reoperating said trunk finder in a first movement to find said group marking and in a second movement to find said line marking to complete a connection between said trunk line and said called line.

5. In a telephone system, trunk lines each ter-

minating in a trunk finder, local subscribers' lines accessible to said trunk finders, local connectors and incoming connectors having access to said local lines, means responsive to a calling local line originating an outgoing trunk call or answering an incoming trunk call for marking the calling line in the banks of said trunk finders, means for enabling a calling local line to hold a trunk connection and operate an incoming connector by way of said trunk connection to complete a local connection to a called local line, means controlled by the operated incoming connector for marking the called local line in the banks of said trunk finders, means for operating the trunk finders to find the marked calling or called local lines and complete connections between such local lines and trunk lines, and means for automatically releasing the local or incoming connectors after completion of said last connections.

6. In a telephone system, trunk lines each having an associated trunk finder, local connectors, incoming connectors, local subscribers' lines accessible to said trunk finders, said local connectors and said incoming connectors, means for operating said local connectors to mark calling local lines in the banks of said finders, means for operating said incoming connectors to mark called local lines in the banks of said finders, and means for operating said trunk finders to find the marked calling or called local lines and complete connections between such local lines and said trunk lines.

7. In a telephone system, trunk lines each having an associated trunk finder, local connectors, incoming connectors, local subscribers' lines accessible to said trunk finders, said local connectors and said incoming connectors, means for operating said local connectors to mark calling local lines in the banks of said finders, means for operating said incoming connectors to mark called local lines in the banks of said finders, a testing circuit in each trunk finder, means for altering said circuits dependent upon whether said finders are to hunt for a calling or a called local line, and means for operating one of said trunk finders until the marked line is connected to the test circuit to complete the connection of such local line to associated trunk line.

8. In a telephone system, a local exchange and two distant exchanges, a plurality of local subscribers' lines in the local exchange, a first group of trunk lines connecting the first distant exchange to the local exchange, a second group of trunk lines connecting the second distant exchange to the local exchange, a trunk finder individual to each trunk line, and means for automatically operating the trunk finder of a trunk line of either group in use in an incoming trunk call or a trunk finder of an idle one of said trunk lines in response to the local subscriber dialling three predetermined digits, one for incoming trunk calls in both said groups, one for outgoing trunk calls in one group, and the other for outgoing trunk calls in the other group.

9. In a telephone system wherein a trunk finder terminating a trunk line is operated in two hunting movements to complete incoming, outgoing, and transfer calls for local subscribers' lines, a group test wiper and a group test circuit in said finder, two line test wipers and a single line test circuit in said finder, said group test wiper and group test circuit always effective regardless of the type of call responsive to the operation of said finder in its first hunting

movement, said first line test wiper and said line test circuit normally effective for completing incoming and outgoing calls responsive to the operation of said finder in its second hunting movement, and means for rendering the second of said line test wipers and said line test circuit effective to complete transfer calls responsive to the operation of said finder in its second hunting movement.

10. In a telephone system, a local exchange, local subscribers' lines at said local exchange, two distant exchanges, a first group of trunk lines connecting the local exchange to the first distant exchange, a second group of trunk lines connecting the local exchange to the second distant exchange, a trunk distributor, means for operating said distributor to select an idle trunk line in the first group of trunk lines in response to a local subscriber originating a trunk call to the first distant exchange, means for operating said distributor to select an idle trunk line in the second group of trunk lines in response to a local subscriber originating a trunk call to the second distant exchange, and means responsive to a local line answering an incoming trunk call in either trunk group for operating said distributor to select the trunk line in use with the incoming call.

11. In a telephone system wherein a trunk finder terminating a trunk line is operated to complete incoming, outgoing, and transfer calls for local subscribers' lines, a trunk distributor used in completing all said different calls, and means in said distributor for guarding said distributor from seizure on a second call until after the trunk finder has been operated to the local line.

12. In a telephone system, a vertical and rotary connector switch including wipers and a switch bank, groups of contacts in said switchbank, a source of signalling current normally associated with the first of said wipers, means for operating said switch in a vertical movement opposite a group of contacts in the switchbank, means operated in case said wipers come to rest opposite a predetermined group of contacts for disassociating said source from said first wiper and associating said source with the second of said wipers, said first means again effective only in case said second means is operated for continuing the operation of said switch in a further vertical movement to position said wipers opposite a desired group of contacts, means for operating said switch in a rotary movement to engage the desired contacts of the selected group, and means for connecting said source to said first or second wiper dependent upon the operated condition of said second means.

13. In a telephone system, party lines, a connector switch operated in two different directions in response to two dialled digits comprising a complete called number and operated in two directive movements in the first of said directions and in one directive movement in the second direction in response to three dialled digits in other called numbers to extend connections to called ones of said lines, a source of signalling current, and means dependent upon the first digit dialled in the called number for connecting said source to one or the other line conductor of the called line.

14. In a telephone system, a two-party line, the call number of the first party on said line comprising a given number, the call number of the second party on said line comprising a pre-

determined number plus said given number, an automatic switch including wipers, means responsive to dialling said given number for operating said wipers one step for each impulse of said given number in two directive movements of different directions into engagement with said line, means responsive to dialling both said predetermined number and said given number for operating said last means to step said wipers one step for each impulse in said predetermined number and one step for each impulse in said given number minus the number of impulses in said predetermined number thereby stepping the wipers into engagement with said line by the same number of steps as there are impulses in the given number but by two directive movements in the first of said directions and by a directive movement in the second direction, and means for selectively signalling either party on said line dependent upon the call number dialled in extending the connection to said line.

15. In a telephone system, a vertical and rotary connector switch including wipers and a switch bank, a party line terminating in said switch bank, means for operating said switch wipers in one or two vertical movements and then a rotary movement to engage the switch banks terminating said party line, and means for selectively signalling the first party on said line in case said switch is operated in only one vertical movement and for selectively signalling the second party on said line in case said switch is operated in two vertical movements.

16. In a telephone system, an automatic switch having wipers and a switch bank, line contacts in said switch bank arranged in groups accessible to said wipers, means for directing the wipers of said switch in one direction in one or two directive movements to select the same group of contacts, and means for then directing the wipers of said switch in another direction in another directive movement to select the desired contacts in the selected group.

17. In a telephone system, an automatic switch having wipers and a switch bank, line contacts in said switch bank arranged in groups accessible to said wipers, means for directing the wipers of said switch in one direction in one or two directive movements to select the same group of contacts, means for then directing the wipers of said switch in another direction in another directive movement to select the desired contacts in the selected group, a partly line terminating in said selected group, and means for selectively signalling the first or second party on said line dependent upon the number of directive movements taken by said switch in the first direction.

18. In a telephone system, an automatic switch including a pair of line wipers, line contacts arranged in groups accessible to said wipers, means responsive to dialled digits in a called number for operating said wipers one step for each impulse in one direction opposite a desired group of contacts and then in another direction into engagement with the desired contacts in the selected group, a source of signalling current normally associated with the first of said wipers, means operative in case the first digit dialled is a predetermined digit for associating said signalling source with the second of said wipers and means operated by the first impulse of the second digit only in case said last means is operated for absorbing the first impulse of the second digit whereby said wiper stepping means

again steps the wipers in said first direction in response to only the remaining impulses of the second digit.

19. In a telephone system, connector switches, local subscribers' lines, an attendant's position, trunk lines, means controlled by the local subscribers or the attendant when connected to said trunk lines for seizing said connector switches and for connecting said switches to the trunk-connected local subscribers' lines or to said attendant's position, means thereafter controlled by said trunk-connected subscribers or the attendant for operating the seized connector switches into engagement with called local subscribers' lines to transfer trunk calls to the local called subscribers' lines, means for transmitting the busy tone to the trunk-connected local subscribers or the attendant when said connectors are operated into engagement with called busy local lines, and means in said connectors operative only in case the connectors have been taken into use by the attendant for causing said connectors to camp on the busy called line and complete the connection therewith in response to such line becoming idle.

20. In a telephone system wherein connector switches are used by local subscriber and an attendant to transfer trunk calls to local subscribers' lines, means for transmitting the busy tone to the local subscriber or the attendant when said connectors are operated into engagement with called busy local lines, means in said connectors operative only in case the connectors have been taken into use by the attendant for causing said connectors to camp on the busy line and complete the connection therewith when such line becomes idle, means in said connectors controlled by the attendant for enabling the attendant to cut in on the busy connection, and means responsive thereto for connecting a special tone to the busy connection to inform the subscribers thereon that the attendant is cut in on their connection.

21. In a telephone system, trunk lines each having an associated trunk finder, local subscribers' lines divided into groups and terminating in the banks of the finders, a calling bank contact and a called bank contact in each finder bank individual to each local line, a group bank contact in each finder bank individual to each group of lines, means responsive to a calling local subscriber originating or answering a trunk call for marking the group contact corresponding to the group the calling line is located in and for marking the calling line's individual bank contact, means controlled by a called local subscriber after being called locally for marking the group contact corresponding to the group the called line is located in and for marking the called line's individual bank contact, and means for operating said trunk finders to hunt for and find said marked group contact and then said individual marked contact to complete connections between said local lines and said trunk lines.

22. In a telephone system, trunk lines, a two-motion finder terminating each trunk line, local subscribers' lines divided into groups and accessible to said trunk finders, local connectors having access to said local lines, means controlled by a calling local line for operating one of said local connectors to mark both the group and line of the calling line in the trunk finder banks, means responsive thereto for operating one of said trunk finders in one movement to find said group marking and in another movement to find

said line marking to connect the associated trunk line to said calling line, incoming finders having access to said trunk lines, an incoming connector individual to each incoming finder and
 5 having access to said local lines, means controlled by the calling subscriber for holding said trunk connection and for operating one of said incoming finder-connector links to connect the calling subscriber's line to a local called sub-
 10 scriber's line, means for marking both the group and line of the called local line in the trunk finder banks, means controlled by the called subscriber for reoperating said trunk finder in one movement to find said group marking and in
 15 another movement to find said line marking to complete a connection between said trunk line and said called local line, and means responsive thereto for automatically releasing said incoming finder-connector link.
 20 23. In a telephone system, trunk lines, a two-motion step-by-step finder terminating each

trunk line, local subscribers' lines divided into groups and accessible to said finders, local connectors having access to said local lines, a trunk answering position in said connectors, means controlled by a calling subscriber for operating one
 5 of said connectors to said trunk answering position in case such subscriber desires to answer an incoming call on any one of said trunk lines, means responsive to the connection of said connector to said answering position for marking
 10 both the group and the line of the calling subscriber in the banks of said trunk finders, means for thereafter operating the finder associated with the trunk line having the incoming call
 15 in a first movement to find said group marking and in a second movement to find said line marking to connector said trunk line to the calling subscriber's line, and means for thereafter automatically restoring said connector to common
 20 use.

JOHN H. VOSS.