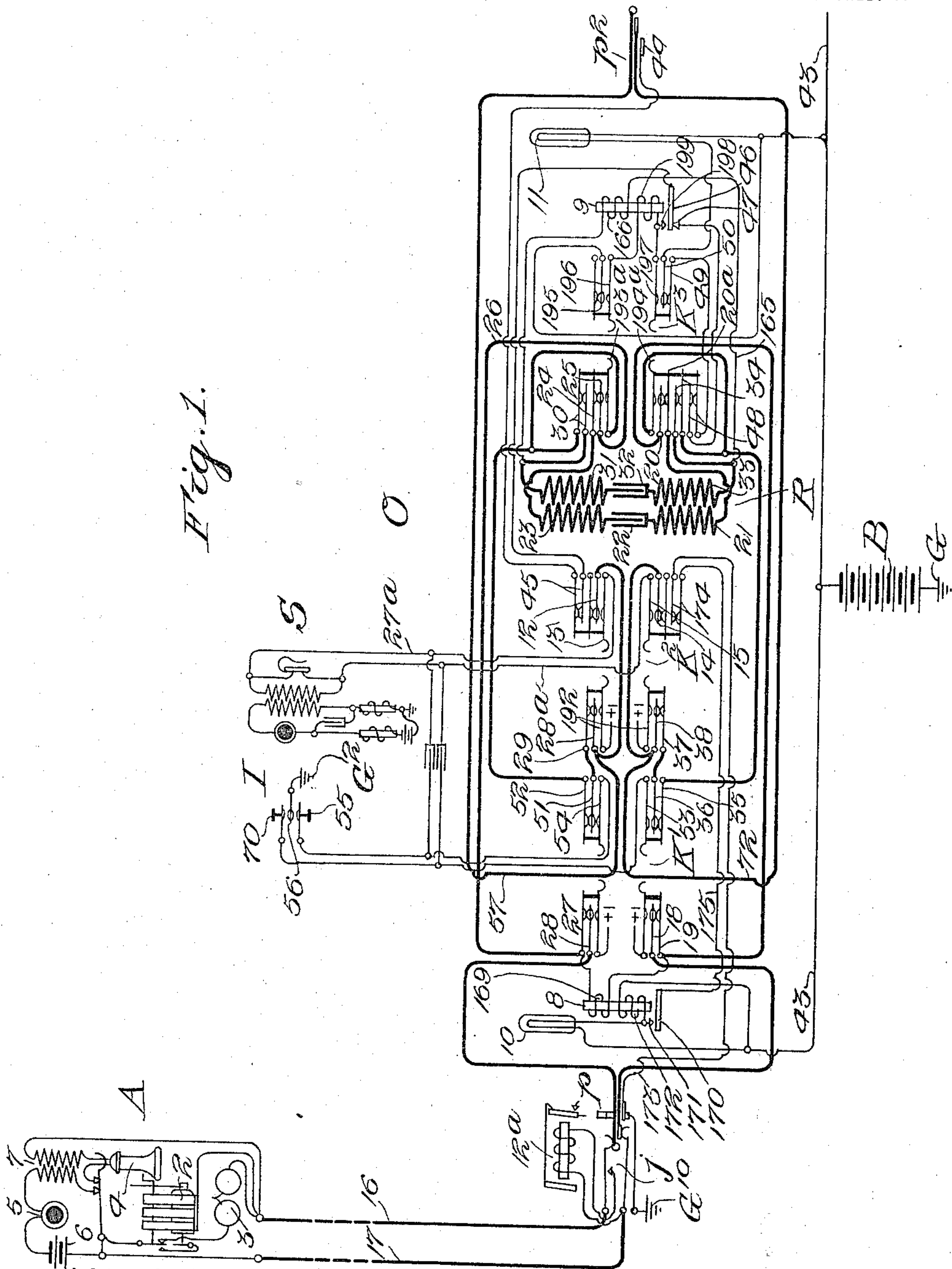


1,224,883.

3 SHEETS--SHEET 1.



Witnesses.
R. H. Bumpstead
A. B. Sperry.

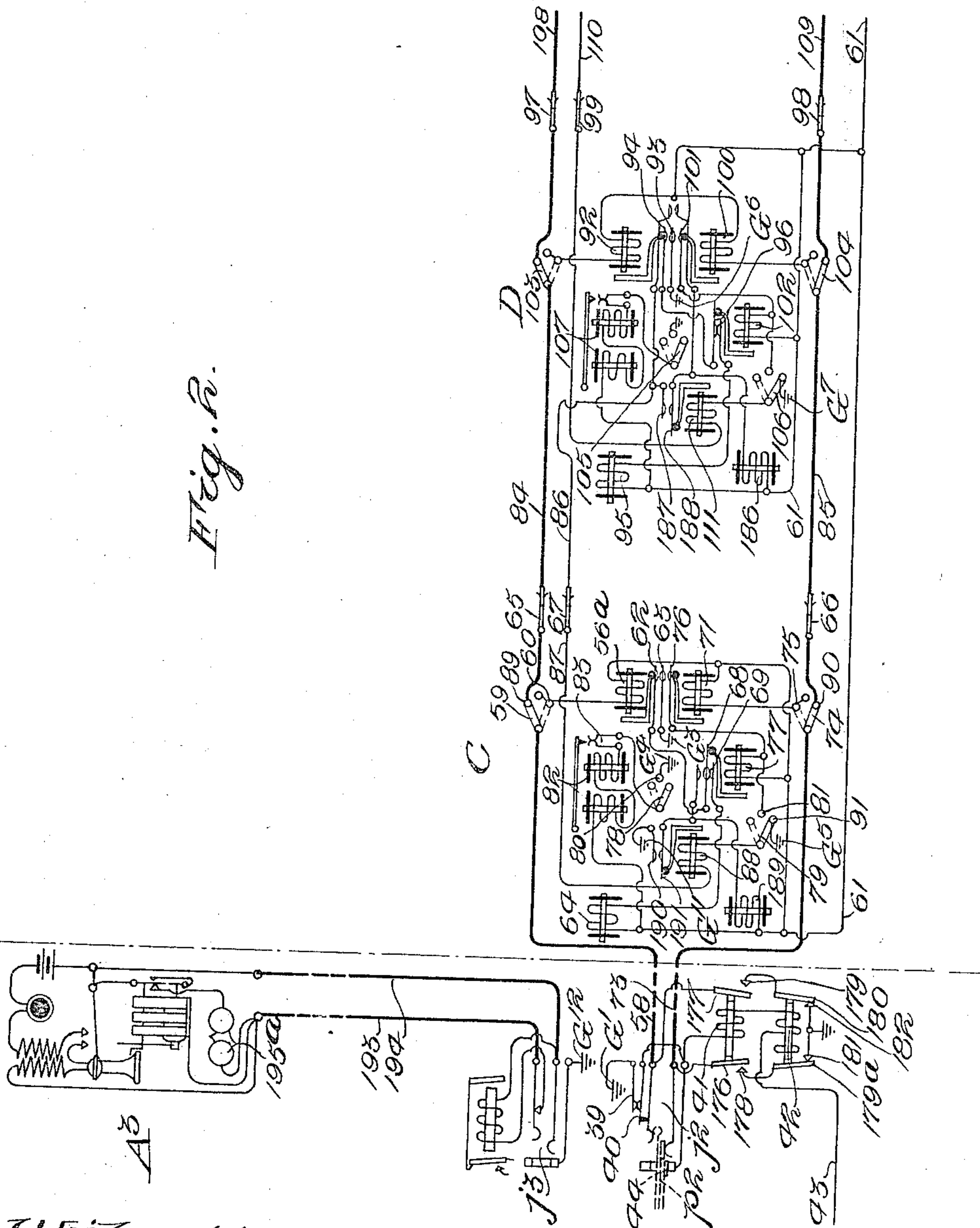
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C. MOLLERUP.
TELEPHONE SUPERVISORY SYSTEM.
APPLICATION FILED JAN. 2, 1909.

1,224,883.

Patented May 1, 1917.
3 SHEETS—SHEET 2.

Fig. 2.



Witnesses:
R. H. Birnbaum
A. B. Sperry

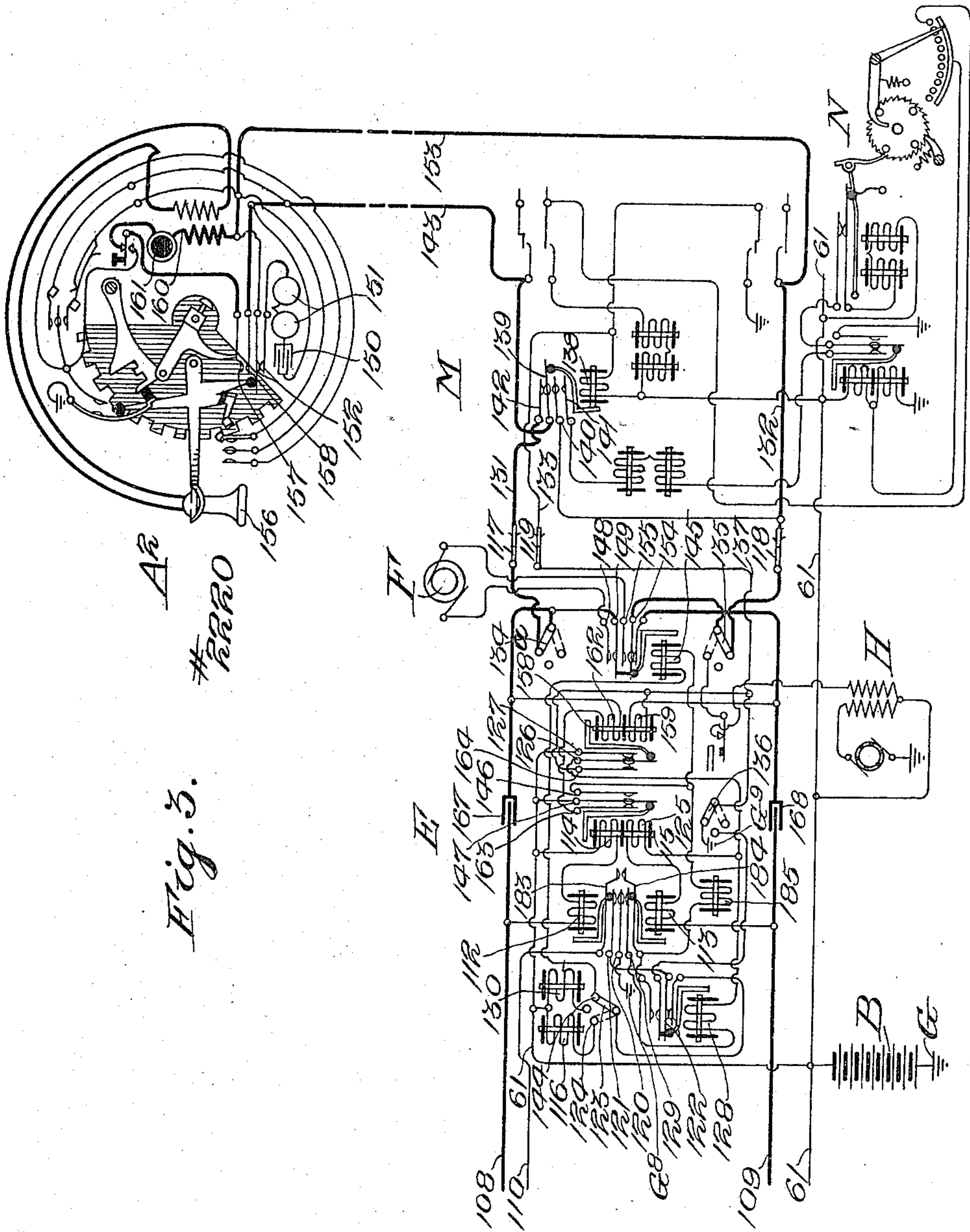
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C. MOLLERUP.
TELEPHONE SUPERVISORY SYSTEM.
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1,224,883.

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3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

CHRISTOPHER MOLLERUP, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SUPERVISORY SYSTEM.

1,224,883.

Specification of Letters Patent.

Patented May 1, 1917.

Application filed January 2, 1909. Serial No. 470,329.

To all whom it may concern:

Be it known that I, CHRISTOPHER MOLLERUP, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Telephone Supervisory Systems, of which the following is a specification.

My invention contemplates an improved cord circuit having means for affording supervision between lines of different character—for example, between a calling manual line and a called automatic common battery line, or between a calling manual line and a local battery manual line, with local battery for the calling line each time—and in which the supervision for various kinds of connections of this kind is accomplished through the medium of a single supervisory relay for each end of the cord circuit, particularly the calling end thereof, as prior to my invention a plurality of relays was necessary for the calling end of a universal cord circuit of this kind.

The nature and advantages of my invention will, however, hereinafter more fully appear.

In the accompanying drawings Figure 1 shows a subscriber's local battery substation A the line conductors of which terminate in the jack *j* at the central office. At O is shown diagrammatically my improved operator's cord for connecting different lines.

Fig. 2 shows diagrammatically the central office switching apparatus of an automatic exchange. C represents a first-selector switch the line conductors of which terminate in the jack *j*² of the manual exchange. D represents a second-selector switch.

In Fig. 3 a connector switch is shown diagrammatically at E, while a central exchange ringer generator is shown at F and a busy-signaling machine at H. A² represents an automatic substation the line conductors of which terminate in the line switch M. At N is shown the master switch that controls the plungers of the group of line switches of which M is a member.

The substation A is of the usual manual local battery type and comprises a magneto generator 2, ringer 3, receiver 4, transmitter 5, local battery 6 and induction-coil 7. The cord O comprises the supervisory relays 8 and 9 and lamps 10 and 11, repeating coil R, keys K¹, K² and K³, and in addition an op-

erator's listening and talking set S and calling device I.

The first-selector switch C and second-selector switch D (Fig. 2) are of the general type of selector switch shown in United States Patent No. 815,321, issued March 13, 1906, to Keith, Erickson & Erickson, but as used here the bridge-cut-off relay and normal conductors are omitted.

The connector switch E is of the general type of connector switch disclosed in United States Letters Patent No. 815,176, issued March 13, 1906, to Keith, Erickson & Erickson, but as here shown is arranged to operate in connection with my improved cord O, and is modified for common battery work.

The automatic substation A² (Fig. 3) is of the usual common battery type of automatic substation.

The line switch M and the master switch N are of the general type shown in English Patent No. 26,301 of 1906, and in the *Western Electrician* of January 25, 1908, and the *American Telephone Journal* of June 6, 1908.

In the drawings there are shown two batteries having their positive terminals preferably grounded. There may, however, be but one battery, or, as shown, a battery may be provided for each exchange.

My improved cord circuit O may be more clearly understood from an explanation of its operation when employed in extending a connection from one subscriber to another. Suppose, for example, that the subscriber at station A (Fig. 1) desires a connection with the substation A² (Fig. 3) of the automatic exchange. In that event the subscriber at A turns the crank of the magneto, thereby sending a current over the line conductors to the central office. This current energizes the drop 12^a, indicating to the operator that the subscriber allotted to the line thereof desires a connection. Accordingly, the operator inserts the plug *p* into the jack *j* and operates the key K² to close the springs 12 and 13 and 14 and 15 in contact, whereby the operator's set S becomes bridged across one pair of the conductors of the repeating coil R, while the calling substation A is bridged across the other pair. The calling subscriber's circuit extends from the tip of the jack *j* to the line conductor 16, through the primary circuit of substation A to the line conductor 17, ring conductors of the

jack j and plug p , through the springs 18 and 19, springs 20 and 20^a, winding 21, condenser 22, winding 23, springs 24 and 25, conductor 26, springs 27 and 28, through the tip of the plug p and jack j to the line conductor 16. The operator's circuit extends from the conductor 27^a to the springs 13 and 12, springs 28^a and 29, springs 51 and 52, springs 30, winding 31, condenser 32, winding 33, springs 34, springs 35 and 36, 37 and 38 and 14 and 15, through the winding of the operator's set to the conductor 27^a. Upon learning the number of the desired substation the operator inserts the plug p^2 into the jack j^2 (Fig. 2), and restores the key K^2 to normal position, this operation extending the line conductors of the calling substation to the trunk conductors leading to the main automatic exchange. Since the substation A is manual in form it is necessary that the desired connection be established by the operator by means of the calling device I. Furthermore, when the plug p^2 enters the jack j^2 (Fig. 2), the springs 39 and 40 are thrust into contact, thereby providing an energizing circuit for the release relays 41 and 42. This circuit extends from ground G^1 to the springs 39 and 40, release relay 41, release relay 42 to the battery lead 43, thence to battery B and to ground G. The release relays 41 and 42 thereupon energize and attract their respective armatures. It should be explained that the relay 42 is slow-acting, while the relay 41 is quick-acting. By slow-acting is meant that a relay, when once energized, remains in its energized position for a moment or two after the energizing circuit thereof is broken. The relay 41, however, is quick-acting, and as soon as the energizing circuit is broken its armatures restore to normal position; also, the circuit is provided for the supervisory lamp 11. This circuit extends from ground G^1 through the springs 39 and 40, sleeve of the jack j^2 to the sleeve conductor 44 of the cord O, springs 45, armature 46, contact point 47, springs 48, 49 and 50, through the supervisory lamp 11 to the battery lead 43, thence to battery B and to ground G. The operator then throws the key K^1 so that the springs 36 and 51 are carried out of engagement with the springs 35 and 52 and into engagement with the springs 53 and 54. This operation bridges across the calling end of the cord circuit O the operator's calling device I by means of which the central office switches of the automatic exchange are operated to extend the connection to substation A², the number of which is arbitrarily chosen as #2220.

For the first digit 2 the operator presses the push button spring 55 onto the ground post 56, thereby sending two ground impulses which operate the vertical line relay 56^a of the first-selector switch C. This cir-

cuit extends from ground G^2 to the springs 56 and 55, springs 54 and 51, 29 and 28^a, conductor 57, tip of the plug p^2 and jack j^2 to the trunk line conductor 58, through the side switch wiper 59, contact point 60, vertical line relay 56^a to the battery lead 61, thence to battery B and to ground G. Each time that the push button spring 55 is pressed onto the ground post 56, the vertical line relay 56^a is energized by a flow of current over the foregoing circuit, and each time that the vertical line relay operates, the spring 62 is pressed onto the ground spring 63. The vertical magnet 64 is thereby energized, and the wipers 65, 66 and 67 of the selector C are raised to the second bank level and brought opposite the first contact. The energizing circuit for the vertical magnet extends from ground G^3 to the springs 63 and 62, private magnet springs 68 and 69, vertical magnet 64 to the battery lead 61, thence to battery B to ground G. Following the two vertical impulses the push button spring 70 is pressed onto the ground post 56, grounding the rotary line conductor, and therefore energizing the rotary line relay 71 of the selector switch C. The current passes from ground G^2 through the springs 56 and 70, springs 53 and 36, springs 37 and 38, conductor 72, through the ring of the plug p^2 and jack j^2 to the trunk conductor 73, side switch wiper 74, contact point 75, rotary line relay 71 to the battery lead 61, thence to battery B and to ground G. The rotary line relay, upon energizing, presses the spring 76 onto the ground spring 63, thereby establishing a circuit through the private magnet 77 from ground G^3 to the springs 63 and 76, private magnet 77 to the battery lead 61, thence to battery B and to ground G. The private magnet, upon energizing and de-energizing, permits the selector side switch to pass from first to second position, whereby the side switch wipers 78 and 79 engage the contact points 80 and 81, respectively. The closure of connection between the side switch wiper 78 and contact point 80 sets up an energizing circuit for the rotary magnet 82 from ground G^4 to the contact point 80, side switch wiper 78, interrupter springs 83 to the winding of the rotary magnet 82, thence to the battery lead 61, and then to battery B and to ground G. The said rotary magnet 82 then operates to rotate the shaft wipers 65, 66 and 67 of the selector C into engagement with the first contact of the second level of the selector bank, from which contact, it is assumed, the trunk line conductors 84, 85 and 86 lead to the second-selector switch D. If the first trunk is busy, however, and the wipers pass over busy trunk lines, then as soon as the private wiper 67 engages the first grounded private bank contact the private magnet 77 energizes again, locking the side switch in second posi-

tion. The energizing circuit for the said private magnet extends from the grounded terminal G of battery B through an occupying switch (not shown) to the private wiper 67, thence over the conductor 87 to the back-release relay 88, side switch wiper 79, contact point 81, through the private magnet 77 to the battery lead 61, thence to battery B and to ground G. The private magnet 77, upon thus becoming energized, locks the side switch wiper 78 in engagement with the contact point 80, whereby the rotary magnet 82 will be energized intermittently until the wipers are carried beyond the last busy trunk line. At the instant that the private wiper 67 leaves the last busy contact point the energizing circuit through the private magnet 77 is broken, and as a result the selector side switch passes to third position. If, however, there are no busy trunk lines, the rotary magnet 82 releases the side switch to third position as soon as the wipers are carried into engagement with the first trunk line. As soon as the side switch passes to third position, as stated, the trunk line conductors 58 and 73 are extended to the conductors 84 and 85 which, in this case, it is assumed lead to the selector switch D. The extension of the line occurs, of course, as soon as the side switch wipers 59 and 74 engage the third-position contact points 89 and 90. Not only are the trunk conductors thus extended, but a guarding potential is established at the private wiper 67, when the side switch wiper 79 passes onto the grounded contact point 91, for protecting the seized trunk line from interference by other calling subscribers. This guarding potential is established from ground G⁵ to the side switch wiper 79, back-release relay 88, conductor 87 to the private wiper 67. It will be evident, of course, that the energizing circuit for the rotary magnet 82, to which reference has already been made, is destroyed when the idle trunk line is seized—that is, when the side switch wiper 78 leaves the contact point 80.

The operation of the calling device I for the second digit 2 affects the second-selector switch D. When the push button spring 55 is twice pressed onto the ground spring 56 for the second digit 2, the vertical line relay 92 of the selector switch D is energized twice in the same manner in which the vertical line relay 56^a of the selector switch C was energized for the first digit 2. The relay 92, upon energizing, presses the springs 93 and 94 into contact, thereby closing an energizing circuit through the vertical magnet 95, said circuit extending from ground G⁶ through the springs 93 and 94, private magnet springs 96 to the winding of the vertical magnet 95, to the battery lead 61, thence to battery B and to ground G. The vertical magnet thereupon ener-

gizes and operates as in the first-selector to carry the shaft wipers 97, 98 and 99 two steps in a vertical direction and opposite the bank contacts of the second level. Following the vertical impulses the push button 70 is pressed onto the ground spring 56 once, thereby energizing the rotary line relay 100 in the same manner in which the rotary line relay 71 of the selector C was energized. The rotary line relay, upon energizing, presses the spring 101 onto the ground spring 93, thereby closing the circuit through the private magnet 102, said circuit extending from ground G⁶ through the springs 93 and 101, winding of the private magnet 102 to the battery lead 61, thence to battery B and to ground G. The operation of the private magnet 102 permits the side switch wipers 103, 104, 105 and 106 to engage their contact points of the second position. When this occurs an energizing circuit is provided for the rotary magnet 107, which now operates in the usual manner to rotate the shaft wipers 97, 98 and 99 over the busy trunk line contacts to select an idle trunk line leading to the connector switch E (Fig. 3). When the idle trunk line is found, the side switch wipers pass to third position, thereby extending the trunk conductors 58 and 73 to the trunk line conductors 108 and 109. When the side switch passes to third position a guarding potential is established in the usual manner, extending from ground G⁷ to the side switch wiper 106 and back-release relay 111, to the contact point engaged by the private wiper 99. The operation of the calling device I for the last two digits affects the connector switch E (Fig. 3) by operating the vertical and rotary line relays 112 and 113. When the vertical trunk conductor 58 is grounded by pressing the spring 55 onto the spring 56, the vertical line relay 112 is energized by a flow of current from ground G² (Fig. 1) to the springs 56 and 55, through the trunk conductor 58, as explained, side switch wiper 59, shaft wiper 65, trunk conductor 84, side switch wiper 103, shaft wiper 97, trunk conductor 108, vertical line relay 112, winding 114 of the differential relay 115 to the battery lead 61, thence to battery B and to ground G. The winding 114 of the relay 115 being included in this circuit, the said relay energizes, but its operation at this particular time is without effect. Each time that the vertical line relay 112 operates for the third digit 2 the vertical magnet 116 operatively energizes to carry the shaft wipers 117, 118 and 119 in a vertical direction, one step at a time, until the said wipers are carried two steps and thus brought opposite the level in which are located the terminals of the line #2220. The circuit through the vertical magnet extends from ground G⁸ through

the springs 120 and 121, private magnet springs 122, side switch wiper 123, contact point 124, through the vertical magnet 116 to the battery lead 61, thence through battery B and to ground G. When the rotary trunk line conductor 73 is grounded, following the grounding of the vertical line conductor, the connector rotary line relay 113 becomes energized from ground G² (Fig. 1) to the springs 56 and 70, to the trunk line conductor 73, as explained, through the side switch wiper 74, shaft wiper 66, trunk conductor 85, side switch wiper 104, shaft wiper 98, trunk conductor 109, winding of the rotary line relay 113, winding 125 of the differential relay 115, springs 126 and 127 to the battery lead 61, thence through battery B and to ground G. The winding 125 of the differential relay 115 being included in this circuit, as is the winding 114 in the vertical line relay circuit, the said relay 115 energizes, but with no effect. The rotary line relay 113, upon energizing, operates to close an energizing circuit through the private magnet 128, which latter in turn operates to release the side switch from first to second position. The energizing circuit through the private magnet 128 extends from ground G⁸ to the springs 120 and 129, to the private magnet 128, springs 126 and 127, to the battery lead 61, thence through battery B to ground G. For the last digit O the operator operates the calling device I, as previously described, grounding the vertical trunk line conductor 58 ten times and the rotary trunk line conductor 73 once. The connector vertical and rotary line relays 112 and 113 are operated over previously traced circuits. However, when the vertical line relay operates, a circuit is closed through the rotary magnet 130 instead of through the vertical magnet 116, since the side switch wiper 123 is now in second position. Each time that the rotary magnet is energized the shaft wipers 117, 118 and 119 are rotated one step at a time until said wipers are carried into engagement with the normal conductors 131, 132 and 133, the first two of which conductors lead to the line terminals of the desired substation. The rotary line relay 113, upon energizing, completes an energizing circuit through the private magnet 128, as before. This latter magnet now operates with one of two results, viz: The release of the side switch from second to third position, or the so-called busy-release of the connector switch. It will be assumed that the former result occurs, and that the side switch wipers 134 and 135 are placed in connection with the shaft wipers 117 and 118, respectively. Furthermore, when the side switch passes to third position the guarding potential is established for protecting the called line. This potential extends from

ground G⁹ to the side switch wiper 136, conductor 137 to the private wiper 119, which latter engages the private contact of the called line. Furthermore, the passage of the side switch wiper 136 to the grounded contact point provides an energizing circuit for the bridge-cut-off relay 138 of the line switch M. This circuit extends from ground G⁹ to the shaft wiper 119, to the winding of the relay 138, to the battery lead 61, thence through battery B and to ground G. The bridge-cut-off relay 138, upon energizing, operates to carry the spring 139 out of engagement with the springs 140 and 141 and into contact with the spring 142. The engagement of the springs 139 and 142 extends the normal conductor 131 to the line conductor 143. In order to signal the subscriber at substation A² the operator presses the push button spring 55 onto the ground spring 56, thereby grounding the vertical line conductor 58, and the connector vertical line relay 112 and the differential relay 115 become energized as before. It will be remembered that the side switch has passed from second to third position, and that the side switch wiper 123 is in engagement with the contact point 144, thereby placing the vertical line relay 112 in control of the ringer relay 145 in the same manner in which the rotary magnet 130 came under the control of the vertical line relay when the side switch passed from first to second position. Therefore, when the vertical line relay presses the springs 120 and 121 into contact the ringer relay 145 is energized by a flow of current from ground G⁸ to the springs 120 and 121, private magnet springs 122, side switch wiper 123, contact point 144, ringer relay 145, differential relay springs 146 and 147 (bearing in mind that the differential relay 115 is energized) to the battery lead 61, thence through battery B to ground G. The ringer relay, upon energizing, operates as usual to bridge the terminals of the ringer generator F across the normal conductors at the called substation. The signaling current is, therefore, sent from the generator F to the springs 148 and 149, side switch wiper 134 to the shaft wiper 117, normal conductor 131, bridge-cut-off relay springs 142 and 139, line conductor 143, condenser 150, ringer 151, springs 152 to the line conductor 153, normal conductor 132, shaft wiper 118, side switch wiper 135, ringer relay springs 154 and 155 back to the generator F. As soon as the operator ceases to press the button 55 the ringer relay 145 becomes deenergized, and the springs assume their normal position. The subscriber at substation #2220, in response to the signal, removes the receiver 156 from the switch-hook, whereby the switch-hook rises and permits the springs 157 and 158 to engage, and the springs 152 to disengage,

thereby removing the ringer from across the line and bridging instead the primary circuit. After the called subscriber answers, the operator withdraws the key K^1 to normal position, thereby extending the trunk conductors 58 and 73 to the windings 31 and 33 of the repeating coil R. The engagement of the springs 157 and 158 when the called subscriber answers closes a series energizing circuit through both windings of the relay 158^a at the connector E, this circuit extending from ground G^9 to the side switch wiper 136, winding 159, side switch wiper 135, shaft wiper 118, conductors 132 and 153, primary winding 160, transmitter 161, springs 157 and 158 to the conductors 143 and 131, shaft wiper 117, side switch wiper 134, winding 162 of the relay 158^a, springs 163 and 147 to the battery lead 61, thence through battery B to ground G. This circuit provides the called subscriber with battery current for talking purposes. Also, when the relay 158^a thus carries current it operatively energizes and carries the spring 126 out of engagement with the spring 127 and into engagement with the spring 164, thereby disconnecting the rotary line relay 113 and the winding 125 from the battery lead 61 and connecting them to ground G^9 . This reversal of polarity provides an energizing circuit for the supervisory relay 9 of the cord O. This circuit extends from ground G^9 through the side switch wiper 136, springs 164 and 126, winding 125, relay 113, trunk conductors 109, 85 and 73, through the ring of the jack j^2 and plug p^2 , springs 38 and 37, springs 36 and 35, springs 34, conductor 165, through the winding 166 of the relay 9, through the springs 30, springs 52 and 51, springs 29 and 28^a to the tip of the plug p^2 and jack j^2 , trunk conductors 58, 84 and 108, through the vertical line relay 112, winding 114 of the relay 115 to the battery lead 61, thence through battery B to ground G. The relay 9 thereupon energizes and attracts its armature 46 from engagement with the contact point 47, whereby the circuit through the supervisory lamp 11 becomes broken; relay 115 is differentially wound and does not operate during connection.

After the called subscriber answers, and the operator restores the key K^1 , the subscribers at the two substations may communicate over the conductors indicated by heavy lines in Figs. 1, 2 and 3. The calling subscriber's circuit extends from the manual substation A to the repeating coil windings 21 and 23 as explained. The called subscriber's circuit extends from the windings 31 and 33 to the trunk conductors 58 and 73, to the conductors 108 and 109, through the condensers 167 and 168 to the normal conductors 131 and 132, thence to the substation A².

When the subscriber at substation A restores his receiver to the switch-hook on the termination of the conversation he turns the magneto 2, or "rings off," thereby providing an energizing current for the supervisory relay 8. This circuit extends from the magneto to the tip conductor 16, through the tip of the jack j and plug p , springs 27 and 28, winding 169 of the relay 8, through the springs 19 and 18, ring of the plug p and jack j to the conductor 17, thence to the other terminal of the magneto. The relay 8, upon energizing, attracts its armature 170 into engagement with the contact point 171, thereby providing a locking circuit through the winding 172, which maintains the relay 8 in an energized position until the plug p is removed from the jack j . This locking circuit extends from ground G^{10} through the ring of the jack to the ring conductor 173, through the springs 174, conductor 175 to the armature 170, contact point 171, through the winding 172 to the battery lead 43, thence through battery B to ground G. When the relay 8 is thus energized the ground potential G^{10} also provides a circuit for the supervisory lamp 10, said circuit extending from ground G^{10} to the contact point 171, as explained, then through the lamp 10 to the battery lead 43, thence through battery B to ground G, when this lamp gives the operator the disconnect signal.

When the subscriber at substation A² restores his receiver to the switch-hook the energizing circuit through the relay 158^a of the connector E is broken, and the relay is restored to normal position, whereby the spring 126 passes out of engagement with the spring 164 and into engagement with the spring 127. This spring again reverses the polarity of the rotary line relay and winding 125 of the relay 115, and the energizing circuit through the winding 166 of the supervisory relay 9 (Fig. 1) is broken, whereby the said relay deenergizes and the armature 46 restores to normal position in contact with the point 47, thus completing the circuit for the supervisory lamp 11, as previously explained. The operator, thus being given a front and back disconnect signal removes the plugs p and p^2 from their respective jacks. When the plug p^2 is removed from the jack j^2 the springs 39 and 40 disengage, thereby breaking the energizing circuit for the release relays 41 and 42. The relay 41 being a quick-acting relay immediately restores to normal position, with its armatures 176 and 177 in engagement with the contact points 178 and 179. The relay 42, however, is slow-acting, as stated, and the armatures 179^a and 180 are maintained in contact with the points 181 and 182 for a moment, thereby transmitting a ground impulse to both trunk line conductors 58 and 73 simultaneously. This produces a release of

the central office switching apparatus, since the relays 112 and 113 of the connector switch E energize simultaneously and press the release springs 183 and 184 into contact, thereby completing an energizing circuit through the release magnet 185 in series with the back-release relay 11 of the selector switch D. This circuit extends from ground G^7 (Fig. 2) through the side switch wiper 106, the back-release relay 111, shaft wiper 99, conductor 110 to the release springs 183 and 184 (Fig. 3), winding of the release magnet 185 to the springs 146 and 147 (bearing in mind that the relay 115 is now energized because the current in the winding 125 is now reversed) to the battery lead 61, thence through battery B to ground G. When the connector release magnet 185 is thus supplied with current it energizes, and as a result the switch shaft and side switch are restored to normal position, thus breaking the connection between the connector switch shaft wipers 117, 118 and 119 and the normal conductors 131, 132 and 133. The back-release relay 111 being in the same circuit with the release magnet energizes simultaneously with the latter, and operates to close an energizing circuit through the selector release magnet 186 in series with the back-release relay 88 of the first-selector switch C, pressing the springs 187 and 188 together. The circuit through the release magnet 186 extends from ground G^5 of the selector switch C through the side switch wiper 79, back-release relay 88, shaft private wiper 67, conductor 86, through the springs 187 and 188, winding of the release magnet 186 to the battery lead 61, thence through battery B to ground G. The release relay 88 now energizes and operates to in turn close an energizing circuit through the release magnet 189 of the selector switch C. This latter circuit extends from ground G^{11} through the springs 190 and 191, through the release magnet 189 to the battery lead 61, thence through battery B to ground G. The release magnets 189 and 186, when operatively energized, will remain in readiness to release their respective switches when the ground connection to the trunk line conductors 58 and 73 is broken. The release-relay 42 is slow-acting, as explained, and maintains the ground to the line conductors 58 and 73 for a moment only; and when its armatures 180 and 179^a restore to normal position the energizing circuits of the release relays and magnets are broken and the respective switches restore to normal position.

In the foregoing it has been shown how a manual subscriber may signal the operator and the operator may in turn operate the switches of the automatic exchange to complete a connection for the manual subscriber. It will now be pointed out how two sub-

scribers of a manual exchange may be connected. Suppose, for example, that the subscriber at substation A desires to speak with the subscriber at substation A³ (Fig. 2). In that event the operator is signaled in the usual manner by the subscriber at station A, and the operator in turn inserts the plug p into the jack j and operates the listening key K^2 to close the springs 12 and 13 and 14 and 15 in contact. After ascertaining the number of the desired substation the operator inserts the plug p^2 into the jack j^3 and restores the key K^2 to normal position. The key K^2 is then thrown to the opposite position, whereby the springs 28^a and 38 are separated from the springs 29 and 37 and pressed into contact with the springs 192. By this operation the terminals of the ringer generator are bridged across the line conductors 193 and 194 of substation A³, the ringing current passing from the springs 192 and 28^a to the tip of the plug p^2 , tip spring of the jack j^3 , line conductor 193 to the ringer 195^a and magneto springs to the ring conductor 194, ring of the jack j^3 and plug p^2 to the ring conductor of the cord O, to the springs 38 and 192 back to the generator; also, the key K^3 is thrown to place in contact the springs 195 and 196 and the springs 197 and 50. The called subscriber at station A³, in response to the signal, removes his receiver from the switch-hook, thereby closing the primary circuit. The line conductors at substation A are connected with the repeating coil windings 21 and 23; also, the line conductors 193 and 194 at substation A³ are extended to the terminals of the repeating coil windings 31 and 33, as explained, the key K^2 having been restored to normal position. The two subscribers may then carry on conversation over the conductors indicated by heavy lines in Figs. 1 and 2. Upon hanging up his receiver the subscriber at substation A operates the magneto 2 to "ring off" and give the operator the disconnect signal. The relay 8 is thereby energized and locked up until the plug p is removed from the jack j .

Upon restoring his receiver the subscriber at substation A³ operates the magneto in the usual manner to give the operator the disconnect signal. When the magneto is thus operated a circuit is established through the supervisory relay 9, said circuit extending from the magneto to the tip conductor 193, through the tip of the jack j^3 and plug p^2 to the springs 28^a and 29, springs 51 and 52, springs 30, through the winding 166 of the relay 9, springs 34, through the springs 35 and 36, springs 37 and 38, through the ring conductor to the ring of the plug p^2 and jack j^3 , thence to the line conductor 194 and back to the magneto. The relay 9 thereupon energizes and attracts its armature 46 into engagement with the contact point 198, whereby the locking circuit is formed, said circuit

extending from ground G^{12} at the jack j^3 to the ring 44 of the plug p^2 to the springs 45, armature 46, contact point 198, through the winding 199 and springs 196 and 195 to the battery lead 43, thence through battery B to ground G. The relay 9 is thereby locked in its energized position until the plug p^2 is removed from the jack j^3 . Also, when the armature 46 thus engages the contact point 198 the circuit is provided for the supervisory lamp 11. This circuit extends from ground G^{12} at the jack j^3 to the armature 46 and contact point 198, as explained, then through the springs 197 and 50 to the lamp 11, then to the battery lead 43, and through battery B to ground G.

When the plugs p and p^2 are removed from their respective jacks and the key K^3 is restored to normal position, the operator's cord O is then in condition to be used for another call, which may be established by any of the methods explained in the foregoing.

In the foregoing connection the repeating coil R remains in the talking circuit. There is also provided a repeating coil cut-out key K^3 by means of which the repeating coil windings may be cut out of the talking circuit and a continuous metallic circuit extended from the calling telephone to the called telephone. When it is desired to extend the connection without the use of the repeating coil the key K^3 is thrown to operate the springs shown on the left. When this is done the talking circuit extends from the tip conductor 16 (Fig. 1) through the tip of the jack and plug to the springs 28 and 27, springs 25 and 193^a, through the springs 52 and 51, 29 and 28^a to the tip of the plug p^2 and jack j^3 to the conductor 193, thence through the substation A^3 to the conductor 194, through the ring of the jack j^3 and plug p^2 , springs 38 and 37, springs 36 and 35 to the springs 194^a and 20, springs 19 and 18, through the ring of the plug p and jack j to the conductor 17, thence to the substation A. When the key K^3 is thus thrown the supervisory relay 9 is disconnected from the cord circuit, since the springs 30 and 34 are separated. The supervisory relay 8, however, remains bridged across the talking conductors, and either subscriber, upon hanging up his receiver and operating his magneto, energizes the supervisory relay 8 and gives the operator the disconnect signal as before.

Thus it will be seen that in a universal cord circuit of this character, and for the different purposes explained, I accomplish the supervision by only a single relay for each end of the cord, especially the calling end thereof, whereas prior to my invention more than two relays were necessary for taking care of this kind of work, and the supervision of the called subscriber was ac-

complished by means of at least two relays for the calling end of the cord, as distinguished from my improved cord and circuit arrangement involving only one relay for each end of the cord circuit.

The cord circuit is preferable on a toll-board, but can be used on any board. If used on a tollboard then the calling subscribers are preferably trunked thereto by any suitable, known or approved means.

The exchange is divided and subdivided, so that the call can be made by the process of elimination, in the well-known way characteristic of switches that have a vertical motion to select groups and sub-groups and rotary motion to connect with a line, either a trunk line or a subscriber's line, in any selected division or subdivision, as the case may be, and depending on the size or ultimate capacity of the exchange.

What I claim as my invention is:—

1. In a telephone system, a cord circuit, a local battery manual line, a common battery automatic line, a plug for use in extending connection from the cord to either line, and means including only a single relay for the calling end of the cord for completely supervising a call to either line.

2. In a telephone system, a cord circuit, a local battery line, a common battery line, a calling line, a plug for use in extending the call to either line, means for connecting the plug with the called line and means including only a single double-wound relay for each end of the cord for supervising the call to either local battery or common battery line.

3. In a telephone system, a cord circuit, a local battery manual line, a common battery automatic line, a plug for use in extending connection from the cord to either line, means including only a single relay for the calling end of the cord for supervising a call to either line, automatic selector and connector switches, and devices associated with the cord circuit to which said switches are responsive for calling and releasing.

4. In a telephone system, a cord circuit, a manual line, an automatic line, a plug for use in extending a call through the cord to either line, a calling line, means including only a single relay for each end of the cord for supervising the call to either manual or automatic line, automatic selector and connector switches, and devices associated with the cord circuit to which said switches are responsive for calling and releasing.

5. In a telephone system, a cord circuit, a local battery line, a common battery line, a calling line, a plug for use in extending the call to either line, means including only a single double-wound relay for each end of the cord for supervising the call to either local battery or common battery line, automatic selector and connector switches, and

devices associated with the cord circuit to which said switches are responsive for calling and releasing.

6. In a telephone system, a cord circuit, a local battery manual line, a common battery automatic line, a plug for use in extending connection from the cord to either line, means including only a single relay for the calling end of the cord for completely supervising a call to either line, and a signal by which the calling subscriber attracts the attention of the operator.

7. In a telephone system, a cord circuit, a local battery line, a common battery line, a calling line, a plug for use in extending the call to either line, means for connecting the plug with the called line, means including only a single double-wound relay for each end of the cord for supervising the call to either local battery or common battery line, and a signal by which the calling subscriber attracts the attention of the operator.

8. In a telephone system, a cord circuit, a local battery manual line, a common battery automatic line, a plug for use in extending connection from the cord to either line, means including only a single relay for the calling end of the cord for supervising a call to either line, switches having one motion to select groups and another motion to connect with a line in any selected group, and devices associated with the cord circuit to which said switches are responsive for calling and releasing.

9. In a telephone system, a cord circuit, a local battery line, a common battery line, a calling line, a plug for use in extending the call to either line, means including only a single double-wound relay for each end of the cord for supervising the call to either local battery or common battery line, switches having one motion to select groups and another motion to connect with a line in any selected group, and devices associated with the cord circuit to which said switches are responsive for calling and releasing.

10. In a telephone system, a plurality of subscribers' lines, a link circuit divided into two inductively related parts for use in extending connection from a calling to a called subscriber's line, a relay at each end of said link circuit for supervising the call, a locking winding for each of said relays, and an operator's key controlling the circuit of said locking windings, said locking circuits each including a pair of normally open contacts adapted to be closed upon said link circuit being brought into use.

11. In a telephone system, manual lines and other lines terminating at the central office in automatic telephone equipment, means including a link circuit for extending connection from a manual line to either another manual line or one of said other lines, a single relay for supervising the call,

a locking winding for said relay, and an operator's key controlling the circuit of said locking winding.

12. In a telephone system, local battery manual lines and common battery automatic lines, means including a link circuit for extending connection from a manual line to either a manual or an automatic line, a single relay for supervising the call, a locking winding for said relay, and an operator's key controlling the circuit of said locking winding.

13. In a telephone system, a plurality of subscribers' lines a link circuit divided into two inductively related parts for use in extending a connection from a calling to a called subscriber's line, a relay bridged across the line for supervising the call at each end of said trunk circuit, a locking winding for each of said relays, and an operator's key controlling the circuit of said locking windings, said locking circuits each including a pair of normally open contacts adapted to be closed upon said link circuit being brought into use.

14. In a telephone system, manual lines and other lines terminating at the central office in automatic telephone equipment, means including a link circuit for extending connection from a manual line to either another manual line or one of said other lines, a single relay bridged across the link circuit for supervising the call, a locking winding for said relay, and an operator's key controlling the circuit of said locking winding.

15. In a telephone system, local battery manual lines and common battery automatic lines, means including a link circuit for extending connection from a manual line to either a manual or an automatic line, a single relay bridged across the link circuit for supervising the call, a locking winding for said relay, and an operator's key controlling the circuit of said locking winding.

16. In a telephone system, a local battery manual subscriber's line, an automatic subscriber's line, a cord circuit for answering a call from the manual line, trunk lines, automatic switches for selecting an idle trunk, and means controlled by the operator at the cord circuit for controlling said switches to find an idle trunk to extend connection to the automatic subscriber's line, and a single relay at each end of said cord circuit for supervising said connection.

17. In a telephone system, a local battery manual subscriber's line, a common battery automatic subscriber's line, a cord circuit for answering a call from the manual line, trunk lines, automatic switches for selecting an idle trunk, means controlled by the operator at the cord circuit for controlling said switches to find an idle trunk line to extend connection to the automatic subscriber's line, and a single relay at each end of said

cord circuit for supervising said connection.

18. In a telephone system, automatic trunking switches having relays bridged across the conductors of the talking circuit for controlling said switches, a local battery manual subscriber's line, an automatic subscriber's line, a cord circuit for answering a call from the manual line, means controlled by the operator at the cord circuit for automatically extending connection to the automatic subscriber's line through said switches, said switches provided with automatic means for reducing the number of bridges across any automatically or semi-automatically established talking circuit, and a single relay at each end of said cord circuit for supervising said connection.

19. In a telephone system, automatic trunking switches having relays bridged across the conductors of the talking circuit for controlling said switches, a local battery manual subscriber's line, a common battery automatic subscriber's line, a cord circuit for answering a call from the manual line, means controlled by the operator at the cord circuit for automatically extending connection to the automatic subscriber's line through said switches, said switches provided with automatic means for reducing the number of bridges across any automatically or semi-automatically established talking circuit, and a single relay at each end of said cord circuit for supervising said connection.

20. In a telephone system, a plurality of local battery manual subscribers' lines, a cord circuit for connecting any two of said lines for talking purposes, other subscribers' lines divided into groups, automatic switching apparatus provided with means for electing one of said groups by one operation and for finding the line of a called subscriber by another operation, a calling device for said cord for operating said apparatus to connect the called line and one of the manual lines via said automatic apparatus and said cord circuit, a centralized source of current for supplying current to said other lines for talking purposes, and a single relay at each end of said cord circuit for supervising said connection.

21. In a telephone system, a plurality of local battery manual subscribers' lines, a cord circuit for connecting any two of said lines for talking purposes, other subscribers' lines divided into groups, automatic switching apparatus provided with means for electing one of said groups by one operation and for finding the line of a called subscriber by another operation, a calling device for said cord for operating said apparatus to connect the called line and one of the manual lines via said automatic apparatus and said cord circuit, said cord provided with a single supervisory relay at

each end thereof for giving the operator supervision of connection between the manual subscribers and between the manual and said other subscribers.

22. In a telephone system, a plurality of local battery manual subscribers' lines, a cord circuit for connecting any two of said manual lines, automatic subscribers' lines having calling devices, automatic switching apparatus associated with said automatic subscribers' lines and operable therefrom through the medium of said calling devices, groups of automatic lines associated with said automatic apparatus, said automatic apparatus provided with means for electing one of said groups by one motion and for picking out an automatic line in the group by another motion, means comprising said cord and automatic apparatus to connect an automatic subscriber's line and a manual line, a centralized source of current for supplying current to the automatic subscriber's line for talking purposes, and a single relay at each end of said cord circuit for supervising said connection.

23. In a telephone system, a plurality of local battery manual subscribers' lines, a cord circuit for connecting any two of said lines for talking purposes, other subscribers' lines divided into groups, automatic switching apparatus provided with means for electing one of said groups by one operation and for finding the line of a called subscriber by another operation, a calling device for said cord for operating said apparatus to connect the called line and one of the manual lines via said automatic apparatus and said cord circuit, a centralized source of current for supplying current to the automatic lines for talking purposes, said cord provided with a single supervisory relay at each end thereof for giving the operator supervision of connection between the manual and between the manual and said other subscribers.

24. In a telephone system, a plurality of local battery manual subscribers' lines, a cord circuit for connecting any two of said lines for talking purposes, other subscribers' lines divided into groups, automatic switching apparatus provided with means for electing one of said groups by one operation and for finding the line of a called subscriber by another operation, a calling device for said cord for operating said apparatus to connect the called line and one of the manual lines via said automatic apparatus and said cord circuit, said cord provided with a repeating coil between the answering and calling plugs and with a single supervisory relay at each end thereof.

25. In a telephone system, a plurality of local battery manual subscribers' lines, a cord circuit for connecting any two of said lines for talking purposes, other subscribers'

lines divided into groups, automatic switch-
ing apparatus provided with means for
electing one of said groups by one operation
and for finding the line of a called sub-
5 scriber by another operation, a calling de-
vice for said cord for operating said appa-
ratus to connect the called line and one
of the manual lines via said automatic appa-
ratus and said cord circuit, a centralized
10 source of current for supplying current to
the automatic lines for talking purposes,

said cord provided with a repeating coil be-
tween the answering and calling plugs and
with a single supervisory relay at each end
thereof.

15

Signed by me at Chicago, Cook county,
Illinois, this 24 day of Dec., 1908.

CHRISTOPHER MOLLERUP.

Witnesses:

GEORGE L. STRANG,
EDWARD D. FALES.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents,
Washington, D. C."