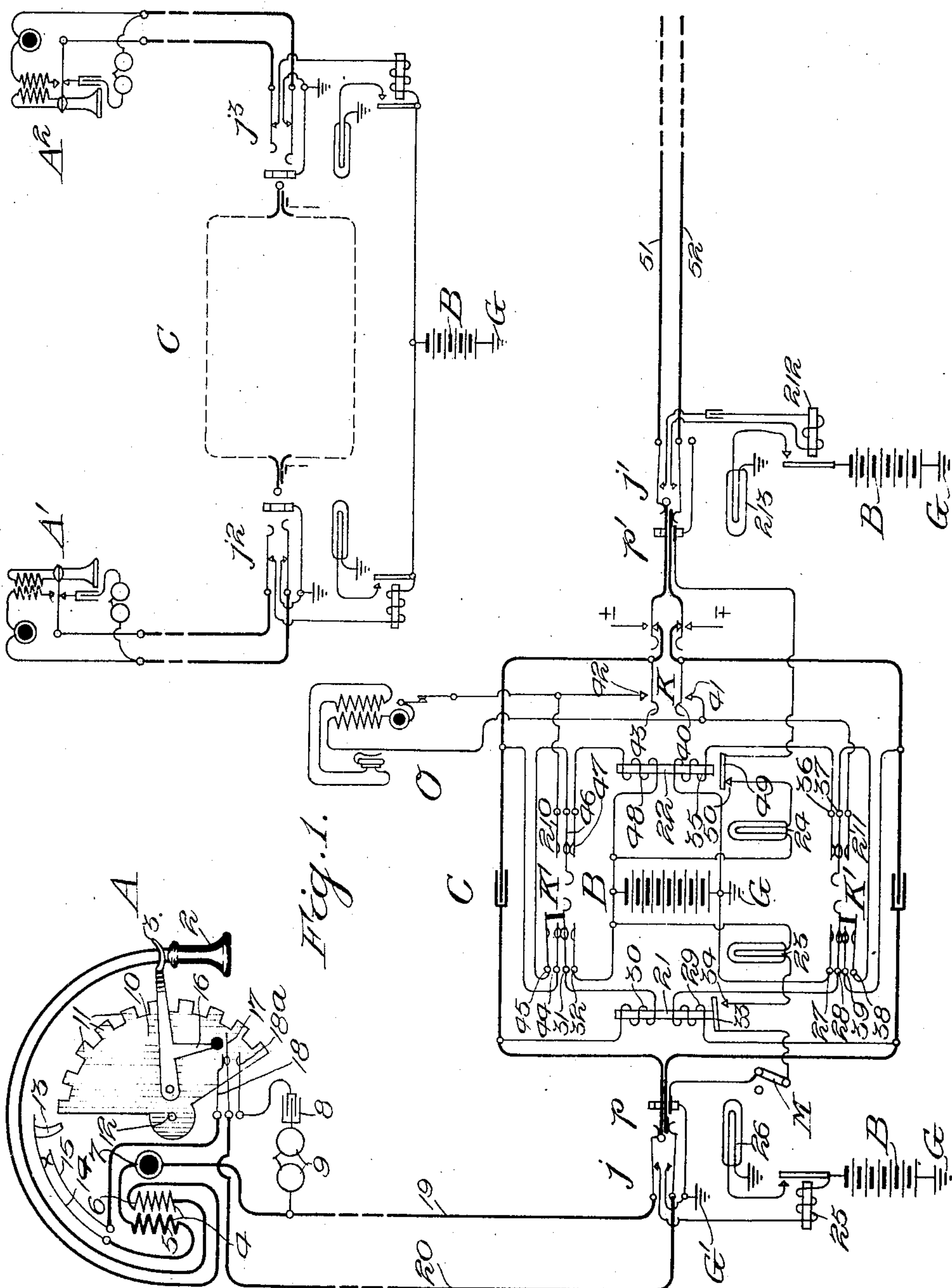


A. B. SPERRY.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED JULY 28, 1908.

1,295,229.

Patented Feb. 25, 1919.
3 SHEETS—SHEET 1.



Witnesses:
R. H. Burfeind
C. R. Nier

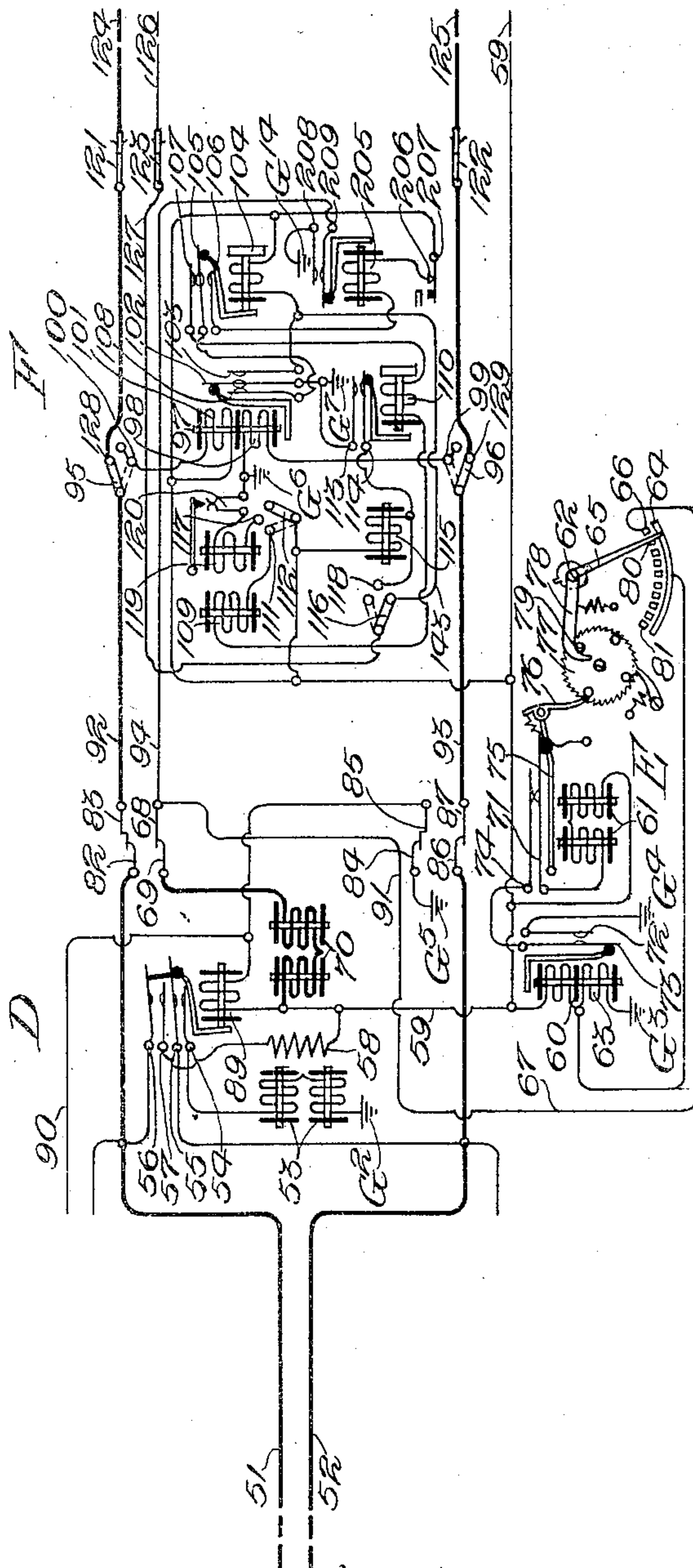
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3 SHEETS—SHEET 2.

Fig. 2.



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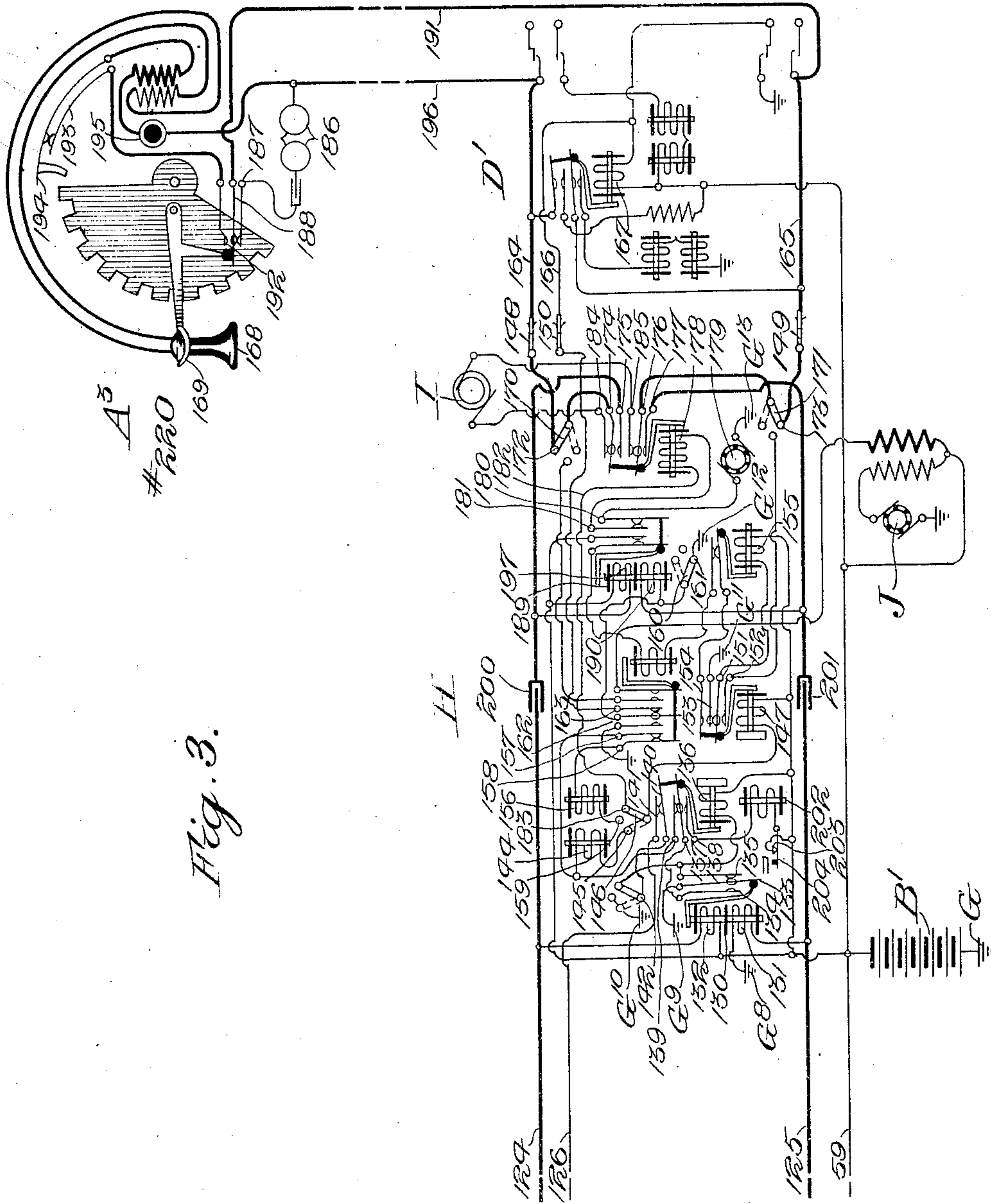


Fig. 3.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

1.295,229.

Specification of Letters Patent.

Patented Feb. 25, 1919.

Application filed July 28, 1908. Serial No. 445,769.

To all whom it may concern:

Be it known that I, ARTHUR B. SPERRY, 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-Exchange Systems, of which the following is a specification.

My invention relates to telephone exchange systems of that character in which a private branch exchange is connected by one or more trunk-lines with a main exchange, the branch exchange being equipped with manual switchboards, and the main exchange being equipped with automatic switches, such as selectors and connectors, controlled by the subscribers thereof.

The object of my invention is the provision of a manual switchboard operator's cord circuit that may be used for connecting together any two subscribers of the same private branch exchange, which may be used for extending connection from an automatic subscriber of the main exchange to any subscriber of the private branch exchange, or which may be used for extending connection from an automatic subscriber of the private branch exchange to a similar subscriber of the main exchange, there being ample supervision of the connection in each case.

Another object of my invention is the provision of a manual switchboard operator's cord circuit that may be used in conjunction or combination with a two-wire automatic telephone exchange system—that is to say, an automatic telephone system in which no operating grounds are employed at the substations, and in which the automatic switches of the exchange are, therefore, controlled by the subscribers over complete metallic line circuits.

It is also an object to provide certain details and features of improvement and combinations tending to increase the general efficiency of a telephone exchange system of this particular character, as will hereinafter more fully appear.

To the foregoing and other useful ends, my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings Figure 1 represents diagrammatically an equipment for a private branch exchange embodying the principles of my invention. A subscriber's automatic substation is shown at A,

and at A¹ and A² are two manual substations. The line conductors of each substation terminate in the usual jack. At C is shown my improved cord circuit by means of which the operator may connect any two subscribers of the private branch exchange, or any subscriber of the branch exchange with any subscriber of the main automatic exchange. In the drawings are shown several batteries B having their positive terminals preferably grounded; there may be, however, but one battery. Either arrangement constitutes a common means for supplying operating and talking current to the subscribers' lines.

In Fig. 2 there is shown diagrammatically a central office equipment in connection with which I have elected to explain my invention. The line switch D is attached to the trunk-line conductors which terminate in a jack at the private branch exchange (Fig. 1). The master switch E controls the plungers of the line switches. At F is shown a first-selector switch.

In Fig. 3 a connector switch is shown at H. To the line conductors of substation A³ there is allotted the line switch D¹, which is the same as the line switch D (Fig. 1). A central office ringer generator is shown at I, and at J is represented a busy-signaling device. A central battery, having its positive terminal preferably grounded, is shown at B'.

As shown in Fig. 1, the substations of the private branch exchange are of two types, automatic and manual.

The automatic substations may be of any suitable or approved type. As shown, it will be seen that substation A is somewhat different from the usual automatic substation, being arranged and modified to operate in connection with a two-wire system—that is, a system in which no ground connection is used at the subscriber's substation. Substation A, for example, comprises the usual receiver 2, switch-hook 3, the induction-coil 4 with the primary winding 5 and the secondary winding 6, transmitter 7, condenser 8, ringer 9, and impulse wheel 10 which has the usual impulse teeth 11. The impulse wheel 10 is secured to the shaft 12, to which shaft there is also secured the dial (not shown). When the dial is turned the impulse teeth 11 are adapted to engage the cam 13 upon the end of the spring 14 and

thereby carry the latter out of engagement with the spring 15. Upon the switch-hook 3 there is the cam 16 which, when the switch-hook is up, permits the springs 17 and 18 to engage, thereby bridging across the subscribers' line conductors 19 and 20 the primary circuit including the transmitter 7 in series with the primary winding 5; but when the switch-hook is lowered the spring 17 is carried out of engagement with the spring 18 and into engagement with the spring 18^a, whereby the ringer 9 in series with the condenser 8 is bridged across the line conductors 19 and 20 instead.

15 The manual substations A¹ and A² are of the usual standard common battery type with the line conductors terminating in jacks at the private branch board.

The operator's cord circuit C is an improvement upon the usual manual common battery cord circuit, since means are provided whereby the operator may connect a manual substation with an automatic substation of the main exchange, and, also, an automatic substation of the branch exchange may be operated to establish connection with a subscriber's station of the automatic exchange. The cord circuit C comprises the usual supervisory relays 21 and 22, supervisory lamps 23 and 24, and ringing and listening key K. In addition there is provided a key K' which is operated when the cord circuit is used in completing a connection to the main exchange. Also, a switch M is provided for disconnecting the ground at the tip from the supervisory lamp 23 when desired. At O there is shown an operator's set with a calling device.

The line switch D and master switch E are of the general type disclosed in English Patent No. 26,301 of 1906, and in the *Western Electrician* of January 25, 1908. The circuit connections are, however, modified to adapt the switches to operate in connection with a two-wire system—that is, a system in which there is no ground at the subscriber's station.

The first-selector switch F is of the general type shown in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson & Erickson. As shown in Fig. 2, the bridge-cut-off relay and the normal conductors have been omitted, and the circuits are otherwise changed to operate in conjunction with the line switch D.

The connector switch H (Fig. 3) is of the general type of connector switch shown in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson & Erickson. Like the line switch D and the first-selector F it is arranged to operate in a system in which there is no ground connection at the subscriber's station.

A clearer understanding of the operation of my improved cord circuit may be had

from an explanation of its operation when employed to connect two lines. As previously stated, the cord circuit C is a combination circuit—that is, it may be used in a private branch exchange to complete the connection between any two local subscribers in the usual manner, or it may be used when any subscriber of the branch exchange desires a connection with a subscriber of the main automatic exchange. The branch exchange operator, or the calling subscriber himself provided he calls from an automatic substation, may operate the main office switches to establish the desired connection. Furthermore, a call coming from the main automatic exchange to the branch exchange may be extended to any subscriber of the branch exchange through the medium of the cord C. For example, it will be pointed out how a subscriber of the private branch exchange may be connected with a subscriber of the main exchange. Suppose that the subscriber at the automatic substation A desires connection with the subscriber at substation A³ (Fig. 3). In that event, when the calling subscriber removes the receiver from the switch-hook an energizing circuit is closed through the line relay 25 (Fig. 1) extending from the ground G' through the jack springs to the line conductor 20 through the substation A to the line conductor 19, jack springs, line relay 25, to the battery B, thence to ground G. The line relay energizes and closes a circuit through the line lamp 26, whereupon the operator inserts the plug *p* into the jack *j*. This breaks the energizing circuit for the line relay 25, which is then restored to normal position. The operator then throws the listening key K to bridge the operator's set O across the line. The subscriber at substation A is provided with battery current from ground G through the springs 27 and 28 (the key K' being in normal position), through the winding 29 of the supervisory relay 21, sleeve conductors of the plug *p* and jack *j* to the line conductor 20, thence through the substation to the line conductor 19, tip conductor of jack *j* and plug *p*, winding 30 of the relay 21, springs 31 and 32, thence through battery B to ground G. The relay 21 energizes and attracts its armature 33, thus disengaging the contact point 34. The operator's set is provided with talking battery current from ground through the winding 35 of the supervisory relay 22, springs 36 and 37, springs 38 and 39, contacts 40 and 41 of the key K, through the primary circuit of the set O, key contacts 42 and 43, springs 44 and 45 and 46 and 47 of the key K', winding 48 of the relay 22, thence through battery B to ground G. The relay 22 energizes and attracts its armature 49, thus disengaging the contact 50. The operator, after learning that a subscriber of

the main exchange is desired, inserts the plug p' into the trunk-line jack j' , and, since the calling subscriber is at the automatic substation A, the operator throws the key K' to the position shown, placing the springs 28 and 39 and 31 and 44 in contact, thereby extending the calling subscriber's line conductors 19 and 20 to the trunk-line conductors 51 and 52. The calling subscriber is then able to establish the desired connection, independently of the operator.

To call the number 220, substation A³ (Fig. 3), the subscriber at substation A (Fig. 1) operates the calling device for each digit in the well-known manner—that is, when the substation line conductors 19 and 20 are extended to the trunk conductors 51 and 52 by the throwing of the key K' , a preliminary impulse provides an energizing circuit for the trip magnet 53 of the line switch D, whereby the line switch D is operated to seize an idle trunk-line leading to a first-selector switch. The dial is turned for the first digit and, upon returning to normal position, operates the first-selector switch to establish connection with an idle trunk-line leading to a connector switch. The impulses delivered by the dial for the last two digits are directed toward the connector H, which operates to place the shaft wipers in connection with the contacts corresponding to the desired number. The preliminary impulse for energizing the trip magnet 53 occurs when the substation line conductors are extended to the trunk-line conductors and the primary circuit is bridged across the line. When the primary circuit is thus bridged across the line, the energizing circuit for the trip magnet 53 is completed and extends from ground G² (Fig. 3) through the trip magnet 53, through the springs 54 and 55, trunk conductor 52, through the sleeve of the jack j' and plug p' , springs 39 and 28, winding 29 of the supervisory relay 21, sleeve of the plug p and jack j to the line conductor 20, through the springs 17 and 18, impulse springs 15 and 14, primary winding 5, transmitter 7 to the line conductor 19, tip of the jack j and plug p , winding 30 of the relay 21, springs 31 and 44, tip of the plug p' and jack j' to the trunk-line conductor 51 (Fig. 2), springs 56 and 57, through the resistance coil 58 to the battery lead 59, thence through battery B' to ground G. As soon as the trip magnet 53 energizes, the armature is attracted and the plunger is liberated and thrust into the bank terminal. When the plunger engages the bank terminal an energizing circuit is established through the motor magnet relay 60, which in turn operates to close an energizing circuit through the motor magnet 61 of the master switch E. The motor magnet then operates to advance all idle plungers that are in locking engagement with the shaft 62 to a point op-

posite the next idle bank terminal similar to the terminal just engaged. The circuit through the relay extends from ground G³ through the winding 63 of the relay 60 to the common segment 64, thence through the wiper 65, through the segment 66, conductor 67, bank terminal springs 68 and 69, through the winding of the release magnet 70 to the battery lead 59, thence through battery B' to ground G. Although this circuit includes the release magnet 70, the said magnet does not operatively energize, since the winding of the relay 60 is of a high resistance, while the winding of the release magnet 70 is comparatively low. The relay 60, upon energizing, operates to place the springs 72 and 73 into contact, whereby a circuit is completed through the motor magnet 61 extending from ground G⁴ through the springs 72 and 73, motor magnet springs 74 and 71, through the winding of the motor magnet 61 to the battery lead 59, thence through battery B' to ground G. The motor magnet 61, upon energizing, attracts its armature 75, whereby the pawl 76 engages the ratchet wheel 77, advancing the latter one step. When the armature 75 is attracted against the magnet cores the springs 71 and 74 disengage, thereby breaking the energizing circuit through the motor magnet 61 and permitting the armature 75 to return to normal position. The cam 78, being in engagement with the pin 79 upon the ratchet wheel 77, is operated to advance the plunger shaft 62, and consequently all idle plungers that may be in normal locked position with the shaft 62, opposite another terminal similar to the terminal engaged, assuming that the next succeeding trunk is idle. Consequently, the wiper arm 65 is carried from the contact point 66, which corresponds to the engaged terminal, to the contact point 80, which latter corresponds to the terminal before which the advanced idle plungers are now resting. Suppose that nine subscribers have called, and that the master switch has thus operated nine steps, carrying the wiper 65 to the last contact point 81. Now, when the motor magnet 61 operates for the next step, when the tenth subscriber calls, the wiper 65 passes back and drops into engagement with the contact point 66. If the first trunk is still busy the wiper 65 finds a battery potential on the contact 66, and an energizing circuit is established through the differential relay 60, which in turn operates to close an energizing circuit through the motor magnet 61. The current through the said relay 60 flows from the said contact 66 through the wiper 65 to the common segment 64, and through the winding 63 of the differential relay 60 to ground G³. When this relay energizes it operates to close the circuit through the motor magnet 61, and the motor magnet then operates, as previously explained, to

rotate the ratchet wheel 77 one step, and the master switch bank wiper 65 one step also and into engagement with the second segment 80. When thus advanced one step the
5 plunger shaft 62 carries all idle plungers that are in locking engagement with said shaft to a position opposite the first idle bank terminal, as previously explained. If there should be a guarding potential at the
10 bank segment 80 the differential relay 60 will remain energized, whereby the energizing circuit through the motor magnet 61 is again completed when the motor magnet springs 74 and 71 again engage, and as a result the motor magnet 61 is again operated,
15 whereby the plunger shaft 62 and the master switch wiper 65 are advanced another step. This process continues as long as the wiper 65 continues to find segments with
20 guarding potentials. As soon as an idle segment is found, however, the energizing circuit through the relay 60 is broken, at which time the said relay in turn breaks the energizing circuit for the motor magnet 61 until
25 the next subscriber makes a call. At the instant that the plunger enters the bank terminal the following springs are pressed into contact: 68 and 69, 82 and 83, 84 and 85, and 86 and 87. The engagement of the springs
30 84 and 85 closes a circuit through the cut-off relay 89 extending from ground G^5 through the springs 84 and 85, relay 89 to the battery lead 59, thence through battery B' to ground G . The said relay, upon energizing, operates to carry the springs 55 and 56 out of engagement with the springs 57 and 54.
35 When these springs disengage, the resistance coil 58 is disconnected from the trunk-line conductor 51, and the trip magnet 53 is disconnected from the trunk-line conductor 52. The engagement of the bank springs 84 and 85 also establishes a guarding potential by way of the normal conductor 90 to the
40 connector private bank contacts corresponding to the trunk-line that terminates in the line switch D to prevent any subscriber from calling the said line after the trunk-line has been engaged at the private branch exchange, as explained. Also, the closure of
45 connection between the springs 68 and 69 establishes a guarding potential at the master switch bank contact 66 over the following circuit: from battery B' to the battery lead 59, thence through the winding of the
50 release magnet 70, through the springs 69 and 68, conductor 91 to the said contact point 66. It will be understood that the engaged bank terminal (being the first bank terminal of the line switch bank) corresponds to the first segment 66 of the master
55 switch bank and, therefore, to the trunk-line conductors 92, 93 and 94 of which terminate in the first-selector switch F. This guarding potential protects the seized trunk
conductors 92, 93 and 94 from being seized by other plungers, as already explained. The closure of connection between the
65 springs 82 and 83 extends the calling subscriber's line conductor 19 to the trunk conductor 92 and the side switch wiper 95 of the first-selector switch F. The closure of contact between the springs 86 and 87, in a
70 similar manner, extends the subscriber's line conductor 20 to the trunk conductor 93 and to the side switch wiper 96 of the selector F. The subscriber has thus established connection with the selector switch, which is now
75 operated by the impulses that are delivered when the dial returns to normal position for the first digit. When the subscribers' line conductors 19 and 20 are thus extended to the first-selector switch F an energizing circuit is established through the line relay 97
80 extending from ground G^6 through the winding 98 to the contact point 99, side switch wiper 96, trunk conductor 93 through the bank springs 87 and 88 to the trunk-line conductor 52, then through the substation and to the trunk conductor 51, as previously
85 explained, through the bank springs 82 and 83, trunk conductor 92, side switch wiper 95, contact point 100, through the winding 101 to the battery lead 59, thence through battery B' to ground G . The relay 97, upon energizing, operates to place the springs 102
90 and 103 in contact, whereby an energizing circuit is established through the release relay 104 extending from ground G^7 through the springs 102 and 103, relay 104 to the battery lead 59, thence through battery B' to
95 ground G . The release relay 104, upon energizing, operates to carry the spring 105 out of engagement with the spring 106 and into engagement with the spring 107. This is the condition of the first-selector switch F when
100 the subscriber operates the dial for the first digit. The first digit being 2, the impulse spring 14 is twice carried out of engagement with the impulse spring 15. As a result the energizing circuit through the line relay 97
105 is broken twice, and the spring 102 comes into contact with the spring 108 twice. After the two impulses are thus delivered the line relay 97 again energizes and carries the spring 102 into contact with the spring 103.
110 The relay 104 is a slow-acting relay—that is, slow to deenergize; and when this energizing circuit is momentarily broken during the vertical impulses just delivered, the said relay does not deenergize, but remains in an operated position with the
115 spring 105 in contact with the spring 107. Then when the spring 102 engages the spring 108 two impulses are transmitted to the vertical magnet 109 from ground G^7 through the springs 102 and 108,
120 to the springs 105 and 107, through the private magnet relay 110, through

the winding of the vertical magnet 109, contact point 111, side switch wiper 112 to the battery lead 59, thence through battery B' to ground G. Two impulses being delivered, the vertical magnet 109 is thereby energized twice, and the shaft wipers are given two vertical steps in the well-known manner. It will be seen that the private magnet relay 110 is included in the energizing circuit of the vertical magnet 109. This relay also energizes, but being a slow-acting relay it energizes on the first impulse and remains so until all the impulses are transmitted. This relay, upon energizing, operates to close the springs 113 and 114 in contact, whereby an energizing circuit is established through the private magnet 115. This circuit extends from ground G' through the springs 113 and 114, private magnet 115 to the battery lead 59, thence through battery B' to ground G. The private magnet relay 110 deenergizes after the last vertical impulse, since this energizing circuit is no longer maintained after the springs 102 and 108 disengage. Hence, the said relay deenergizes, permitting the springs 113 and 114 to disengage, whereby the energizing circuit through the private magnet 115 is in turn broken, which private magnet now deenergizes and permits the side switch to pass from first to second position, allowing the side switch wipers 112 and 116 to engage the contact points 117 and 118, respectively. The closure of contact between the side switch wiper 112 and the contact point 117 sets up an energizing circuit for the rotary magnet 119 from ground G⁸ through the interrupter springs 120, through the winding of the rotary magnet 119, contact point 117, side switch wiper 112 to the battery lead 59, and through battery B' to ground G. The said rotary magnet then operates to rotate the shaft wipers 121, 122 and 123 of the selector F into engagement with the first contact of the second level of the selector banks, from which contact it is assumed the trunk-line conductors 124, 125 and 126 lead to the connector switch H. If the first trunk-line is busy, however, and the wipers have to pass over busy trunk-lines, then as soon as the private wiper 123 engages the first private bank contact, the private magnet 115 again energizes, locking the side switch in second position. The energizing circuit for said private magnet extends from the grounded terminal G of the battery B' through an occupying switch (not shown), through the private wiper 123, thence through the conductor 127 to the side switch wiper 116, contact point 118, through the winding of the private magnet 115 to the battery lead 59, thence through battery B' to ground G. The private magnet 115, upon thus becoming energized, locks the side switch wiper 112 in engagement with the contact point 117, whereby the rotary magnet 119 will be energized step by step until the wipers are carried beyond the last busy trunk-line. At the instant the private wiper leaves the last busy contact point the energizing circuit through the private magnet 115 is destroyed, and as a result the selector side switch passes to third position. If, however, there are no busy trunk-lines, the private magnet 115 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 subscribers' line conductors 19 and 20 are extended to the conductors 124 and 125 which, in this case, it is assumed lead to the connector switch F. The extending of the line occurs, of course, as soon as the side switch wipers 95 and 96 engage the contact points 128 and 129, respectively. When the subscribers' lines are thus extended to the connector switch H, an energizing circuit is established through the line relay 130 in the same manner in which the energizing circuit was established through the line relay 97 of the selector F when the subscribers' line conductors 19 and 20 were extended through the line switch bank to the trunk conductors 92 and 93. The energizing circuit through the line relay 130 extends from ground G⁸ through the winding 131, trunk conductors 125, 93 and 52 to the line conductor 20 thence through the substation to the line conductor 19, trunk conductors 51, 92 and 124, thence through the winding 132 to the battery lead 59, and through battery B' to ground G. The line relay 130, upon energizing, operates to shift the spring 133 from the spring 134 to the spring 135, whereby an energizing circuit is established through the release relay 136 extending from ground G⁹ through the springs 133 and 135, relay 136 to the battery lead 59, thence through battery B' to ground G. When the relay 136 energizes, the spring 137 is shifted out of contact with the spring 138 and into contact with the spring 139, and the spring 140 is shifted into engagement with the spring 141. This primary operation of the connector relays 130 and 136 occurs at the instant that the side switch wipers of the selector F pass to third position and extend the subscribers' line conductors to the connector H. The engagement of the springs 141 and 140 establishes a guarding potential for protecting the trunk-line conductors 124, 125 and 126 against seizure by another line and first-selector. This potential extends from ground G¹⁰ to the side switch wiper 142, springs 140 and 141, conductor 126 to the private bank contact engaged by the shaft wiper 123. Furthermore, when the side switch of the first-selector F passes to third position a new energizing circuit is established through the release relay 104, said

circuit extending from ground G^{10} at the connector switch to the conductor 126, through the shaft wiper 123, side switch wiper 116, conductor 143, through the release relay 104 to the battery lead 59, thence through battery B' to ground G .

The operation of the dial for the last two digits affects the connector switch, and when the dial is operated for the second digit 2 the impulse spring 14 is twice carried out of engagement with the spring 15, thereby momentarily deenergizing the line relay 130 twice, whereby the spring 133 twice engages the spring 134, thus sending two impulses to the vertical magnet 144 from ground G^9 through the springs 133 and 134, springs 137 and 139, through the vertical magnet 144, contact point 145, side switch wiper 146, private magnet relay 147 to the battery lead 59, thence through battery B' to ground G . The private magnet relay 147 energizes when the first impulse is delivered, and since the said relay is slow-acting it remains in an operated position until all the vertical impulses have been sent. The vertical magnet, upon being energized, operates one step at a time to carry the shaft wipers 148, 149 and 150 two steps to a point opposite the second level. The relay 147, upon energizing, shifts the spring 151 out of engagement with the spring 152 and into engagement with the spring 153; also, the spring 154 is shifted out of engagement with the spring 153. When the springs 151 and 153 engage, an energizing circuit is established through the private magnet 155 from ground G^{11} through the springs 153 and 151, private magnet 155 to the battery lead 59, thence through battery B' to ground G . The relay 147 being a slow-acting relay remains in an operated position while the vertical impulses are being sent, but after all the impulses have been delivered, and the line relay 130 returns to its operated position, the circuit through the relay 147 becomes broken, thus permitting the springs 151 and 154 to return to normal position. When the springs 151 and 153 disengage, the circuit through the private magnet 155 becomes broken, whereby the said magnet deenergizes, permitting the side switch to pass from first to second position. The calling subscriber now operates the calling device for the last digit 0, thereby transmitting ten impulses and operating the line relay 130 ten times. Each time that the line relay springs 133 and 134 engage, an energizing circuit is established through the rotary magnet 156 from ground G^9 through the said springs 133 and 134 and through the springs 137 and 139, locking relay springs 157 and 158, through the rotary magnet 156 to the contact point 159, thence through the side switch wiper 146, through the private magnet relay 147 to the battery lead 59, thence

through battery B' to ground G . Again the private magnet relay energizes, as in the previous case, remaining so until all the impulses are transmitted, thereby retaining the private magnet energized also. The rotary magnet 156 then operates to rotate the shaft wipers into engagement with the desired line #220. If this line is busy at the time, the connector side switch will be locked in second position. It will be assumed, however, that the desired line is not busy and that the connection is established. As soon as the line relay 130 ceases to operate for the last digit the private magnet relay 147 deenergizes, as heretofore explained, in this instance permitting the side switch to trip to third position. The result is that the side switch wipers respectively engage their third-position contact points. When the side switch wiper 160 engages the contact point 161 a guarding potential is completed at the private wiper 150 for protecting the seized line from outside interference while the connection is established. This guarding potential extends from ground G^{12} to the contact point 161, thence by way of the side switch wiper 160, locking relay springs 162 and 163 to the private wiper 150. Not only does this guarding potential prevent other connectors from calling in on the same line over multiples of the normal conductors 164, 165 and 166, but it also provides means for energizing the cut-off relay 167 of the line switch D' , whereby the switch D is prevented from operating when the called subscriber removes his receiver 168 from the switch-hook 169. It will also be seen that when the side switch passes to third position the trunk-release conductor 126 that runs between the first-selector and the connector is provided with guarding potential from ground G^9 through the line relay springs 133 and 135 to the trunk conductor 126. However, while the side switch is in first and second position a guarding potential for this trunk 126 is also provided from ground G^9 , but through the side switch wiper 142 direct. The reason for this is that the guarding potential from ground G^9 is interrupted while the line relay 130 is operating, and there is a possibility of some other selector similar to the selector F stopping on the same trunk-line. After the side switch passes to third position, however, there is no such danger, and the potential is provided from ground G^9 through the line relay springs, as stated. Of course, when the side switch wipers 170 and 171 engage their third-position contact points 172 and 173 the calling subscriber's line is placed in connection with the called subscriber's line over the heavy conductors shown passing through the ringer relay springs 174 and 175 on one side, and 176 and 177 on the other side. As soon as the connection is thus established,

the ringer relay 178 is energized over the circuit established when the side switch wiper 146 engages the contact point 183, the energizing current flowing from ground G¹³ through the interrupter 179, through the back-bridge relay springs 180 and 181, ringer relay 178, conductor 182, contact point 183, side switch wiper 146, private magnet relay 147 to the battery lead 59, thence through battery B' to ground G. It will be seen that as the interrupter 179 revolves, the energizing circuit of the ringer relay 178 will be broken periodically so as not to ring the called subscriber continuously. Furthermore, it will be seen that each time that the ringer relay is energized the springs 174 and 176 are separated from the ringer relay springs 175 and 177, thereby breaking connection between the calling line and the called line, and pressing the springs 174 and 176 onto the springs 184 and 185 which are the terminals of the ringer generator I. As a result ringing current is sent over the called line for energizing the bell 186 while the springs 187 and 188 are in contact. However, as soon as the called subscriber answers, the back-bridge relay 189 is energized by a flow of current from ground G¹², contact point 161, side switch wiper 160, winding 190 of the back-bridge relay 189, ringer relay springs 177 and 176, side switch wiper 171, contact point 173, rotary line wiper 149, normal conductor 165, line conductor 191, switch-hook springs 188 and 192, impulse springs 193 and 194, transmitter 195, line conductor 196, normal conductor 164, shaft wiper 148, contact point 172, side switch wiper 170, ringer relay springs 174 and 175, winding 197 of the back-bridge relay 189, thence to the battery lead 59, and through battery B' to ground G. Once the back-bridge relay 189 is energized, however, the energizing circuit for the ringer relay 178 is interrupted at a point between the springs 180 and 181, thus making it impossible for the ringer relay to energize as long as the called subscriber is on the line. The subscribers being thus connected they may communicate over the main talking conductors indicated by the heavy lines in Figs. 1, 2 and 3, and including on one side the condenser 200 at the connector H, and on the other side the condenser 201.

After the subscribers are through talking, if the calling subscriber hangs up his receiver he opens up the line circuit at a point between the springs 17 and 18, thereby initiating the release of all of the switches. This release is brought about as follows: At the instant that the circuit is broken between the said springs 17 and 18, the double-wound line relay 130 and the release relay 136 of the connector H deenergize. At the instant that the slow-acting relay 136 and the line relay 130 deenergize, the energizing

circuit for the release magnet 202 is closed at a point between the springs 137 and 138 and at another point between the springs 133 and 134. A flow of current is, therefore, set up from ground G⁹ through the springs 133 and 134, through the springs 137 and 138 to the release magnet 202, thence through said magnet and to the off-normal spring 204, to the contact point 203 and to the battery lead 59, thence through battery B' to ground G. The release magnet instantly releases the connector switch shaft and side switch, thereby breaking the energizing circuit through the back-bridge relay 189 if the called subscriber has not in the meantime restored his receiver, and also the energizing circuit through the bridge-cut-off relay 167 of the called line switch D'. As soon as the connector switch shaft reaches its lowest position it breaks the circuit for the release magnet 202 by separating the off-normal spring 204 from the contact point 203, at which instant the release magnet of the connector is also restored. The operation of the line relay 130 and of the slow-acting relay 136 not only causes the release of the connector, as described, but also the release of the preceding switches, because the ground connection from ground G⁹ to the trunk-release conductor 126 is interrupted by both of these relays. Since the release relay 104 is dependent upon this ground for its energized condition, as already explained, it follows that they will fall back, with the following results: As soon as the release relay 104 of the selector F deenergizes, the springs 105 and 106 are brought into contact, and as a result the energizing circuit for the release magnet 205 is closed. The energizing current for this release magnet 205 then flows from ground G⁷ through the springs 102 and 108, and through the said springs 105 and 106 to the release magnet 205, thence through said magnet to the contact point 206, off-normal spring 207 to the battery lead 59, thence through battery B' to ground G. The release magnet, upon energizing, then restores the first-selector side switch and switch shaft, which switch shaft, upon reaching its lowest position, opens the energizing circuit for the release magnet 205 at a point between the off-normal spring 207 and the contact point 206. Furthermore, when the release magnet 205 energizes and closes the springs 208 and 209 in contact an energizing circuit is established through the release magnet 70 of the line switch D. This circuit extends from ground G¹⁴ through the springs 208 and 209, conductor 94 to the bank springs 68 and 69, thence through the release magnet 70 of the line switch D to the battery lead 59, and through battery B' to ground G. It will be seen that the release magnet will then energize

and attract its armature, remaining in readiness to restore the switch. As the release magnet 205 deenergizes and separates the springs 208 and 209, the release circuit is broken, which permits the release magnet 70 of the line switch D to deenergize, thereby withdrawing the plunger from the bank terminal. As a result the bank springs 68 and 69, as well as the other bank springs of the line switch D, are separated, thus preventing any other action from the trunk. After the switches are thus restored, of course, the calling subscriber can then proceed to make another call.

Furthermore, when the subscriber at substation A restores his receiver, the energizing circuit through the windings 29 and 30 of the supervisory relay 21 (Fig. 1) becomes broken, and the relay armature 33 returns to normal position in contact with the point 34, thereby closing a circuit through the supervisory lamp 23. The glowing of this lamp indicates to the operator that the subscriber at substation A has restored his receiver and no longer desires the trunk-line connection. The plugs p and p' are removed from the jacks j and j' and the key K' is restored to normal.

Had the subscriber at the manual substation A^1 desired connection with the automatic station A^3 , the connection would have been made by the operator. The plug p is inserted in the jack j^2 and the plug p' in the trunk-line jack j' . The key K' is operated to place the springs 46 and 40, and 47 and 210 in contact, thereby bridging the operator's set and calling device O across the trunk-line conductors 51 and 52. The operator then operates the calling device once, in the usual manner, for each digit of the desired number to complete the connection. After the desired connection is established the key K' is thrown in the opposite direction, and the line conductors of the substation A^1 are extended to the trunk conductors 51 and 52. When the subscriber at substation A^1 restores his receiver on the termination of the connection, the circuit through the connector line relay is broken, as explained in connection with substation A, and the central office switching apparatus is restored in the usual manner. Also, when this occurs the circuit through the supervisory relay 21 is broken and the operator is given a disconnect signal. It should also be pointed out that the substation A, by means of the cord C, may become a regular substation of the main automatic exchange. This is sometimes desirable, as at night. For instance, the trunk-line may be plugged in on the substation A and all incoming calls are received at the substation A; also from the substation A a call may be made to the main exchange. Of course, when the

line is not in use the supervisory relay 21 would be in a deenergized position, and the signal lamp 23 would glow continuously, but to meet this condition the night switch M is provided, whereby the ground at the jack may be cut off from the supervisory relay armature 33. When a call comes in over the trunk-line for a subscriber at the branch exchange an energizing circuit is closed through the trunk-line relay 212 including in series the ringing current generator of the calling connector. The line relay 212, upon energizing, closes a circuit through the signal lamp 213. The operator responds by inserting the plug p' into the trunk-line jack j' , and upon learning that substation A^2 , for example, is wanted inserts the plug p into the jack j^2 , and throws the key K' to the position shown. This operation extends the trunk-line conductors 51 and 52 to the line conductors of the substation A^2 . The substation A^2 then receives ringing current direct from the connector of the automatic exchange. When the subscriber at substation A^2 answers, the back-bridge relay of the connector energizes and breaks the energizing circuit for the ringer relay in the same manner as when an automatic substation is called.

The cord circuit C may also be used to complete connection between the lines of two local private branch exchange subscribers. Suppose that a local subscriber A^1 desires connection with another local subscriber at substation A^2 . The plug p is inserted in the jack j^2 and the plug p' in the jack j^3 . The keys K and K' remain in normal position during conversation; the substation A^1 is provided with talking battery current through the windings of the supervisory relay 21, and through the winding of the supervisory relay 22 the substation A^2 receives similar current. These two relays energize and attract their respective armatures, but when either subscriber restores his receiver the corresponding supervisory relay deenergizes and permits its armature to engage its contact point, thereby closing a circuit through the supervisory lamp. This circuit extends from ground at the jack over the third conductor to the relay armature and contact point, through the supervisory lamp to the battery B and to ground G. The operator is thereby given the disconnect signal and accordingly removes the plugs from the jacks.

In the foregoing it has been shown how my improved cord circuit may be used in extending a connection from an automatic substation and from a manual substation of the private branch exchange to a subscriber of the main automatic exchange; also how a subscriber of the automatic exchange may call and receive connection with a subscriber

of the branch exchange. Furthermore, any two subscribers' stations of the branch exchange may be connected by the cord C in the usual way. When the cord is used in a trunk-line connection the trunk key K' is thrown to the position indicated, and the relay 21 controls the circuit of the supervisory lamp 23, the supervisory relay 22 being disconnected from the circuit when the key K' is thus thrown. The key K' is used only when the cord is used in a trunk connection, the key K being the usual ringing and listening key. Thus it will be seen that the cord circuit C is not limited to service in one class of connections, but is a combination cord, and admits of use both in local connections and in trunk connections, which latter may, moreover, be either incoming or outgoing.

The cord circuit C is, therefore, of universal utility, being adapted for use in trunking either from or to the main exchange, and being also adapted for connecting any two subscribers of the branch exchange. There is ample supervision at all times, regardless of the character of the connection. The supervision is double in all local connections—that is to say, there is both front and back supervision—while in calls from the main to the branch exchange, or from the branch to the main exchange, there is single supervision only. Moreover, it will be seen that this cord circuit is adapted to operate in conjunction with a two-wire telephone system—that is to say, a system of the kind shown in which no operating grounds are employed at the substations, and in which the automatic switches of the exchange are, therefore, controlled by the subscribers over complete metallic line circuits. Again, it will be seen that the trunk-line extending between the branch and main exchanges is a two-way trunk line—that is to say, one adapted for calling in either direction. The cord circuit, as explained, is adapted to serve in conjunction with the two-way trunk-line for extending calling connections in either direction.

What I claim as my invention is:—

1. In a telephone system, a two-way trunk-line, a spring jack for one end of said trunk-line, an operator's cord provided with a plug for insertion in said jack to extend connection over the trunk-line in one direction, an automatic switch for seizing the other end of said trunk-line to extend connection over the same in the opposite direction, means in said cord circuit for supervising the connections, and another automatic switch controlled over the two sides of said cord circuit in series for extending connection from one end of said trunk-line.

2. In a telephone system, a two-way trunk-line, a spring jack for one end of said trunk-

line, an operator's cord provided with a plug for insertion in said jack to extend connection over the trunk-line in one direction, an automatic switch for seizing the other end of said trunk-line to extend connection over the same in the opposite direction, another automatic switch for extending connection from one end of said trunk-line, and means by which a calling subscriber may control said last-mentioned automatic switch after the said plug has been inserted in said jack.

3. In a telephone system, telephones, a two-conductor line individual to each telephone, a two-way trunk-line, a non-numerical trunking switch for extending connection from one end of said trunk-line, means for extending connection to or from the other end of said trunk-line, and means by which a calling subscriber controls said switch over two sides of the line circuit in series.

4. In a telephone system, telephones, a two-conductor line individual to each telephone, a two-way trunk-line, an automatic switch allotted to one end of said trunk-line for extending connection therefrom, means by which a calling subscriber controls said switch over two sides of the line circuit in series, and means for extending connection to or from the other end of said trunk-line.

5. In a telephone system, telephones, a two-conductor line individual to each telephone, a two-way trunk-line, an automatic switch for seizing and thereby extending a call over said trunk-line in one direction, another automatic switch for extending a call over the trunk-line in the opposite direction, and means by which calling subscribers control said automatic switches over two sides of the line circuits in series.

6. In a telephone system, subscribers' line circuits including a pair of talking conductors, a two-way trunk line, automatic switches, means by which calling subscribers control said switches over said talking conductors in series to extend calls over said trunk line in opposite directions, and a two-way cord circuit adapted for use in calling in either direction over said trunk line.

7. In a telephone system, subscribers' line circuits including a pair of talking conductors, a two-way trunk line, a manual switch-board operator's cord circuit which is two-way for extending connections to or from one end of said trunk line, an automatic switch for extending a connection from the other end of said trunk line, and means by which a subscriber calling over said cord circuit and trunk line controls said automatic switch over a pair of said talking conductors in series.

8. In a telephone system, a two-way trunk-line, automatic switches for extending connection to or from one end of said trunk-

line, a jack for the other end of said trunk-line, subscribers' lines, and a two-strand cord circuit for extending connection from a subscriber's line to said trunk-line, or vice versa, depending upon the direction of the call, one of said switches controlled over the two sides of said cord circuit in series.

9. In a telephone system, a two-way trunk-line, automatic devices for extending connection to or from one end of said trunk-line, a spring jack for the other end of said trunk-line, subscribers' lines, a cord circuit adapted for connecting together any two of said subscribers' lines, means for adapting the said cord circuit for use in connecting a subscriber's line with the said trunk-line, and a supervisory signal for the cord circuit controlled by the calling subscriber.

10. In a telephone system, a two-way trunk-line, an automatic switch for extending connection from one end of said trunk-line, another automatic switch for extending connection to the same end of said trunk-line, a spring jack for the other end of said trunk-line, a line signal associated with said spring jack, subscribers' lines terminating at a manual switchboard, an impulse sender or calling device for the substation of at least one of said subscribers' lines, an operator's cord circuit for connecting together any two of said subscribers' lines, means by which the operator adapts the said cord circuit for use in extending connection from the line having the calling device to the trunk-line, said cord circuit being two-way to extend connection either to or from the trunk-line, and means whereby both front and back supervision is given the operator at the said cord circuit.

11. In a telephone system, a subscriber's line including a pair of talking conductors, an operator's cord circuit, an automatic switch, means for connecting said cord circuit with said switch, and means by which a calling subscriber controls the said automatic switch over said talking conductors and the two talking strands of said cord circuit in series.

12. In a telephone system, a subscriber's line circuit including a pair of talking conductors, a trunk line extending from one exchange to another, means for establishing a connection between said line circuit and said trunk line, an automatic switch at one end of said trunk line, and means by which a calling subscriber controls said switch over a circuit including the two talking conductors of both the subscriber's line and said trunk line in series.

13. In a telephone system, a metallic line circuit, a trunk-line extending from one exchange to another, means for establishing a connection between said line circuit and said trunk-line, an automatic switch at one end

of said trunk-line, and means for controlling said switch over the metallic circuit including the two sides of said trunk-line in series.

14. In a telephone system, a metallic line circuit, an automatic switch, a manual switchboard operator's cord circuit provided with two parallel talking strands, and means for controlling said automatic switch over the metallic circuit including said talking strands in series.

15. In a telephone system, a line circuit having two individual talking conductors, a trunk-line, another trunk-line, a non-numerical trunking switch for automatically connecting one trunk-line with the other, and means comprising a relay individual to the switch for controlling said switch over the talking conductors in series.

16. In a telephone system, line circuits each including a pair of talking conductors, a trunk-line, an automatic switch for seizing said trunk-line, another trunk-line, a non-numerical trunking switch for automatically connecting the first trunk-line with the second trunk-line, and means for controlling said switches over line circuits each including a pair of said talking conductors in series.

17. The combination, in a semi-automatic telephone exchange trunking system, of selectors and connectors responsive to a calling subscriber, and means by which an operator connects a selector with the line of the calling subscriber before the call can be extended in the direction of the called subscriber, a line relay for each selector and connector, each line relay being energized over two sides of the calling line in series.

18. The combination, in a telephone exchange system, of a plurality of subscriber's lines, a number of first selector switches less than the number of subscribers' lines, a trunk, means manually controlled for connecting said trunk to any of said selectors and to any calling line, whereby such said first selector switch is brought into connection with any calling line, together with means whereby the said selector switch may then be controlled by the subscribers to select the line wanted whereby a talking circuit may be set up between the calling and the wanted lines, said talking circuit including conductors in both sides of the calling line, and to restore the switches after use, and signal devices connected with the manual portion of the apparatus to indicate to the operators the necessity for connection and disconnection, each selector having a line relay energized over said talking conductors in said both sides of the calling line in series, substantially as described.

19. The combination, in a telephone exchange system, of a plurality of subscribers' lines, a number of first selector switches less

than the number of subscribers' lines, means including operators' cord circuits for connecting said first selector switches with the calling lines, each of said cord circuits common to said selectors for connecting any line with any selector together with sending devices at the substations, and responsive devices at the central station whereby the said selector switches may then be controlled by the subscribers to select the lines wanted to establish a talking circuit that includes a conductor in each side of the calling line, and to restore the switches after use, line-annunciators and clearing-out annunciators connected with the lines and cords, respectively, to indicate to the operators the desire of the respective subscribers for connection and disconnection, each selector having a line relay energized over said talking conductors in said both sides of the calling line in series, substantially as described.

20. In a telephone system, an automatic switch for finding the called line, means including operator controlled connections for connecting said switch, and a line relay for said switch energized over the two sides of the calling line in series to control the operation of said switch to set up a talking circuit over said two sides, said operator's connection normally disconnected from said relay.

21. In a telephone system, trunks divided into groups, a switch for automatically selecting an idle trunk in a predetermined group, means whereby an operator connects the said switch with a calling line, and a line relay individual to each switch whereby the calling subscriber then controls the said switch, said relay energized over said two sides of the calling line in series, said line relay normally disconnected from said operator's means.

22. In a telephone system, subscribers' lines divided into groups, an automatic switch for enabling a calling subscriber to find any certain line in any predetermined group, means including operator-controlled connections for extending connections from the calling line to said switch, and a line relay individual to said switch to set up a talking circuit over two sides of the calling line whereby said calling subscriber controls the said switch, said relay energized over the two sides of the calling line in series, said line relay normally disconnected from said operator's controlled connection.

23. In a telephone system, an automatic switch for finding the called line, means including operator-controlled connections for extending connections from the calling line to said switch, a line relay individual to said switch whereby the calling subscriber then controls the said switch to set up a talking circuit over two sides of the calling line,

said relay energized over said two sides of the calling line in series, and means whereby the calling subscriber signals the operator for disconnection, said line relay normally disconnected from said operator's controlled connection.

24. In a telephone system, trunks divided into groups, a switch for automatically selecting an idle trunk in a predetermined group, a line leading to said switch, means whereby an operator connects the said line with a calling line, means whereby the calling subscriber then controls the said switch over the two sides of said first line in series to set up a talking circuit over the said two sides of the calling line, said relay normally disconnected from said operator's means, and means whereby the calling subscriber signals the operator for disconnection.

25. In a telephone system, subscribers' lines divided into groups, an automatic switch for enabling a calling subscriber to find any certain line in any predetermined group, means including operator-controlled connections for extending connections from the calling line to said switch, a line relay whereby the calling subscriber controls the said switch to set up a talking circuit over two sides of the calling line, said relay energized over the said two sides of the calling line in series, said relay being normally disconnected from said operator-controlled connections, and means whereby the calling subscriber signals the operator for disconnection.

26. In a telephone system, an automatic switch for finding the called line, means including operator-controlled connections for extending connections from the calling line to said switch, means whereby the calling subscriber then controls the said switch over the two sides of the calling line in series, and supervisory relay mechanism whereby the called subscriber signals the operator for disconnection.

27. In a telephone system, trunks divided into groups, a switch for automatically selecting an idle trunk in a predetermined group, means whereby an operator connects the said switch with a calling line, means whereby the calling subscriber then controls the said switch over the two sides of the calling line in series, and supervisory relay mechanism whereby the called subscriber signals the operator for disconnection.

28. In a telephone system, subscribers' lines divided into groups, an automatic switch for enabling a calling subscriber to find any certain line in any predetermined group, means including operator-controlled connections for extending connections from the calling line to said switch, means whereby the calling subscriber controls the said

switch over the two sides of the calling line in series, and supervisory relay mechanism whereby the called subscriber signals the operator for disconnection.

- 5 29. In a telephone system, a plurality of first selectors, each adapted to operate in accordance with the first digit of the called number, a switch for automatically selecting idle first selectors, a manual switchboard
10 whereby an operator connects the said switch and the automatically selected idle first selector with the line of the calling subscriber, and means whereby the calling subscriber controls the said selector over the
15 two sides of the calling line in series.

30. In a telephone system, an operator's cord circuit, an automatic switch, a line relay normally disconnected from said cord circuit individual to said switch for controlling the
20 switch whereby a talking circuit may be set up therethrough and over conductors in the two sides of the cord circuit and an energizing circuit for said relay which includes the said two sides of a cord circuit in series.

- 25 31. In a telephone system, a main exchange and a branch exchange, a cord circuit at said branch exchange for use in extending a connection between subscribers of said branch exchange, or between said branch
30 exchange and said main exchange, front and back supervisory signals for said cord, and means for rendering said back supervisory signal inoperative when a call goes in from the branch exchange to the main exchange.

- 35 32. In a telephone system, a main exchange and a branch exchange, a cord circuit at said branch exchange for use in extending connection between subscribers of said branch exchange, or between said branch
40 exchange and said main exchange, means for giving double supervision of calls when said cord is used for establishing a connection between subscribers of said branch exchange, or for extending connection from said main
45 exchange to said branch exchange, and means for giving single supervision when said cord is used for extending a connection from said branch exchange to said main exchange.

- 50 33. In a telephone system, a main exchange and a branch exchange, a cord circuit for use in establishing a connection between subscribers of said branch exchange, or for extending a connection between said branch
55 exchange and said main exchange, front and back supervisory signals for said cord circuit, an impulse-transmitting device, automatic switches at the central office controlled thereby, an operator's key, and means controlled by said key for connecting the oper-
60 ator's impulse-transmitting device with said cord, and for disconnecting one of said supervisory signals from said cord.

34. In a telephone system, a branch ex-
change and a main exchange, a cord circuit 65
at said branch exchange, a supervisory relay normally bridged across said cord, a super-
visory signal controlled by said relay, an operator's key, an impulse-transmitting de-
vice, means controlled by said key for dis- 70
connecting said relay from said cord and for connecting said impulse-transmitting device with said cord to transmit impulses, and an automatic switch controlled by said im-
pulses. 75

35. In a telephone system, a calling and a called subscriber's line, means including an operator's cord circuit and an automatic switch for extending a connection between said lines, means for connecting one end of
80 said cord with said calling subscriber's line and the other end with said automatic switch, a pair of condensers in the two sides of said cord, thereby preventing direct con-
nection between said subscribers' lines and 85
said automatic switch, a key for short-circuiting said condensers so as to establish a direct connection between said subscriber's line and said switch, a supervisory relay, and means controlled by said key switch 90
for rendering said supervisory relay inoper-
ative.

36. In a telephone system, telephones, a two-conductor line individual to each tele-
phone, a two-way trunk-line, an automatic 95
switch allotted to one end of said trunk line for extending connection therefrom comprising a central battery common to the lines, means by which a calling subscriber initially controls said switch over two sides of the
100 line circuit in series, and means for extending connection to or from the other end of said trunk line.

37. In a telephone system, telephones, a two-conductor line individual to each tele- 105
phone, a two-way trunk line, an automatic switch allotted to one end of said trunk line for extending connection therefrom comprising a central battery common to the
lines, means by which a calling subscriber 110
initially controls said switch over two sides of the line circuit in series, and means for extending connection to or from the other end of said trunk line, said switch responsive to the closure of a bridge circuit across
115 the trunk line.

38. In a telephone system, a trunk line terminating at one end in a manual con-
nective terminal and provided at the other
end with two branches, terminating, re- 120
spectively, in fixed and movable contacts in numerical and non-numerical automatic trunking switches, means including said terminal and the said non-numerical switch for extending calls over said trunk line in
125 one direction, and means including said

numerical switch and said terminal for extending calls over said trunk line in the opposite direction.

39. In a telephone system, a trunk line terminating at one end in a spring jack, means including said jack and an automatic switch at the other end of said trunk line controllable thereover for extending calls over said trunk line in one direction, and means including a second automatic switch operable to seize said trunk line at one end and the said jack at the other end of said trunk line for extending calls thereover in the opposite direction, other automatic switches associated with said first automatic switch in a group, trunk lines accessible to said group of switches, and a master switch common to the switches of said group for selecting an idle trunk for calls in said first direction.

40. In a telephone system, a trunk line terminating at one end in a spring jack and provided at the other end with two branches, terminating, respectively, in fixed and movable contacts in numerical and non-numerical automatic trunking switches, means including said jack and the said non-numerical switch for extending calls over said trunk line in one direction, and means including said numerical switch and said jack for extending calls over said trunk line in the opposite direction.

41. In a telephone system, a trunk line terminating at one end in a manual connective terminal and provided at the other end with two branches, terminating, respectively, in fixed and movable contacts in numerical and non-numerical automatic trunking switches, means including said terminal and the said non-numerical switch for extending calls over said trunk line in one direction, means including said numerical switch and said terminal for extending calls over said trunk line in the opposite direction, and a circuit for making said trunk line busy to said numerical switch whenever the said non-numerical switch is operated.

42. In a telephone system, a trunk line terminating at one end in a manual connective terminal and provided at the other end with two branches, terminating, respectively, in fixed and movable contacts in numerical and non-numerical automatic trunking switches, means including said terminal and the said non-numerical switch for extending calls over said trunk line in one direction, means including said numerical switch and said terminal for extending calls over said trunk line in the opposite direction, and means including a relay for rendering said non-numerical switch inoperative whenever said trunk line is seized by said numerical switch.

43. In a telephone system, a trunk line

terminating at one end in a spring jack, means including said jack and an automatic switch at the other end of said trunk line controllable thereover for extending calls over said trunk line in one direction, means including a second automatic switch to seize said trunk line at one end and the said jack at the other end of said trunk line for extending calls thereover in the opposite direction, and a circuit for making said trunk line busy to said second switch whenever the said first switch is operated, other automatic switches associated with said first automatic switch in a group, trunk lines accessible to said group of switches, and a master switch common to the switches of said group for selecting an idle trunk for calls in said first direction.

44. In a telephone system, a trunk line terminating at one end in a spring jack, means including said jack and an automatic switch at the other end of said trunk line controllable thereover for extending calls over said trunk line in one direction, means including a second automatic switch operable to seize said trunk line at one end and the said jack at the other end of said trunk line for extending calls thereover in the opposite direction, and means for rendering said first switch inoperative whenever said trunk line is seized by said second switch, other automatic switches associated with said first automatic switch in a group, trunk lines accessible to said group of switches and a master switch common to the switches of said group for selecting an idle trunk for calls in said first direction.

45. In a telephone system, a trunk line terminating at one end in a spring jack and provided at the other end with two branches, terminating, respectively, in fixed and movable contacts in numerical and non-numerical automatic trunking switches, means including said jack and the said non-numerical switch for extending calls over said trunk line in one direction, means including said numerical switch and said jack for extending calls over said trunk line in the opposite direction, and a circuit for making said trunk line busy to said numerical switch whenever the said non-numerical switch is operated.

46. In a telephone system, a trunk line terminating at one end in a spring jack and provided at the other end with two branches, terminating, respectively, in fixed and movable contacts in numerical and non-numerical automatic trunking switches, means including said jack and the said non-numerical switch for extending calls over said trunk line in one direction, means including said numerical switch and said jack for extending calls over said trunk line in the opposite direction, and means including a

relay for rendering said non-numerical switch inoperative whenever said trunk line is seized by said numerical switch.

47. In a telephone system, a line circuit, 5 a link circuit to connect therewith, a pair of condensers in said link circuit, a relay having a winding bridged around each of said condensers, a supervisory signal, means for displaying said signal when said link 10 and line circuits are connected, and means for rendering said signal inoperative when said relay is energized.

48. In a telephone system, a trunk line, an operator's call signal at one end thereof, 15 means at the other end of said trunk for supplying ringing current, means whereby said signal is responsive to the flow of ringing current over the trunk, and electrically controlled means for calling and 20 releasing automatically over circuits each of which includes a portion of one side of the trunk line in series with a portion of the other side thereof.

49. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, and an operator's trunk circuit in combination with non-numerical trunk selecting switching means for 25 connecting any one of said lines with any one of said numerical trunk selectors, whereby the connected selector may be operated from the connected line. 30

50. In a telephone system, lines, numerical trunk selecting switches, an operator's trunk circuit in combination with non-numerical trunk selecting switching means for 35 connecting any one of said lines with any one of said numerical trunk selectors, and means controlled from the line for releasing the numerical switch after it has been operated. 40

51. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, an operator's trunk 45 circuit in combination with non-numerical trunk selecting switching means for connecting any one of said lines with any one of said numerical trunk selectors, whereby the connected selector may be operated from 50 the connected lines, and means controlled from the line for releasing the numerical switch after it has been operated.

52. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, an operator's trunk 55 circuit in combination with non-numerical trunk selecting switching means for connecting any one of said lines with any one of said numerical trunk selectors, whereby the connected selector may be operated from the 60 connected line, and signal devices connected with the manual portion of the apparatus to indicate to an operator the necessity for connection and disconnection.

53. In a telephone system, lines, numerical trunk selecting switches, an operator's trunk circuit in combination with non-numerical trunk selecting switching means for 65 connecting any one of said lines with any one of said numerical trunk selectors, means controlled from the line for releasing the numerical switch after it has been operated, 70 and signal devices connected with the manual portion of the apparatus to indicate to an operator the necessity for connection and 75 disconnection.

54. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, an operator's trunk circuit in combination with non-numerical 80 trunk selecting switching means for connecting any one of said lines with any one of said numerical trunk selectors, whereby the connected selector may be operated from the connected line, means controlled from the 85 line for releasing the numerical switch after it has been operated, and signaling devices connected with the manual portion of the apparatus to indicate to an operator the necessity for connection and disconnection. 90

55. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, and an operator's trunk circuit in combination with non-numerical trunk selecting switching means for 95 connecting any one of said lines with any one of said numerical trunk selectors, whereby the connected selector may be operated from the connected line to establish a talking circuit from the connected line to another line. 100

56. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, an operator's trunk circuit in combination with non-numerical 105 trunk selecting switching means for connecting any one of said lines with any one of said numerical trunk selectors, whereby the connected selector may be operated from the connected line to establish a talking circuit from the connected line to another line, 110 and means controlled from the connected line for releasing the numerical switch after it has been operated.

57. In a telephone system, lines, numerical trunk selecting switches, impulse sending means for said lines, an operator's trunk circuit in combination with non-numerical trunk selecting switching means for connecting any one of said lines with any one 120 of said numerical trunk selectors, whereby the connected selector may be operated from the connected line to establish a talking circuit from the connected line to another line, the connected selector being controlled over 125 two sides of the talking circuit in series.

58. In a telephone system, lines, numerical trunk selecting switches, impulse send-

ing means for said lines, an operator's trunk
circuit in combination with non-numerical
trunk selecting switching means for connect-
ing any one of said lines with any one of
5 said numerical trunk selectors, whereby the
connected selector may be operated from the
connected line to establish a talking circuit
from the connected line to another line, and
means controlled from the connected line for
10 releasing the numerical switch after it has

been operated, the connected selector being
controlled over the two sides of the talking
circuit in series.

Signed by me at Chicago, Cook county,
Illinois, this 20 day of July, 1908.

ARTHUR B. SPERRY.

Witnesses:

ETHEL A. EDGELL,
EDWARD D. FALES.