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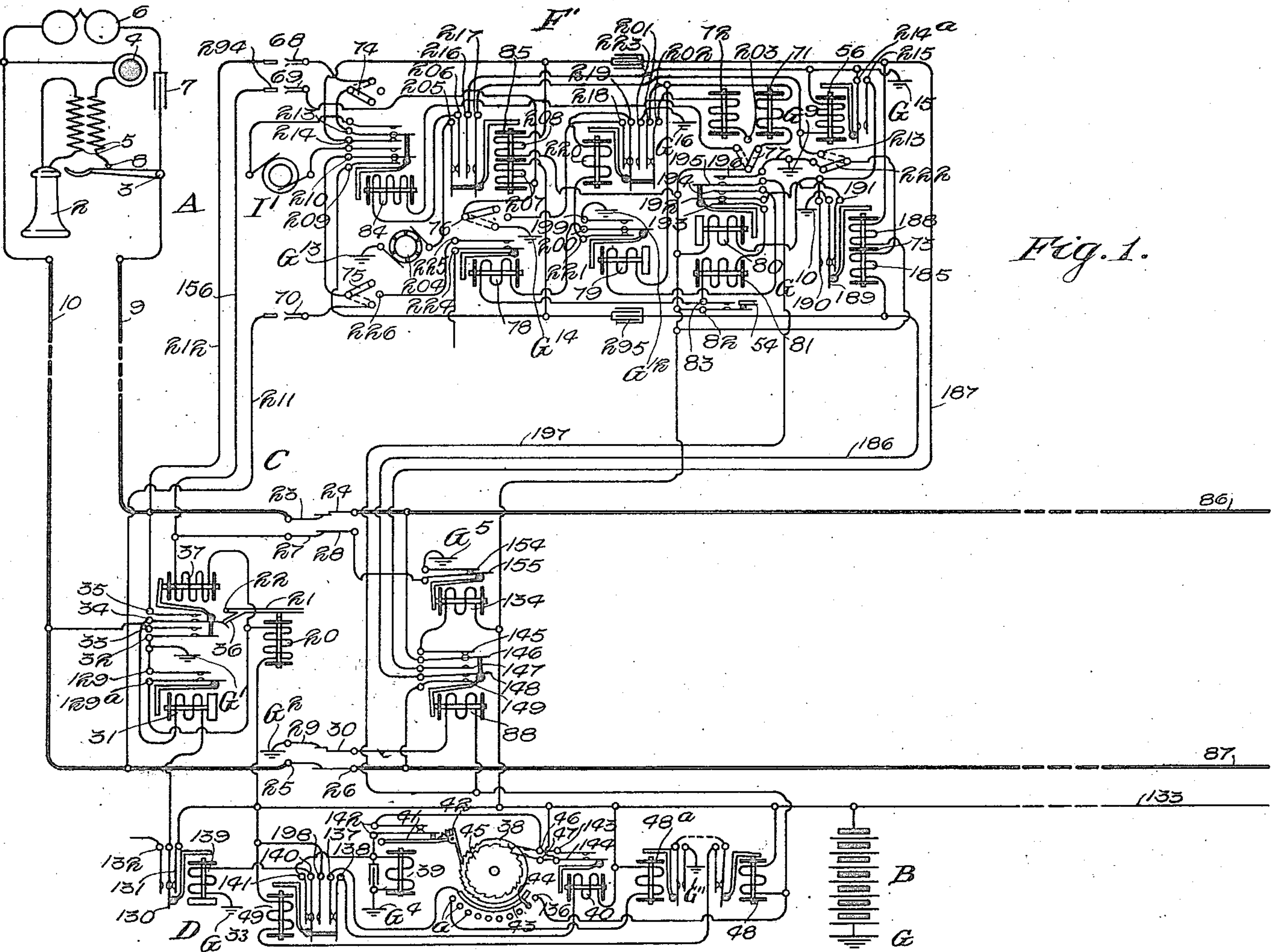
T. G. MARTIN.
TELEPHONE EXCHANGE TRUNKING SYSTEM.

APPLICATION FILED DEC. 10, 1910.

Patented Dec. 28, 1915.

5 SHEETS--SHEET 1.

Fig. 1.



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5 SHEETS—SHEET 2.

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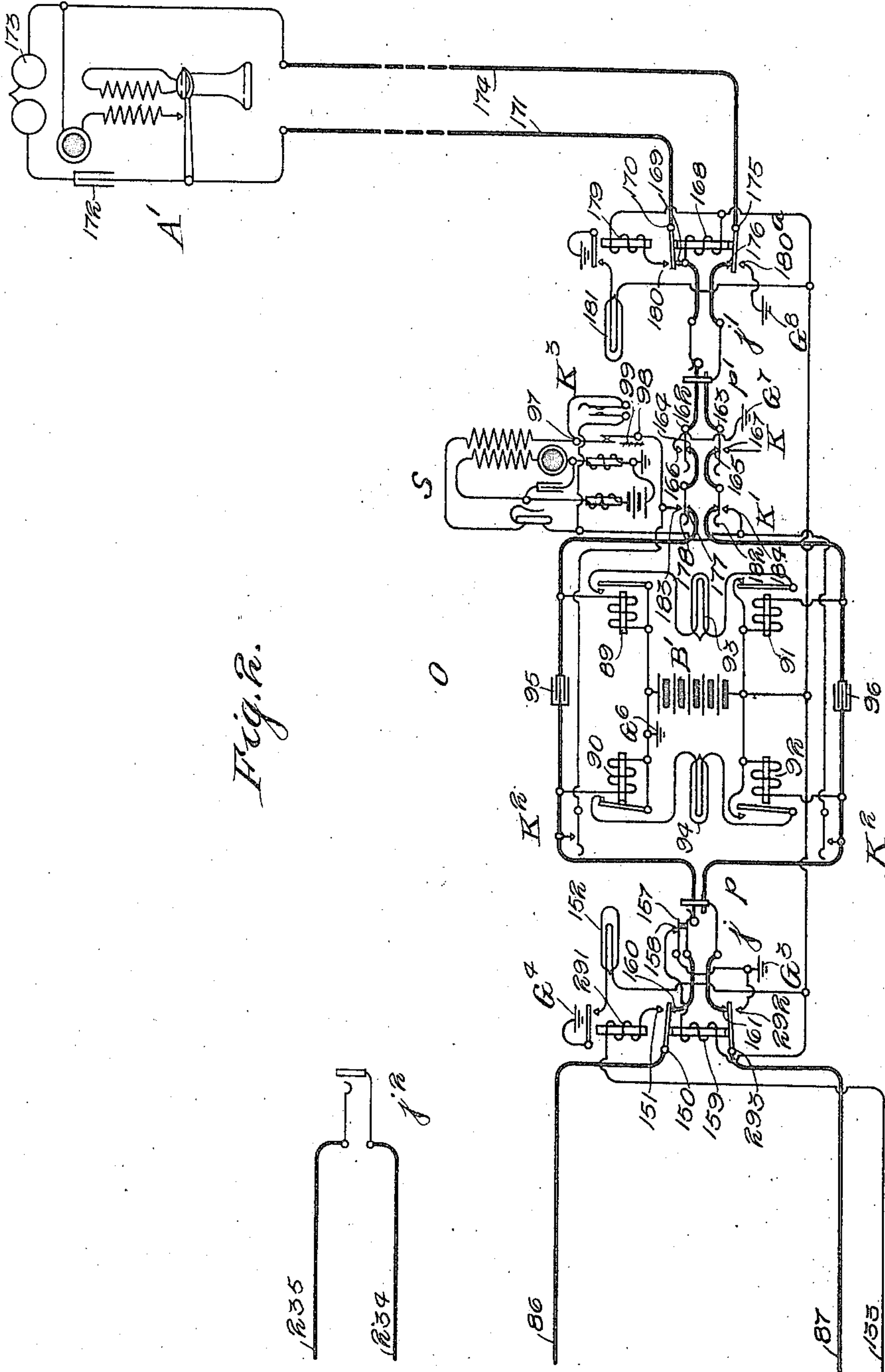


Fig. 2.

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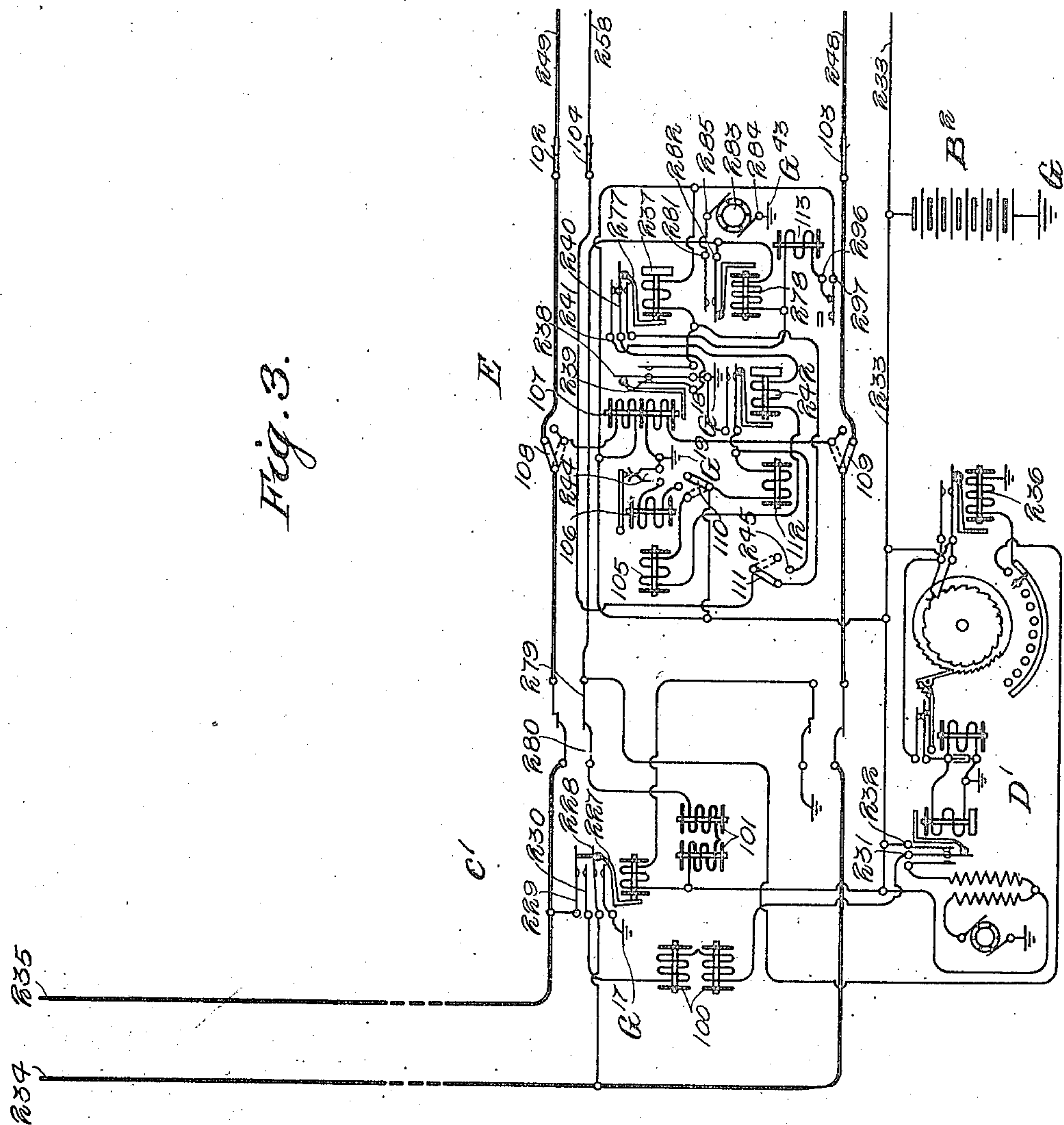
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5 SHEETS—SHEET 3.

Fig. 3.



Witnesses
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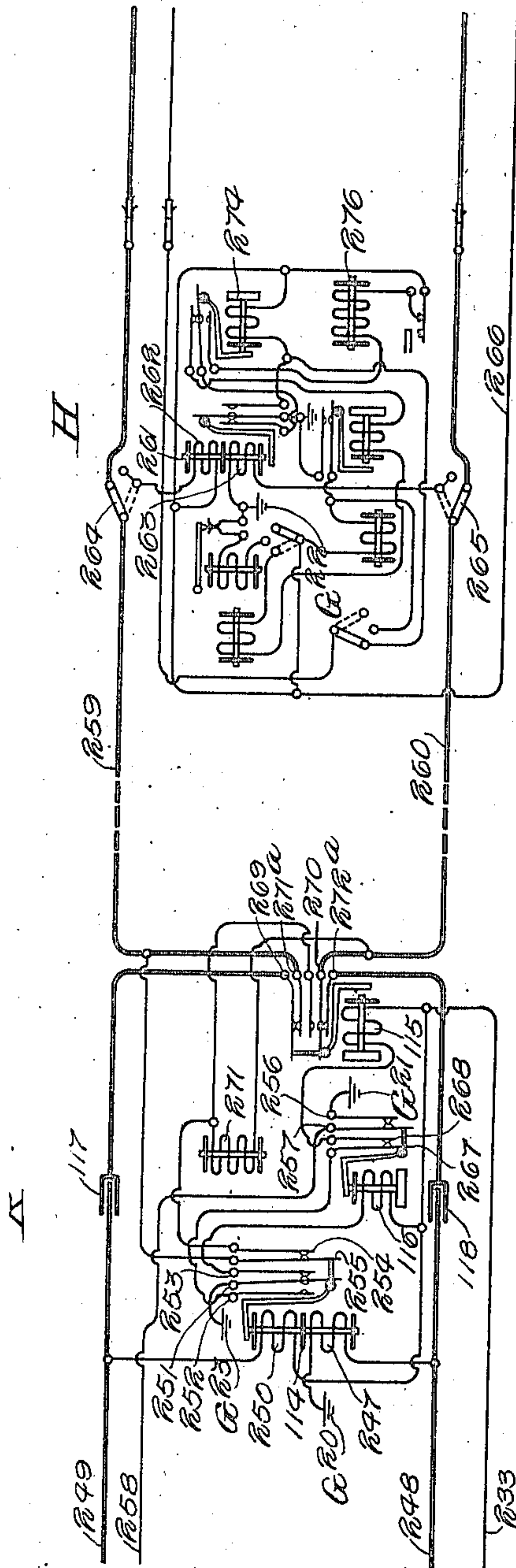
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5 SHEETS—SHEET 4.

Fig. 4.



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5 SHEETS—SHEET 5.

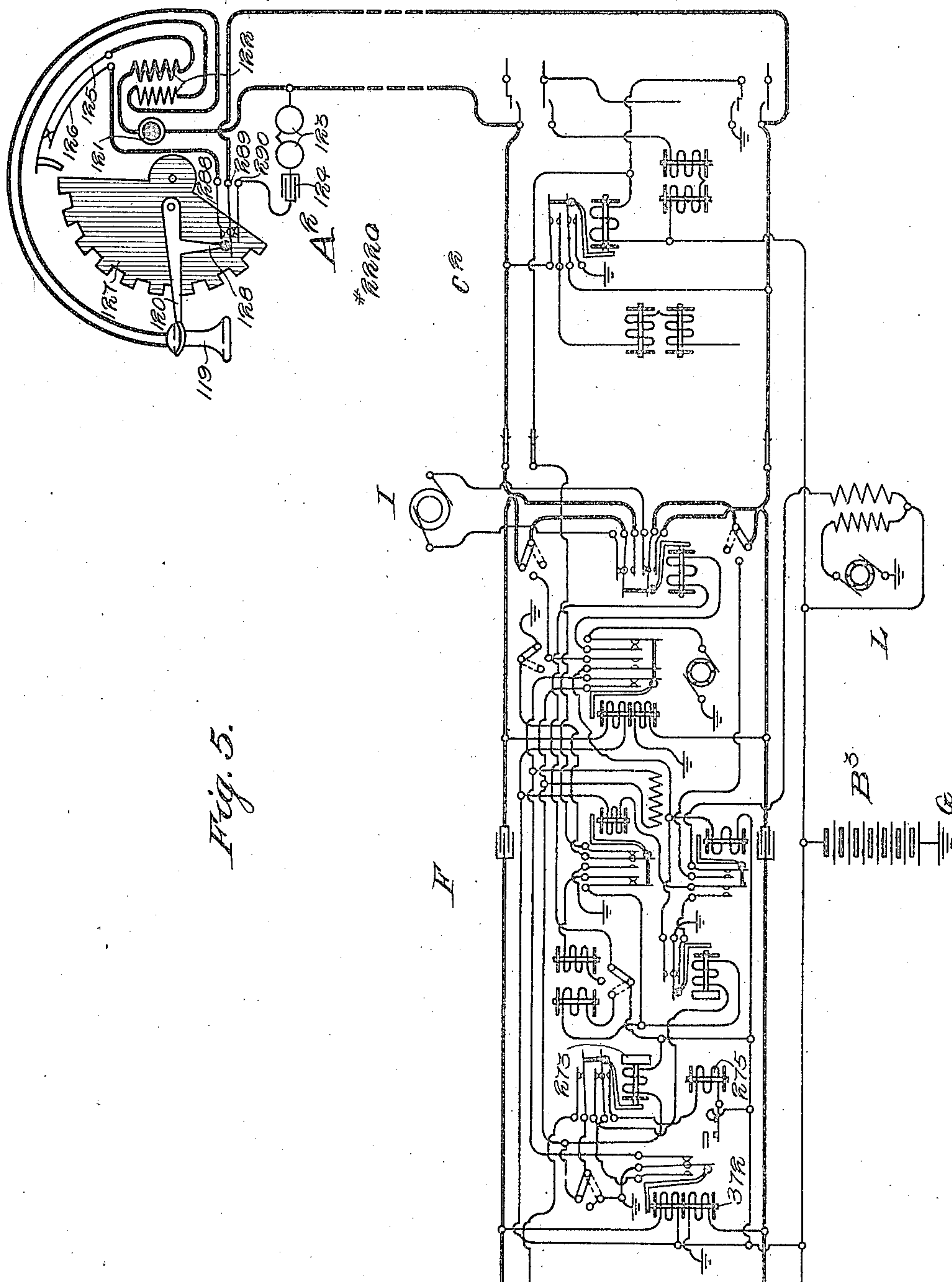


Fig. 5.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE TRUNKING SYSTEM.

1,165,690.

Specification of Letters Patent.

Patented Dec. 28, 1915.

Application filed December 10, 1910. Serial No. 596,710.

To all whom it may concern:

Be it known that I, TALBOT G. MARTIN, 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 Trunking Systems, of which the following is a specification.

My invention relates to telephone exchange systems in general.

It relates more particularly to semi-automatic telephone exchange systems of the kind in which two-way trunk lines are employed, and more especially to systems of this kind in which the subscribers' telephone lines are of the manual type, being provided with the customary manual equipment only at the substations, and terminating in a manual board, or in means for establishing connection with a manual board. In this respect my invention is in the nature of an improvement on my co-pending application Serial No. 316,742, filed May 14, 1906.

It also relates to systems of the kind in which provision is made for repeating switch-operating impulses from one section of the line circuit to the other, as is sometimes necessary in extending connection from one exchange to another, or from one telephone line to another in a situation where it is desirable to transmit the original impulses over the entire circuit. The repeating mechanism herein disclosed is in the nature of an improvement on the repeater disclosed in my co-pending application Serial No. 507,210, filed July 12, 1909.

Objects of my invention are to provide an improved construction and arrangement whereby, in a semiautomatic system of the above-mentioned general character, the same trunk lines may be used for calling in opposite directions between a main exchange and a branch exchange, thus obviating the necessity of having one set of trunks for calling into the manual board at the main exchange, and another set of trunks for calling out or in the opposite direction; to provide an improved construction and arrangement whereby a two-way trunk may terminate at one end in a numerical switch, and may have the same end connected with a non-numerical switch, the first switch being operative to extend connection from the trunk line, and the second switch being operative to extend connection to the said trunk line,

there being also means at the other end of the trunk line for extending connection thereto and therefrom; to provide an improved construction and arrangement whereby two-way trunks may be employed between subscribers' line switches and a manual board, or between subscribers' non-numerical line switches and a switchboard of any suitable character, whereby connections may be made to and from the subscribers' lines over the same trunks; to provide an improved construction and arrangement whereby an automatic switch between a calling subscriber and a manual board at which the call is answered may be automatically released by the withdrawal of the answering plug from the jack of the trunk over which the connection is established from the automatic switch to the manual board; to provide an improved construction and arrangement whereby, in a semi-automatic system of this general character, the automatic switch between the calling subscriber and the manual board may be released by the hanging up of the receiver at the calling substation—that is to say, whereby this may be done only when the operator has withdrawn the plug, as previously stated, or when the subscriber hangs up before the operator has answered; and to provide an improved construction and arrangement whereby a repeater in a two-wire system is operative to disconnect or cut off the condensers thereof to prevent the same from remaining in the line circuit while the impulses are being repeated over one section thereof to another.

It is also an object to provide certain details and features of improvement and combinations tending to increase the serviceability of a telephone exchange system of this particular character.

As will hereinafter more fully appear, my invention relates in some measure to what is ordinarily known as a two-wire system—that is to say, an automatic or semi-automatic system in which certain of the switches are controlled over the two sides of the line circuit in series, as distinguished from other systems in which the said switches are operative or controlled by grounding first one side and then the other of the ground circuit leading thereto, and which latter system is ordinarily known as a three-wire system.

It will also be seen that my invention relates to a system of this kind in which the current for both switching and talking purposes is supplied from a central source, or from several central sources, a system of this kind being ordinarily known as a common battery system.

In the accompanying drawings Figures 1 and 2 taken together represent a complete connection between a calling substation A (Fig. 1) and a called substation A' (Fig. 2), and also means whereby the substation A' may call substation A, in a system embodying the principles of my invention. The apparatus shown in Fig. 1 is situated in a branch exchange, while Fig. 2 represents a portion of a distant manual exchange. Figs. 3, 4 and 5 show the central office switching apparatus by means of which the manual substation A' may obtain connection with the automatic substation A² (Fig. 5) by passing through an intermediate automatic exchange represented in Fig. 3 and a portion of Fig. 4.

The manual substations A and A' may be of any suitable or approved type. As shown, the substation A comprises the usual receiver 2, switch hook 3, transmitter 4, induction coil 5, ringer 6 and condenser 7. The ringer 6 and condenser 7 are permanently bridged across the line conductors 9 and 10. The circuit through the transmitter 4 is normally open, but when the receiver is removed from the hook, the said hook engages the contact point 8, bridging the transmitter 4 across the line conductors in series with the primary winding of the induction coil 5. The line conductors 9 and 10 are connected to an individual switch C at the branch exchange.

The individual or line switch C is of the general type disclosed in British Patent #26,301 of 1906, and in the *Western Electrician* of Chicago, Illinois, of January 25, 1908. The switch C is provided with a pull-in magnet 20 which has an armature 21 pivoted at the point 22. To the opposite end of the armature 21 there is attached a plunger (not shown) adapted to force springs 23, 25, 27 and 29 into contact with springs 24, 26, 28 and 30, respectively. The energizing circuit of the magnet 20 is controlled by the calling subscriber through the medium of the relay 31. The plunger arm 21 is provided with a small projection 36 which operates when said arm 21 is attracted to separate springs 32 and 34 from the springs 33 and 35, respectively. The springs 32 and 34 may also be operated by the cut-off relay 37. Although only one set of springs 23, 24, 25, 26, 27, 28, 29 and 30 is shown, each switch C is in reality provided with a bank comprising a number of such sets of springs, each set forming the terminals of a two-way trunk line between

the two exchanges. Each trunk is multiplied through the corresponding bank springs of a group of switches controlled by the master switch D.

The master switch D is also of the general type shown and described in the said British patent and *Western Electrician*. Among other details the master switch comprises a ratchet wheel 38, a motor magnet 39, a motor magnet relay 40 and a bank of contacts comprising a common segment 43 and a number of individual segments *a*. The ratchet wheel 38 is connected to a shaft (not shown) with which the plungers of the idle line switches normally rest in locking engagement. The connection between the wheel 38 and the plunger shaft is such that a rotary motion of the wheel gives to the shaft a reciprocating motion to move the idle plungers from a position in front of one trunk to another. The wheel 38 is actuated by the magnet 39 through the medium of the armature 41 and pawl 42. The wiper 44 is secured to the plunger shaft and is adapted to always keep some one of the individual segments *a* in electrical connection with the common segment 43. Secured to the ratchet wheel 38 there is a notched wheel 45, made preferably of insulating material, which controls a pair of springs 46 and 47. The notches in the wheel 45 are so spaced that the springs 46 and 47 may disengage only when the plungers that are engaged with the plunger shaft are in a position directly in front of the bank terminal of a trunk. When a line switch operates, its plunger engages the bank springs of the idle trunk in front of which it is being held by the plunger shaft. The motor magnet relay 40 is accordingly energized through the wiper 44. This relay operates to close the circuit of the motor magnet 39, which then operates to rotate the ratchet wheel 38, and the notched wheel 45 is moved far enough to force springs 46 and 47 into engagement, which furnishes a new energizing circuit for the motor magnet 39. The motor magnet 39 will thus continue to operate until the idle plungers are directly opposite the terminals of an idle trunk. When this position is reached the springs 46 and 47 separate, and as the master switch wiper 44 has been moved to a position corresponding to the terminals of said idle trunk, the relay 40 becomes deenergized and opens the circuit of the operating magnet 39.

Each of the trunks to which the line switch C has access is provided with a relay 48, 48^a, etc., of which only the ones belonging to the first and last trunks are shown. Each of these relays is adapted to be energized whenever the trunk to which it belongs is in use. When all the relays 48, 48^a, etc., are energized a circuit is closed through the relay 49, which in turn operates

to disconnect the relay 40 from the common bank segment 43 and to cause the battery to be disconnected from the relay 31 of all the line switches C to prevent the operation of said switches when all the trunks are busy. The plungers of the line switches C are self-aligning—that is, when a plunger is released from its operated position it immediately returns to locking engagement with the plunger shaft, thus assuming a position in front of the terminal of the same trunk before which all the other idle plungers are resting.

The connector F' is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson. Among other details the connector comprises the wipers 68, 69 and 70 secured to a shaft (not shown) which has a vertical motion controlled by the vertical magnet 71 and a rotary motion controlled by the rotary magnet 72. The operation of the connector is controlled by the calling operator through the medium of the double-wound line relay 73. The side switch, composed of the wipers 74, 75, 76, 77 and 222, is controlled by the private magnet 78 in a well-known manner. The circuit of the private magnet 78 is controlled by the relay 79. The relay 79 and release relay 80 are slow acting relays—that is, slow to deenergize after their energizing circuits have been broken. The means for releasing the switch is provided in the release magnet 81. The release magnet 81 is disconnected from battery by the separation of the off normal springs 82 and 83 as long as the switch shaft is in its lowest position. As soon, however, as the shaft is raised one or more steps the arm 54 permits the springs 82 and 83 to engage to connect the magnet 81 with the battery B. After a connection is completed the ringer relay 84 operates to connect the generator I' with the called substation. After the receiver is removed from the hook the called substation is provided with talking battery current through the back-bridge relay 85. The high resistance relay 86 provides means whereby the operator may obtain supervision of a call through the connector F'.

The two-way trunk 86 and 87, besides terminating in the bank contacts of the line switch C, is also connected to the connector F' through the springs of the relay 88. This two-way trunk terminates in the main exchange in the jack j. When the trunk is used to extend a call from the branch to the main exchange the relay 88 operates to disconnect the connector switch F' from the trunk conductors.

The operator's cord circuit O comprises the supervisory relays 89, 90, 91 and 92, lamps 93 and 94 and keys K, K' and K². The circuit through the cord is divided into

two parts by the condensers 95 and 96. The operator's talking set S is similar to the ordinary operator's set used in manual systems, with the addition of a calling device consisting of the impulse springs 97 and 98 and the impulse wheel 99. When the impulse wheel is rotated forward the springs 97 and 98 are not operated, but as the impulse wheel returns to normal position the springs 97 and 98 are separated a number of times, depending upon the digit to be called. With the talking set S there is associated a key K³ by means of which the receiver may be short-circuited when the calling device is being used.

The lines of the substation A' terminate in the jack j'.

The line switch C', which is allotted to the jack j² of the manual exchange, is the same as that disclosed in the *Western Electrician* of January 25, 1906, referred to above, with the exception of a slight change in the circuit connection which renders the switch C' operable by simply closing the line circuit. The plunger of the line switch C' is normally held out of the bank against the tension of a spring. When the magnet 100 is energized it unlocks the plunger, allowing it to be forced into the bank by said spring. If, after the line switch has been operated, the release magnet 101 is energized it places the apparatus in such a position that the plunger will be withdrawn from the bank by a spring upon the following deenergization of the magnet 101. The trunks from the banks of the line switch C' lead to first selector switches E. The group of line switches of which the switch C' is a member is controlled by a master switch D', which is like the master switch D.

The first selector E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, but is slightly modified to operate in a two-wire system—that is, in a system in which no ground connection is used at the substation, or in which the switches are controlled over the two sides of the line circuit in series. Among other details the selector E comprises a set of wipers 102, 103 and 104 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 105 and a rotary motion controlled by the rotary magnet 106. The operation of the switch is controlled by the calling operator through the medium of the double-wound line relay 107. The side switch, comprising the wipers 108, 109, 110 and 111, is controlled by the private magnet 112 in a well known manner. The means for releasing the switch are provided in the release magnet 113. The selector E is provided with the so-called connector release—that is, the shaft and side switch are restored to

normal position immediately upon the energization of the release magnet 113, rather than by its deenergization as shown in the said selector patent. The selector E is also provided with a bank of contacts adapted to be engaged by the wipers 102, 104 and 103, and to at least a part of which are connected trunk lines leading through repeaters R to selector switches H of a distant exchange.

The repeater R is provided for the purpose of repeating impulses to the switches of the distant exchange. The repeater is provided with a double-wound line relay 114 which is similar to the line relays of the selector and connector switches. During the time the repeater is operating the calling line is disconnected from the trunk by the slow acting relay 115. The slow acting relay 116 maintains an energizing circuit for the release relay of the selector E after it has operated. The talking circuit through the repeater is divided into two parts by the condensers 117 and 118.

The selector H is similar to the selector E and the connector F is similar to the connector F' with the omission of the supervisory relay 56.

At L is shown a busy signaling machine and at I a ringing current generator is shown.

The line switch C², which is individual to the line of substation A², is like the line switch C'.

The automatic substation A² may be of any approved type. As herein represented, the substation A² comprises the usual receiver 119, switch hook 120, transmitter 121, induction coil 122, ringer 123, condenser 124, impulse springs 125 and 126 and impulse wheel 127. The switch hook 120 controls the substation circuits through the medium of the cam arm 128 and springs 288, 289 and 290.

As shown, each exchange is provided with a battery, having one terminal grounded, to provide current for talking and for operating the switches.

In order to give a clearer understanding of my invention I will now explain the operation of the various apparatus employed when the subscriber A calls subscriber A' and when subscriber A' calls either subscriber A or subscriber A².

When the receiver at substation A is removed and the hook 3 engages the contact point 8, a circuit is closed through the slow-acting line relay 31 of the line switch C. This circuit extends from ground G' through the springs 32 and 33, line conductor 10, transmitter 4, primary winding of the induction coil 5, contact point 8, switch hook 3, line conductor 9, springs 35 and 34, relay 31, springs 130 and 131 to the battery lead 133, thence through the battery B to ground G. The relay 31, upon energizing, closes a

circuit extending from ground G' through the springs 129 and 129^a and pull-in magnet 20 to the battery lead 133. The magnet 20, upon energizing, operates to force the plunger into the bank and to separate the springs 34 and 32 from the springs 35 and 33, respectively, whereby the circuit of the relay 31 is broken. The relay 31 being slow to deenergize maintains its springs in contact until the relay 134 has had time to close a new holding circuit through the magnet 20, as will be explained later. When the bank springs 29 and 30 are pressed into engagement by the plunger of the line switch C an energizing circuit is closed through the relays 88, 48 and 40. This circuit extends from ground G² through bank springs 29 and 30, relay 88, thence one branch passes through relay 48 to the battery lead 133, and another branch passes through the contact point 136, master switch wiper 44, bank segment 43, relay springs 137 and 138 and relay 40 to battery lead 133. The relay 88, upon energizing, operates to disconnect the connector F' from the trunk conductors 86 and 87 and to connect the relay 134 with the conductor 86. The energization of the relay 48 has no effect unless all the other trunks to which the line switch C has access are busy, as will be explained later. The relay 40, upon energizing, closes an energizing circuit through the relay 139 and motor magnet 39. This circuit extends from ground G³ through relay 139, springs 140 and 141, and from ground G⁴ through the magnet 39 to interrupter springs 142, and through springs 143 and 144 to battery lead 133. Since this circuit includes the interrupter springs the magnet 39 operates in a manner similar to that of a buzzer to rotate the ratchet wheel 38 and advance the idle plungers to an idle trunk. As soon as the wheel 38 is advanced one step the springs 46 and 47 are forced into engagement by the wheel 45, thereby maintaining the operating circuit of the magnet 39 independent of the relay 40. The magnet 39 will thus continue to operate until the spring 47 drops into the next tooth of the wheel 45, at which time the plungers will have reached a position directly in front of the terminals of the next trunk after the one just seized, and the wiper 44 will have left the contact 136 and allowed the relay 40 to deenergize. Since the relay 40 is deenergized and the springs 46 and 47 separated, the circuit of the magnet 39 is broken and the plungers come to rest in front of this trunk. If the next trunk after the one seized had been busy, the master switch wiper 44 would have found a guarding potential upon the corresponding bank contact, the relay 40 would have remained energized when the springs 46 and 47 were separated, and the magnet 39 would have continued to advance the plungers until an

idle trunk was reached. The relay 139 which was energized in multiple with the magnet 39 is a slow-acting relay, and consequently it remains in an energized position during the entire time the magnet 39 is operating. The relay 139, in its operated position, disconnects the battery from the relay 31 of all the line switches which are controlled by the master switch D, and connects a busy signaling machine with the idle lines. The spring 132 of the relay 139 is connected with a busy signaling machine similar to the busy signaling machine L (Fig. 5). With this arrangement it is impossible to operate a line switch C while its plunger is being moved from one trunk to another, and any subscriber attempting to make a call at that time will receive the busy signal.

When the bank springs 23 and 25 are pressed into engagement with the springs 24 and 26, respectively, by the line switch plunger the line conductors 9 and 10 are extended to the main exchange over the trunk conductors 86 and 87, and a circuit is closed through the relays 134 and 291. This circuit extends from ground G^3 (Fig. 2) through contact point 292 and armature 293, and over trunk conductor 87 and line conductor 10, to and through substation A and back over line conductor 9 to trunk conductor 86, from which one branch passes through relay springs 146 and 145 and relay 134 to the battery lead 133, and another branch passes over the trunk to the main exchange and through armature 150, contact point 151 and relay 291 to battery lead 133. The battery lead 133 is common to all the trunks leading from the exchange of Fig. 1. The relay 291, upon energizing, operates to close a circuit from ground G^4 through the lamp 152 to battery B' to signal the operator. The relay 134, upon energizing, closes a holding circuit through the magnet 20 before the relay 31 has time to deenergize, as before stated. This circuit extends from ground G^5 through the springs 154 and 155, bank springs 28 and 27, relay 37 and magnet 20 to the battery lead 133. The relay 134, in its energized position, also supplies a guarding potential from ground G^5 over the private normal conductor 156 to the private bank contact 294 of all the connectors which have access to the line of substation A. This guarding potential protects the calling line from interference over the connectors. The operator answers the signal of the lamp 152 by inserting the plug p into the jack j and throwing the key K^2 to bridge the operator's set S across the cord. When the plug p enters the jack j the springs 157 and 158 are forced into engagement to close a circuit extending from the ground G^3 through the cut-off relay 159 to the battery B'. The relay 159, upon

energizing, operates to attract its armatures 150 and 293 out of engagement with the contact points 151 and 292 and into contact with points 160 and 161, respectively. The separation of the armatures from points 151 and 292 opens the circuit through the relay 291, which deenergizes and allows the lamp 152 to be extinguished. When the armatures 150 and 293 engage the contact points 160 and 161, the trunk is connected with the cord and the calling substation is provided with talking battery current over a circuit extending from ground G^6 through supervisory relay 90, tip conductors of plug p and jack j , trunk conductor 86, line 9, through the primary winding and transmitter of substation A and over line 10, trunk 87, armature 293, contact point 161, sleeve conductors of jack j and plug p and relay 92 to battery B'. A branch circuit also extends from conductor 86 through relay 134 to maintain it energized, but the said relay has a high resistance so as not to impair the talking efficiency.

Upon learning the number of the desired substation the operator restores K^2 , inserts the plug p' into the jacket j' of the desired line and throws the key K to shift the springs 162 and 163 out of engagement with springs 164 and 165 and into contact with springs 166 and 167, respectively, whereby the calling line is disconnected from the cord and a ringing current generator is bridged across the called line. The engagement of springs 166 and 162 also closes an energizing circuit through the cut-off relay 168, said circuit extending from ground G^7 through springs 166 and 162, tip conductors of plug p' and jack j' and relay 168 to battery B'. The relay 168, upon the energizing connects the line of substation A' with the jack j' . The path of the ringing current for the substation A' extends from ground G^7 through key springs 166 and 162, tip of plug p' and jack j' , relay springs 169 and 170, line 171, condenser 172, ringer 173, line 174, relay springs 175 and 176, sleeve of jack j' and plug p' , key springs 163 and 167 and through a generator (not shown) to ground. After ringing the called substation the key K is restored to normal position, completing the connection between calling and called lines. After the key K is restored the relay 168 remains energized over a circuit extending from ground G^6 through the supervisory relay 89, springs 177 and 178 of key K' , springs 164 and 162 of key K and through relay 168 to battery. The relay 89, which is included in this circuit, is also energized and operates to close a circuit from ground G^6 through the lamp 93 and back contact of the relay 91 to battery. When the called subscriber removes the receiver the substation A' is provided with talking current from the battery B'.

through the relays 89 and 91, and the two subscribers may converse over the heavy conductors shown in Figs. 1 and 2. The relay 91 is energized by the talking current and operates to open the circuit of the lamp 93.

After the conversation is completed the operator is given the disconnect signal in the following manner: The restoration of the receiver at the called substation opens the energizing circuit of the relay 91, which deenergizes and again closes the circuit of the lamp 93. The restoration of the receiver at the calling substation destroys the energizing circuit of the relay 92, but the relay 90 remains energized in series with the relay 134. The deenergization of the relay 92 closes the circuit through the lamp 94. The simultaneous glowing of the lamps 93 and 94 signifies to the operator that both subscribers have hung up their receivers, and that the plugs p' and p may be removed from the jacks. The removal of the plug p' from the jack j' breaks the circuit of the relays 89 and 168. The relay 89, upon deenergizing, breaks the circuit of the lamp 93. The removal of the plug p from jack j breaks the circuits of the relays 90, 159 and 134. The relay 90, upon deenergizing, breaks the circuit of the lamp 94. The relay 159 disconnects the trunk from the jack j and restores the relay 291 to the trunk. The relay 134, upon deenergizing, removes the guarding potential from the calling line and breaks the holding circuit of the line switch magnet 20. The magnet 20, upon deenergizing, allows the plunger to be withdrawn from the bank and the line switch C to be again connected with the line. The withdrawal of the plunger allows the relays 48 and 88 to deenergize, the latter operating to restore the connector F' to the trunk 86—87.

When the subscriber at substation A' wishes to call substation A the operation is as follows: The removal of the receiver at the substation A' closes a circuit through the relay 179. This circuit extends from ground G^8 through contact point 180^a, armature 175, line 174, transmitter and primary winding of substation A', line 171, armature 170, contact point 180 and relay 179 to battery B'. The relay 179, upon energizing, closes a circuit through line lamp 181. In answer to the signal of lamp 181 the operator inserts the plug p into the jack j' and operates the key K^2 to connect the talking set S with the line. The insertion of plug p into jack j' closes an energizing circuit through the relays 90 and 168 in series. The relay 168, upon energizing, destroys the circuit of relay 179 and connects the line with the plug p , whereupon the calling substation is provided with talking current from battery B' through relays 90 and 92. The re-

lay 92 is also energized by the talking current. Upon learning the number of the desired substation, which is assumed to be 20, the operator restores key K^2 , inserts plug p' into jack j and operates key K' to connect springs 178 and 182 with springs 183 and 184, respectively. The operation of key K' disconnects the cord from the trunk and bridges the operator's set S across the trunk. As soon as the key K' is thrown, an energizing circuit is closed through the line relay 73 of the connector F'. This circuit extends from ground G^9 through side switch wiper 222, winding 185 of relay 73, conductor 186, relay springs 148 and 149, trunk conductor 87, armature 293 and contact 161, sleeve conductors of jack j and plug p' , springs 182 and 184 of key K' , operator's receiver, impulse springs 97 and 98, springs 183 and 178, tip of plug p' and jack j , contact 160, armature 150, trunk conductor 86, relay springs 146 and 147, conductor 187, and winding 188 of relay 73 to battery lead 133. The relay 73, upon energizing, closes a circuit extending from ground G^{10} through springs 189 and 190 and relay 80 to battery lead 133. The relay 80, upon energizing, shifts spring 192 out of engagement with spring 193 and into contact with spring 194, and closes the contact between springs 195 and 196. The engagement of springs 195 and 196 establishes a guarding potential at the master switch bank contact 136, and closes a circuit extending from ground G^9 through said springs over conductor 197 and through relay 48 to battery lead 133. It is thus evident that the relay 48 is energized whenever the trunk to which it belongs is in use, regardless of whether the call goes from the branch exchange to the main exchange, or from the main exchange to the branch exchange. When all the trunks are in use at one time all the relays 48 to 48^a, inclusive, will be energized and close a circuit from ground G^{11} through the relay 49 to battery lead 133. The relay 49, upon energizing, shifts the spring 140 out of engagement with the spring 141 and into engagement with the spring 198, and forces the spring 138 out of engagement with the spring 137. The disengagement of the springs 137 and 138 disconnects the relay 40 from the bank segment 43 to prevent the operation of the master switch while all the trunks are busy. The engagement of the springs 140 and 198 closes an energizing circuit through the relay 139, which operates to disconnect the battery from the line switch relays 31. As soon as any trunk becomes idle its relay 48 deenergizes and opens the circuit of the relay 49, which restores the master switch circuits to normal condition.

When the operator operates her calling device for the first digit (2) of the desired

number, the impulse springs 97 and 98 are separated twice, thus twice breaking the circuit of the connector line relay 73. During the operation of the calling device the key K^3 may be operated to short-circuit the receiver to prevent the impulses from passing through it. Each time the circuit of the relay 73 is opened, the said relay deenergizes, momentarily opening the circuit of the relay 80 and allowing the springs 189 and 191 to come into engagement. The relay 80 is slow to deenergize, and this momentary opening of its circuit is not sufficient to allow it to restore to normal position. The engagement of the springs 189 and 191 closes an energizing circuit extending from ground G^{10} through the springs 189 and 191, 192 and 194, private magnet relay 79, vertical magnet 71 and side switch wiper 77 to the battery lead 133, thence through the battery B to ground G. The vertical magnet receives two impulses over the circuit just traced, and operates to raise the shaft and wipers 68, 69 and 70 two steps to a position opposite the second row or level of bank contacts. As soon as the shaft leaves its lowest position the arm 54 permits the springs 82 and 83 to engage and connect the release magnet 81 with battery. The relay 79 is energized by the first impulse to the vertical magnet, but being a slow-acting relay does not have time to deenergize between impulses. The relay 79, upon energizing, closes a circuit from ground G^{12} through the springs 199 and 200 and private magnet 78 to the battery lead 133 through the springs 83 and 82.

After the last impulse is delivered to the vertical magnet the relay 79 has time to deenergize and open the circuit of the private magnet 78. The private magnet 78 then in turn deenergizes and permits the side switch to pass from first to second position. The movement of the side switch wiper 77 from first to second position shifts the battery connection from the vertical magnet 71 to the rotary magnet 72. Now, when the calling device is operated for the last digit the line relay 73 operates in the same manner as for the first digit, but in this case the engagement of the springs 189 and 191 closes a circuit through the rotary magnet 72. This circuit extends from ground G^{10} through the springs 189 and 191, 192 and 194, private magnet relay 79, springs 201 and 202, magnet 72, contact point 203 and side switch wiper 77 to the battery lead 133. Since the last digit is O the rotary magnet receives ten impulses over the circuit just traced, and operates to rotate the wipers ten steps onto the contacts of the desired line. The private magnet relay 79 is again energized by the first of this series of impulses and again closes the circuit of the private magnet 78. After the last im-

pulse is delivered the relay 79 deenergizes, allowing the private magnet 78 to deenergize, if the called line is idle; and trip the side switch to third position. The engagement of the side switch wipers 74 and 75 with their third-position contact points completes the connection between the calling and called lines. The engagement of the wiper 77 with its third-position contact point closes a circuit extending from ground G^{13} through the interrupter 204, springs 205 and 206, ringer relay 84 and side switch wiper 77 to battery lead 133. Since this circuit includes the interrupter 204 the ringer relay 84 is energized intermittently. Each time the relay 84 is energized it operates to disconnect the calling and called lines, and bridge the ringer generator I' across the called line. Thus the bells 6 at substation A will be rung intermittently as long as the circuit through the relay 84 and interrupter 204 is maintained.

When the side switch wiper 222 engages its third-position contact point 213, the relay 73 is connected to ground G^{15} through the high resistance supervisory relay 56. Also, as soon as all the impulses have been delivered for the last digit the operator restores key K' , thus closing circuits through the supervisory relays 89 and 91. The circuit through relay 91 extends from the non-grounded terminal of battery B' (Fig. 2) through said relay, normally closed springs of keys K' and K , sleeve conductors of plug p' and jack j , trunk conductor 87, springs 149 and 148 of relay 88, conductor 186, winding 185 of relay 73, side switch wiper 222 and relay 56 to ground G^{15} . Since this circuit includes relay 56, sufficient current does not flow to operatively energize the relay 91. The relay 89 is energized over a circuit extending from ground G^6 through the said relay, normally closed springs of keys K' and K , tip conductors of plug p' and jack j , trunk conductor 86, springs 146 and 147, conductor 187, and winding 188 of relay 73 to battery lead 133, thence through the battery B to ground G. The relay 89, upon energizing, closes a circuit through the lamp 93 and battery B' . In order to prevent the deenergization of the connector release relay 80 in case the relay 73 should allow its armature to drop back when the relay 56 enters its circuit, the relay 56 is provided with a couple of springs 214^a and 215, which maintain the circuit of the relay 80 as long as the circuit of the relay 56 is closed.

When the called subscriber removes his receiver from the switch hook, or as soon thereafter as the relay 84 deenergizes, the called substation is provided with talking current over a circuit extending from ground G^{14} through the side switch wiper 76, winding 207 of the relay 85, ringer relay

springs 209 and 210, side switch wiper 75,
 wiper 70, conductor 211, line 10, transmitter
 4, primary winding of the induction coil 5,
 line 9, conductor 212, wiper 68, side switch
 5 wiper 74, ringer relay springs 213 and 214,
 and winding 208 of the relay 85 to the
 battery lead 133. Since both windings of
 the relay 85 are included in this circuit, this
 relay becomes energized and operates to
 10 separate the springs 205 and 206, and to
 press the springs 216 and 217 into engage-
 ment with each other. The separation of
 the springs 205 and 206 breaks the circuit
 of the relay 84 to prevent the ringing of
 15 the bells 6 after the called subscriber has
 answered. The engagement of the springs
 216 and 217 short-circuits the relay 56,
 thereby permitting sufficient current to flow
 through the supervisory relay 91 (Fig. 2)
 20 to energize it. The relay 91, upon energiz-
 ing, breaks the circuit of lamp 93, thus
 signifying to the operator that the sub-
 scriber at substation A has answered.

As soon as connection is completed to the
 25 line of substation A by the connector F',
 that line is protected by a guarding poten-
 tial extending from ground G¹⁴ through side
 switch wiper 76, and private wiper 69 to
 the private bank contact 294, and thence to
 30 the corresponding contact in the bank of
 each of the connectors which have access to
 the line of substation A. A circuit also ex-
 tends from the contact 294 over conductor
 156 and through the relay 37 and magnet 20
 35 of switch C to battery lead 133. The relay
 37, upon energizing, disconnects the line
 switch C from the line conductors 9 and 10.
 It should be stated here that although suffi-
 cient current flows through relay 37 and
 40 magnet 20 to maintain the armature 21 in
 an operated position, it is not strong enough
 to pull down the said armature from its nor-
 mal position.

After a conversation is completed, the
 45 hanging up of the receiver at the called sub-
 station breaks the circuit of the connector
 back bridge relay 85, which deenergizes and
 removes the short circuit from the relay 56.
 The relay 56 thus again enters the circuit
 50 of the relay 91 (Fig. 2), allowing the arma-
 ture of said relay to drop back and close the
 circuit of lamp 93. The hanging up of the
 receiver at the calling substation breaks the
 energizing circuit of the relay 92, which de-
 55 energizes and closes a circuit through the
 lamp 94. The simultaneous glowing of the
 lamps 93 and 94 signifies to the operator
 that both receivers have been hung up. The
 removal of the plugs *p* and *p'* from their
 60 respective jacks breaks the circuits of the
 relays 90 and 89, respectively, which deen-
 ergize and extinguish the lamps 94 and 93.
 The removal of the plug *p'* from the jack
 also breaks the circuits of the connector re-
 65 lays 73 and 56. The deenergization of both

relays 56 and 73 opens the circuit of the
 relay 80. The relay 80, upon deenergizing,
 removes the guarding potential from the
 master switch bank contact 136, opens the
 circuit of the relay 48 and closes an energiz- 70
 ing circuit for the release magnet 81. This
 circuit extends from ground G¹⁰ through the
 springs 189 and 191, 192 and 193, magnet 81
 and springs 83 and 82 to the battery lead
 133. The magnet 81, upon energizing, re- 75
 stores the switch shaft and side switch to
 normal position. When the switch shaft
 reaches its lowest position it separates the
 springs 82 and 83, thus allowing the magnet
 81 to become deenergized. 80

Returning now to that stage of the opera-
 tion when the wipers of the connector F'
 have been advanced to the terminals of the
 desired line, and before the private magnet
 relay 79 has deenergized, it will be ex- 85
 plained how the operator is given the busy
 signal in case the called line is busy. It is
 evident that whenever a line is busy, a
 guarding ground potential is present at the
 private bank contact 294 of each of the con- 90
 nectors which have access to the line. Thus,
 when the private magnet relay 79 deener-
 gizes, with the wipers resting on the con-
 tacts of a busy line, a circuit is closed ex-
 tending from the guarded bank contact 294 95
 through the side switch wiper 76 (which is
 now in second position), relay springs 218
 and 219, relay 220, springs 221 and 200 of
 the relay 79, and through the private mag-
 net 78 to the battery lead 133. The current 100
 flowing over this circuit prevents the pri-
 vate magnet 78 from deenergizing, and
 causes the relay 220 to be energized. In its
 energized position the relay 220 closes a
 locking circuit for itself and the magnet 78, 105
 said circuit extending from ground G¹⁶
 through the springs 223 and 219, and
 through the relay 220 and magnet 78 to the
 battery lead 133, as before traced. As long
 as the magnet 78 thus remains energized 110
 the side switch is locked in second position
 and the operator receives a signal from a
 busy signaling machine similar to the ma-
 chine L (Fig. 5) through the springs 224
 and 225 of the private magnet 78, contact 115
 point 226, side switch wiper 75, springs
 210 and 209, condenser 295, conductor 186,
 springs 148 and 149, thence over the con-
 ductor 87 to and through the operator's
 set and back over the trunk conductor 86, 120
 springs 146 and 147, conductor 187, and
 winding 188 of the relay 73 to the battery
 lead 133, to which the other side of the
 busy signaling machine is connected. The
 conductor F' is released in this instance by 125
 the removal of the plug *p'* from the jack,
 just as in the previous case. The locking
 circuit of the relay 220 and magnet 78 is
 broken at the springs 82 and 83 when the
 switch shaft reaches its lowest position. 130

When the subscriber A' desires to call substation A² (#2220), the operator is signaled in the regular way. The operator inserts the plug *p* in the jack *j'*, ascertains the number of the desired line, inserts the plug *p'* into the jack *j*², throws the key K' and operates the calling device once for each digit of the number of the line wanted. The insertion of the plug *p'* into the jack *j*² completes an energizing circuit through the trip magnet 100 of the line switch C' (Fig. 3). This circuit extends from ground G¹⁷ through the springs 227 and 228, over the trunk conductor 234 to and through the operator's set and back over the conductor 235, through the springs 229 and 230, trip magnet 100 and springs 231 and 232 to the battery lead 233, thence through the battery B² to ground G. The magnet 100, upon energizing, releases the plunger, allowing it to enter the bank to extend the connection to the first selector E. The master switch D' operates in the same manner as explained for the master switch D to move the plungers of the idle line switches to an idle trunk. In this case, however, the motor magnet relay 236 is energized in series with the release magnet 101, the resistance of the relay 236 being high enough to prevent sufficient current from flowing to operate the magnet 101.

As soon as the connection is extended to the selector E, the line relay 107 is energized and operates in the same manner as the line relay 73 of the connector F' to close the circuit of the release relay 237. When the calling device is operated for the first digit the line relay 107 responds to the impulses. Each time the relay 107 deenergizes it closes a circuit extending from ground G¹⁸ through springs 238 and 239, 240 and 241, private magnet relay 242, vertical magnet 105, side switch wiper 110 to battery lead 233, thence through battery B² to ground G. The vertical magnet receives two impulses over the circuit just traced and operates to raise the shaft and wipers two steps. As soon as the shaft leaves its lowest position the release magnet 113 is connected to battery through the off-normal springs 296 and 297. The slow-acting relay 242, which is included in the energizing circuit of the vertical magnet, operates in the same manner as the relay 79 of the connector F' to cause the private magnet 112 to trip the side switch to second position. When the side switch wiper 110 engages its second-position contact point a circuit is closed through the rotary magnet 106. This circuit extends from ground G¹⁹ through interrupter springs 244, magnet 106, and side switch wiper 110 to battery lead 233. The rotary magnet 106, upon energizing, operates to rotate the wipers one step, press down the armature of the private magnet 112, and open its own circuit at the interrupter

springs 244. When the circuit of the rotary magnet is thus opened its armature drops back, and if the first trunk is not busy, the armature of the private magnet follows it and allows the side switch to pass into third position, extending the connection to the repeater R. If, however, the first trunk of the second level is busy, the private wiper 104 finds the first contact which it engages connected to ground through the repeater of the busy trunk. When the wiper 104 thus strikes a busy trunk a circuit is closed extending from the grounded bank contact through wiper 104, side switch wiper 111, contact point 245 and private magnet 112 to battery lead 233. The private magnet is thus energized and locks the side switch in second position. Consequently, the magnet 106 is again energized as soon as the interrupter springs 244 come into engagement after the rotary armature falls back. The magnet 106 thus continues to operate to advance the wipers step by step until the wipers find the terminals of an idle trunk whereupon the magnet 112 becomes deenergized and allows the side switch to pass to third position. As soon as the wiper 110 leaves its second-position contact point it disconnects the battery from the rotary magnet 106. The movement of wipers 108 and 109 from second to third position cuts off the line relay 107 and extends the connection through to the repeater R.

When the connection is extended to the repeater the relay 114 becomes energized by a circuit extending from ground G²⁰ through winding 247 of relay 114, conductor 248, thence through selector E and line switch C' to and through the operator's calling device and back through switches C' and E, and over conductor 249 and through winding 250 of relay 114 to battery lead 233. The relay 114, upon energizing, operates to shift spring 251 out of engagement with spring 252 and into contact with springs 253, and to close contact between springs 254 and 255. The engagement of springs 251 and 253 closes a circuit through the relay 116. The relay 116, upon energizing, connects the relay 115 with spring 252 of relay 114, supplies a guarding ground to the selector private bank contacts of the trunk, and closes a new energizing circuit for the release relay 237 of the selector E. This circuit extends from ground G²¹ through springs 256 and 257 and over conductor 258 to the private bank contacts of the selector switches which have access to the trunk, thence over wiper 104, side switch wiper 111 and relay 237 to battery lead 233. This circuit is closed before the relay 237 has time to deenergize after its former circuit is broken by the deenergization of relay 107. The engagement of the springs 254 and 255 of relay 114 closes a bridge across the trunk conductors 259 and

260 through the impedance coil 271. When the impedance coil 271 is thus bridged across the trunk the line relay 261 of the selector H is energized over a circuit extending from
 5 ground G^{22} through winding 263 of relay 261, side switch wiper 265, conductor 260, coil 271, springs 254 and 255, conductor 259, side switch wiper 264, and winding 262 of relay to 261 to battery lead 266, thence
 10 through the battery B^3 to ground G. When the calling device is operated for the remaining digits of the called number, the relay 114 responds to the impulses in the same manner as did the selector line relay 107 for
 15 the first digit. Each time the relay 114 de-energizes it separates the springs 255 and 254, thus repeating the impulses to the trunk conductors 259 and 260. Also, each time the relay 114 de-energizes, it closes a circuit ex-
 20 tending from ground G^{23} through springs 251 and 252, 267 and 268, and relay 115 to battery lead 233. The relay 115 is energized by the first impulse for each digit, but, being a slow-acting relay, its circuit is not
 25 opened long enough to permit it to de-energize until after the last impulse for that digit is delivered. In its operated position, the relay 115 separates springs 269 and 270 from springs 271^a and 272^a, respectively. It is
 30 thus evident that the conductors 259 and 260 are disconnected from the condensers 117 and 118 and the impedance coil 271 is short-circuited during the time the relay 114 is operating to repeat impulses. The relay 116
 35 is slow acting and consequently remains in its energized position while the relay 114 is operating.

The impulses for the second digit (2) are repeated, in the manner described, to the
 40 line relay 261 of the second selector H. The selector H responds to the operation of relay 261, and operates in the same manner as the first selector E to select an idle trunk leading to a connector F (Fig. 5.) The
 45 impulses for the last two digits are repeated by the repeater relay 114 to the line relay 372 of the connector F. The connector responds to these impulses in essentially the same manner as the connector F' to extend
 50 the connection to the called line. The impedance coil 271 of the repeater R furnishes a bridge across the trunk conductors 259 and 260 to maintain the line relay 372 of the connector energized after the connection
 55 is completed, and yet prevents the talking currents from passing from one side of the line to the other.

After the conversation is completed the release of the central office switches is initiated by the removal of the plug p' , as in the previous case. When the plug p' is removed from the jack it opens the energizing circuit of the relay 114 of the repeater R. The relay 114 upon de-energizing,
 60 breaks the circuit of the relay 116, and of

the line relay 372 of the connector F. The relay 372, upon de-energizing, breaks the circuit of the release relays 273 and 274 of the connector F' and selector H, respectively. The relays 273 and 274, upon de-energizing,
 70 close the energizing circuits of the release magnets 275 and 276 of their respective switches. The magnets 275 and 276, upon energizing, restore their respective switches to normal position, as explained for the
 75 connector F'. When the relay 116 of the repeater R de-energizes it breaks the circuit of the release relay 237 of the selector E. The relay 237, upon de-energizing, closes the circuit of the release magnet 113, which
 80 operates to restore the selector mechanism to normal position. The relay 237, upon de-energizing, also closes a circuit extending from ground G^{18} through the springs 238 and 239, 240 and 277, relay 278, bank springs
 85 279 and 280 and release magnet 101 to the battery lead 233. The relay 278 has a comparatively high resistance and consequently the magnet 101 is not energized over this circuit. The relay 278 is energized, how-
 90 ever, and operates to close the springs 281 and 282 into engagement. As soon as the interrupter 283 reaches a position to short-circuit the brushes 284 and 285 it connects the ground G^{43} with the release magnet 101
 95 without any interposed resistance. The magnet 101 thereupon energizes and places the mechanism of the line switch C' in position to withdraw the plunger upon the de-energization of the magnet 101, when the
 100 interrupter breaks the connection between the brushes 284 and 285. It is to be understood, of course, that although the switches, through which connection is es-
 105 tablished with the line #2220, are shown in operated position to more clearly illustrate the talking circuit, the said switches would not remain in such position if there was no plug in the jack j^2 , as shown.

From the foregoing it will be seen that I
 110 provide an improved and highly efficient semi-automatic telephone exchange system. It will be seen, for example, that the trunk lines between the main exchange and the
 115 branch exchange are of the two-way type—that is to say, they are of the kind which permit calling in opposite directions, as distinguished from other systems in which some trunks are provided for calling only in
 120 one direction and others are provided for calling only in the other direction. Thus, and with my improved arrangement, a considerable saving is accomplished, as less apparatus is necessary and the cost of main-
 125 tenance is consequently much less. Moreover, it will be seen that, and as a further distinguishing feature, these two-way trunks terminate at one end in numerical switches, whereby connection may be ex-
 130 tended therefrom, and in the same end in

non-numerical switches, by which latter connection may be extended thereto. Again, and with my improved arrangement, the two-way trunks lead directly from subscribers' line switches to a manual board, although for the broader purposes of my invention the said two-way trunks may lead from subscribers' non-numerical switches to any other suitable equipment for extending connection thereto and therefrom. Also, and as previously explained, the automatic switches between the calling subscribers and the manual switchboard can be released by the removal of the answering plugs from the jacks of the manual board, whereby the operator can restore the non-numerical line switches when the subscribers are through talking. It will be seen though, as was previously described, that under certain circumstances the calling subscriber can release his non-numerical switch, but only in the event that he hangs up after the operator has withdrawn the plug, or before the operator has answered. Finally, it will be seen that I provide a new and highly efficient form of repeater for use in a two-wire system. This repeater, as shown and described, has a simple provision for cutting off or disconnecting the condensers while the impulses are being repeated.

What I claim as my invention is:—

1. In a telephone system, a manual board, a non-numerical switch, a telephone line terminating at said board, a telephone line terminating at said switch, a two-way trunk line extending from the said switch to the said board, means controllable at said board for extending connection over said trunk line from said first-mentioned telephone line to said last-mentioned telephone line, and means for controlling said switch over said last-mentioned telephone line to extend connection therefrom over said trunk line and to said board.

2. In a telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, means for controlling said switch over said trunk, a non-numerical switch provided with means for seizing the said one end of said trunk, and devices at the other end of said trunk for extending connection thereto and therefrom.

3. In a telephone system, a two-way trunk, a subscriber's non-numerical line switch for seizing said trunk to extend connection over the same in one direction, and means for calling over said trunk in the other direction.

4. In a telephone system, a two-way trunk, a subscriber's line switch for seizing one end of said trunk to extend a call over the same in one direction, a jack in which the other end of said trunk terminates, a cord circuit adapted to be connected with said trunk for

extending connection thereto and therefrom, and a potential circuit for making the trunk busy at one end as a result of the seizure of the other end.

5. In a telephone system, a manual board, an automatic switch and a trunk for extending a calling connection to said board, and means for releasing said switch by the opening of the manual connection at said board.

6. In a telephone system, a manual board including a cord terminating in a plug, an automatic switch and a trunk terminating in a jack for extending a calling connection to said board, and means for releasing said switch by the removal of the answering plug from the jack of the trunk on said board.

7. In a telephone system, a trunk terminating in a jack, a manual board for one end of said trunk including a cord terminating in a plug, an automatic switch by which a calling line is automatically connected with the other end of said trunk, and means for releasing by the hanging up of the receiver at the calling substation only when the operator has withdrawn the plug from the jack of said trunk or when the operator has not answered.

8. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means including a two-wire repeater provided with condensers in the line circuit thereof, means for controlling said repeater by a series of impulses, means controlled by said repeater for repeating said impulses over a metallic circuit, and means for automatically cutting off said condensers while the impulses are being repeated.

9. In a two-wire telephone system, a manual board, a non-numerical switch, a telephone line terminating at said board, a telephone line terminating at said switch, a two-way trunk line extending from the said switch to the said board, means controllable at said board for extending connection over said trunk line from said first-mentioned telephone line to said last-mentioned telephone line, and means for controlling said switch over said last-mentioned telephone line to extend connection therefrom over said trunk line and to said board, said switch being controllable over the two sides of the line circuit thereof in series.

10. In a two-wire telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, means for controlling said switch over said trunk, a non-numerical switch provided with means for seizing the said one end of said trunk, and devices at the other end of said trunk for extending connection thereto and therefrom, said switches being controllable over the two sides of the line circuit thereof in series.

11. In a two-wire telephone system, a two-way trunk, a subscriber's non-numerical line switch for seizing said trunk to extend connection over the same in one direction, and means for calling over said trunk in the other direction, said switch being controllable over the two sides of the line circuit thereof in series.

12. In a two-wire telephone system, a two-way trunk, a subscriber's line switch for seizing one end of said trunk to extend a call over the same in one direction, and a manual board at the other end of said trunk to extend connection over the same in the other direction, said switch being controllable over the two sides of the line circuit thereof in series.

13. In a two-wire telephone system, a two-way trunk, a subscriber's line switch for seizing one end of said trunk to extend a call over the same in one direction, and a manual board at the other end of said trunk to extend connection thereto and therefrom, said switch being controllable over the two sides of the line circuit thereof in series.

14. In a two-wire telephone system, a manual board, an automatic switch and a trunk for extending a calling connection to said board, and means for releasing said switch by the opening of the manual connection at said board, said switch being controllable over the two sides of the line circuit thereof in series.

15. In a two-wire telephone system, a manual board including a cord terminating in a plug, an automatic switch and a trunk terminating in a jack for extending a calling connection to said board, and means for releasing said switch by the removal of the answering plug from the jack of the trunk on said board, said switch being controllable over the two sides of the line circuit thereof in series.

16. In a two-wire telephone system, a trunk terminating in a jack, a manual board for one end of said trunk including a cord terminating in a plug, an automatic switch by which a calling line is automatically connected with the other end of said trunk, and means for releasing by the hanging up of the receiver at the calling substation only when the operator has withdrawn the plug from the jack of said trunk or when the operator has not answered, said switch being controllable over the two sides of the line circuit thereof in series.

17. In a common battery telephone system, a manual board, a non-numerical switch, a telephone line terminating at said board, a telephone line terminating at said switch, a two-way trunk line extending from the said switch to the said board, means controllable at said board for extending connection over said trunk line from said first-

mentioned telephone line to said last-mentioned telephone line, means for controlling said switch over said last-mentioned telephone line to extend connection therefrom over said trunk line and to said board, and a central source of talking and operating current for said system.

18. In a common battery telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, means for controlling said switch over said trunk, a non-numerical switch provided with means for seizing the said one end of said trunk, devices at the other end of said trunk for extending connection thereto and therefrom, and a central source of talking and operating current for said system.

19. In a common battery telephone system, a two-way trunk, a subscriber's non-numerical line switch for seizing said trunk to extend connection over the same in one direction, means for calling over said trunk in the other direction, and a central source of talking and operating current for said system.

20. In a common battery telephone system, a two-way trunk, a subscriber's line switch for seizing one end of said trunk to extend a call over the same in one direction, a manual board at the other end of said trunk to extend connection over the same in the other direction, and a central source of talking and operating current for said system.

21. In a common battery telephone system, a two-way trunk, a subscriber's line switch for seizing one end of said trunk to extend a call over the same in one direction, a manual board at the other end of said trunk to extend connection thereto and therefrom, and a central source of talking and operating current for said system.

22. In a common battery telephone system, a manual board, an automatic switch and a trunk for extending a calling connection to said board, means for releasing said switch by the opening of the manual connection at said board, and a central source of talking and operating current for said system.

23. In a common battery telephone system, a manual board including a cord terminating in a plug, an automatic switch and a trunk terminating in a jack for extending a calling connection to said board, means for releasing said switch by the removal of the answering plug from the jack of the trunk on said board, and a central source of talking and operating current for said system.

24. In a common battery telephone system, a trunk terminating in a jack, a manual board for one end of said trunk including a cord terminating in a plug, an automatic switch by which a calling line is automati-

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cally connected with the other end of said trunk, means for releasing by the hanging up of the receiver at the calling substation only when the operator has withdrawn the plug from the jack of said trunk or when the operator has not answered, and a central source of talking and operating current for said system.

25. In a telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, a non-numerical switch provided with means for seizing one end of said trunk, means for controlling said numerical switch over said trunk, and means for cutting off said numerical switch from said trunk when said non-numerical switch connects with said trunk.

26. In a telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, a non-numerical switch provided with means for seizing the same end of said trunk, means for controlling said numerical switch over said trunk, a relay, and means for energizing said relay to cut off said numerical switch from said trunk when said non-numerical switch connects with said trunk.

27. In a telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, a non-numerical switch provided with means for seizing the same end of said trunk, means for controlling said numerical switch over said trunk, and means for preventing said non-numerical switch from seizing said trunk when said numerical switch is operated.

28. In a telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, a non-numerical switch provided with means for seizing the same end of said trunk, a busy test contact with which a wiper of said non-numerical switch is adapted to engage, a relay, and means for energizing said relay when said numerical switch is being operated to place a busy potential upon said contact to thereby prevent said non-numerical switch from seizing said trunk.

29. In a telephone system, a manual board, a two-way trunk terminating at one end in said board, a numerical switch in which the opposite end of said trunk terminates, a non-numerical switch provided with means for seizing the last-mentioned end of said trunk, means for controlling said numerical switch over said trunk, and means for cutting off said numerical switch from said trunk when said non-numerical switch connects with said trunk.

30. In a telephone system, a manual board, a two-way trunk terminating at one end in said board, a numerical switch in which the opposite end of said trunk ter-

minates, a non-numerical switch provided with means for seizing the last-mentioned end of said trunk, means for controlling said numerical switch over said trunk, a relay, and means for energizing said relay to cut off said numerical switch from said trunk when said non-numerical switch connects with said trunk.

31. In a telephone system, a manual board, a two-way trunk terminating at one end in said board, a numerical switch in which the opposite end of said trunk terminates, a non-numerical switch provided with means for seizing the last-mentioned end of said trunk, means for controlling said numerical switch over said trunk, and means for preventing said non-numerical switch from seizing said trunk when said numerical switch is operated.

32. In a telephone system, a manual board, a two-way trunk terminating at one end in said board, a numerical switch in which the opposite end of said trunk terminates, a non-numerical switch provided with means for seizing the last-mentioned end of said trunk, a busy test contact with which a wiper of said numerical switch is adapted to engage, a relay, and means for energizing said relay when said numerical switch is being operated to place a busy potential upon said contact to thereby prevent said non-numerical switch from seizing said trunk.

33. In a telephone system, a plurality of subscribers' lines, means including a repeater for establishing a connection between two of said lines, means for controlling the operation of said repeater over two sides of a line circuit in series, condensers in the line circuit of said repeater, a relay, and means for energizing said relay during the operation of said repeater to cut off said condensers from the line circuit.

34. In a telephone system, a manual board, a non-numerical switch, a telephone line terminating at said board, a telephone line terminating at said switch, a two-way trunk line extending from the said switch to the said board, means controllable at said board for extending connection over said trunk line from said first-mentioned telephone line to said last-mentioned telephone line, means for controlling said switch over said last-mentioned telephone line to extend connection therefrom over said trunk line and to said board, and automatic means for signaling the board.

35. In a telephone system, a two-way trunk, a numerical switch in which said trunk terminates at one end thereof, means for controlling said switch over said trunk, a non-numerical switch provided with means for seizing the said one end of said trunk, devices at the other end of said trunk for extending connection thereto and

therefrom, and automatic means for signaling the other end.

36. In a telephone system, a two-way trunk, a subscriber's non-numerical line switch for seizing said trunk to extend connection over the same in one direction, means for calling over said trunk in the other direction, and means for signaling automatically in the first direction.

37. In a telephone system, a manual board, an automatic switch and a trunk for extending a calling connection to said board, and means for automatically signaling the board and for releasing said switch by the opening of the manual connection at said board.

38. In a telephone system, a manual board including a cord terminating in a plug, an automatic switch and a trunk terminating in a jack for extending a calling connection to said board, and means for automatically signaling the same and for releasing said switch by the removal of the answering plug from the jack of the trunk on said board.

39. In a telephone system, a trunk terminating in a jack, a manual board for one end of said trunk including a cord terminating in a plug, an automatic switch by which a calling line is automatically connected with the other end of said trunk, and means for automatically signaling the other end of the trunk and for releasing by the hanging up of the receiver at the calling substation only when the operator has withdrawn the plug from the jack of said trunk or when the operator has not answered.

40. In a telephone system, a plurality of lines, an individual non-numerical trunking

switch for each line, a plurality of trunks common to said switches for extending connections from said lines, a common trunk selecting mechanism for locating an idle trunk line for said switches, trunking means associated with the other end of said trunk lines for extending connections in the reversed direction, an automatic progressively movable connector switch for each trunk line, said connectors controlled over said trunk lines from the said last mentioned trunking means, for extending connections from said trunks.

41. In a telephone system, subscribers' lines, a manual switchboard, non-numerical trunking switches for said lines, trunk lines extending between said switches and said board, connector numerical switches between said trunk lines and said subscribers' lines, and having access to said subscribers' lines, a master switch associated with said trunk lines for selecting an idle trunk line, said non-numerical trunking switches controlled over said lines for extending connection to the idle trunk line for extending connection to said manual board, means for said manual board for extending connection over any one of said trunk lines in the reversed direction to any one of said connector switches and for operating such a connector over the extended connection to establish a circuit with any one of said subscribers' lines.

Signed by me at Chicago, Cook county, Illinois, this 27 day of Nov., 1910.

TALBOT G. MARTIN.

Witnesses:

A. J. RAY,
E. D. FALES.