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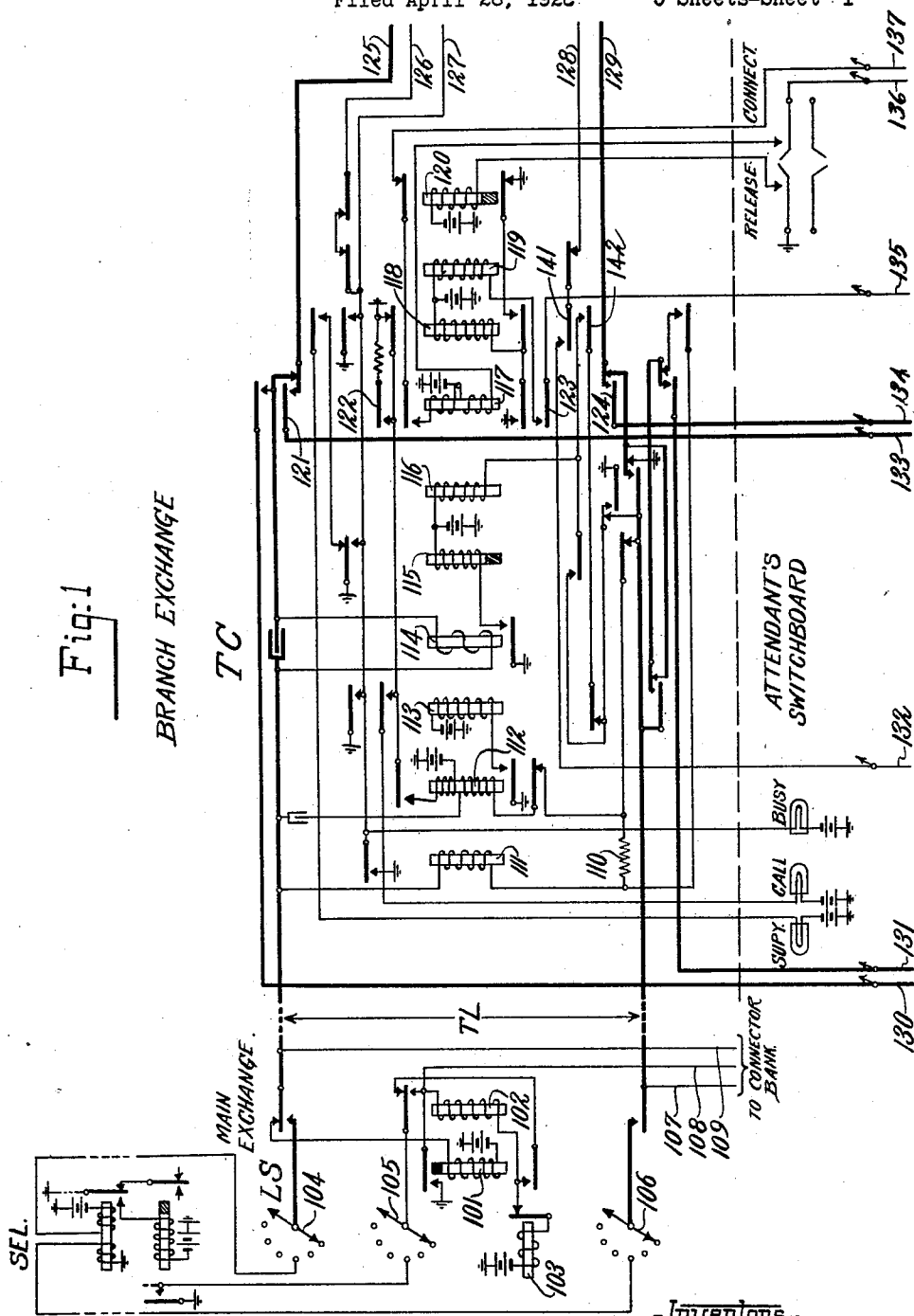
G. E. SCHOMAKER ET AL

1,809,071

TELEPHONE SYSTEM

Filed April 28, 1928

5 Sheets-Sheet 1



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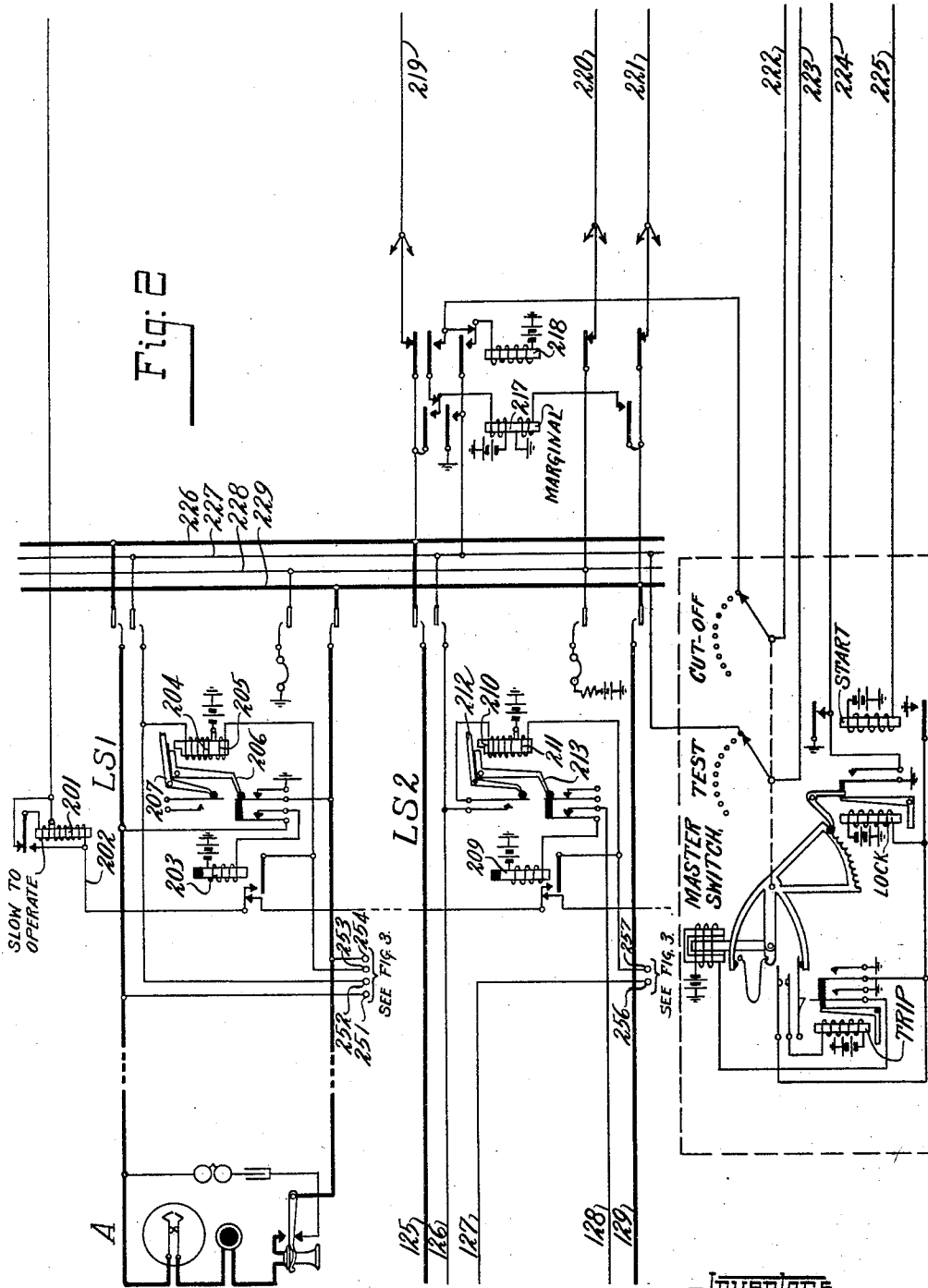
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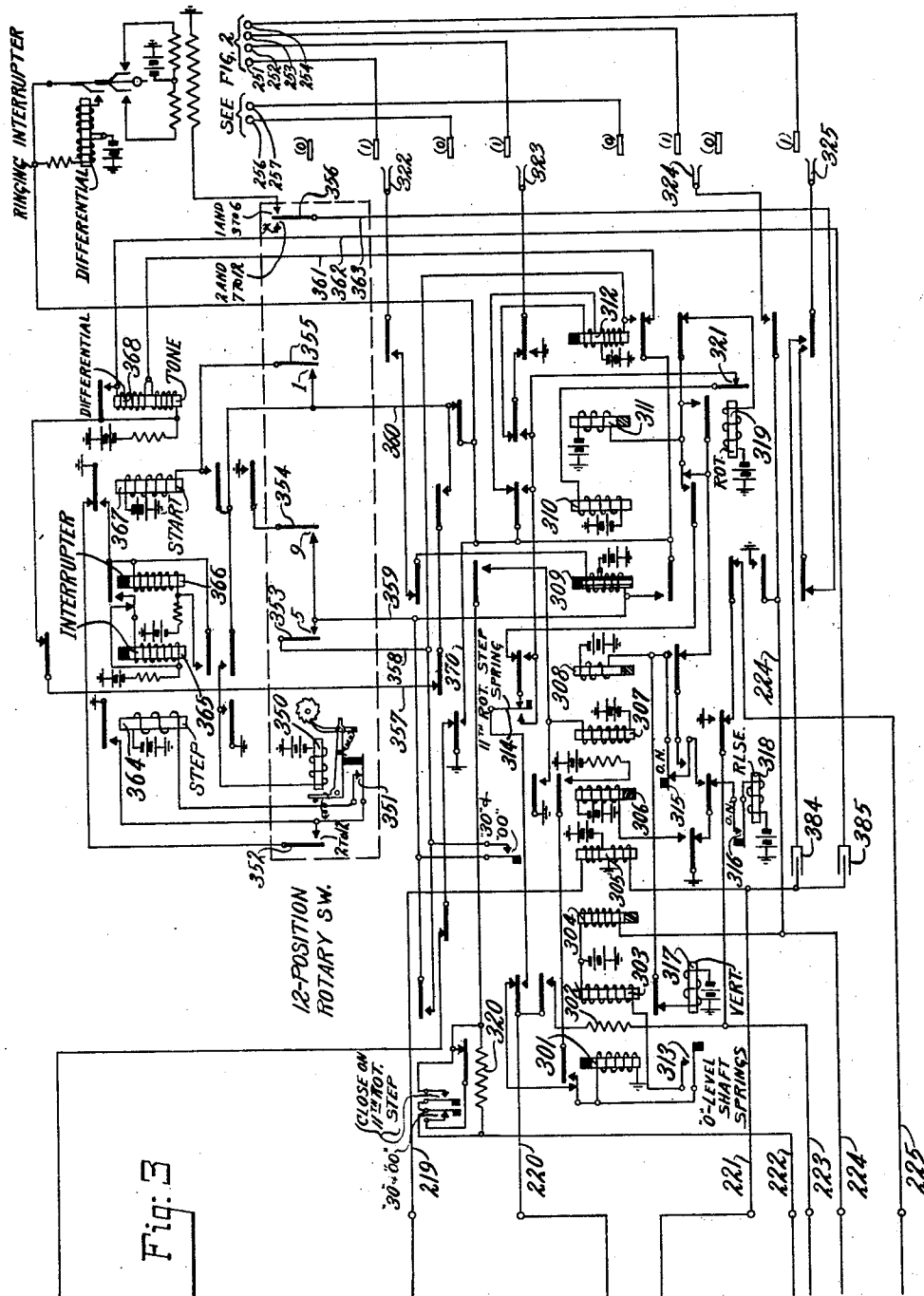
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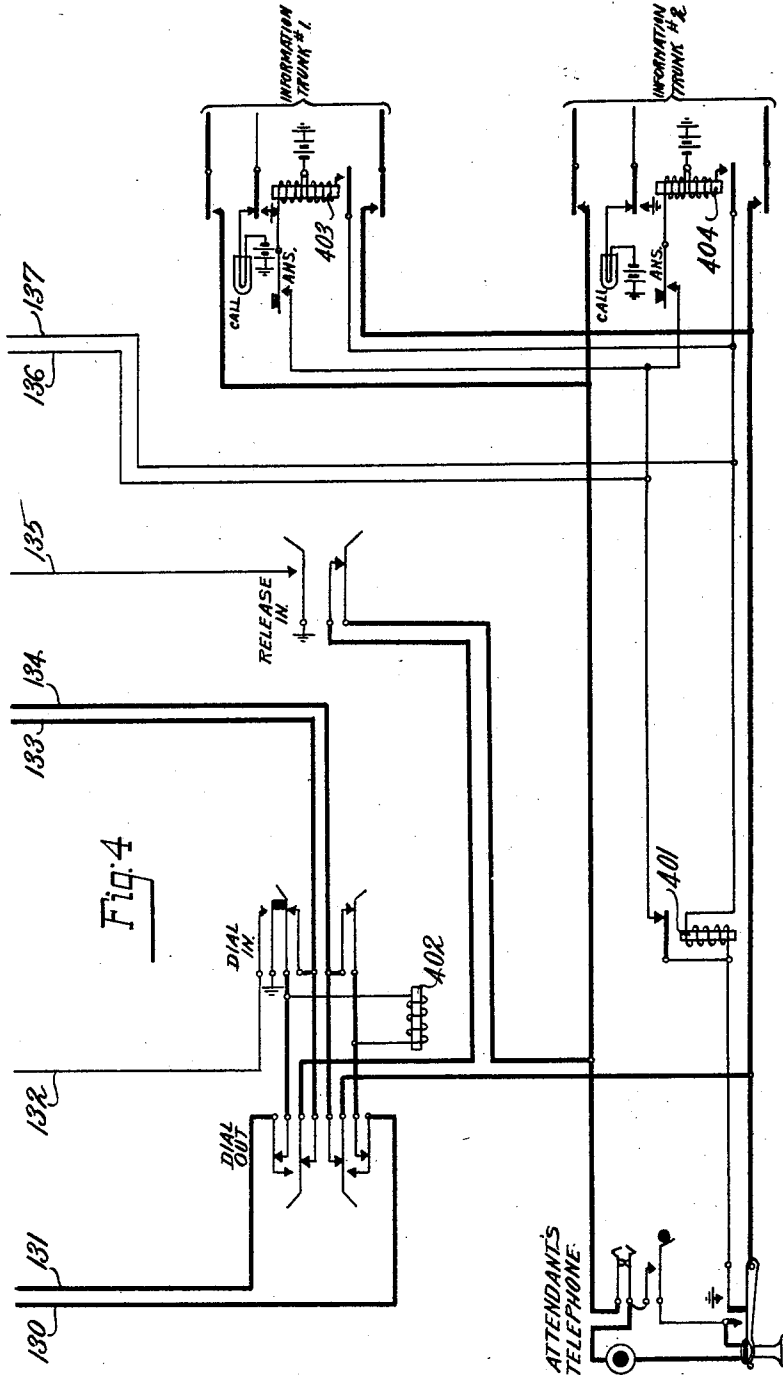
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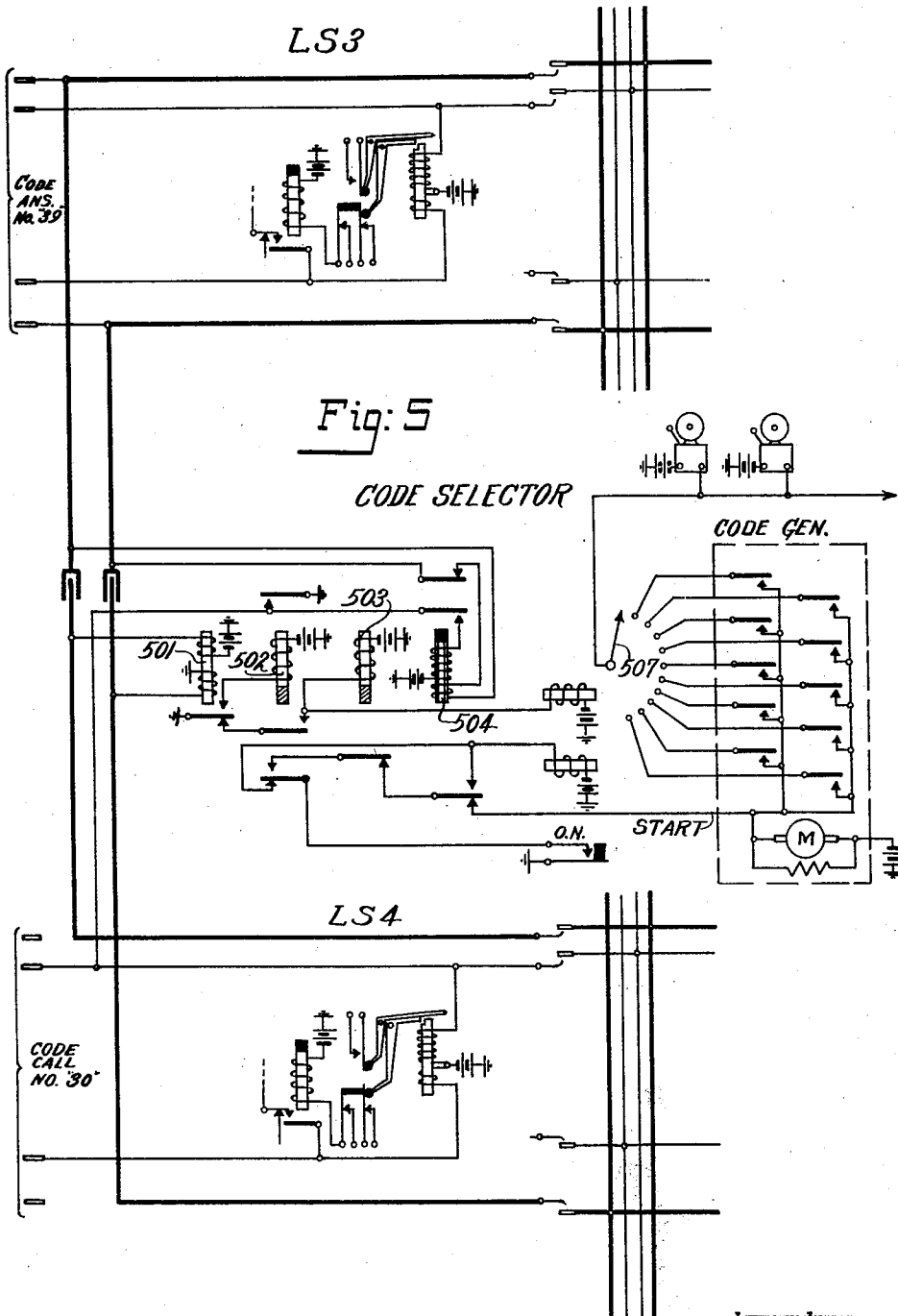
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TELEPHONE SYSTEM

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5 Sheets-Sheet 5



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## UNITED STATES PATENT OFFICE

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## TELEPHONE SYSTEM

Application filed April 28, 1928, Serial No. 278,462, and in Great Britain August 26, 1927.

The present invention relates to telephone systems in general, but is concerned more particularly with the branch-exchange equipment in a telephone system employing both  
5 main and branch exchanges, although several features of the invention are not specifically limited thereto.

The invention has been applied to an automatic telephone system including an automatic main exchange and an automatic  
10 branch exchange having an attendant's cabinet located therein to enable an attendant at the branch exchange to complete incoming calls and to set up connections from a branch-exchange subscriber to a main-exchange sub-  
15 scriber when requested to do so.

One object of the invention is the application of the so-called by-pass method of operation to the branch-exchange switching apparatus so that a single connector will suffice, this connector being used merely to operate the lineswitch on the called line to cause it to seize the same trunk previously  
20 seized by the calling lineswitch.

A features of the invention lies in the arrangement whereby each of the ten trunks presided over by a master switch is normally connected to the common connector switch, but is disconnected therefrom and connected  
25 instead to an individual battery feed and holding relay as soon as a connection has been set up over the trunk.

According to a further feature of the invention, the master switch is arranged so that it does not operate to preselect a new trunk when a call is made, but waits until the common connector has been operated over the seized trunk to signal the subscriber on the called line and to operate the lineswitch  
30 on the called line to make connection with the calling line through the trunk in use, whereupon the master switch operates in the usual manner to preselect another idle trunk.

Another object of the invention is the provision of a timing device individual to the connector for freeing the connector automatically in case the subscriber has not  
35 dialled the complete number and caused the connector to be freed when disconnected from the trunk as above mentioned.

According to a further feature of the invention, the above-mentioned timing device is released and started over again after the complete number has been dialled in order to control the application of ringing current  
40 and the regular release of the connector.

A special feature of the arrangement is that ringing current is transmitted as soon as the connection has been completed, only a short preliminary ring being given at that  
45 time. A moment later, the timing device causes a long ring to be transmitted to the called line. This long ring is useful in a private automatic exchange in order to locate the substation that is being signalled when  
50 several substations are located close together, such as, for example, at adjacent desks in an office.

Another object of the invention is the production of suitable arrangements in a system  
55 of the foregoing character whereby certain subscribers are permitted to call through to the main exchange, while calls from other substations to the main exchange are barred.

Another object of the invention is the provision of arrangements in the connector for preventing the connecting up of a battery supply to a trunk line when a connection is being made thereover to the main exchange or to a certain local equipment (a code call  
60 machine for example) while permitting a battery supply connection to be made in case the call is a regular local call. This permits branch-exchange subscribers to dial main-exchange numbers and special local numbers.  
65

Another object of the invention is the provision of suitable arrangements in the incoming trunk lines for controlling the operation of the connector so that it will fail to  
70 cause the battery supply to be connected to a local trunk line in case the call is incoming to the branch exchange from the main exchange, the arrangement being preferred wherein the transmitter in the branch exchange is energized from current transmitted  
75 over the inter-exchange trunk line from the main exchange.

Another object of the invention is the provision of suitable arrangements for enabling  
80

an attendant at an attendant's cabinet associated with the inter-exchange trunk lines to answer and extend calls incoming from the main exchange, to answer the calls incoming to her cabinet from the branch exchange, and to set up tail-to-tail connections between main-exchange and branch-exchange subscribers.

Another object of the invention is the provision of a novel arrangement whereby both busy-tone current and dial-tone current are transmitted to the connector from the tone equipment over the same conductor, arrangements being provided for causing the flow of tone current to be distinctly different at one time from the flow of tone current at the other time so as to differentiate between the dial tone and the busy tone.

There are other objects and features of the invention having to do for the most part with the circuit details necessary to carry out the objects and features above mentioned. The various objects and features of the invention will be understood best from a further perusal of the description in connection with the accompanying drawings.

Referring now to the drawings comprising Figs. 1 to 5, they show by means of the usual circuit diagrams a sufficient amount of equipment in a telephone system involving the features of the invention to enable the same to be understood. More in particular, these drawings show equipment located in a main exchange, indicated at the left in Fig. 1, and the essential equipment of a branch exchange interconnected with the main exchange by means of the trunk line TL, Fig. 1, and others. The branch exchange may be considered as belonging to the type ordinarily designated as a private branch exchange, an attendant being located at the branch exchange to complete incoming calls by ascertaining the number desired and controlling the operation at the automatic switching equipment, outgoing calls being completed responsive to the dialling operation on the part of the calling subscriber without the aid of the branch-exchange attendant.

The apparatus shown in Fig. 1 includes the portion of the main-exchange equipment at the left, and the trunk circuit TC at the right of the interconnecting trunk line TL. In the lower part of Fig. 1 there is indicated certain keys and lamps located at the switchboard of the attendant and individual to the trunk circuit TC.

The remaining portion of the attendant's equipment is indicated in Fig. 4, which should be placed under Fig. 1 with the interconnecting lines in alignment. The keys and other apparatus in Fig. 4 are common to the several trunk circuits such as the trunk circuit TC, Fig. 1. Fig. 4 shows two so-called information trunks extending to the attendant's switchboard from the local switching

equipment for a purpose to be explained hereinafter.

Fig. 2 shows lineswitches LS1 and LS2 having common access to the trunk line comprising conductors 226—229 and to the other trunk lines presided over by the associated master switch. The master switch associates all idle lineswitches with an idle one of the trunk lines.

The lineswitch LS1 is individual to the line of the local substation A, while the lineswitch LS2 is individual to the trunk line TL with which it is associated through the medium of the trunk circuit TC, Fig. 1, being connected with such trunk circuit by way of conductors 125—129.

Fig. 3 shows the single connector of the branch exchange having wipers 322—325. This connector, through the common conductors 219—221, is normally connected to each of the trunk lines accessible to the lineswitches, one of them being the one comprising conductors 226—229, Fig. 2. This connector has access to each of the lines and lineswitches of the branch exchange. Fig. 3 shows also the control equipment and auxiliary equipment including the 12-position rotary switch and its associated relays, and the ringing interrupter.

Fig. 5 shows the code call apparatus including the lineswitches LS3 and LS4 associated with the code answering and code calling numbers respectively and the code selector having wiper 507. This apparatus is accessible to the connector shown in Fig. 3 through the bank contact shown at the left of Fig. 5 and is operated in a manner to be explained subsequently. The lineswitches LS3 and LS4 are under the control of the master switch shown in Fig. 2.

Mechanically, the master switch shown in Fig. 2 together with the lineswitches LS1 and LS2 of the same drawing and the lineswitches LS3 and LS4 of Fig. 5 are of the usual type, the plungers of the lineswitches being preferably of the self-restoring type; that is, a plunger, when released, returns at once to the control of the master switch rather than waiting for the master switch to return again to the position from which the lineswitch was plunged.

The connector shown in Fig. 3 is mechanically of the well-known vertical and rotary type having its bank contacts arranged in horizontal rows or levels.

The apparatus having been described in general, a detailed description of its operation will now be given. For this purpose it will be assumed that the subscriber at substation A desires to converse with another local subscriber.

#### *Local call from substation A*

When the receiver is removed at substation A, line relay 203 of the lineswitch LS1

energizes over the two conductors of the calling line and the substation circuit in series and closes a circuit through the pull-down winding of the lineswitch by way of conductor 202, at the same time disconnecting the operating conductor from the succeeding lineswitches. The ground potential on conductor 202 is obtained from the upper contacts of relays 307 and 304 of the connector, Fig. 3, and through the high-resistance lower winding of the delay-relay 201. As long as the high-resistance lower winding on this relay is unshunted, the lineswitch is prevented from operating. The delay relay is slow to operate due to the high impedance of its lower winding which prevents a quick building up of the current and due to the short-circuited upper winding of the relay, which winding is on the armature end of the relay and therefore prevents the magnet flux from reaching the armature quickly after it is built up. The delay relay is provided primarily to take care of the situation which might arise in case a lineswitch attempts to reoperate immediately after being released, in which case it might plunge in on a trunk other than that preselected by the master switch if it were permitted to operate before it has restored to the position of the master switch. When relay 201 operates it places the low-resistance upper winding in shunt of the lower winding, whereupon the pull-down winding 205 is magnetized sufficiently to operate armatures 206 and 207, closing the connection through from the lineswitch to the trunk comprising conductors 226—229 and disconnecting line relay 203 and ground from the conductors of the calling line.

Line relay 305 of the connector now operates over the calling line through conductors 226 and 229 of the seized trunk and conductors 219 and 221 of the connector. Upon operating, line relay 305 closes a circuit for relay 306, whereupon the release relay 306 operates and closes a circuit for relay 307, which relay, at its lower armature, places ground on the release trunk conductor 223, thereby closing a holding circuit through the test wiper of the master switch and over trunk conductor 227 and contacts of the lineswitch LS1 for the bridge-cut-off winding 204 of the lineswitch. This circuit is established before the slow-acting relay 203 has had time to fall back and it serves to maintain the armatures 206 and 207 of the lineswitch operated.

As a further result of the operation of relays 306 and 307, Fig. 3, the switch is prepared for operation by the lower armature of relay 306, and ground is removed at the upper armature of 307 from the delay relay 201, which relay falls back in preparation for the next call. From this it will be seen that no further lineswitches can be operated from calling lines for the time being, because

ground potential is removed from the contact chain of the line relays.

The calling subscriber now hears the above-mentioned dial tone and dials the first digit in the desired number, the digit 5, for example, whereupon line relay 305 retracts its armature five times momentarily. Each time it does so, a circuit is closed through the lower armature of release relay 306 for vertical magnet 317, the circuit at the time of its first closure including the lower associated off-normal spring, the upper spring 315, and the lower contacts of relay 303. By the operation of the vertical magnet, the wipers 322—325 are raised step by step until they stand opposite the fifth level of the bank contacts. Relay 308 is operated in multiple with vertical magnet 317 upon the first impulse of current, and, being slow acting, it remains operated throughout the digit, thereby maintaining its own circuit and that of the vertical magnet intact after the off-normal contacts have shifted, as they do upon the first vertical step. At the end of the vertical movement, relay 308 falls back and transfers the operating conductor from the vertical magnet 317 to the rotary magnet 319.

When the next digit is dialled, the digit 6 for example, line relay 305 is deenergized six times momentarily, transmitting an impulse to rotary magnet 319 each time it deenergizes. These impulses are transmitted through the lower armature of relay 306, the two lower off-normal contacts associated with off-normal spring 315, the lower armature, normal, of relay 308, normally closed contacts controlled by the lower armature of relay 310, and contacts of relay 312. Magnet 319 responds to these impulses and rotates the wipers 322—325 step by step until they come into engagement with the sixth set of bank contacts (not shown) in the fifth level. Relay 311 is energized in multiple with magnet 319 throughout the rotary movement and at its inner upper armature it disconnects test wiper 323 from the test winding of switching relay 312 and connects it instead through interrupter contacts 321 to the combined stepping and busy relay 310, and at its lower armature it places a shunt around the associated contacts of relay 310 so as to prevent the interruption of the rotary-magnet operating circuit during the rotary movement in case relay 310 operates during such movement, due to a ground potential being engaged on a busy test contact by test wiper 323.

At the upper armature of relay 307, ground is placed on conductor 370, starting the ringing interrupter to operating as follows: When the left-hand winding of the operating magnet energizes through the associated resistance, the reed is drawn to the left, whereupon the differential right-hand winding en-

ergizes in the opposite direction, causing the magnet to release the reed which swings to the right. The right-hand winding deenergizes and the reed is attracted again. The intermittent current flow through the lower contacts of the reed, as it vibrates, passes through the primary winding of the associated transformer and induces the alternating ringing current in the secondary winding.

Ground potential is extended from conductor 370 to the differential tone relay 368 through contacts of relay 312. Relay 368 buzzes at a rather high rate and places a "dial tone" on conductor 221 through condenser 385.

Ground potential is extended also to start relay 367 from conductor 370 through the upper contacts of relay 311 and switch cam 355 in position 1. The timing switch thereupon starts operating in a manner to be later explained.

#### *Called line busy*

Assuming now that the line of the desired subscriber is busy when called, relay 310 is energized over test wiper 323 by a ground potential when the wipers of the connector come to rest on the bank contacts of the called line, and when relay 311 falls back the circuit of rotary magnet 319 and its own circuit is opened at the lower contacts of the relay, thereby preventing further rotary movement of the connector in the case of further operation of the calling device at the calling substation. It will be noted that relay 310 is now locked energized from conductor 370 through its own inner upper armature, and the rotary-magnet interrupter contacts 321. It is to be noted further that it is unnecessary to have the locking circuit of relay 310 controlled by relay 311 to prevent relay 310 from locking up during the rotary movement, as is ordinarily done, because, in this case, the rotary magnet 319 opens the circuit of relay 310 on each step of the wipers. With busy relay 310 energized, a ground potential is extended from the grounded conductor 370 by way of the upper contacts of relays 311, 310 and 308 to the junction of the winding of relay 368 and the associated resistance, by way of the upper contacts of interrupter relay 365. As a result, relay 368 is intermittently short-circuited, as relay 365 pulls up and falls back, causing it to give forth an intermittent buzzing sound instead of a continuous buzzing sound heretofore given. This intermittent buzzing sound is recognized by the calling subscriber as the busy signal. Upon hearing this signal, the calling subscriber replaces his receiver, permitting relays 305, 306, 307, and 310 to fall back, and resulting in the release of the connector and of the calling lineswitch LS1. In this case the master switch does not advance and in the next call takes the same trunk.

#### *Called line idle*

Assuming now that the desired line is idle when called busy relay 310 is not energized at the end of the rotary movement and relay 312 is operated instead, when relay 311 falls back and connects the upper winding of relay 312 to wiper 323. The circuit of relay 312 extends from the grounded conductor 370 by way of the contacts of relay 310 to the upper winding of relay 312, and thence by way of contacts of relays 311 and 312 to test wiper 323. The circuit is completed to battery through the cut-off winding of the called line-switch, which winding is similar to the winding 204 of the lineswitch LS1. The energization of this winding results in the operation of the cut-off armature, corresponding to armature 206, clearing the called line of its attachments. Relay 312 operates over this circuit and at its inner lower armature locks itself to conductor 370, at the same time removing the operating potential from the tone relay 368, whereupon the buzzing operation of relay 368 ceases and the application of the buzzing tone to the lower talking conductor no longer takes place. As a further result of its operation, relay 312 disconnects the rotary magnet 319; at its inner upper armature it disconnects test wiper 323 from its own upper winding and connects it directly to ground so as to maintain the cut-off winding of the called line switch operated; and at its upper and lower contacts it connects up the wipers 322 and 325 to the ringing circuit. The lower wiper is connected to the ringing lead 363, and the upper wiper is connected to the upper winding of ring-cut-off relay 309. The application of ringing current to the called line is accomplished in a way which will now be explained.

#### *Operation of timing switch*

It was mentioned hereinbefore that the timing apparatus, including the 12-position rotary switch, is started when start relay 367 operates from conductor 370 through contacts of relay 311 and cam 355 when the switch is seized. When it operates, relay 367 locks itself to conductor 360 at its inner lower armature, and at its upper armature it starts interrupter relays 366 and 365 operating. Relay 366 closes a circuit for relay 365. Relay 365 operates and short-circuits relay 366, which relay then falls back, short-circuiting and open-circuiting relay 365. Relay 365 falls back and removes the short circuit from around relay 366, allowing relay 366 to reoperate. This operation keeps up as long as relay 367 is operated. The operation is slowed down and is steadied by the copper collars on the armature ends of the cores of the relays, which are thereby rendered slow to operate and slow to release.

Each time relay 365 operates it closes a cir-

cuit from the grounded conductor 360 for magnet 350. Each time magnet 350 falls back, after pulling up over this circuit, it advances the ratchet device one step, each step representing a separate one of the twelve positions. The pulses are delivered at a rate of about two per second.

The device is started when the connector is seized so that the connector may be restored to common use at the end of about four and one-half seconds in case the second digit has not been dialled in the meantime. Such action results from the operation of ring-cut-off relay 309 through cam 354 in position 9 of the device and in a manner to be brought out hereinafter.

Now, when relay 311 responds to the second and last series of impulses in the number, during the rotary movement of connector and just prior to the test which results in the finding of the line idle and the operation of relay 312 just described, it removes ground at its upper armature from the interrupter start conductor 360, whereupon start relay 367 falls back and closes a restoring circuit for the timing switch by closing a circuit for the stepping relay 364 through cam 352 (positions 2 to 12) and the interrupter contacts 351 of magnet 350. Relay 364 operates and closes at its lower armature a circuit for magnet 350, whereupon this magnet operates and opens the circuit of the stepping relay. The stepping relay falls back and permits the deenergization of the magnet, resulting in the advance of the timing switch one step. When the magnet deenergizes the circuit of relay 364 is reestablished. The relay and the magnet operate alternately in this manner until the restoring circuit is opened, when the switch passes beyond position 12 and arrives in position 1. It will be noted that start relay 367 cannot reoperate to open the restoring circuit until the switch arrives in position 1, owing to the fact that start relay 367, on falling back, opens its locking circuit. When start relay 367 reoperates, either responsive to the timing switch arriving in its position 1 or to the falling back of relay 311 at the end of the second digit, whichever takes place last, the interrupter relays 365 and 366 start driving the timing magnet 350 again. Now, while the timing switch is still in position 1, ringing current from the secondary winding of the ringing interrupter is placed on ringing lead 363, projecting ringing current out over the calling line over the lower contacts of relays 309 and 312, which ringing current returns by way of the upper line conductor, wiper 322, and the upper contacts of relay 312 and 309 to battery by way of the upper winding of relay 309. The slow-acting ring-cut-off relay 309 is not operated by this ringing current, as no flow of direct current takes place due to the inclusion of the usual condenser in the ringing circuit.

The ringing circuit is opened at cam 356 and lead 363 is grounded directly while the timing switch is in position 2, but in positions 3 to 6 the ringing circuit is closed again and a further and longer application of ringing current takes place. The ringing current is applied in this manner so that the particular telephone which is ringing may be readily located when several telephones are mounted close together. The short preliminary ring calls attention to the call and the long ring occurring shortly after enables the correct telephone to be located.

A portion of the ringing current flows back to the calling line through the small condenser 384, informing the calling subscriber of the ringing operation.

The ring-cut-off relay 309 may be operated over the called line in case the called subscriber responds after the connection has been completed by the switching relay 312. When operated in this way, relay 309 operates through its upper winding over the called line and locks itself to conductor 370 at its inner lower armature. If relay 309 is not so operated, it is operated automatically by the timing device when it arrives in position 5. The circuit at this time is from ground by way of the inner lower armature, operated, of relay 312, cam 353 of the timing device, conductor 359, and the lower winding of relays 309 to battery. Upon operating, relay 309 locks itself to conductor 370 at its inner lower armature; opens a point in the master-switch-start circuit at its third armature from the bottom; disconnects the upper and lower wipers at its upper and lower armatures; thereby stopping the flow of current to the called line; and at one of its lower armatures it places ground on conductor 224, thereby operating relay 304 to open a further point in the ground-supply connection to relay 201 (Fig. 2), and placing ground on the pull-down wiper 324, closing a circuit through the bank contact on which wiper 324 is standing for the pull-down winding of the called lineswitch, similar to winding 205 of the lineswitch LS1. When this occurs, the lineswitch on the called line operates and connects the called line with the same trunk line with which the calling line is connected, because the master switch is still standing in the same position. As soon as the lineswitch on the called line operates, its upper winding is energized in parallel with winding 204 of the lineswitch LS1 from conductor 227 of the trunk, which winding serves to maintain the lineswitch operated after the current flow through the pull-down winding has ceased.

As a further result of the operation of relay 309, it closes at its inner upper armature a circuit from ground through the upper armature of relay 306, through the upper armature of relay 301, the "30" and "00" cam springs,

and over cut-off conductor 222 and the corresponding wiper of the master switch for operating the cut-off and battery-feed relays 218 and 217 of the trunk line over which the connection has been completed. Relay 218 operates when this circuit is closed and locks itself at its inner upper armature to the grounded conductor 227, at the same time opening its initial circuit; it disconnects conductor 226, 228, and 229 of the trunk line from the corresponding conductors 219, 220, and 221 of the connector at its upper and at its two lower armatures; and at its middle upper armature it extends the ground potential to the upper winding of battery-feed relay 217. This relay is marginally adjusted and does not operate if the resistance 320 (Fig. 3) is included in its circuit. Resistance 320 is, however, short-circuited at this time at the associated contacts, with the result that relay 217 operates and locks itself to trunk conductors 226 and 229 at its upper and lower armatures, at the same time opening its initial circuit. Relay 217 now remains energized over the calling and called lines in multiple, supplying talking current to the transmitters through its windings. At its inner upper armature, relay 217 places a multiple ground connection on the holding conductor 227 so as to maintain both lineswitches operated and so as to maintain a busy test potential on the corresponding contact in the bank of the test wiper of the master switch.

The two subscribers may now converse with each other over their respective lines and through conductors 226 and 229 of the trunk line.

#### Connector release

In the connector, line relay 305 falls back when the trunk line is disconnected from the connector by relay 218, and relay 306 falls back shortly thereafter, opening the circuit of relay 307, whereupon relay 307 falls back. The falling back of relay 306 removes ground at its upper armature from cut-off conductor 222 and the falling back of relay 307 removes ground at one point from release trunk conductor 223, leaving the lineswitches held up solely from the ground potential supplied from the conductor 227 of the trunk at the inner upper armature of relay 217. At its upper armature, relay 307 prepares to replace ground on the pull-down conductor 202 (Fig. 2), at the same time removing ground from the locking and start conductor 370, stopping the operation of the ringing interrupter and the relays associated with the timing switch and resulting in the deenergization of relays 309 and 312. Start relay 367 of the timing switch now falls back and causes this switch to be restored to its normal position in the manner above pointed out.

With relays 307 and 309 deenergized, re-

lease trunk conductor 223 is connected through contacts of these relays to the master switch start conductor 225, with the result that the ground potential encountered by the test wiper of the master switch, on the test contact associated with conductor 227 of the trunk line, energizes the start relay of the master switch to cause the master switch to preselect another trunk line, as will be later explained.

Responsive to the deenergization of relay 306 of the connector, release magnet 318 operates through the associated off-normal contacts 316 and contacts of relay 305 and 306 and restores the connector to its normal position in the usual manner. The release magnet circuit is opened at off-normal contacts 316 when the normal position of the switch is attained.

#### Release of connection

When the conversation is terminated, the two subscribers replace their receivers, whereupon battery-feed relay 217 falls back and disconnects itself from the trunk line, at the same time removing ground from the conductor 227, whereupon relay 218 falls back and the bridge-cut-off windings of the lineswitch LS1 and of the called lineswitch both deenergize, whereupon the lineswitches restore and, due to their self-aligning plungers, come immediately to the control of the master switch opposite the instant preselected trunk. The connection is now released and the apparatus is in readiness for use in completing subsequent connections.

#### Master switch operation

The master switch is of the usual mechanical design and advances to preselect trunks under power supplied by the so-called U-spring shown just below the solenoid of the master switch. The master switch is shown in the position occupied just after the solenoid has operated to align the plungers opposite the tenth trunk line, which is the trunk line shown in the drawings. Now, when the start relay is operated through the test wiper and over conductors 223 and 225, the ground-control conductor 224 is grounded at the upper armature of the start relay so as to maintain the relay 304 of the connector operated during the master switch operation, and at the lower armature of the start relay a circuit is closed for the locking relay, whereupon the locking relay operates and makes a further ground connection to conductor 224 and unlocks the associated segment, permitting the U-spring to advance the master switch to the next trunk line. If the next trunk line is idle, the start relay falls back immediately, followed by the locking relay, stopping the master switch on the trunk. If, however, the trunk line is busy instead of idle, the test wiper of the master switch encounters a

ground potential on the test contact of the trunk line and the start relay is maintained operated, and the advance of the master switch continues.

5 When an idle trunk line is found, start and lock relays fall back, stopping the master switch on this trunk. With the start and lock relays both deenergized and with ring-cut-off relay 309 of the connector deenergized  
10 responsive to the preceding release of the connector, the circuit of relay 304 is opened and this relay falls back, reconnecting ground to the pull-down conductor 202 (Fig. 2) through the delay relay 201. The apparatus remains in this position until another  
15 call is made.

Assuming now that the master switch has advanced step by step until it is now standing on the first trunk line, and that a connection is set up involving this trunk line, the start relay operates in the heretofore described manner upon the release of the connector after the connection has been set up. At this time, the trip relay energizes in multiple with the locking relay through the associated finger-controlled contacts, held in engagement by the upper finger of the master switch. Upon energizing, the trip relay locks the locking magnet to ground at its  
20 right-hand contacts, and at its inner contacts it closes a circuit for the solenoid of the master switch, causing the master switch to be operated in a clockwise direction. The circuit of the trip relay is opened as soon as  
25 the master switch starts to move, but the springs remain mechanically locked in their operated position by the locking spring controlled by the lower finger of the master switch, which is now out of engagement with  
30 such locking spring.

When the master switch reaches the position shown in the drawings, the lower finger of the master switch unlocks the mechanically-locked springs of the trip relay, permitting them to open the locking relay and master switch operating circuit. If this trunk is idle at this time, the start relay is not operated and the locking magnet falls  
35 back.

#### *Outgoing calls*

It will be assumed now that the subscriber at substation A desires to converse with a subscriber whose line terminates in the main  
40 exchange. The procedure is for the calling subscriber to remove his receiver and dial the number of the desired main-exchange line, preceded by the digit 0 which is necessary to extend his line to a trunk line  
45 leading to the main exchange.

When the receiver is removed, the line-switch LS1 operates in the heretofore described manner and seizes a trunk line, the one shown in the drawings and comprising  
50 conductors 226—229, for example. When

this occurs, the connector and other apparatus shown in Fig. 3 respond as hereinbefore described.

When the calling subscriber dials the preliminary digit 0, ten impulses of current are delivered to vertical magnet 317, whereupon the wipers 322—325 are raised step by step until they come to rest opposite the tenth level of bank contacts. When the switch shaft carries the wipers up to the tenth level (the "0" level), the "0"-level shaft springs 313 are closed, operating relay 303 from the grounded condenser 220 by way of contacts of relays 303 and 301 and the "0"-level contacts 313. Conductor 220 is grounded by way of conductor 228 and the corresponding contacts of the lineswitch LS1. Relay 303 operates and at its middle upper armature removes the short circuit from around the winding of relay 301 and extends the grounded conductor 220 by way of the eleventh-rotary-step spring 314 and its right-hand contact, inner upper armature, operated, of the relay 308, and the interrupter contacts 321 to stepping relay 310. This circuit is completed just at the end of the last vertical step and while the slow-acting relay 308 is still energized in multiple with vertical magnet 317. Stepping relay 310 operates over this circuit and locks itself to conductor 370 at its inner upper armature, at the same time preparing a circuit for rotary magnet 319 at its lower armature. Relay 301 energizes in series with relay 303 responsive to the removal of the short circuit from around relay 301 by relay 303, and removes the shunt from around resistance 320 in the cut-off lead. Incidentally, relay 301 locks itself at its inner upper armature to battery through the inner upper contacts of relay 306 and the associated resistance, thereby shunting this resistance around relay 303, but this operation has no particular effect at this time.

When the slow-acting relay 308 falls back, it opens the initial circuit of relay 310 at its inner upper armature and completes the circuit of the rotary magnet through the lower armatures of relays 310 and 312. Relay 310 remains locked up at its inner upper armature to conductor 370 so as to maintain the rotary magnet circuit closed. Responsive to the energization of the rotary magnet 319, the wipers 322—325 are rotated into engagement with the first set of bank contacts in the tenth level. Relay 311 is energized in parallel with the rotary magnet and transfers test wiper 323 to the circuit of stepping relay 310 at its inner upper armature. Near the end of its stroke, rotary magnet 319, at contacts 321, opens the circuit of relay 310, whereupon relay 310 falls back and opens the rotary magnet circuit, causing the rotary magnet to fall back and close contacts 321 again.

If the trunk line terminating in the first

set of contacts in the tenth level is busy, ground potential is encountered on the tenth contact of said trunk line by wiper 323, operating the stepping relay 310 again. Relay 310 again operates magnet 319, causing the wipers to take another step. This alternate operation is repeated as long as the wiper 323 engages busy contacts, and if all the trunk lines are busy the operation continues until the wipers have been advanced to the eleventh-rotary-step position, operating spring 314, which opens a point in the rotary magnet circuit and connects the grounded spring to the circuit of relay 310 through contacts 321, maintaining relay 310 operated so as to send back the interrupted busy signal from the tone relay 368 after relay 311 falls back, as hereinbefore described. The eleventh-rotary-step contacts above and slightly to the left of relay 301 operate to shunt resistance 320 so that the battery-feed relay of the trunk line may operate over conductor 222 in case the calling subscriber does not hang up, but waits until after the switch-through operation occurs responsive to the above-described operation of ring-cut-off relay 309 in position 5 of the timing switch.

Assuming now that the trunk line extending from the "0"-level bank contacts shown in the drawings through terminals 256—257 to the lineswitch LS2 is found to be idle, wiper 323 does not encounter ground potential on the corresponding contact thereof and relay 310 does not energize again after the wipers have come to rest on the contact set. In this case, the deenergization of the slow-acting multiply relay 311 is followed by the energization of relay 312 through its upper winding, over the conductor extending through terminal 256 and the correspondingly numbered terminal of Fig. 2, conductor 127, and the busy lamp shown in Fig. 1 to battery. The busy lamp becomes lighted and relay 312 operates, performing the functions described hereinbefore. With relay 303 operated, the closing of the locking circuit for the lower winding of relay 312 closes a multiple circuit for the lower winding of relay 309 through the upper contacts of relay 303. Relay 309 thereupon operates and performs the functions hereinbefore described including the grounding of the pull-down wiper 324 to cause the lineswitch on the called trunk to operate and grounding the cut-off lead 222 at its inner upper armature.

When wiper 324 is grounded, a circuit is closed through terminal 257 for the pull-down winding 211 of the lineswitch LS2, operating the lineswitch to disconnect the line relay 209 and to make connection with the trunk line comprising conductors 226—229. The springs of the plunger arms 212 connect up the grounded B. C. O. (bridge-cut-off) conductor 126 to the B. C. O. winding 210 so as to hold the lineswitch operated. When

ground is placed on conductor 222, it is obtained through the resistance 320 on account of the fact that relay 301 is now energized, and, although relay 218 of the trunk is able to energize and lock itself to conductor 227, the marginally adjusted line relay 217 does not energize when the operating conductor is extended to it because of the presence of the resistance 320 in series with the conductor. Consequently, the battery feed is not connected up locally and the calling subscriber is thereby enabled to operate the switches in the main exchange directly by his calling device, as will be subsequently pointed out.

With the lineswitches LS1 and LS2 both operated, the bridge of substation A across the line thereof is effective in producing a current flow over conductors 125 and 129 (associated with the lineswitch LS2) and through the local trunk line conductors 226 and 229. Conductor 129 is connected to ground in the trunk circuit TC through contacts of relays 116 and 117, and conductor 125 is connected to battery in the main exchange through contacts of relay 117 in the trunk circuit TC, relay 114 of the trunk circuit TC, contacts of switching relay 102 of the lineswitch LS at the main exchange, and line relay 101. Series relay 114 operates in this connection in series with line relay 101 and closes a circuit for release relay 115, whereupon relay 115 places a ground potential on release trunk conductor 127 so as to maintain the inter-exchange trunk line busy to the connector. A branch connection exists through the upper contacts of relays 119 and 120 to the B. C. O. conductor 126, holding ground being thereby extended through contacts of the lineswitch LS2 to the release conductor 227 of the local trunks, maintaining relay 218 of the trunk and the winding 204 of the lineswitch LS1 operated. This operation of relay 115 occurs, of course, before the release of the connector, initiated by the action of relay 218 in disconnecting the talking conductors of the trunk line from conductors 219 and 221, takes place.

Relay 116 operates over the lower talking conductor and through its own contacts and those of relay 115, and locks itself to ground locally, at the same time switching the lower talking conductor through and removing ground from the right-hand section thereof.

In the main exchange, the operation of line relay 101 results in an idle trunk being selected in the usual manner by the lineswitch LS, this lineswitch being operated by the self-interrupting magnet 103 under the control of test wiper 105. When an idle trunk line is reached, relay 102, which is short-circuited by the ground potential encountered by wiper 105 during the operation of the lineswitch, is no longer short-circuited and energizes in series with the relatively low resistance magnet and switches the connection through to

the wipers 104—106. Line relay 101 is disconnected, and the connection is extended through the line relay of the associated selector, which operates the associated release relay to ground the release trunk conductor of the selector, thereby closing a holding circuit for relay 102 before the slow-acting relay 101 has had time to fall back.

In the branch exchange, the master switch is caused to advance in the hereinbefore-described manner when relays 307 and 309 have both fallen back, and another idle trunk line is preselected, leaving the connection established from the line of substation A to the main exchange through the lineswitches LS1 and LS2 and the trunk line TL.

The subscriber at substation A now dials the various listed digits in the number of the desired subscriber, whereupon the main exchange switching mechanism operates to complete the connection in the usual manner.

When the subscriber at substation A replaces his receiver after conversation, the main exchange connection is released in the usual manner and the series line relay 114 in the trunk circuit TC falls back and opens the circuit of release relay 115. Release relay 115 falls back after a slight interval and removes ground from conductor 127, whereupon the line switches LS1 and LS2 release and cut-off relay 218 falls back.

*Attempted main exchange call from restricted line*

It will now be assumed that a local subscriber who is not entitled to make main exchange calls attempts to make a call to the main exchange. For the purpose of explanation it will be convenient to assume that the line of substation A is changed from the unrestricted to the restricted class by removing the jumper associated with the lineswitch spring which contacts with the bank contact connected with discriminating conductor 228. In this case conductor 228 is not grounded when the lineswitch LS1 is operated upon the removal of the receiver and conductor 220 of the connector is therefore not grounded. Now when the digit 0 is dialled, relays 301 and 303 operate in series through contacts 313, and relay 303 extends conductor 220 through contacts of the still-operated slow-acting relay 308 and interrupter contacts 321 to stepping relay 310. Relay 303 places a ground potential on conductor 220 from the grounded conductor 223 through resistance 302 so as to operate relay 310. Relay 310 operates through resistance 302 and locks itself to conductor 370. Then, when relay 308 falls back to start the rotary movement, it transfers conductor 220, at its upper armature, to the rotary magnet 319 through contacts of relays 310 and 312. Rotary magnet 319, however, will not operate through resistance 302, and relay 310 remains

operated, giving the calling subscriber a busy signal in the hereinbefore described manner. The connector is released by the calling subscriber or by the timing device in case the calling subscriber does not hang up.

*Incoming call from main exchange*

Assume that the trunk line TL is seized in the main exchange over conductors 107—109 by a connector switch of the usual type.

When this is done, the connector places ground on private-normal conductor 108, operating relay 102 sufficiently to cause its upper armature springs to move out of engagement with their resting contacts, but the relay does not operate sufficiently to cause the wipers to be connected up owing to the usual mechanical interlocking arrangement (not shown) between the armature of relay 101 and the armature of relay 102.

Make-busy relay 111, which is bridged across the trunk-line conductors through contacts of relay 115 and in series with the high resistance 110, energizes from the battery potential superimposed on the ringing circuit (not shown), so as to make the trunk line busy in the branch exchange by grounding conductor 127, no matter whether the connection is made to the trunk line during the ringing period or during the silent period. The high resistance 110 limits the current flow to such a value that the ring-cut-off relay (not shown) will not operate.

When ringing current is sent over the talking conductors of the trunk line TL by the connector, it operates the ring-up relay 112 of trunk circuit TC, whose lower winding is bridged across these conductors through the associated condenser, lower contacts of relay 112, and the lower contacts of release relay 115. Upon operating, relay 112, at its upper armature, closes a locking circuit for itself through contacts of relay 118. At its lower armature, it removes its lower winding from in bridge of the talking conductors, and, at its inner lower armature, it operates relay 113, which makes a second ground connection to conductor 127. The second connection to conductor 127, at the upper contacts of relay 113, is of utility during the ringing period, as it maintains conductor 127 grounded uninterruptedly, even though relay 111 flutters responsive to the ringing current.

As a further result of its operation, relay 113 closes a circuit for the call lamp at the attendant's switchboard at its inner upper armature through contacts of relay 118, and at its lower armature it makes certain circuit changes so that the ring-cut-off operation to be later performed in the calling connector will be controlled over a loop circuit without any local grounded connections to the talking conductors.

When the attendant notes the lighted con-

dition of the call lamp shown below the trunk circuit TC, she removes the receiver from the attendant's telephone, Fig. 4, which is common to a number of trunk circuits such as TC, thereby supplying a ground potential through relay 401 to conductor 137 and through contacts of the relay to pick up conductor 136. The talking circuit of the telephone is bridged across the associated talking conductors. The operator now throws the combined release and connect key, individual to the trunk circuit TC into connect position, thereby extending ground from pick-up conductor 136 to the lower winding of connecting relay 117. Relay 117 operates and locks itself through its upper winding and through the inner upper contacts of relay 120 to the common holding conductor 137. Guard relay 401, Fig. 4, now operates in series with the upper winding of relay 117, Fig. 1, and disconnects ground from pick-up conductor 136, thereby preventing the operator from operating another connecting relay such as 117 until such time as the operator disconnects by hanging up her receiver or releases the connection by throwing the combined release and connect key into release position.

The operator restores the key after she has operated it momentarily, leaving relay 117 locked up as above mentioned. With relay 117 operated, it will be noted that the talking circuit is split and that conductors 125 and 129 extending to the lineswitch LS1 are connected to common conductors 133 and 134, and that the main-exchange talking conductors are connected at the upper and lower armatures of the relay to common conductors 130 and 131. Relay 113 being operated at this time, conductor 131 is joined to the lower main-exchange talking conductor through the lower armature of relay 117 and the lower armature, operated, of relay 113.

Upon reference to Fig. 4, it will be noted that the common talking conductors 130 and 131 are joined through contacts of the dial key to conductors 133 and 134 and that the joined talking conductors are bridged by the impedance 402 and by the talking bridge of the attendant's telephone. The usual ring-cut-off operation is now performed in the calling connector responsive to current over the upper talking conductor through relay 114, through impedance 402 and the attendant's telephone in parallel, and back over the lower talking conductor. At the same time, the usual ring-cut-off relay of the seizing connector responds so as to disconnect. The usual talking-current-supply connections are substituted for the ringing connections.

Relays 114, 115, and 116 pull up one after the other (as in the hereinbefore-described outgoing call) as relay 114 receives current in series with the left-hand section of the upper talking conductor.

As a further result of the operation of connecting relay 117, it operates holding relay 118 at its inner lower armature, whereupon relay 118 operates and locks itself at its inner lower armature through the lower contacts of release relay 120. At armature 141, relay 118 prepares a circuit for line relay 209 of the lineswitch LS2; it prepares a circuit for the supervisory lamp of the trunk circuit at its upper armature; and it extinguishes the call lamp at its inner upper armature by removing the shunt from around the resistance associated with armature 122 of the operated connect relay 117.

Having caused her position equipment to be connected with the trunk circuit TC in the above manner, the operator learns the desired number from the calling subscriber and then throws her dial-in key, shown in Fig. 4, thereby disconnecting the impedance 402 and the extended main exchange talking conductors 130 and 131 from the extended branch exchange talking conductors 133 and 134, leaving her telephone bridged across conductors 133 and 134. At the upper contacts of the key, ground is placed on conductor 132, closing a circuit through armature 141 of relay 118, lower contacts of relay 119, conductor 128, and the lineswitch cut-off contacts for line relay 209. Relay 209 pulls up and operates the lineswitch to seize a trunk line, the trunk line comprising conductors 226—229 for example. Responsive to the operation of the lineswitch, the B. C. O. winding 210 is energized as a holding winding through the associated contacts of the lineswitch from the ground potential placed on conductor 126 in the trunk circuit TC through the upper contacts of relays 119 and 120 from the grounded conductor 127. As a further result of the operation of the lineswitch, the grounded conductor 126 is extended through the bank of the lineswitch to release trunk conductor 227, thereby making the trunk busy in the master switch bank and closing a circuit over conductor 223 and contacts of relays 307 and 309 of the connector for the start relay of the master switch over conductor 225. The start relay, being stiffly adjusted as in common practice, does not operate at this time owing to the fact that its circuit is shortly opened at the contacts of relay 307 which energizes responsive to the operation of relay 306 on account of line relay 305 energizing over conductors 219 and 221 through the attendant's telephone which is now connected to the incoming talking conductors 125 and 129 as above pointed out. In case difficulty is experienced in preventing the start relay from energizing, its circuit may be altered to include an added pair of normally closed contacts on delay relay 201.

The operator now dials the digits in the desired number, whereupon the conductor is set on the line of the called subscriber, the

line of substation A for example, in which case the substation A is signalled by ringing current, after which the lineswitch LS1 is operated through wiper 324 of the connector and through terminal 253 when the ring-cut-off relay 309 operates. Ground is placed on cut-off conductor 222 at the inner upper contacts of ring-cut-off relay 309 to operate relay 218, Fig. 2, through the cut-off wiper of the master switch, but battery-feed relay 217 is not operated at this time owing to the fact that the resistance 320 is inserted into the circuit owing to the previous operation of relay 301 over conductor 220 from the battery connection supplied at the contacts of the lineswitch LS2 for that purpose. Relay 301 is locked at this time through its own contact and the inner upper contacts of relay 306 to the associated resistance, and its initial circuit is opened. The result of this is that the battery supply for talking purposes comes to the called substation A from the main exchange rather than from the branch exchange, this being in accordance with well-established practice.

In case the operator, during the setting up of a local connection, discovers that she has made a mistake in dialling, or, for any other reason, wishes to release the connector and start over again, she presses the release-in key, Fig. 4, opening the line circuit at the lower contacts of the key and grounding conductor 135 at the upper contacts of the key so as to operate the release-in relay 119, Fig. 1, through armature 123 of relay 117. Relay 119 disconnects ground from the lineswitch private normal conductor 126 at its upper armature and opens a point in the line relay circuit at its lower armature. When the key is released, the restored lineswitch reoperates and the connector is prepared for operation as hereinbefore explained.

Having dialled the local number, the operator restores the dial-in key, reconnecting the two sections of the talking circuit together so that the subscribers may converse.

After listening in, either before or after restoring the dial-in key, to make sure that the desired subscriber has responded, the operator replaces the receiver on her telephone, opening the locking circuit of the upper winding of connecting relay 117 of the trunk circuit TC. Relay 117 falls back and connects the two talking sections together and disconnects the operator's talking conductors. At its armature 122, relay 117 opens the circuit of relay 112, whereupon relays 112 and 113 fall back.

Relay 111 is now bridged across the talking conductors through contacts of the operated relay 118 and contacts of the non-operated relays 117 and 113 so as to hold the condition of answered supervision in the main exchange after the branch-exchange subscriber hangs up. This bridge is effective, in case

the operator hangs up right after dialling, to hold the connector in the branch exchange operated until it is released responsive to the operation of the timing device or to the response of the called subscriber. Relay 118 remains locked up through its own inner lower contacts and the lower contacts of relay 120.

When the called subscriber replaces his receiver at the end of the conversation, line relay 114 falls back and opens the circuit of release relay 115, which relay falls back and lights the supervisory lamp through contacts of relay 118. When the calling subscriber hangs up, the connector in use releases (unless it is of the release-by-last-party type), permitting relay 102 to restore and connect up line relay 101 of the lineswitch. Line relay 101 does not operate at this time, even though relay 111 is bridged across the talking conductor of the trunk line owing to the fact that there is no operating ground potential connected to the lower trunk line conductor.

When the operator notes the lighted condition of the supervisory lamp, she throws her release-connect key in release position, operating relay 120, bringing about the release of relay 118. The lineswitches LS2 and LS1 release and relay 218 falls back responsive to the removal of ground potential from the conductor 126 at the upper contact of relay 120.

The entire connection is now released and the apparatus involved therein is in readiness to be used in setting up further connections.

#### *Setting up a tail-to-tail connection*

It will now be assumed that the subscriber at substation A desires to converse with a main-exchange subscriber and that he wishes the attendant to set up the connection and notify him when it is ready. In order to get in touch with the attendant, the subscriber at substation A dials the number assigned to one or the other of the "information" trunks, Fig. 4, whereupon the lineswitch associated with such trunk is caused to operate to connect such trunk with the calling line. Assuming that the number of information trunk #1 is dialled, and that this trunk is idle at the time and is accordingly seized, the call lamp associated therewith is operated over the private normal conductor in parallel with the bridge-cut-off winding of the lineswitch, corresponding to winding 204 of the lineswitch LS1.

Upon noting the lighted condition of the call lamp, the operator responds by momentarily operating the answering key associated with relay 403, whereupon relay 403 operates through the switchhook contacts of the attendant telephone and through contacts of relay 401 and locks itself in series with the said relay. Relay 403 disconnects the private normal conductor from the call lamp and connects it to ground instead, although the

latter is not essential as the connection is being held up by the battery-feed relay of the trunk in use, corresponding to battery-feed relay 217, Fig. 2. At its upper and lower contacts, relay 403 connects the conductors of the information trunk to the operator's talking circuit, enabling the attendant to converse with the calling subscriber. Upon being informed as to the calling subscriber's desires, the operator replaces the receiver on the associated telephone, whereupon relay 403 falls back. The connection set up from the line of substation A is released when the calling subscriber hangs up.

In order to complete the connection to the desired main-exchange subscriber, the operator removes the receiver from her telephone and observes the busy lamps associated with the various trunk circuits such as the trunk circuit TC, and throws the connect key of an idle one, the one of trunk circuit TC for example, whereupon relays 117 and 118 operate as before described, and relay 117 connects the two sections, respectively, of the trunk to the operator's set over conductors 130 and 131, and conductors 133 and 134. When the bridge across conductors 130 and 131 is placed across the trunk conductors extending to the main exchange, there is a ground potential encountered by conductor 131 through contacts of the operated relay 117, and contacts of the unoperated relays 113 and 116. This ground potential is transmitted over conductor 131 and through impedance 402, Fig. 4, to the upper trunk conductor over conductor 130, to operate the line relay 101 of the lineswitch LS in the main exchange. Relays 114 and 115 are operated, as before. When an adle selector is seized by the lineswitch LS, ground potential through the lower winding of the line relay of the selector is placed on the lower talking conductor of the trunk line TL operating relay 116 through its own inner lower contacts, contacts of relay 113, and armature 142 of relay 118. Upon operating, relay 116 locks itself energized independent of the lower talking conductor and joins the lower talking conductor of the trunk line TL to the lower left-hand talking conductor 129, at the same time removing the local ground connection from the lower talking conductor.

In order to be able to operate the main-exchange switches to set up the connection to the called line, the operator throws her dial-out key, connecting conductors 130 and 131 to her telephone and disconnecting conductors 133 and 134 therefrom. Following this, the attendant manipulates the calling device on her telephone in accordance with the digits in the desired number, causing the connection to be set up to the desired line in the usual manner. Assuming that the called line is idle and that the subscriber responds to the call, the attendant in-

forms him that the subscriber at substation A desired to converse with him and requests him to wait a moment while she completes the connection.

The operator thereupon releases her dial-out key, throws her dial-in key, causing the lineswitch LS2 to operate in the manner described heretofore, and dials the number of the subscriber at substation A, whereupon the connection is extended to his line in the manner hereinbefore described. It will be noted that the impedance winding 402 associated with the dial key, Fig. 4, is placed across conductors 130 and 131 so as to hold the main-exchange connection while the operator is dialling the local number of the subscriber at substation A.

From this point on, the connection is handled in the manner described hereinbefore in connection with the description of the handling of an incoming call.

#### *The code call equipment*

In explanation of the code call equipment shown in Fig. 5, it may be pointed out that in a private establishment it often happens that there are a number of employees who are called quite frequently and whose work causes them to be often away from their telephones. In order to transmit the calls to such persons, the code call arrangement has been devised. It will now be described how the code call arrangement operates in the present system.

Assuming now that a local subscriber has called, is unable to reach a code-assigned subscriber at his telephone, and that he desires to use the code call equipment, the calling subscriber removes his receiver and dials the code-call number 30, followed by the particular code digit assigned to the person in question. Assuming that the calling subscriber is the one at substation A, Fig. 2, the removal of the receiver results in the operation of lineswitch LS1 to seize a trunk line, the one shown in the drawing for example. The common connector shown in Fig. 3 is prepared for operation in the usual manner; is raised up with the third level of bank contacts when the first digit 3 is dialled; and is rotated into engagement with the tenth set of bank contacts in the third level, Fig. 5, when the second digit 0 is dialled. The contacts associated with resistance 320 and labelled "30" and "00" are separated at this time by the usual cam arrangement on the shaft of the switch, thereby inserting the associated resistance 320 into circuit with the switching conductor 222 so as to prevent the subsequent operation of the battery feed relay 217. Assuming that the code call number is idle at this time, switching relay 312 of the connector pulls up in the usual manner over test wiper 323 through the bridge-cut-off winding of the lineswitch LS4. Responsive to the

pulling up of relay 312 the usual locking circuit is closed for the lower winding thereof from conductor 370 and a parallel circuit is now closed for the lower winding of ring-cut-off relay 309 through the associated cam springs labelled "30" and "00". Relay 309 operates and places a ground potential on wiper 324 thereby closing a circuit through the said wiper and the bank contacts on which it is standing for the pull-down winding of the lineswitch LS4, operating the lineswitch LS4 to extend a connection to the same trunk line with which the lineswitch LS1 is connected. Cut-off relay 218, Fig. 2, is operated in the usual manner, but the marginal relay 217 is not operated owing to the fact that resistance 320 is inserted in circuit at this time by the associated cam springs as above pointed out.

Line relay 501 of the code selector now operates over the associated talking conductors and the corresponding conductors of the trunk line in use by the lineswitches LS4 and LS1 and over the line of substation A and closes a circuit for the associated release relay 502 which operates and places ground on the associated release trunk and private normal conductor so as to hold up the two lineswitches and cut-off relay 218. This ground potential is placed on this conductor prior to the removal of ground potential therefrom through wiper 323 of the connector. Relay 502 also prepares the code selector for operation at its lower armature.

When the calling subscriber dials the code digit assigned to the particular desired person, line relay 501 falls back a corresponding number of times and operates the rotary magnet of the code selector each time it falls back. Relay 503 operates in parallel with the rotary magnet when the first impulse is received, and, being slow-acting, remains operated through the series of impulses. When relay 503 falls back at the end of the digit it closes a circuit through contacts of relay 504 and through off-normal contacts O. N. for starting the motor of the code generator and for supplying a ground potential through the cam contacts of the generator to the various bank contacts. The motor now operates the cam contacts to generate their respective codes in the usual manner and the selected code is supplied through wiper 507 to the code bells through the contacts on which wiper 507 is standing.

Assuming that the person called fails to respond, the calling subscriber replaces his receiver whereupon line relay 501 falls back followed shortly by the deenergization of relay 502 to permit the release of the connection when it removes ground from the associated release-trunk conductor.

When the desired person hears his code being broadcast throughout the plant, he proceeds to the nearest telephone, and, after

removing the receiver and obtaining control of the connector in the usual manner through the operation of the lineswitch on the telephone in use, dials the code-answering number "39", whereupon the connector connects with the lineswitch LS3. The switching relay 312 of the connector is operated at this time in series with the B. C. O. winding of LS3, and connects up wipers 322 and 325, thereby applying ringing current to the line conductors of lineswitch LS3. Relay 504, Fig. 5, now energizes in series with ring-cut-off relay 309 of the connector, on account of having its lower winding bridged across the talking conductors, and closes a locking circuit for itself to the associated grounded conductor at its inner upper contacts, at the same time disconnecting its lower winding from in bridge of the talking conductors and removing ground from the start conductor of the code generator as well as operating the release magnet to restore the wiper 507 to normal. The circuit of the release magnet is opened at the off-normal contacts of the switch when the wiper 507 reaches its normal position.

In the connector, ring-cut-off relay 309 energizes at the same time that relay 504, Fig. 5, energizes and it locks itself at its inner lower armature and performs the functions hereinbefore described, including the grounding of the cut-off conductor 222 to cause the cut-off and battery-feed relays of the trunk in use, corresponding to relays 218 and 217, Fig. 2, to operate to isolate the trunk and to connect up a source of transmitter-supply current.

The conversation now takes place between the line of substation A and the line used by the called subscriber in answering the code call, the switching apparatus included in the connection being the lineswitch LS1 which is plunged in on the trunk comprising conductors 226—229, the lineswitch LS4 which is plunged on the same trunk, the lineswitch LS3, and the lineswitch of the answering line, which is plunged in on the same trunk as the lineswitch LS3.

After the conversation is over, the lineswitch LS3 and the lineswitch of the answering line are both released when the answering subscriber replaces his receiver allowing the battery-feed and holding relay corresponding to relay 217, Fig. 2, to fall back and unground the associated release trunk conductor.

When the subscriber at substation A replaces his receiver, line relay 501, Fig. 5, falls back and again closes a circuit for the rotary magnet and relay 503 in parallel, at the same time opening the circuit of the slow-acting release relay 502. A moment later relay 502 falls back and opens the rotary-magnet circuit and closes the release-magnet circuit, whereupon the wiper 507 is restored

to its normal position. Relay 502 also ungrounds the associated release trunk conductor, permitting the lineswitches LS4 and LS1 to restore, and permitting the cut-off relay 218, Fig. 2, to fall back.

The branch exchange has been described hereinbefore as of one 100-line capacity. The circuits of the connector shown in Fig. 3, however, have been arranged so that they will function in connection with a modified bank arrangement when a private automatic exchange of this character is arranged for a capacity not to exceed fifty lines.

When the exchange is arranged to have an ultimate capacity of one hundred lines the connector of Fig. 3 is provided with a two-section bank similar to that of the connector switch shown in Fig. 169, page 213, of "Telephone Including Automatic Switching", by Smith, published by Frederick J. Drake Company, Chicago, Illinois. In the connector shown in Fig. 3 the upper bank section is a 200-contact section like the lower section in the publication referred to.

Now, when a private automatic exchange is installed in a situation wherein it is likely that the required capacity will never exceed fifty lines, a 200-contact bank of only one section may be installed, in which case the two wiper sets are adjusted closer together, so that when the bottom set is opposite the first bank level the top set is opposite the sixth level. The bottom wiper set uses the lower half of the bank while the upper wiper set uses the upper half of the bank.

In this case only five first digits are required and it is therefore convenient to assign the digits 2 to 6 rather than the digits 1 to 5, on account of the fact that the digit 1 is often undesirable owing to the danger of preliminary impulses and faulty line conditions giving the effect of the dialling of the digit 1 before the dialling operation starts, this condition being well known and generally understood. The wiper sets are therefore adjusted so that they will come opposite the levels 1 and 6 of the bank when the digit 2 is dialled and will not extend a connection to the talking conductors of any called line if raised only one step. The reason is that the wipers 322 and 325 of the connector are the wipers of the lower set and do not engage with any bank contacts, while the wipers 323 and 324 of the upper set engage with bank contacts in the fifth level, which is the upper level of the line contacts and are therefore not connected up, being left dead, as are the 0-level contacts of wipers 322 and 325 in Fig. 3.

In case the arrangement were used in connection with outgoing trunk lines that required the line contacts of the bank to be connected up, the wipers 322 and 325 would then be placed in the upper set and wipers 323 and 324 would form the lower set. In

this case, wiper 323 would not engage a bank contact when the first digit is "1" and switching relay 312 would not operate to connect up wipers 322 and 325.

For many years, it has been standard practice to assign the digit 0 to trunk lines outgoing from a private automatic exchange, for which reason it is desirable to assign the digit 0 even in the modified 50-line private automatic exchange above described, even though the dialling of the digit 6 is sufficient to cause the seizure of one of these trunk lines. In Fig. 3, it will be noted that the circuit of vertical magnet 317 includes contacts of relay 303 which is operated through the associated "0" level shaft springs 313. When the 100-line private automatic exchange is used, the lower contacts of relay 303 perform no useful function, but, when the private automatic exchange, modified as above outlined, is used, the springs 313 are arranged to operate when the shaft is raised six steps, whereupon relay 303 operates and opens the circuit of the vertical magnet thereby preventing the wipers from advancing above the outgoing trunk level.

What is claimed is:

1. In a telephone system wherein each of a plurality of lines is provided with a single individual line switch, trunk lines accessible to such line switches, means controlled over a calling line for causing the line switch individual to such calling line to seize an idle one of said trunk lines, and means including directive switching mechanism normally connected in multiple to each of said trunk lines controlled over the calling line for causing the line switch individual to a desired called line to complete a talking connection between the calling and the called lines by seizing the same trunk line previously seized by the line switch individual to the calling line.

2. In a telephone system wherein the line switches individual, respectively, to subscribers' lines are presided over by a single master switch and have access in common to a group of trunk lines, means controlled over any trunk line after such trunk line has been seized by a line switch of a calling line to complete a talking connection between such calling line and a desired called one of said lines by causing the line switch individual to said called line to seize the same trunk line previously seized by the line switch of the calling line.

3. In a telephone system wherein the line switches individual, respectively, to the lines entering the exchange are presided over by a common master switch which causes them all to normally preselect a single idle one of a plurality of trunk lines accessible thereto in common, means for maintaining the master switch and the idle line switches at rest when a line switch is operated over a calling line to seize the preselected trunk, and means con-

trolled over the calling line and the seized trunk line for completing a talking connection between the calling line and a desired called one of said lines by operating the line switch of the called line to seize the same trunk line.

4. In a telephone system wherein the line switches individual, respectively, to the lines entering the exchange are presided over by a common master switch which causes them all to normally preselect a single idle one of a plurality of trunk lines accessible thereto in common, means for maintaining the master switch and the idle line switches at rest when a line switch is operated over a calling line to seize the preselected trunk, means controlled over the calling line and the seized trunk line for completing a talking connection between the calling line and a desired called one of said lines by operating the line switch of the called line to seize the same trunk line, and means for thereupon operating the master switch to cause the remaining idle line switches to preselect another idle trunk line.

5. In a telephone system, a line having a line switch individual thereto, a plurality of trunk lines accessible to said line switch, and means for operating said line switch to seize a preselected idle one of said trunk lines to initiate a call outgoing from said line and for operating said line switch to seize a particular one of said trunk lines to complete a call incoming to said line.

6. In a telephone system wherein each line entering a central exchange is provided with a line switch individual thereto, a plurality of trunks accessible to said line switches in common, switching mechanism in the exchange, means for operating any line switch either over the line to which it is individual or through the said switching mechanism in the exchange to seize one of said trunk lines, and a master switch common to all said line switches for predetermining the trunk lines with which the line switches connect so that the lines of operated line switches are telephonically connected together in pairs.

7. In a telephone system wherein switching mechanism is provided for connecting any one of a number of subscribers' lines to any one of a plurality of trunk lines, an automatic connector switch having access to all said lines and normally in association with said trunk lines in common, means for operating said connector switch over a calling line and over one of said trunk lines to effect a connection between the calling line and another line through said trunk line and independent of the connector switch, and means for thereupon isolating said trunk line from said connector switch while leaving the other trunk lines in association therewith.

8. In a telephone system wherein a plurality of trunk lines may be connected by

switching mechanism to any one of a plurality of subscribers' lines, a single automatic connector switch normally connected to each of said trunk lines, means for operating said connector switch over a calling line and over one of said trunk lines to complete a connection, and means for thereupon disconnecting said trunk line from the connector switch, leaving the remaining trunk lines connected thereto.

9. In combination, a plurality of telephone lines, an automatic connector switch having access thereto, a plurality of trunk lines each normally connected to said connector switch, and non-numerical switching means for connecting any calling one of the first-mentioned lines to any one of said trunk lines.

10. In combination, a plurality of telephone lines, an automatic connector switch having access thereto, a plurality of trunk lines each normally connected to said connector switch, and non-numerical switching means operative to connect any calling or any called one of said lines to any one of said trunk lines.

11. In a telephone system, an automatic connector switch, a trunk line normally connected thereto, means for extending a calling line to said trunk line, means controlled over the calling line for operating said connector switch into association with a called line, means for completing a connection between the calling and called lines over a circuit path independent of the connector, a cut-off relay individual to said trunk line, and means effective upon the said completion of the connection for operating said cut-off relay to isolate said trunk line from said connector switch.

12. In a telephone system, an automatic connector switch, a trunk line normally connected thereto, means for extending a calling line to said trunk line, current-supply connections in said connector switch for supplying transmitter current to the calling line, means controlled over the calling line for operating said connector switch into association with a called line, means for completing a connection between the calling and called lines over a circuit path independent of the connector, a cut-off relay individual to said trunk line, means effective upon the said completion of the connection for operating said cut off relay to isolate said trunk line from said connector switch, a current supply relay in said trunk line, and means for connecting such relay to the trunk line to supply transmitter current after the trunk line has been disconnected from the connector.

13. In a telephone system, an automatic connector switch, a trunk line normally connected thereto, means for extending a calling line to said trunk line, means controlled over the calling line for operating said con-

connector switch into association with a called line, means for completing a connection between the calling and called lines over a circuit path independent of the connector, transmitter supply connections in said trunk line, and means effective upon the said completion of a connection for disconnecting said connector switch from said trunk line and for closing said transmitter supply connections.

14. In a by-pass telephone system wherein a single connector is normally connected in multiple to each of a plurality of trunk lines and is arranged to be temporarily used by any one of them to control the operation of the switching mechanism which completes the talking connections, a timing device, and means controlled by the timing device for freeing the connector from a trunk line automatically in case the normal operation of the connector has not been completed over the trunk line before a predetermined time has elapsed.

15. In a by-pass telephone system wherein a single connector is common to a plurality of trunk lines and is arranged to be temporarily used by any one of them to control the operation of the switching mechanism which completes the talking connections, a timing device, means controlled by the timing device for freeing the connector from a trunk line automatically in case the normal operation of the connector has not been completed over the trunk line before a predetermined time has elapsed, and means effective in case the setting operation of the connector is completed within the allowed time interval for restoring said timing device and for reoperating it to control the application of ringing current to the called line.

16. In a by-pass telephone system wherein a single connector is common to a plurality of trunk lines and is arranged to be temporarily used by any one of them to control the operation of the switching mechanism which completes the talking connections, a timing device, means controlled by the timing device for freeing the connector from a trunk line automatically in case the normal operation of the connector has not been completed over the trunk line before a predetermined time has elapsed, means effective in case the setting operation of the connector is completed within the allowed time interval for restoring said timing device and for reoperating it to control the application of ringing current to the called line, and means effective upon the response of the called subscriber for causing the connector to be freed.

17. In a by-pass telephone system wherein a single connector is common to a plurality of trunk lines and is arranged to be temporarily used by any one of them to control the operation of the switching mechanism which completes the talking connections,

means effective upon the response of the called subscriber for causing the connector to be freed, a timing device, and means effective and controlled by the timing device in case the called subscriber does not respond within a predetermined time for releasing the connector nevertheless.

18. In a telephone system, lines, means for setting up connections thereto, means for immediately making a relatively short application of ringing current to any called line to attract the attention of the called subscriber, means for making a substantially longer application of ringing current to the called line a moment later to enable the particular subscriber called to ascertain that his telephone is ringing and not another which may be located nearby, and means for preventing any further applications of ringing current to the called line.

19. In a telephone system wherein the substations may be physically located relatively closetogether, a central exchange, means at the central exchange for making a connection to the line of any one of said substations, means for immediately making a short application of ringing current to the called line to attract attention, means for making a substantially longer application of ringing current to the called line a moment later so as to enable the called telephone to be readily located, and means for preventing any further applications of ringing current to the called line.

20. In a telephone system wherein connections between calling lines and called lines are set up by non-numerical switching mechanisms under the control of a numerical switching mechanism common to the several lines, certain of said lines being subscriber lines, certain other of said lines being trunk lines, said subscriber lines being divided into two classes, a restricted and non-restricted class, and means located in the common numerical switch and controlled from the individual calling lines for preventing the setting up of connections from lines of the restricted class to said trunk lines while permitting calls of this nature from the non-restricted lines.

21. In a telephone system wherein connections between calling lines and called lines are set up by non-numerical switching mechanisms through local links and under the control of numerical switching mechanism normally connected to each of the several links, certain of said lines being subscriber lines, certain other of said lines being trunk lines, transmitter-current supply connections associated with each local link, means effective upon the completion of a connection for disconnecting the link in use from the numerical switching mechanism and for closing the transmitter-supply connections, and means controlled by said numerical switch for preventing the closing of the transmitter-supply

connections in case the call is from or to one of said trunk lines, while permitting the link in use to be disconnected from the numerical switching mechanism.

22. In a telephone system wherein connections are set up through an automatic connector switch common to a plurality of lines, means for extending a connection from a calling one of said lines to said connector switch, a tone-current-supply lead extending to said connector switch, and means for supplying tone current of one character to the calling line over said lead and through connector switch when connection is made to the connector switch from a calling line to indicate to the calling subscriber that he may operate the connector switch, and for supplying tone current of a different character to the calling line over said lead and through said connector responsive to a busy condition of a called line to indicate such condition to the calling subscriber.

23. In a telephone system wherein a trunk line extending between a first exchange and a second exchange is divided into two sections in the first exchange as regards one talking conductor thereof, the first exchange side of said one talking conductor being normally grounded, while the inter-exchange portion of such conductor is normally ungrounded, means in the first exchange for placing a bridge across the talking conductors of the trunk line to originate a call to the second exchange under one condition and to answer a call from the second exchange under another condition, and switching means controlled responsive to the receipt of ringing current in the first exchange from the second exchange by way of said trunk line for automatically causing the bridge to be placed across the undivided trunk line conductor and the grounded section when a call is being originated and to be placed instead across the undivided conductor and the ungrounded portion of the divided conductor when a call is being received.

24. In a telephone system wherein a trunk line comprising two normally joined sections is provided with means individual thereto for disconnecting the two sections from one another and for connecting them respectively to apparatus common to such trunk line and to a plurality of other similar trunk lines, one section of said trunk line terminating in an automatic switchboard, and means included in said common equipment for initially preparing the automatic switching mechanism at said automatic switchboard for operation.

25. In a telephone system wherein a trunk line comprising two normally joined sections is provided with means individual thereto for disconnecting the two sections from one another and for connecting them respectively to apparatus common to such

trunk line and to a plurality of other similar trunk lines, one section of said trunk line terminating in an individual automatic line switch, and means included in said common equipment for operating said line switch.

26. In a telephone system wherein a non-isolated trunk-connected private automatic exchange has means provided for completing all talking connections between subscribers' lines and trunk lines entering such exchange directly through the line switches individual, respectively, to such lines and trunk lines, attendant's switchboard equipment in the private automatic exchange associated with the trunk lines entering such exchange, means whereby a calling branch exchange subscriber can set up a connection from his line over a connecting trunk through the medium of his own individual line switch and the individual line switch in which the connecting trunk terminates in the private automatic exchange without the aid of the attendant, means whereby the attendant can cause the operation of the line switches necessary to complete a connection incoming over a connecting trunk to the line of a subscriber of the private automatic exchange, and means whereby the attendant can set up "tail-to-tail" connections over an interconnecting trunk between the line of an outside subscriber and the line of a private-automatic-exchange subscriber.

27. In a by-pass telephone system wherein an automatic connector switch is common to a plurality of trunk lines and is arranged to be used temporarily by any one of them to control the operation of the switching mechanism which completes the talking connections, means for supplying ringing current to called lines from said connector switch.

28. In a by-pass telephone system wherein an automatic connector switch is common to a plurality of trunk lines and is arranged to be used temporarily by any one of them to control the operation of the switching mechanism which completes the talking connections, means for supplying ringing current to called lines from said connector switch, and means whereby said connector switch automatically reverts to common use following the ringing operation.

29. In a by-pass telephone system wherein an automatic connector switch is common to a plurality of trunk lines and is arranged to be used temporarily by any one of them to control the operation of the switching mechanism which completes the talking connections, means for supplying ringing current to called lines from said connector switch, and means whereby the common connector switch automatically reverts to common use after making a predetermined application of ringing current to the called line.

30. In a telephone system of the type

wherein each line entering the exchange is provided with an individual non-housing line switch and wherein the banks of the line switches are multipled together and connected to trunk lines, means for setting up a connection between any pair of said lines by causing the individual line switches of such lines to seize the same trunk line, and transmitter current supply connections to both lines involved in a connection by way of the trunk line in use through the same choke coil windings.

31. In a telephone system, a line having a line switch individual thereto, a plurality of trunk lines accessible to said line switch, and means for operating said line switch to seize a preselected idle one of said trunk lines to initiate a call outgoing from said line and for operating said line switch to seize a particular one of said trunk lines to complete a call incoming to said line, said line switch being arranged to seize any given trunk line through the same set of terminals regardless of whether it is operating to initiate a call or to complete a call.

32. In a telephone system, a line having a line switch individual thereto, a plurality of trunk lines accessible to said line switch, means responsive to the initiation of a call over said line for operating said line switch to seize one of said trunk lines, and a delay relay to render said means ineffective for a predetermined interval after the initiation of the call.

33. In a telephone system, a line having a line switch individual thereto, a plurality of trunk lines accessible to said line switch, means for operating said line switch to seize one of said trunk lines on both incoming and outgoing calls, and a delay relay to prevent the immediate operation of said line switch on an outgoing call.

34. In a telephone system, a line having a line switch individual thereto, a plurality of trunk lines accessible to said line switch, an operating circuit for said line switch closed upon the initiation of a call over said line, a slow acting relay having a high resistance winding normally included in said operating circuit to prevent the operation of said line switch, and means responsive to the energization of said relay for shunting the high resistance winding with a low resistance winding to permit the operation of said line switch.

35. In a telephone system, a plurality of lines each having a line switch individual thereto, a plurality of trunks each accessible to each of said line switches, and a common connector normally connected in multiple to each of said trunks.

36. In a telephone system, a plurality of lines each having a line switch individual thereto, a plurality of trunks each accessible to each of said line switches, a common con-

connector normally connected in multiple to each of said trunks, and means for disconnecting said connector from any of said trunks without disconnecting it from the remainder of the trunks.

37. In a telephone system, a plurality of lines each having a line switch individual thereto, a plurality of trunks each accessible to each of said line switches, a common connector normally connected in multiple to each of said trunks, a cut-off relay individual to each of said trunks, and means in said connector for operating the cut-off relay of a particular trunk to disconnect said connector from said trunk.

38. In a telephone system, a plurality of lines each having a line switch individual thereto, a plurality of trunks accessible to said line switches, a common connector switch normally connected in multiple to each of said trunks and having access to each of said line switches, and means controlled by said connector for operating any one of said line switches to seize a predetermined one of said trunks.

39. In a telephone system, a line, a line switch individual to said line, a connector having access to said line switch, a line relay in said line switch responsive to the initiation of a call over said line, and means for operating said line switch controlled by said line relay on a call outgoing from said line and controlled by said connector independently of said line relay on a call incoming to said line.

40. In a telephone system, a plurality of lines each having a line switch individual thereto, a plurality of trunks accessible to said line switches and selected thereby under the control of a single master switch, means for operating any of said line switches to either initiate or complete a call over its associated line, and means for preventing the operation of said master switch when one of said line switches is operated to initiate a call.

41. In a telephone system, a plurality of lines each having a line switch individual thereto, a plurality of trunks accessible to said line switches and selected thereby under the control of a single master switch, means for operating any of said line switches to either initiate or complete a call over its associated line, means for preventing the operation of said master switch when one of said line switches is operated to initiate a call, and means for operating said master switch when one of said line switches is operated to complete a call.

42. In a telephone system, a group of line switches, a master switch, means for operating the line switch of any line when the line is either calling or being called, and means for operating said master switch only when a line is called.

43. In a telephone system, a group of line switches, a master switch controlling said line switches, a connector having access to said line switches, and means in said connector for controlling said master switch.

of said switch for a limited time, means included in the switch for selecting and signaling any called line, and means for connecting the calling and called lines over a path excluding said switch.

44. In a telephone system, a calling and a called line, a trunk, a battery feed relay individual to said trunk, a connector normally connected to said trunk, means for completing a talking connection between said calling and called line independent of said connector, means controlled by said connector for operating said battery feed relay, and contacts on said relay for locking itself to the talking conductors of said trunk in series with battery to supply transmitter current for the talking connection.

In witness whereof, I hereunto subscribe my name this 30th day of March, A. D. 1928.

GEORGE E. SCHOMAKER.

In witness whereof, I hereunto subscribe my name this 28th day of February, A. D. 1928.

ROY F. GOULD.

45. In a telephone system, a plurality of trunks, a cut-off relay and a battery feed relay individual to each of said trunks, a common connector switch normally connected in multiple to each of said trunks, means for operating said connector to establish a telephone connection over one of said trunks, and means responsive to the completion of the connection for operating said cut-off relay to disconnect said connector from the trunk and for operating said battery feed relay to supply transmitter current over said trunk.

46. In a telephone system, a plurality of trunks, a cut-off relay and a battery feed relay individual to each of said trunks, a common connector switch normally connected in multiple to each of said trunks, means for operating said connector to establish a telephone connection over one of said trunks, means responsive to the completion of the connection for operating said cut-off relay to disconnect said connector from the trunk and for operating said battery feed relay to supply transmitter current over said trunk, and means for preventing the operation of said battery feed relay in case the connector was operated to a particular position to establish the connection.

47. In a telephone system, lines, a connector common to said lines and arranged to be temporarily used to establish a connection between a calling and a called line, a timing device associated with said connector to control the application of ringing current to the called line, and means controlled by said timing device for releasing said connector after a predetermined application of ringing current to the called line.

48. In a telephone system, a calling line, means including a connector controlled over said line for selecting a called line, means in said connector for ringing the called line, and means for then establishing a talking connection between said calling and called lines over a path excluding said connector.

49. A telephone system comprising a single directive switch, means whereby any calling subscriber may obtain the exclusive use

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