E. D. FALES.

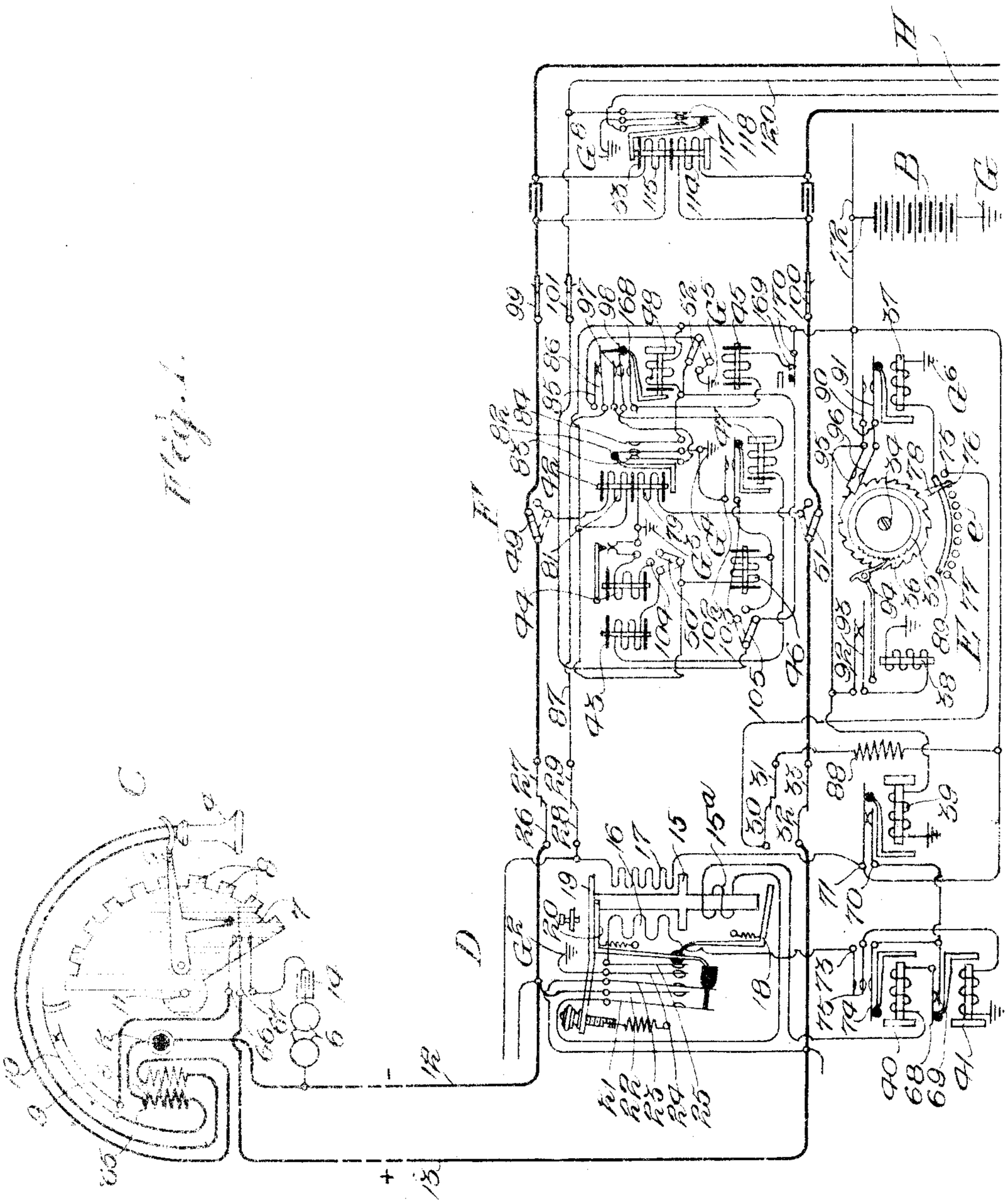
TELEPHONE TRUNKING SYSTEM.

APPLICATION FILED JULY 6, 1908.

1,064,719.

Patented June 17, 1913.

3 SHEETS—SHEET 1.



Witnesses.

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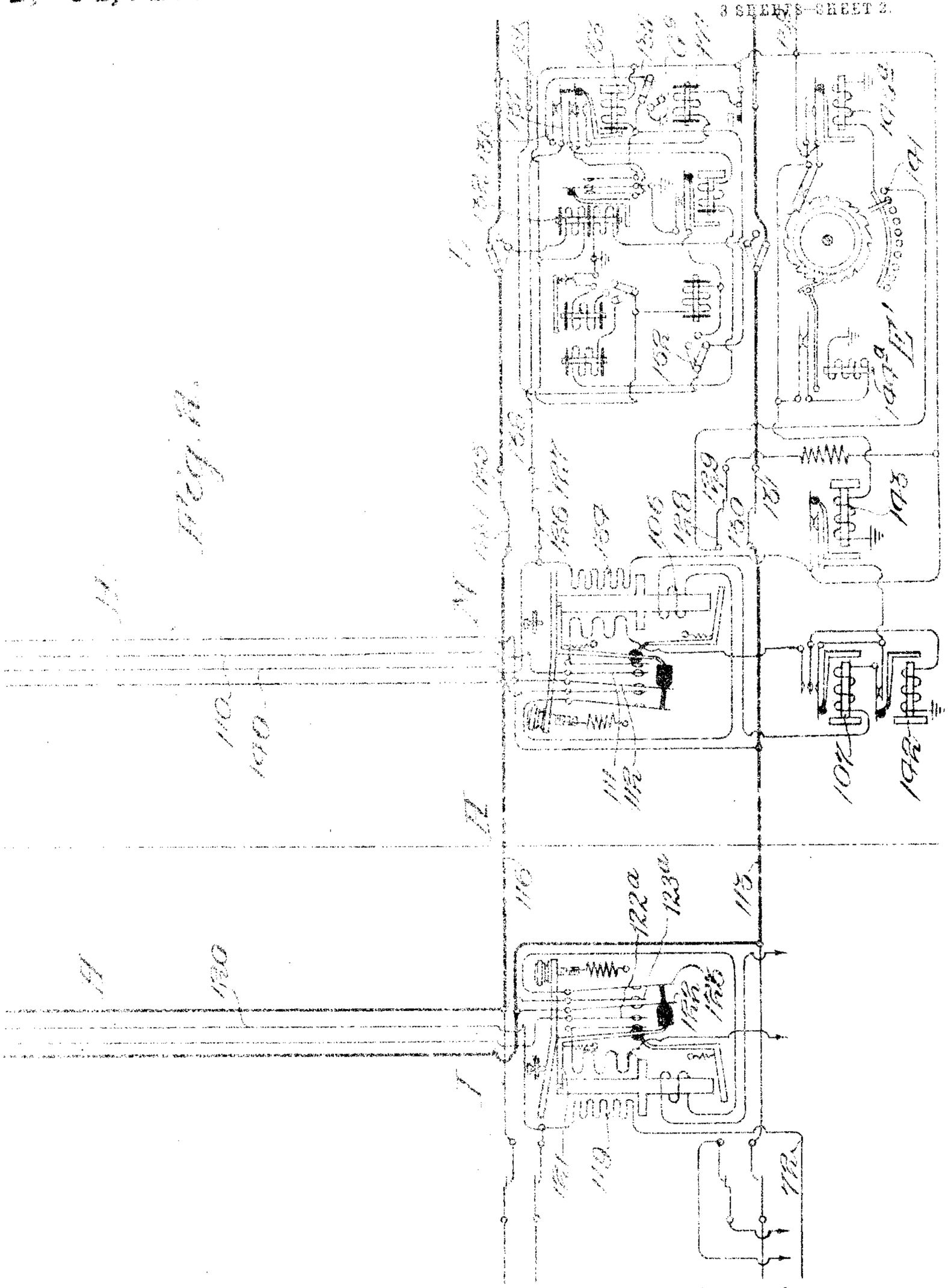
3 SHEETS—SHEET 3.



Witnesses.

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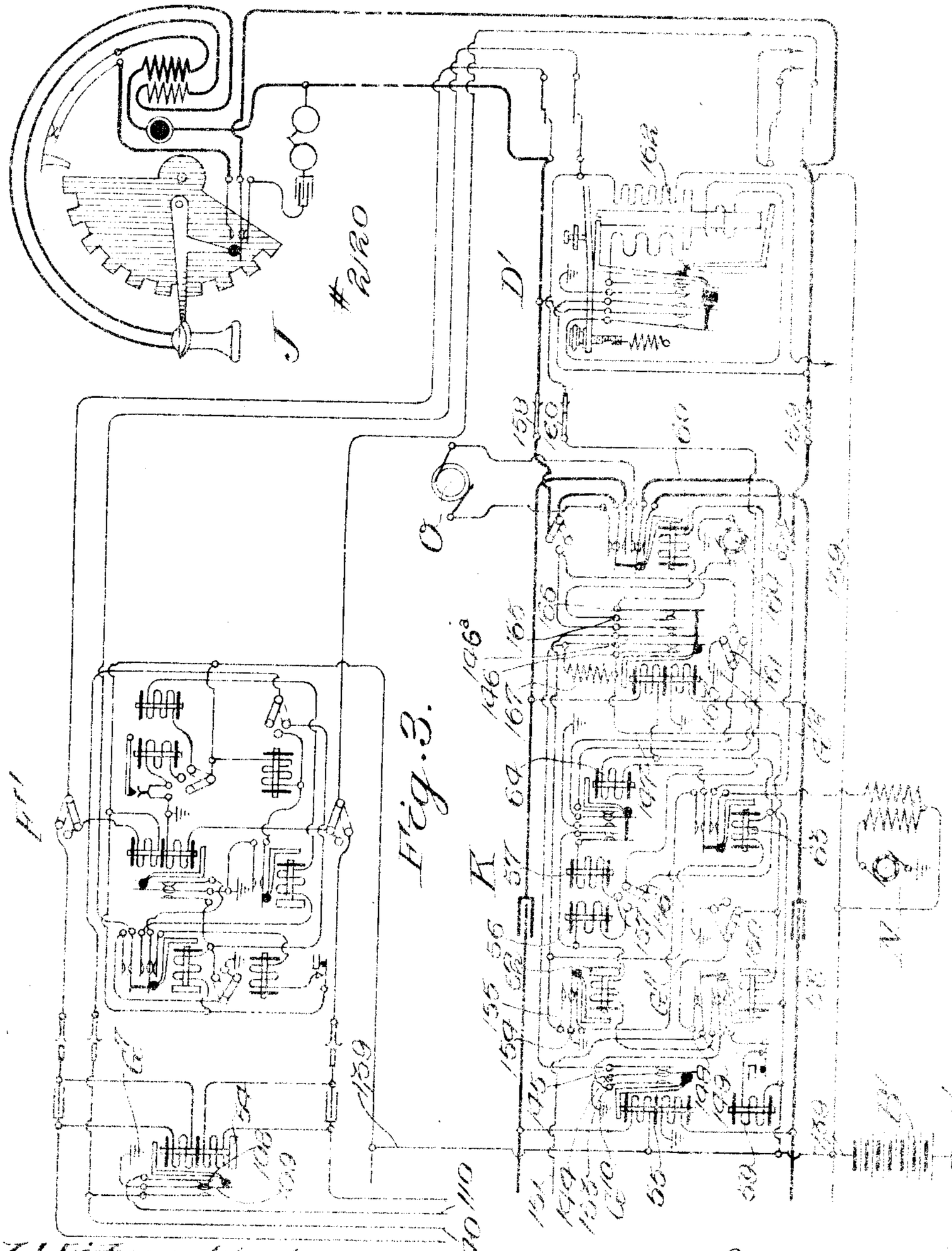

Fig. 3.

Witnesses.

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UNITED STATES PATENT OFFICE.

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TELEPHONE TRUNKING SYSTEM.

1,064,719. Specification of Letters Patent. Patented June 17, 1913.

Application filed July 6, 1908. Serial No. 442,198.

To all whom it may concern:

Be it known that I, EDWARD D. FALES, a citizen of the United States of America, and resident of La Grange, Cook county, Illinois, have invented a certain new and useful Improvement in Telephone Trunking Systems, of which the following is a specification.

My invention relates to trunking systems for telephone or other similar service, and it relates more particularly to two-way trunks for use in automatic telephone exchange systems, as, for example, for trunking between two automatic exchanges, although in certain respects, as will hereinafter appear, my invention is not limited to either a two-way or a one-way trunk.

My invention contemplates a two-way trunk-line provided with a non-numerical trunking switch at each end thereof, whereby the seizure of either end of said trunk-line serves automatically to operate a non-numerical trunking switch at the other end thereof, and to thus automatically extend connection therefrom to an idle switch, such, for example, as a selector or connector, according to the size and character of the exchange.

My invention further contemplates the provision of a two-way trunk in a two-wire automatic telephone exchange system—that is to say, in a system in which the subscribers control or operate the automatic switches over complete metallic line circuits, rather than by means of a ground at the calling substation.

It also contemplates a two-wire system in which non-numerical trunking switches are provided for extending connection from trunk-lines to other trunk-lines, such non-numerical trunking switches being preferably interposed between numerical switches, as, for example, between the first and second selectors of a ten thousand or even larger exchange.

My invention contemplates, furthermore, a system in which certain switches can be tested and operated manually or forcibly to seize one end of a trunk-line, as is often necessary in the inspection of the central station apparatus, without making the other end of the two-way trunk busy, and whereby any switch operated in this way to seize a two-way trunk can be forcibly or manually released therefrom without danger of leaving the other end of the trunk in a busy condition—that is to say, without danger of leaving it subject to such a guarding potential as would prevent seizure thereof by subscribers attempting to call over the trunk in the opposite direction.

In addition it contemplates certain details and combinations and features of improvement tending to increase the general efficiency of a telephone exchange system, as will hereinafter more fully appear.

In the accompanying drawings Figures 1, 2 and 3 are a diagrammatical representation of a circuit connection established between a calling subscriber in Fig. 1 from one exchange, and a called subscriber in Fig. 3 at a second exchange, the said connection being established over a two-way trunk of the circuit connection aforesaid.

The exchange in which the calling subscriber, shown in Fig. 1, is located is designated as exchange A or group A. This exchange or group is provided with a centralized battery B having, preferably, a grounded terminal G. This battery may be used for supplying all talking and operating current to the exchange A. Of the apparatus allotted to the exchange A, the drawings show the calling subscriber's station C, the line switch D allotted to said substation and individual to said substation C, but controlled, together with a number of other similar line switches, by the common mechanism E usually known as the master switch. Accessible to the line switch D is the numerical switch F, usually known as the first-selector, which is one of a group of selectors common to a number of line switches D greater in number than the number of selectors F in the group. The line switches D which have access to the group of selectors aforesaid may be divided in one or more groups, and may be controlled by one or more master switches E. This arrangement, however, is not necessary, as there may be only one group of line switches D controlled by one master switch E, the total number of which line switches may be much greater than the total number of selectors F. Through the medium of the selectors F the two-way trunks of my invention, such as the two-way trunk H, may be reached from the A exchange, as, for example, by the sub-

scriber C, as indicated in the drawings. The selectors F may or may not have access solely to two-way trunks H. The arrangement may be such, however, that the selector F will have access to trunks H from certain levels, while from other levels switches such as second-selectors or connectors, or selectors and connectors, may be reached. It will be seen that the two-way trunk H terminates in the A exchange in a line switch I to the left of which are shown conductors in a trunk-line which may terminate in a connector switch or in a selector switch. The exchange in which the called subscriber J is located is designated as the A^1 exchange. Of the A^1 exchange apparatus the drawings show in addition to the called substation the called subscriber's line switch D^1, which is the same as the line switch D; a first-selector switch F^1, which is the same as the selector switch F; a connector switch K and a second-selector L; and the line switch M is shown, which is the A^1 exchange terminal of the two-way trunk H. In the A^1 exchange there is shown another battery B^1 having, preferably, a grounded terminal G^1. This battery may be used for supplying all talking and operating current to the A^1 exchange. It is not absolutely essential that these separate exchanges shall be supplied with current from separate batteries, inasmuch as the batteries B and B^1 may be one and the same battery. It is to be understood that in the usual arrangement a line switch D (Fig. 1) is provided with ten trunks, each a duplicate of the single trunk indicated, and each terminating in a selector switch F, as does the trunk shown. It is to be understood also that in the usual arrangement each of these trunks is made common to all of the line switches of the same group, and it is obvious, therefore, that although the trunk running from the selector F to the line switch D is shown with only one line-switch bank-terminal, this trunk is in reality provided with as many terminals as there are line-switch banks—that is, as many terminals as there are line switches. In like manner the trunk H is shown with only one bank terminal in the selector F—that is, it is to be understood that there are as many multiples of these terminals as there are selectors to which the trunk H is common. Likewise the A^1 exchange two-way trunk line switch M is provided with ten trunks, each terminating in a second-selector L, and the selector F' has access to the two-way trunks H just as the selector F in Fig. 1 has access to the said trunks H; and similarly, the second-selector L has access to a number of connectors K. It will be seen that the two-way trunk to the left of the dotted line in Fig. 2 is an exact duplicate of that section of the two-way trunk to the right thereof.

Concisely stated, the general method of operation is as follows: When a subscriber C (Fig. 1) calls a subscriber J (Fig. 3) the subscriber C removes the receiver and thus operates his line switch D to establish connection with the selector F. The selector F is then operated by the subscriber upon the first move of the dial, by which operation the wipers are raised to a certain bank level along which they automatically rotate to pick out the first idle two-way trunk H available. As soon as the selector F stops on the trunk and connects the calling subscriber therewith, the line switch I is cut off from the trunk while the line switch M is operated to establish connection with the second-selector L. Of course, the selector F makes the trunk H busy at the A exchange to all other switches to which the said trunk is accessible from that exchange. At the A^1 exchange the operation of the line switch M makes the trunk busy to all switches which have access to the trunk H at said exchange. It will be understood that by this operation the trunk is made instantly busy at both ends. When the line switch M establishes connection with the selector L it cuts itself off from the trunk, thus giving the calling subscriber C a clear line from the A exchange to the A^1 exchange. By the second operation of the dial the calling subscriber operates the second-selector L, which latter operates in a similar manner to the selector F to find the connector K. The said connector now, as is usually the case, responds to the last two operations at the calling subscriber's telephone, and in this manner the calling and called subscribers are placed in connection. After connection is established, as soon as the calling subscriber hangs up his receiver all of the switches are restored. It will be seen that when a call passes from the A^1 exchange to the A exchange, as, for example, when the subscriber J calls the subscriber C, then the order of operation is exactly reversed. First the line switch D^1 operates to connect with the selector F^1, which in turn responds to the first operation of the dial at the station and finds the two-way trunk H. As soon as connection is established with the said trunk the line switch M is cut off from the trunk, while the line switch I is caused to operate to establish connection with a suitable switch, such as a selector F, and from thereon the operation of the selector and of the connector is the same as previously explained.

Having thus outlined the general mode of operation, a somewhat detailed description of the apparatus is as follows: As shown at C (Fig. 1) the telephone is provided with the usual transmitter 2, induction-coil 3, re-

ceiver 4, switch-hook 5 and ringer 6. In addition it is provided with the usual calling mechanism comprising the impulse wheel 7 having on its periphery the impulse teeth 8 for operating the impulse springs 9 and 10. The said impulse wheel 7 is, of course, mounted on the same shaft 11 as the dial, being rigid with the same. Normally—that is, when the switch-hook is down—the bell 6 is bridged across the line conductors 12 and 13 through the condenser 14. The line switch D is a modified form of the line switch disclosed in British patent to A. E. Keith No. 26,301 of 1906, and in the *Western Electrician* of Chicago, Illinois, of January 25, 1908. As herein represented the line switch plunger (not shown) is attached to the plunger arm 19 which is controlled by a magnet 15 having the line winding 15ª, a pull-in winding 16 and a bridge-cut-off winding 17. The magnetic circuit of the winding 15ª is separate and distinct from the magnetic circuit of the windings 16 and 17. The winding 15ª controls the armature 18, the winding 16 controls the plunger 19 and also the bridge-cut-off armature 20, while the winding 17 is strong enough to only operate the said bridge-cut-off armature 20. The various armatures allotted to this magnet 15 control the springs 21, 22, 23, 24 and 25, as will hereinafter more fully appear. The line switch is also provided with ten sets of bank terminals each comprising eight springs as follows: 26 and 27, 28 and 29, 30 and 31, and 32 and 33. The master switch E comprises the usual plunger guide shaft (not shown), which is connected with the shaft 34 in such a manner that a rotary motion of the latter communicates an oscillatory motion to the guide shaft, a gear wheel 35, a cam wheel 36 through the medium of which the operation of the master switch is timed, the motor relay 37, motor magnet 38, open main relay 39 and a couple of auxiliary relays 40 and 41. The selector F comprises the line relay 42, the vertical magnet 43, the rotary magnet 44, the release magnet 45, private magnet 46, private magnet relay 47 and the release relay 48. As shown, the switch F is also provided with the usual side switch which, in this case, comprises the wipers 105, 49, 50, 51, and 52. The two-way trunk H has exclusively allotted to it a trunk relay 53, the line switch I which is a slight modification of the line switch D as far as the circuits are concerned (the mechanical operations of the two switches D and I being the same), the line switch M which is a duplicate of the line switch I, and the trunk relay 54 which is a duplicate of the relay 53. The selector L and the selector F' are the same as the selector F. The connector K comprises the line relay 55, vertical magnet 56, rotary magnet 57, the release relay 58, the release magnet 59, the ringer relay 60, back-bridge relay 163, private magnet relay 62, private magnet 63 and the locking relay 64. In addition there is provided in each exchange a busy-signal device N for supplying all busy-signaling current to the exchange, and a signalling current to the exchange, and a ringer generator O for supplying all ringing current. It is obvious, however, that one machine N and one machine O may be made to furnish all necessary current from these sources.

In addition to the foregoing general description of the system and apparatus and of the mode of operation, the system will now be further described by explaining in detail each step taken by a calling subscriber in establishing connection with a desired subscriber and in disconnecting therefrom. For example, the subscriber C (Fig. 1), in establishing connection with the subscriber J (Fig. 3) whose number, it will be assumed, is 2120, proceeds by removing his receiver 4, thereby permitting the switch-hook 5 to rise, with the result that the ringer 6 is disconnected from across the line, and the circuit closed through the transmitter 2, primary winding 65 of the induction-coil 3, and the impulse springs 10 and 9. This circuit is closed by the engagement of the springs 66 and 67. As soon as this circuit is closed the line winding 15ª of the line switch D is energized in series with the auxiliary relay 40. The energizing circuit, it will be seen, extends from ground G^2 at the line switch D through the springs 24 and 23 to the line conductor 13, thence through the phone to the line conductor 12 and back to the line switch D, then through the springs 22 and 21, winding 15ª and coil 40, thence through said coil and through the springs 68 and 69, and through the open main relay springs 70 and 71 to the battery lead 72, thence through battery B to ground G. The winding 15ª, upon energizing, presses the springs 25 and 24 into contact through the medium of the armature 18, thereby energizing the pull-in winding 16. It will be seen that the energizing circuit of the pull-in winding 16 is open at two points, namely between the springs 25 and 24 and between the auxiliary relay springs 73 and 74; but since the windings 15ª and 40 are energized in series, both of these points are closed at the same time. The flow of current is as follows: from ground G^2 through the springs 24 and 25 and pull-in winding 16, through the springs 73, 75 and 74, through the open main relay springs 70 and 71 to the battery lead 72. When the auxiliary relay 40 energizes, not only is the circuit for the pull-in magnet 16 closed at this point, but the energizing circuit for the relay 41 is closed at the same time. Said relay, upon energizing, opens the circuit of the relay 40,

which thereupon deënergizes and thereby opens the energizing circuit of the pull-in magnet 16. The time during which the energizing circuit of the pull-in magnet 16 is maintained is controlled by the action of the relays 41 and 40. In order that the controlling action of the relays 40 and 41 may be insured these relays are, as indicated, loaded and made slow-acting. When the pull-in winding 16 energizes, the plunger is driven into the bank, and the armature 20 is, at the same time, so depressed that the springs 21 and 23 are separated from the springs 22 and 24, respectively. It will be seen that as soon as the springs 23 and 24 and the springs 21 and 22 separate, the energizing circuit for the winding 15^a and also for the coil 40 is broken, so that these relays have no opportunity to reënergize when the energizing circuit of the winding 15^a and the relay 40 is again completed by the deënergizing of the auxiliary relay 41. As previously stated, there are ten trunk-lines running from the bank of the line switch D, only one of which is shown and which terminates in the selector F. For each one of these trunk-lines the master switch bank E is supplied with a corresponding contact. As shown in Fig. 1, the trunk terminating in the selector F has allotted to it the master switch bank contact 75. In the course of the description this trunk will be spoken of as the first trunk, inasmuch as the first contact 75 has been allotted to it. The next trunk would, of course, have allotted to it the contact 76 and would be spoken of as the second trunk, and so on, while the trunk to which the contact 77 is allotted will be spoken of as the tenth trunk. The purpose of the master switch E, it will be understood, is to maintain all plungers that are in locked engagement with the plunger shaft opposite the next idle trunk-line.

In this description it is assumed that the first trunk-line is the one that is idle at the time that the subscriber C removes his receiver to make his call. In that case the master switch wiper 78 is resting in engagement with the contact 75, thereby maintaining the line switch bank spring 30 in engagement with the motor relay 37. When the plunger operates, as described, due to the energizing action of the winding 16, the line switch bank springs (as shown in Fig. 1) are brought into contact in sets as follows: 26 and 27, 28 and 29, 30 and 31, and 32 and 33. By the closure or connection of the springs 26 and 27 on the negative side of the line, and of the springs 32 and 33 on the positive side of the line, the calling line is extended to the selector switch F. The instant that this circuit is completed to the selector F the line relay 42 energizes from ground G^3 through the winding 79 of said relay, through the telephone by way of the positive line conductor 13, thence through the telephone to the negative line conductor 12, then through the second winding 81 of the selector line relay 42 to the battery lead 72, and through battery B to ground G. As soon as the relay 42 energizes, the spring 82 is separated from the spring 83 and carried into contact with the spring 84, whereby the slow-acting release relay 48 is energized. The energizing current for this coil 48 flows from ground G^4 through the said springs 82 and 84 and through the coil 48 to the battery lead 72. As soon as the relay 48 operates, the springs 85 and 86 are brought into contact, and since the side switch wiper 52 is in first position the bridge-cut-off winding 17 of the line switch D is energized for holding the plunger in operative position. This energizing circuit, it will be seen, extends from ground G^5 through the side switch wiper 52, springs 85 and 86, trunk-release conductor 87, through the bank springs 29 and 28, and through the bridge-cut-off winding 17 to the battery lead 72. The closure of contact between the line switch bank springs 30 and 31 establishes a negative guarding potential at the master switch bank contact 75 through the resistance coil 88 for driving the master switch from opposite the trunk-line leading to the switch F, and for preventing the master switch E from again stopping on the contact 75 and thereby preventing any subscriber from tripping in on the trunk leading to the selector F until the trunk running to said switch is made idle. It will be seen that as soon as this guarding potential is set up a circuit is established through the motor relay 37, since the master switch wiper 78 is resting on the contact 75 when the line switch bank springs 30 and 31 close. This energizing circuit, it will be seen, extends from ground G^6 through the said relay 37, through the master switch bank common segment 89, master switch wiper 78, contact 75, through the line switch bank springs 30 and 31, then through the resistance coil 88 to the battery lead 72. The relay 37, upon energizing, closes the springs 90 and 91 in contact, whereby an energizing circuit is closed for the magnets 39 and 38 which are connected in multiple. As soon as this circuit is closed the motor magnet 38 begins to operate, advancing the ratchet wheel 34 and the cam 36. It will be seen that the motor magnet 38 is provided with interrupter springs 92 and 93, so that its armature 94 will continue to vibrate as long as the circuit is maintained closed at the springs 90 and 91. It should be explained that the teeth on the ratchet 35 are very close together, and it requires a number of operations of the magnet 38 to advance the master switch wiper 78 from the contact 75 to the contact 76. How-

ever, before the wiper 78 leaves the contact 75 and breaks the energizing circuit of the motor relay 37, the cam wheel 36 is advanced sufficiently to close the cam springs 95 and 96 in contact. These springs remain in contact until the next tooth on the cam wheel 36 separates the spring 95 from the spring 96, and by that time the wiper 78 has advanced into engagement with the contact 76. Of course, if the contact 76 is also busy the master switch will not stop on this contact, but will pass on to the next, and so on. It is obvious that should the contact 76 be busy the usual guarding potential will be found there by the wiper 78, and the motor relay 47 will, therefore, energize and repeat the operation already described. It is obvious that as long as the springs 90 and 91, or the springs 95 and 96, are in contact the open main relay 39 remains energized, and it is also obvious that as long as this relay is energized no line switch is able to trip, since the circuits of all line windings 15^a are open at this point. After the calling subscriber has removed his receiver and thus obtained connection with the selector switch F, as explained, he then operates his dial for sending in the impulses for the thousands digit of the number 2120. In so doing he advances the impulse wheel 7 sufficiently so that on its return two of the impulse teeth 8 will successively engage the impulse spring 10, separating it twice from the main spring 9 and thereby causing the line relay 42 of the selector R to be energized twice. Each time that the said line relay deënergizes, the springs 82 and 83 fall into contact, and since the release relay 48 is energized and is slow-acting, thus maintaining the springs 97 and 98 in contact, the vertical magnet 43 is energized twice by a flow of current from ground G^4 through the springs 82 and 83, though the release relay springs 98 and 97 to the private magnet relay 47, thence through said relay and through the vertical magnet 43 to the side switch wiper 50, thence to the battery lead 72. By this operation the vertical magnet 43 raises the switch shaft and, therefore, the wipers 99, 100 and 101 two steps.

It will be seen that the energizing circuit of magnet 43 passes through the private magnet relay 47. This relay 47 energizes at the first impulse and, being slow-acting, remains energized until all of the impulses are sent through the vertical magnet 43. The relay 47, upon energizing, closes the springs 102 and 103 into contact, thereby energizing the private magnet 46. This private magnet 46 remains energized as long as the vertical magnet 43 is operated, and then when the relay 47 deënergizes it also deenergizes and permits the side switch to pass from first to second position in the usual manner. As soon as the side switch passes to second position, and more particularly when the side switch wiper 50 engages the contact point 104, the energizing circuit for the rotary magnet 44 is closed. The rotary magnet, upon energizing, rotates the shaft one step, thereby carrying the wipers 99, 100 and 101 into engagement with the first trunk-line which, in this case, it is assumed is the trunk-line H. Of course, if this trunk-line is busy the selector will not stop on the first trunk-line, but will automatically rotate until it finds an idle trunk-line in the usual manner—that is, the private wiper 101, upon finding the grounded contact point, reënergizes the private magnet 46, whereby the side switch is locked in second position as long as the said private wiper continues to find such grounded contacts. In the case assumed, however, namely that the first trunk-line H is idle, the private magnet 46 does not reënergize; but the rotary magnet, upon operating, not only rotates the shaft and wipers as described, but also operates the armature of the private magnet and trips the side switch to third position, thereby breaking the energizing circuit for the rotary magnet 44 and extending the calling line into connection with the trunk-line H through the side switch wipers 49 and 51, as shown. As soon as the subscriber's line is extended into connection with the trunk-line H, the trunk relay 53 (Fig. 1) and the relays 106 and 107 of the trunk switch M are energized in series. The energizing circuit, it will be seen, passes from ground G^7 at the trunk relay 54 (Fig. 3), thence through the springs 109 and 108, conductor 110, springs 111 and 112 of the trunk switch M (Fig. 2), to the trunk conductor 113, through the winding 114 of the trunk relay 53 (Fig. 1), through the telephone and back through the other winding 115 of the trunk relay 53 to the negative trunk conductor 116, thence through the line winding 106 of the trunk switch M, and through the relay 107 to the battery lead 139 over a circuit similar to that traced for the line switch D. The result is that the trunk relay 53 energizes, locking the release relay of the selector F and energizing the bridge-cut-off relay of the trunk switch I, the trunk switch M is tripped, seizing the selector L, and making the trunk busy at the A^1 exchange. When the trunk relay 53 (Fig. 1) energizes it shifts the spring 117 into engagement with the spring 118, locking the release relay 48 of the selector F over a circuit extending from ground G^8 through the selector private wiper 101, selector side switch wiper 105, relay 48 to the battery lead 72. At the same time the engagement of the springs 117 and 118 sets up an energizing circuit for the bridge-cut-off relay 119. This circuit, it will be seen, also extends from ground G^8 through the

said springs 118 and 117, thence it extends over the conductor 120, through the bridge-cut-off relay 119 to the battery lead 72. As soon as the bridge-cut-off winding 119 energizes, the bridge-cut-off armature 121 is attracted, and the springs 122 and 123 are separated from the springs 122ª and 123ª, as shown, for disconnecting the switch I from across the trunk conductors.

It will be understood that the trunk switch M operates exactly the same as the line switch D (Fig. 1), and that as soon as the plunger operates, the bank springs shown in Fig. 2 are thrown into contact in the following order: 124 and 125, 126 and 127, 128 and 129, 130 and 131. Furthermore, it will be seen that the selector L acts exactly the same as the selector F as soon as the line is extended to the said selector by the engagement of the trunk switch bank springs 124 and 125 on one side, and 130 and 131 on the other side—that is, the line relay 132 energizes, in turn energizing the release relay 133, which then operates to lock the cut-off relay 134 of the trunk switch M over the following circuit: from ground G^9 through the side switch wiper 135, release relay springs 136 and 137, trunk release conductor 138, trunk switch bank springs 127 and 126, bridge-cut-off winding 134 to the battery lead 139. It will be seen that this ground G^9 not only locks the bridge-cut-off winding 134, as explained, but also supplies guarding potential over the conductor 140 to the private bank contacts of the switches F^1. In this connection attention should be called to the fact that the guarding potential for the switches F is supplied by the trunk relay 53 from ground G^8. It should be understood that as soon as the trunk switch M operates, the master switch E^1 (which is the same as the master switch E, Fig. 1) also operates, exactly the same as the master switch E—that is, the trunk leading to the selector L is vacated, and a guarding potential is maintained at the master switch bank contact corresponding to this trunk, namely the contact 141, by the trunk switch M for maintaining the selector L busy. It is obvious that the magnets 142, 143, 144ª and 145ª of the master switch E^1 are the same as the magnets 41, 39, 38 and 37, respectively, of the master switch E. The subscriber is now ready to operate the dial for the hundreds digit 1, whereby the selector L may be operated to establish connection with the connector K. It will be seen that the line relay 132 of the selector L is energized in series with tne windings of the trunk relay 53 (Fig. 1); but although the line relay 132 responds to the dial, the relay 53 does not, it being a slow-acting relay. Since the selector L operates exactly the same as the selector F it responds to the action of the dial in exactly the same manner as the selector F; and as soon as the side switch passes to third position the subscriber's line is extended to the connector K over the heavy conductors, as shown. It will be seen that as soon as connection is established with the connector K the connector line relay 55 energizes, thereby shifting the spring 144 onto the spring 145 and thus energizing the release relay 58 from ground G^{10} through the back-bridge relay springs 146ª and 146, conductor 147, release relay 58 to the battery lead 139. As soon as the release relay 58 energizes, and more particularly as soon as the springs 148 and 149 are closed in contact, the release relay 133 of the selector L is locked from ground G^{11} through the side switch wiper 150, springs 148 and 149, trunk-release conductor 151, side switch wiper 152 of the selector L, and through the release relay 133 to the battery lead 139. The subscriber is now ready to operate his dial for the tens digit 2. In so doing he operates the line relay 55 twice, thus permitting the spring 144 to fall back onto the spring 153 twice, and in turn operating the vertical magnet 56 twice. It will be seen that this energizing circuit for the vertical magnet 56 contains a private magnet relay 62, which is a slow-acting relay exactly the same as the private magnet relay 47 of the selector F. This relay 62, upon energizing, in turn energizes the private magnet 63 by pressing the springs 154 and 155 into contact. This energizing circuit is, of course, broken when the impulses stop coming in, and therefore the private magnet 63 permits the side switch to pass from first to second position. After the side switch passes to second position, and particularly as the side switch wiper 156 is then in engagement with the contact point 157, the subscriber is ready to operate his dial for the units digit 0. The line relay 55, of course, responds ten times, and as a result the rotary magnet 57 is energized ten times in series with the slow-acting private magnet relay 62. By these two operations of the dial it will be seen that the subscriber has raised the connector shaft one step and rotated it ten steps, thus carrying the connector wipers 158, 159 and 160 into engagement with the desired line. As soon as the private magnet 63 again deënergizes, in response to the action of the relay 62, the connector side switch passes to third position and thereby connects the calling and called subscribers (as shown) by the heavy conductors. It will be seen that when the side switch passes to third position the side switch wiper 161 establishes connection with the ground G^{12}, thereby furnishing the guarding potential at the private wiper 160 for protecting the called line, and also for energizing the bridge-cut-off winding 162.

of the called line. Also, when the side switch wiper 156 passes to third position an energizing circuit is established with the ringer relay 60 in series with the ringer interrupter 164, whereby the called subscriber, as soon as connection is established with his line, is rung automatically. As soon as the called subscriber answers he draws talking battery current through the back-bridge relay 163, which relay then energizes and cuts off the ringing circuit by operating the springs 165 and 166. After the subscribers are through talking, if the calling subscriber hangs up first he opens his line circuit at the telephone by separating the springs 66 and 67, and thereby permits the connector line relay 55 and the trunk relay 53 to deenergize. As soon as the trunk relay 53 deenergizes, the energizing circuit for the release relay 48 of the selector F is broken, with the result that the springs 85 and 86 are separated, while the springs 98 and 168 are closed in contact. The separation of the springs 85 and 86 breaks the energizing circuit of the cut-off winding 17 of the line switch D, with the result that the plunger is released and the springs 26 and 27, 28 and 29, 30 and 31, and 32 and 33 are restored to normal, as well as the armature 20 which controls the springs 21 and 23. By the engagement of the springs 98 and 168 of the selector F the energizing circuit of the release magnet 45 is closed. The circuit of this release magnet, when the shaft is in normal position, is open at a point between the contacts 169 and 170; but as soon as the shaft is raised one step these contacts close, and when the shaft is operated the only point where the release circuit is open is between the springs 98 and 168. As soon as these springs come into contact, as stated, the switch is released. It should be stated, of course, that the energizing circuit for the release magnet is again broken when the shaft reaches normal and separates the springs 169 and 170. When the trunk relay 53 deënergizes it not only produces the restoration of the selector switch F and of the line switch D, but it also cuts off the energizing circuit of the bridge-cut-off winding 119 of the trunk switch I, thereby permitting this switch I to be restored also. When the connector line relay 55 deënergizes, as stated, the release relay 58 also deënergizes, thereby closing an energizing circuit for the release magnet 59, which is in all respects similar to that of the selector F. The connector switch shaft is, therefore, restored, and the energizing circuit of the release magnet 59 is broken as soon as the shaft reaches normal. Not only does the deenergizing action of the release relay 58 release the connector, but by breaking the energizing circuit of the release relay 133 of the selector L this relay 133 deënergizes, closing an energizing circuit for the release magnet 171, thereby releasing the selector switch L. The said relay 133 also breaks the locking circuit of the cut-off winding 134 of the trunk switch M, thereby permitting this switch to be restored also. The connector switch in releasing, as above explained, obviously breaks the energizing circuit of the bridge-cut-off winding 162 of the called line, thus permitting the switch D^1 to be also restored to normal.

In the foregoing description a call over the trunk H from the A exchange to the A^1 exchange has been fully considered. A call in the reverse direction is obviously the same, with the exception that in that case the calling line would be the line J, for example, which would operate the line switch D^1 to establish connection with the selector F^1. The selector F^1, upon finding the trunk H, energizes the cut-off winding 134 of the trunk switch M and operates the line switch I. It then connects the trunk H with a selector switch similar to the selector switch L, and from thence connection may be made with a connector and with the called line.

From the foregoing it will be seen that by my invention I provide a two-way trunk for use in conjunction with a two-wire automatic telephone exchange system, whereby the two-way trunking is accomplished through the medium of complete metallic line circuits, and without grounding the lines at the substations. Furthermore, it will be seen that I provide a two-wire trunk having a non-numerical trunking switch at each end thereof, whereby either end of the trunk is extended in the direction of the called subscriber by a non-numerical trunking operation. These two-way trunks which are equipped with non-numerical trunking switches at each end are also equipped with master switches—that is to say, there is at least one master switch which is common to all of the trunks at one end thereof, and another master switch which is common to all of the trunks at the other end thereof. In this way I also provide a two-wire system in which provision is made for non-numerical trunking for the purpose of extending connection from trunk-lines to other trunk-lines, and preferably this non-numerical trunking occurs between the first and second selectors—that is to say, subsequent to the trunking operation in accordance with the first digit of the called number, but prior to the trunking operation for the second digit of the called number. With such arrangement all of the numerical switches are common to the subscribers of the different exchanges for either local calls or calls from one exchange to the other, there being no numerical switches that are in-

dividual to the two-way trunk-lines, so that the same selectors are accessible either over the two-way trunks or over the one-way trunks of the same exchange, and nothing but non-numerical switches are allotted exclusively to the two-way trunks. Furthermore, with my improved two-way trunk arrangement the switches can be inspected and tested at the exchanges, as by forcibly or manually causing a switch to seize one end of a two-way trunk-line without making the other end thereof busy.

In making tests or mechanical adjustments of switches it is often necessary or convenient to manually operate a switch to place its wipers in connection with a trunk line. From the explanation of the mode of operation of the system it is evident that if the selector F (Fig. 1) is thus manually operated to seize a trunk line there will be no telephone or other apparatus bridged across the line to close the circuit of the line relay of the trunk switch M at the distant exchange (Fig. 2), and thus no apparatus at the said exchange will be operated. Consequently, when the exchange inspector releases the switch that he was testing, as by forcibly or manually releasing the same, there is then no danger of the other end of the trunk-line being left in a busy condition, and consequently the switches can be freely tested without danger when they are released of leaving the two-way trunks in a busy or off-normal condition, as was heretofore the case with certain kinds of apparatus.

My invention, it will be seen, relates to automatic telephone systems in which are used switches of the general character disclosed in United States Letters Patent Nos. 815,176 and 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, the above-mentioned British Patent No. 26,301 of 1906, the *Western Electrician* of Chicago, Illinois, of January 25, 1908, and in the *American Telephone Journal* of New York, N. Y., of June 6, 1908.

What I claim as my invention is:—

1. In a telephone system, a two-way trunk-line, a non-numerical trunking switch for each end of said line, and trunks, each switch adapted to automatically select idle trunks.

2. In a telephone system, a two-way trunk-line, means for seizing said line, a non-numerical trunking switch for each end of said line, instrumentalities operative to make either end of the line busy when the other end is seized, and trunks, each switch adapted to automatically select idle trunks.

3. In a telephone system, a two-way trunk-line, a non-numerical trunking switch for each end of said line, each switch adapted to automatically extend a trunking connection from said line in the direction of the called subscriber, numerical trunking switches for seizing either end of said trunk-line, and instrumentalities operative to render either end of said trunk-line busy when the other end is seized.

4. In a telephone system, a two-way trunk-line, means for seizing said line, a non-numerical trunking switch for each end of said line, instrumentalities operative to make both ends of said trunk-line busy when either end thereof is seized, and trunks, each switch adapted to automatically select idle trunks.

5. In a telephone system, a two-way trunk-line, a non-numerical trunking switch for each end of said line, each switch adapted to automatically extend a trunking connection from said line in the direction of the called subscriber, numerical trunking switches for seizing either end of said trunk-line, and instrumentalities operative to render both ends of said trunk-line busy when either end thereof is seized.

6. In a telephone system, a set of two-way trunks, a set of non-numerical trunking switches for the said trunks at one end thereof, a master switch for said set of trunking switches, another set of non-numerical switches for said trunks at the other end thereof, and another master switch for said last-mentioned set of trunking switches.

7. In a telephone system, a trunk-line, another trunk-line, a non-numerical trunking switch for automatically connecting one trunk-line with the other, means for controlling said switch over a complete metallic line circuit, and automatic means for seizing either end of said first-mentioned trunk-line.

8. In a telephone system, a trunk-line, an automatic switch for seizing one end of said trunk-line, another trunk-line, a non-numerical trunking switch for automatically connecting the first trunk-line with the second trunk-line, means for successively controlling said switches over complete metallic line circuits, and means for automatically seizing the other end of said first-mentioned trunk-line.

9. In a telephone system, a two-way trunk-line, means for automatically extending connection from either end thereof in the direction of the called subscriber, automatic switches for seizing either end of said trunk-line, and means for controlling said switches over complete metallic line circuits.

10. In a telephone system, a two-way trunk-line, automatic switches for extending connection from either end thereof in the direction of the called suscriber, other automatic switches for seizing either end of said trunk-line, and means by which all of said switches are controlled over complete metallic line circuits.

11. In a telephone system, a trunk-line, a

first-selector operative in accordance with the first digit of the called number to seize one end of said trunk-line, a second-selector operative in accordance with the second digit of the called number to extend the connection in the direction of the called subscriber, a non-numerical trunking switch for automatically extending connection from the said trunk-line to the second-selector, and means whereby said selectors and switch are all controlled over complete metallic line circuits.

12. In a telephone system, a two-way trunk, automatic switches for seizing either end of said trunk, means for making the ends of said trunk busy, and means for permitting an inspector to test and manually operate a switch to seize the trunk without making the other end thereof busy.

13. The combination, in a telephone system, of a two-way trunk line, a non-numerical trunking switch for each end of said line, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

14. The combination, in a telephone system, of a two-way trunk line, means for seizing said line, a non-numerical trunking switch for each end of said line, instrumentalities operative to make either end of the line busy when the other end is seized, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

15. The combination, in a telephone system, of a two-way trunk line, a non-numerical trunking switch for each end of said line, each switch adapted to automatically extend a trunking connection from said line in the direction of the called subscriber, numerical trunking switches for seizing either end of said trunk line, instrumentalities operative to render either end of said trunk line busy when the other end is seized, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

16. The combination, in a telephone system, of a two-way trunk line, means for seizing said line, a non-numerical trunking switch for each end of said line, instrumentalities operative to make both ends of said trunk line busy when either end thereof is seized, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

17. The combination, in a telephone system, of a two-way trunk line, a non-numerical trunking switch for each end of said line, each switch adapted to automatically extend a trunking connection from said line in the direction of the called subscriber, numerical trunking switches for seizing either end of said trunk line, instrumentalities operative to render both ends of said trunk line busy when either end thereof is seized, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

18. The combination, in a telephone system, of a set of two-way trunks, a set of non-numerical trunking switches for the said trunks at one end thereof, a master switch for said set of trunking switches, another set of non-numerical switches for said trunks at the other end thereof, another master switch for said last-mentioned set of trunking switches, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunks to control the said motions.

19. The combination, in a telephone system, of a trunk line, another trunk line, a non-numerical trunking switch for automatically connecting one trunk line with the other, means for controlling said switch over a complete metallic line circuit, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk lines to control the said motions.

20. The combination, in a telephone system, of a trunk line, an automatic switch for seizing said trunk line, another trunk line, a non-numerical trunking switch for automatically connecting the first trunk line with the second trunk line, means for successively controlling said switches over complete metallic line circuits, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk lines to control the said motions.

21. The combination, in a telephone system, of a two-way trunk line, means for automatically extending connection from either end thereof in the direction of the called subscriber, automatic switches for seizing either end of said trunk line, means

for controlling said switches over complete metallic line circuits, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

22. The combination, in a telephone system, of a two-way trunk line, automatic switches for extending connection from either end thereof in the direction of the called subscriber, other automatic switches for seizing either end of said trunk line, means by which all of said switches are controlled over complete metallic line circuits, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

23. The combination, in a telephone system, of a trunk line, a first selector operative in accordance with the first digit of the called number to seize one end of said trunk line, a second selector operative in accordance with the second digit of the called number to extend the connection in the direction of the called subscriber, a non-numerical trunking switch for automatically extending connection from the said trunk line to the second selector, means whereby said selectors and switch are all controlled over complete metallic line circuits, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk line to control the said motions.

24. The combination, in a telephone system, of a two-way trunk, automatic switches for seizing either end of said trunk, means for making the ends of said trunk busy, means for permitting an inspector to test and manually operate a switch to seize the trunk without making the other end thereof busy, a switch provided with a member having one motion to find a group, and another motion to find the called line in any predetermined group, and mechanism for controlling circuit over the said trunk to control the said motions.

25. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, a non-numerical automatic trunking switch for each end of said line, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

26. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, means for seizing said line, a non-numerical automatic trunking switch for each end of said line, instrumentalities operative to make either end of the line busy when the other end is seized, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

27. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, a non-numerical trunking switch for each end of said line, each switch adapted to automatically extend a trunking connection from said line in the direction of the called subscriber, numerical trunking switches for seizing either end of said trunk line, instrumentalities operative to render either end of said trunk line busy when the other end is seized, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

28. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, means for seizing said line, a non-numerical automatic trunking switch for each end of said line, instrumentalities operative to make both ends of said trunk line busy when either end thereof is seized, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

29. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, a non-numerical trunking switch for each end of said line, each switch adapted to automatically extend a trunking connection from said line in the direction of the called subscriber, numerical trunking switches for seizing either end of said trunk line, instrumentalities operative to render both ends of said trunk line busy when either end thereof is seized, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

30. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a set of two-way trunks, a set of non-numerical trunking switches for the said trunks at one end thereof, a master switch for said set of trunking switches, another set of non-numerical switches for said trunks at the other end thereof, another

master switch for said last-mentioned set of trunking swiches, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunks.

31. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a trunk line, another trunk line, a non-numerical trunking switch for automatically connecting one trunk line with the other, means for controlling said switch over a complete metallic line circuit, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk lines.

32. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a trunk line, an automatic switch for seizing said trunk line, another trunk line, a non-numerical trunking switch for automatically connecting the first trunk line with the second trunk line, means for successively controlling said switches over complete metallic line circuits, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk lines.

33. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, means for automatically extending connection from either end thereof in the direction of the called subscriber, automatic switches for seizing either end of said trunk line, means for controlling said switches over complete metallic line circuits, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

34. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk line, automatic switches for extending connection from either end thereof in the direction of the called subscriber, other automatic switches for seizing either end of said trunk line, means by which all of said switches are controlled over complete metallic line circuits, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

35. In a telephone system, subscriber's lines, means for establishing a connection between two of said lines, said means including a trunk line, a first selector operative in accordance with the first digit of the called number to seize one end of said trunk line, a second selector operative in accordance with the second digit of the called number to extend the connection in the direction of the called subscriber, a non-numerical trunking switch for automatically extending connection from the said trunk line to the second selector, means whereby said selectors and switch are all controlled over complete metallic line circuits, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

36. In a telephone system, subscribers' lines, means for establishing a connection between two of said lines, said means including a two-way trunk, automatic switches for seizing either end of said trunk, means for making the ends of said trunk busy, means for permitting an inspector to test and manually operate a switch to seize an end of the trunk without making the other end thereof busy, a central source or sources of electricity, and means for supplying current therefrom for talking purposes to substations connected for conversation over said trunk line.

37. In a telephone system, a two-way trunk, an automatic switch for including said trunk in a calling connection in one direction, another automatic switch for including said trunk in a calling connection in the other direction, means including an automatic switch controllable over the two sides of the trunk line in series for completing the call in one direction, and means including another automatic switch controllable over the two sides of the trunk line in series for completing the call in the other direction.

38. In a telephone system, a two-way trunk line, an automatic switch for extending connection from one end of said trunk line, another automatic switch for extending connection from the other end of said trunk line, and means for controlling each switch over the two sides of the trunk line in series.

39. In a telephone system, a two-way trunk line, automatic mans for including said trunk line in a calling connection in one direction, automatic means for including said trunk line in a calling connection in the other direction, subscribers' lines, an automatic switch controllable over said trunk line and the two sides of a subscriber's line in series to extend the call in one direction, and another automatic switch controllable over the trunk line and the two sides of a subscriber's line in series to extend the call in the other direction.

40. In a telephone system, a two-way

trunk, means including automatic switches for automatically trunking in opposite directions over said trunk line, and means for controlling said automatic switches over the two sides of said two-way trunk line in series in either direction.

Signed by me at Chicago, Cook county, Illinois, this 2nd day of July, 1908.

EDWARD D. FALES.

Witnesses:
J. NORBY,
ALBERT J. SAUSER.