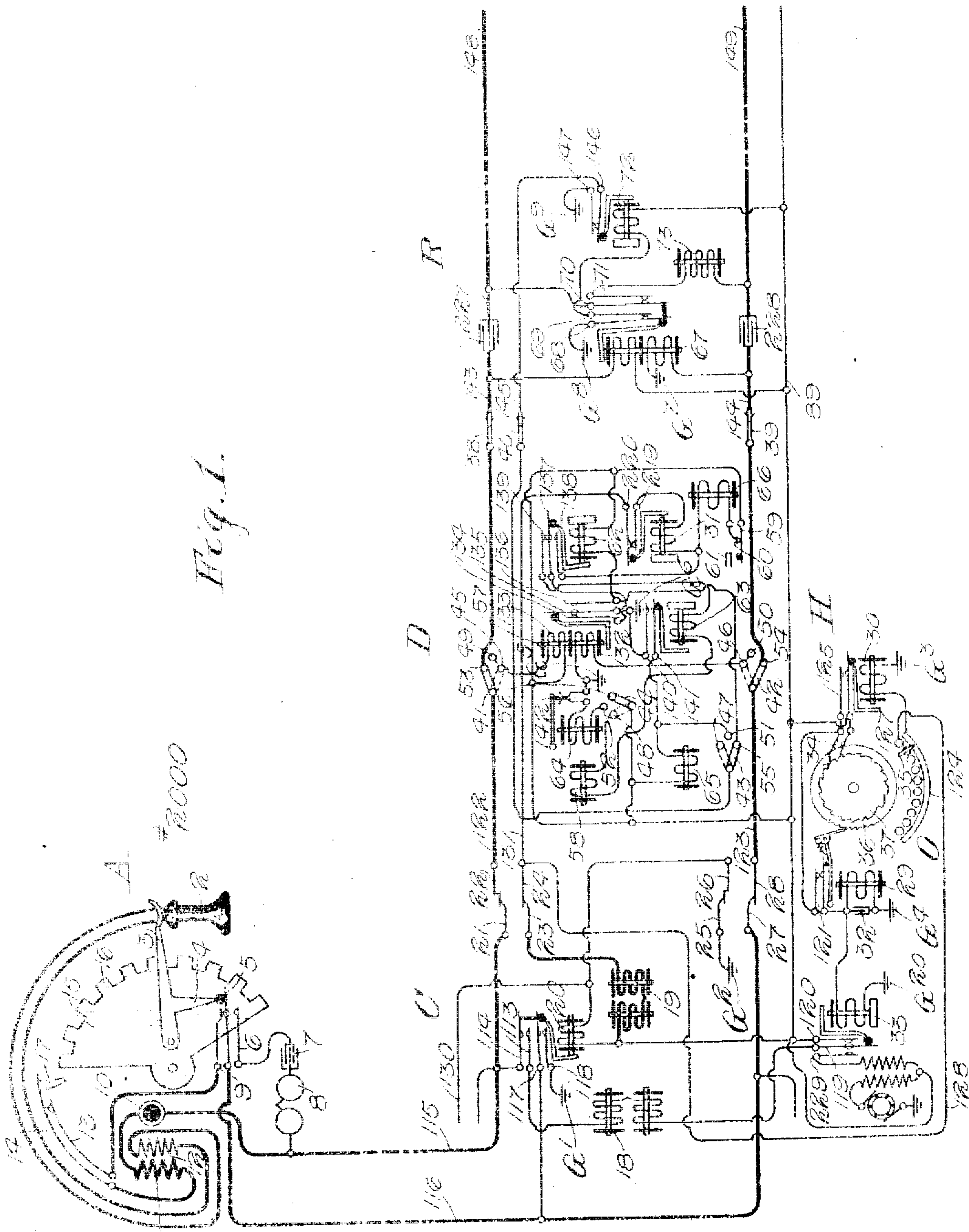


T. G. MARTIN.
COMMON BATTERY TWO WIRE REPEATER SYSTEM.
APPLICATION FILED JULY 12, 1909.

1,260,424.

Patented Mar. 26, 1918.

2 SHEETS—SHEET 1.



Witnesses
J. Morby.
E. H. Clegg

Inventor:
T. G. Martin
By Buckley, Prudden & Dwyer
Attorneys

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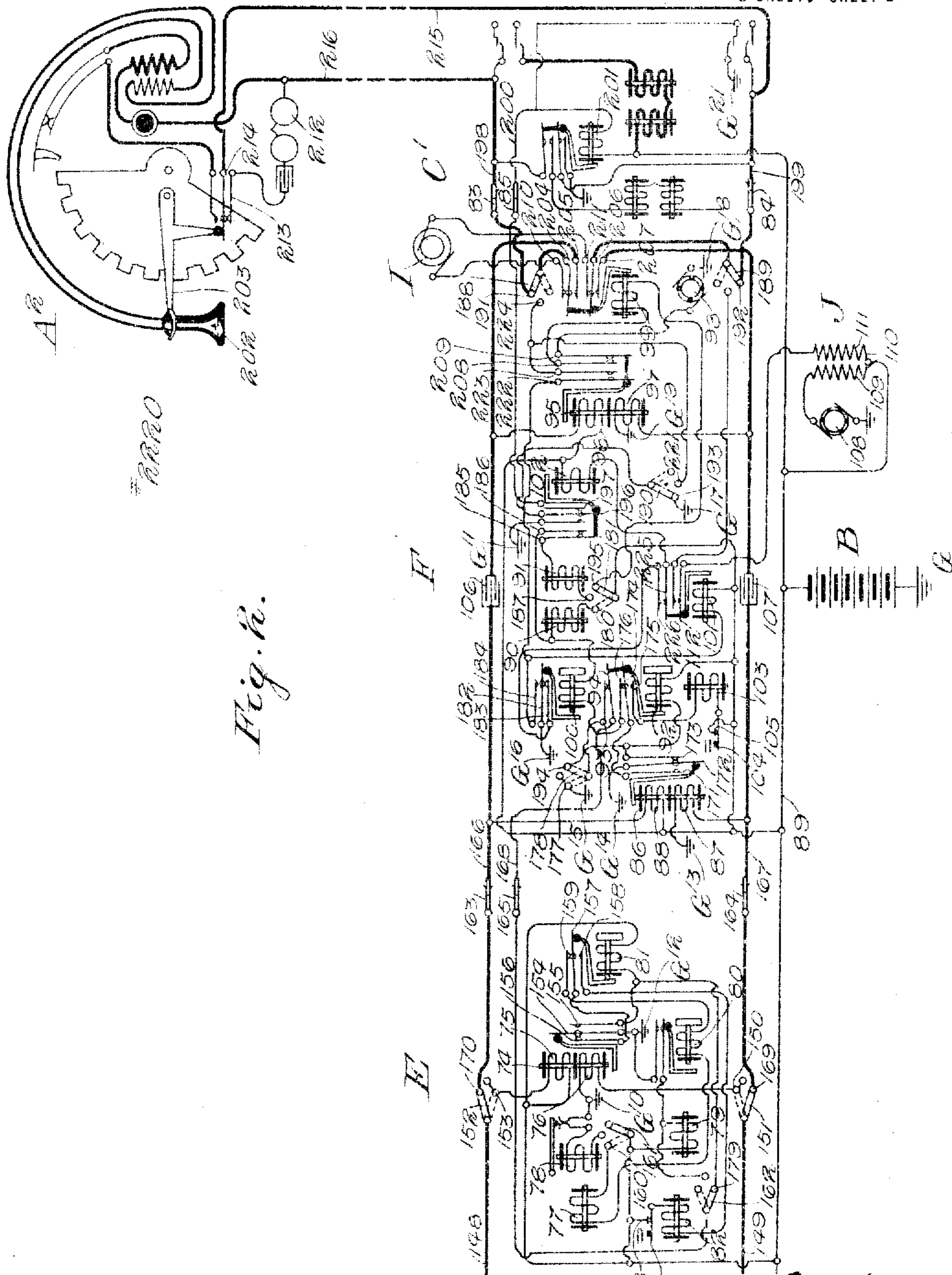


Fig. 2.

Witnesses
J. Norby.
E. H. Clegg

Inventor
T. G. Martin
By Buckley, Mauds, Drury
Attorneys

UNITED STATES PATENT OFFICE.

TALBOT G. MARTIN, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

COMMON-BATTERY TWO-WIRE REPEATER SYSTEM.

1,260,424.

Specification of Letters Patent.

Patented Mar. 26, 1918.

Application filed July 12, 1909. Serial No. 507,210.

To all whom it may concern:

Be it known that I, TALBOT G. MARTIN, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Common-Battery Two-Wire Repeater Systems, of which the following is a specification.

My invention relates to automatic or semi-automatic telephone exchange systems of that kind in which a repeater is employed for controlling one or more of the automatic devices by which the call is extended in the direction of the called subscriber, and in which the said repeater and device are each controlled over the two sides of the line in series, as is usual in two-wire systems. In a system of this kind suitable provision is made for obtaining connection with the repeater, and the latter is then employed for repeating the calling impulses to the automatic switching device for the purpose of causing the latter to seize the called line, or for causing the same to extend the connection in the direction of the called subscriber, depending upon the size and character of the exchange. As stated though, the said repeater and automatic switch are both controlled over the two sides of the line circuit in series, whereby no operating grounds are necessary at the substations of the system, or at any other points from which it is desired to exercise control of the repeaters and automatic switches.

My invention contemplates a system of this kind in which the current for talking purposes is supplied to the substations from a central source, or from suitable means provided at the exchange or central station, as distinguished from systems in which the subscriber's transmitters are supplied with current from local batteries. For this purpose I provide an improved repeater which is not only adapted to be controlled over the two sides of the line circuit in series, and which is in turn adapted to control one or more automatic switches over the two sides of the trunk circuit in series, but which is also adapted for use in a common battery trunking connection between calling and called subscribers. In this way certain coils of the repeater may be utilized for feeding talking current to the calling subscriber in a system in which no operating grounds are necessary at the substations.

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

In the accompanying drawings Figures 1 and 2 taken together represent diagrammatically a calling substation A connected by means of central office switching apparatus with a called substation A² in a system embodying the principles of my invention. The switches through which the stations A and A² are shown connected comprise the so-called line switch C which is allotted to the calling line, the first selector D, the repeater R, the second selector E, the connector F and the line switch C' of the called line. The line switch C is individual to the line of the substation A, while the line switch C' is individual to the line of the substation A². The said line switches are identical. For operating the switches there is usually provided at each central office a source of current or battery B having its positive terminal preferably grounded at G. By referring to Figs. 1 and 2 it will be seen that the switches in Fig. 1 are located in one office, while the switches in Fig. 2 are located at a distant office. The switches in Fig. 2 are operated from substation A through the medium of the repeater R, which is allotted to one of the trunk lines connecting the two exchanges.

It will be understood, of course, that in this system the line switches in each exchange are arranged in groups, as well as the first selectors, second selectors and connectors. There may be one-tenth as many connectors as subscribers, and the number of second selectors may be one-tenth of the total number of subscribers, as well as the number of first selectors. A common arrangement is to divide the subscribers into divisions, according to the numbers thereof, the subscribers having numbers beginning with one thousand all belonging to one division, the subscribers having numbers beginning with two thousand belonging to another division, and so on throughout the entire ten thousand subscribers of the one exchange. This will, of course, result in ten divisions of any exchange having a capacity of ten thousand subscribers, so that in calling any subscriber will necessarily first select one of the ten divisions. Each of these divisions is then sub-divided into ten groups—that is to say, the subscribers of

any one division, the numbers of which are between one hundred and two hundred, are arranged in one subdivision or group, those between two and three hundred in another subdivision, and so on, the last group being the naught hundred. In this way a ten thousand subscriber exchange is divided into ten divisions, and each division is then subdivided into ten subdivisions or groups. All of the subscribers whose numbers are between one hundred and two hundred of any thousand are arranged in a row or larger group; all subscribers whose numbers are between two hundred and three hundred are found in another row or group of subdivisions, and so on throughout the exchange. With this arrangement any given bank level of any particular subdivision or group of first selectors, which first selectors represent one hundred subscribers, has connected to it an equal number of second selectors. In a similar manner each bank in any particular group of second selectors has allotted to it a group of connectors, which connectors are adapted to close connection directly with the lines of the called subscribers. Between the first selectors and the calling subscribers are placed the line switches, one for each line, which are arranged in groups or subdivisions. Trunk lines from the line switches to the first selectors are provided on the well-known percentage basis. Also, trunk lines between the first and second selectors and between the second selectors and connectors are provided on the percentage basis, so that ordinarily the trunk lines are less in number than the total number of subscribers. Each trunk line will, then, have multiple terminals.

The substations in the system may be of any suitable or approved type. The substation A, for example, comprises a receiver 2, a switch hook 3 for controlling the substation circuits, which is accomplished by any suitable means, such as the cam arm 4. When the switch hook is down the cam arm 4 forces the spring 5 into engagement with the spring 6, thereby bridging the condenser 7 and the ringer 8 in series across the line. When the switch hook descends it forces the spring 5 out of engagement with the spring 9, thus removing the primary circuit of the substation from across the line. The primary circuit comprises the transmitter 10, the primary winding 11 of the induction coil 12, and the impulse springs 13 and 14, all in series. Being an automatic substation it is provided with a calling device including a dial (not shown), an impulse wheel 15 and the impulse springs 13 and 14. The dial is rigidly secured to the impulse wheel 15 and is of the well-known type, provided with finger holes; and when the dial is rotated on returning to normal position the impulse wheel is moved in such a manner as to carry

the spring 14 out of engagement with the spring 13 momentarily as the teeth 16 come into contact with the bushing 17. It will be understood, of course, that the wheel 15 and dial are provided with a proper tension spring which will restore them to normal position on release of the dial by the subscriber. Another spring is provided to raise the switch hook 3 when the weight of the receiver 2 has been removed.

The line switch C may be of any suitable or approved type. For example, it may be a modified form of the line switch disclosed in British Patent No. 26,301 of 1906, and described in the *American Telephone Journal* of Chicago, Illinois, of June 6, 1908. In its general form it comprises a trip magnet 18 (Fig. 1), a release magnet 19 and a bridge-cut-off relay 20. The trip magnet 18 is designed to operate the usual plunger for pressing the bank springs 21 and 22, 23 and 24, 25 and 26, and 27 and 28 into engagement. This plunger is so arranged that when in normal position it is under the control of the master switch H, whereby the said plunger may always be removed from opposite a busy trunk to a position opposite an idle trunk. The release magnet 19 operates to restore the plunger to normal position. The bridge-cut-off relay 20 operates to shift the springs 117 and 114 out of engagement with the springs 118 and 113.

The master switch H may be of any suitable or approved type. For example, it may be a modified form of the master switch described in said *American Telephone Journal* of Chicago, Illinois, of June 6, 1908. It comprises in its general form a motor magnet 29, a motor magnet relay 30, a relay 33, ratchet wheel 36, interrupter wheel 37, master switch bank O, wiper 35 and condenser 32. The master switch shaft controls the plungers of several idle line switches, usually one hundred, always holding them in readiness to engage an idle trunk. This particular master switch shaft has a step-by-step reciprocating motion, and all idle plungers are held in locking engagement with said shaft. The plungers of the line switches used in this invention, and as described in the above-mentioned publication, are not self-aligning—that is, a plunger does not automatically come into locked engagement with the shaft after being tripped, but waits until the shaft again resumes the original position where the plunger was tripped. When one line switch operates, its plunger is tripped and engages the springs of the bank terminals of an idle trunk. The motor magnet relay 30 is accordingly energized. This relay operates to close the motor magnet circuit and open the main relay circuit. The motor magnet 29 operates to rotate the ratchet wheel 36 and interrupter wheel 37. When the ratchet wheel is rotated one notch the interrupter

wheel has moved enough to close the springs 34, which keeps the motor magnet operating until the idle plungers are directly opposite the bank terminals of an idle trunk. When this position is reached the springs 34 separate, and as the master switch wiper 35 has been moved to a position on the master switch bank corresponding to the terminals of said idle trunk, the motor magnet relay 30 is deenergized, which in turn deenergizes the motor magnet 29. While the motor magnet is operating, the slow acting relay 33 is energized, thereby shifting the spring 119 out of engagement with the spring 120 and into engagement with the spring 229. By this operation the trip magnets 18 of all of the line switches which are controlled by the master switch H are disconnected from the battery lead, and connected with a busy signaling apparatus as long as the said master switch is operating. This prevents any line switch from being operated while the plunger is being moved from one trunk to another, and any subscriber who attempts to make a call while the master switch is operating will receive a busy signal, because his line is connected to a busy signaling apparatus through the trip magnet 18 and springs 119 and 229.

The first selector switch D may be of any suitable or approved type—for example, of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, adapted, however, to a two wire common battery system. In its modified form it comprises the shaft (not shown) which carries the line wipers 38 and 39 and private wiper 40, a side switch which is well known and comprises the side switch wipers 41, 42, 43 and 44. The side switch is controlled by the private magnet, and when the side switch is in first position the side switch wipers 41, 42, 43 and 44 engage the contact points 45, 46, 47 and 48, respectively. When in second position, the wipers engage the contact points 49, 50, 51 and 52, respectively, and in third position the contact points 53, 54, 55 and 56, respectively. Through the medium of the double wound line relay 57, and while the side switch is in first position, the subscriber controls the vertical magnet 58, which latter operates to raise the switch shaft and shaft wipers 38, 39 and 40 vertically. When the shaft is raised one or more steps vertically the off-normal spring 59 engages the contact point 60, being normally held out of engagement by the shaft arm 61. The release relay 62 is controlled by the double wound relay 57 and, since when the side switch is in third position the relay 57 is disconnected, it is controlled from the next apparatus, which in this case is the repeater R. The private magnet relay 63, being a slow acting relay and in series with the vertical magnet, con-

trols the private magnet 65, locking the side switch in its first position while the impulses are being delivered. When the side switch passes to its second position and engages its second position contacts, the rotary magnet 64 rotates the shaft and shaft wipers, and when an idle line is found the side switch is permitted to take its third position. The release magnet 66 operates to restore the shaft and side switch to their normal position, the circuit being closed only when the shaft is off normal and the release relay 62 is in normal position. The magnet is of the connector-release magnet type. The slow acting relay 31 is connected in the release trunk. It gives the release magnet 19 time to release the line switch by holding the trunk open for an instant.

The repeater R shown in Fig. 1 comprises, among other features, the following details:—A double wound line relay 67 having the same general features as the first selector double wound line relay 57. The relay 67, when operated, forces the springs 68 and 70 into engagement with the springs 69 and 71, respectively, energizing the repeater release relay 72, which is of the same general type of relay as the first selector release relay 62. When the springs 70 and 71 are in contact, the trunk conductors are closed through the impedance coil 73. Thus, every time the relay 67 is deenergized by the opening of the substation circuit, the trunk circuit through the relay springs and impedance coil 73 is broken. The release relay 72 protects the seized trunk by establishing a guarding potential at the private bank multiple contacts and provides a holding ground for the first selector release relay 62. The condensers 227 and 228 are provided to separate the repeater circuits.

The second selector E (Fig. 2) is similar to the first selector D, and is provided with the usual double wound line relay 74 having its windings 75 and 76 connected to the trunk line conductors through the first position contact points and side switch wipers in the usual manner. Since like parts are similarly represented, the vertical magnet 77, rotary magnet 78, private magnet 79, private magnet relay 80 and release relay 81 will be recognized and understood. The release magnet 82 is operated in the same manner in connection with the switch E as the release magnet 66 is operated in connection with the switch D. In the switch E the relays 80 and 81 are so arranged that they deenergize slowly, the same as the relays 62 and 63 in the selector switch D.

The connector switch F is a modified form of the connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson. The connector switch shaft (not shown), like the selector switch shaft, car-

ries the line wipers 83 and 84 and the private wiper 85. The connector switch is also controlled by the calling subscriber through the medium of a double-wound line relay 86 provided with the windings 87 and 88. One terminal of the winding 88 is connected to the battery lead 89, while the other terminal is connected with one trunk line conductor. The winding 87 is connected with ground at one terminal and with the other trunk line conductor at the other terminal. Through the medium of this relay the subscriber controls the vertical motion of the shaft and shaft wipers 83, 84 and 85, by means of the vertical magnet 90, while the side switch is in first position; and the subscriber controls the rotary motion of the shaft and shaft wipers by means of the rotary magnet 91 while the side switch is in second position. The connector switch F is also provided with the slow deenergizing release relay 92, which is similar to the release relay 62 of the selector D, with the additional springs 93 and 94. These springs are provided to establish a guarding potential to prevent another selector from seizing this connector and to provide a holding ground for the release relay 81 of the selector E. The private magnet relay 100, as usual, controls the private magnet 101, which latter controls the side switch wipers. The back-bridge relay 95, comprising the windings 96 and 97, serves as a means whereby the called subscriber is provided with battery current for talking purposes.

As illustrated, the connector switch is of the automatic ringing type—that is, a signaling of the called subscriber is not dependent upon the calling subscriber pressing a signaling button, for as soon as connection is established with the called line, the interrupter 98 intermittently closes an energizing circuit through the ringer relay 99, whereby the terminals of the ringer generator I are intermittently bridged across the normal conductors of the called line. The busy locking relay 102 is so arranged that if a busy line is called the connector side switch is locked in second position and the calling subscriber is given the busy signal. The means whereby the connector switch is released consists of the usual connector release magnet 103 which, when the switch shaft is raised one or more steps, is connected to the battery lead 89 by the normal spring 104 and contact point 105. By means of the condensers 106 and 107 the circuit through the connector is divided into two sections. The busy signaling apparatus J comprises the interrupter 108 in series with the winding 109 of the induction coil 110. The winding 111 is connected with the spring 112 of the private magnet 101.

The operation of the system may be more clearly understood from an explanation of

its operation in the course of establishing a connection. It is assumed that the subscriber at substation A wishes to call the subscriber at substation A², which is like substation A and designated as number 2220. The operation of the central office switches to bring about this connection is as follows: When the subscriber at substation A removes the receiver 2 from the switch hook 3 the cam arm 4 allows the springs 5 and 9 to engage, whereby an energizing circuit is completed for the trip magnet 18, said circuit extending from ground G' through the bridge-cut-off relay springs 118 and 117, line conductor 116, switch hook springs 5 and 9, impulse springs 13 and 14, primary winding 11 of the induction coil 12, transmitter 10 of substation A, line conductor 115, bridge-cut-off relay springs 114 and 113, trip magnet 18, relay springs 119 and 120 to battery lead 89, thence through battery B to ground G. As soon as the trip magnet 18 energizes, the plunger arm is tripped and the plunger engages the bank springs previously mentioned. When the bank springs of an idle trunk are thus closed the line conductors 115 and 116 are cut through to the trunk line conductors 122 and 123, whereby the line relay 57 of the first selector D is energized. This circuit extends from ground G⁵ through the winding 132 of the relay 57, contact point 46, side switch wiper 42, trunk line conductor 123, springs 28 and 27, line conductor 116, primary circuit of substation A, line conductor 115, springs 21 and 22, trunk line conductor 122, side switch wiper 41, contact point 45, winding 133 to the battery lead 89, thence through battery B to ground G. The relay 57, upon energizing, operates to disengage the spring 135 from the spring 134 and to place the springs 135 and 136 in contact. The former action clears the release trunk 131 of the ground G⁶, which prevents the release magnet 19 of the line switch from energizing. The latter action establishes an energizing circuit through the release relay 62, said circuit extending from ground G⁶ through the springs 135 and 136, release relay 62 to the battery lead 89. The release relay 62, upon energizing, operates to carry the spring 137 out of engagement with the spring 138 and into engagement with the spring 139. This is the condition of the first selector D when the subscriber operates the dial for the first digit. When the bank springs 25 and 26 close, as the line switch/plunger trips, the bridge-cut-off relay 20 is energized over a circuit extending from ground G² through said bank springs, bridge-cut-off relay 20 to the battery lead. The relay operates, forcing the springs 114 and 117 out of engagement with the springs 113 and 118, clearing the line conductors of the line 1:

switch wiper 44 to the battery lead 89, thence through battery B to ground G. The said rotary magnet then operates to rotate the shaft and shaft wipers 38, 39 and 40 into engagement with the first contact of the second level of the selector banks, from which contact it is assumed the trunk conductors 143, 144 and 145 lead to the repeater R. If the first trunk line is busy, however, and the wipers have to pass over busy trunk-lines, then as soon as the private wiper 40 engages the first private bank contact the private magnet 65 again energizes, locking the side switch in second position. The energizing circuit for said private magnet extends from the grounded terminal G⁶ of the battery B through a busy repeater R (not shown) through the private wiper 40, side switch wiper 43, contact point 51, private magnet 65 to battery lead 89, thence through battery B to ground G. The rotary magnet 64 will then continue to rotate the shaft wipers 38, 39 and 40 until the private wiper 40 leaves the last busy contact and the energizing circuit of the private magnet 65 is broken, deenergizing the private magnet and permitting the side switch wipers to engage their third position contacts. The energizing circuit of the rotary magnet 64, as well as the energizing circuit of the line relay 57, is broken when the side switch takes the third position. If, however, there are no busy trunk-lines the side switch is tripped to third position as soon as the wipers are carried into engagement with the first trunk line. As soon as the side switch passes to third position, as stated, the subscriber's line conductors 115 and 116 are extended to the conductors 143 and 144 which, in this case, it is assumed lead to the repeater R, and when thus extended an energizing circuit is established through the line relay 67 of the repeater switch. This circuit extends from ground G⁷ through one winding of the line relay 67, conductor 144, shaft wiper 39, contact point 54, side switch wiper 42, trunk-line conductor 123, bank springs 28 and 27, line conductor 116, primary circuit of substation A, line conductor 115, bank springs 21 and 22, trunk-line conductor 122, side switch wiper 41, contact point 53, shaft wiper 38, conductor 143, through the other winding of the line relay 67 to the battery lead 89, and through battery B to ground G. The line relay, upon energizing, forces the springs 68 and 70 into engagement with springs 69 and 71, respectively. The springs 68 and 69, on thus being closed, set up an energizing circuit for the release relay 72 from ground G⁸ through the springs 68 and 69, release relay 72 to the battery lead 89. When said relay operates, the spring 146 engages the spring 147, providing an energizing circuit for the release relay 62 of the selector D and establishing a guarding po-

tential at the corresponding private contact of the other selector banks to prevent another selector from seizing this trunk and repeater. Said energizing circuit extends from ground G⁹ through the springs 147 and 146, conductor 145, shaft wiper 40, side switch wiper 43, contact point 55, release relay 62 to the battery lead 89, thence through battery B to ground G. Thus the selector D is prevented from releasing by means of the ground at the repeater R. When the line relay springs 70 and 71 close in contact, an energizing circuit is established for the line relay 74 (Fig. 2) of the second selector E over the trunk-line conductors 148 and 149. This circuit extends from ground G¹⁰ through the winding 76 of the line relay 74, side switch contact point 150, side switch wiper 151, trunk line conductor 149, resistance coil 73 of the repeater R, springs 71 and 70, trunk-line conductor 148, side switch wiper 152, contact point 153, winding 75 of the line relay to the battery lead 89, thence through battery B to ground G. The relay 74, upon energizing, operates to place the springs 154 and 155 in contact, and to disengage the spring 154 from the spring 156, whereby an energizing circuit is established through the release relay 81, said circuit extending from ground G¹² through the springs 154 and 155, release relay 81 to the battery lead 89. The relay 81, upon energizing, operates to carry the spring 157 out of engagement with the spring 158 and into engagement with the spring 159. This is the condition of the second selector and repeater when the subscriber operates the dial for the second digit. It is seen that the trunk line between the first and second selectors is divided into two sections by the condensers 227 and 228, and that all selective impulses delivered to the second selector and connector at the distant exchange are transmitted through the repeater R. The second digit being 2, the impulse spring 14 is twice carried out of engagement with the impulse spring 13, whereby the energizing circuit through the repeater line relay 67 is twice broken momentarily. The relay 67, of course, deenergizes twice momentarily, and permits the springs 70 and 71 to disengage twice for a short period of time, thus breaking the energizing circuit of the second selector line relay 74 twice. When the impulses are transmitted both line relays are operated over the same circuit as previously traced. The release relays 72 and 81, being slow-acting as mentioned, do not deenergize during the transmission of the impulses, but remain in an operated condition. When the relay 74 deenergizes momentarily the spring 154 engages the spring 156, whereby an energizing circuit is completed through the vertical magnet 77, said circuit extending from

switch circuit. When the bank springs 23 and 24 are closed in contact, an energizing circuit is established through the motor magnet relay 30, it being understood that the ground connection to the release trunk at the selector D is removed almost instantaneously. Said energizing circuit extends from ground G³ through relay 30, common segment 124 of the master switch bank O, wiper 35, individual segment 127, conductor 128, bank springs 24 and 23, release magnet 19 to the battery lead 89, thence through battery B to ground G. It is evident that the motor magnet relay 30 and release magnet 19 are both included in this circuit; but the flow of current is not sufficient to operate the magnet though the relay is operated, closing the motor magnet circuit and the circuit of the relay 33. The motor magnet circuit extends from ground G⁴ through the magnet 29, interrupter springs 121, motor magnet relay springs 125 to the battery lead, thence through battery B to ground G. The circuit of the relay 33 extends from ground G²⁰ through the relay 33, interrupter springs 121, motor magnet relay springs 125 to the battery lead. The relay 33 is slow-acting—that is, slow to deenergize, and thus remains in an operated condition while the motor magnet is operating to advance the ratchet wheel 36 and interrupter wheel 37, which in turn advances all idle plungers that are in locking engagement with the shaft to a position opposite the next idle bank terminal. The relay 33, when operated, disconnects the battery lead from all trip magnets, thus making it impossible for a trip magnet to release a plunger while the motor magnet is operating. When the wiper 35 leaves the individual contact 127, and if the next individual contact is not guarded by a battery potential, the motor relay 30 will be deenergized. However, the motor magnet will continue operating the ratchet wheel until the idle plungers are in a position directly in front of the waiting idle trunk. This is accomplished by the springs 34, which are arranged in multiple with the springs 125, making contact until forced apart by the interrupter wheel 37. It is evident that in order to give this condition the interrupter wheel 37 must be set in a position to operate these springs 34 according to the relative position of the idle plungers. It will be understood that the bank terminal (shown) of the line switch bank corresponds to the first segment of the master switch bank O and, therefore, corresponds to the trunk line conductors 122, 123 and 131 which terminate in the selector D. The engagement of the bank springs 25 and 26, besides providing an energizing circuit for the bridge-cut-off relay, establishes a guarding potential over the private normal conductor 130 to the

connector bank terminals corresponding to the line of the calling subscriber, to prevent any other subscriber from calling the said line after the calling subscriber at substation A removes his receiver preparatory to making a call. Up to this point the subscriber at substation A has simply removed his receiver. He now turns the dial for the first digit of the number desired, releasing it when it returns to normal position.

The first digit being 2, the impulse spring 14 is twice carried out of engagement with the impulse spring 13, whereby the energizing circuit through the line relay 57 is broken twice, and the spring 135 comes into contact with the spring 134 twice. After the two impulses are thus delivered, the line relay again energizes and carries the spring 135 into contact with the spring 136. As previously explained, the relay 62 is a slow-acting relay—that is, slow to deenergize; and when this energizing circuit is momentarily broken, during the impulses just delivered, said relay does not deenergize, but remains in an operated position. When the spring 135 engages the spring 134, two impulses are transmitted to the vertical magnet 58. This circuit extends from ground G⁶ through the springs 135 and 134, springs 137 and 139, private magnet relay 63, vertical magnet 58, contact point 48, side switch wiper 44 (the side switch being in first or normal position) to the battery lead 89, thence through battery B to ground G. The vertical magnet is thereby energized twice and the shaft and shaft wipers raised two vertical steps in the well-known manner. It will be seen that the private magnet relay 63 is also included in the energizing circuit of the vertical magnet 58. This relay also energizes, but being a slow acting relay it operates on the first impulse and remains in an operated position until all the impulses are delivered. This relay, upon energizing, operates to close the springs 140 and 141 in contact, whereby an energizing circuit is established through the private magnet 65, said circuit extending from ground G⁶ through springs 140 and 141, private magnet 65 to the battery lead 89. The private magnet relay 63 deenergizes after the last impulse, since this energizing circuit is no longer maintained after the springs 134 and 135 disengage. Hence said relay permits the springs 140 and 141 to disengage, whereby the energizing circuit through the private magnet 65 is broken, which private magnet deenergizes and permits the side switch wipers 43 and 44 to engage the contact points 51 and 52, respectively. The closure of contact between the side switch wiper 44 and contact point 52 sets up an energizing circuit for the rotary magnet 64 from ground G⁵ through the interrupter springs 142, rotary magnet 64, contact point 52, side

ground G^{12} through the springs 154 and 156, springs 157 and 159, private magnet relay 80, vertical magnet 77, contact point 160, side switch wiper 161 to the battery lead 89. The vertical magnet 77 is thereby energized twice, and the shaft and shaft wipers are raised two vertical steps in the well-known manner. The private magnet relay 80 and private magnet 79 are operated similarly to the first selector private magnet relay 63 and private magnet 65, thus locking the side switch in first position during the sending of the impulses, and releasing it to second position when the impulses have been delivered. The side switch wipers 161 and 162 now engage their second position contact points, closing the energizing circuit of the rotary magnet 78, whereupon the rotary magnet 78 rotates the shaft wipers 163, 164 and 165 into engagement with the bank contacts of a trunk leading to a connector switch, an idle trunk being chosen in the same manner as previously explained for the first selector. After the switch comes to rest with the side switch in third position, the shaft wipers 163, 164 and 165 are in engagement with the trunk conductors 166, 167 and 168, respectively, which lead to the connector switch F. At the instant that the side switch wipers 151 and 152 pass to third position, into engagement with the contact points 169 and 170, the subscriber's line conductors are extended to the switch F, and an energizing circuit is established through the line relay 86 in the same manner in which the energizing circuit was established through the line relay 74 of the selector switch E when the repeater relay 67 was first energized. The energizing circuit through the line relay 86 extends from ground G^{13} through the winding 87 of the line relay 86, trunk line conductors 167 and 149, resistance coil 73, springs 71 and 70, trunk conductors 148 and 166, through the winding 88 of the line relay to the battery lead 89, thence through battery B to ground G. The line relay 86, upon energizing, operates to shift the spring 172 out of contact with the spring 171 and into contact with the spring 173, whereby an energizing circuit is established through the release relay 92, said circuit extending from ground G^{14} through springs 172 and 173, release relay 92 to the battery lead. When the relay 92 energizes, the spring 174 is shifted out of engagement with the spring 175 and into engagement with the spring 176, and the spring 94 is shifted into engagement with the spring 93. The engagement of the springs 93 and 94 establishes a guarding potential for protecting the trunk line conductors 166, 167 and 168 against seizure by another second selector. This potential extends from ground G^{15} through the contact point 177, side switch wiper 178,

springs 93 and 94, trunk line conductor 168 to the private bank contacts multiplied through the selector banks of this group. Furthermore, after the side switch of the second selector E passes to third position a new energizing circuit is established for the release relay 81, said circuit extending from ground G^{15} through the conductor 168, shaft wiper 165, side switch wiper 162, contact point 179, release relay 81 to the battery lead 89, thence through battery B to ground G. This is the condition of the connector when the subscriber operates the dial for the last two digits.

The third digit being 2, the impulse spring 14 is twice carried out of engagement with the impulse spring 13, whereby the energizing circuit through the repeater relay 67 is twice momentarily broken. The relay 67 de-energizes twice momentarily, and permits the springs 70 and 71 to disengage twice, thus breaking the energizing circuit of the connector line relay 86 twice. When the impulses are transmitted both line relays are operated over the circuits previously traced. The release relays 72 and 92, being slow-acting, as mentioned, do not de-energize during the impulses, but remain in an operated condition. When the line relay 86 de-energizes momentarily, the spring 172 engages the spring 171, whereby an energizing circuit is completed through the vertical magnet 90, said circuit extending from ground G^{14} , springs 172 and 171, springs 174 and 176, private magnet relay 100, vertical magnet 90, contact point 180, side switch wiper 181 to the battery lead 89, thence through battery B to ground G. The vertical magnet 90 is thereby energized twice, and the shaft and shaft wipers are raised two vertical steps in the well known manner. The private magnet relay 100 is also included in this energizing circuit of the vertical magnet 90. This relay also energizes, but being a slow acting relay it operates on the first impulse and remains in an operated position until all the impulses are delivered. This relay, upon energizing, operates to shift the spring 182 out of engagement with the spring 183 and into engagement with the spring 184, whereby an energizing circuit is established through the private magnet 101, said circuit extending from ground G^{16} through springs 182 and 184, private magnet 101 to the battery lead 89. The private magnet relay 100 de-energizes, of course, after the last impulse, since this energizing circuit is no longer maintained at the springs 171 and 172, whereby the energizing circuit through the private magnet 101 is broken. The magnet 101 now de-energizes, permitting the side switch wipers to engage their respective second position contact points.

The calling subscriber now operates the

calling device for the last digit O, thereby transmitting ten impulses through the line relay 67 of the repeater, operating the line relay 86 of the connector F ten times. Each time the line relay springs 171 and 172 engage, an energizing circuit is established from ground G^{14} through the said springs 172 and 171, springs 174 and 176, private magnet relay 100, springs 186 and 185, rotary magnet 91, contact point 187, side switch wiper 181 to the battery lead 89. The rotary magnet 91 then operates to rotate the shaft wipers 83, 84 and 85 into engagement with the desired line #2220. Again the private magnet relay 100 energizes, as in the previous case, remaining so until all the impulses are transmitted, thereby retaining the private magnet 101 also energized and the side switch in second position. If the line #2220 is busy at the time, the connector side switch will be locked in second position in a manner to be described, and the calling subscriber is given a busy signal, thus making it impossible to extend the calling line into connection with the called line. Before describing the results that follow when the connector finds a busy line, the description of how a connection is established will be completed. As soon as the line relay 86 ceases to operate for the last digit, the private magnet relay 100 deenergizes, as heretofore explained, in this instance permitting the private magnet 101 to deenergize, allowing the side switch to pass to third position, and the side switch wipers 188, 189, 190, 178 and 181 to engage the contact points 191, 192, 193, 194 and 195, respectively. When the side switch wiper 190 engages the contact point 193, a guarding potential is extended from ground G^{17} through said contact point and side switch wiper, locking relay springs 196 and 197 to the private wiper 85, for protecting the seized line from outside interference while the connection is established. Not only does this guarding potential prevent other connectors from connecting with this line over multiples of the normal conductors 198, 199 and 200, but it also provides means for energizing the cut-off relay 201 of the line switch C' , whereby said line switch C' is prevented from operating when the called subscriber removes his receiver 202 from the switch hook 203. It will also be seen that when the side switch passes to third position, the trunk release conductor 168 that runs between the second selector E and connector F is provided with a guarding potential from ground G^{14} through the line relay springs 172 and 173, contact point 194, side switch wiper 178, release relay springs 93 and 94 to the trunk conductor 168. Of course, when the side switch wipers 188 and 189 engage their third position contact points 191 and 192, the calling subscriber's

line is placed in connection with the called subscriber's line over the heavy conductors shown, passing through the ringer relay springs 204 and 205 on one side and 206 and 207 on the other side. As soon as connection is thus established, the ringer relay 99 is energized over the circuit established when the side switch wiper 181 engages the contact point 195, the energizing current flowing from ground G^{18} through the interrupter 98, the back bridge relay springs 209 and 208, ringer relay 99, contact point 195, side switch wiper 181 to the battery lead 89, thence through battery B to ground G. It will be seen that as the interrupter 98 revolves, the energizing circuit of the ringer relay 99 will be broken periodically, so as not to ring the called subscriber continuously. Each time that the ringer relay 99 is energized, the springs 204 and 206 are separated from the springs 205 and 207 and pressed against the springs 210 and 211, thereby breaking the calling line from the called line and connecting the called line with the terminals of the ringer generator I. As a result, ringing current is sent over the called line for energizing the bell 212 while the springs 213 and 214 are in contact.

As soon as the called subscriber answers, the back bridge relay 95 is energized by a flow of current from ground G^{19} , winding 97 of the back bridge relay 95, ringer springs 207 and 206, side switch wiper 189, contact point 192, shaft wiper 84, normal line conductor 199, line conductor 215, primary circuit of the substation A^2 , line conductor 216, normal conductor 198, contact point 191, side switch wiper 188, ringer relay springs 204 and 205, winding 96 of the back bridge relay to the battery lead 89, thence through battery B to ground G. When the back bridge relay energizes, the spring 209 is shifted out of engagement with the spring 208, thereby breaking the ringer relay energizing circuit. In this way the called subscriber is automatically signaled and cuts off the ringing current by answering the signal. The subscribers being thus connected may communicate over the main talking conductors indicated by the heavy lines and including the condensers 106 and 107 at the connector F.

When the subscribers are through talking, and if the called subscriber hangs up his receiver first, the energizing circuit for the back bridge relay 95 is broken and the relay deenergizes, closing the ringer circuit again and ringing the bell again if the calling subscriber has not yet hung up his receiver. When the calling subscriber hangs up his receiver, the energizing circuit for the repeater relay 57 is broken at a point between the springs 5 and 9, thereby initiating the release of all the switches. This release is brought about, as follows: At the instant

the circuit is broken, as mentioned, the repeater relay 67 deenergizes, breaking the circuit for the release relay 72 as well as for the connector line relay 86. The connector line relay 86, upon deenergizing, breaks the energizing circuit of the release relay 92 as well as of the release relay 81 of the second selector. Both these relays accordingly, on restoring to a normal position, close the release magnet circuits of both the selector and connector. At the connector this circuit extends from ground G^{14} through the line relay springs 172 and 171, release relay springs 174 and 175, release magnet 103, off normal spring 104, contact point 105 to the battery lead 89, thence through battery B to ground G. At the second selector the energizing circuit extends from ground G^{12} , line relay springs 154 and 156, release relay springs 157 and 158, release magnet 82, off normal spring 217, contact point 218 to the battery lead 89, thence through battery B to ground G. The release magnets on both switches instantly restore the side switches to normal position and release the shafts, thereby breaking the energizing circuit through the back-bridge relay at the connector 95 if the called subscriber has not in the meantime restored his receiver, and also breaking the energizing circuit through the bridge-cut-off relay 201 of the line switch C'. As soon as each shaft reaches its lowest position it breaks the energizing circuit for the release magnet on that switch. Both the second selector and connector are now in a normal position. The first selector is released similarly by a breaking of the energizing circuit of its release relay. This occurs when the release relay 72 (its circuit being broken as mentioned) deenergizes, breaking the energizing circuit for the release relay 62. The release relay 62 accordingly deenergizes and closes the springs 137 and 138 into contact, thereby closing an energizing circuit for the release magnet 66 from ground G^6 through springs 135 and 134, springs 137 and 138, release magnet 66, contact point 60, off-normal spring 59 to the battery lead 89, thence through battery B to ground G. The release magnet 66 accordingly energizes and releases the selector switch shaft instantly, restoring the side switch to normal position. When the shaft reaches its lowest position the arm 61 engages the off-normal spring 59, shifting the spring 59 out of engagement with the contact point 60, thereby breaking the energizing circuit of the release magnet 66. When the release relay springs 137 and 138 come into contact, as before mentioned, another energizing circuit is closed for the release magnet 19 of the line switch C. This circuit extends from ground G^6 through the line relay springs 135 and 134, springs 137 and 138, releasing relay 31, springs 219 and

220, release trunk conductor 131, release magnet 19 to the battery lead 89, thence through battery B to ground G. This circuit includes the magnet 19, as above, which is accordingly energized, and also includes the slow-acting relay 31, which is also energized. But the relay 31 breaks its own energizing circuit as well as the energizing circuit for the release magnet 19 and, being slow-acting, does not instantly resume a normal position. During this interval, when the relay 31 is fully operated, the release magnet 19 is deenergized, and the plunger is withdrawn from the bank terminal contacts, releasing said line switch completely. Of course, the release magnet cannot again energize when the relay 31 falls back, because the bank springs 23 and 24 are disengaged. When the bank springs 25 and 26 disengage, the bridge-cut-off relay 20 deenergizes. The first selector and line switch are now completely released, and the subscribers at either substation may instantly call again any number desired.

Returning now to that stage of the call where the calling subscriber was operating the connector switch in accordance with the last digit O, it will be explained what takes place in the event that the desired line is busy. When the line #2220 is calling, or when it has been called by someone else, the private bank contacts, in which the normal conductor 200 terminates, are connected to ground. If another connector switch has called the line this guarding potential will be supplied from a ground terminal similar to the ground terminal G^{17} in the connector switch F, as already explained; but if the line #2220 is calling, the line switch C' will be operated and the guarding potential will be supplied from the ground G^{21} . In a similar way the line switch C protects the calling line A, when the bank springs 25 and 26 come into contact. Therefore, when the subscriber sends in the last impulse the private wiper 85 is carried onto a grounded contact, and when the slow acting relay 100 deenergizes, instead of the side switch tripping to third position, as in the case where the line is not busy, it is locked, and the calling subscriber is then given a busy signal. The new energizing circuit for the private magnet 101, maintained during the time the private magnet relay 100 is deenergizing, extends from the grounded terminal of the battery through an occupying switch (not shown), through the private normal conductor 200, shaft wiper 85, locking relay springs 197 and 196, side switch wiper 190, contact point 221, through the springs 223 and 222 of the back bridge relay 95 (this relay being now energized over a circuit which will be traced later,) through the private magnet 101 to the battery lead 89, and thence through battery B to ground

G. The back bridge relay 95 is energized whenever the private wiper engages a grounded contact with the side switch in second position. Accordingly, the instant the busy contact is touched by the private wiper, the relay 95 is energized over a circuit from the grounded terminal of the battery through an occupying switch (not shown), through the private wiper 85 and to the contact point 221, as previously traced, thence through the contact point 224, side switch wiper 188, ringer springs 204 and 205, winding 96 of the back bridge relay 95 to the battery lead 89. When the private magnet relay 100 deenergizes, and the spring 182 engages the spring 183, an energizing circuit is established for the locking relay 102. Said circuit extends from ground G^{16} through springs 182 and 183, private magnet springs 226 and 225, locking relay 102 to the battery lead 89. The relay 102, upon energizing, shifts the holding ground for the private magnet from an occupying switch through the private wiper, as previously traced, to the ground G^{11} . Thus, when the subscriber #2220, who was busy, releases his switches, and of course removes the ground potential from the private contact, the connector F will not trip in on this line, but will continue to give the calling subscriber the busy-signal, the private magnet being still locked. When the calling subscriber hangs up his receiver, he breaks the circuit of the repeater relay 67 and initiates the release of all the switches, as before explained.

From the foregoing it will be seen that I provide a repeater for controlling the switch or switches that are employed for automatically extending connection in the direction of the called subscriber, in a system in which no operating grounds are necessary at the substations, and in which the supply of current for talking purposes is derived from suitable means at the exchange or central station, rather than from batteries at the substations. The repeaters are controlled over the two sides of the line circuit in series, and the automatic switches are also controlled over the two sides of the line circuit in series. In other words, the circuits for controlling the repeaters, and the circuits controlled by the repeaters, each include the two sides of the talking circuit in series—that is to say, include portions of the two sides of the talking circuit in series. The repeaters R serve to extend connection from two-wire calling subscribers to two-wire called subscribers, the equipment of the calling subscriber being identical with that of the called subscriber.

It will be seen that the selectors and connectors have vertical motion to select groups and rotary motion to then find a line in any

selected group. The rotary motion of the selectors is, of course, automatic, whereby the selection of idle trunks is accomplished automatically. On the other hand, the rotary motion of the connectors is under the direct and constant control of the calling subscriber, whereby a particular or predetermined line in the selected group may be seized. Means are provided for automatically reducing the number of bridges across any established talking circuit. The bridge or bridges remaining across any talking circuit are, as explained, adapted to serve as a means for controlling the trunk-release circuits over which the switches are released after the subscribers are through talking.

What I claim as my invention is:—

1. In a telephone system, the combination of a talking circuit between calling and called subscribers having a section normally disconnected from the calling line, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in series to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current through the repeater and over portions of the said circuit to the calling subscriber for talking purposes.

2. In a telephone system, the combination of a talking circuit between calling and called subscribers having a section normally disconnected from the calling line, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in series to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current through said automatic switch and over portions of the said circuit to the called subscriber for talking purposes.

3. In a telephone system, the combination of a talking circuit between calling and called subscribers having a section normally disconnected from the calling line, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in

series to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said
 5 repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current over portions of the said circuit to the calling subscriber for talking
 10 purposes.

4. In a telephone system, the combination of a talking circuit between calling and called subscribers having a section normally disconnected from the calling line, and automatic switch and means for transmitting a
 15 varying number of impulses over portions of the two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in
 20 series to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said
 25 repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current over portions of the said circuit to the called subscriber for talking
 purposes.

5. In a telephone system, the combination of a two-wire calling telephone line, a suitable called telephone line, means including
 30 a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said
 35 repeater including a double-wound relay bridged across said line, and a common battery for supplying talking current to the calling line, the said two-wire telephone line
 40 being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series.

6. In a telephone system, the combination of a two-wire calling telephone line, a suitable called telephone line, means including
 45 a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said
 50 repeater including a double-wound relay bridged across said line, and a common battery for supplying talking current to the called line, the said two-wire telephone line
 55 being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series.

7. In a telephone system, the combination of a suitable calling telephone line, a two-wire called telephone line, means including
 60 a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said
 repeater including a double-wound relay bridged across said line, and a common battery for supplying talking current to the

calling line, the said two-wire telephone line
 65 being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series.

8. In a telephone system, the combination of a suitable calling telephone line, a two-
 70 wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said
 repeater including a double-wound relay
 75 bridged across said line, and a common battery for supplying talking current to the called line, the said two-wire telephone line being provided with a calling mechanism at
 the substation thereof for controlling the
 80 two sides of the line in series.

9. In a telephone system in which the subscribers' lines are divided into groups, means for establishing a talking circuit be-
 85 tween calling and called subscribers, comprising a talking circuit section common to all of the lines of a group, an automatic switch, means for transmitting a varying
 number of impulses over portions of the
 90 two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, to extend connection in the direction of the
 called subscriber, a repeater in the talking
 95 circuit individual to said section for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means
 at the central station for supplying current
 100 through the repeater and over portions of the said circuit to the calling subscriber for talking purposes, said automatic switch having first one motion to select a group and
 then a second motion to find the called line
 105 in the predetermined group.

10. In a telephone system in which the subscribers' lines are divided into groups, the combination of a talking circuit between
 110 calling and called subscribers, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said circuit in series to control
 said switch to extend connection in the direction of the called subscriber, a repeater
 115 in the talking circuit for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at
 the central station for supplying current
 120 through said automatic switch and over portions of the said circuit to the called subscriber for talking purposes, said automatic switch having first vertical motion to select
 a group and then rotary motion to find the
 125 called line in the predetermined group.

11. In a telephone system in which the subscribers' lines are divided into groups, the combination of a talking circuit between

calling and called subscribers, an automatic switch and means for transmitting a varying number of impulses over the two sides of a portion of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in series to extend connection in the direction of the called subscriber, a repeater in the talking circuit for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current over portions of the said circuit to the calling subscriber for talking purposes, said automatic switch having first vertical motion to select a group and then rotary motion to find the called line in the predetermined group.

12. In a telephone system in which the subscribers' lines are divided into groups, the combination of a talking circuit between calling and called subscribers, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in series to extend connection in the direction of the called subscriber, a repeater in the talking circuit for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current over portions of the said circuit to the called subscriber for talking purposes, said automatic switch having first vertical motion to select a group and then rotary motion to find the called line in the predetermined group.

13. In a telephone system in which the subscribers' lines are divided into groups, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending a talking circuit from the calling line to the called line, and a common battery for supplying talking current to the calling line, the said calling telephone line being provided with a calling mechanism at the substation thereof for transmitting a varying number of impulses over the two sides of a portion of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, said automatic switch having first vertical motion to select a group and then rotary motion to find the called line in the predetermined group.

14. In a telephone system in which the subscribers' lines are divided into groups, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extend-

ing a talking circuit from the calling line to the called line, and a common battery for supplying talking current to the called line, the said calling telephone line being provided with a calling mechanism at the substation thereof for transmitting a varying number of impulses over the two sides of a portion of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, said automatic switch having first vertical motion to select a group and then rotary motion to find the called line in the predetermined group.

15. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a talking circuit between calling and called subscribers, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current through the repeater and over portions of the said circuit to the calling subscriber for talking purposes, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

16. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a talking circuit between calling and called subscribers, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series to extend connection in the direction of the called subscriber, a repeater in the talking circuit for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current over portions of the said circuit to the calling subscriber for talking purposes, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

17. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a talking circuit between calling and called subscribers, an automatic switch and means for transmitting a varying number of impulses over portions of the two sides of said talking cir-

cuit in series to control said switch over the two sides of a different portion of said talking circuit in series to extend connection in the direction of the called subscriber, a repeater in the talking circuit for controlling the said automatic switch, said repeater being also controllable over portions of the two sides of said circuit in series, and means at the central station for supplying current over portions of the said circuit to the called subscriber for talking purposes, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

18. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a two-wire calling telephone line, a suitable called telephone line, means including a repeater and an automatic switch controlled thereby for extending a talking circuit from the calling line to the called line, and a common battery for supplying talking current to the calling line, the said two-wire telephone line being provided with a calling mechanism at the substation thereof for transmitting a varying number of impulses over the two sides of a portion of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

19. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a two-wire calling telephone line, a suitable called telephone line, means including a repeater and an automatic switch controlled thereby for extending a talking circuit from the calling line to the called line, and a common battery for supplying talking current to the called line, the said two-wire telephone line being provided with a calling mechanism at the substation thereof for transmitting a varying number of impulses over the two sides of a portion of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

20. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending a talking circuit from the calling line to the called line, and a common battery for supplying talking current to the

calling line, the said calling telephone line being provided with a calling mechanism at the substation thereof for transmitting a varying number of impulses over the two sides of a portion of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

21. In a telephone exchange trunking system in which the trunk lines are divided into groups, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending a talking circuit from the calling line to the called line, and a common battery for supplying talking current to the called line, the said calling telephone line being provided with a calling mechanism at the substation thereof for transmitting a varying number of impulses over the two sides of a portion of said talking circuit in series to control said switch over the two sides of a different portion of said talking circuit in series, said automatic switch having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the predetermined group.

22. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of a talking circuit between calling and called subscribers, said talking circuit having a section normally disconnected from the subscribers' lines, an automatic switch controllable over portions of the two sides of said circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said repeater being controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current through the repeater and over portions of the said circuit to the calling subscriber for talking purposes, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

23. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of a talking circuit between calling and called subscribers, said talking circuit having a section normally disconnected from the subscribers' lines, an automatic switch controllable over portions of the two sides of said circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for con-

trolling the said automatic switch, said repeater being controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current through said automatic switch and over portions of the said circuit to the called subscriber for talking purposes, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

24. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of a talking circuit between calling and called subscribers, said talking circuit having a section normally disconnected from the subscribers' lines, an automatic switch controllable over portions of the two sides of said circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said repeater being controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current over portions of the said circuit to the calling subscriber for talking purposes, and means for automatically reducing the number of bridges across the conductors of any talking circuit during establishment thereof.

25. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of a talking circuit between calling and called subscribers, said talking circuit having a section normally disconnected from the subscribers' lines, an automatic switch controllable over portions of the two sides of said circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said repeater being controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current over portions of the said circuit to the called subscriber for talking purposes, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

26. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of subscribers' lines which are free from operating grounds outside of the exchange or central station, trunk lines provided with repeaters, means controllable over said subscribers' lines for automatically selecting idle repeaters, automatic switches controllable by said repeaters,

means at the exchange or central station for supplying talking current to calling subscribers, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

27. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of subscribers' lines which are free from operating grounds outside of the exchange or central station, trunk lines provided with repeaters, means controllable over said subscribers' lines for automatically selecting idle repeaters, automatic switches controllable by said repeaters, means at the exchange or central station for supplying talking current to called subscribers, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

28. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, the combination of subscribers' lines which are free from operating grounds outside of the exchange or central station, trunk lines provided with repeaters, means controllable over said subscribers' lines for automatically selecting idle repeaters, automatic switches controllable by said repeaters, means at the exchange or central station for supplying talking current to both calling and called subscribers, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

29. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, said talking circuit having a section normally disconnected from the subscribers' lines, the combination of a two-wire calling telephone line, a suitable called telephone line, means including a repeater individual to said section controlled over two sides of a portion of said talking circuit in series and an automatic switch controlled thereby over two sides of a different portion of said talking circuit in series for extending connection from the calling line to the called line, a common battery for supplying talking current to the calling line, the said two-wire telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

30. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic

switches, said bridges including a battery connected in series therein, the combination of a two-wire calling telephone line, a suitable called telephone line, means including
 5 a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, a common battery for supplying talking current to the called line, the said two-wire
 10 telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and means for automatically reducing the number of bridges across the conductors of
 15 any talking circuit during the establishment thereof.

31. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic
 20 switches, said bridges including a battery connected in series therein, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection
 25 from the calling line to the called line, a common battery for supplying talking current to the calling line, the said calling telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.
 35

32. In a telephone system employing relay bridges across the conductors of the talking circuit for controlling automatic switches, said bridges including a battery connected
 40 in series therein, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling
 45 line to the called line, a common battery for supplying talking current to the called line, the said calling telephone line being provided with a calling mechanism at the substation thereof for controlling the two
 50 sides of the line in series, and means for automatically reducing the number of bridges across the conductors of any talking circuit during the establishment thereof.

33. In a telephone system employing
 55 means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of a talking circuit between calling and called subscribers, said talking circuit
 60 having a section normally disconnected from the subscribers' lines, an automatic switch controllable over portions of the two sides of said talking circuit in series, to extend connection in the direction of the called sub-

scriber, a repeater in the talking circuit individual to said section for controlling the
 65 said automatic switch, said repeater being controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current
 70 through the repeater and over portions of the said circuit to the calling subscriber for talking purposes, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of
 75 any talking circuit.

34. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the
 80 conductors of the talking circuit, the combination of a talking circuit between calling and called subscribers, said talking circuit having a section normally disconnected from the subscribers' lines, an automatic switch controllable over portions of the two sides
 85 of said talking circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit individual to said section for controlling the said automatic switch, said repeater being
 90 controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current over portions of the said circuit to the calling subscriber for talking purposes, and
 95 trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

35. In a telephone system employing means for automatically disconnecting or
 100 cutting off an automatic switch from the conductors of the talking circuit, the combination of a talking circuit between calling and called subscribers, said talking circuit having a section normally disconnected from
 105 the subscribers' lines, an automatic switch controllable over portions of the two sides of said talking circuit in series, to extend connection in the direction of the called subscriber, a repeater in the talking circuit
 110 individual to said section for controlling the said automatic switch, said repeater being controllable over different portions of the two sides of said circuit in series, means at the central station for supplying current
 115 over portions of the said circuit to the called subscriber for talking purposes, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.
 120

36. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the
 125 conductors of the talking circuit, the combination of subscribers' lines which are free from operating grounds outside of the exchange or central station, trunk lines provided with repeaters, means controllable

over said subscribers' lines for automatically selecting idle repeaters, automatic switches controllable by said repeaters, means at the exchange or central station for supplying talking current to calling subscribers, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

37. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of subscribers' lines which are free from operating grounds outside of the exchange or central station, trunk lines provided with repeaters, means controllable over said subscribers' lines for automatically selecting idle repeaters, automatic switches controllable by said repeaters, means at the exchange or central station for supplying talking current to called subscribers, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

38. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of subscribers' lines which are free from operating grounds outside of the exchange or central station, trunk lines provided with repeaters, means controllable over said subscribers' lines for automatically selecting idle repeaters, automatic switches controllable by said repeaters, means at the exchange or central station for supplying talking current to both calling and called subscribers, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

39. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of a two-wire calling telephone line, a suitable called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said repeater including a double-wound relay bridged across said line, a common battery for supplying talking current to the calling line, the said two-wire telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

40. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of a two-wire calling telephone line,

a suitable called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said repeater including a double-wound relay bridged across said line, a common battery for supplying talking current to the called line, the said two-wire telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

41. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said repeater including a double-wound relay bridged across said line, a common battery for supplying talking current to the calling line, the said calling telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

42. In a telephone system employing means for automatically disconnecting or cutting off an automatic switch from the conductors of the talking circuit, the combination of a suitable calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said repeater including a double-wound relay bridged across said line, a common battery for supplying talking current to the called line, the said calling telephone line being provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series, and trunk-circuit-controlled releasing means for restoring the switch disconnected from the conductors of any talking circuit.

43. In a telephone system, the combination of a two-wire calling telephone line, a two-wire called telephone line, means including a repeater and an automatic switch controlled thereby for extending connection from the calling line to the called line, said repeater including a double-wound relay bridged across said line, and centralized means for supplying current to said lines for talking purposes, the said telephone lines being each provided with a calling mechanism at the substation thereof for controlling the two sides of the line in series,

44. In a telephone system, a repeater and an automatic switch controlled thereby, said repeater provided with a line relay having two windings, a battery connected in series between said windings, a trunk line across which the said windings and battery are permanently bridged, automatic means for seizing said trunk line, a ground-controlling relay for said repeater, a trunk-release circuit for said automatic means controlled by said ground-controlling relay, said ground-controlling relay having an energizing circuit controlled by the said line relay, which energizing circuit remains closed during conversation, whereby said trunk-release circuit also remains closed during conversation, and release mechanism responsive to the opening of said trunk-release circuit by the said ground-controlling relay.

45. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a pair of condensers in opposite sides of said trunk, a bridge in said repeater across said trunk on one side of said condensers, a double-wound relay in said bridge, and a second bridge containing an electromagnetic element across said trunk on the opposite sides of said condensers controlled by said double-wound relay.

46. In a telephone system, a subscriber's line, a trunk line, means including an automatic switch, controllably over two sides of said subscriber's line in series for extending a connection from said line to said trunk, a repeater in said trunk, a bridge in said repeater across said trunk, a double-wound relay in said bridge, and a second bridge containing an electromagnetic element across said trunk controlled by said double-wound relay.

47. In a telephone system, a subscriber's line, a trunk line, means including an automatic switch, controllably over two sides of said subscriber's line in series for extending a connection from said line to said trunk, a repeater in said trunk, a bridge in said repeater across said trunk, a double-wound relay in said bridge, a second bridge containing an electromagnetic element across said trunk controlled by said double-wound relay, and a slow acting relay in said repeater, controlled by said double-wound relay for controlling the release circuit for said automatic switch.

48. In a telephone system, a subscriber's line, a trunk line, means including an automatic switch for extending a connection from said subscriber's line to said trunk, a pair of condensers in opposite sides of said trunk, a bridge in said repeater across said trunk on one side of said condensers, a double-wound relay in said bridge, a second bridge containing an electromagnetic element across said trunk on opposite sides of said condensers controlled by said double-wound relay, a slow acting relay in said repeater controlled by said double-wound relay, and a release circuit for said automatic switch controlled by said slow acting relay.

49. In a telephone system, a calling line, a called line, a link circuit for connecting the two over a talking circuit, an automatic progressively movable switch controlling said circuit and operated over two sides of a portion of said circuit in series, an impulse sender associated with the calling line, an impulse repeater interposed between said line and said switch, said repeater individual to said link and responsive to impulses from said sender over two sides of a different portion of the talking circuit in series, said repeater controlling said switch in response to said impulses, and a central battery for supplying current for talking purposes to the talking circuit.

50. In a telephone system, a calling line, a called line, a link circuit for connecting the two over a talking circuit, an automatic progressively movable switch controlling said circuit and operated over the two sides of a portion of said circuit in series, an impulse sender associated with the calling line, an impulse repeater interposed between said line and said switch, said repeater individual to said link and responsive to impulses from said sender over two sides of a different portion of the talking circuit in series, said repeater controlling said switch in response to said impulses, a central battery for supplying current for talking purposes to the talking circuit, said repeater normally disconnected from the calling line.

Signed by me at Chicago, Cook county Illinois, this 2nd day of July, 1909.

TALBOT G. MARTIN.

Witnesses:

EDWARD D. FALES,
J. NORBY.