Nov. 30, 1937. N. H. SAUNDERS ET AL 2,100,523

AUTOMATIC TELEPHONE SYSTEM

Filed Dec. 16, 1935 3 Sheets-Sheet 1

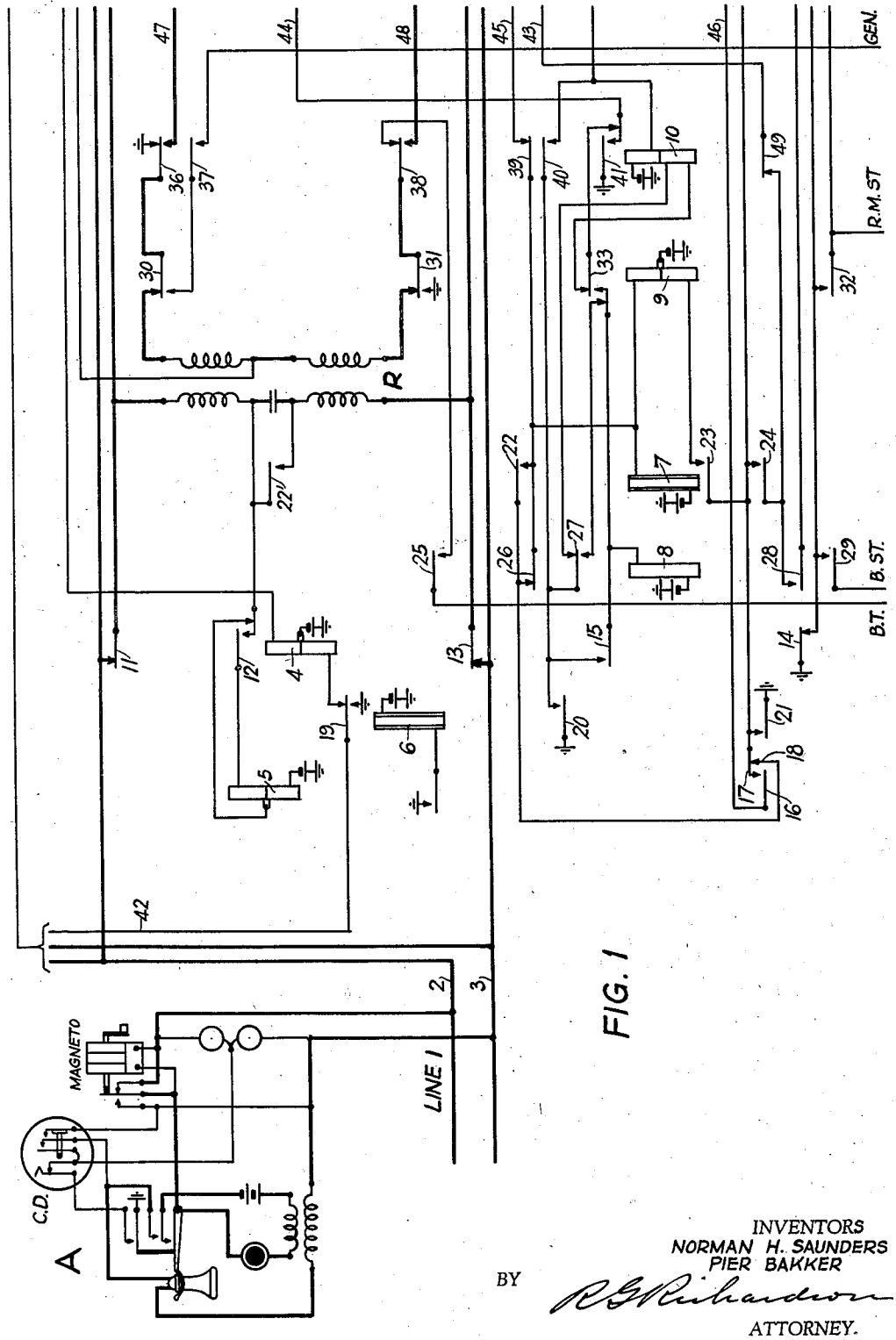

FIG. 1

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Filed Dec. 16, 1935 3 Sheets-Sheet 2

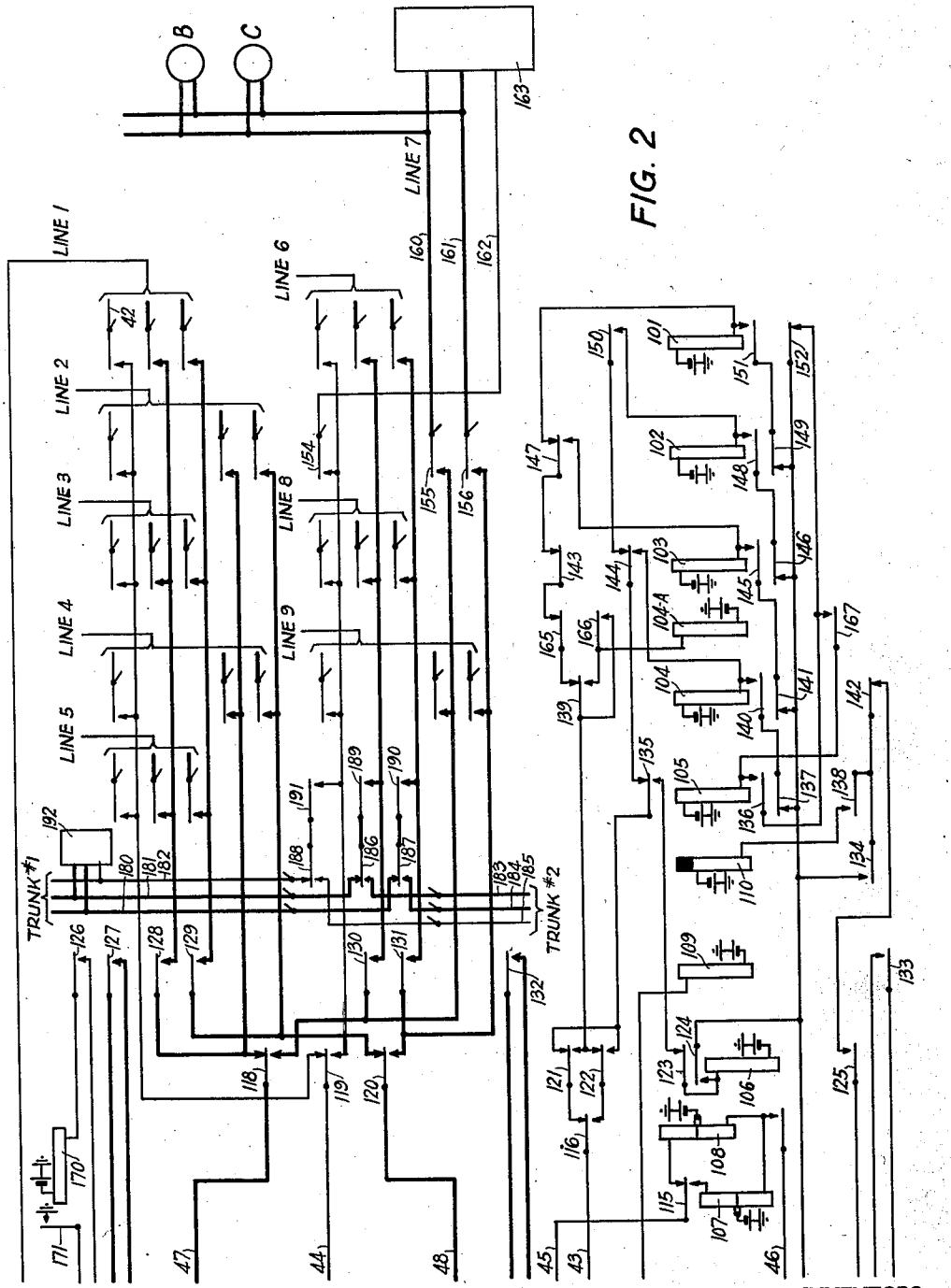

FIG. 2

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Filed Dec. 16, 1935 3 Sheets-Sheet 3

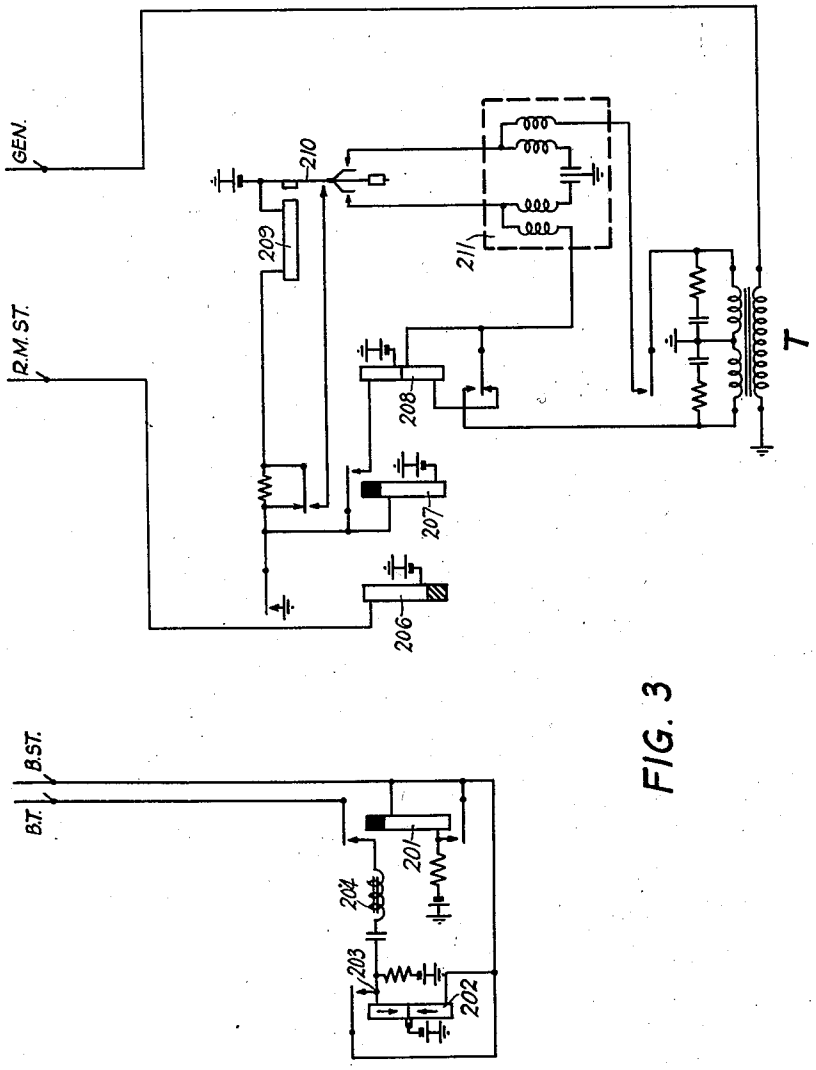

FIG. 3

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Patented Nov. 30, 1937

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UNITED STATES PATENT OFFICE

2,100,523

AUTOMATIC TELEPHONE SYSTEM

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Application December 16, 1935, Serial No. 54,637

13 Claims. (Cl. 179—17)

The present invention relates in general to automatic telephone systems and more in particular to small automatic systems which are adapted for use in rural communities. The object of the invention may be stated to be the provision of a new and improved system of this character.

The complete system as installed comprises nine subscribers' lines and two trunk lines. The subscribers' lines may be party lines and the stations are of the local battery magneto type. Each station has a dial or calling device. The trunk lines provide for interconnection with another exchange. Each subscriber's line and each trunk line is provided with an individual relay type connector, and each connector has access to all the lines and trunk lines.

The automatic switchboard or exchange proper therefore consists of eleven relay connectors when fully equipped. There is also a storage battery or other source of direct current for operating the relays, and means for supplying ringing current and busy signalling current.

The invention and novel features thereof will be described hereinafter with reference to the accompanying drawings, which show by means of the usual circuit diagrams sufficient of the equipment involved to enable an adequate explanation to be made.

Referring to the drawings, Figs. 1 and 2 show the complete equipment for one subscriber's line of the system. A subscriber's line and one station thereon is shown at the left of Fig. 1, and is labeled "LINE 1". The remainder of Fig. 1 and Fig. 2 show the relay connector which is individual to line 1. There is also indicated at the right of Fig. 2 several stations on line 7 and the connector 163 individual to that line. Fig. 3 shows the ringing machine and the arrangement for generating busy signalling current. The battery symbols shown throughout the drawings will be understood to refer to a single battery or other source of direct current.

It will be assumed now that a call is to be made from station A on line 1 to station B on line 7, the telephone number of the latter station being 792. When the receiver is removed at station A, a dialling circuit is completed which extends from ground at the upper pair of switchhook springs by way of the impulse springs of calling device CD, upper ringer magnet, line conductor 2, contact 11, a winding of repeating coil R, contact controlled by spring 12 of relay 4, and lower winding of line relay 5 to battery. Relay 5 energizes over the above circuit and closes a circuit for slow-acting release relay 6. Relay 6, on energizing, shifts the test conductor 42 from the cut-off relay 4 to ground, thereby making line 1 busy.

Having listened in his receiver to make sure that his line is not in use by another party on the same line, the subscriber at station A will now dial the first digit of the desired number. As a result the dialling circuit is interrupted momentarily seven times at the calling device CD, and the line relay 5 falls back seven times, relay 6 remaining energized due to its being slow acting. On the first deenergization of relay 5 a circuit is closed from ground by way of 21, 17, 18, 26, and windings of relays 7 and 9 in parallel to battery. Relays 7 and 9 accordingly energize, and the former relay closes its energizing circuit over a new path including contacts 22, so as to maintain its circuit closed if relay 8, the busy test relay, should energize and open 26. Relay 7 is slow acting and remains operated over the described circuit while line relay 5 is responding to the first digit. At 23 relay 7 closes another circuit for relay 9 so this relay holds up also. At 22' relay 7 short circuits the condenser which is in series with the left-hand windings of the repeating coil. This operation has the effect of including the line conductor 3 in the dialling circuit in parallel with line conductor 2. Relay 9 prepares a circuit for the busy test relay 8 at 33, and at 32 places ground on the ringing machine start lead RMST, thereby starting up the ringing machine.

On its first deenergization line relay 5 also closes a circuit from ground by way of 21, 17, 18, 26, and 22, 39, 45, 115, and upper winding of relay 108 to battery. Relays 107 and 108 are the so-called odd and even relays, used to control the counting relays 101—105. On energizing relay 108 closes a circuit from ground by way of 21, 24, 49, 43, 116, 122, 139, 165, 143, 147, and relay 101 to battery. Relay 101 therefore energizes, locks itself at 151, and prepares a circuit for relay 102 at 150. It will be observed also that relay 101 makes a tentative selection of lines 1 and 6, but the connections closed to these lines are open at other points and consequently may be neglected at this time. It may be noted, however, that the test conductor 42 of line 1 is closed through to busy relay 8 and since line 1 is busy the relay 8 will be energized. This does no harm due to the provision of contacts 22, as previously mentioned.

On energizing after its first deenergization, line relay 5 separates springs 17 and 18, but armature

116 picks up ground at 117 and thus closes a circuit over 46 for the lower winding of relay 108 which maintains the relay energized. The lower winding of relay 107 is also included in this circuit and relay 107 accordingly energizes. Relay 107 breaks the former operating circuit of relay 108 at 115 and prepares a holding circuit for itself at the same point.

On the second deenergization of line relay 5, armature 16 disengages spring 17 and the latter again engages spring 18. This recloses the circuit over 45, which now holds up relay 107, and breaks the circuit over 46, which permits relay 108 to fall back. On deenergizing, relay 108 closes a circuit by way of grounded conductor 43, 116, 121, 135, 144, 150, and relay 102 to battery. Relay 102 energizes, locks itself at 148, opens the locking circuit of 101 at 149, permitting 101 to deenergize, and prepares a circuit for relay 103 at 147. Relay 102 closes connections to lines 2 and 7 but for reasons previously stated these connections may be neglected.

On energizing after the second deenergization, line relay 5 breaks the circuit over 45 and permits relay 107 to fall back. Relay 108 being deenergized, no circuit is closed over 46.

On the third deenergization of line relay 5, a circuit is again closed over 45 for relay 108. On energizing, relay 108 closes the prepared circuit for relay 103. The latter relay energizes, locks itself at 145, unlocks relay 102 at 146, and prepares a circuit for relay 104 at 144.

On energizing again, the line relay 5 holds relay 108 over 46 and energizes relay 107 over the same circuit, all as previously explained.

On the fourth deenergization of line relay 5, relay 107 is held over 45, while relay 108 is allowed to fall back, closing the circuit for relay 104, previously prepared by relay 103. On energizing, relay 104 locks itself at 140, unlocks 103 at 141, and prepares a circuit for relay 104A at 139.

On the next energization of the line relay, the circuit over 45 is broken and relay 107 falls back. Relays 107 and 108 are both deenergized now.

On the fifth deenergization of line relay 5, a circuit is closed over 45 for relay 108, which operates and closes the previously prepared circuit for relay 104A. On energizing, relay 104A locks itself at 133, breaks the chain to relay 101 at 165, and closes a circuit for relay 105 at 167. On energizing, relay 105 locks at 136, opens the locking circuit of 104 at 137, and prepares a circuit for relay 106 at 135.

On energizing again, the line relay 5 closes a circuit over 46 which holds relay 108 and operates relay 107.

On the sixth deenergization of line relay 5, the circuit over 46 is broken, allowing relay 108 to fall back, while relay 107 is held over 45. On deenergizing, relay 108 releases relay 104A, and closes a circuit for relay 106, previously prepared by relay 105 at 135. Relay 106 energizes and locks at 124, also breaking its initial energizing circuit at 123. Relay 106 is a reflexing relay, which provides for using the counting chain 101—105 over again to count the digits 6 to 0, this being accomplished by shifting the test lead 44 and talking conductors 47 and 48 from their normal association with lines 1—5 into association with lines 6—9 and the two trunk lines.

In addition to the foregoing, relay 106 reverses the connections between the contacts at 116 and the two operating leads extending to the counting chain, the same being effected at 121 and 122. Since relay 108 is now deenergized a circuit is closed from the grounded conductor 43 by way of 116, 121, 139, 165, 143, 147, and relay 101 to battery. Relay 101 energizes, locks itself at 151, breaks the locking circuit of 105 at 152, and prepares a circuit for 102 at 150.

On the next energization of line relay 5, the circuit over 45 is broken and relay 107 falls back.

On the seventh and last deenergization of line relay 5, a circuit is closed over 45 for energizing relay 108, which operates and closes the previously prepared circuit for relay 102, it being recalled that relay 106 is now locked up so that the circuit is completed over 43, 116, 122, 135, 144, and 150 to 102. On energizing, relay 102 locks itself at 148, unlocks relay 101 at 149, and prepares a circuit for relay 103 at 147. This latter circuit, of course, is of no interest in the present case, since the last deenergization of the line relay has occurred.

The line relay energizes again after the final deenergization and comes to rest in energized position. Relay 108 is accordingly held over 46 and relay 107 is energized. These relays, however, have no further functions to perform.

It will be recalled now that relays 7 and 9 are maintained in energized position while the line relay is responding to the first digit. This is due to the fact that relay 7 has its circuit closed on each deenergization of the line relay and being slow acting is able to stay in operated position, holding relay 9 energized by way of 23. When the line relay comes to rest, however, relay 7 receives no more impulses and shortly falls back. Before this occurs a test is made of line 7, which has been selected by relay 102.

The rectangle 163 represents the relay connector individual to line 7 and test conductor 162 corresponds to test conductor 42, Fig. 1. It will be seen that if line 7 is idle the conductor 162 will extend through to the cut-off relay in the connector 163 while if the line is busy the conductor 162 will be grounded. If busy due to the line being in calling condition, the test conductor will be grounded at contacts such as 19, as already explained, while if the busy condition is due to the line having been called by another connector the test conductor will be grounded at contacts such as 41 of such other connector.

Assuming now that line 7 is busy when called, the test relay 8 is energized over a circuit which extends from the grounded test conductor 162 by way of 154, 119, 44, contacts controlled by 41, 33 (relay 9 is still energized), and winding of test relay 8 to battery. On energizing, relay 8 grounds the busy start lead BST at 29, prepares a locking circuit for itself at 27, opens the initial energizing circuit of relay 7 at 26, and connects the busy tone lead BT to the talking circuit at 25. Relays 7 and 9 now fall back and test relay 8 is locked up over 27 to ground at 20.

The grounding of lead BST energizes relay 202, Fig. 3. On energizing, this relay closes a circuit for its upper winding and since the windings are in opposition the relay falls back and opens the circuit of its upper winding, whereupon it again energizes. Thus relay 202 operates as a buzzer while conductor BST is grounded. Relay 201, which short circuits itself on energizing, also operates as a buzzer, but at a very much slower speed due to being slow to energize and also slow to fall back. The operation of relay 202 rapidly changes the potential at 203 and thus produces a tone current on conductor BT. This conductor is interrupted at regular intervals by relay 201 to

give the calling subscriber the characteristic busy signal. 204 is a radio frequency choke coil.

On hearing the busy signal the calling subscriber will hang up his receiver. This breaks the dialling circuit at the switchhook springs and the line relay 5 falls back, followed by release relay 6. The falling back of relay 6 breaks the locking circuit of any relays that may be energized at this time and the connector is thus restored to normal.

It will be assumed now that line 7 is idle when called. This being the case, no ground is found on conductor 162 when the busy test is made and relay 8 is not energized. When relay 9 falls back a circuit is closed for relay 10 which extends from ground at 29, by way of 27, lower winding of 10, 33, contacts controlled by 41, 44, 119, 154, 162, and winding of the cut-off relay (similar to 4) of the called line. The cut-off relay energizes and disconnectes the line relay at contacts corresponding to 11 and 13, Fig. 1. Relay 10 also energizes and locks itself at 40. Relay 10 grounds the test conductor 162 at 41, opens the conductor 45 at 39, opens conductor 43 at 49, closes points in the talking circuit at 36 and 38, and prepares the ringing circuit at 37. Relay 109 energizes in parallel with the upper winding of relay 10. Relay 109 prepares a circuit for relay 170 at 126, and shunts contacts 11 and 13 of relay 4 at 127 and 132. Relay 109 also closes certain contacts 128, 129, 130, and 131, which would be included in the talking circuit if lines such as line 2 or line 6 had been called. The purpose of these contacts is to prevent the possibility of momentarily connecting together two lines such as line 1 and line 2 while the counting relays are operating. Relay 101, for instance, connects up line 1 and relay 102 connects up line 2 and breaks the circuit of 101, from which it follows that line 2 is connected up before line 1 is disconnected. This does no harm, however, because of the insertion of contacts 127 and 128 which are open at the time the counting relays are operating.

Relay 109 also places a ground on the ringing machine start conductor RMST at 133. This conductor, it should be stated, is first grounded at 32 by relay 9 when dialling begins, the object being to get the ringing machine in operation so that it will be ready for use upon the dialling of the second digit, which is a ringing digit. When conductor RMST is grounded, the start relay 206 is energized. This relay is slow acting so that it holds up during the slight interval between the falling back of relay 9 and the pulling up of relay 109.

On energizing, relay 206 closes a circuit for the vibrator magnet 209, which attracts the vibrating element 210 with considerable power, so that no time will be lost in building up the proper amplitude of vibration. Relay 206 also closes a circuit for slow-to-energize relay 207. When this relay operates it inserts a resistance in the circuit of magnet 209, and closes a circuit over which the magnet short circuits itself through element 210. The vibrator now starts operating at normal amplitude, magnet 209 alternately attracting and releasing element 210. Relay 207 also closes a circuit for relay 208 which is slow to energize due to its normally short circuited lower winding. Relay 208, on energizing, connects the vibrator contacts through to the primary winding of transformer T. The delay introduced by relay 208 is desirable to prevent possible welding together of the vibrator contacts on starting, which is especially liable to happen in the case of the left-hand pair of contacts. The device enclosed within the rectangle 211 is a suppressor of radio frequency currents.

Having selected the desired line by dialling the digit 7, the calling subscriber can now proceed with the dialling of the remaining digits of the number, which will be effective to promote the ringing operation. The desired station on the line is signalled by code ringing, and the code of such station is one long ring and one short ring. This code is produced by dialling the final digits 9 and 2 of the called number, as will now be explained.

When the digit 9 is dialled the line relay 5 falls back nine times and sends nine impulses to relays 7 and 9, which pull up and hold on throughout the series of impulses as previously explained. If relays 107 and 108 are in energized position, as they are in the instant case, they both fall back on the first deenergization of the line relay, 107 not being able to hold up because 45 is open at 39. The falling back of 108 causes no further action at the counting chain because 43 is open at 49. Relay 9 closes the ringing circuit in an obvious manner at 30 and 31, producing a long ring on the called line.

When the digit 2 is dialled, the line relay 5 controls the relays 7 and 9 the same way, except that these relays are held up only for the duration of two impulses instead of nine impulses, which produces a short ring on the called line.

The telephone at station B may be the same as the telephone at station A, and it will be seen therefore that when the receiver is removed both sides of line 7 will be grounded through the ringer magnets, calling device, and switchhook contacts. This closes a simplex circuit for energizing relay 170, which was connected up to the junction of the right-hand windings of repeating coil R by relay 109. On energizing, relay 170 closes a circuit for the upper winding of relay 4, which operates. The opening of contacts 11 and 13 is of no effect because they have been shunted at 127 and 132. At 12 the upper high resistance winding of line relay 5 is connected in series with the lower winding. At 14 ground is removed from the ringing machine start lead RMST, which stops the ringing machine unless some other connector is in ringing position. At 15 a circuit is closed for relay 8, which operates and locks to ground at 20. The function of relay 8 at this time is to open the circuit for relays 7 and 9 at 26, and thereby prevent further operation of these relays such as would occur if another digit should be dialled at station A, or if the dial should be accidentally disturbed sufficient to operate the calling device. The locking up of relay 8 also prevents the operation of relays 7 and 9 when the receiver is hung up at station A.

The desired connection has now been established and the subscribers can engage in conversation. The talking circuit is shown in heavy lines and may be readily traced. The calling station is connected to the left-hand windings of repeating coil R over conductors 2 and 3 and through contacts of relay 109. The right-hand windings of the repeating coil are connected to the called station through contacts of relays 9, 10, 106, and 102, and over conductors 160 and 161. When the subscribers are through talking they will hang up their receivers. The replacement of the receiver at station A breaks the circuit of line relay 5 which falls back and breaks

the circuit of release relay 6. Upon the deenergization of relay 6 all energized relays such as 10, 106, 109, and 102 have their locking circuits opened and they restore to normal.

The manner in which connections are set up to other subscribers' lines in the system will be clear enough from the foregoing. It will be obvious, for instance, that if the subscriber at station A had dialled the digit 3 instead of the digit 7 he would have selected line 3 by means of counting relay 103. Relays 101 to 105 select lines 1 to 5 responsive to digits 1 to 5. On digits 6 to 9 the counting relays 101 to 104 select lines 6 to 9, due to the operation of relay 106, which energizes whenever a digit greater than the digit 5 is dialled. On the digit 0 the counting relay 105 selects the first trunk line.

There are two trunk lines and provision is made for automatically selecting the second trunk line if the first is busy. Explaining how this is done, when the subscriber at station A dials the digit 0 the connector operates as previously described except that the counting proceeds for ten deenergizations of line relay 5, resulting in the energization of relay 105 on the tenth deenergization. On energizing, relay 105 locks itself at 136, breaks the locking circuit of 104 at 137, and prepares a circuit for 110 at 138. Relay 105 also selects the first trunk line at 189, 199, and 191, since relay 106 is now energized.

If the first trunk line is busy there will be a ground potential on test conductor 132, and test relay 8 will energize over a circuit including ground at 182, 188, 191, 119, 44, 33, and winding of relay 8 to battery. Relay 8 having energized and relay 104 having deenergized, a circuit may be traced from ground at 21 by way of 24, 28, 125, 142, 138, and winding of relay 110 to battery. On energizing, relay 110 locks itself at 134, and at 186, 187, and 188 substitutes the second trunk for the first. If the second trunk is busy the busy test relay 8 will be held up from ground on test conductor 185 of the second trunk, and when relays 7 and 9 fall back, the busy test relay 8 will stay locked up and will give the calling subscriber a busy signal. On the other hand, if the second trunk is idle there will be no ground on test conductor 185, and the busy test relay 8 will fall back as soon as the switch is made from the first trunk to the second. Then when relays 7 and 9 fall back a circuit will be closed for relay 10 which operates and closes the connection through in the manner previously explained. It will be understood, of course, that if the first trunk is idle when called the test relay 8 will not energize and no circuit will be completed for relay 110, so that the first trunk will be taken for use.

As stated before, each trunk line is equipped with an individual relay connector which is the same as the connector shown in the drawings. The connector for trunk 1 is indicated in the drawings at 192. The trunk lines extend to an operator's position at a distant exchange, where they terminate in jacks and suitable associated equipment. Each trunk may terminate, for instance, in a trunk circuit such as the trunk circuit TC5 which is shown in Fig. 6 of Patent No. 1,772,690, August 12, 1930.

Assuming now that the subscriber at station A has operated the connector shown to establish a connection with the first trunk line, the cut-off relay in the connector 192 will be energized to cut off the line relay. The trunk number will include a ringing digit, the complete number being 05, for instance, and when the last digit 5 is dialled ringing current will be transmitted over trunk conductors 180 and 181 to operate a ring-up relay in the trunk circuit at the distant end, which locks and brings in the line lamp. When the operator plugs in to answer, the lamp is extinguished and a grounded simplex circuit is established over the two trunk conductors 180 and 181 in parallel, energizing relay 170 of the calling connector with results previously explained. The ground connection for the simplex circuit includes a marginal supervisory relay which cannot energize in series with relay 170, the latter being of high resistance. The marginal supervisory relay remaining unoperated, the supervisory lamp in the operator's cord circuit remains dark, indicating the continued presence of the calling party on the line.

The desired connection is now completed by the operator. When the calling party at station A is through talking he will replace his receiver, releasing the connection to trunk 1. The deenergization of the cut-off relay in connector 192 thereupon restores the normal connection of the trunk conductors 180 and 181 to the line relay of the associated connector 192. The lower winding of the line relay (similar to 5) is of relatively low resistance and the distant supervisory relay now energizes, lighting the supervisory lamp in the operator's cord and informing the operator that the calling party has hung up.

If the operator at the distant exchange should desire to call a station such as B, she will plug into one of the trunk lines, trunk 1 for instance. As before mentioned the art of plugging in completes a grounded simplex circuit, which in the present case will energize the line relay of the connector 192. The lower winding only of the line relay is included in the circuit and the marginal supervisory relay therefore energizes, lighting the supervisory lamp in the operator's cord circuit. The number is now dialled and the connection completed in the manner described. When the called party answers the relay in connector 192 which corresponds to relay 170 is energized, energizing in turn the cut-off relay such as 4, which inserts the high resistance upper winding of the line relay in series with the lower winding. This causes the distant supervisory relay to fall back and put out the supervisory lamp. When the called party hangs up the relays such as 170 and 4 fall back again, the upper winding of the line relay is cut out, the distant supervisory relay pulls up, and the supervisory lamp is lighted again.

The foregoing brief explanation of the supervision on trunk calls has been given so that the reason for the high and low resistance windings of the line relay and for the high resistance relay 170 may be understood. As regards the latter relay it may be pointed out further that although this relay could theoretically be eliminated by connecting the junction of the right-hand repeating coil winding direct to the upper winding of relay 4 by way of 126 and making the upper winding of relay 4 a high resistance winding, this would not be practical because of the number of contact springs on relay 4. It will be understood that these supervisory features are not involved on local calls. On a call from station A to station B, for instance, the insertion of the high resistance winding of the line relay 5 in the dialling circuit when the called party answers has no particular function, although conceivably this operation could be made to control some substation device such as a coin collector. How-

ever this may be, it is desirable in any event to have the connectors in a given exchange all alike for various reasons, and especially for convenience of maintainance.

If the subscriber at station A should desire to call another station on his own line, he can do this by operating his magneto, or hand generator, code ringing the wanted station in the well known manner. There is a condenser inserted between the left-hand windings of the repeating coil R at the connector to avoid placing a heavy shunt on the generator. The removal of the receiver at station A of course operates line relay 5, which operates release relay 6, and the line is made busy by grounding conductor 42 at 19.

It will be clear that the relay connector herein disclosed can be readily modified for use in a ten line isolated exchange. Line 10 would be connected up at contacts 189, 190, and 191 of relay 105 and relay 110 would be omitted, as well as the circuits for operating it. The supervisory arrangements could also be left out, that is, relay 105 could be a single wound relay, contacts 12 could be left out, and relay 170 could be omitted, since the upper winding of relay 4 would not have to be of high resistance. The connector therefore would be considerably simplified over the one shown herein.

The invention having been described, what is considered to be new and is desired to have protected by Letters Patent will be set forth in the following claims.

What is claimed is:

1. In a telephone system, a subscriber's line, a relay connector individual to said line, a chain of counting relays in said connector controlled by digit impulses received over said line, contacts on each counting relay for selecting two other lines, and means controlled in accordance with the value of the digit received for making a selection between the two lines selected by any counting relay.

2. In a telephone system, a subscriber's line, a relay connector individual to said line, other lines, means including counting relays in said connector for connecting said first line to any one of said other lines, means for controlling said counting relays by transmitting digit impulses over said first line, and ringing means responsive to additional digit impulses transmitted over said first line, and means for preventing the said counting relays from responding to the impulses which control the said ringing means.

3. In a relay connector, a chain of counting relays under dial control for selecting and extending talking connections to a plurality of lines, means for operating any counting relay once or twice depending on the value of the digit dialled, a series of lines arranged to be selected by said relays on the first operation thereof, and a second series of lines arranged to be selected by said relays on the second operation thereof.

4. In a relay connector, a chain of five counting relays for selecting and extending talking connections to a plurality of lines, means for controlling said relays to count the impulses in any digit from one to five, or to count the impulses in any digit from six to naught by reoperation after five impulses have been counted, two groups of lines to which connections are extended by said relays, and circuit arrangements whereby the group in which a line is selected depends on whether or not the controlling digit is greater than five.

5. A reflex counting relay arrangement comprising a chain of counting relays less in number than the maximum number of impulses to be counted, means for operating and reoperating certain or all of said relays responsive to a series of impulses containing more impulses than there are relays, and circuit arrangements whereby the relays which count the odd impulses the first time they are operated count the even impulses on reoperation and whereby the relays which count the even impulses the first time they are operated count the odd impulses on reoperation.

6. A reflux counting relay arrangement comprising a chain of counting relays, a control relay energizing on the odd impulses of a series to be counted and deenergizing on the even impulses, two control conductors leading from front and back contacts, respectively, of said control relay to said counting chain, circuits for energizing the odd relays of said chain over one control conductor and the even relays over the other control conductor, and circuit arrangements such that when the number of impulses already counted equals the number of counting relays the next impulse will cause the said control conductors to be reversed with respect to said control relay contacts.

7. In a relay connector, a chain of counting relays for selecting and completing talking connections to lines, means for operating said relays successively responsive to dialling operations, circuits such that the operation of any relay except the first causes the release of the previously operated relay, whereby upon the completion of a dialling operation only one relay will remain energized, and means for preventing the interconnection of lines associated with adjacent relays during the interval that such relays are both in operated position.

8. In a telephone system, a subscriber's line, a calling device at the station on said line, line conductors, and a line relay at the exchange, a control circuit including said calling device, a single one of said conductors, and said line relay, and means at the exchange responsive to operation of said calling device for converting said circuit into a simplex circuit comprising both conductors of said line.

9. In a telephone system, a local battery magneto party line, a directively controlled switching device individual to said line at the exchange, a repeating coil associated with said line at said device, a control circuit for said device normally including only one side of said line and one winding of said repeating coil, there being a condenser inserted between the line windings of said coil to increase the impedance thereof to magneto ringing current, and means for short circuiting said condenser to include both sides of the line in said control circuit when the same is used to directively control said device.

10. In a connector, a line relay, a slow acting relay energized by said line relay while responding to impulses, a busy test relay controlling the circuit of said slow acting relay, means for energizing said busy relay or not depending on whether or not a called line with which connection is established by said connector is busy, ringing means controlled by said line relay and slow acting relay if the called line is idle, and means for operating said busy relay when the called party responds for preventing further energization of said slow acting relay under control of said line relay.

11. A relay exchange comprising subscribers' lines and a trunk line, a relay connector indi-

vidual to each line, a line relay in each connector having a low resistance winding controlled over the two sides of the associated line in parallel, an answering relay in each connector having a high resistance winding controlled over the two sides of a called line in parallel, and means effective responsive to the operation of the answering relay in any connector for inserting a high resistance in series with the line relay of such connector.

12. In a relay connector, an incoming line, a plurality of outgoing lines, a chain of counting relays, means for energizing a variable number of said relays successively by digit impulses transmitted over said incoming line to select and connect a desired outgoing line to said incoming line, each counting relay having contacts for connecting a different outgoing line to said incoming line, another outgoing line alternative to a particular one of said first mentioned outgoing lines, means including a relay effective in case said particular outgoing line is busy when connected up by the associated counting relay for switching the connection to said alternative outgoing line, and means for locking the concerned counting relay to maintain the connection.

13. In a relay connector, an incoming line, a plurality of outgoing lines, including two trunk lines, a chain of counting relays for connecting said incoming line to said outgoing lines, including one counting relay common to said trunk lines, a trunk switching relay, and means for operating said connector by impulses over said incoming line to connect the same with either one of said trunk lines through serially related contacts on said last mentioned counting relay and said switching relay.

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