B. D. WILLIS.

CORD CIRCUIT FOR TELEPHONE SYSTEMS.

APPLICATION FILED OCT. 4, 1911.

1,156,450.

Patented Oct. 12, 1915.

3 SHEETS—SHEET 1.

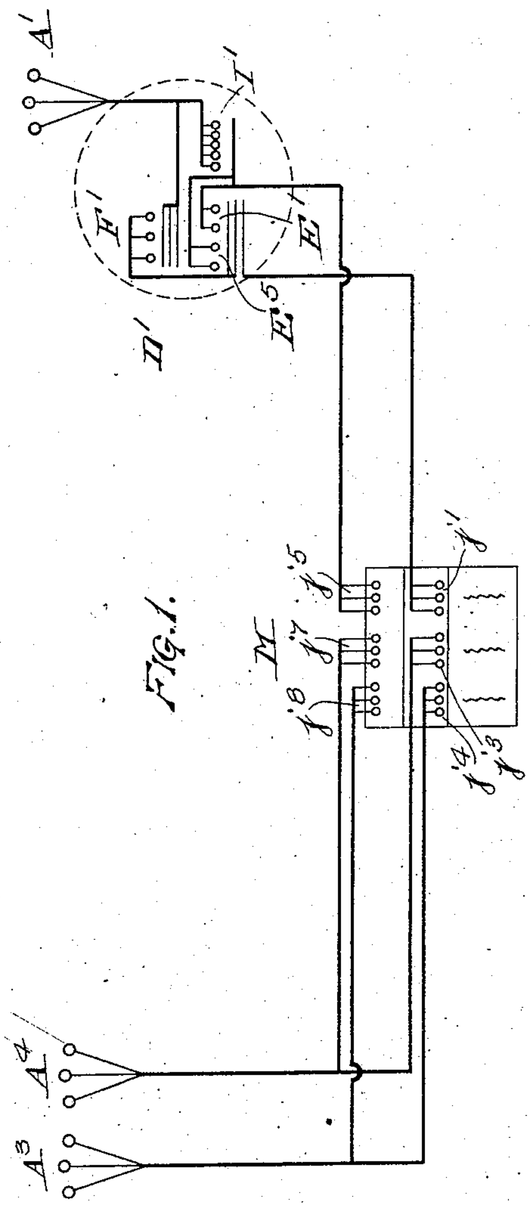

Fig. 1.

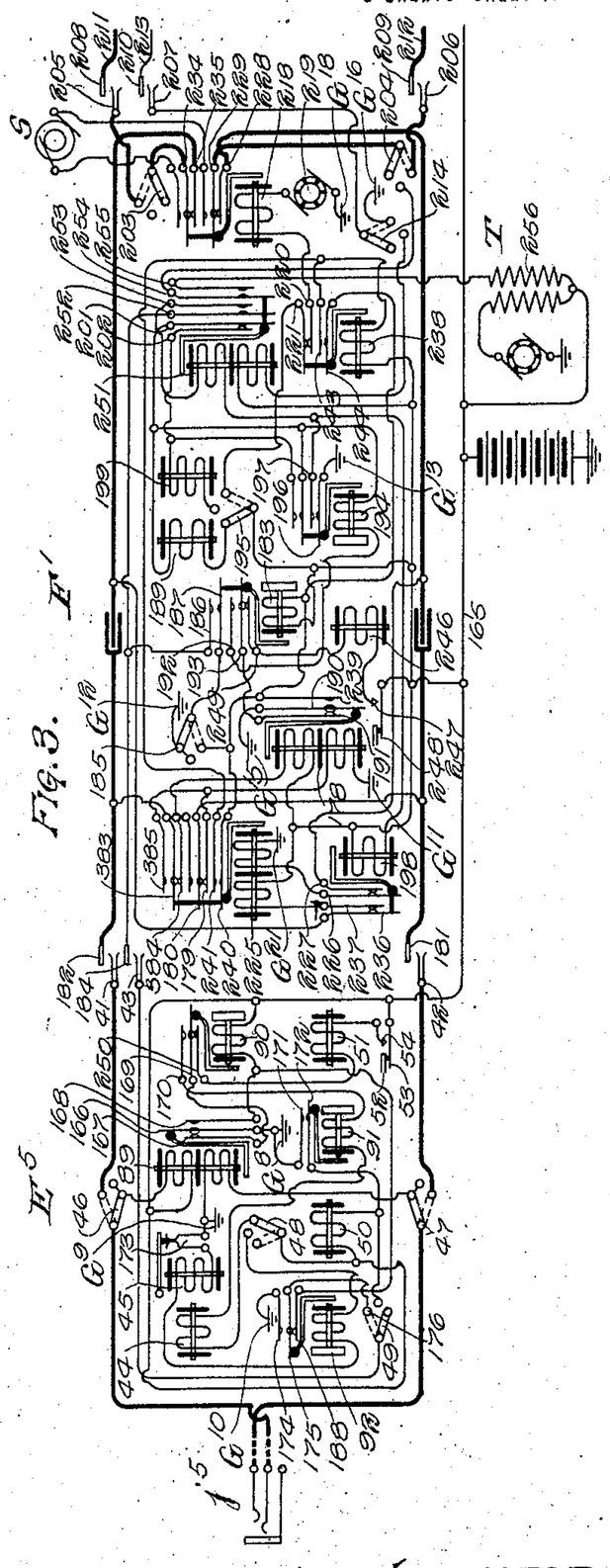

Fig. 3.

WITNESSES

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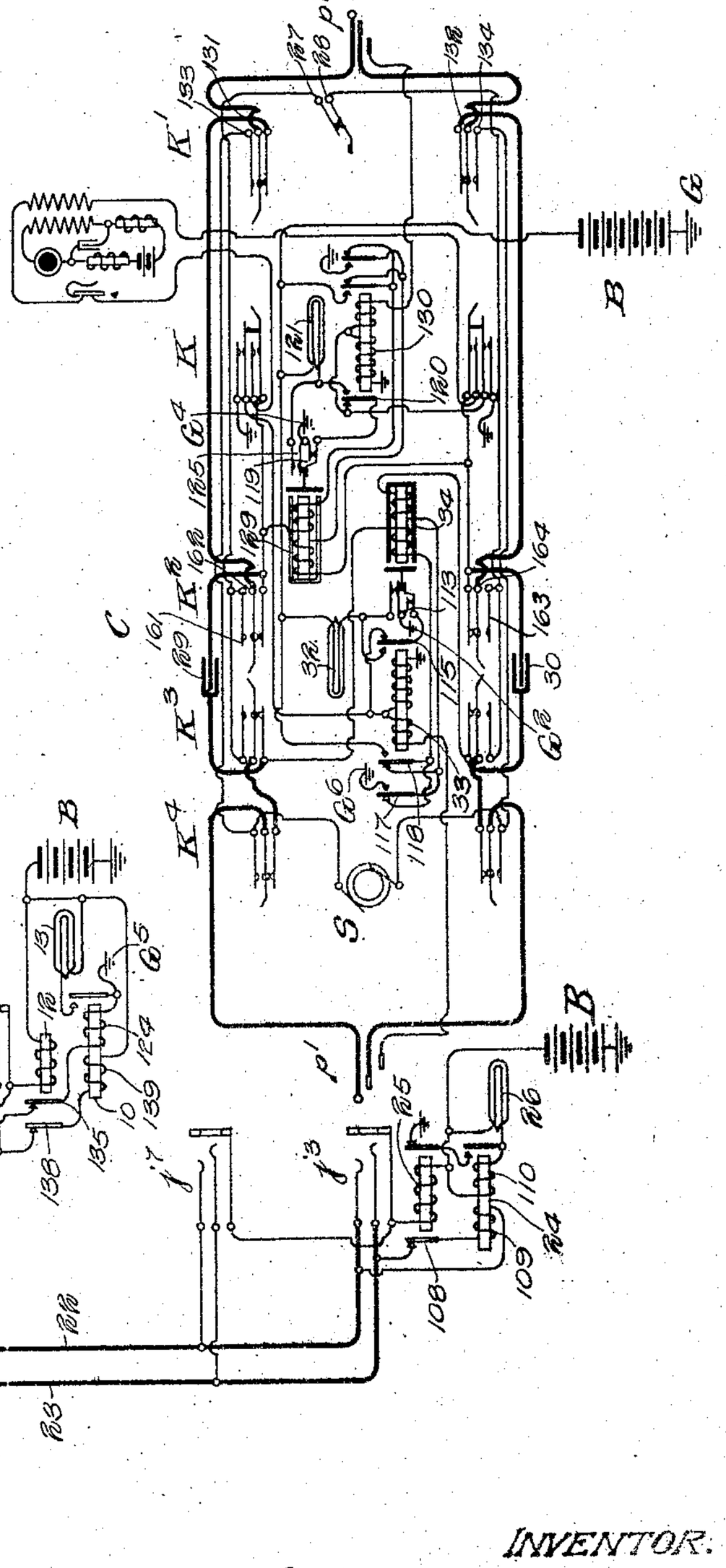

Fig. 2.

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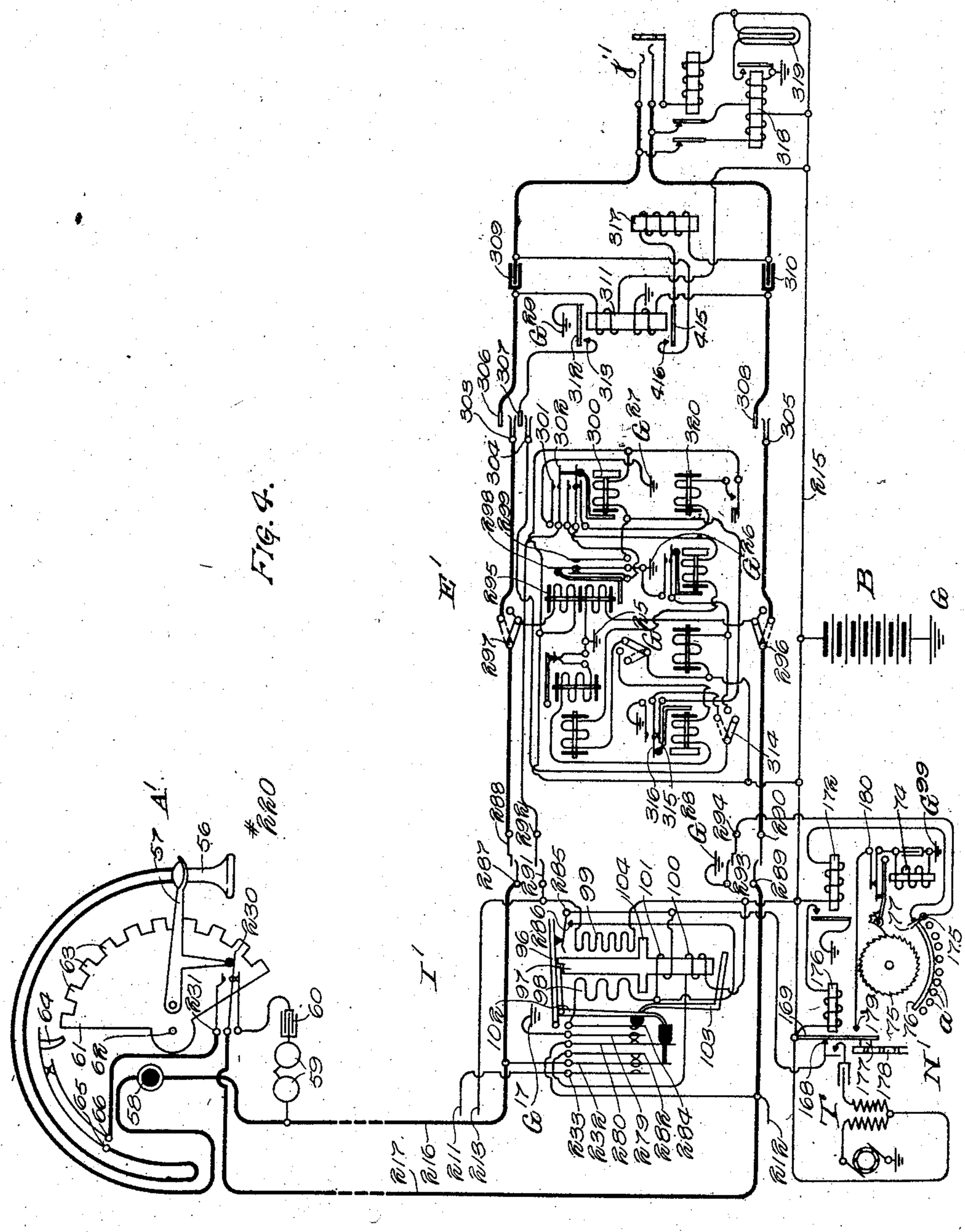

FIG. 4.

WITNESSES

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CORD-CIRCUIT FOR TELEPHONE SYSTEMS.

1,156,450. Specification of Letters Patent. Patented Oct. 12, 1915.

Application filed October 4, 1911. Serial No. 652,754.

To all whom it may concern:

Be it known that I, BERNARD D. WILLIS, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Cord-Circuits for Telephone Systems, of which the following is a specification.

My invention relates to telephone systems, and more particularly to an improved cord circuit for use in the same.

My improved cord circuit is especially adapted for use in connection with semi-automatic telephone systems, and is what I term a "universal cord circuit" in that it may be used to connect with magneto or local battery manual lines, common battery manual lines, or with trunk lines leading to and from an automatic exchange. Usually, when a cord circuit is connected with different types of lines in this manner, difficulty is encountered in obtaining proper supervision owing to the fact that different supervisory circuits are required when connection is made with a local battery line than those which are required for a common battery line. In my improved cord circuit the supervisory circuits are automatically adapted, upon insertion of the plug into the jack, to the particular line with which connection is made.

A further feature of novelty is the provision of a cord circuit which is adapted for use in both local and common battery manual lines, and with an automatic system in which supervision is obtained by reversing the battery upon the line when the called subscriber answers.

A further object of novelty is in the improved method of obtaining supervision from local battery magneto lines, whether these lines are in a manual system or in a semi-automatic system. Ordinarily, the cords for use with magneto lines are provided with a single relay in each end of the cord. This relay has two windings, one of which is bridged across the cord and the other of which is adapted to be included in a locking circuit including a pair of normally open springs controlled by its own armature and the third conductor of the plug and jack. When the subscriber rings off, the relay is energized by magneto current in its bridged winding. Upon energizing, this relay closes the circuit of its locking winding, and likewise closes the circuit of the disconnect signal. The magneto current being alternating in character, and the current in the locking winding being direct, if the last impulse of the magneto current happens to be in the direction to oppose the current in the locking winding, there would be danger of the relay being unlocked and no disconnect signal given. In my improved cord circuit I obviate this objectionable feature by the use of two relays, one bridged across the cord and one in the third conductor, said second relay being normally short-circuited through the springs of the first relay as well as through a pair of its own springs. When the bridged relay is energized by the magneto current, it opens the short-circuit of the other relay, which immediately energizes and opens its short-circuit at another point. The second relay cannot then be disturbed by any further operations of the bridged relay, and is, therefore certain to remain energized to keep the circuit of the disconnected signal closed.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which—

Figure 1 is a diagrammatic representation of a telephone system embodying the principles of my invention. Fig. 2 is a diagrammatic representation of a common battery manual line A^4, a local battery manual line A^3 and a manual switchboard operator's cord circuit C. Figs. 3 and 4 are views representing automatic switching apparatus and substations.

In Fig. 1, M represents a portion of a manual switchboard to which are connected local battery manual lines A^3, common battery lines A^4 and trunk lines leading to and from an automatic exchange D′. The exchange D′ is of the so-called two-wire type, *i. e.*, of the type in which the central office apparatus is controlled over the two sides of the calling line in series. Referring to the exchange D′, each of the substations A′ is provided with an individual or line switch I′ at the central office. A group of these line switches has common access to a number of first selector switches E′. The selectors E′ have access to a number of trunk lines, some of which lead to connector switches F′, while others lead to jacks j' on the manual board M. From the jacks j^5 on the manual board M trunk lines lead to se-

lector switches E^5 which have access to the same trunks as the selectors E'. Of course, the exchange may comprise a number of groups of substations such as herein shown, with their accompanying line, selector and connector switches interconnected in the usual manner.

Fig. 3 represents one of the jacks j^5 at the manual board M, together with its corresponding selector switch E^5 and a connector switch F' at the automatic exchange D'.

Fig. 4 is a representation of one of the substations A' of the exchange D', together with its line switch I', a master switch N', a selector E' and a jack j' at the manual board M.

In the various drawings there are shown a number of batteries B, having one terminal grounded, for operating the switching apparatus, relays, signals, etc. There are also shown a number of ringing current generators S and busy signaling machines T. Any number of batteries, ringing current generators and busy signaling machines may be used, but generally one of each in each office is found to be a satisfactory arrangement.

The common battery manual substation A^4 (Fig. 2) may be of any suitable type, and, as herein shown, comprises the usual receiver 2, switch hook 3, transmitter 4, ringer 5, induction coil 6 and condenser 7. At the central office the line conductors 8 and 9 are connected to an answering jack j^4 and one or more multiple jacks j^8. At the central office there is also allotted to the line the usual line relay 10, cut-off relay 12 and line lamp 13.

The local battery substation A^3, as herein represented, comprises a receiver 14, switch hook 15, transmitter 16, local battery 17, induction coil 18, condenser 19, magneto generator 20 and a ringer 21. At the central office there is allotted to the line conductors 22 and 23 an answering jack j^3, one or more multiple jacks j^7, a line relay 24, a cut-off relay 25 and a signal lamp 26.

The operator's cord circuit is similar in general respects to the usual cord circuits used in manual switchboard practice. Among other details it comprises two plugs p' and p^2 connected together through the condensers 29 and 30. A listening key K is provided by means of which the operator may connect her talking set with the cord circuit. Each end of the cord is provided with a ringing key and a calling device key. Since this cord is to be used for extending connection to automatic exchanges, it is equipped with an automatic calling device. This calling device may be of any suitable type and is herein represented diagrammatically by the two springs 27 and 28. The cord is provided with the usual answering and calling supervisory lamps 32 and 121, each controlled by a pair of relays, as hereinafter described. As the supervisory circuits of each end of the cord are similar, only the answering end will be referred to at this time. The relay 34 is a polarized relay, having a pair of energizing windings, whose armature is pivoted in the center and may be attracted in either direction, depending upon the direction of the current in the windings. The armature returns to its mid-position whenever the relay is deënergized. The connection between the windings of the relay 34 is controlled by the relay 33 in such a manner that the two windings may be connected directly together in a bridge of the cord circuit, or may have the battery B connected between them. The relay 33 comprises two windings permanently connected together with a lead running off from the junction point, which lead is adapted to be connected to ground by the operation of the listening key K. The left-hand winding of the relay 33 comprises comparatively few turns and has a rather low resistance and is connected with the sleeve of the plug p'. The right-hand winding of this relay comprises a larger number of turns and is more sensitive than the left-hand winding.

The selector switches E^5 (Fig. 3) and E' (Fig. 4) are of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, being modified somewhat in order to operate in a two-wire system, *i. e.*, a system in which the automatic switches are controlled over the two sides of the line in series, in the manner shown in British patent to S. G. S. Dicker No. 1298 of 1910. Referring especially to the selectors E^5, each of these selectors comprises, among other details, a set of wipers 41, 42 and 43 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 44 and a rotary motion controlled by the rotary magnet 45. The so-called side switch, comprising the wipers 46, 47, 48 and 49, is controlled by the private magnet 50 in a well-known manner. Means for releasing the switch are provided in the release magnet 51, which magnet releases the switch immediately upon energizing. As long as the switch shaft is in its lowest position, an arm 52 on said shaft disconnects the magnet 51 from the battery by separating the springs 53 and 54. The operation of the switch is controlled by the operator through the medium of the double-wound line relay 89. The selector likewise includes the relays 90, 91 and 92, which are slow acting, for a purpose which will be more clearly understood by reference to the complete operation of the system which follows.

The connector F' (Fig. 3) is of the general type of connector switches disclosed in

United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors, is modified to operate in a two-wire system, as shown in said British Patent No. 1298 of 1910.

As herein represented, the automatic substation A′ (Fig. 4) comprises the usual receiver 56, receiver hook 57, transmitter 58, ringer 59 and condenser 60. In addition, the substation is provided with an impulse wheel 61 secured to a shaft 62 to which there is also attached a dial (not shown) which is provided with finger holes. The impulse wheel 61 carries upon its periphery a number of impulse teeth 63 which are so arranged that as the dial and impulse wheel return to normal position after having been rotated forward by the calling subscriber, each tooth that passes the cam 64 momentarily forces the spring 65 out of engagement with the spring 66. The dial and impulse wheel are returned to normal position by a spring (not shown).

The individual switch I′ is of the general type disclosed in British patent to R. W. James No. 26,301 of 1906, and in the *American Telephone Journal* of New York, N. Y., of June 6, 1908, being of a somewhat modified construction, however. Among other details the switch I′ comprises a plunger (not shown) attached to the plunger arm 96 which is controlled by the magnet 97. The magnet 97 has four energizing windings, namely, a pull-in winding 98, a cut-off winding 99, a line winding 100 and an auxiliary winding 101. The magnetic circuit of the windings 98 and 99 is separate from that of the windings 100 and 101, whereby the energization of the windings upon one end of the magnet does not affect the armatures upon the other end. The winding 98 will operate both the armature 102 and the plunger arm 96, while the winding 99 is strong enough to operate only the armature 102. If, however, the winding 99 is energized while the plunger arm is in its attracted position, said arm may be held in this position by the winding 99 alone.

The master switch N′ is similar to the master switch shown and described in British Patent No. 1423 of 1910. Among its essential details it comprises a motor magnet 74 for operating the ratchet wheel 75. The ratchet wheel 75 is connected with a so-called plunger shaft (not shown) in such a manner that a continuous rotary motion of said wheel gives to said shaft an oscillating motion to move the idle plungers back and forth in front of their trunk terminals. Secured to the plunger shaft there is also a locking plate 178 having in its surface a number of circular openings which are adapted to be engaged by the pin 177 on the armature 169. The openings in the plate 178 are so spaced that the pin 177 can engage one of them only when the plungers that are in engagement with the plunger shaft are directly in front of the terminal of a trunk line. The master switch N′ is also provided with a bank of contacts comprising the common segment 76 and one individual segment *a* for each trunk line. The wiper 77 is adapted to always keep the common segment 76 in electrical connection with the segment *a* which corresponds to the trunk line before the terminals of which the idle plungers are being held by the master switch.

The operation of the system is as follows: Concerning first the local battery or magneto substation, the operator is signaled from the substation A^3 (Fig. 2) by the operation of the magneto generator 20, after which the receiver is removed from the hook, whereby the local transmitter circuit is closed and the secondary circuit bridged across the line. When the generator 20 is operated, current flows through the springs 106 and 105, which are closed when the crank is turned, thence over the line 23, through the armature 108, winding 109 of the relay 24 and back over the line 22 to the generator 20. This current through the winding 109 energizes the relay 24, which operates to close a circuit through the lamp 26 and a locking circuit for itself through the winding 110. The relay 24 thus remains locked and the lamp 26 continues to glow until the call is answered. The operator answers the call by inserting the plug *p′* into the jack j^3 of the calling line. The engagement of the sleeve conductors of the plug *p′* and the jack j^3 completes a circuit extending from ground G^2 through the closed springs 113 of the relay 34, armature 115 and its back contact, left-hand winding of the relay 33, plug *p′* and jack j^3, and through the cut-off relay 25 to the battery B. The cut-off relay 25 of the local battery lines has a comparatively high resistance, so that although it is energized over this circuit it does not permit sufficient current to flow through the left-hand winding of the relay 33 to operatively energize it. The energization of the relay 25 opens the bridge across the calling line through the winding 109 of the relay 24, and breaks the circuit through the winding 110 and the lamp 26. The subscribers' lines 22 and 23 are now connected with the tip and ring strands of the cord C, respectively, across which are bridged the two windings of the relay 34 in series.

By operating the listening key K the operator may connect the talking set with the cord to inquire with what line connection is desired. Connection can then be extended to any other line, as will hereinafter be explained.

The subscriber at substation A^3 has con-

trol of the supervisory lamp 32 at the cord C through the medium of the relays 34 and 33. The two windings of the relay 34 are connected in series across the cord. One end of the right-hand winding of the relay 33 is connected to ground direct, while the other end of said winding is connected to battery through the cut-off relay 25 and to ground through its own armature 115 and the normally closed contacts of the relay 34. The right-hand winding of the relay 33 is, therefore, normally short-circuited. When the subscriber at substation A^3 rings off upon the termination of the conversation, the relay 34 will be actuated by the ringing current from the substation magneto generator 20. As soon as the relay 34 operates to open the springs 113, the short-circuit is removed from the right-hand winding of the relay 33, allowing it to energize in series with the relay 25. The attraction of the armature 115 by the energization of the right-hand winding of the relay 33 opens the short-circuit at a second point, so that said relay 33 remains energized after the springs close again. The engagement of the armature 115 with its front contact closes a circuit through the lamp 32, said circuit extending from ground G^2 through the springs 113, armature 115 and lamp 32 to battery B. When the relay 33 energizes it will be seen that the battery B is inserted between the windings of the relay 34, but this is without function at this time. In fact, as far as its operation in connection with magneto lines is concerned, it will be evident that the relay 34 could be simply a single-wound non-polarized relay connected permanently across the cord circuit. It will also be evident that in so far as the operations just described are concerned, the left-hand winding of the relay 33 is functionless. The relay 33 will remain energized and maintain the circuit of the lamp 32 until the plug p' is removed.

The above is the operation of the falling end of the cord C when a magneto substation such as the substation A^3 is the calling substation, and is entirely independent of the character of the line to which the connection is extended by the calling plug p^2. In fact the supervisory circuits of the two ends of the cord are entirely independent of each other, so that a description of the operation of either the calling or answering end is true regardless of the character of the line with which the other end of said cord is connected.

When the substation A^3 is the called substation, the calling plug p^2 will be inserted in the jack j^7, and the substation A^3 will be signaled by throwing the key K' to force the springs 131 and 132 into engagement with the springs 133 and 134, respectively, whereby the calling and called lines are disconnected and the generator S bridged across the called line. After the conversation is completed the operator may be given a disconnect signal by the operation of the generator 20 in much the same manner as when the substation A^3 is the calling substation. In this case the current from the generator 20 flows through the relay 129 in the calling end of the cord. The relay 129 being in all respects the same as the relay 34 operates to remove a short-circuit from the left-hand winding of the relay 130, which is like the relay 33 in the other end of the cord. The relay 130 operates to close a circuit through the lamp 121 in the same manner in which the relay 33 closes a circuit through the lamp 32.

When a common battery substation A^4 is the calling substation, the operator is signaled simply by the removal of the receiver from the switch hook. The engagement of the switch hook 3 with the contact point 133 completes a circuit extending from ground G^5 through the winding 124 of the relay 10, armature 135, line 8, switch hook 3, contact point 133, primary winding of the induction coil 6, transmitter 4, line 9, armature 138 and winding 139 to battery B. The relay 10, upon energizing, closes a circuit through the lamp 13. When the operator inserts the plug p' into the jack j^4 in answer to the signal displayed by the lamp 13, the calling line is extended to the tip and ring strands of the cord C and an energizing circuit is closed through the left-hand winding of the relay 33 of the cord and through the cut-off relay 12 of the line A^4. This circuit extends from ground G^2 through the springs 113 and 115, left-hand winding of the relay 33, sleeve of the plug p' and jack j^4 and through the relay 12 to battery B. The relay 12 has a lower resistance than the cut-off relay 25 of the local battery line A^3, so that in this instance the relay 33 is energized through its left-hand winding. The relay 12, upon energizing, disconnects the relay 10 from the line, which relay then deënergizes to break the circuit of the lamp 13. The energization of the relay 33 serves, through the medium of its armatures 117 and 118, to connect one winding of the relay 34 to ground and the other winding to the non-grounded pole of the battery, thereby providing the calling substation with talking current over a circuit extending from ground G^6 through the armature 117, the right-hand winding of the relay 34, ring strand of the cord C, ring conductor of the plug p' and jack j^4, line 9, substation A^4, line 8, tip of the jack j^4 and plug p', tip strand of the cord C, left-hand winding of the relay 34 and armature 118 to battery B. The relay 34 is energized by this current in the proper direction to separate the springs 113, thereby preventing the closure of the circuit of the lamp

32 by the engagement of the armature 115 with its front contact upon the energization of the relay 33. When the receiver at the substation A^4 is restored to the switch hook upon the termination of the conversation, the energizing circuit of the relay 34 is destroyed, allowing the springs 113 to close. The engagement of these springs completes a circuit through the lamp 32. This circuit extends from ground G^2 through the springs 113, armature 115 and its front contact, and lamp 32 to battery B. When the plug p' is removed, the relays 12 and 33 deenergize, restoring the calling line and answering end of the cord to normal position.

If the common battery substation A^4 is a called substation, the calling plug p^2 is then inserted into one of the multiple jacks j^8. The engagement of the sleeve contacts of the plug p^2 and jack j^8 completes a circuit from ground G^4 through the springs 119, armature 120, right-hand winding of the relay 130 and through the relay 12 to battery. As has been explained, the relay 130 is similar to the relay 33 in the other end of the cord, and controls circuits which are similar to the circuits controlled by the latter relay. Therefore, the energization of the relay 130 serves to connect the ring strand of the calling end of the cord to ground through one winding of the relay 129, and to connect the tip strand to battery through the other winding of the same relay. Since the receiver at the called substation is on the switch hook at the time the plug is inserted, the relay 129 is not energized immediately. Consequently, the energization of the relay 130 also closes a circuit through the lamp 121. This circuit extends from ground G^4 through the springs 119 of the relay 129, armature 120 and its front contact and lamp 121 to battery B. The operator signals the common battery substation in the same manner as the local battery substation is signaled—that is, by operating the key K', to bridge the generator S across the line. When the called subscriber removes his receiver, a bridge is closed across the line through the secondary circuit of the substation. The relay 129 at the cord thereupon energizes in the proper direction to separate the springs 119. The separation of these springs destroys the circuit of the lamp 121. The extinguishing of the lamp signifies to the operator that the called subscriber has answered. When the receiver at the called substation is again restored to the hook, the relay 129 deënergizes again, lighting the lamp 121, thus giving the operator a front disconnect signal—that is, a disconnect signal in the calling end of the cord.

When a connection is desired with one of the automatic substations of the automatic exchange D' (substation A' shown in Fig. 4, for instance), the plug p^2 is inserted into the jack j^5 (Fig. 3). The sleeve conductors of the jacks of the trunks leading to the automatic exchange have no connection to battery, so that no circuit is closed through the right-hand winding of the relay 130 at this time. The engagement of the tip and ring conductors of the plug p^2 and jack j^5 connects the cord C with a selector switch E^5, through which latter connection with any line in the exchange D' may be obtained. The operator now operates the key K^2 to force the springs 162 and 164 into engagement with the springs 161 and 163, respectively, whereby the automatic calling device is bridged across the trunk line. A circuit is thus completed from ground G^9 (Fig. 3) through the lower winding of the selector line relay 89, side switch wiper 47, tip springs of the jack j^5 and plug p^2, springs 162 and 161 of the key K^2, calling device springs 27 and 28, key springs 163 and 164, ring of the plug p^2, ring spring of the jack j^5, side switch wiper 46 and upper winding of the relay 89 to the battery lead 165. The relay 89, upon energizing, operates to shift the spring 166 out of engagement with the spring 167 and into contact with the spring 168, whereby a circuit is closed through the slow acting relay 90. This circuit extends from ground G^8 through the springs 166 and 168 and relay 90 to the battery lead 165. The relay 90, upon energizing, operates to extend a connection from the spring 167 through the relay 91 to the vertical magnet 44. Assuming the number of the substation A' to be 220, the operator now operates the calling device to separate the springs 27 and 28 momentarily twice to operate the selector E^5. Each time the springs 27 and 28 are separated the selector line relay 89 deënergizes momentarily, completing a circuit through the vertical magnet 44. This circuit extends from ground G^8 through the springs 166 and 167, 169 and 170, relay 91, magnet 44 and side switch wiper 48 to the battery lead 165. The vertical magnet 44 receives two impulses over this circuit, operating to raise the wipers 41, 42 and 43 two steps opposite the second row or level of bank contacts. The relay 91 being slow acting does not have time to deenergize during the momentary interruptions of its circuit by the relay 89 during the above operation. The relay 91, which is included in the energizing circuit of the vertical magnet, is energized by the first impulse, and being slow acting remains in its energized position until after the last impulse has been delivered to the vertical magnet. In its energized position the relay 91 operates to complete a circuit from ground G^8 through the springs 171 and 172 and the private magnet 50 to the battery lead 165. When the relay 91 deënergizes

after the last impulse is delivered to the vertical magnet 44, the circuit of the private magnet 50 is broken. The private magnet thereupon deënergizes and allows the side switch to pass to second position. The movement of the side switch wiper 48 from first to second position disconnects battery from the vertical magnet 44, and completes a circuit through the rotary magnet 45. This circuit extends from ground G^9 through the interrupter springs 173, rotary magnet 45, slow acting relay 92 and side switch wiper 48 to the battery lead 165. The rotary magnet energizes upon the closure of this circuit and operates to rotate the wipers 41 42 and 43 one step, force down the private magnet armature and to open its own circuit at the interrupter springs 173. The rotary magnet thereupon deënergizes and, if the first trunk of the second level is idle, allows the private magnet armature to fall back, causing the side switch to pass to third position. If the first trunk is busy, however, the private wiper 43 finds the first contact guarded by a ground potential, thereby completing a locking circuit for the private magnet 50. This circuit extends from the grounded bank contact through the wiper 43, side switch wiper 49 (in second position) and the magnet 50 to the battery lead 165. This locking circuit prevents the side switch from passing to third position. As long as the side switch remains in second position the rotary magnet 45 continues to operate in a manner similar to that of a buzzer to rotate the wipers 41, 42 and 43 past the busy trunks.

As soon as the wiper 43 passes onto the non-grounded contact of an idle trunk, the private magnet 50 deënergizes and the side switch passes to third position. The disengagement of the wiper 48 with its second-position contact point breaks the operating circuit of the rotary magnet 45. The relay 92, which is included in the operating circuit of the rotary magnet, is slow acting and consequently remains energized for an instant after the wipers are rotated the last step. Consequently, at the instant the side switch passes to third position the seized trunk is provided with a guarding potential from ground G^{10} through the springs 174 and 175, contact point 176, side switch wiper 49 and private wiper 43 to the selector private bank contacts of the trunk line leading to the connector F'. The engagement of the side switch wipers 46 and 47 with their third-position contact points extends the connection from the cord C to the connector F' through the shaft wipers 41 and 42. The relay 178 is thereupon energized by a flow of current from ground G^{11} through the lower winding of said relay, through the springs 179 and 180, contact 181, wiper 42, thence through the cord C and back over the other side of the line, through the wiper 41, bank contact 182, springs 383 and 384 and through the upper winding of the relay 178 to the battery lead 165. The relay 178, upon energizing, operates to close the circuit of the relay 183. The relay 183, upon energizing, operates to place a new guarding potential on the private bank contact 184 to guard the trunk after the relay 92 deënergizes. This new potential extends from ground G^{12} through the side switch wiper 185, springs 187 and 186 to the contact 184. Also, as soon as the relay 92 of the selector E^5 deënergizes, the relay 90 is provided with a new circuit extending from ground G^{12} to the contact 184, as just traced, through the wiper 43, side switch wiper 49, springs 175 and 188 of the relay 92 and relay 90 to battery. This circuit is closed before the relay 90 has time to deënergize after its former circuit is broken by the deënergization of the relay 89 when the side switch passes to third position. The relay 92 is quicker in its action than the relay 90, and its only function is to provide a guarding potential for the seized trunk until the relay 183 of the connector has time to energize.

The operation of the operator's calling device for the second digit 2 breaks the circuit of the connector line relay 178 twice. Each time the relay 178 deënergizes, a circuit is closed through the vertical magnet 189. This circuit extends from ground G^{15} through the springs 190 and 191, 193 and 192 of the relay 183 (which remains energized while the impulses are being delivered), relay 194, vertical magnet 189 and side switch wiper 195 to the battery lead 165. The magnet 189 operates to raise the shaft wipers two steps. The slow acting relay 194 is energized by the first impulse to the vertical magnet, and closes a circuit from ground G^{13} through the springs 196 and 197 and private magnet 198 to the battery lead 165. The relay 194 remains in its operated position until after the last impulse is delivered to the vertical magnet, whereupon it deënergizes, breaking the circuit of the private magnet 198, which then permits the side switch to pass to second position. Now, when the relay 178 deënergizes in response to the operation of the operator's calling device for the last digit 0, it closes a circuit through the rotary magnet 199. This circuit extends from ground G^{15} through the springs 190 and 191, 193 and 192, relay 194, springs 201 and 202, rotary magnet 199 and side switch wiper 195 to battery. The rotary magnet receives ten impulses over this circuit, operating to rotate the wipers onto the contacts of the desired line. The slow acting relay operates to close the circuit of the private magnet while these impulses are being de-

livered, just as in the case of the previous digit. When the relay 194 deënergizes after the last impulse is delivered, the private magnet 198 deënergizes also, if the called line is idle, and permits the side switch to pass to third position. The engagement of the side switch wipers 203 and 204 with their third-position contact points extends the line connection through the wipers 205 and 206, contacts 208 and 209 and the conductors 211 and 212 to the called line (Fig. 4). The engagement of its third-position contact point by the side switch wiper 214 extends a guarding potential to the connector private bank contacts of the called line, and provides an energizing circuit for the cut-off winding 99 of the line switch I'. This circuit extends from ground G^{16} through the side switch wiper 214 to the private wiper 207 and contact 210, and thence to the corresponding contact in the banks of all connectors which have access to the line #220. From the contact 210 the circuit also extends over the conductor 213 and through the winding 99 of the switch I' to the battery lead 215. The winding 99, upon energizing, attracts the armature 102, which operates to disconnect the ground G^{17} and the line winding 100 from the called line, and to connect the conductor 211 with the line 216.

When the connector side switch wiper 195 reaches third position, the ringer relay 218 begins to be intermittently energized over a circuit extending from ground G^{18} through the interrupter 219, relay 218, springs 220 and 221 and side switch wiper 195 to the battery lead 165. Each time the relay 218 is energized it operates to disconnect the calling and called lines, and to bridge the generator S across the called line to ring the bells 59.

After the operator at the cord C (Fig. 2) has completed the call, the key K^2 is restored to normal position, thereby cutting off the calling device and substituting therefor a bridge consisting of the relay 129. This relay is thus included in the energizing circuit of the connector line relay 178, and the current is in such a direction as to attract the armature in the proper direction to close the springs 125, thereby closing a circuit through the lamp 121.

When the called subscriber removes his receiver in answer to the call, the circuit of the ringer 59 is opened and the talking circuit is bridged across the line. The first time the ringer relay 218 of the connector deënergizes after this occurs, the called substation is provided with talking current over a circuit extending from ground G^{21} through the right-hand winding of the relay 225, springs 226 and 227 of the private magnet 198, ringer relay springs 228 and 229, side switch wiper 204, shaft wiper 206, contact 209, lines 212 and 217, hook switch springs 230 and 231, receiver 56, transmitter 58, line 216, springs 232 and 233, conductor 211, contact 208, wiper 205, side switch wiper 203, ringer relay springs 234 and 235, springs 236 and 237 and left-hand winding of the relay 225 to the battery lead 165. The relay 225 is energized by this current, and by shifting the springs 180 and 383 reverses the line connections of the relay 178, thereby reversing the direction of the flow of the current in the trunk line leading from the manual to the automatic office. This reversal of the current causes the polarized relay 129 at the cord to attract its armature in the opposite direction to open the springs 125 and thereby extinguish the lamp 121, which informs the operator that the called subscriber has answered.

Another result of the energization of the connector back bridge relay 225 is the closure of a circuit through the relay 238. This circuit extends from ground G^{15} through the springs 190 and 239 of the line relay 178, springs 240 and 241 of the relay 225 and relay 238 to battery. The relay 238, upon energizing, breaks the circuit of the ringer relay 218 at the springs 221 and 220, and forms a locking circuit for itself by the closure of the springs 243 and 244 so as to prevent the circuit of the relay 218 from being again energized when the called subscriber hangs up his receiver and allows the relay 225 to deënergize.

The hanging up of the receiver at the called substation breaks the energizing circuit of the connector back bridge relay 225, causing it to deënergize, which again reverses the current in the relay 129 at the operator's cord. This reversal of the current causes the armature of the relay 129 to be again attracted in the direction to close the springs 125, thereby lighting the lamp 121 to give the operator the disconnect signal.

The release of the selector E^5 and connector F' is brought about by the removal of the plug p^2 from the jack j^5. The removal of this plug breaks the energizing circuits of the connector line relay 178 and the relay 129 at the cord. The deënergization of the relay at the cord extinguishes the lamp 121. The deënergization of the connector line relay 178 breaks the circuit of the release relay 183, and that of the selector release relay 90, since its circuit is controlled by the relay 178 after the side switch wiper 185 reaches third position. The deënergization of the relays 183 and 90 closes the energizing circuits of the release magnets of their respective switches. The circuit of the release magnet 246 of the connector F' extends from ground G^{15} through the springs 190 and 191, 193 and 249, magnet 246 and springs 247 and 248 to the battery

lead 165. The release circuit of the selector E^5 extends from ground G^8 through the springs 166 and 167, 169 and 250, magnet 51 and springs 54 and 53 to the battery lead 165. The energization of the magnets 246 and 51 causes the mechanism of their respective switches to be restored to normal position. The circuits of the magnets 246 and 51 are opened at the springs 247 and 248 and 54 and 53 when the shafts of the respective switches reach their lowest positions.

Returning now to that stage of the operation of the connector F′ when the wipers have been rotated onto the contacts of the desired line and before the private magnet relay 194 has deënergized to permit the private magnet to trip the side switch to third position, it will be explained how the calling subscriber receives the busy signal in case the called line is busy. When the called line is busy the private wiper 207 finds the contact 210 guarded by a ground potential which completes a circuit through said wiper 207, side switch wiper 214 (in second position) and the lower winding of the relay 251 to battery. If the relay 251 is thus energized when the relay 194 deënergizes, the side switch cannot pass from second position because the private magnet remains locked over a circuit extending from ground G^{12} through the side switch wiper 185, springs 187 and 186, 252 and 253, upper winding of the relay 251 and private magnet 198. The locking of the side switch prevents the completion of connection with the called line, while the engagement of the springs 254 and 255 on the relay 251 connects the busy signaling machine T with the calling line. A busy signaling current then flows from the battery lead 165 through the secondary of the induction coil, through the springs 255 and 254, side switch wiper 204, ringer relay springs 229 and 228, thence over the talking circuit represented by the heavy conductors to and through the cord C to the calling substation and back over the other side of the line and through the upper winding of the connector line relay 178 to the battery lead 165 and thence to the induction coil 256.

When one of the automatic subscribers, the subscriber at substation A′ (Fig. 4), for instance, wishes to make a call through the manual board, the operator is signaled as follows: When the receiver at substation A′ is removed from the hook, a circuit is closed through the line winding 100 of the line switch I′. This circuit extends from ground G^{17} through the springs 279 and 280, line 217, hook switch springs 230 and 231, impulse springs 66 and 65, receiver 56, transmitter 58, line 216, springs 232 and 282 and winding 100 to the battery lead 215. The winding 100 thereupon attracts the armature 103, which operates to close a circuit from ground G^{17} through the springs 279 and 284, windings 98 and 101 of the magnet 104, contact point 168 and armature 169 to the battery lead 215. The winding 98, upon energizing, attracts the plunger arm 96 and cut-off armature 102. The armature 102 operates to disconnect the ground G^{17} and winding 100 from the calling line. The armature 103 does not fall back immediately when the circuit of the winding 100 is broken, but remains held up by the current in the winding 101 until said winding is short-circuited at the springs 285 and 286 by the plunger arm 96. When this occurs the winding 101 deënergizes slowly, and after an instant allows the armature 103 to fall back to break the circuit of the pull-in winding 98. By the slow action of the winding 101 the falling back of the armature 103 is delayed long enough to permit a circuit to be closed through the winding 99 before the circuit of the winding 98 is broken.

The circuit through the winding 99 is closed as follows: When the plunger arm is attracted, the line conductors 216 and 217 are extended to the selector E′ through the springs 287 and 288 and 289 and 290, which are forced into contact by the line switch plunger. Thus a circuit is closed from ground G^{25} through the line relay 295, side switch wiper 296, thence over the heavy conductors to and through the substation A′ and back over the other side of the line and through the side switch wiper 297 and the upper winding of the relay 295 to the battery lead 215. The relay 295, upon energizing, operates to close a circuit from ground G^{26} through the springs 298 and 299 and relay 300 to the battery lead 215. The relay 300, upon energizing, completes a circuit from ground G^{27} through the springs 301 and 302, 292 and 291 and winding 99 of the magnet 104 to the battery lead 215. The current in this winding serves to hold the plunger arm 96 and armature 102 in their operated positions after the winding 98 is deënergized.

When the springs 293 and 294 are forced into engagement by the plunger of the line switch I′, a circuit is closed through the relay 172 of the master switch N. This circuit extends from ground G^{28} through the springs 293 and 294, master switch bank contact 175, wiper 77 and relay 172 to the battery lead 215. The relay 172, upon energizing, operates to close a circuit through the relay 176. The relay 176, upon energizing, operates to withdraw the pin 177 from the plate 173 and to close the circuit of the motor magnet 74. This circuit extends from ground G^{29} through the magnet 74, interrupter springs 180, contact point 179 and armature 169 to the battery lead 215. Since this circuit includes the interrupter

springs 180, the magnet 74 continues to operate in a manner similar to that of a buzzer as long as the armature 169 engages the contact point 179. The ratchet wheel 75 is thus given a continued rotary motion to move the plunger shaft and all idle plungers that are in engagement therewith away from the trunk just seized toward an idle one. After the plunger shaft has been moved a short distance, the wiper 77 passes off the contact 175, allowing the relays 172 and 176 to be deënergized. The armature 169 cannot fall back after the relay 176 is deënergized until the next opening in the plate 178 passes under the pin 177, thus preventing the master switch from stopping until the idle plungers have reached a position directly in front of the terminals of a trunk line. If the next trunk line after the one seized by the switch I′ had been busy, the wiper 175 would have found the corresponding contact grounded, the relays 172 and 176 would have remained energized while the next opening in the plate 178 was passing under the pin 177, and consequently the plungers would have been carried past the busy trunk to an idle one.

Now, when the subscriber at substation A′ operates his calling dial for the digit corresponding to the bank level of the selector E′, to which are connected the trunk lines leading to the manual board, the selector E′ operates in the same manner as explained for the selector E^5 to bring the wipers 303, 304 and 305 into engagement with the contacts 306, 307 and 308 of an idle trunk line leading to a jack j' through the condensers 309 and 310. When the side switch of the selector E′ passes to third position, the relay 295 is disconnected from the line and the relay 311 is substituted therefor. The relay 311, upon energizing, furnishes a guarding potential for the trunk line, and a holding circuit for the release relay 300 of the selector E′. This circuit extends from ground G^{29} through the armature 312, contact point 313, contact 307 and the corresponding contact in the banks of all selectors which have access to this trunk line, and also over the wiper 304, side switch wiper 314, springs 416 and 415 and the relay 300 to the battery lead 215.

The engagement of the armature 315 with the contact point 316 upon the energization of the relay 311 bridges the coil 317 across the end of the trunk leading to the jack j'. It will be seen that the jack j' and relays associated therewith are exactly like the jack j^4 of the common battery manual line A^4 (Fig. 2). Thus, when the coil 317 is bridged across the trunk it has the same effect as when the receiver at the substation A^2 is removed—that is, the line relay 318 energizes and lights the lamp 319. The operator thereupon inserts the plug p' into the jack j', whereupon the relays 33 and 34 operate in the same manner as when the plug p' is inserted into the jack j^4 of the line A^4. When the receiver at the substation A′ is restored to the switch hook, the trunk relay 311 deënergizes, breaking the holding circuit of the selector release relay 300 and opening the bridge across the trunk line through the coil 317. This permits the relay 34 at the cord C to deënergize and close the circuit of the supervisory lamp 32 in the same manner as explained when the receiver at a calling common battery substation A^4 is hung up.

The relay 300 at the selector E′ deënergizes shortly after its circuit is broken by the relay 311 and, upon deënergizing, closes the circuit of the release magnet 320 and destroys the holding circuit of the winding 99 of the line switch E′. The selector E′ and the line switch I′ are thus restored to normal position and left in readiness for another call.

It will thus be seen that I have devised an improved cord circuit which is automatically adapted for use in establishing a connection between local battery manual lines, common battery lines, or with trunk lines extending to an automatic exchange.

While I have illustrated my invention in connection with a semi-automatic telephone system in which switches of a well-known type are employed, it will be understood that I do not wish to limit my invention to such a system, as my improved cord circuit is equally as well adap ed to be used in connection with any known automatic switches, or may even be used in connection with an entirely manual system in which it is desired to establish a connection between local battery magneto subscribers, or between local battery magneto subscribers and common battery subscribers. Other obvious uses and modifications will readily suggest themselves to anyone skilled in the art, and I do not, therefore, wish to limit myself to the exact con uction shown and described.

What I claim as my invention is:—

1. In a telephone system, a cord circuit, a relay bridged across the talking circuit, a second relay normally short-circuited through springs of the first-mentioned relay, means for momentarily energizing the first-mentioned relay to remove the short-circuit from the second relay, means for energizing the second relay when the short-circuit is removed, means controlled by the second relay, when energized, to maintain the short-circuit open, and a lamp adapted to be lighted by the energization of the second relay.

2. In a telephone system, a cord circuit, a relay bridged across said cord circuit, a second relay having a coil normally short-circuited through the springs of said first-mentioned relay, means controlled by said

second relay, when energized, to maintain the short-circuit open, and a supervisory signa controlled be said second relay.

3. In a telephone system, a cord circuit, a three-conductor plug therefor, a relay bridged across said cord circuit, a second relay connected to the sleeve of said plug, a supervisory signal controlled by said second relay, and a short-circuit for said second relay controlled by said bridged relay.

4. In a telephone system, a cord circuit, a relay bridged across said cord, a plug for said cord, a second relay connected to a contact of said plug, a normally closed short-circuit for said second relay, means for opening said short-circuit upon energization of said bridged relay, and a supervisory signal controlled by said second relay.

5. In a telephone system, a cord circuit, a relay bridged across said cord, a second relay, a normally closed short-circuit about said second relay, means controlled by said bridged relay for opening said short-circuit, means controlled by said second relay for maintaining said short-circuit open, and a supervisory signal controlled by said second relay.

6. In a telephone system, a plurality of subscribers' lines, magnetos at the substations thereon, a cord circuit adapted to be connected with said lines, a relay bridged across said cord adapted to be controlled by said magnetos, a second relay in said cord, a short-circuit for said second relay controlled by said bridged relay, and a disconnect signal controlled by said second relay.

7. In a telephone system, a plurality of subscribers' lines, magnetos at the substations thereon, a cord circuit adapted to be connected with said lines, a relay in said cord adapted to be energized by current from said magnetos, a second relay, a normally closed short-circuit for said second relay controlled by said first mentioned relay, and a supervisory signal controlled by said relays.

8. In a telephone system, a plurality of subscribers' lines, magnetos at the substations thereon, a cord circuit adapted to be connected with said lines, a plug for said cord having a pair of talking contacts and a third contact, a relay connected to said third contact, a normally closed short-circuit about said relay, a second relay bridged across said cord for controlling said short-circuit, and a supervisory signal controlled by said first-mentioned relay.

9. In a telephone system, a plurality of subscribers' lines, magnetos at the substations thereon, a cord circuit adapted to be connected with said lines, a plug for said cord having a pair of talking contacts and a third contact, a relay connected to said third contact, a normally closed short-circuit about said relay, a second relay bridged across said cord for controlling said short circuit, means controlled by said first-mentioned relay for maintaining said short-circuit open when said first-mentioned relay is energized, and a supervisory signal controlled by said first-mentioned relay.

10. A telephone system including magneto manual lines, common battery manual lines and automatic lines, a cord circuit for use in establishing a connection between any two of said lines, a supervisory signal for said cord, and means for controlling said signal by reversing the current upon the line when connection is established with an automatic line.

11. A telephone system including manual and automatic lines, a cord circuit for use in extending a connection from a manual to an automatic line, a supervisory signal in said cord circuit, and means for controlling said signal by reversing the current upon the line when a called automatic subscriber answers.

12. A telephone system including automatic subscribers' lines, a cord circuit for use in extending a connection to said lines, a relay bridged across said cord, means for reversing the current through said relay when the called subscriber answers, and a supervisory signal controlled by said relay.

13. A telephone system including manual lines and automatic lines, a cord circuit for use in extending a connection between any two of said lines, a relay in said cord circuit, a supervisory signal, and three different methods by which said relay controls the operation of said supervisory signal, depending upon the character of the line with which said cord is connected.

14. In a telephone system, local battery and common battery manual lines and automatic lines, cut-off relays associated with said manual lines, a cord circuit for use in establishing a connection between any two of said lines, a supervisory relay in said cord, a supervisory signal controlled by said relay, means whereby the method of operation of said supervisory relay is dependent upon the resistance of said cut-off relay when connection is made with a manual line, a second relay in said cord, a second supervisory signal controlled by said second relay, and means whereby the operation of said second relay is dependent upon a reversal of current upon the line when connection is made with an automatic line.

15. In a telephone system, a cord circuit, a double-wound polarized relay normally bridged across said cord circuit, a second relay provided with means for including a battery in the bridge between the windings of said polarized relay, and means for energizing said second relay when a plug of the cord is inserted into a jack.

16. In a telephone system, a subscriber's

line terminating in a jack, a cord circuit, adapted to be connected with said line, a double-wound relay normally connected directly in bridge of said cord circuit, a second relay, means for energizing said second relay when connection is made between said cord and jack, and means controlled by energization of said second relay for connecting a battery in the bridge between the windings of said double-wound relay.

17. In a telephone system, a subscriber's line terminating in a jack, a cut-off relay connected with a contact of said jack, a cord circuit having a plug adapted to be connected with said jack, a double-wound polarized relay connected in bridge of said cord, a second relay, means for connecting said second relay in series with said cut-off relay when said plug is inserted in said jack, means controlled by the energization of said second relay for including a battery between the windings of said polarized relay and in bridge of the cord circuit, and a supervisory signal controlled by said relays.

18. In a telephone system, a subscriber's line, a cut-off relay associated with said line, a cord circuit, a relay bridged across said cord circuit, a second relay normally short-circuited through the springs of said first-mentioned relay, means for energizing said second relay in series with said cut-off relay, means controlled by said second relay, when energized, to maintain the short-circuit open, and a supervisory signal controlled by said second relay.

19. In a telephone system, a subscriber's line, a cut-off relay associated with said line, a second relay bridged across said cord circuit, a third relay having a pair of energizing windings, a short-circuit for one of said windings normally closed through springs controlled by said second relay, circuit means for energizing said third relay in series with said cut-off relay, and circuit means controlled by the energization of said third relay for opening said short-circuit and for including a battery in series with said second relay in bridge of the cord circuit.

20. In a telephone system, common battery and local battery subscribers' lines, cut-off relays of different resistances associated with the different types of lines, a cord circuit for use in establishing connection between any two of said lines, a relay connected in bridge of said cord circuit, a second relay having a pair of energizing windings, a normally closed short-circuit about one of said energizing windings, means for including the other of said energizing windings in series with one of said cut-off relays when connection is made between the cord and the line, means whereby the operation of said second relay, when so connected, depends upon the resistance of said cut-off relay, and means controlled by the energization of said second relay for including a battery in series with said first-mentioned relay in bridge of the cord.

21. In a telephone system, automatic and manual subscribers' lines, means for establishing a talking circuit between any two of said lines, a supervisory signal for supervising said connection, a battery adapted to be connected with said talking circuit, and means for controlling said supervisory signal by reversing the connection of said battery to said talking circuit.

22. In a telephone system, a plurality of automatic and manual subscribers' lines, means for establishing a talking circuit between any two of said lines, a battery adapted to be bridged across said talking circuit, a supervisory signal for supervising said connection, and means for controlling said supervisory signal by reversing the connection of said battery with said talking circuit.

23. In a telephone system, a plurality of automatic and manual subscribers' lines, means for establishing a talking circuit between any two of said subscribers' lines, a supervisory signal for supervising said connection, a battery adapted to be bridged across said talking circuit, means for reversing the connection of said battery with said talking circuit upon the response of the called subscriber, and means for controlling said supervisory signal by said reversal of current.

24. In a telephone system, a plurality of automatic and manual subscribers' lines, means including a cord circuit for establishing a talking circuit between any two of said lines, a supervisory signal in said cord circuit, a battery adapted to be connected with said talking circuit, and means for reversing the connection of said battery with said talking circuit to control said supervisory signal.

25. In a telephone system, a plurality of automatic and manual subscribers' lines, means including a cord circuit for establishing a talking circuit between any two of said lines, a supervisory signal in said cord, a battery adapted to be connected with said talking circuit, means for reversing the connection of said battery with said talking circuit upon the response of the called subscriber, and means for controlling the supervisory signal upon said reversal of current.

26. In a telephone system, a plurality of automatic and manual subscribers' lines, a cord circuit, an automatic switch for finding a called subscriber's line, means for establishing a connection between said cord and said automatic switch, a supervisory signal in said cord, and means in said switch for producing a reversal of current for controlling said supervisory signal.

27. In a telephone system, a plurality of automatic and manual subscribers' lines, a

cord circuit, an automatic switch for finding a called subscriber's line, a supervisory signal in said cord, a battery normally bridged across the talking conductors in said switch, means for reversing the connection of said battery with said conductors, and means for controlling said supervisory signal by said reversal of current.

28. In a telephone system, a plurality of automatic and manual lines, means for establishing a talking connection between any two of said lines, said means including a cord circuit for extending a connection from a calling subscriber's line, means including an automatic switch for extending a connection from said cord to the called line, a supervisory signal in said cord, a battery normally bridged across the talking conductors in said switch, a relay for controlling said connection, means for energizing said relay upon the response of the called subscriber, means controlled by the energization of said relay for reversing the connection of said battery with the talking conductors, and means for controlling said supervisory signal by said reversal of current.

29. In a telephone system, a plurality of subscribers' lines, trunking means including a cord circuit for establishing a connection between two of said lines, a relay bridged across said cord, a third conductor in said cord, a relay in said third conductor, said last mentioned relay being normally short-circuited by said first mentioned relay, and a supervisory signal controlled by said two relays.

30. In a telephone system, local battery manual lines, common battery manual lines and automatic lines, a cord circuit for use in establishing connection between any two of said lines, a supervisory signal in said cord, and means for operating said signal by different kinds of current, depending upon the line with which said cord is connected.

31. In a telephone system, local battery manual lines, common battery manual lines and automatic lines, a cord circuit for use in establishing connection between any two of said lines, a supervisory signal in said cord, and means for operating said signal by a momentary impulse of alternating current, or from a common direct current source, or by a reversal of current, depending upon the line with which said cord is connected.

32. In a telephone system, manual lines, local battery means for supplying talking current to certain of said lines, common battery means for supplying talking current to other of said lines, magnetos for certain of said lines, automatic lines, a cord circuit provided with means adapting it for use in establishing a connection between any two of said lines, said cord circuit having supervisory signals operable by said magnetos and by the common battery.

33. In a telephone system, a cord circuit, a relay bridged across the talking circuit, a second relay normally short-circuited through springs of the first-mentioned relay, electrically controlled means for momentarily energizing the first-mentioned relay to remove the short-circuit from the second relay, circuit means for energizing the second relay when the short-circuit is removed, automatic means controlled by the second relay, when energized, to maintain the short-cuit open, and a lamp adapted to be lighted by the energization of the second relay.

34. In a telephone system, a cord circuit, a relay bridged across said cord circuit, a second relay having a coil normally short-circuited through the springs of said first-mentioned relay, automatic means comprising said second relay whereby, when the second relay is energized, the short-circuit is maintained open, and a supervisory signal controlled by said second relay.

35. In a telephone system, a cord circuit, a relay bridged across said cord, a plug for said cord, a second relay connected to a contact of said plug, a normally closed short-circuit for said second relay, automatic means comprising said bridged relay for opening said short-circuit upon energization of said bridged relay, and a supervisory signal controlled by said second relay.

36. In a telephone system, a cord circuit, a relay bridged across said cord, a second relay, a normally closed short-circuit about said second relay, circuit means controlled by said bridged relay for opening said short-circuit, automatic means comprising said second relay for maintaining said short-circuit open, and a supervisory signal controlled by said second relay.

37. In a telephone system, a plurality of subscribers' lines, magnetos at the substations thereon, a cord circuit adapted to be connected with said lines, a plug for said cord having a pair of talking contacts and a third contact, a relay connected to said third contact, a normally closed short-circuit about said relay, a second relay bridged across said cord for controlling said short-circuit, automatic means comprising said first-mentioned relay for maintaining said short-circuit open when said first-mentioned relay is energized, and a supervisory signal controlled by said first-mentioned relay.

38. A telephone system including magneto manual lines, common battery manual lines and automatic lines, a cord circuit for use in establishing a connection between any two of said lines, a supervisory signal for said cord, and electrically operated means for controlling said signal by reversing the current upon the line when connection is established with an automatic line.

39. A telephone system including manual and automatic lines, a cord circuit for use in

extending a connection from a manual to an automatic line, a supervisory signal in said cord circuit, and electrically operated means for controlling said signal by reversing the current upon the line when a called automatic subscriber answers.

40. A telephone system including automatic subscribers' lines, a cord circuit for use in extending a connection to said lines, a relay bridged across said cord, automatic electrically controlled means for reversing the current through said relay when the called subscriber answers, and a supervisory signal controlled by said relay.

41. In a telephone system, local battery and common battery manual lines and automatic lines, cut-off relays associated with said manual lines, a cord circuit for use in establishing a connection between any two of said lines, a supervisory relay in said cord, a supervisory signal controlled by said relay, electrically controlled means comprising said supervisory relay dependent for its operation when connection is made with a manual line, upon the resistance of said cut-off relay, a second relay in said cord, a second signal controlled by said second relay, and means whereby the operation of said second relay is dependent upon a reversal of current upon the line when connection is made with an automatic line.

42. In a telephone system, a cord circuit, a double-wound polarized relay normally bridged across said cord circuit, a second relay provided with means for including a battery in the bridge between the windings of said polarized relay, and circuit means and a battery for energizing said second relay when a plug of the cord is inserted into a jack.

43. In a telephone system, a subscriber's line terminating in a jack, a cord circuit adapted to be connected with said line, a double-wound relay normally connected directly in bridge of said cord circuit, a second relay, means for energizing said second relay when connection is made between said cord and jack, and circuit means controlled by the energization of said second relay for connecting a battery in the bridge between the windings of said double-wound relay.

44. In a telephone system, a subscriber's line terminating in a jack, a cut-off relay connected with a contact of said jack, a cord circuit having a plug adapted to be connected with said jack, a double-wound polarized relay connected in bridge of said cord, a second relay, circuit means for connecting said second relay in series with said cut-off relay when said plug is inserted in said jack, circuit means controlled by the energization of said second relay for including a battery between the windings of said polarized relay and in bridge of the cord circuit, and a supervisory signal controlled by said relays.

45. In a telephone system, a subscriber's line, a cut-off relay associated with said line, a cord circuit, a relay bridged across said cord circuit, a second relay normally short-circuited through the springs of said first-mentioned relay, circuit means for energizing said second relay in series with said cut-off relay, circuit means controlled by said second relay, when energized, to maintain the short-circuit open, and a supervisory signal controlled by said second relay.

46. In a telephone system, common battery and local battery subscribers' lines, cut-off relays of different resistances associated with the different types of lines, a cord circuit for use in establishing connection between any two of said lines, a relay connected in bridge of said cord-circuit, a second relay having a pair of energizing windings, a normally closed short-circuit about one of said energizing windings, circuit means for including the other of said energizing windings in series with one of said relays when connection is made between the cord and the line, said second relay dependent for its operation upon the resistance of said cut-off relay, and circuit means controlled by the energization of said second relay for including a battery in series with said first-mentioned relay in bridge of the cord.

47. In a telephone system, automatic and manual subscribers' lines, trunking means for establishing a talking circuit between any two of said lines, a supervisory signal for supervising said connection, a battery adapted to be connected with said talking circuit, and automatic means for controlling said supervisory signal by reversing the connection of said battery to said talking circuit.

48. In a telephone system, a plurality of automatic and manual subscribers' lines, trunking means for establishing a talking circuit between any two of said lines, a battery adapted to be bridged across said talking circuit, a supervisory signal for supervising said connection, and automatic means for controlling said supervisory signal by reversing the connection of said battery with said talking circuit.

49. In a telephone system, a plurality of automatic and manual subscribers' lines, trunking means for establishing a talking circuit between any two of said subscribers' lines, a supervisory signal for supervising said connection, a battery adapted to be bridged across said talking circuit, electrically controlled means for reversing the connection of said battery with said talking circuit upon the response of the called subscriber, and automatic means for controlling said supervisory signal by said reversal of current.

50. In a telephone system, a plurality of automatic and manual subscribers' lines,

trunking means including a cord circuit for establishing a talking circuit between any two of said lines, a supervisory signal in said cord circuit, a battery adapted to be connected with said talking circuit, and automatic means for reversing the connection of said battery with said circuit to control said supervisory signal.

51. In a telephone system, a plurality of automatic and manual subscribers' lines, trunking means including a cord circuit for establishing a talking circuit between any two of said lines, a supervisory signal in said cord, a battery adapted to be connected with said talking circuit, automatic means for reversing the connection of said battery with said talking circuit upon the response of the called subscriber, and automatic means for controlling the supervisory signal upon said reversal of current.

52. In a telephone system, a plurality of automatic and manual subscribers' lines, a cord circuit, an automatic switch for finding a called subscriber's line, trunking means for establishing a connection between said cord and said automatic switch, a supervisory signal in said cord, and automatic means in said switch for producing a reversal of current for controlling said supervisory signal.

53. In a telephone system, a plurality of automatic and manual subscribers' lines, a cord circuit, an automatic switch for finding a called subscriber's line, a supervisory signal in said cord, a battery normally bridged across the talking conductors in said switch, automatic means for reversing the connection of said battery with said conductors, and automatic means for controlling said supervisory signal by said reversal of current.

54. In a telephone system, a plurality of automatic and manual lines, trunking means for establishing a talking connection between any two of said lines, said means including a cord circuit for extending a connection from a calling subscriber's line, electrically controlled means including an automatic switch for extending a connection from said cord to the called line, a supervisory signal in said cord, a battery normally bridged across the talking conductors in said switch, a relay for controlling said connection, circuit means and a battery for energizing said relay upon the response of the called subscriber, automatic means controlled by the energization of said relay for reversing the connection of said battery with the talking conductors, and automatic means for controlling said supervisory signal by said reversal of current.

55. In a telephone system, local battery manual lines, common battery manual lines and automatic lines, a cord circuit for use in establishing connection between any two of said lines, a supervisory signal in said cord, and electrically controlled means for operating said signal by different kinds of current, depending upon the line with which said cord is connected.

56. In a telephone system, local battery manual lines, common battery manual lines and automatic lines, a cord circuit for use in establishing connection between any two of said lines, a supervisory signal in said cord, and electrically controlled means for operating said signal by a momentary impulse of alternating current, or from a common direct current source, or by a reversal of current, depending upon the line with which said cord is connected.

Signed by me at Chicago, Cook county, Illinois, this 12th day of Sept., 1911.

BERNARD D. WILLIS.

Witnesses:
JENNIE NORBY,
E. H. CLEGG.